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Report of the Fifteenth Annual Forest Pest Control Forum
Government Conference Centre
Ottawa, Ontario
November 17-19, 1987

Rapport du quinzième colloque annuel sur la répression des ravageurs forestiers
Centre des conférences du Gouvernement
Ottawa (Ontario)
Du 17 au 19 novembre 1987

Canadian Forestry Service
Ottawa, Ontario
January, 1988

Service canadien des forêts
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The Forest Pest Control Forum is held under the aegis of the Canadian Forestry Service to provide the opportunity for representatives of provincial and federal governments and private agencies to review and discuss forest pest control operations in Canada and related research.

Le colloque sur la répression des ravageurs forestiers de déroule sous l'égide du Service canadien des forêts dans le but de donner l'opportunité aux représentants des gouvernements fédéral et provinciaux ainsi qu'aux organismes privés de passer en revue et de discuter les activités relatives à la répression des ravageurs forestiers, de même que la recherche connexe.

B.H. Moody
Canadian Forestry Service/Service canadien des forêts
Ottawa, Ontario/Ottawa (Ontario)
January, 1988/Janvier 1988

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RESEARCH, ENVIRONMENTAL MONITORING AND HEALTH CONCERNS/
PRÉOCCUPATIONS TOUCHANT LA RECHERCHE ET LE CONTROLE ET LA SAUTÉ
DE L'ENVIRONNEMENT

LIST OF ATTENDEES
LISTE DES PERSONNES PRÉSENTES

United States Forest Service
Peter W. Orr, Broomall, PA

Maine Forest Service
H. Trial, Augusta
Thomas Rumpf, Augusta

Newfoundland Department of Forest Resources and Lands
H. Crummey, St. John's

Nova Scotia Department of Lands and Forests
T.D. Smith, Truro

New Brunswick Department of Natural Resources
N.E. Carter, Fredericton

New Brunswick Department of the Environment
Wendy Sexsmith, Fredericton

Quebec Department of Energy and Resources
Pierre M. Marotte, Quebec
Michel Auger, Quebec
Louis Dorais, Quebec

Ontario Ministry of Natural Resources
J. Churcher, Maple

Department of Natural Resources Manitoba
G. Munro, Winnipeg (Chairperson)

Saskatchewan Department of Parks and Renewable Resources
M. Pandila, Prince Albert

Research and Productivity Council
Charles J. Wiesner, Fredericton

J.D. Irving Limited
B. Brunson, Saint John

Canadian Pulp and Paper Association
Jean-Pierre Martel, Montreal

University of Toronto
J.R. Carrow, Faculty of Forestry

Department of Fisheries & Oceans
Barry Hobden, Winnipeg

Environment Canada
Ian Nicholson, Commercial Chemicals Branch, Ottawa

Environmental Protection Service
Wayne Pierce, St. John's

Canadian Wildlife Service
N. Garrity, Fredericton
Peter A. Pearce, Fredricton
D.G. Busby, Fredericton

Agriculture Canada
D. Walter, Plant Health Division, Ottawa
H. Krehm, Plant Health Division, Ottawa
Al Schmidt, Plant Health Division, Ottawa

Canadian Forestry Service
G.A. Van Sickle, Victoria
H. Cerezke, Edmonton
L. Magasi, Fredericton
P.C. Nigam, Fredericton
D.G. Embree, Fredericton
E.G. Kettela, Fredericton (Chairperson)
A. Juneau, Ste. Foy
D. Lachance, Ste. Foy
G.M. Howse, Sault Ste. Marie
A. Retnakaran, Sault Ste. Marie
K. Frankenhuyzen, Sault Ste. Marie
B.V. Helson, Sault Ste. Marie
J.H. Meating, Sault Ste. Marie
T.J. Ennis, Sault Ste. Marie
E.T. Caldwell, Sault Ste. Marie (chairperson)
J.C. Mercier, Ottawa
J.A. Armstrong, Ottawa
E.S. Kondo, Ottawa (chairperson)
B.H. Moody (secretary)
Mike Power, PNFI
C.J. Sanders, Sault Ste. Marie
Malcolm Shrimpton, Ottawa
Gus Steneker, Ottawa
Jack H. Smyth, Sault Ste. Marie
John Hudak, St. John's
Les Carlson, Ottawa
Pritam Singh, Ottawa
Carl Winget, Ottawa
Peter Kingsbury, Sault Ste. Marie
John Cunningham, Sault Ste. Marie
Kevin Barber, Sault Ste. Marie
Doug Pitt, Sault Ste. Marie

NOTICE OF 1988 MEETING

The Sixteenth Annual Forest Pest Control Forum

will be held in

Gatineau Room, 4th Floor

Government Conference Centre

2 Rideau Street, Ottawa

November 15, 16, 17, 1988

(8:30 a.m. - 4:00 p.m.)

Avis de la réunion de 1988

Le seizième colloque annuel

sur la répression des ravageurs forestiers

aura lieu dans le

Salon Gatineau, 4er étage

Centre de conférences du Gouvernement

2, rue Rideau, Ottawa

du 15, 16, 17 novembre 1988

(de 8:30 h à 16:00 h)

FIFTEENTH ANNUAL FOREST PEST CONTROL FORUM/
QUINZIÈME COLLOQUE ANNUEL SUR LA RÉPRESSION DES RAVAGEURS FORESTIERS

SUSSEX ROOM, 1ST FLOOR
2 RIDEAU STREET, OTTAWA

NOVEMBER 17-19, 1987
8:30 AM - 5:00 PM

PROPOSED AGENDA/
ORDRE DU JOUR PROVISOIRE

1. **Welcome and Introductory Remarks/ Discours de bienvenue** — J.C. Mercier

2. **General Forest Pests Status and Pest Management/ Ravageurs forestiers et gestion: état de la situation en général**

2.1 Introductory Remarks/ Allocution d'ouverture — E.S. Kondo (Session Chairman)

Insects

2.2	Mountain Pine Beetle	B.C. Alberta	G.A. Van Sickle vice Miyagawa H. Cerezke
2.3	Jack Pine Budworm	Manitoba Saskatchewan Ontario	G. Munro, H. Cerezke M. Pandila J. Churcher G. Howse J. Meating
2.4	Gypsy Moth	Ontario B.C. N.B. U.S.	J. Churcher J. Meating G.A. Van Sickle L.P. Magasi P. Orr
2.6	Hemlock Looper	Newfoundland	H. Crummey J. Hudak
2.7	Others		

4.6 Ontario — G. Howse, J.J. Churcher, J. Meating

Outbreak Status 1987, Forecast 1988
Control Program 1987
Reports on Operations and Assessments
Prospects and Plans 1988

4.7 *Prairie* Provinces — G. Munro, C. Cerezke

Outbreak Status 1987
Prospects 1988

4.8 British Columbia — G.A. Van Sickle

Outbreak Status 1987
Prospects 1988

4.9 Report on Pheromone Trapping in Canada and USA — C. Sanders

4.10 Others

5. RESEARCH, ENVIRONMENTAL MONITORING AND HEALTH CONCERNS/ PRÉOCCUPATIONS TOUCHANT LA RECHERCHE ET LE CONTRÔLE ET LA SAUTÉ DE L'ENVIRONNEMENT

5.1	Introductory Remarks	E. Caldwell (Session Chairman)
5.2	Overview of FPMI Issues	George Green
5.3	Registration Update	W.D. Stewart
5.4	Highlights of Biorational Program	vice Ennis
5.5	Highlights of Chemical Program	Errol Caldwell
5.6	Status of Insecticide Research	Blair Helson Leo Cadogan
5.7	Status of Herbicide Research	Doug Pitt
5.8	Foliar deposits, canopy penetration and efficacy of neat vs. diluted applications of *B. t.* vs. gypsy moth	Kees van Frankenhuyzen (with Charles Wiesner)

6. **ISSUE DEBATE AND PREPARATION OF RECOMMENDATIONS/ DISCUSSION SUR LE SUJET ET PRÉPARATION DE RECOMMANDATIONS**

6.1 Introductory Remarks — G. Munro (Session Chairman)

6.2 *B.t.* contamination

6.3 FPCF Mandate

6.4 Others

7 **WORKSHOPS (November 19) / ATELIERS**

1) "Forest Protection - A Challenge for the Future" - FPMI video — E. Caldwell

2) The Use of Viruses and Improved Spray Atomization for control of pine beauty moth in Scotland - J. Cunningham

   plus "Frontiers of Insect Control" - 20 min. video

3) Others

FIDS Heads Meeting (closed session) November 19 and 20

Committee for Review and Improvement of Survey Assessment Techniques (November 16) - T. Smith (Chairman)

REMARKS

BY

JEAN CLAUDE MERCIER

ASSOCIATE DEPUTY MINISTER

CANADIAN FORESTRY SERVICE

TO THE

15TH ANNUAL FOREST PEST CONTROL FORUM

OTTAWA, NOVEMBER 17 - 19, 1987

On behalf of the Honourable Gerald Merrithew, Minister of State for Foresty and Mines, and the Canadian Forestry Service, I want to welcome you to the 15th Annual Pest Control Forum.

I attended last year's Forum, at which the Forum mandate was agreed upon by the membership and recommendations were made. The CFS has addressed some of these recommendations by the formation of the Forum Steering Committee which met yesterday and will be reporting to this Forum later on.

Also, to reflect the recommendations, I noticed that the agenda has been divided into four main half-day sections on operational pest control reports; pest distributions; research, environmental monitoring and health concerns; and issue debate and recommendations.

This Forum exemplifies federal-provincial cooperation. It provides you, the forest pest managers across the country with timely information essential to planning next year's forest pest operations. This Forum also furnishes you with the first opportunity to compare and to discuss this year's results and future operations with your colleagues.

For those of us in the Canadian Forestry Service, this Forum provides an opportunity to present our interim findings on forest pests in cooperation with provincial and other federal agencies.

It also provides an opportunity for federal and provincial researchers, including Dr. Green and his staff of our Forest Pest Management Institute, to present research results to forest managers and elicit immediate reaction. Here is an opportunity for you to express your concerns for research directly to the researchers. This dialogue ensures that research is clearly focussed on the needs of our clients.

I would like to take this opportunity to draw your attention to an important event that took place in early autumn this year and is relevant to your preoccupations.

At its annual meeting held in Grand Falls, Nfld., September 8-10, the Canadian Council of Forest Ministers (CCFM) adopted a National Forest Sector Strategy for Canada. The strategy made several recommendations, including recognition of pesticides as a legitimate and important tool for forest management, and supported a strong action to reduce damage to the forest by pollutants.

The recommendation reads as follows:

> "It is recommended that all elements of the forest sector recognize that pesticides are among the legitimate means for effective forest management in specific areas, that their use continue to be regulated; and:
>
> - Ensure that all pest management operations are ecologically and economically justified;
> - Encourage development and use of effective alternative methods of pest control, including integrated pest management;
> - Accelerate research into the environmental effects of pesticides; and
> - Ensure that the process for registration of pesticides for forest use is not cost-prohibitive and is open to public scrutiny."

Now that the Canadian Council of Forest Ministers has approved the National Forest Sector Strategy, I am certain we shall witness in the near future significant progress on technological issues related to our forest industry. That strategy presents a consensus arrived at by major players in the forest community about the future course of the sector's development.

In February 1988, another big step in dealing with technological issues in the forest sector will be taken when the council of forest ministers hosts the Forestry Research Forum on Innovation and Technology in the Forest Sector in Edmonton.

This Forestry Forum will clearly identify research priorities, indicate the strategic course to be followed and clarify the roles and responsibilities of all players and partners in the forest community.

It seems to me that this more focussed approach to science, technology and innovation in the forest community is very much like what you as pest managers and researchers have done to promote protection of the forests and to enhance our interests in the area of pest management.

For my part, I want to give you some sense of where we in the CFS are proceeding with our forest pest research. In the CFS Strategic Plan 1987-1997, the section on Forest Resource Protection states that the CFS will emphasize research on and develop an integrated approach to Forest Pest Management.

In the CFS Strategic Plan for Research, priority has been given to the major pests, the main one being the spruce budworm. Research will emphasize population dynamics, application of impact data, the development of a greater variety of budworm control techniques and determination of the long-term effects of these techniques on the environment.

Strong research programs will also be maintained on a number of other major forest pests that cause significant forest losses across Canada. These include the mountain pine beetle (in B.C., Alberta and Saskatchewan), stem and root rots, hemlock looper, sclerroderris canker, gypsy moth, balsam woolly aphid, wood borers, and a number of nursery pests. In most cases, research will be centred on fundamental studies of epidemiology and population dynamics, on the impact of pest, and on the development of integrated pest management systems that incorporate new biotechnological tools.

The recent emphasis on forest renewal and second growth stands means that increasing attention needs to be focussed on pests of plantations and intensively managed stands.

I note that a new pest problem, the pinewood nematode, is on your agenda for this meeting. European concern about importing the nematode from North America has led to non-tariff barriers on exports of pulp chips to Scandinavian countries. The risk of extension of these bans to softwood lumber for the European economic community threatens an export market approaching $400 million per year. The CFS is committing research funding approaching $500,000 in this year to collaborate with External Affairs and Agriculture Canada to counter this potential loss. Let me suggest that pest problems affecting exports through non-tariff barriers may be of increasing concern to us.

The Forest Insect and Disease Survey Strategic Plan was completed and approved by senior management committee during 1987. This document provides guidance for the development of the FIDS program over the next several years, and will clarify CFS and provincial roles in monitoring the health of Canada's forests.

Forest Insect and Disease Survey will continue its special responsibility, in cooperation with other federal and provincial agencies, for obtaining and reporting information on regional, national and international forest pest situations, forecasting, conducting related short-term research on such pests, and developing methodologies for pest survey activities. FIDS role in relation to forest pests quarantine will be better defined in the plan.

Now, I want to spend some moments discussing a new book on pest control which the CFS will be publishing. Dr. Jack Armstrong, whom you all know as a frequent participant at the Forum, is on special assignment to coordinate a sequel to "Aerial Control of Forest Insects" by Dr. M.L. Prebble. I am aware that many of you will be contributing authors. I also understand that Jack will be here later on to present an update on the book.

Reference will also be made to the decreasing availability of chemical insecticides and the general tightening of the regulations governing the registration and use of insecticides.

I think that those of you who have been asked to write articles for this book should feel honoured to contribute and I encourage you to work hard to meet the deadline set by Jack Armstrong.

Last year I mentioned our continued effort to develop and refine the technology of aerial application of pesticides by both small and large aircraft. However, research is costly and resources limited and, therefore, there was a need to review the state of the art and to clarify our future orientations. This was addressed at the recent NRC/CFS Symposium on the "Aerial Application of Pesticides in Forestry," held last month in Ottawa. The symposium attracted an impressive number of researchers and expertise from as far as the United Kingdom and New Zealand, and I hope that the session summaries will identify critical areas of research and development that will contribute significantly to improvements in our ability to apply pesticides more effectively, efficiently and safely.

Now, if I may, I would like to brief you on some of the recent and significant changes in the organization of the Canadian Forestry Service.

There will be two assistant deputy ministers along with the directors general of Finance and Administration and Communications reporting directly to me. The six regional directors general will be reporting to the ADM (Forestry Operations) which is currently being staffed. The directors of two National Forestry Research Institutes, the director general of the Forest Science Directorate (previously Forest Research and Technical Services), and three other CFS headquarters' directorates report to Dr. Jag Maini, ADM (Forest Policy). Finally, last year you agreed upon the role and mandate of the Forum and I am pleased to see that the agenda has reflected this. For instance, it was suggested that the use of herbicides in vegetation management in forestry be part of the forum. It is encouraging to see several papers on herbicides on this year's agenda.

I am pleased to note that representatives of forest agencies in the United States could be represented at the meeting. Our collaboration and information exchange with colleagues from the USA is of particular mutual benefit.

Finally, I want to thank you for giving me the opportunity to share a few moments with you on behalf of my minister and the CFS. The Forest Pest Control Forum is a valuable organization and I hope your deliberations will give it the greater recognition it deserves. I look forward to hearing the conclusions and recommendations of this year's Forum.

ALLOCUTION

DE

JEAN CLAUDE MERCIER
SOUS-MINISTRE ASSOCIÉ
SERVICE CANADIEN DES FORÊTS

À L'OCCASION DU
QUINZIÈME COLLOQUE ANNUEL SUR LA RÉPRESSION DES RAVAGEURS FORESTIERS

OTTAWA, DU 17 AU 19 NOVEMBRE 1987

Au nom de l'honorable Gerald Merrithew, ministre d'État aux Forêts et aux Mines, et du Service canadien des forêts, il me fait plaisir de vous souhaiter la bienvenue au quinzième colloque annuel sur la répression des ravageurs forestiers.

J'ai assisté au colloque de l'année dernière au cours duquel les membres ont approuvé le mandat et formulé des recommandations. Le Service canadien des forêts (SCF) a appliqué certaines de ces recommandations en créant le Comité directeur du colloque qui s'est réuni hier; un compte rendu de cette réunion nous sera présenté un peu plus tard au cours du présent colloque.

Également en ce qui a trait aux recommandations, j'ai remarqué que l'ordre du jour avait été divisé en quatre grandes séances d'une demi-journée portant sur les sujets suivants : rapports opérationnels sur la répression des ravageurs; répartition des ravageurs; préoccupations en matière de recherche, de surveillance environnementale et de santé; et discussion et recommandations.

Le présent colloque est un exemple de collaboration fédérale-provinciale. Il vous permet, vous les responsables de la lutte contre les ravageurs à l'échelle du pays, d'obtenir des renseignements utiles afin de planifier les opérations de lutte contre les ravageurs pour l'année qui vient. C'est également une occasion unique d'examiner avec vos collègues les résultats de l'année qui vient de se terminer et d'envisager les opérations à venir.

À ceux d'entre nous qui travaillent au Service canadien des forêts, cette réunion nous permet de présenter les résultats d'essais que nous avons obtenus en collaboration avec des organismes provinciaux et d'autres organismes fédéraux en ce qui concerne les ravageurs forestiers. Les chercheurs des gouvernements fédéral et provinciaux, incluant Monsieur Green et son personnel de l'Institut pour la répression des ravageurs forestiers, peuvent également présenter les résultats de leurs recherches aux gestionnaires des ressources forestières et obtenir une réaction immédiate. Vous pouvez donc faire part directement aux chercheurs de vos préoccupations en matière de recherche. Grâce à cet échange, nous sommes assurés que la recherche est nettement axée sur les besoins de nos clients.

Je voudrais profiter de l'occasion pour attirer votre attention sur un événement important qui s'est déroulé au début de l'automne dernier et qui a rapport à vos préoccupations.

Lors de sa réunion annuelle, tenue à Grand Falls (Terre-Neuve) du 8 au 10 septembre dernier, le Conseil canadien des ministres des forêts (CCMF) a adopté la "Stratégie nationale pour le secteur forestier canadien". Celle-ci comporte plusieurs recommandations, notamment la reconnaissance des *pesticides* comme des outils légitimes de la gestion des ressources forestières, et préconise une action énergique visant à réduire les dommages causés aux forêts par les polluants.

La recommandation se lit comme suit:

> "Il est recommandé que tous les intervenants du secteur forestier reconnaissent que les pesticides sont des outils légitimes de la gestion des ressources forestières dans certaines régions et que leur utilisation soit réglementée; et
>
> - qu'on s'assure que toutes les opérations de lutte contre les ravageurs soient justifiées du point de vue écologique et économique;
>
> - qu'on favorise la mise au point et l'utilisation de méthodes de remplacement pour lutter contre les ravageurs, y compris la gestion intégrée des ravageurs;
>
> - qu'on accélère la recherche portant sur les effets des pesticides sur l'environnement;
>
> - qu'on s'assure que le processus d'homologation des pesticides utilisés en foresterie ne soit pas exagérément coûteux et que le public ait accès aux dossiers."

Maintenant que le Conseil canadien des ministres des forêts a adopté la Stratégie nationale, je suis certain que nous pourrons constater, dans un proche avenir, des progrès importants au niveau de la technologie liée à notre industrie forestière. Cette stratégie représente l'opinion de la majorité des principaux intéressés de la communauté forestière concernant l'orientation future du développement de ce secteur.

En février 1988, une autre étape importante sera franchie dans le domaine de la technologie forestière lorsque le Conseil des ministres des forêts sera l'hôte à Edmonton du Colloque sur l'innovation et la technologie dans le secteur forestier. Ce colloque identifiera clairement les priorités en matière de recherche, indiquera la stratégie à suivre et établira clairement les rôles et les responsabilités de tous les intéressés et partenaires de la communauté forestière.

Il me semble que cette approche mieux définie à l'égard de la science, de la technologie et de l'innovation dans la communauté forestière ressemble beaucoup au travail que vous les chercheurs et les responsables de la lutte contre les ravageurs avez fait pour promouvoir la protection des forêts et nous intéresser davantage à la question de la répression des ravageurs.

En ce qui me concerne, je veux vous donner une idée de l'orientation des recherches sur les ravageurs forestiers au Service canadien des forêts. Dans le cadre du *Plan stratégique du SCF* pour 1987-1997, il est dit, dans la section sur la protection des ressources forestières, que les recherches porteront sur une approche intégrée de lutte contre les ravageurs forestiers et sa mise au point.

Selon le *Plan stratégique de recherche du SCF*, la priorité a été accordée aux principaux ravageurs, dont le plus important est la tordeuse des bourgeons de l'épinette. Les recherches porteront principalement sur la dynamique des populations, l'application des données d'impact et la mise au point d'une plus grande variété de méthodes de lutte contre la tordeuse, et la détermination des effets à long terme de ces techniques sur l'environnement.

Des programmes de recherche importants seront également maintenus sur plusieurs autres grands ravageurs forestiers responsables d'importantes pertes de ressources forestières au Canada. Ces ravageurs comprennent le dendroctone du pin ponderosa (en Colombie-Britannique, en Alberta et en Saskatchewan), les pourritures des tiges et des racines, l'arpenteuse de la pruche, le chancre scléroderrien, la spongieuse, le puceron lanigère du sapin, les perceurs du bois et plusieurs autres ravageurs des pépinières. Dans la plupart des cas, les recherches seront axées sur des études fondamentales dans le domaine de l'épidémiologie et de la dynamique des populations, sur les répercussions des ravageurs et sur la mise au point de systèmes intégrés de lutte contre les ravageurs qui font appel à de nouveaux moyens biotechnologiques.

L'accent récent qui a été mis sur la reconstitution des forêts et la régénération naturelle des peuplements signifie qu'il faut s'intéresser davantage aux ravageurs des plantations et des peuplements exploités intensivement.

Je remarque qu'un nouveau ravageur, le nématode du pin, figure à l'ordre du jour. L'inquiétude des Européens relativement à l'importation du nématode en provenance de l'Amérique du Nord a conduit à l'établissement de barrières non tarifaires s'appliquant aux exportations de copeaux à pâte vers les pays scandinaves. Le risque de voir ces interdictions étendues au bois d'oeuvre résineux pour les pays de la communauté économique européenne menace un marché d'exportation qui s'élève à presque 400 millions de dollars par année. Le Service canadien des forêts consacre cette année près de 500 000 $ à la recherche afin de trouver les moyens, de concert avec les Affaires extérieures et Agriculture Canada, d'éviter une telle perte. Permettez-moi de vous dire que le problème des ravageurs touchant les exportations par le biais de barrières non tarifaires peut être une source grandissante de préoccupations pour nous.

Le *Plan stratégique du Relevé des insectes et des maladies des arbres* a été achevé et approuvé par le Comité supérieur de gestion en 1987. Ce document contient des lignes directrices en vue de l'élaboration du programme du Relevé des insectes et des maladies des arbres, ou RIMA, pour les prochaines années, et établira plus clairement le rôle du Service canadien des forêts et du gouvernement provincial dans le domaine de la surveillance de la santé des forêts au Canada.

En collaboration avec d'autres organismes fédéraux et provinciaux, les responsables du RIMA continueront leur travail particulier de collecte et de diffusion de données sur la situation régionale, nationale et internationale des ravageurs forestiers, de prévision, de réalisation de recherches connexes de courte durée sur ces ravageurs et de mise au point de méthodes en vue du relevé des ravageurs. Le rôle du RIMA relativement à la question de la quarantaine pour les ravageurs forestiers sera beaucoup mieux défini dans le plan.

J'aimerais maintenant vous entretenir d'un nouveau livre portant sur la lutte contre les ravageurs qui sera publié bientôt par le Service canadien des forêts. Monsieur Jack Armstrong, qui n'est pas un inconnu pour vous puisqu'il participe souvent au colloque, a comme mission spéciale de coordonner la suite de l'ouvrage de M.L. Prebble intitulé *Traitements aériens pour combattre les insectes forestiers au Canada*, travail auquel plusieurs d'entre vous participeront, m'a-t-on indiqué. À ce qu'il paraît, Monsieur Armstrong présentera une mise à jour du livre au cours du présent colloque.

Il sera également question de la disponibilité de moins en moins grande des insecticides chimiques et du renforcement général des règlements régissant l'homologation et l'utilisation des insecticides.

Je pense que ceux parmi vous qui ont été choisis pour participer à la rédaction de ce livre doivent en être honorés, et je vous incite à travailler sans relâche afin de respecter l'échéance fixée par Monsieur Armstrong.

L'année dernière, j'ai fait état de nos efforts soutenus pour mettre au point et perfectionner la technique de l'application aérienne des pesticides au moyen de petits et de gros aéronefs. Toutefois, les recherches sont coûteuses et les ressources limitées, et il était donc nécessaire de revoir l'état des connaissances et d'établir clairement nos orientations futures. Ces sujets ont été abordés lors du symposium du Conseil national de recherches et du Service canadien des forêts sur l'application aérienne des pesticides en foresterie, qui a eu lieu le mois dernier à Ottawa. Ce symposium a attiré un nombre impressionnant de chercheurs et de spécialistes venus d'aussi loin que le Royaume-Uni et la Nouvelle-Zélande. J'espère que les résumés des séances détermineront les domaines critiques de la recherche et du développement qui permettront d'accroître considérablement l'efficacité et la sécurité de l'application des pesticides.

Maintenant, si vous me le permettez, j'aimerais vous indiquer rapidement quelques grandes modifications apportées récemment à l'organisation du Service canadien des forêts.

Deux sous-ministres adjoints ainsi que le directeur général des Finances et de l'Administration et le directeur général des Communications relèveront directement de moi. Les six directeurs généraux régionaux relèveront du sous-ministre adjoint (Opérations forestières) qui sera nommé sous peu. Les directeurs des deux instituts nationaux de recherche forestière, le directeur général de la Direction générale des sciences forestières (autrefois la Direction générale de la recherche et des services techniques) et trois autres directions de l'Administration centrale du Service canadien des forêts relèvent de Monsieur Jag Maini, sous-ministre adjoint (Politique forestière). Finalement, l'année dernière vous vous êtes entendu sur le rôle et le mandat du colloque, et je suis heureux de voir que l'ordre du jour en est le reflet. Par exemple, il a été proposé que l'utilisation des herbicides dans le domaine de l'exploitation des végétaux dans le secteur forestier figure parmi les sujets traités au colloque. Il est encourageant de voir que plusieurs exposés sur les herbicides sont à l'ordre du jour.

Il me fait plaisir de constater que des représentants des organismes forestiers des États-Unis ont pu assister à la réunion. Notre collaboration et l'échange d'information avec des collègues des États-Unis est d'un intérêt mutuel spécial. En terminant, je vous remercie de m'avoir permis de partager quelques moments avec vous au nom du Ministre et du Service canadien des forêts. Le colloque sur la répression des ravageurs forestiers est une tribune d'un grand intérêt et j'espère que par vos débats il recevra toute la considération qu'il mérite. J'attends avec impatience vos conclusions et vos recommandations.

PACIFIC REGION - 1987

STATUS OF IMPORTANT FOREST PESTS

AND EXPERIMENTAL CONTROL PROJECTS

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SUMMARY OF IMPORTANT PESTS

The following have been selected as the pests most likely to be of interest to participants. Equally significant in terms of losses are several forest diseases such as root rots, dwarf mistletoes, stem decays, rusts and cankers. However, once established, these are perennial and fluctuate little from year to year and annual surveys are neither practical or necessary; controls for such diseases are more practical as preventative treatments, combined with stand management practices during the harvest-regeneration phase or juvenile stand tending. Also not included are impacts such as nursery and regeneration losses; quarantine matters; aesthetics; increased fire hazards; or earlier losses from white pine blister rust.

For more detailed information of these and other pests active in the Pacific Region in 1987, the reader is referred to "Forest Pest Conditions in British Columbia and Yukon" by CFS-FIDS, published annually by P.F.C., Victoria, B.C.

Mountain Pine Beetle

The beetle continues to be the most damaging forest insect in British Columbia. The area and volume of lodgepole pine and some western white pine killed by the beetle declined for the third consecutive year by about 30% overall, to the lowest level in 7 years. However, more than 8 900 active infestations still cover more than 67 500 ha from the International border to northeast of Prince Rupert. This is almost double the area burned by forest fires in B.C. in 1987 (35 650 ha) and the volume lost is about 12% of the lodgepole pine harvested in British Columbia in 1985. Unsalvageable lodgepole pine killed by the beetle in 1985 and earlier are a legacy over 1.86 million ha and 75 000 ha in the Cariboo and Kamloops regions, respectively.

Beetle populations were almost eliminated by below normal temperatures in the Cariboo Region in late 1984 and early 1985. A new infestation, however, developed this year in mature pine over 500 ha near Frankly Arm on Chilko Lake near the coast mountain range. Elsewhere, active infestations slowed but continued in three forest regions, and increased slightly in the Prince Rupert and Prince George regions. Areas containing recently killed mature pine mapped during 1987 aerial surveys, were: Kamloops Region 19 000 ha, down 60% from 1986; Nelson Region 23 000 ha, down 18%; down twofold in the Vancouver Region to 1 470 ha; up 25% in the Prince Rupert Region to 18 600 ha and up fourfold in the Prince George Region to 4 850 ha.

Infestations along the B.C.-Alberta border and in Glacier and Yoho National Parks declined for the second consecutive year but increased again in Kootenay National park. Mature lodgepole pine at Copper Creek killed by 1986 beetle attack, contain broods which could pose a threat to mature stands along the eastern boundary of Manning Provincial Park where a successful interagency control program had been completed. Cooperative aerial and ground surveys in Mt. Robson Provincial Park and west of Jasper National Park located only about 5 beetle-attacked trees which were then felled and burned.

A mild 1986-87 winter and hot, dry 1987 summer resulted in increased numbers of new attacks on mature lodgepole pine in 43 stands cruised in five forest regions. These ranged from an average of 7% in the Kamloops Region to 42% in the Prince Rupert Region with a province wide average of 24%, up from 11% in 1986. Current attacks exceeded the 1986 levels in all regions, except the

Cariboo, and included the eastern part of the Prince Rupert Region; the northwestern part of the Prince George Region; the East Kootenay in the Nelson Region, and east of the Okanagan Valley in the Kamloops Region. Throughout most of the Cariboo Region, current attack by mountain pine beetle was evident only in single trees at widely scattered locations and does not pose an immediate threat. However, secondary bark beetles, particularly Ips spp., and to a lesser degree, Dendroctonus murrayanae were very common for the second consecutive year in the western part of the Cariboo region, southwest of Prince George and at widespread locations in the Nelson and Prince Rupert regions. Pine engraver beetles attacked an average of 36% of the trees tallied adjacent to eight recently harvested stands in the Cariboo Region.

Salvage of beetle-killed and adjacent susceptible pine continued at double the AAC in some Timber Supply Areas. Recent changes in regulations and reduced availability of economically accessible beetle-killed pine may result in reduced AAC in the near future.

Spruce Beetle

The overall decline in area and volume of mature white and Engelmann spruce killed by the beetle in B.C. continued for the fifth consecutive year. Salvage and sanitation contributed to the decline, and host depletion and natural factors, including below normal temperatures, resulted in significant brood mortality. Most of the 3 000 ha of infested spruce mapped in aerial surveys was in 63 separate infestations, of which 33 were in the Kamloops (up slightly from 1986) and 23 in the Prince George regions. Infestations in the Prince Rupert Region declined to single, scattered trees from 940 ha in 1986.

Twenty, very light strip attacked mature spruce were infested in pockets along the Haines Road in the Prince Rupert Region north of the B.C.-Alaska border. New road construction in the area since 1983 predisposed the mature spruce to attack. Cooperative programs, however, have removed or felled and peeled infested trees and significantly reduced the potential for continuing tree mortality.

Budworms

More than 834 000 ha of mixed age-class Douglas-fir in four forest regions were defoliated by western budworm, more than double the area affected in 1986. Defoliation was light on 76% of the area, with 22% moderate and 2% severe. There were more than 1 060 separate areas of infestation.

Areas of expansion included the eastern part of the Cariboo Region, the Clearwater, Wells Gray Park, Adams Lake and Vernon areas in the Kamloops Region and near Pemberton in the Vancouver Region. Populations again increased in the southern part of the Cariboo Region where early larval stages had been significantly reduced by colder than normal temperatures in the late spring of 1986. The small area of defoliation in the Nelson Region declined by half.

Parasitism of early and late instar larvae occurred at all 28 sites sampled, mostly in the Kamloops Region, and averaged 18% (range 6-79%), up 10% from 1986, but still too low to effectively reduce populations.

Numbers of egg masses at 67 infested stands in 4 regions forecast severe defoliation at 61% of the sites in 1988, moderate at 27% and light at the remainder.

Tree mortality and growth loss is variable. In 65 plots of open growing regeneration Douglas-fir, moderately defoliated for about 4 successive years, tree mortality averaged 3% (range 0 to 33%) and much of the remainder are severely defoliated. Greater damage exists where regeneration is overtopped by older trees. In three stands near Cache Creek where the budworm infestation declined in 1985, mortality of mature Douglas-fir ranged from 4 to 35% after 7 successive years of severe defoliation. Mortality of the overtopped regeneration is high. Diameter increment in mature trees declined 1 or 2 years after the first defoliation in 1979, and has been almost nil since 1982.

A second year experimental aerial spray applied Bacillus thuringiensis over about 200 ha of budworm infested Douglas-fir at Paul Lake Provincial Park near Kamloops. An additional 700 ha of immature Douglas-fir in 11 nearby blocks were sprayed. Populations were reduced by up to 97% (avg. 68%) in 6 plots, but not in the other 5 plots.

To improve and calibrate western budworm detection methods, numbers of mid- to late instar budworm larvae and of adult males caught in 70 pheromone-baited non-sticky traps were monitored in 4 regions at 14 sites with low populations but a history of budworm outbreaks. Up to 33 larvae per tree were collected per 1 m^2 beating sheet (3 branches on 25 trees) and up to 1100 male adults per trap. Further analysis and additional sampling is necessary before numbers can be correlated with population potential and damage.

Defoliation of alpine fir and spruce forests by two-year cycle budworm was mostly light over 59 750 ha in 243 infestations in 4 forest regions. Mature two-year 'off-year' cycle larvae defoliated high elevation stands over 11 500 ha in the Nelson Region. Early instar 'on-year' cycle budworm larvae defoliated the remaining areas: 17 000 ha in the Kamloops Region; 11 250 ha in the Cariboo region and 20 000 ha in the Prince George Region. Immature 'on-year' cycle larvae were forecast to be numerous this year based on 1986 egg samples, however, significant discoloration was not expected until 1988 when they mature. A mild 1986-87 winter and warm spring probably contributed to increased larval survival and an increase in bud feeding and defoliation intensity. Egg samples at two sites in the Nelson Region indicate moderate to high numbers of these immature 'off-year' cycle budworm larvae in 1988.

Current foliage of alpine fir and white spruce were lightly to moderately defoliated by one-year cycle eastern spruce budworm over 59 400 ha north and west of Fort Nelson. In 1986, the first year of major expansion since the mid-1970's, stands over nearly 95 000 ha were moderately defoliated. Defoliation extended into the Northwest and Yukon Territories for the second consecutive year. A factor which influenced the apparent decrease in area was severe unseasonal rainstorms. These delayed aerial surveys by a month and washed off evidence of light budworm defoliation and reduced the accuracy of the aerial detection. Larvae and adult male populations were also monitored at 16 locations in three regions to improve and calibrate methods to detect budworms in fir-spruce forests. Up to 300 males were collected. Further study is necessary before numbers can be correlated with populations damage and potential.

Blackheaded Budworm and Hemlock Sawfly

In the third consecutive year of outbreak blackheaded budworm and sawfly larvae defoliated mature and some immature western hemlock over 15 600 ha on the Queen Charlotte Islands, but populations declined near Kitimat. Defoliation was classified severe for 13% of the area, moderate for 47% and light for 25%; with 15% dead following successive years of severe defoliation. This compares with 12% severe, 57% moderate and 31% light defoliation over 44 300 ha in 1986.

Populations increased slightly in the interior wet belt and the lower mainland following a decline in 1986. In Wells Gray Provincial Park in the Kamloops Region mature western hemlock over 1 100 ha in 5 separate pockets were lightly defoliated and near Holberg on northern Vancouver Island hemlock on about 5 ha were very lightly defoliated. New foliage of white spruce and alpine fir was very lightly defoliated at 20 locations in the eastern part of the Prince Rupert Region over 150 ha where budworm populations have been common at fluctuating levels since 1982 with light defoliation over 150 ha.

Decreased defoliation of western hemlock stands on the Queen Charlotte Islands in 1988 is forecast to be severe at 1 location, moderate at 3, trace or light at 24 and none at the remainder. This is based on the number of eggs per 10 m^2 of hemlock foliage from each of 35 sample sites. Defoliation is not expected near Kitimat. Light defoliation of hemlock is forecast near Holberg on Vancouver Island and light to moderate defoliation on spruce is forecast at 7 locations in the eastern part of the Prince Rupert Region.

Budworm larval parasitism at Honna Valley on the Queen Charlotte Islands averaged 6%, too low to independently reduce the population to non-damaging levels.

The numbers of Neodiprion tsugae cocoons on the hemlock branch samples indicates continuing populations in 1988 at 10 of 27 sample sites, mostly on Graham Island. Sawfly prepupal mortality was highly variable, averaging 53% (range 8-88%) at the 27 sites sampled. Infection by Entomophthora was detected at a single location only, indicating continued sawfly populations in 1988. Viral infection averaged 14% and parasitism averaged 37%.

Douglas-fir Tussock Moth

The number of male adults in pheromone-baited sticky traps increased for a second consecutive year in Douglas-fir stands in the Kamloops and Nelson regions. No larvae were collected at permanent sampling sites or elsewhere in previously defoliated stands in either region. The previous tussock moth infestation collapsed in 1984.

About 387 adult males were trapped in 45 of 120 traps at 12 of 20 sites in 2 regions. This is a significant increase over 1986 when 75 moths were taken in 25 of the traps. This indicates some defoliation may occur in 1988 and possibly an outbreak starting in 1989.

Larch Defoliators

Larch casebearer populations in western larch stands in southeastern B.C. declined for the third consecutive year. Isolated pockets of moderate defoliation of larch occurred in the West Kootenay but elsewhere in the host range populations were generally at endemic levels. Defoliation at 16 of 26 long term study sites in the Nelson Region averaged less than 10%, restricted largely to the lower third of the crowns; at the remainder there was no defoliation.

Prepupal parasitism averaged 18.1% (range 3-38%) at 21 of 25 sample sites; there were no pupae at four sites. A native chalcid, Spilochalcis albifrons and an introduced parasite Chrysocharis laricinellae were most common, but Agathis pumila occurred only in very low numbers. About 331 male and female adult parasites, Chrysocharis laricinellae and Agathis pumila from Europe were released in three infested stands in the Nelson Region as part of a biological control program continued by CFS-FIDS since 1966.

Larval population assessments at 20 sites in the Nelson and Kamloops regions predict severe defoliation at 5%, moderate at 20% and light or negligible defoliation at the remainder; a slight increase from 1987. Benefits of the releases were evident over a ten-year period with the reduction of larval populations and increased parasitism.

An average of 5 male adults were attracted to each of 5 pheromone-baited sticky traps in 4 stands beyond the known limits of casebearer populations in the East Kootenay. None were found in traps in 6 stands beyond known population limits in the West Kootenay and east of the Okanagan Valley.

Only endemic larch budmoth populations with no visible larval feeding damage occurred in widely separated pockets of western larch in the western part of the host range in the Kamloops and Nelson regions, following a population collapse in 1986.

Numerous small pockets of tamarack in the northern part of the Prince Rupert Region south of the Yukon border were moderately defoliated by increased larch sawfly populations.

Black Army Cutworm

Conifer seedlings and herbaceous ground cover were severely defoliated and planting programs delayed by greatly increased cutworm populations in newly infested areas of two-year old burns in the Nelson Region and to a lesser extent in the Kamloops Region. Populations declined significantly in previously infested areas in the Cariboo, Prince George and Prince Rupert regions.

Parasitism of cutworm larvae and pupae in 1986 contributed to the decline along with predation by voles and birds. Larval/pupal parasitism in new infestations in the Nelson Region averaged 2.3%, too low to reduce populations in 1988, while parasitism approached 50% in the Kamloops Region. Continuing populations are forecast for parts of the Nelson and Kamloops regions, but should remain low elsewhere. This is based on 230 sticky and 4 multipher traps baited with experimental pheromones which attracted up to 64 male moths per trap at 43 sites in 4 regions. An additional 93 traps (57 sticky, 36 multipher) set out by BCFS near Clearwater in the Kamloops Region attracted up to 45 adults per trap (avg. 11). Cutworms could pose a threat to 1988 plantings where slash burning occurred in 1986 in parts of the interior from the East Kootenay to the Bulkley District in the Prince Rupert Region.

Building on earlier work by R. Shepherd in cooperation with FIDS, a 3-year contract to develop a predictive warning system linking moth catches in pheromone traps with subsequent defoliation and including a seedling and vegetation damage index was started this year.

Populations of a variegated cutworm, Peridroma saucia which occurred for the first time in high numbers in 1986 in the eastern part of the Cariboo Region was, as predicted, not present on the site in 1987. Some spruce seedlings and ground cover over part of the plantation had been severely defoliated. Over-wintering mortality of pupae was 77%; 64% died during the winter; predation killed 11% and 2% were parasitized. Pheromone-baited sticky traps at two recently burned sites nearby attracted an average of 1 and 5 moths, probably too few to sustain a potentially damaging larval population.

Pinewood Nematode

During 1987, 439 woodborer collections, mostly from log decks, were extracted for nematodes. Included were 17 species of cerambycids, 8 species of buprestids and 5 of siricids. The most frequent collection was 246 Monochamus scutellatus of which 12% contained some species of nematodes. Identification of the nematodes is still in progress and many different genera and species which are normal insect or bacterial associates were recovered. Other woodborers, some with nematodes associated, included M. maculosus (18%), Buprestis rusticorum (16%) and B. nutallii (23%). Less frequently collected were M. notatus, Xylotrechus undulatus and Dicera tenebrosa. About equal numbers of male and female borers were collected. Large numbers (tens of thousands) of nematodes were commonly extracted from the infected Buprestis spp. while much smaller numbers were associated with the Monochamus (usually less than 50 with only 3 specimens exceeding 300). In most cases, the extracted nematodes were free living bacterial feeders in the Tylenchidae or Rhabdidae and occasionally Aphelenchidae. Only two M. maculosus contained Bursaphelenchus; one from near Wasa Lake had B. xylophilus, m form while a sample near Kamloops had B. sp. Cultures are being maintained.

From 210 extractions of wood from symptomatic trees, various species of nematodes occurred in 27%. Lodgepole pine was most frequently sampled followed by western white pine, ponderosa pine and Scots pine. Numbers of nematodes extracted were generally low with only 12 samples greater than 150. Most appear to be common bacterial or insect associates. Only previously damaged or predisposed trees at 12 of the locations (8%) sampled in 1987 contained B. xylophilus in small numbers. Individual, recently or almost dead, fire damaged or secondary beetle-attacked lodgepole near Creston and Marysville in the Nelson Region, Prince George and Vanderhoof contained "m" form B. xylophilus. The "r" form was found in single pines near Boston Bar and Cassiar and in a Douglas-fir near Skookumchuck, with both forms in a lodgepole pine near Brisco. Only males were recovered near Smithers and Lower Post. The "m" form was also found in a recently dead western white pine in D'Arcy, in dying branches of Scots pine at Smithers and was again recovered from the dead standing lodgepole pine near Houston first sampled in 1986. With about 500 trees and 500 potential vectors sampled since 1985 throughout B.C. and the Yukon, the PWN is not a conspicuous or damaging forest problem.

During June and July, 1987 barrier and sticky traps were placed adjacent to large wood chip piles at Crofton and Prince George to determine if any potential PWN vectors frequented the yards. Traps were serviced regularly. Wood borers were neither observed nor trapped. The most commonly trapped insects were only leaf beetles (Altica tombacina) and weevils of herbaceous vegetation.

Gypsy Moth

About 7500 traps were monitored throughout the province in the twelfth year of the cooperative program with Agriculture Canada (Plant Health), B.C. Ministry of Forests and CFS-FIDS. About 216 adult male gypsy moth adults were trapped this year in British Columbia in 56 pheromone sticky traps in 8 areas. This compares with 24 moths in 19 sticky traps in 8 areas in 1986.

Males were caught for the second consecutive year, with 194 at Kelowna, (up from 7 in 1986) and 5 at Belmont Park near CFB Esquimalt, (up from 3). New catches were at Qualicum Beach (1) and Parksville (12) on Vancouver Island and at Tsawwassen (3) near Vancouver. New egg masses were found at Kelowna (19), Belmont Park (6) and 3 at Parksville in addition to 25 old masses. No adults were trapped at CFB Chilliwack following three years of positive trapping and four applications of B. thuringiensis in 1987.

No adults were found in 282 traps set out by CFS-FIDS in 233 forested recreation areas in national and provincial parks, commercial campgrounds and near military bases and north coastal ports.

Balsam Woolly Aphid

For the first time the aphid was discovered substantially beyond the 1976 regulation and infestation zones. About 80 km north of the zone's boundary, mature amabilis fir were infested in a 150 ha natural stand on West Thurlow Island in Johnstone Strait. About 30% of the amabilis fir, which comprises 10% of the mixed conifer stands, has been killed by aphids over several years.

Limited aerial surveys and ground checks of an additional 60 amabilis and grand fir stands within and outside the zones found only very light active aphid populations and only within the quarantine zone.

Mortality of mature amabilis fir, attributable to aphid attack, averaged 14.5% (range 0-95%) in or near 10 plots established by CFS in 1966 and 1970 near Vancouver and Victoria.

Cone and Seed Pests

Cone crops were generally light to occasionally heavy in interior forests, but rare in coastal areas. Cone and seed pests were at the highest levels in recent years due in part to favorable overwintering conditions. Western spruce budworm, at epidemic levels over more than 830 000 ha, also contributed to a high incidence of damage in at least two seed orchards. A Douglas-fir coneworm destroyed most cones and some new shoots in two 100 ha Douglas-fir stands in the Cariboo Region. Douglas-fir cone moth infested up to 85% of the cones (avg. 28%) at 34 sites in 4 regions, although most of the damage occurred in the Kamloops Region and the eastern part of the Nelson Region. Spruce cone maggot infested up to 80% of white and Engelmann spruce cones at 12 sites mainly in the Prince Rupert and Prince George regions. A spruce seed moth infested up to 70% of the white spruce cones in northern regions and up to 85% of the Engelmann spruce near Creston in the Nelson Region.

Ten coastal and two interior seed orchards were surveyed in 1987. For the second consecutive year Cooley spruce gall aphid severely infested Douglas-fir in five coastal seed orchards and up to 25% of the Sitka spruce in four orchards. Balsam woolly aphid lightly infested twigs of up to 35% of the amabilis fir in three orchards near Victoria and another near Nanaimo; all are within the infestation and regulation zones. A previously undescribed gall midge infested up to 40% of the cones on 1 to 15% of the yellow cedar stock in three seed orchards on Southern Vancouver Island. Western red cedar midge damaged up to 40% of the cones in two orchards. Control actions, using Dimethoate, were implemented in most coastal seed orchards against moderate to high populations of Douglas-fir cone gall midge (90% cones infested), Douglas-fir conemoth (45%) and fir coneworm (55%). Ground and aerial applications of Sevin and B.t. were made in one interior seed orchard against high numbers of western spruce budworm.

Experimental Control Projects

Bark Beetles

Most control actions against bark beetles involve rescheduling of harvest, salvage, single tree cut and burn, trap tree programs, pheromone baiting, hazard rating systems and additional access road construction. About 1/4 of the 150 field plots established in B.C. as part of a joint USA-Canada study for evaluating hazard rating systems against the mountain pine beetle have been re-examined for final mortality following the decline of infestations in the central Interior region. About 2/3 of the increment core samples required for this study have been analyzed. A preliminary analysis of part of the data base is planned for 1988-89.

A new study was initiated to evaluate the impact of outbreaks by the mountain pine beetle on the structure and dynamics of lodgepole pine stands. Also, field data had been collected to evaluate the reliability of predicting mountain pine beetle population trend based on late spring sampling of brood.

A joint experiment with Phero Tech Ltd., Vancouver, B.C., to evaluate the effects of a repellent bait containing verbanone on dispersal and attack behaviour of the mountain pine beetle gave inconclusive results.

Spruce Weevil

A search is being conducted in Europe for parasitoids and predators of *Pissodes* spp. that may be suitable for establishment on *P. strobi*. There are 8 species of *Pissodes* in Europe, 4 on pine, 3 on spruce and 1 on fir. All but one species, *P. validirostris* which attacks pine cones, typically attack dead or severely weakened trees. *Pissodes strobi* being somewhat atypical of the genus attacks leaders and no equivalent exists in Europe. *Pissodes notatus* was chosen for collection in Europe because its phenology closely parallels that of *P. strobi*, but while adults feed on leaders, oviposition occurs along most of the length of the trunk. Young pines are susceptible to attack if already weakened; older trees are also attacked. Unfortunately little *P. notatus* attack was found whereas attack by *P. validirostris* was common. Accordingly, a collection of Scots pine cones attacked by *P. validirostris* was shipped to Ottawa. The emerged parasitoids (there were no predators) were then tested at Pacific Forestry Centre in laboratory cages for acceptance of *P. strobi*. Not all parasitoids were tested since European documentation showed some to have undesirable properties for a biological control agent. Two braconids readily oviposited in Sitka spruce leaders attacked by *P. strobi* and progeny of both parasitoids were successfully reared to adults. No success was obtained with very few ichneumonid specimens also tested. However, the ichneumonid may well prove to be specific to *P. validirostris*. Further cage testing is planned with these parasitoids as more material is gathered in Europe.

Winter Moth

Defoliation of deciduous trees and shrubs in the Greater Victoria area by significantly reduced winter moth populations, was very light and scattered for the third consecutive year. Parasitism by Cyzenis albicans and Agrypon flaveolatum is being evaluated; initial assessments indicate about 60% overall parasitism by the two species.

Western Spruce Budworm

Due to the early spring and budworm development a joint PFC-FPMI-BCFS, trial of B.t. was postponed until 1988.

Regeneration Pests

Sirococcus blight, caused by the fungus Sirococcus strobilinus, is a seed-borne disease of container-grown spruce (Picea spp.) in British Columbia. Currently, management of the disease consists of detecting infested seedlots prior to sowing and then alerting nursery staff so that fungicides can be applied promptly if the disease appears. The main disadvantage is that the disease may become well established before it is noticed and secondly, even with early detection, several fungicide applications may be needed. Attempts to eliminate diseased seeds by repeated cleaning of infested seedlots have been unsuccessful. Thermotherapy, i.e. treatment with hot water, was tested as a control.

Experiments in 1986 showed the optimum combination of hot water temperature and exposure period for eliminating S. strobilinus from pre-soaked, unstratified spruce seeds was 47C for 30 minutes. However, when tested in a container nursery, this temperature/time combination caused a statistically significant decrease in germination percentages as compared with the controls. Heat treated seeds also required more days to reach 50% germination. These results show that thermotherapy with hot water is not a practical method for sanitizing infested seedlots.

Because of the impracticality of thermotherapy for Sirococcus control in spruce seedlots, three fungicides were tested in 1987 on seeds or young germinants. Two, Bayleton (triadimefon) 50WP and Tilt (propiconazole) 250E, are effective against S. strobilinus on pine in forest nurseries in the USA. The third fungicide, Daconil 2787F (chlorothalonil), is the pesticide currently used in B.C. nurseries for Sirococcus blight control. Fungicides were applied to stratified spruce seeds: 1) in the pre-soak water before stratification, 2) at sowing, 3) at 50% seedling emergence, 4) at 100% seedling emergence, or 5) at 50 and 100% seedling emergence. The trial will be summarized in November, 1987 when seedling growth measurements are made. Results to date indicate that all three fungicides reduced, but did not completely eliminate, S. strobilinus.

Ferbam fungicide has been tested for control of Inland spruce cone rust (Chryomyxa pirolata) on white spruce seed orchard trees near Salmon Arm, B.C. Two applications of ferbam applied at pollination reduced cone losses from as high as 60% to less than 3% (Can. J. For. Res. 16:360-362). Seed yield and germination were not appreciably affected by the fungicide. Recently, as the result of this research, ferbam has been registered for use against spruce cone rust.

Six fungicides were tested for efficacy against gray mould, Botrytis cinerea, on container-grown seedlings of white spruce, western red cedar, western hemlock, Sitka spruce and Douglas-fir. Phytotoxicity of the fungicides to the seedlings was also determined. Beginning in the 14th week after germinant emergence, the fungicides were applied bi-weekly for the next 2 months. To ensure that adequate inoculum of the pathogen was present, the seedlings were inoculated with a mixture of 10 isolates of B. cinerea after the first fungicide application, and on alternate weeks thereafter for a total of six inoculations. Growth of all species except Douglas-fir was very slightly inhibited by one or more of the fungicides. Iprodione gave excellent Botrytis control on all seedling species. Anilazine gave adequate control on all species except Douglas-fir and western red cedar, and some needle browning was observed on both spruce species. Control on western red cedar was excellent with thiram, and good on all other species except western hemlock. Folpet gave good control on Douglas-fir and Sitka spruce. Disease control on western hemlock and white spruce was excellent with dichloran. Caption provided good gray mould control on Douglas-fir. In vitro tolerance tests showed that all 10 of the B. cinerea isolates used in the experiment were sensitive to iprodione, dichloran and to caption at the 2 X dosage. All isolates were tolerant to anilazine and most were tolerant to thiram, folpet and to caption at the 0.5 X and 1 X dosage.

Pinewood Nematode

Greenhouse inoculation trials with 1 to 3 year old seedlings are in progress to determine the host range of PWN on Canadian conifers and the susceptibility of Finnish provenances of lodgepole pine and Scots pine. To date more than 2500 inoculations have been made using 9 PWN isolates including a B.C. m form, Ontario and N.B. r forms, 2 Quebec m forms, an Alberta r form and a French and U.S.A. isolate. In preliminary results Canadian isolates have infected and killed small numbers of pL, wP, AP, and JP with classic pine wilt symptoms. Black, white and engelmann spruces, DF, bF and wH remain healthy. Scots pine and 4 provenances of pL from northern B.C. of interest to Finland have been shown susceptible to most isolates tested. Cross inoculation of major hosts with m and r forms of PWN have been made to compare their pathogenicities. Production of tannin and phenol is being evaluated as a possible measure of resistance. Wood chip and soil transmission studies have not yet commenced.

G.A. Van Sickle
November 10, 1987

Date: November 9, 1987

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1987 PEST CONTROL FORUM

B.C. Forest Service Report

Pest management programs in British Columbia have addressed specific insect and disease issues, as well as general training needs, information systems development, and incorporation of pest-related data into the forest planning process.

Entomology

Bark beetles remain a major forest insect problem in five of the six Forest Regions of the Province. Mountain pine beetle, *Dendroctonus ponderosae*, remains the primary problem; spruce beetle, *D. rufipennis*, remains at low levels in most areas of the Province. Outbreaks of balsam bark beetle, *Dryocoetes* sp, continue in some areas although no special management efforts are being allocated at this time. *Ips pini* has been causing damage in some regions. These spot outbreaks are commonly in areas where pine beetle has declined and are likely the result of salvage and sanitation harvesting efforts. Cultural practices are expected to reduce losses to *Ips* in the near future. Current outbreak status of these pests is indicated by the presentation of the Forest Insect and Disease Survey unit of the Canadian Forestry Service at Pacific Forestry Centre.

The 1987/88 fiscal year is the fourth year of a bark beetle management program. Approximately $9.6 million were allocated this year to continue activities which include: 1:10,000 aerial photographic surveys; detailed aerial and ground detection and delineation surveys; directed sanitation harvesting; single tree treatment projects, access construction; and use of aggregating semi-chemicals to enhance the efficiency of operations. This program has proven successful in reducing the spread of targetted infestations and has been very successful in mopping up residual populations remaining after major treatment programs and climate-induced infestation reductions.

Large amounts of susceptible host remain, even in areas where infestations have apparently collapsed. Therefore, detection and management programs will be continued.

Western Spruce Budworm, *Choristoneura occidentalis*, continues to cause defoliation throughout most of the dry-belt Douglas-fir stands in the Kamloops Forest Region. Neighbouring regions are also affected to various degrees.

Prepared by: P.M. Hall and J.A. Muir, B.C. Forest Service, Protection Branch
Presented by: A. VanSickle, Canadian Forestry Service

A program was implemented in 1987 to quantify losses in dry-belt stands affected by budworm and to establish the feasibility of using B.t. to protect valuable understory.

Thirty-two permanent sample plots were established in 1987 in high value managed (faller's selection, partial cut regime) and natural stands. One half of these plots were incorporated into 11 spray blocks and subsequently treated with B.t. at a rate of 30 BIU per hectare. Mensurational and insect impact parameters were measured in all plots. A report detailing the results of this project will be available in early winter of 1987.

Additional plots will be established in 1988 and treatments will likely be applied. The objective of the spray operational trial is to attempt to protect understory trees. Timing of larval emergence and budflush in the canopy versus understory and in managed versus natural stands create problems in effecting adequate foliage protection. The project will be continued to refine operational experience and techniques.

Gypsy moth, *Lymantria dispar*, is also of concern to the B.C. Forest Service. The Forest Service is continuing to participate in a cooperative pheromone trapping program with Agriculture Canada, Plant Health, and the Canadian Forestry Service. Approximately 2,000 traps were placed by Forest Service staff in 1987 in recreation sites and forested areas. Additionally, Forest Service staff have participated in egg mass surveys in Victoria, Parksville, and Kelowna.

The Forest Service strongly supports the lead efforts of Agriculture Canada in survey and erradication programs and intends to continue or augment its current cooperative efforts. Erradication efforts have been successful to date and should continue to be so given strong commitment by involved agencies.

Other studies and specific projects have been undertaken dealing with such pests as *Pissodes strobi*, *Actebia fennica*, *Acleris gloverana*, and others.

Pathology

Dwarf Mistletoes An extensive roadside survey of lodgepole pine stands in the Prince George Forest Region indicated that an average 15% of the area was infested by dwarf mistletoe, with up to 90% of the stands infested in the southwestern portion of the Region. A project is underway to determine the impact of the infestation in cooperation with Dr. A. Thomson, Pacific Forestry Centre. A similar project is being undertaken in the Kamloops Forest Region.

Root diseases In Vancouver Forest Region, a joint project is in progress with J. Kumi (MacMillan Bloedel) to investigate root diseases and ecological features, based on MB permanent sample plots. A risk or hazard rating will be developed.

Survey methods are being developed for interior, mature stands for the purpose of obtaining root disease incidence data over extensive management areas. A study of the effect of spacing in young stands with armillaria root disease or laminated root rot was established at Merritt. A survey of 10 - 15 year old plantations indicated widespread, damaging effects of armillaria root disease in southeastern B.C.

In northern B.C., the biology and spread of tomentosus root rot are being studies in young spruce plantations. Several control trials were established to tomentosus root rot in the Prince Rupert Forest Region, including a tree species planting trial on an infested site, and a trial removal of stumps and roots from 10 ha by a tracked excavator and crawler tractor.

Stem diseases and injuries A study of widespread dieback and cankering of Douglas-fir in interior plantations and stands was undertaken by B.J. Van der Kamp and R. Reich, University of B.C. Ecological factors and the role of several associated fungi are being studies. Ministry staff in the Cariboo Forest Region have established plots to determine the levels of damage and long-term build-up or changes in incidence.

In the Prince Rupert Region, staff are surveying damage to young western hemlock stands by porcupine. Some control trials, including introduction of fishers, have been established. A contract to review and formulate control strategies has been undertaken by T. Sullivan, Mammal Pest Management Ltd.

Air Pollutants. Reports by the B.C. Ministry of Environment and Parks, Waste Management Branch, indicated potential damage by ozone to nursery seedlings and forests in or near the Vancouver area (lower mainland). Ministry staff are participating in an interagency committee to initiate research to assess the possible impacts. Surveys are also planned for a forested area around a sulphite pulp will at Port Alice to assess the extent of damage by sulphur dioxide.

General

Pest Management Training. Staff are preparing detailed course outlines and materials to train staff for operational pest management activities.

Data and information bases. Several projects are underway to modify or develop systems to record data from various pest control activities, and to provide information to formulate prescriptions and plan control programmes. Improvements in stand and forest yield models are also being pursued to include effects and impacts of western spruce budworm, mountain pine beetle and root diseases.

Pest losses and impact on timber supply have been estimated for all of the Timber Supply Areas of the Province. This procedure is now underway to provide a similar information base for each of the Tree Farm Licenses.

FOREST PESTS IN MANITOBA, 1987

Spruce Budworm

White Pine Weevil

Jack Pine Budworm

Dutch Elm Disease

Dwarf Mistletoe

Armillaria Root Rot

Plantation Pest Surveys

by

A. Ankney, Y. Beaubien, T. Boyce, L. Christianson
K. Knowles, T. Meyer, M. Slivitzky, S. Warner

Presented to the 15th Annual Forest Pest Control Forum

by

Geoff Munro

SPRUCE BUDWORM

Introduction

Spruce budworm infestations persisted along the Winnipeg River (13th consecutive season) and in the Falcon-Westhawk (3rd consecutive season) areas of Whiteshell Provincial Park. Moderate to severe defoliation occurred throughout these areas. Light defoliation occurred in Hecla Island Provincial Park.

Aerial spray program using the bacterial insecticide Thuricide 48LV (*Bacillus thuringiensis*) was carried out at Dorothy Lake and Falcon Lake in Whiteshell Provincial Park. Control measures were recommended last fall based on host tree condition, following repeated budworm attack, and Forest Protection's eggmass survey predicting moderate and severe defoilation for 1987.

An eggmass survey to predict 1988 was conducted at Whiteshell Provincial Park, Hecla Island Provincial Park, Grindstone Peninsula cottage subdivisions and the Saint Lakes area.

Aerial Spray Progam

Whiteshell Provincial Park

Pre-Spray Survey (May 12 to May 19, 1987)

The pre-spray sample indicates larval numbers and shoot and larval development. This survey confirms the necessity to spray and determines the correct timing of application.

Two 45 cm. branch samples were collected from balsam fir and white spruce. In each plot, branches were taken at mid-crown from opposite sides of each of five sample trees. At Dorothy Lake four sample plots were located in treated area and four in the untreated area. Four treated plots and three untreated plots were set up at Falcon Lake. Each branch was examined for budworm larvae. Collected larvae were segregated into instars and an index of larval development, a weighted averge, was calculated. The mean number of larvae per 45 m branch tip was used to compare pre and post-spray samples. New shoots were assessed according to Auger's Classes and a shoot development index was calculated.

Post-Spray Survey (May 26 - June 2, 1987)

The post-spray survey was conducted 5 days after spray application. Samples were collected and branches assessed according to same procedures used for the pre-spray survey.

Application

The aerial application using Thuricide 48 LV undiluted at 20 BIU per hectare was carried out one week following the pre-spray survey. Larval development at this time was approximately 3.5 and shoot development was in Auger's Class 4.

TABLE 1

SPRAY BLOCKS

Block #	Location	Size (ha)	Block Opening	Date Sprayed	Temp.	Relative Humidity	Wind km/hr
1	Dorothy Lk)	178	87/05/19	87/05/19	14°C	60%	5 SW
1A	Dorothy Lk)						
2	Dorothy Lk)	193	87/05/19	87/05/19	14°C	60%	Calm S.
3	Dorothy Lk)						
4	Falcon Lk	165	87/05/19	8/05/20	13°C	94%	Calm S.

TABLE 2

LARVAL SURVEY RESULTS

Treated Areas

Location

	Pre-Spray Survey				
	Larvae/45 cm branch	Larval Index	Shoot Index	Post-Spray Survey Larvae/45 cm branch	% Larval Reduction
Falcon Lake	13	2.7	3.7	20	-
Dorothy Lake	18	3.0	4.5	17	-
Untreated Areas					
Falcon Lake	30	2.7	4.2	37	-
Dorothy Lake	14	3.0	4.4	15	-

The net change in larval numbers from pre to post-spray was similar for both treated and untreated areas. Moderate defoliation occurred in both treated and untreated areas. Essentially no control was achieved.

TABLE 3

1987 DEFOLIATION ASSESSMENT RESULTS

Treated areas

Location	1987 Defoliation Result
Falcon Lake	Moderate
Dorothy Lake	Moderate

Untreated areas

Location	
Falcon Lake	Moderate
Dorothy Lake	Light-Moderate

All aspects of the spray project including the quality of the product are being examined to determine the reason for failure.

DEFOLIATION PREDICTIONS FOR 1988

EGGMASS SURVEY

Method

Two branches 45 cm in length were collected at mid-crown from alternate sides of each tree sampled. Each plot consisted of five sample trees. Branch width was measured for each 45 cm. branch and the branch area calculated. All spruce budworm eggmasses were counted on each branch. The number of eggmasses per 10 m^2 of branch area was calculated. The mean number of eggmasses per 10 m^2 was used as an average for each sample area. Defoliation predictions were based on these values as follows:

Light
- up to 35% defoliation of the current shoots
- based on 30 or less eggmasses per 10 m^2 of branch area.

Moderate
- 35% to 70% defoliation of the current shoots
- based on 60 to 110 eggmasses per 10 m^2 of branch area.

Severe
- 70% + defoliation of the current shoots and possible feeding an old foliage
- based on 220+ eggmasses per 10 m^2 of branch area.

1987 EGGMASS SURVEY RESULTS

Location	Eggmasses/10 m^2	1988 Defoliation Prediction
Dorothy Lake Area (Whiteshell)	125	Moderate-Severe
Falcon Lake (Whiteshell)	42	Light-Moderate
Hecla Island	3	Light
Grindstone Penninsula	7	Light
Saint Lakes	2	Light
Lake Winnipeg East (Abitibi-Price FML)	161	Moderate-Severe

Discussion

The Whiteshell infestations are expected to continue in 1988. Aerial spraying should be considered again for the Dorothy Lake area and possibly Falcon Lake. Stand conditions should be assessed in the Falcon Lake area prior to a decision being reached. No control action is required for Hecla Island or Grindstone Penninsula. The budworm and its impact will continue to be monitored in the Lake Winnipeg East area with the intent that harvesting plans be altered if warranted.

WHITE PINE WEEVIL - 1987

Sanitation pruning to control the white pine weevil, *Pissodes strobi* in white spruce plantations located in the Interlake Region of Manitoba continued for the 4th consecutive year. In 1987 a total of 1,961 infested white spruce trees were pruned over a 335 hectare area.

Problems with timing sanitation pruning prior to adult emergence occurred in 1985 and 1986. The characteristic shepard's crook is less distinctive on spruce than pine allowing only a 1-2 week period for pruning to occur. In 1987 a late frost occurred. The presence of the frost damage made identification of weevil activity a little more difficult. An additional problem arose from weevils reinvading previously attacked stems immediately below last year's adult emergent holes. With this type of attack, there are no visible external symptoms. As a consequence, all trees displaying old damage had to be examined for 1987 weevil attack.

Jack Pine Budworm

Jack pine budworm populations returned to endemic levels throughout most of the province. Moderate defoliation was observed only at Brereton and Westhawk Lakes in Whiteshell Provincial Park.

Egg mass surveys were carried out on permanent plots located in high priority jack pine areas. Although egg mass counts are not complete, all samples processed to date predict nil to light defoliation in 1988.

Pheromone traps were placed at 12 permanent plot locations throughout the province. Moth captures were low at all locations.

Jack Pine Budworm
Damage Appraisal Survey

INTRODUCTION

The major defoliator of jack pine in Manitoba is the jack pine budworm. Populations of this insect rise to epidemic proportions rapidly and are also subject to sudden collapse. Outbreaks generally last 2 to 4 years. Top-kill, growth loss and reduced vigor are the most common forms of damage. Tree mortality seems to occur when other stresses are involved.

The jack pine budworm caused severe defoliation of jack pine in the Thompson area for two consecutive years, 1984 and 1985. In mature stands, top kill, tree decline and mortality was observed by the following spring. Decline and mortality continued to occur throughout the 1986 and 1987 growing seasons. A survey involving approximately 9 staff weeks was carried out to assess budworm damage in mature jack pine. Younger more vigorous stands were not surveyed due to their apparent recovery from severe defoliation. The field work was done in October of 1986 and September, 1987.

METHOD

An inventory cruise using the Manitoba Forest Inventory survey system was carried out within the infestation area. In addition to volume data, information on tree condition was collected for each of 3 crown levels. Condition categories were:

Vigorous
Declining
Dead

For the purposes of this survey, declining refers to trees or portions of trees which will definitely die. Within this category new growth is absent and very little live foliage remains. No dead trees killed prior to budworm attack were included in the survey.

A survey of felled trees was done to relate levels of decay to tree condition. Trees were felled and bucked up to a minimum diameter of 3.5". Each log was rated as:

Sound
Incipient Decay (Stain)
Advanced Decay

A survey for white spotted sawyer bettle, a common secondary pest which results in the down grading of lumber, was carried out on logs of the felled trees and at a number of the plot locations associated with the inventory cruise. Each log is sampled by removing 1 sq. ft. of bark and counting the number of larvae and larva entrance holes.

Severity of attack is rated as follows (Raske and Safranyik, 1970):

Infestation Class	Woodborer Holes/Sq. Ft.	Expected % Value Loss to Lumber
Light	0.5 or less	5% or less
Moderate	1.0 to 1.5	11.5% to 18.0%
Severe	3.0 or more	29% or more

The percent value loss is a consequence of the lumber down grading due to the presence of wood borer holes rather than a volume or strength loss.

RESULTS

Volumes derived from gross merchantable volume (m^3/ha/tree) tables for Manitoba, have been amalgamated to represent losses for the whole infestation area. This approach seemed reasonable based on the budworm's usual distribution pattern i.e.: at the peak of epidemics severe defoliation tends to be consistent throughout the infestation area. As well, sample stands with the exception of one, were in the mature age class, therefore eliminating the variability of damage that often occurs between age classes. Results based on 97 prism plots, are as follows:

Jack pine volume prior to budworm damage:	111.2 m^3/ha
Jack pine volume in declining state:	6.1 m^3/ha
Volume of budworm killed jack pine:	11.1 m^3/ha
Potential volume loss due to budworm:	17.2 m^3/ha

The potential volume loss due to budworm is 15.5% (based on declining and dead samples) of the total volume of jack pine available prior to the budworm damage. On an individual stand basis, potential volume loss ranges from 5.2% to 22.4% of the jack pine component. The fairly narrow range suggests the 15.5% mean is an accurate indicator to represent losses in mature and overmature stands throughout the infestation area. See Appendix I for volume data by stand.

Tree conditions expressed as a percent of the total jack pine sampled throughout the area are as follows:

	% of total JP Sampled
Dead and declining upper crown	20.4%
Dead and declining upper and mid crown	8.8%
whole tree decline	6.4%
Tree Mortality	11.2%

17.5% of the jack pine sampled were dead or declining. This group will constitute the majority of the volume loss. Percent dead and declining ranged from a low of 5.2% to a high of 22.4%. Again, the narrow range suggests a fairly random distribution of the budworm and subsequent damage.

See Appendix II for tree conditions for individual stands.

Decay is at a fairly low level at this time. Both red ring rot (likely _Fommes pini_) and blue stain fungi were present. Results are as follows:

Tree Condition	Logs with advanced decay	Logs with incipient decay	Sound logs
Dead Upper Crown	0%	12.5%	87.5%
Declining	0%	50%	50%
Dead	20%	60%	20%

Although advanced decay was present in 20% of the logs sampled from dead trees, it was less than 10% of the log volume in all cases.

Sawyer beetle attack was quite variable and only of minor consequence on dead trees. Declining trees and trees having dead upper crowns had an insignificant level of attack.

Tree Condition	% of Sample Logs Attacked	Severity of Attack		
		Moderate	Moderate-Severe	Severe
Dead Upper Crown	4%	4%	-	-
Declining	0%	-	-	-
Dead	47%	17%	17%	13%

Less than half the sample logs from dead trees were attacked with 13% of these being severely attacked.

DISCUSSION

- The intent of this survey was to determine budworm related volume loss in mature jack pine. Vigorous younger stands did not have the top-kill, decline and mortality observed in the older age classes, and were therefore not included in the survey. Consequently, any growth loss suffered by younger stands has not been addressed.

- The percent of dead and declining jack pine is 17.5% while the potential volume loss is 15.5%. The similarity of these two figures indicates there is no tendency for damage to be concentrated in any particular size class. If the potential volume loss were significantly less than the % dead and declining, the damage would be predominantly on smaller intermediate and suppressed trees.

- 20.4% of the jack pine has dead or declining upper crowns. Results from the felled tree survey indicate there is no volume loss associated with this condition. The dead upper crown in all cases was above the smallest merchantable log (minium top diameter of 3.5 inches) cut from any of the sample trees. However, the abundance of dead tops may be of some concern with regard to safety while harvesting.

- 8.8% of the jack pine has dead or declining upper and mid crowns. There will be some volume loss from this category, but it is not likely to exceed 1% to 2% at this time, since only a portion of the tree is being lost. The greater concern here is that trees in this condition may continue to deteriorate and eventually die, thus adding another 9.6 m^3/ha (derived from gross merchantable volume tables) or 8.6% volume loss in the future. Permanent plots will be established to monitor this situation.

- The decay survey indicates a fairly high percentage of dead and declining trees have stain (incipient decay). These trees are for all practicle purposes sound and suitable for sawlogs or pulp at this time. Advanced decay which does represent a volume loss at present is minimal, as it was found in 20% of the dead tree samples and was always less than 10% of the log volume. Consequently, the 15.5% volume loss (derived from volumes of dead and declining trees) is an expected loss rather than an actual loss at present. If damaged stands throughout the area can be harvested within the next year or so, losses can be kept to a minimum. If this is not feasible, at least 15.5% of the mature and overmature jack pine volume will be lost and possibly considerably more, if trees with dead upper and mid crowns deteriorate.

APPENDIX I

Jack Pine Volume Data for Individual Stands

Management Unit	Township and Range	Stand	Number of Plots	Average Age	Volume (m^3/ha) Total	Declining	Dead	Potential Volume Loss
84	73-5W	303	10	50	30.6	0.4	1.2	5.2%
85	74-5W	178	10	75	93.1	4.0	2.6	7.1%
85	74-5W	273	6	90	156.4	4.6	22.7	17.2%
85	76-2W	124	9	85	97.1	4.3	9.3	14.0%
87	75-5W	161	5	70	76.4	8.4	5.8	18.6%
87	75-5W	168	12	80	128.1	7.6	11.8	15.1%
87	75-5W	169	5	85	132.9	2.8	19.5	16.8%
87	76-4W	55	7	85	145.9	15.0	17.8	22.4%
87	76-4W	60	5	85	83.8	6.3	7.2	16.1%
87	76-4W	111	9	85	78.9	3.2	4.8	10.0%
87	76-4W	193	4	80	187.4	3.7	31.3	18.7%
87	76-4W	186	9	85	158.8	12.9	15.6	17.9%

$$\text{Potential Volume Loss} = \frac{\text{Declining + Dead}}{\text{Total}} \times 100\%$$

APPENDIX II

Jack Pine Tree Conditions For Individual Stands

Management Unit	Township and Range	Stand	Dead or Declining Upper Crown	Dead or Declining Upper & Mid Crown	Whole Tree Decline	Tree Mortality	Combined Decline and Mortality
84	73-5W	303	---	---	2.8%	11.1%	13.9%
85	74-5W	178	13.3%	8.0%	6.7%	1.3%	8.0%
85	74-5W	273	25.0%	7.9%	4.7%	15.7%	20.3%
85	76-2W	124	42.3%	5.7%	5.7%	9.9%	15.5%
87	75-5W	161	---	3.7%	11.1%	11.1%	22.7%
87	75-5W	168	27.6%	12.4%	6.7%	9.5%	16.2%
87	75-5W	169	31.9%	---	2.3%	15.9%	18.2%
87	76-4W	55	26.5%	18.1%	10.9%	12.1%	22.9%
87	76-4W	60	2.8%	19.5%	8.4%	8.4%	16.7%
87	76-4W	111	20.0%	5.8%	4.3%	7.2%	11.4%
87	76-4W	193	25.0%	15.4%	2.0%	19.3%	21.2%
87	76-4W	186	4.5%	3.6%	9.1%	13.6%	22.7%

DUTCH ELM DISEASE

During the 1987 summer surveillance season, approximately 13,000 elms were examined in and around urban and rural municipalities. Of these, 1,133 were confirmed to have Dutch Elm Disease and 12,899 were classified as hazards, many of these probably dead as a result of Duth Elm Disease (DED). Due to the large number of elms infected in wild stands throughout southern Manitoba, particulary in eastern and central regions, control efforts were concentrated on elms in and around the 43 cost-sharing agreement cmmunities. Trees in the wild were largely ignored due to the impracticality of controlling the disease in those areas.

The number of municipalities with DED remained at about 77 during the year. Communities with the disease included major urban centres like Winnipeg, Brandon, Portage la Prairie, Morden, Neepawa, Selkirk, Steinbach & Winkler.

The disease is near Dauphin in the R.M. of Ste. Rose, however, Dauphin remained disease free again this year.

Although DED continues to increase in the wild stands, diseased elms in urban centres with control programs were comparably low. Less than one percent of Winnipeg's elms were diseased, and in Brandon, less than two percent of the elms were infected. Again, most of these trees are found in the wild stands along the riverbanks where control measures are less effective. The City of Winnipeg reported 1,797+ samples taken this year of which 1,645 were confirmed DED and an additional 6,585 were marked as Hazards.

The disease has continued to increase along most of southern Manitoba's rivers. Large increases in disease have occurred on the Red and Assiniboine Rivers around Winnipeg, along the Assiniboine to Portage la Prairie and west of Brandon as far as the St. Lazare area. The Whitemud River around Westbourne has shown a considerable increase in disease, as well as the east escarpment of Riding Mountain National Park. The smaller river and creek systems in south central Manitoba also experienced more pockets of infection, thus endangering the farm shelterbelts in the areas around Winkler, Altona, Morden and Carman. The Souris River southwest of Brandon was surveyed by air and reported to be extensively infected right into the United States and back into Saskatchewan. However, the natural elm population drops off just a few miles into Saskatchewan. It is expected that the disease will be exported to Saskatchewan via the Assiniboine River west of the St. Lazare area.

The community of Minnedosa which had one diseased tree in 1986 experienced one tree again this year. Rivers, which had one tree last year was disease free this year. Neepawa, which had three diseased trees in 1984, none in 1985 and 1986 had one tree this year. Communities such as Portage, Morden, Morris, Ste. Anne and Souris experienced a considerable increase this year as compared to last. Major decreases were observed in Brandon, Crystal City, Carman, and Stonewall. These communities have shown favourable results from sanitation practises which have included pruning and basal spraying.

The first diseased tree in rural Manitoba this year was observed in Morden on May 26th and in the Winnipeg area about June 4th. A generally early spring with relatively low infestations of cankerworms, provided decent conditions for sampling of diseased trees. June was fairly productive for sampling, however, most identification was done in July and the first week in August.

From November 1, 1986 to October 31, 1987, the Provincial Dutch Elm Disease sanitation crew removed about 9,000 elm trees. In addition, approximately 2,550 decadent elms were removed in the Brandon Buffer Zone and 1,081 in the Winnipeg Buffer Zone (La Salle and Assiniboine River areas). These trees were removed under the winter works projects which ran from November 1986 to April 1987.

DWARF MISTLETOE MANAGEMENT IN MANTIOBA: A STATUS REPORT FOR 1987

Introduction

Dwarf mistletoe causes extensive damage in Manitoba, reducing both the quantity and quality of merchantable timber. Two species of dwarf mistletoe occur in the province; *Arceuthobium americanum* attacks jack pine and *A. pusillum* attacks white and black spruce. Since the spring of 1984, dwarf mistletoe surveys, research and operational sanitation projects have been carried out under the Canada-Manitoba Forest Renewal Agreement. The Agreement provides $280,000 per year for dwarf mistletoe management, over its five-year duration.

Aerial Survey

A comprehensive aerial survey for jack pine dwarf mistletoe was conducted in early 1987 over the central portion of Manitoba. An event recorder (a device consisting of an audio tape linked with a chart recorder) was used to map 4 000 km^2 in the area near Grand Rapids. Parallel lines one mile apart were flown at 60 m.p.h. at an altitude of 500 feet over jack pine cover-type stands. The information gathered on the chart and audio tape was subsequently interpreted and transferred onto provincial cover-type maps. Accurate navigation and maintenance of a constant ground speed by the aircraft are essential to the success of this method of passive mapping. Blocks are flown when snow is on the ground because this allows for better definition of the dark dwarf mistletoe brooms, symptomatic of *Arceuthobium americanum*, against the white snow background.

Subsequent ground truthing covered over 100 kilometres during which dwarf mistletoe infection was rated at fifty-metre intervals, resulting in over 2,000 point samples. During the course of the ground truthing, potential treatment sites and harvestable stands were identified. Research data, in the form of mature and juvenile transects, was also gathered.

Research

A total of sixty permanent plots have been established in Manitoba to monitor dwarf mistletoe infections and the effect of various operational sanitation treatments on the parasite. Forty of these are located in the southern part of the province and twenty are located in the central region near Grand Rapids. The earliest plots were established in 1978. These plots have now yielded over five million pieces of information that are all on computer file. A mapping system has been adapted from a program developed at the Univeristy of Manitoba to allow the mapping of individual trees in the permanent plots and integration of all collected information.

In addition, over a dozen temporary plots associated with ethephon spray and morphological change research have been established in the Moose Lake area east of The Pas.

Two research projects funded by the Agreement are being delivered by the Univeristy of Manitoba Botany Department. A Ph.D. study dealing with heretofore lacking fundamental research on pollen retention and dispersal will be completed this spring by J. Gilbert. This study is also examining seed germination of Arceuthobium americanum on jack pine and should indicate vulnerable stages in the parasite's life cycle, with a view to more effective management. Half a dozen additional study plots in the Belair area have been monitored for the last three years in relation to this study.

Research by T. R. Meyer is continuing on the behavior of dwarf mistletoe infections in Manitoba jack pine stands to provide both a conceptual understanding and data to develop a loss simulator model. When completed, the model will predict the development of dwarf mistletoe in jack pine stands over time, and resulting volume losses. The model will also serve as the basis for a forest management decision support system to identify cost-effective disease management strategies.

Operations

Operational projects in this fiscal year have been limited to post-harvest sanitation of recent and backlog cutover areas. Sixty kilometres north of The Pas, at Mitchell Lake, 130 hectares of old cutover has been cleaned of dwarf mistletoe; 650 hectares of recent clearcut have been treated at Talbot Lake, 150 kilometres east of The Pas.

The same type of sanitation project is presently under way in the Belair area, about 100 kilometres northeast of Winnipeg. Diversion funding is providing the monies for the Belair projects which include the cleanup of 135 hectares of jack pine cutover and 30 hectares of black spruce cutover. Cottage owners associations in this area have also been encouraged to carry out sanitation work in their subdivisions through the provision of information and equipment. Mother nature also lent a hand late this spring. A large destructive fire at Wallace Lake completely obliterated the easternmost known outlier infection of *Arceuthobium americanum.*

ARMILLARIA ROOT ROT

Armillaria root rot continues to be a problem in some red pine plantations in eastern and southeastern Manitoba. The disease has been found in plantations ranging in age from 5 - 50 years of age. Activities this year included continued monitoring of existing impact plots and an additional study to determine relative susceptibilities of red pine and jack pine and the determination of high risk root rot areas prior to planting.

An impact study initiated in 1983 has monitored active infection centres in 11, 13 and 14 year old plantations in Belair Provincial Forest. Within the five study plots, mortality due to Armillaria was 39%, 34%, 18%, 14% and 18% at the end of the 1987 field season. Over the 1987 field season the percent increase in mortaility was 5%, 1%, 1%, 0% and 1%. The cummulative increase in mortality over the four year period has been 15%, 13%, 9%, 3% and 5%.

The study initiated this year has the following objectives and methods:

Objectives

1. Determine the relative susceptibilities of red pine and jack pine.

2. Determine if the capture of Armillaria by the "trap log method" (Mallet and Hiratsuka, 1985) can be related to seedling mortality.*

3. Determine if Armillaria can be retrieved from suspect sites such as overmature declining stands, dwarf mistletoe infection centres, or areas under any other form of stress.

4. Determine if Armillaria can be retrieved from thinned red pine plantations.

Methods

The following methods correspond to the above objectives:

1. Plant red pine and jack pine seedlings in known Armillaria infection centres and monitor for infection. It may take some time to obtain results in the field. Therefore, seedlings will be potted at the Birds Hill Nursery. Armillaria isolates retrieved from trap logs will be placed in with the potted seedlings to speed the inoculation process.

2. Place one inch green aspen stakes in a grid pattern throughout the infection centres planted with the test seedlings.**

3. Place one inch green aspen stakes in suspect areas in overmature stands and decadent dwarf mistletoe infected sites, plus healthy vigorous pine stands just reaching rotation age. As a control, it would be necessary to stake non-suspect areas for comparison.

4. Place one inch green aspen stakes in thinned areas of red pine plantations.

* Dr. Y. Hiratsuka (Northern Forestry Centre) recommends green aspen stakes driven approximately 10 inches into the ground are effective for the capture of the Armillaria fungus. Pine stakes, when used for this purpose, become colonized rapidly by other fungi and bacteria, making retrieval of Armillaria difficult.

** Aspen stakes are to remain in the ground throughout the growing season. Once removed they will be examined for mycelial fans and rhizomorphs. A certin percentage of the samples will be cultured in the lab for identifiction of specific strains of the fungus.

PLANTATION PEST SURVEY

1987 - STATUS REPORT

The summer of 1987 was the initial year for the Plantation Pest Survey in Manitoba, which was conducted jointly by the Manitoba Department of Natural Resources and the Canadian Forestry Service. This survey is intended to determine major plantation pests causing deformity and/or mortality in young stands. More detailed impact studies and/or pest management decisions will be based on these initial surveys.

The survey was conducted on seven plantations of either Red or Jack Pine, and covered 159 hectares, 1,464 trees, of which 89% was classified as vigorous. The Jack Pine stands had more problems which were mainly Western Gall Rust and Pitch Nodule Maker. The Red Pine plantations had no major, and few minor problems.

A grid pattern survey method was used to cover the entire plantation systematically. It allowed the surveyors to draw accurate maps and to locate and estimate the percentage of occurrences of pockets of mortality and/or damage. A 4 x 10 m temporary plot was established every 80 m along the compassed grid lines, and all trees dead or alive with the plot boundaries were assessed. The 1987 season was a trial period for this new project and modifications in the survey method and sampling intensity are planned for the 1988 season.

STATUS OF SASKATCHEWAN'S FOREST PESTS IN 1987

Madan Pandila
Saskatchewan Parks, Recreation and Culture

Aerial and field surveys conducted by Forestry Branch of Saskatchewan Parks, Recreation and Culture in collaboration with the Canadian Forestry Service (CFS) and the industry, indicate the following general condition of various pests in the Provincial Forest.

Spruce Budworm

The current outbreak of spruce budworm appeared in 1982 in Tall Pines area south of Hudson Bay. Since then the infestation has been steadily on an increase , however harvesting operations have been reducing the impact of the infestation. This year, light to moderate intensity of infestation is still present in most of this area with some increase of infestation on the west side of Big Valley Lake.

The Red Earth infested area remained practically static this year with moderate infestation. The southern part of the infested area south of Hwy. 163, showed an increase in area and the infestation level.

Jack Pine Budworm

This infestation appeared in 1984 along the Saskatchewan-Manitoba border and since then has progressively covered all the eastern and the Central commercial zone of the Provincial Forest. This year moderate to severe defoliation occurred between the Torch River and White Gull Creek in the north and the Nisbet Forest west of Prince Albert and in MacDowell area.

No significant defoliation was detected in Fort-a-la Corne, Torch River Provincial Forest, Tobin Lake, Nipawin, Jan Lake, Deschambault Lake and Pelican Narrows which were severely infested last year. It appears that infestation of jack pine budworm has declined in the eastern part of the Provincial Forest.

Mountain Pine Beetle

Mountain Pine Beetle is under control and is at its lowest population level since its first appearance in 1979-80 in the Cypress Hills. A monitoring program with 300 tree baits was set up this year to assess the population level. No beetles in tree baits were found this year.

Spruce Beetle

Spruce beetle is causing some mortality of mature spruce in Cypress Hills. The population level is low but has the potential of becoming a major pest. Twenty five tree baits have been set up to monitor the population level. No major change in mortality level has been noticed this year.

Forest Tent Caterpillar and other defoliators

The present outbreak of aspen defoliators (forest tent caterpillar and large aspen toetrix) started in 1984 near Green Water Provincial Park in the east and south of Lloydminster area in the west. Since then these defoliators have been on the increase. This year severe defoliation occurred over a large area in the east extending from Yorkton to Nipawin and in the west from Unity to the Bronson Forest.

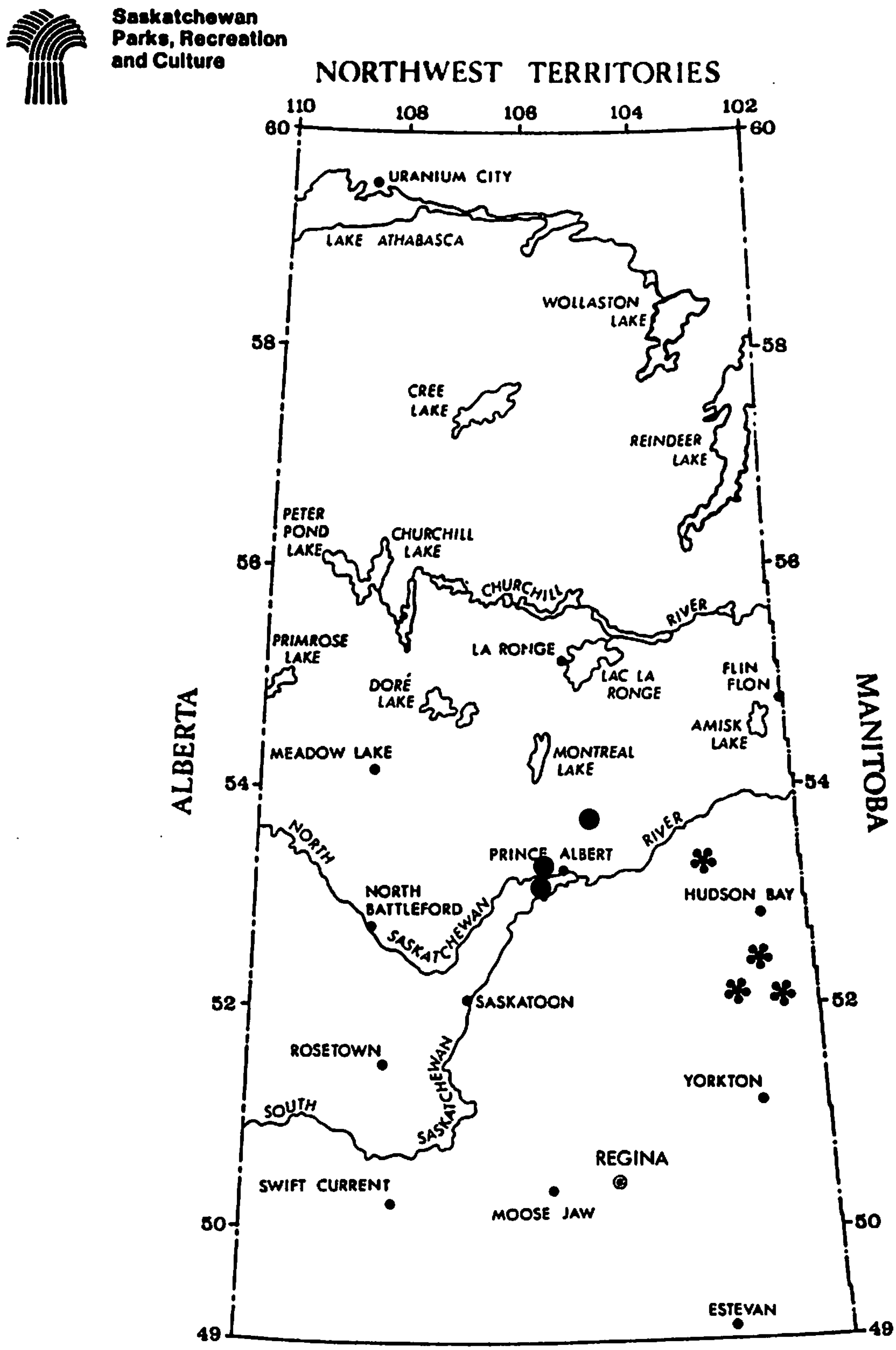
This year due to early spring, the larvae hatched in April and full grown caterpillar stage lasted to mid june. The results of egg band survey for next years prediction are not yet complete, but the general indications are that the infestation will spread in the central part of the province towards Prince Albert and Saskatoon area.

Dutch Elm Disese

No incidence of D.E.D. has so far been recorded this year from samples sent by various cities and samples collected from south eastern and eastern part of Saskatchewan.

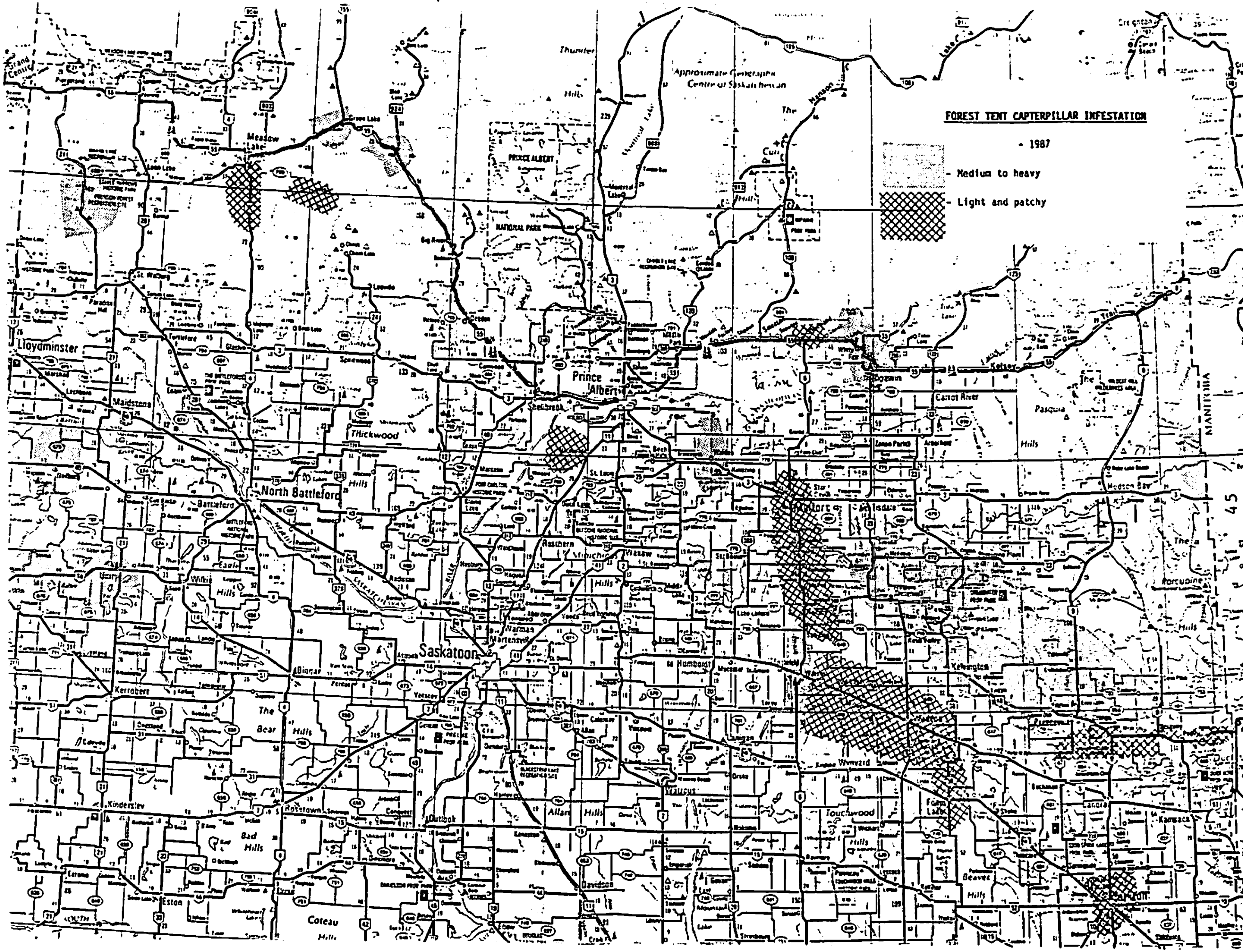
D.E.D. public information display was shown in the cities of Regina, Saskatoon, Weyburn, Yorkton, Prince Albert, Moose Jaw and Swift Current.

MP/ar
October 2, 1987



SASKATCHEWAN

1987 ✱ ......SPRUCE BUDWORM
● ......JACK PINE BUDWORM


FOREST TENT CAPTERPILLAR INFESTATION
- 1987
- Medium to heavy
- Light and patchy
Lloydminster
North Battleford
Prince Albert
Saskatoon
Meadow Lake
Maidstone
Battleford
Biggar
Kerrobert
Kindersley
Rosetown
Outlook
Davidson
Humboldt
Wynyard
Watrous
Melfort
Tisdale
Nipawin
Carrot River
Hudson Bay
Kelvington
Foam Lake
Touchwood
Eston
Coteau Hills
Bad Hills
The Bear Hills
Allan Hills
Thickwood Hills
Porcupine
Pasquia Hills
Rosthern
Wakaw
Shellbrook
MANITOBA

REPORT TO THE FIFTEENTH ANNUAL FOREST PEST CONTROL FORUM

November 17 - 19, 1987

REPORTS ON THE STATUS OF FOREST PESTS
IN THE WESTERN/NORTHERN REGION IN 1987
NORTHERN FOREST CENTRE

Reports Covering the Following Agenda Items:

2.2 Mountain Pine Beetle
2.3 Jack Pine Budworm
2.7 Others (Forest Tent Caterpillar)
2.9 Pinewood Nematode
4.7 Spruce Budworm Distribution and Pest Management

Prepared by H. F. Cerezke,
Head of FIDS at NoFC

Report to 15th Forest Pest Control Forum, November 17-19,1987
H.F. Cerezke, Western/Northern Region

2.2 Mountain pine beetle (Dendroctonus ponderosae Hopk.)

Status in Alberta, Saskatchewan and Rocky Mountain National Parks

Infestations of the mountain pine beetle remained at low endemic levels at all locations in southwestern Saskatchewan, Alberta and the Rocky Mountain National Parks, except in Kootenay National Park where population levels are epidemic. Aerial surveys conducted in the National Parks indicated the following:

National Park	No. of patches	No. of new fader trees in 1987 (in 1986)
Banff	8	(10) 25
Kootenay	145	(5500) 3870
Yoho	27	(130) 105
Waterton Lakes	-	(55) 220
Jasper	0	(0) 0

All the infestations in Banff were at high elevations and appear to be the result of immigrated beetles from lower elevations. Because of cooler climatic conditions and a shorter season, there was delayed development and almost nil brood survival.

Similar numbers of lodgepole pine were killed this year by the beetle in Kootenay Park, compared to 1986, and numbers of patches of infestations were also similar and distributed generally in the same locations. Overwinter brood survival was also high in the spring of 1987 when sampling suggested expanding populations. The outlook for 1988 is likely to be similar as this year. Little or no control work is anticipated in any of the National Parks. No change is expected in Yoho Park in 1988, while in Waterton Lakes Park, a further decline in the numbers of new fader trees is expected. Many of the fader trees recorded this year appeared as singles and may have been due to Ips populations and to girdling by porcupines.

On provincial forest lands in southwestern Alberta, infestations of the mountain pine beetle remained at low endemic levels for the second consecutive year. The province, however, continued its program of detection and control, with the application of a commercially prepared pheromone bait. This year baits were placed out at 50 locations by the Alberta Forest Service in two main areas, Kananaskis and southern Bow-Crow Forest. A total of 118 trees were attacked, about half of which were cut and burned. This represents a slight increase in overall numbers of new attacked trees compared to last year. The Alberta Forest Service spent about $47,000 in 1987 on all aspects of the survey detection and control program. A similar surveillance program is expected next year.

Two provincial parks in the Cypress Hills on the southern boundary of Saskatchewan and Alberta were also monitored for endemic population levels with pheromone baits. On the Saskatchewan side, no beetle strikes were recorded while about 10 baited trees on the Alberta side had only a few attacks. A similar level of pheromone detection survey is anticipated in 1988.

In the Provincial Park on the Saskatchewan side, a long-term program of lodgepole pine removal has been initiated. This program will extend over 30-40 years and allow the gradual removal by small block clearcuts, and thus change the present forest to one of multiple age classes from the present mature evenaged stands. This should have the effect of beetle-proofing the stands in time. A similar long-term plan to protect park forests is planned on the Alberta side of the Cypress Hills.

A Mountain Pine Beetle Interagency Technical Committee met again this fall to review and update 1987 infestations in western Canada and to examine potential outbreak areas and control requirements along the Alberta-B.C. boundary.

2.3 Jackpine budworm (Choristoneura pinus pinus) in Manitoba, Saskatchewan and Alberta : Status and Pest Management

A major decline in areas of moderate-to-severe defoliation by the jackpine budworm occurred in 1987, in both Manitoba and Saskatchewan, while in Alberta the size of infestation stayed about the same.

Province	Area of Mod.-Severe defoliation (ha) in: 1986	1987	% Reduction
Manitoba	132000	100	>99
Saskatchewan	176000	6200	96
Alberta	70	70	0

In Manitoba, foliage samples for egg mass density counts were made at seven locations to predict the 1988 defoliation levels. All but two locations are forecast to have NIL defoliation, while two locations, Rennie and Ingolf are forecast to have LIGHT defoliation.

In Saskatchewan, further declines in areas of infestation and in defoliation intensity are anticipated in 1988, and a similar trend is also expected in the infestation areas in Alberta.

In the area of research and pest management of the jackpine budworm in the Western/Northern Region the following Abstract of a paper prepared by Dr. W. Jan A. Volney, CFS, Northern Forestry Centre summarizes an important aspect of this work. The title is:

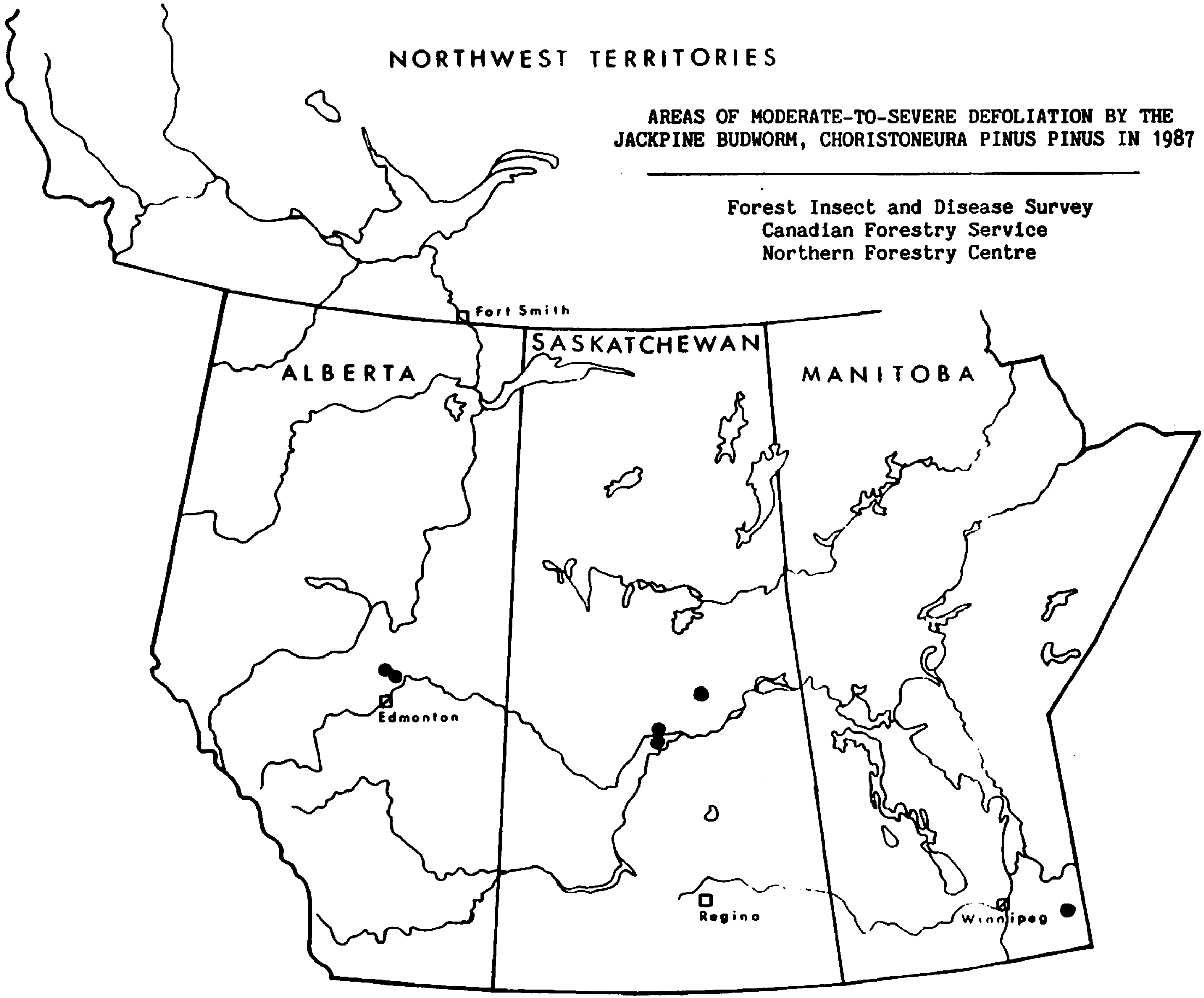
HISTORICAL ANALYSIS OF JACK PINE BUDWORM OUTBREAKS

"A review of Forest Insect and Disease records on jack pine budworm (Choristoneura pinus pinus Freeman) outbreaks in the forests of the prairie provinces suggested that the area affected by the insects fluctuates irregularly but with an increasing trend. A time series analysis indicated that the trend is real and there is an apparent 10-year cycle to outbreaks. Outbreaks are also associated with two elements of the fire history of the region. The first of these is an association between the size of the areas burned two to three decades before the outbreak and the size of the outbreak. The reason for this is that it takes at least 20 years for stands regenerated by fire to become reproductively mature and begin flowering. The second association between fires and outbreaks peak about 4 to 7 years following peak fire years. This association appears to be related to the influence of drought on inducing flowering in mature stands and the correlated elevated survival in jack pine budworm populations when trees produce abundant flower crops. This information can be used in long term simulations of outbreak incidence as well as forecasts of outbreaks as many as four years prior to the event.

The information required to refine these forecasts and long term simulations depends on a better understanding of the insects population ecology."

Dr. Volney's present research program is aimed towards solving these issues, and his present studies include:

1. Development of sampling procedures.
2. The reciprocal interaction of the insect and tree growth.
3. Life table studies.
4. Techniques to evaluate the impact of defoliation on stand development.



AREAS OF MODERATE-TO-SEVERE DEFOLIATION BY THE JACKPINE BUDWORM, CHORISTONEURA PINUS PINUS IN 1987

Forest Insect and Disease Survey
Canadian Forestry Service
Northern Forestry Centre

2.7 Forest Tent Caterpillar (Malacosoma disstria) Status and update for Western/Northern Region in 1987

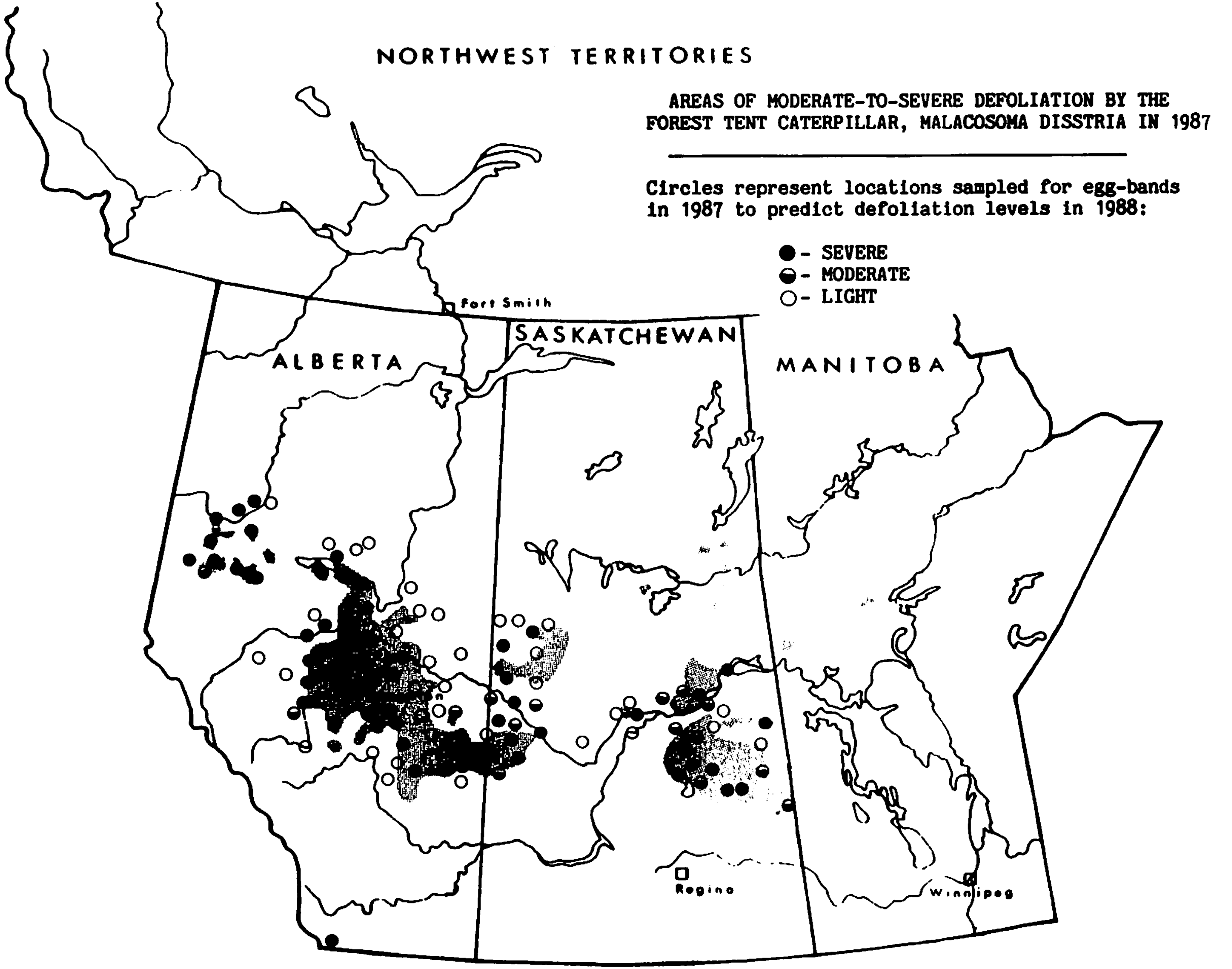
Within the three prairie provinces, major expansions of moderate-to-severe defoliation caused by the forest tent caterpillar occurred in Alberta and Saskatchewan, while in Manitoba there was a decline. Estimated total area of outbreak in each province is given below, in comparison with 1986.

Province	Total area of outbreak with Mod-Severe defol'n in ha		% Change
	1986	1987	
Manitoba	17100	4400	-75
Saskatchewan	400000	1,250,000	312
Alberta	3,160,890	6,307,088	200

The outbreak extends throughout the central part of the two provinces, primarily within the agricultural zone. However, about 10-15% of infested areas now occur on provincial forest lands where aspen utilization is a growing industry.

Control programs were undertaken by the province in two provincial parks, and by various acreage and farm groups.

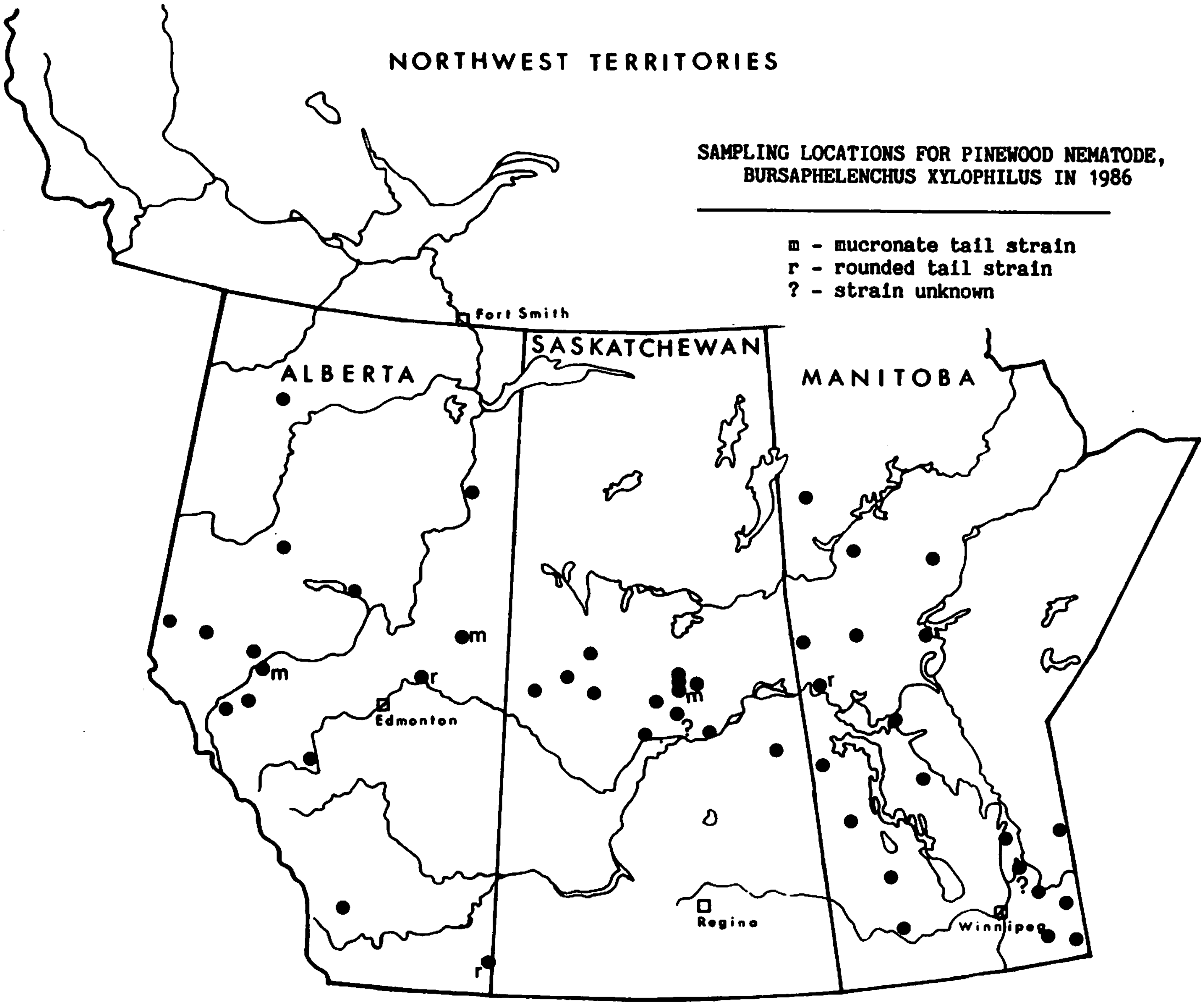
Egg-band surveys conducted this fall in Alberta and Saskatchewan indicate that the infestations are likely to continue at the same defoliation intensity levels, and possibly even expand in 1988.


NORTHWEST TERRITORIES
AREAS OF MODERATE-TO-SEVERE DEFOLIATION BY THE FOREST TENT CATERPILLAR, MALACOSOMA DISSTRIA IN 1987
Circles represent locations sampled for egg-bands in 1987 to predict defoliation levels in 1988:
● - SEVERE
◒ - MODERATE
○ - LIGHT
Fort Smith
ALBERTA
SASKATCHEWAN
MANITOBA
Regina
Winnipeg

2.9 Pinewood Nematode (Bursaphelenchus xylophilus) Update and Status for Western/Northern Region in 1987

An extensive survey was conducted by FIDS in the three prairie provinces in 1986 as part of a nation-wide survey to detect the presence, distribution and tree host species of the pinewood nematode. Wood discs were collected at 49 locations; 20 in Manitoba, 14 in Saskatchewan and 15 in Alberta. At each location, three wood discs were collected from recent dead/ dying coniferous tree species, and similarly from adjacent live trees for comparison. As many as 3 and 4 different conifer species were sampled at each location. All wood discs were processed at the Northern Forestry Centre, following standard nematode extraction procedures. In addition, about 12 specimens of adult Monochamus and Xylotrechus species of woodborers were dissected and extracted for nematodes. Also, several wood and frass samples associated with the bark beetles, Dendroctonus murrayanae and D. valens were similarly examined.

Todate, only a portion of the extracted nematode samples have been identified by the Biosystematic Research Institute in Ottawa. The pinwood nematode (mucronate tail form) was extracted from either balsam fir or white spruce at three locations: near Whitecourt and near Lac La Biche, Alberta and near Candle Lake, Saskatchewan. The rounded tail form of pinewood nematode was extracted from either jack pine or lodgepole pine, also at three locations: near Smoky Lake and in the Cypress Hills, Alberta, and at Clearwater, Manitoba. A large number of nematode species other than Bursaphelenchus xylophilus were identified in the wood samples submitted, while Tylenchid species were associated with the woodborer and bark beetle species.


NORTHWEST TERRITORIES
SAMPLING LOCATIONS FOR PINEWOOD NEMATODE, BURSAPHELENCHUS XYLOPHILUS IN 1986
m - mucronate tail strain
r - rounded tail strain
? - strain unknown
Fort Smith
ALBERTA
SASKATCHEWAN
MANITOBA
Edmonton
Regina
Winnipeg

4. SPRUCE BUDWORM DISTRIBUTION AND PEST MANAGEMENT

4.7 Spruce Budworm Update and Status in the Western/Northern Region in 1987

In the Western/Northern Region the number of spruce budworm infestations and areas affected decreased in Manitoba, remained stable in the Northwest Territories, but increased substantially in Saskatchewan and Alberta. Overall in Manitoba the total area Moderately-to-Severely defoliated decreased from 32320 ha reported in 1986 to 15540 ha in 1987, or about a 50% decrease. Most of the decrease occurred in the southeast part of the province in three Forest Sections: Pineland (260 ha), Lake Winnipeg East (14500 ha) and Interlake (780 ha).

Province/Territory	Areas of Mod-Severe Defoliation (ha) 1986	1987
Manitoba	32320	15540
Saskatchewan	18500	31600
Alberta	390	5000
Northwest Territories	17800	17000
Totals	69010	69140

Pheromone lures in Multi-pher traps were placed out at 13 locations where foliage samples were also collected to obtain egg-mass density estimates. Based on these data, areas predicted for infestations in 1988 are as follows:

Hecla Island Provincial Park ----- Light
Lac St. George ------------------- Light
Spruce Woods Provincial Forest --- Light-Moderate
Wanipigow ------------------------ Moderate
Whiteshell Provincial Park ------- Severe

In Saskatchewan, there was about a 2-fold increase in size of areas with moderate-to-severe defoliation. Total area mapped was 31,600 ha, compared to 18,500 ha last year. THese occurred in two general locations in east-central Saskatchewan: Porcupine Provincial Forest (16,600 ha) and Pasquia Hills (15,000 ha).

Predictions of expected outbreak pattern for 1988 are based on egg-mass density estimates and pheromone trap results at five locations within the areas of infestation. Moderate defoliation is expected to occur in the Pasquia Hills outbreak, while in the Porcupine Provincial Forest, Light-to-Moderate infestation levels may occur, suggesting a declining trend.

In Alberta, small areas of moderate-to-severe defoliation (about 350 ha) occurred at five locations in central Alberta within the agricultural zone, including two provincial parks. Shoot damage on white spruce was severe, resulting from high budworm populations and from a severe May 19-20 frost and snow storm. Temperatures ranged as low as -6 to -10 oC. in some locations northeast of Edmonton, causing complete mortality of some white spruce in farm shelterbelts. Within the city of Edmonton where moderate-to-severe defoliation occurred last year, only Trace-to-Light defoliation occurred this year. High populations of the spruce bud moth, Zeiraphera canadensis, and the spruce cone worm, Dioryctria reniculelloides, were recorded within Edmonton and surrounding area last year but appeared to be totally absent this year, probably because of the frost-bud kill.

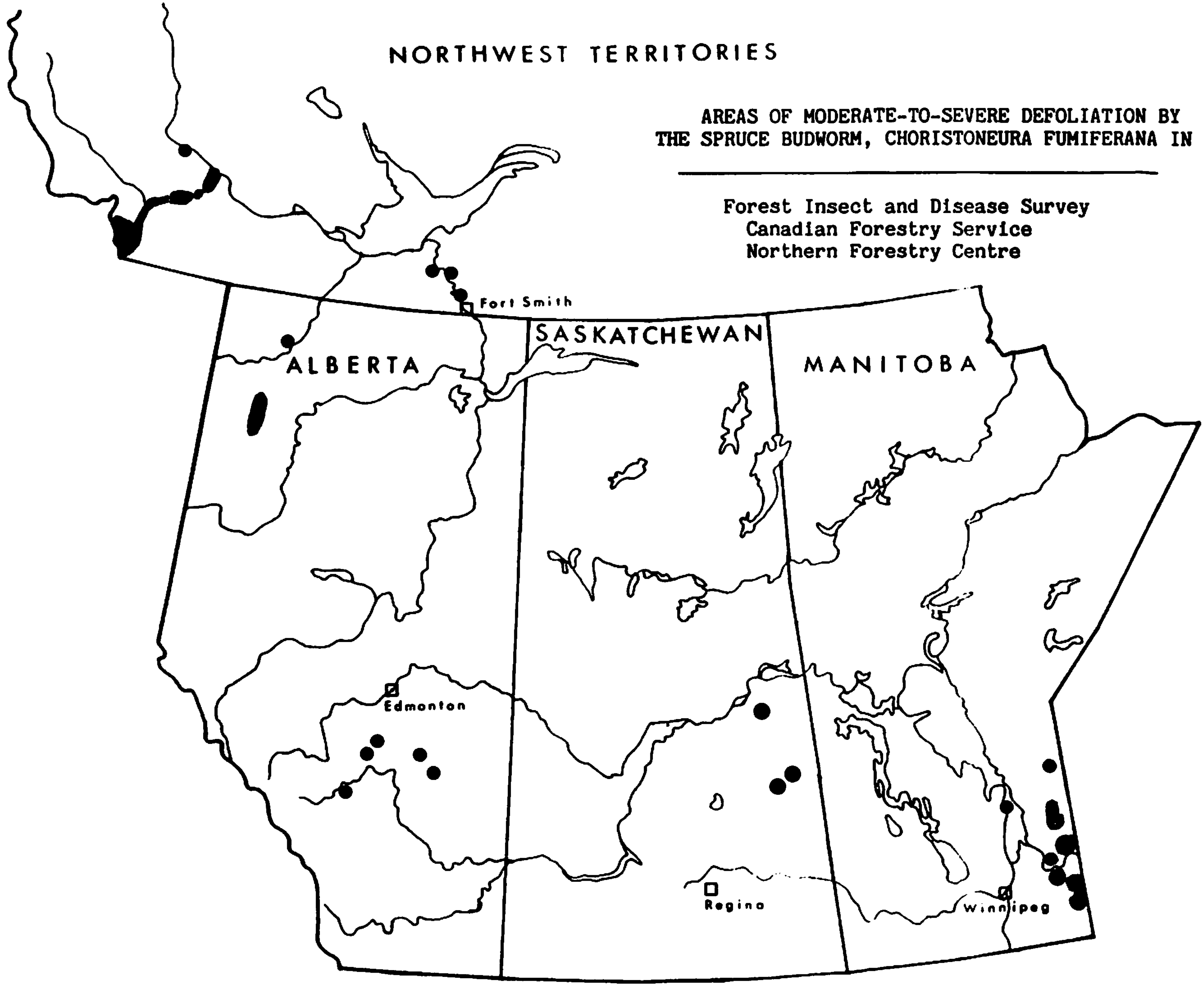
A new infestation of Moderate-to-Severe defoliation, affecting about 5000 ha and an additional 2500 ha of Light defoliation occurred in northwestern Alberta, in the Footner Lake Forest. The area was mapped in detail by the Alberta Forest Service onto forest cover type maps. This will allow a detailed annual review of the budworm infestations and impact, and provide a basis for implementation of a pest management program. No aerial spray program is anticipated but salvage harvesting may be necessary on a priorized stand basis. Foliage samples within the outbreak area have been collected jointly by the AFS and CFS for egg-mass density counts, defoliation measurements and L2 counts to provide a 1988 forecast. While still incomplete the general picture thus far is for a continuation of the outbreak.

In the Northwest Territories, infestations along the Liard River remained much the same as in 1986, with about the same number of ha affected (est. 17,000 ha). For much of the area this represents the fifth year of Moderate-to-Severe defoliation; some tree decline and mortality is expected. However, only general aerial survey mapping was done and no detailed damage impact assessments have been done.

The infestations along the Slave River also remained about the same, affecting 200-300 ha, and showed some decline in one or two locations. No foliage samples were collected in the Northwest Territories to assess defoliation or predict the 1988 infestation levels.

AREAS OF MODERATE-TO-SEVERE DEFOLIATION BY THE SPRUCE BUDWORM, CHORISTONEURA FUMIFERANA IN 1987

Forest Insect and Disease Survey
Canadian Forestry Service
Northern Forestry Centre



THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1987

Hudak, J., P.L. Dixon and L.J. Clarke

REPORT TO THE 15TH ANNUAL FOREST PEST CONTROL FORUM,
OTTAWA, 17-19 NOVEMBER 1987

NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
ST. JOHN'S, NEWFOUNDLAND
A1C 5X8

THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1987

by

Hudak, J., P.L. Dixon and L.J. Clarke

Larval Development and Defoliation - Weather conditions in late April and throughout May and June were relatively warm, however the nights remained cool with a few having frost in central areas. In late June weather warmed up and July and early August were much warmer and drier than normal causing drought conditions in many areas. Host tree development early in the season was more advanced than normal in most areas because of the lack of ground frost under the heavy snowfall during the winter. However, insect development was only slightly ahead of normal.

Surveys conducted in early summer showed moderate to high numbers of looper larvae south of Corner Brook. The reddish discoloration of severe defoliation was less evident in this older part of the infestation because the surviving trees damaged last year produced less foliage this year. However, very severe reddening was evident elsewhere as the high larval population especially north of Bonne Bay completely defoliated the trees and advanced regeneration. There was no fir foliage left for late developing larvae. They were observed feeding on black spruce, birch, alder, maple and any herbaceous vegetation. Most of these larvae died of starvation. A few isolated infestations with moderate to high larval numbers remained in eastern and central Newfoundland.

The aerial survey showed that the area of defoliation covered about 160 000 ha including 150 000 ha in the moderate and severe category (Figure 1). A more intensive survey with helicopter showed severe defoliation on about 67 000 ha of productive forests.

Control Programs - The Department of Forest Resources and Lands conducted an operational control program against the looper and treated about 165 000 ha with fenitrothion and about 4 000 ha with *Bacillus thuringiensis* (*B.t.*).

The Canadian Forestry Service in co-operation with the Department of Forest Resources and Lands conducted an experimental program testing the effectiveness of new formulations and dosages of fenitrothion, *B.t.* and diflubenzuron. The results of these experiments are detailed in a separate report.

Biological Mortality Factors - In 1987 hemlock looper samples were collected from 22 locations across Newfoundland.

The majority of larval and pupal parasitoids were the tachinid flies *Winthemia occidentis* and *Madremyia saundersii*. Several specimens of parasitic wasps were also recovered. The incidence of pathogenic fungus was greater in larval than pupal samples. *Paecilomyces farinosus* was the major fungus disease. *Entomophaga aulicae*, *Erynia radicans* and *Verticillium lecanii* also occurred.

Parasitism and fungal disease in late instar larvae averaged 7% and 25% respectively in the older part of the infestation and only 1% in the younger part. Pupal parasitism was 5% and less than 1% in the older and younger infestations respectively, while fungi caused about 2% pupal mortality throughout the outbreak. Less than 1% of the larvae and pupae were infected by an unidentified microsporidian. In addition to the above about 5% of the larvae were infected in the older and younger infestations respectively by a fungus tentatively identified as *Aureobasidium pullulans*. This fungus was less common in pupae and its pathogenicity is being investigated.

Damage Assessments - The majority of the severe defoliation occurred in western Newfoundland in predominantly mature and overmature stands, but some semi-mature stands were also severely damaged. Tree mortality ranging from 50% to over 90% is already evident in areas severely defoliated in 1986 and similarly high levels of tree mortality is expected in stands defoliated in 1987. The Department of Forest Resources and Lands will assess the damage at the inventory level.

Forecast of Hemlock Looper Outbreak for 1988 - The egg survey commenced in mid-October and branches were collected from about 520 sample points throughout the Island. The forecast will be provided after the processing of the branch samples have been completed.

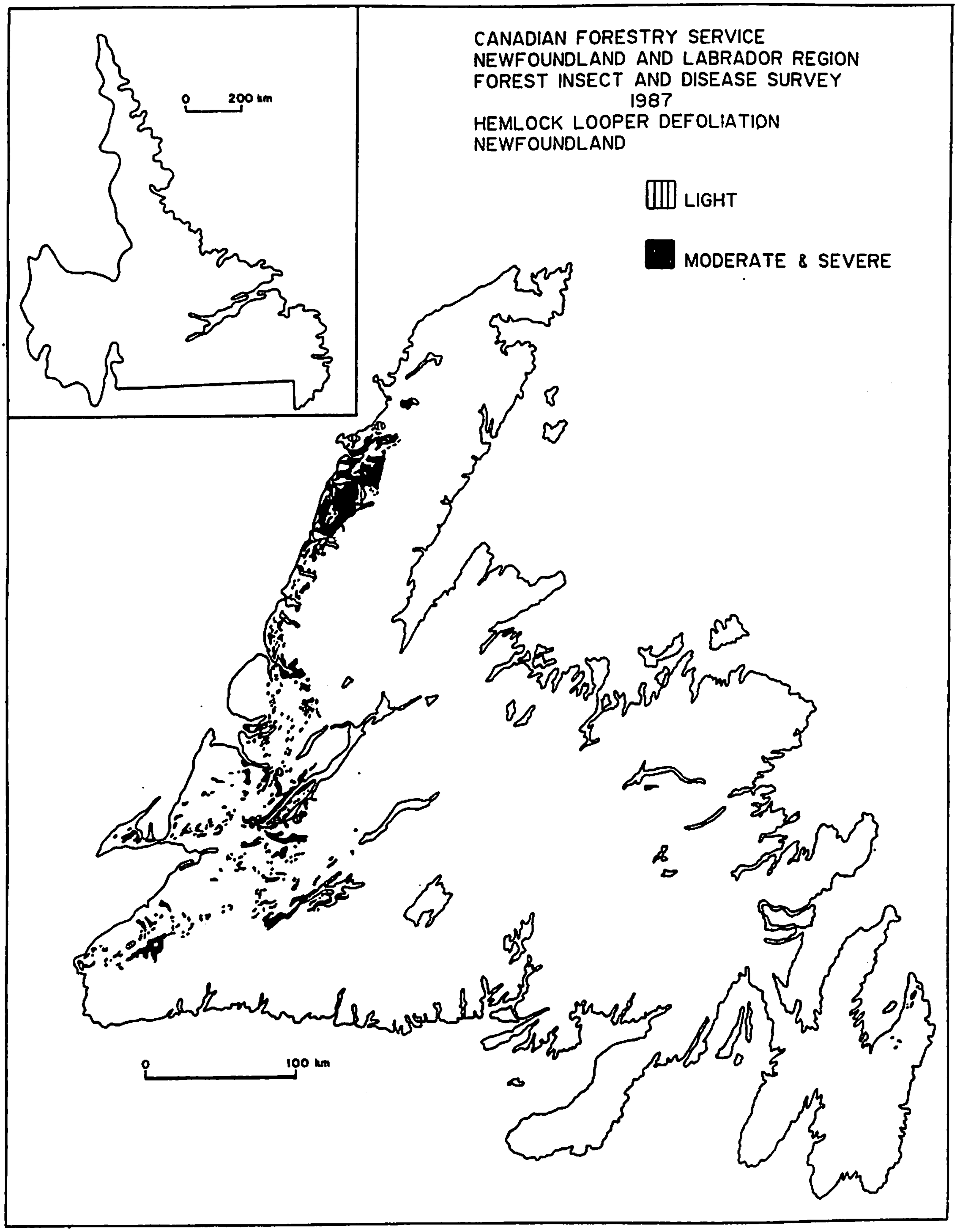


Figure 1. Areas of defoliation caused by the hemlock looper in Newfoundland in 1987.

INSECT CONTROL PROGRAM IN NEWFOUNDLAND IN 1987

by H. Crummey

(Prepared for the 1987 Annual Pest Control Forum, Ottawa - November 17-18, 1987)

SPRUCE BUDWORM

The Canadian Forestry Service (C.F.S.) forecast for 1987 indicated that 34 000 hectares were expected to be infested with 9 800 hectares of this in the moderate and severe category expected in two locations. Because of the locations of these infestations, no control program was proposed.

HEMLOCK LOOPER

This is the third consecutive year of the present looper outbreak in insular Newfoundland. The C.F.S. forecast for 1987 indicated that a total of approximately 460 000 hectares including 327 000 hectares in the moderate and severe defoliation category were expected and situated mainly in western Newfoundland from the Codroy Valley in the southwest through to Hawkes Bay on the Great Northern Peninsula and extending eastward from Stephenville to mainly just south of Red Indian Lake in central Newfoundland; although there were small patches further eastward to the Avalon Peninsula.

Based on these figures, the Department of Forest Resources and Lands, in conjunction with the two paper companies (Corner Brook Pulp and Paper [Kruger] and Abitibi-Price), proposed a control program on high priority stands in the moderate and severe forecast areas and on silviculturally important areas in the light forecast. Initially, a program was drafted to treat about 237 000 hectares. After further refinement and re-orientation based on available aircraft type, about 220 000 hectares consisting of 90 spray blocks ranging in size from 195 hectares up to 27 600 hectares were proposed for treatment (Figure 1, Table 1). Of the 90 blocks, 82 were to receive two applications (four - six days apart) of the chemical insecticide Fenitrothion (Folithion) at 210g ai/1.5 L/ha in an oil-based formulation and eight blocks (approximately 6 500 hectares) were scheduled to receive one application of the biological insecticide - *Bacillus thuringiensis* (B.t.) (Dipel 132) at 30 BIU/2.36L/ha (undiluted). One of the B.t. blocks was to receive a second application for comparison purposes.

Spray aircraft were contracted from Conifair Aviation of St. Jean, Quebec and consisted of one four-engine Douglas DC-6 equipped with boom and nozzle spray apparatus, one team of four single-engine (600 h.p.) Grumman AgCats and one team of four single-engine (1,200 h.p.) Ayres Bull Thrushes. The single-engine spray aircraft were equipped with six AU 5,000 each. In addition, six other aircraft consisting of three twin-engine fixed wings and three helicopters provided supervisory, navigational and/or sampling support for the program. There were three bases of operation located at Stephenville Airport, Deer Lake Airport and Port au Choix Airstrip with the DC-6 operating from Stephenville, the Bull Thrushes mainly from Deer Lake and the AgCats mainly from Port au Choix.

Spray operations commenced on June 27 and terminated on August 4, a total of 39 days. Spray missions took place on 31 of the 39 days (79%) from at least one of the bases. The usual average for previous years was about 50%. The maximum number of spray days for any one team was 29 (75%) for the Bull Thrushes. The DC-6 and AgCats sprayed on 56% and 54% of available days respectively. The higher percentage for the Bull Thrushes resulted mainly from close proximity of spray blocks to spray bases combined with relatively good spray weather.

Of the 90 proposed blocks, 78 (87%) received treatment. This consisted of 72 blocks (92%) being treated with Fenitrothion (Folithion) and 6 blocks (8%) being treated with B.t. (Dipel 132). The total area treated was 168 595 hectares consisting of 149 862 hectares (89%) receiving two applications of Fenitrothion, 14 500 hectares (9%) receiving one application of Fenitrothion, 875 hectares (0.5%) receiving two applications of B.t. and 3 308 hectares (2%) receiving one application of B.t. The blocks which were not treated (10 chemical and 2 B.t.) and those which received only one application of Fenitrothion (8) had very low or insufficient looper numbers to warrant the full prescribed treatment and were, therefore, eliminated without being sprayed or sufficient looper population reduction occurred after the first application so that the second application was not necessary. All other proposed areas where larval numbers were sufficient to cause defoliation and, therefore, warranted protection, were treated. The DC-6 sprayed 42% of the area, the Bull Thrushes 41% and the AgCats 17%.

Pre-spray larval population levels were again variable within the forecast as is typical of the looper distribution. Sampling methodology consisted of 'beating' larvae from three trees per plot by using poles and a 1.8 m x 2.4 m beating sheet. An average number of larvae per tree was determined per plot and used to generate block data on pre-spray and post-spray population levels. Sampling continued from time of hatching until the late larval instar (L4). The average number of larvae per block for all blocks ranged from one per sample unit up to about 1,500 with the majority being greater than ten larvae per unit which was sufficient to cause significant defoliation.

Blocks were given priority for treatment based on insect numbers, logistics and value of stands (eg. silviculture); therefore, some areas received treatment at the 'ideal' time while others were somewhat delayed. The strategy was to spray all blocks requiring treatment with at least one application of insecticide during early larval feeding to reduce populations and protect foliage as soon as possible. With this in mind, priority was given to blocks that had the highest larval numbers based on extensive plot sampling.

Detailed analysis of all sample data from all plots is ongoing, but preliminary results by block follow*. Blocks were analyzed by treatment, either one or two applications of Fenitrothion or one or two applications of B.t. A number of blocks which were treated received rainfall within one - two days after treatment and were not included in these results. Blocks that received two applications of Fenitrothion had larval population reductions that ranged from 60% to 100% with the average reduction of about 88%. Forty-seven percent of the blocks had greater than 90% population reduction and, in fact, 29% of the blocks had greater than 95% reduction. In non-sprayed areas, population reductions ranged from 0% - 99% with the average reduction of 47%. Only 9% of the check areas for each block had greater than 90% reduction, 58% had less than 60% reduction, the minimum reduction occuring in the spray blocks and, in fact, 26% had no population reduction. Blocks (eight in number) receiving only one application of Fenitrothion generally had lower population levels and were treated at a later date than the double application blocks. The average population reduction in these was 69%. This is in comparison with the above figures for check areas.

* Those blocks for which data is available (N=64).

Blocks (six in number) which were treated with B.t. had population numbers similar to those in chemical blocks. Four blocks, three with a single application and one with a double application of Dipel 132, were sampled. Two of the three blocks receiving a single application (applied late in the program) had average population reductions between 80 and 85%. The other block had a 34% population reduction. The block receiving two applications (applied at an earlier date) had a similar population reduction (83%) after the first application and 99% reduction after the second application. B.t. seems to have given reasonable population reduction on the limited number of blocks treated in this program.

Ground defoliation estimates were made on all blocks and check areas prior to spray and after spray. However, there appeared to be a number of problems associated with the comparison of sprayed and unsprayed areas. Although there was generally less average defoliation in treated versus untreated areas, the difference was not great. This is believed to be the result of sampling anomalies. Aerial defoliation estimates of sprayed and unsprayed areas as well as a general defoliation survey conducted by the Canadian Forestry Service have been carried out. Results have been tabulated, and indicate that overall there was noticeably more defoliation evident outside the borders of sprayed blocks and other unsprayed areas including buffer zones than within treated areas. The objective of limiting defoliation was achieved. In the chemical blocks, 84% of the treated area had no noticeable defoliation, 5% had light, 3% had moderate and 8% had severe defoliation. In the B.t. blocks, 78% had no noticeable defoliation, 6% light, 1% moderate and 15% severe (Table 2). Generally defoliation was higher in areas previously defoliated and/or with high larval numbers, evident from the air, prior to treatment.

Environmental monitoring was again carried out as a requirement of a provincial licence to spray. The consulting firm of S. Fudge and Associates monitored six spray areas for impact of Fenitrothion on songbirds and also collected foliage for residue analysis. Draft reports have just been received and are presently being evaluated.

The cost of the program is expected to be slightly less than the budget figure of $3.6 million which is cost-shared by Government and the pulp and paper industry (1/3:2/3 ratio). The program employed approximately 55 people directly plus an additional 30 people employed by contractors.

In addition to the operational program, the C.F.S., in cooperation with the Department of Forest Resources and Lands, carried out an experimental spray program to field test Fenitrothion, Dimilin and B.t. (Dipel 132, 176 and 264) against the hemlock looper. The objectives were to test earlier applications, new dosages, new formulations and the micronair AU 4000. Results are presented separately.

The 1988 looper forecast is not yet available. C.F.S. crews have just completed field work and samples are being processed. Results are expected in early January.

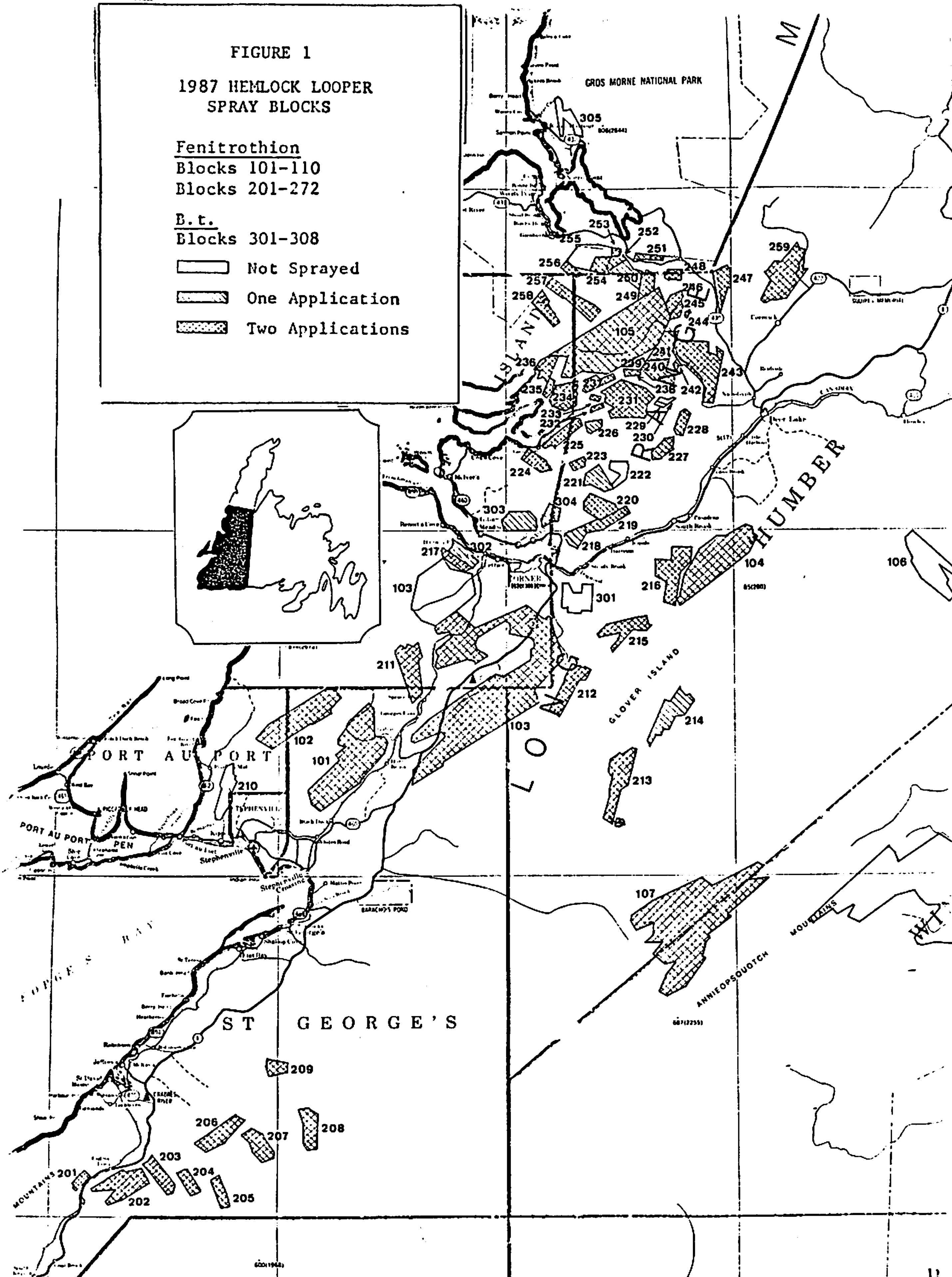


FIGURE 1

1987 HEMLOCK LOOPER SPRAY BLOCKS

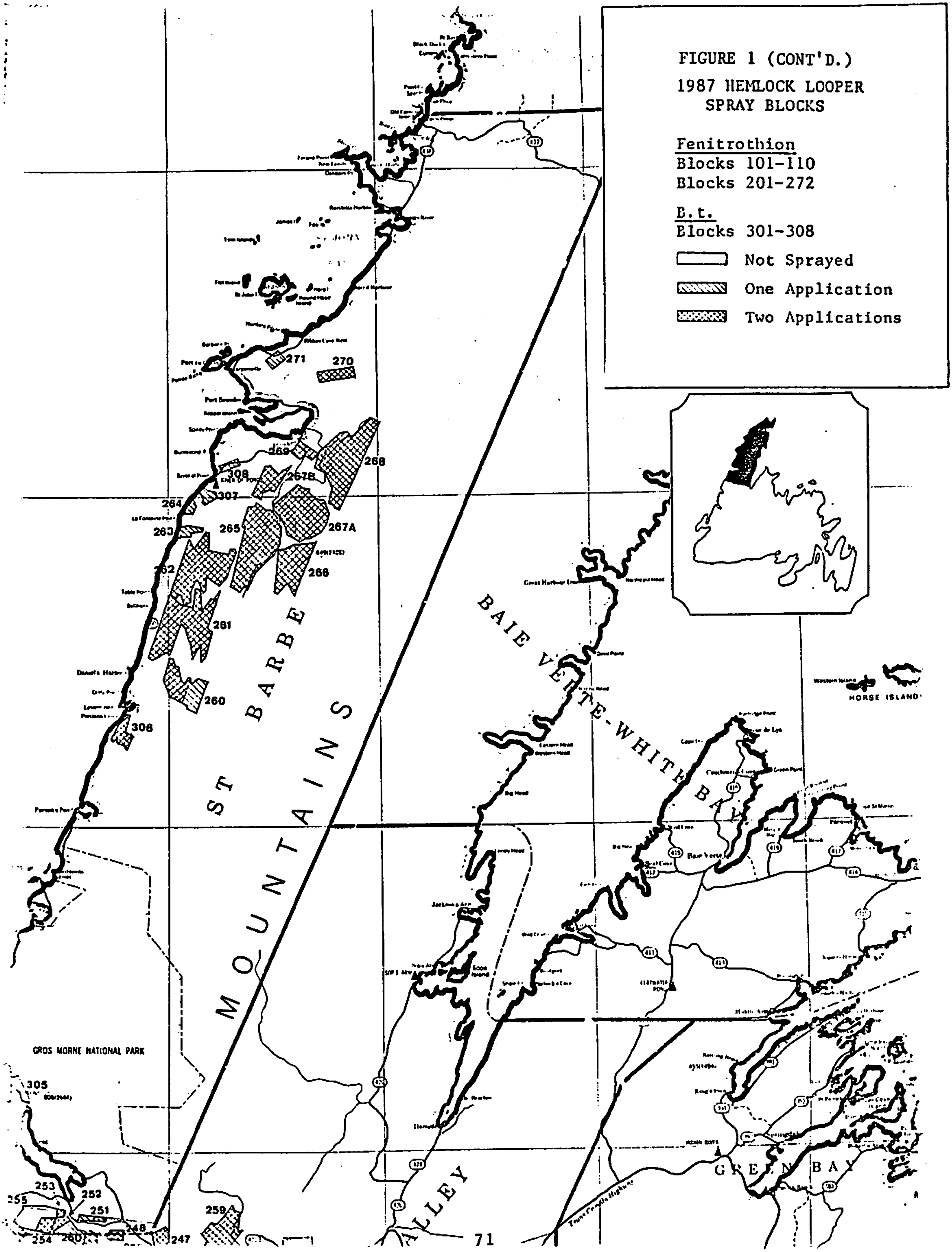


FIGURE 1 (CONT'D.)
1987 HEMLOCK LOOPER
SPRAY BLOCKS
Fenitrothion
Blocks 101-110
Blocks 201-272
B.t.
Blocks 301-308
Not Sprayed
One Application
Two Applications
ST BARBE MOUNTAINS
BAIE VERTE-WHITE BAY
GREEN BAY
GROS MORNE NATIONAL PARK
HORSE ISLAND
271
270
269
268
267B
267A
308
307
264
263
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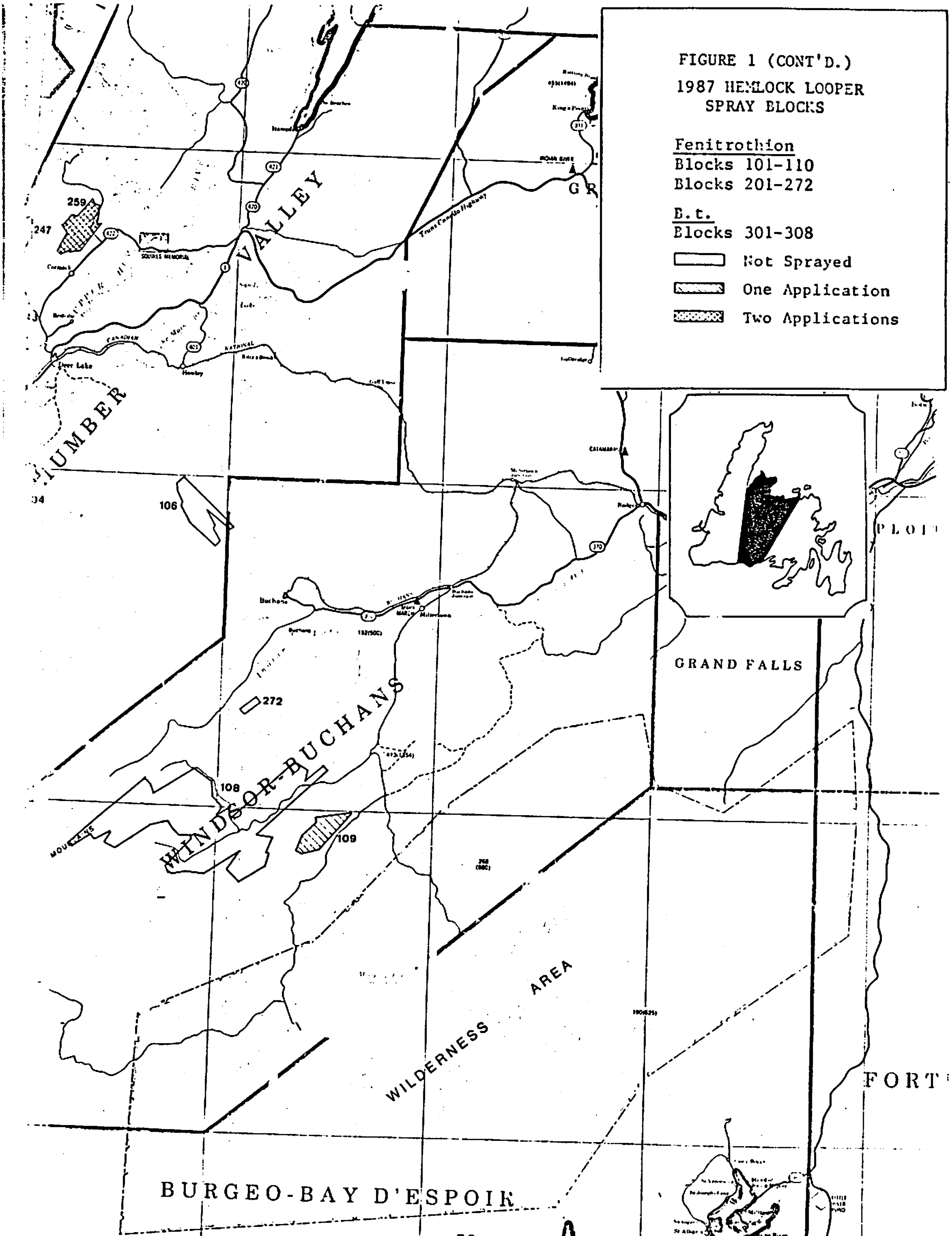

FIGURE 1 (CONT'D.)
1987 HEMLOCK LOOPER SPRAY BLOCKS

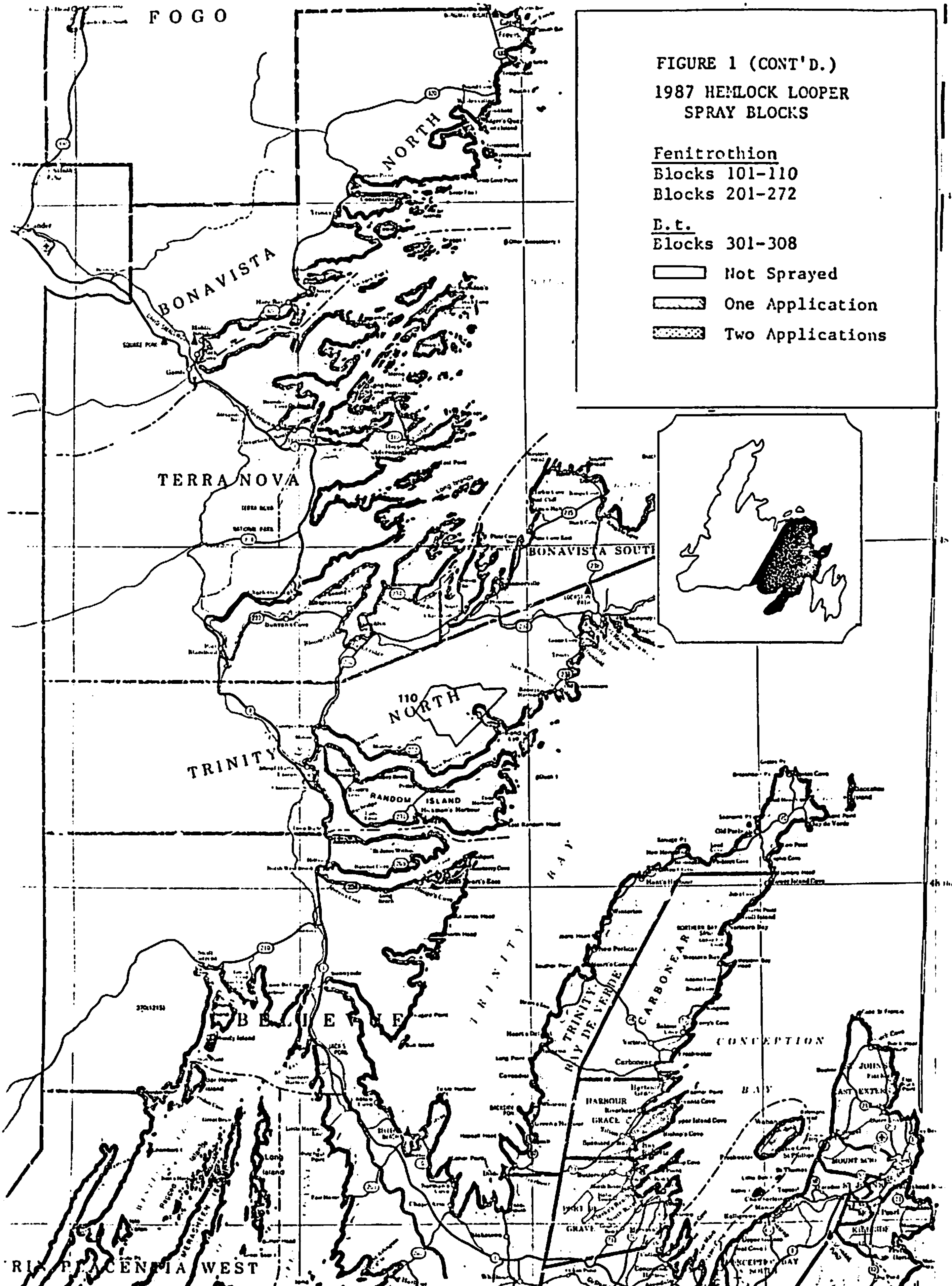

FIGURE 1 (CONT'D.)
1987 HEMLOCK LOOPER SPRAY BLOCKS

TABLE 1

1987 HEMLOCK LOOPER SPRAY PROGRAM
Hectares

Block #	Received One Application	Received Two Applications	Total Block Area Treated
Chemical(a)			
101	159	8 797	8 956
102	419	3 611	4 030
103	1 116	20 372	21 488
104	-	5 181	5 181
105	259	8 364	8 623
106	Dropped	-	-
107	149	13 615	13 764
108	Dropped	-	-
109	2 379	-	2 379
110	Dropped	-	-
TOTALS	4 481	59 940	64 421
201	100	460	560
202	512	2 618	3 130
203	59	1 166	1 225
204	-	470	470
205	-	735	735
206	333	3 165	3 498
207	-	1 070	1 070
208	-	1 275	1 275
209	22	895	917
210	Dropped	-	-
211	-	2 510	2 510
212	204	1 581	1 785
213	-	2 765	2 765
214	2 735	-	2 735
215	-	1 395	1 395
216	-	4 040	4 040
217	-	1 015	1 015
218	985	-	985
219	-	1 170	1 170
220	-	940	940
221	770	-	770
222	Dropped	-	-
223	-	280	280
224	-	1 005	1 005
225	-	1 470	1 470
226	465	-	465
227	-	630	630
228	15	380	395
229	Dropped	-	-
230	Dropped	-	-
231	-	2 660	2 660
232	-	260	260

TABLE 1 (Cont'd.)

1987 HEMLOCK LOOPER SPRAY PROGRAM
Hectares

Block #	Received One Application	Received Two Applications	Total Block Area Treated
233	-	290	290
234	-	1 840	1 840
235	-	235	235
236	-	1 025	1 025
237	-	586	586
238	-	340	340
239	Dropped	-	-
240	-	1 135	1 135
241	-	1 430	1 430
242	-	195	195
243	-	3 710	3 710
244	-	225	225
245	-	465	465
246	-	430	430
247	280	595	875
248	47	548	595
249	-	860	860
250	965	-	965
251	-	780	780
252	-	475	475
253	-	480	480
254	-	405	405
255	Dropped	-	-
256	-	305	305
257	-	1 515	1 515
258	-	1 180	1 180
259	150	1 500	1 650
260	1 227	2 018	3 245
261	-	6 915	6 915
262	295	6 110	6 405
263	-	570	570
264	210	-	210
265	-	5 000	5 000
266	290	2 430	2 720
267A & B	-	6 020	6 020
268	-	4 975	4 975
269	-	570	570
270	95	810	905
271	310	-	310
272	Dropped	-	-
TOTALS	10 069	89 922	99 991
CHEMICAL TOTALS	14 550	149 862	164 412

TABLE 1 (Cont'd.)

1987 HEMLOCK LOOPER SPRAY PROGRAM
Hectares

Block #	Received One Application	Received Two Applications	Total Block Area Treated
B.t. (b)			
301	Dropped	-	-
302	535	-	535
303	1 465	-	1 465
304	448	-	448
305	Dropped	-	-
306	-	875	875
307	445	-	445
308	415	-	415
B.T. TOTALS	3 308	875	4 183
GRAND TOTALS	17 858	150 737	168 595

(a) Fenitrothion (Folithion) - 210 g ai/1.5L/ha
(b) Dipel 132 - 30 BIU/2.36L/ha (undiluted)

TABLE 2

1987 HEMLOCK LOOPER DEFOLIATION

(% OF BLOCK AREA BY CATEGORY)

CHEMICAL

Block #	Nil	Light	Moderate	Severe
101	93	-	<1	7
102	84	1	8	6
103	93	3	<1	4
104	97	-	-	3
105	96	<1	2	1
107	Not Available			
109	90	-	<1	9
201	100	-	-	-
202	99	-	-	<1
203	100	-	-	-
204	80	-	-	20
205	25	-	16	59
206	94	-	-	6
207	22	-	14	64
208	-	-	10	90
209	34	-	14	52
211	88	-	-	12
212	91	1	-	8
213	94	-	-	6
214	83	-	4	13
215	99	-	1	-
216	99	-	1	-
217	14	46	25	15
218	100	-	-	-
219	100	-	-	-
220	99	-	-	1
221	100	-	-	-
223	100	-	-	-
224	100	-	-	-
225	98	-	1	1
226	100	-	-	-
227	88	12	-	-
228	80	-	20	-
231	99	-	-	<1
232	100	-	-	-
233	97	-	3	-
234	99	-	<1	-
235	100	-	-	-
236	86	-	4	10
237	100	-	-	-
238	100	-	-	-
239	100	-	-	-
241	100	-	-	-
242	92	-	-	8
243	95	<1	4	<1
244	92	5	3	-

TABLE 2 (Cont'd.)

1987 HEMLOCK LOOPER DEFOLIATION

(% OF BLOCK AREA BY CATEGORY)

CHEMICAL

Block #	Nil	Light	Moderate	Severe
245	97	-	-	3
246	51	16	10	23
247	100	-	-	-
248	95	4	-	<1
249	100	-	-	-
250	100	-	-	-
251	75	21	-	4
252	100	-	-	-
253	100	-	-	-
254	100	-	-	-
256	100	-	-	-
257	92	8	-	<1
258	84	-	16	<1
259	100	-	-	-
260	33	-	2	65
261	23	57	9	11
262	84	2	5	9
263	89	2	7	2
264	87	-	-	13
265	49	39	5	7
266	29	25	43	3
267A & B	91	-	-	9
268	88	2	3	7
269	88	7	-	5
270	80	-	13	7
271	100	-	-	-
TOTAL CHEMICAL	84	5	3	8

Bt

Block #	Nil	Light	Moderate	Severe
302	68	20	-	12
303	96	1	2	<1
304	82	16	-	2
306	45	-	-	55
307	73	10	4	13
308	98	-	-	2
TOTAL B.T.	78	6	1	15

JACK PINE BUDWORM IN ONTARIO[1]

- Outbreak Status in 1987
- Forecasts 1988
- Results of Spraying Operations, 1987

by

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[1] Report prepared for the Fifteenth Annual Forest Pest Control Forum, Ottawa, November 17-19, 1987.

[2] Canadian Forestry Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario.

[3] Ontario Ministry of Natural Resources, Pest Control Section, Maple, Ontario.

OUTBREAK STATUS, 1987

The current jack pine budworm outbreak began in 1982 when 981 ha of moderate-to-severe defoliation were detected in Parry Sound and Huronia districts. By 1985, the area of defoliation had increased to some 3,660,069 ha affecting three different geographical regions of the province - southern, northeastern and northwestern. The infestation in northeastern and southern Ontario declined substantially in 1986 when a total of 1,743,725 ha of moderate-to-severe defoliation were mapped. A further decline occurred in 1987 when 504,749 ha of defoliation were observed, all of it in northwestern Ontario (Table 1 and Fig. 1). Population elsewhere in the province have apparently returned to endemic levels.

In northwestern Ontario, the larger areas of moderate-to-severe defoliation which occurred in 1986 broke up into numerous smaller patches, the majority of which occurred in Dryden and Red Lake districts. The largest single infestation was located in the area surrounding Nungesser Lake in Red Lake District where jack pine stands within an area of 163,532 ha were defoliated. A second large pocket encompassing 47,172 ha straddled the Red Lake-Sioux Lookout district boundaries in the Aerofoil Lake area. The remainder of the 1987 defoliation was composed of some 350 separate pockets scattered throughout the region and ranged in size from just a few hectares to several thousand hectares.

Defoliation levels within the infested area also declined in 1987. In 1986, roughly 48% of the mapped defoliation fell into the severe category, while in 1987 this figure fell to 18%.

FORECASTS 1988

A total of 252 jack pine budworm egg-mass samples were collected in Ontario in 1987. All but 53 of these locations were in the Northwestern Region, the only region with observable budworm defoliation this year. Samples collected in the North Central, Northern, Northeastern and Algonquin regions indicate that this pest has returned to endemic levels in these areas and should not cause any defoliation in 1988. Overall, egg-mass densities have declined by 75% (Table 2). A comparison of egg-mass densities at 97 locations sampled in the Northwestern Region in 1986 and 1987 showed an overall decrease of 73% (Table 3). Significant reductions in egg-mass densities were observed in all districts in the region.

Based on results of the 1987 egg-mass survey and historical records of earlier jack pine budworm outbreaks, the current jack pine budworm outbreak will be significantly reduced in the Northwestern Region in 1988. Small, scattered pockets of light-to-moderate defoliation may persist in some areas - for example in the Nungesser Lake area in Red Lake District and in the east-central portion of Dryden District - but large extensive areas of moderate-to-severe defoliation are not expected to occur.

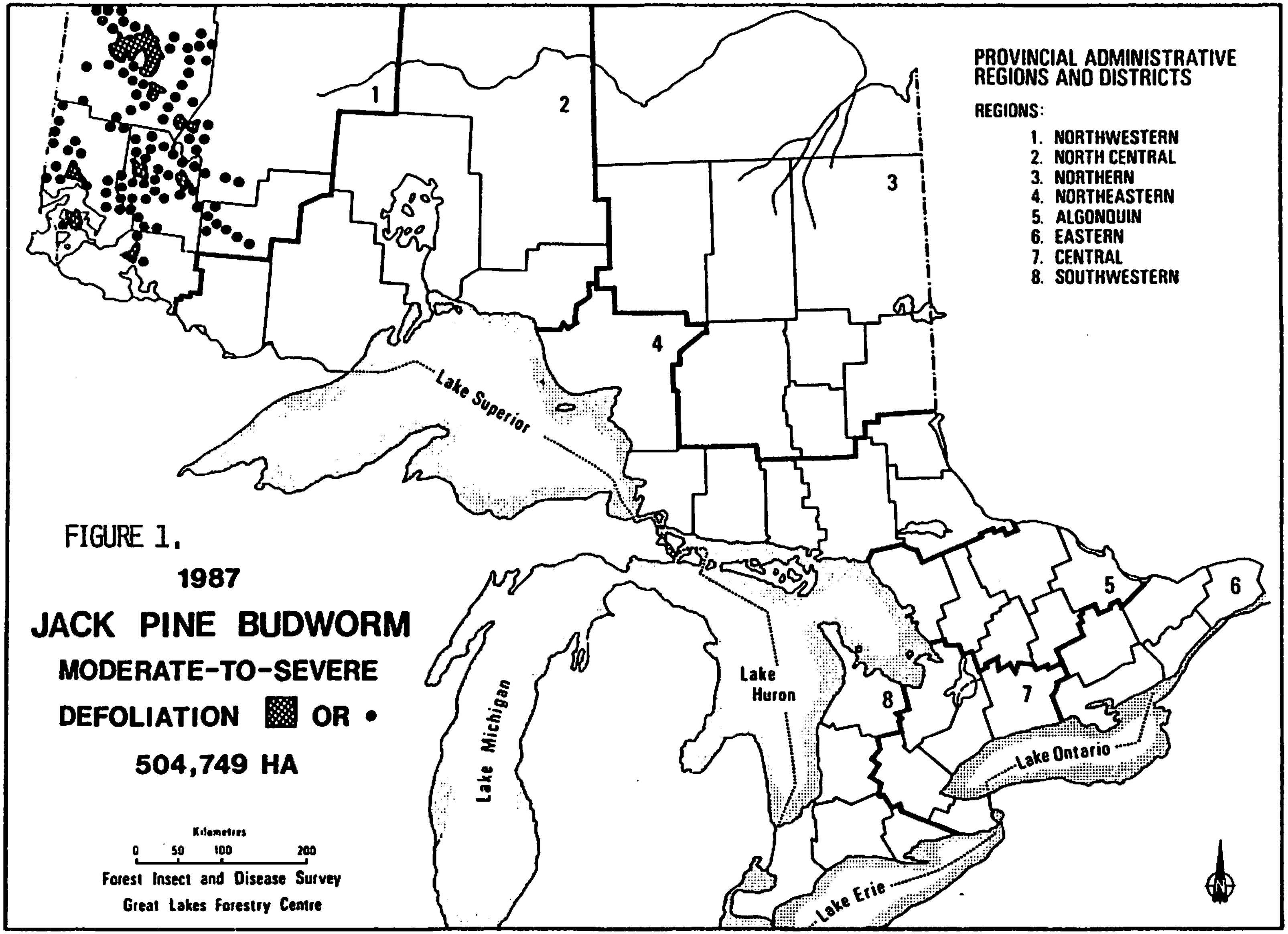


FIGURE 1.

1987

JACK PINE BUDWORM

MODERATE-TO-SEVERE DEFOLIATION ▩ OR •

504,749 HA

Forest Insect and Disease Survey
Great Lakes Forestry Centre

Table 1. Gross area (ha) of current moderate-to-severe defoliation by the jack pine budworm in Ontario from 1982-1987.

Region District	1982	1983	1984	1985	1986	1987
		Area of moderate-to-severe defoliation (ha)				
Northwestern						
Red Lake			139,334	1,027,202	877,521	286,949
Fort Frances			14,044	44,652	99,391	11,237
Ignace			0	15,973	37,435	21,194
Kenora			0	372,242	315,731	69,344
Sioux Lookout			0	16,646	90,408	30,520
Dryden			0	16,103	133,653	85,505
			153,378	1,477,818	1,554,139	504,749
North Central						
Atikokan		6,970	335,770	278,623	31,391	
Thunder Bay		0	34,798	6,783	0	
		6,970	370,568	285,406	31,391	
Northeastern						
Sault Ste. Marie		0	746	14,262	0	
Blind River		9,250	118,021	256,351	24,741	
Espanola		8,880	233,027	217,665	1,212	
Sudbury		11,840	76,896	385,762	30,129	
Temagami		0	530	6,224	0	
North Bay		0	0	6,792	545	
		29,970	429,220	887,056	56,627	
Northern						
Chapleau			95,598	546,198	60,929	
Gogama			49,102	334,815	32,540	
Kirkland Lake			26,895	74,742	0	
			171,595	955,755	93,469	
Algonquin						
Parry Sound	593	30,202	25,639	54,034	8,099	
Central						
Huronia	80					
Southwestern						
Owen Sound	308					
TOTAL	981	67,142	1,150,158	3,660,069	1,743,725	504,749

Table 2. Comparison of jack pine budworm egg-mass densities in Ontario in 1986 and 1987.

Region	No. of locations sampled 1987	No. of locations common to 1986 and 1987	Average number of egg-masses 1986	1987	Change %
Northwestern	199	97 (7)*	6.4	1.7	-73
North Central	12	7	4.3	0.3	-93
Northern	13	8	0.3	0	-100
Northeastern	22	17	1.0	0	-100
Southern Ontario	6	6	0.5	0.2	-66
Overall	252	135	5.0	1.3	-75

* includes 7 locations aerially sprayed with *B.t.* in 1987.

Table 3. Comparison of jack pine budworm egg-mass densities in the Northwestern Region in 1986 and 1987.

District	No. of locations common to 1986 and 1987	Average number of egg-masses 1986	1987	Change %
Dryden	21 (2)*	9.7	2.4	-75
Fort Frances	12	5.4	0.1	-98
Ignace	10	4.7	2.2	-53
Kenora	19 (4)*	8.6	0.9	-90
Red Lake	29 (1)*	4.5	2.4	-47
Sioux Lookout	6	2.0	0.3	-83
Overall	97	6.4	1.7	-73

* includes 7 locations aerially sprayed with *B.t.* in 1987.

RESULTS OF SPRAYING OPERATIONS

The Ontario Ministry of Natural Resources aerially sprayed some 105,463 ha of forest in four districts in the Northwestern Region in 1987 to protect stands of jack pine from defoliation by the jack pine budworm. Spray blocks in Kenora, Fort Frances, Dryden and Red Lake districts were treated with a single application of Dipel 132 at a rate of 20 BIU/1.57L/ha using fixed-wing aircraft (Ag Cats and Pawnees). No experimental trials were conducted against the jack pine budworm in 1987.

Most of northern Ontario experienced unusually warm weather in April and early May followed by cool, wet conditions in late May (Fig. 2). Despite this abnormal spring weather, insect and host development was not significantly affected and all blocks were opened for spraying between June 1-3, several days earlier than 1986. Spraying began on June 3 when most larvae were third and fourth instars and was completed June 15. Examples of insect development curves are presented in Figure 3.

A total of 124 plots (10 trees per plot) were established in some 28 spray blocks and another 40 plots were established in unsprayed areas to assess the effectiveness of the aerial spraying program. Results are presented in tables 4 and 5 and figure 4. In tables 4 and 5, results, in terms of population reduction due to treatment and defoliation, have been calculated on the basis of the presence or absence of male staminate flowers. Larval densities are generally higher on trees with staminate flowers than on trees without flowers. As well, larval development rates and exposure to the insecticide may differ in these two situations. Male staminate flowers were observed on approximately 29% of the trees sampled in the two districts this year.

On a plot-to-plot and block-to-block basis, spray efficacy was typically quite variable. However, the overall results of the 1987 program indicate substantial foliage protection at all population densities. Average survival rates (from early instar larvae to adults) in spray blocks and check plots are presented in Table 6.

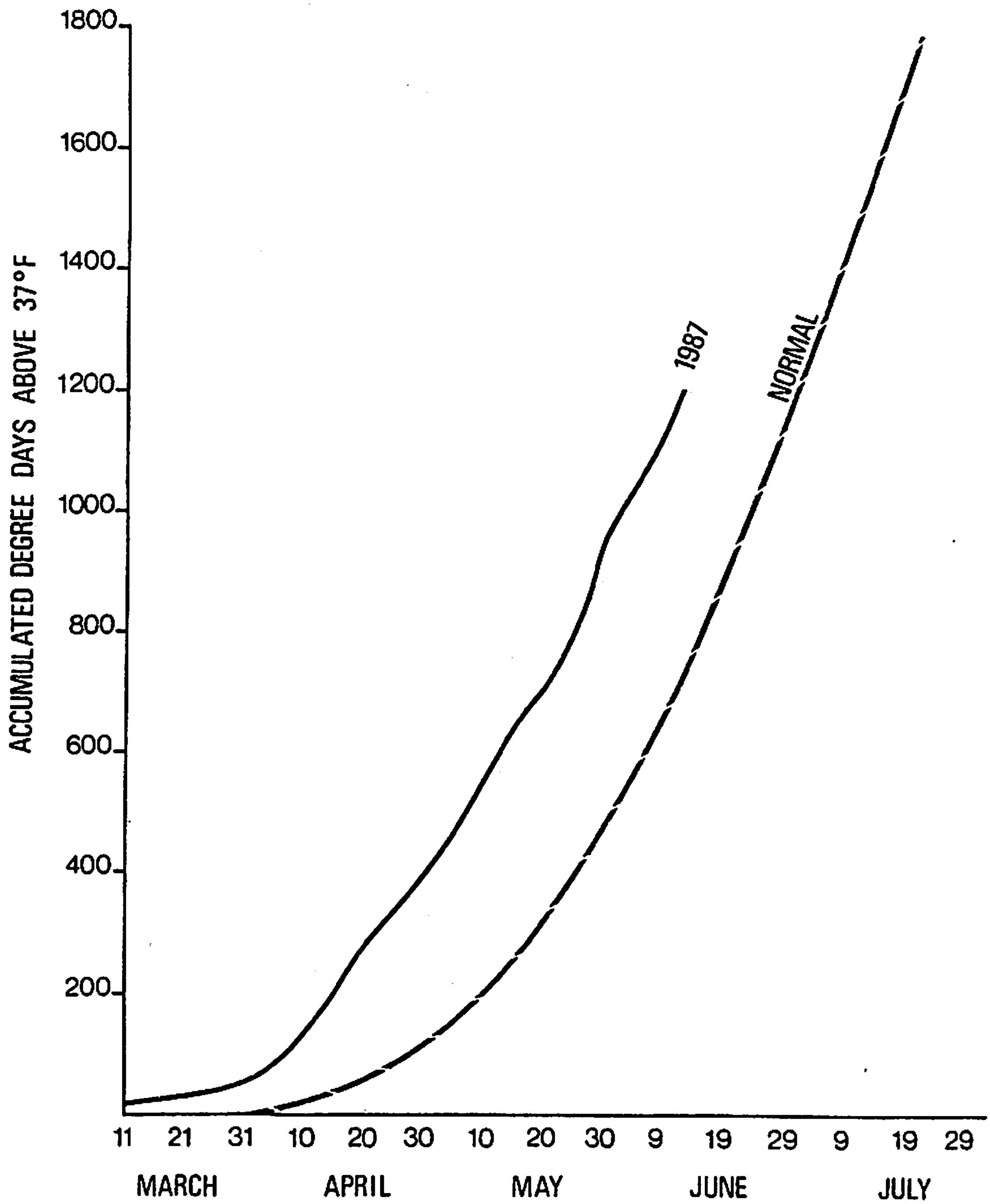


Figure 2. Heat accumulation in degree days for Dryden, Ontario, 1987. (Threshold 2.8°C).

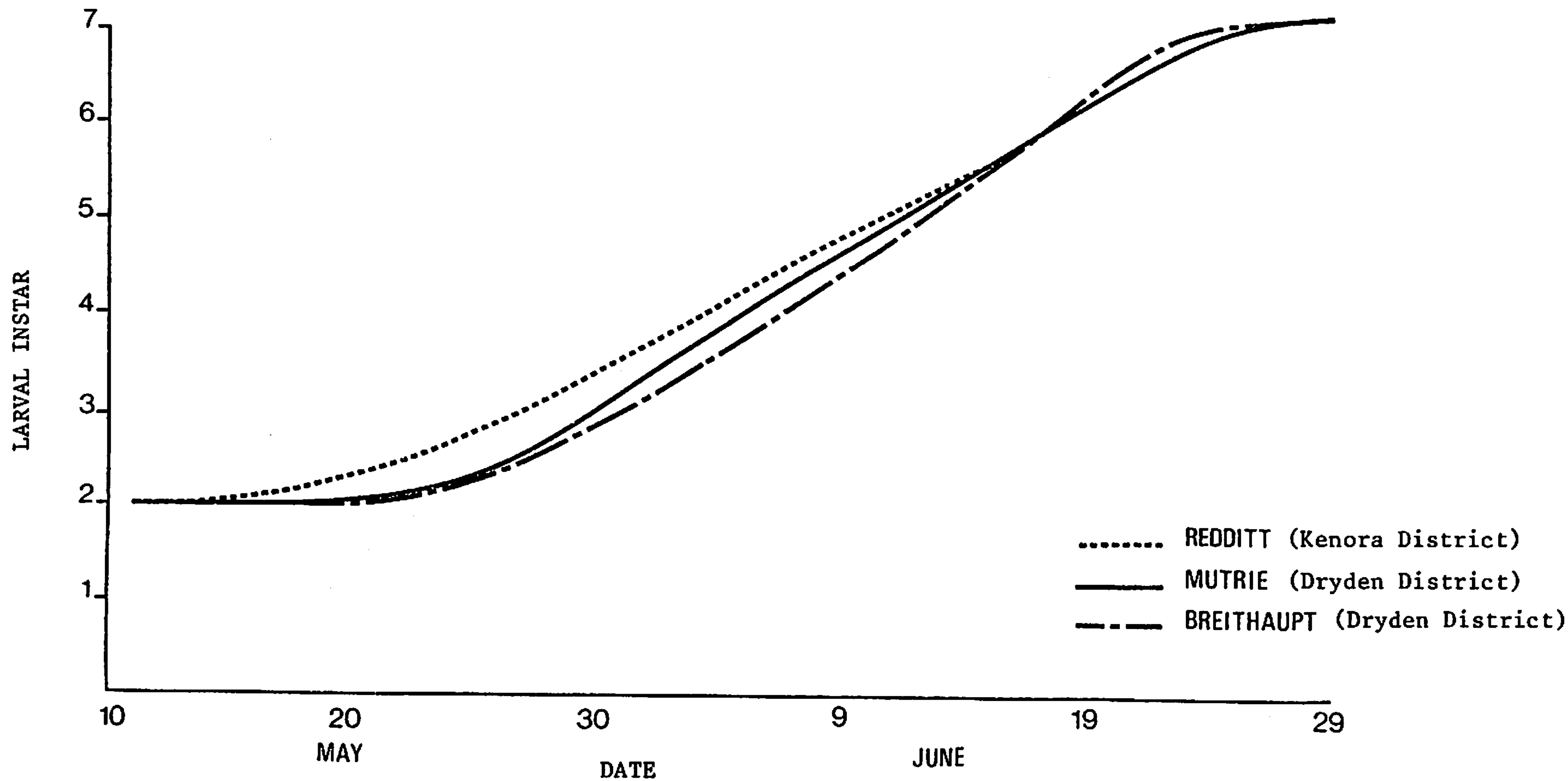


Figure 3. Jack pine budworm larval development rates in northwestern Ontario, 1987.

Table 4. Jack pine budworm: Population reduction and foliage protection attributable to a single application of Dipel 132 (20 BIU/1.57Lha) on jack pine in Kenora District, 1987.

	Staminate Flowers Present			Staminate Flowers Absent		
Block No.	Prespray larvae per 60 cm branch tip	% Population reduction due to treatment	% 1987 defol.	Prespray larvae per 60 cm branch tip	% Population reduction due to treatment	% 1987 defol.
8D	7.8	100	13	2.2	100	9
Checks	7.7		42	2.3		20
13	13.7	83	7	2.0	0	7
Checks	13.3		63	2.1		18
20	5.2	84	14	2.4	100	13
Checks	5.8		30	2.3		20
24A	8.4	100	7	2.9	100	10
Checks	8.1		47	3.1		28
26	3.1	100	13	0.6	0	5
Checks	3.3		46	2.1		18
27B	7.5	100	23	3.9	100	15
Checks	7.7		42	4.0		28
29	12.4	95	18	6.6	94	25
Checks	13.3		63	6.5		40
32	13.9	90	26	9.3	92	27
Checks	13.3		63	9.6		59
36	7.3	89	25	5.1	97	20
Checks	7.7		42	5.3		44
38	11.9	100	5	7.0	100	6
Checks	11.1		64	7.4		52
39	6.0	95	29	2.4	51	25
Checks	5.8		30	2.3		20
40	10.2	0	28	6.8	30	29
Checks	9.8		55	6.5		40
41	16.0	24	49	13.2	55	46
Checks	17.6		65	12.9		61
45B	4.1	100	7	0.7	100	9
Checks	3.7		45	2.1		18

(cont'd)

Table 4. Jack pine budworm: Population reduction and foliage protection attributable to a single application of Dipel 132 (20 BIU/1.57L/ha) on jack pine in Kenora District, 1987 (concl.)

	Staminate Flowers Present			Staminate Flowers Absent		
Block No.	Prespray larvae per 60 cm branch tip	% Population reduction due to treatment	% 1987 defol.	Prespray larvae per 60 cm branch tip	%Population reduction due to treatment	% 1987 defol.
46	14.9	100	28	8.4	100	35
Checks	13.9		62	8.4		47
47	9.8	88	30	6.9	100	17
Checks	9.8		55	6.5		40
53	8.2	91	7	3.5	85	7
Checks	8.1		47	3.1		28
56N	8.5	91	19	4.9	100	12
Checks	8.1		47	5.3		44
57	9.6	100	38	5.9	96	29
Checks	9.8		55	5.8		44

Table 5. Jack pine budworm: Population reduction and foliage protection attributable to a single application of Dipel 132 (20 BIU/1.57L/ha) on jack pine in Dryden District, 1987.

	Staminate Flowers Present			Staminate Flowers Absent		
Block No.	Prespray larvae per 60 cm branch tip	% Population reduction due to treatment	% 1987 defol.	Prespray larvae per 60 cm branch tip	% Population reduction due to treatment	% 1987 defol.
2	14.1	99	14	5.7	97	16
Checks	13.3		63	5.4		46
3	15.7	65	25	3.7	24	40
Checks	17.7		65	3.6		27
7	2.2	100	5	1.3	61	8
Checks	2.5		33	2.3		21
8	8.4	90	11	3.3	76	11
Checks	7.9		39	3.6		26
18	24.9	68	50	7.4	64	33
Checks	17.7		65	7.3		49
20	18.1	78	50	9.4	70	52
Checks	17.7		65	8.8		55
21	17.8	69	43	4.8	74	27
Checks	17.7		65	4.7		32
22	13.0	87	15	3.8	59	18
Checks	13.3		63	3.7		28
26	18.7	13	25	4.0	26	16
Checks	17.7		65	4.4		28

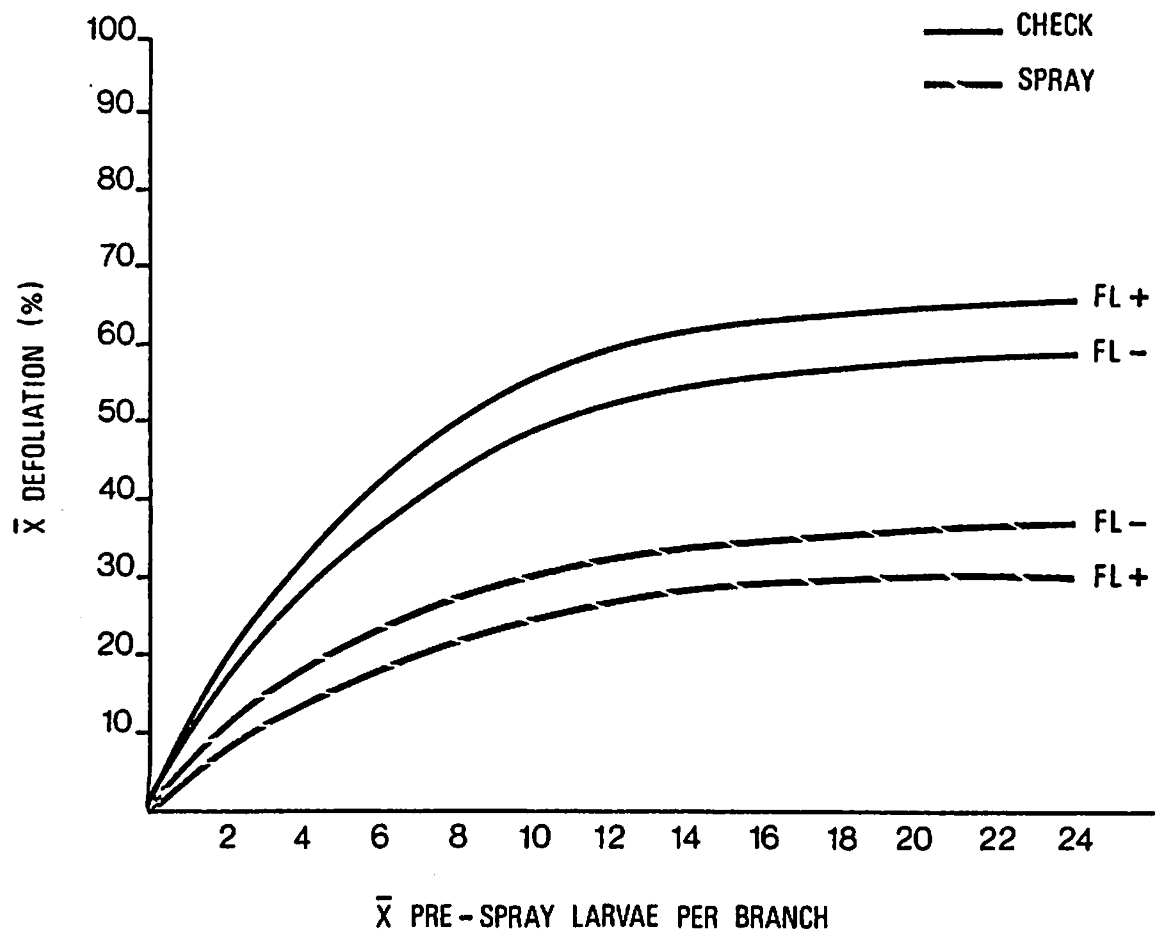


Figure 4. Jack pine budworm: Jack pine defoliation rates on trees with and without staminate flowers in areas treated with a single application of Dipel 132 at 20 BIU/1.57L/ha.

Table 6. Jack pine budworm: Survival rates in sprayed and unsprayed (check) plots on jack pine in the Northwestern Region, 1987.

	Flowers present + or not -	Prespray living larvae per 60 cm branch tip	Postspray living budworm per 60 cm branch tip	Survival rate
Spray plots	+	11.5	0.7	.059
Spray plots	-	5.0	0.3	.062
Checks	+	7.7	2.0	.265
Checks	-	6.6	2.3	.342

JACK PINE BUDWORM CONTROL OPERATIONS IN ONTARIO - 1987

J. J. Churcher
Pest Control Section
Ministry of Natural Resources

A reduction in the area of moderate to severe defoliation of all major insect pests resulted in a smaller aerial control program than in the previous year. On November 13, 1986, the Minister of Natural Resources announced that, once again, Ontario would use only the biological insecticide *Bacillus thuringiensis* (B.t.) in its aerial insecticide programs. Because of this decision early in the planning process, our extensive open house and media briefing programs of previous years and the public's acceptance of forest insect control and the use of B.t., large scale public information centres were not deemed necessary. Local district offices that were proposing aerial spray projects held one day open houses in the district office and provided display material for public review for 30 days. Media briefings were held but drew little interest.

In 1986 the jack pine budworm populations in northeastern Ontario collapsed, leaving only the large area of infestation in the northwest (Figure 1). As a result, all the spraying for jack pine budworm in 1987 occurred in the northwestern part of the province (Figure 2). A total of 105,463 hectares were treated with B.t., specifically using the commercial formulation Dipel 132. The insecticide was used in a single 'neat' application at a rate of 20 BIU/1.6 L/ha.

Four airstrips were used in 1987, located in the Fort Frances, Dryden, Kenora and Red Lake Districts. Fifteen fixed-wing spray aircraft and six pointer aircraft were used, all equipped with rotary atomizers. There were no major incidents associated with this program.

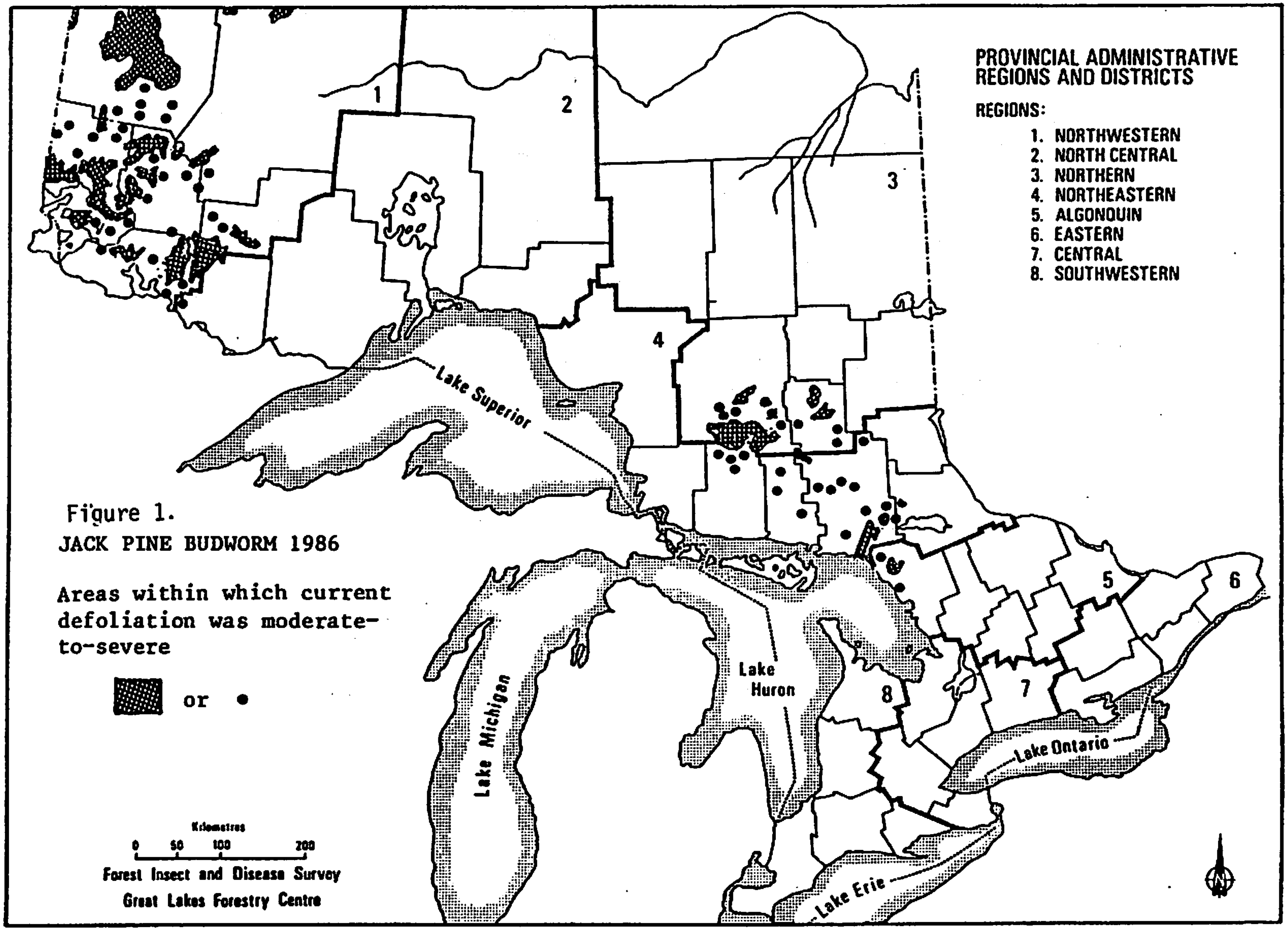


Figure 1.
JACK PINE BUDWORM 1986

Areas within which current defoliation was moderate-to-severe

▩ or ●

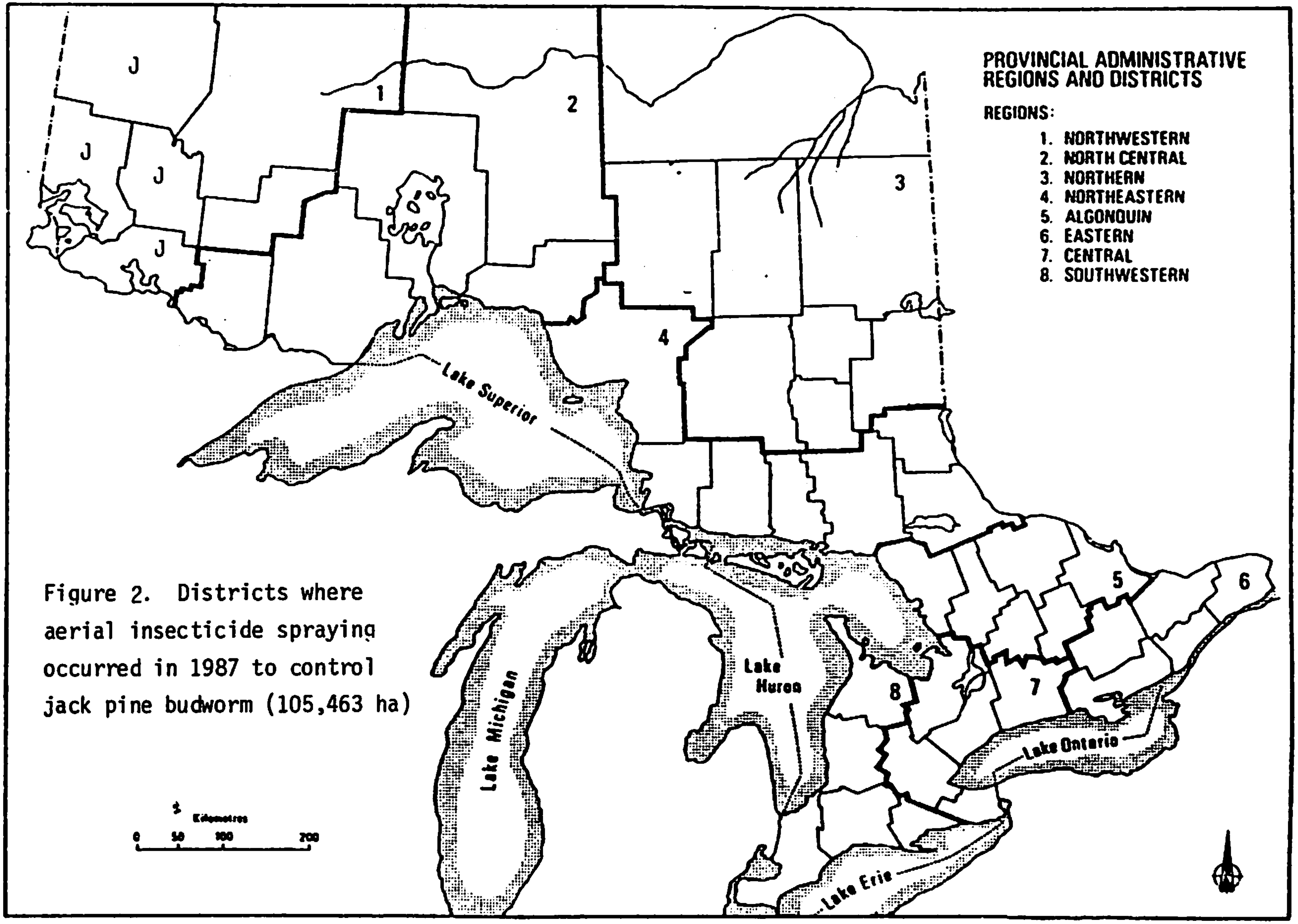


Figure 2. Districts where aerial insecticide spraying occurred in 1987 to control jack pine budworm (105,463 ha)

GYPSY MOTH IN ONTARIO, 1987[1]

- Outbreak Status 1987
- Forecasts 1988
- Results of Spraying Operations, 1987

by

J.H. Meating[2], G.M. Howse[2] and R.A. Lessard[3]

[1] Report prepared for Fifteenth Annual Forest Pest Control Forum, Ottawa, November 17-19, 1987.

[2] Canadian Forestry Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario.

[3] Ontario Ministry of Natural Resources, Pest Control Section, Maple, Ontario.

OUTBREAK STATUS 1987

In 1981, approximately 1,450 ha of gypsy moth defoliation were discovered in the Kaladar area of eastern Ontario. Over the next few years, the infestation increased in size until 1985 when some 246,342 ha of defoliation occurred. After five years of expansion, the gypsy moth infestation declined in 1986 to 167,776 ha. Egg-mass surveys conducted in the fall of 1986 indicated that the decline would continue in 1987 and, indeed, only 12,678 ha of moderate-to-severe defoliation was mapped in 1987, a reduction of 92% (Tables 1-3).

Most of this defoliation occurred as small scattered pockets from the western Carleton Place and Brockville districts, westward through the Tweed and Napanee districts (Fig. 1). The largest of these pockets occurred in Lake Township in the northwestern Tweed District encompassing approximately 1,787 ha. Another large pocket about 925 ha in size was recorded north of the village of Clayton in the Carleton Place District. Despite this declining trend the insect continues to expand westward from the older infested areas in the central Tweed and Napanee districts. This was particularly evident in the southeastern Lindsay District where the area of moderate-to-severe defoliation increased from 417 ha in 1986 to 888 ha in 1987. Most of this defoliation was located north of Carmel in Haldimand Township and north of Campbellcroft at the west end of Rice Lake in Hope Township. Although populations declined in the southern Bancroft and Pembroke districts, small numbers of larvae were collected in previously uninfested areas at the Petawawa National Forestry Institute and at Carson Lake Provincial Park, Pembroke District.

Further west, low numbers of larvae were observed in numerous other areas in the Lindsay District and for the first time, small numbers of larvae were found in the southern Minden District as far north as Mountain Lake. Larvae were also collected at a number of locations in the Maple and Huronia districts with the highest populations in the main tract of the Durham Regional Forest where a light infestation was found within an area of about 10 ha of mixed hardwoods. Small numbers of larvae were also collected at Bronte Creek Provincial Park, Maple District, and at Mara, Springwater, Bass Lake and Awenda provincial parks along with the Midland Golf Club in Huronia District. Light infestations were present in several woodlots in the southern Niagara District. In the Southwestern Region, medium-to-heavy infestations occurred in hardwood stands in three lots on Concession 6, South Walsingham Township, Simcoe District.

Larval Trapping

For the fifth consecutive year, a larval trapping program was carried out in provincial parks in southern Ontario by the FIDS Unit and the OMNR Parks Branch. The program takes advantage of the gypsy moth larval habit of descending from the trees during the day to seek hiding places. A folded strip of burlap tied around the tree trunk provides a hiding place for the larvae where they are easily captured. The traps are installed by the FIDS rangers and monitored by parks personnel on a daily basis. At parks within or on the fringe of the

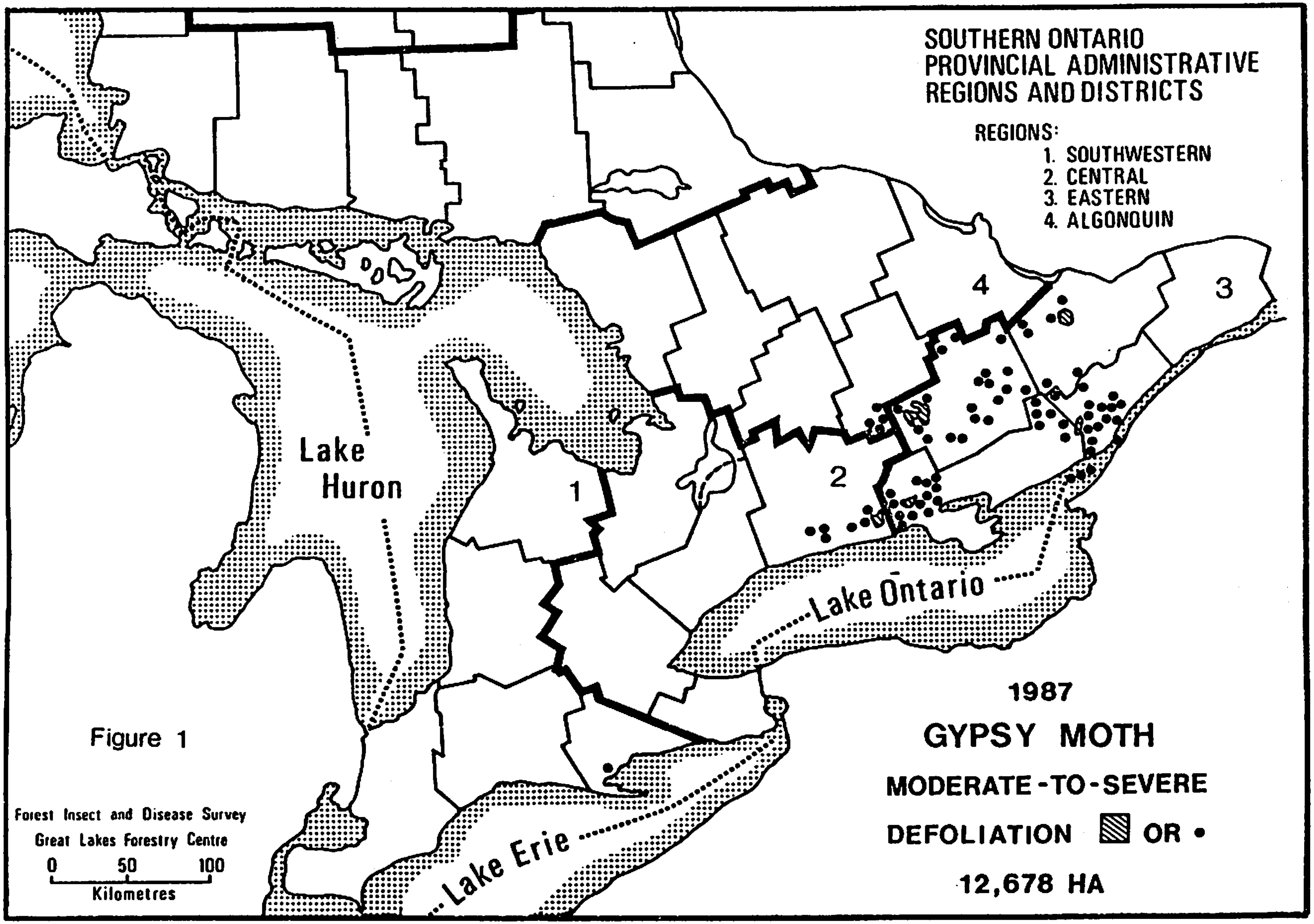

SOUTHERN ONTARIO
PROVINCIAL ADMINISTRATIVE
REGIONS AND DISTRICTS
REGIONS:
1. SOUTHWESTERN
2. CENTRAL
3. EASTERN
4. ALGONQUIN
Lake Huron
Lake Ontario
Lake Erie
1
2
3
4
1987
GYPSY MOTH
MODERATE-TO-SEVERE
DEFOLIATION ▧ OR •
12,678 HA
Forest Insect and Disease Survey
Great Lakes Forestry Centre
0 50 100
Kilometres
Figure 1

Table 1. Gypsy moth infestations in Ontario, 1981-1987.

Year	Gross area (ha) of moderate-to-severe defoliation
1981	1,450
1982	4,800
1983	40,954
1984	80,624
1985	246,342
1986	167,776
1987	12,678

Table 2. Gross area (ha) of moderate-to-severe defoliation by the gypsy moth in 1985, 1986 and 1987.

Region	District	1985	1986	1987
Eastern	Tweed	172,232	73,525	3,329
	Napanee	58,326	57,780	4,781
	Carleton Place	4,197	13,386	1,355
	Brockville	11,232	22,283	2,099
Algonquin	Pembroke	90	221	0
	Bancroft	240	164	111
Central	Lindsay	25	417	888
Southwestern	Simcoe	0	0	115
		246,342	167,776	12,678

Table 3. Gross area (ha) of moderate-to-severe defoliation by the gypsy moth in 1986 and 1987.

County	1986	1987
Northumberland	1,430	2,131
Peterborough	179	167
Hastings	11,668	4,511
Lennox and Addington	8,627	407
Prince Edward	540	0
Frontenac	109,442	1,775
Leeds	22,283	2,099
Lanark	13,356	1,355
Ottawa-Carleton	221	0
Durham	0	118
Simcoe District	0	115
	167,776	12,678

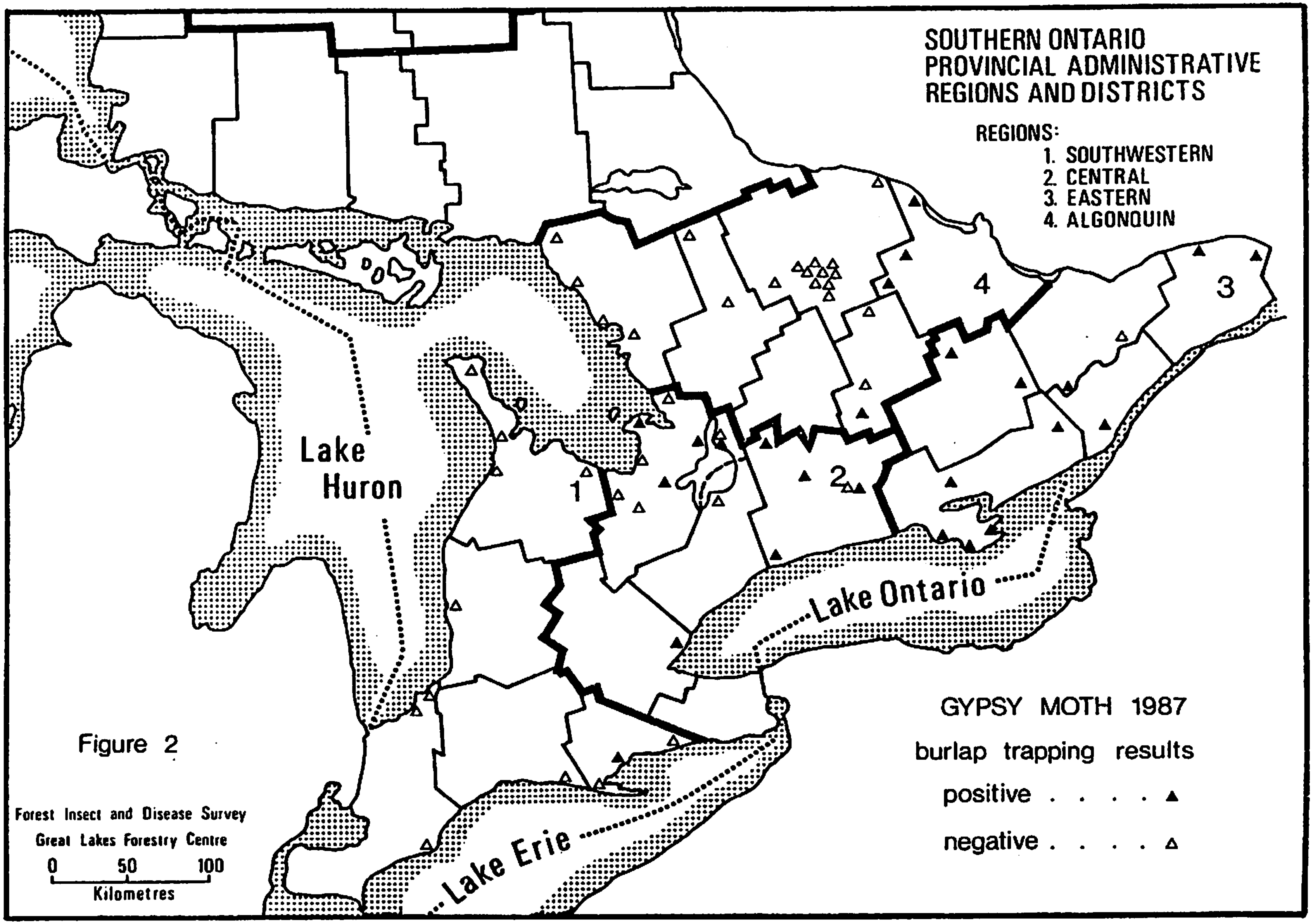
infestation, observations of gypsy moth larvae were quantified. Outside of this area larvae were recorded simply as present or absent.

Larvae were captured at all parks in the Eastern Region with the exception of Rideau Provincial Park in Carleton Place District. Positive results were obtained at four of the 23 locations trapped in the Algonquin Region including new records at Carson Lake Provincial Park and the Petawawa National Forestry Institute, Pembroke District. In the Central Region, larval catches were made at 9 of sixteen locations trapped and included new records at Balsam Lake Provincial Park, Lindsay District and Awenda, Bass Lake and Springwater parks in the Huronia District. Larvae were captured at only one of the 12 parks trapped in the Southwestern Region, namely Turkey Point Provincial Park in Simcoe District where an active infestation is known to occur. Results of the larval trapping program are presented in Figure 2.

Pheromone Trapping

In southern Ontario, an adult pheromone trapping program was carried out at the same parks where burlap trapping took place as well as in a few other locations. As usual, two pheromone traps were set out at each park with one located within a camping area and the other near the park entrance. Ten pheromone traps were also deployed at each of the Canadian Forces at Petawawa and Borden and the Canadian Forces Tank Range at Meaford. Moths were captured at all 65 locations where one or more traps were recovered (Fig. 3). At a few locations all the traps deployed were destroyed or stolen. The average number of moths per trap increased marginally from 15.3 moths in 1986 to 15.7 moths in 1987. However, in the Eastern Region where widespread heavy infestations declined drastically this year, the average number of moths per trap declined from 23.2 in 1986 to 16.2 in 1987. In most other areas moth catches were at similar levels of those in 1986 with the exception of Algonquin Park District which increased from 5.3 to 12.7 moths/trap, and Owen Sound District from 4.7 to 12.1. Moth catches at a single location in Aylmer District increased from 6 to 18.5 moths per trap. Moth catches at CFB Petawawa averaged 19.6/trap, at CFB Borden 18.8/trap, and 7.4/trap at C.F.T.R. Meaford. These results may be particularly significant because of the potential for spread from these areas due to the constant movement of equipment and personnel to other parts of the country.

In northern Ontario, a similar adult pheromone trapping program is carried out in most provincial parks and some private campgrounds as a cooperative project between the Plant Health Division of Agriculture Canada and the FIDS Unit. Methods are similar to the southern Ontario project with 2 traps installed at each park, one near the park entrance and the other in a camping area. Ten traps were deployed in parks where positive catches were made in 1986. The highest and most consistent moth catches in northern Ontario were made in the North Bay, Sudbury and Espanola districts of the Northeastern Region. In Espanola District, moth catches were made at South Bay Resort for the third consecutive year, and Red Lodge in Bidwell Township on Manitoulin Island for the fourth consecutive year. A small number of moths were captured at Chutes Provincial Park, Salter


SOUTHERN ONTARIO
PROVINCIAL ADMINISTRATIVE
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2
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4
GYPSY MOTH 1987
burlap trapping results
positive . . . . . ▲
negative . . . . △
Forest Insect and Disease Survey
Great Lakes Forestry Centre
0 50 100
Kilometres

Figure 2

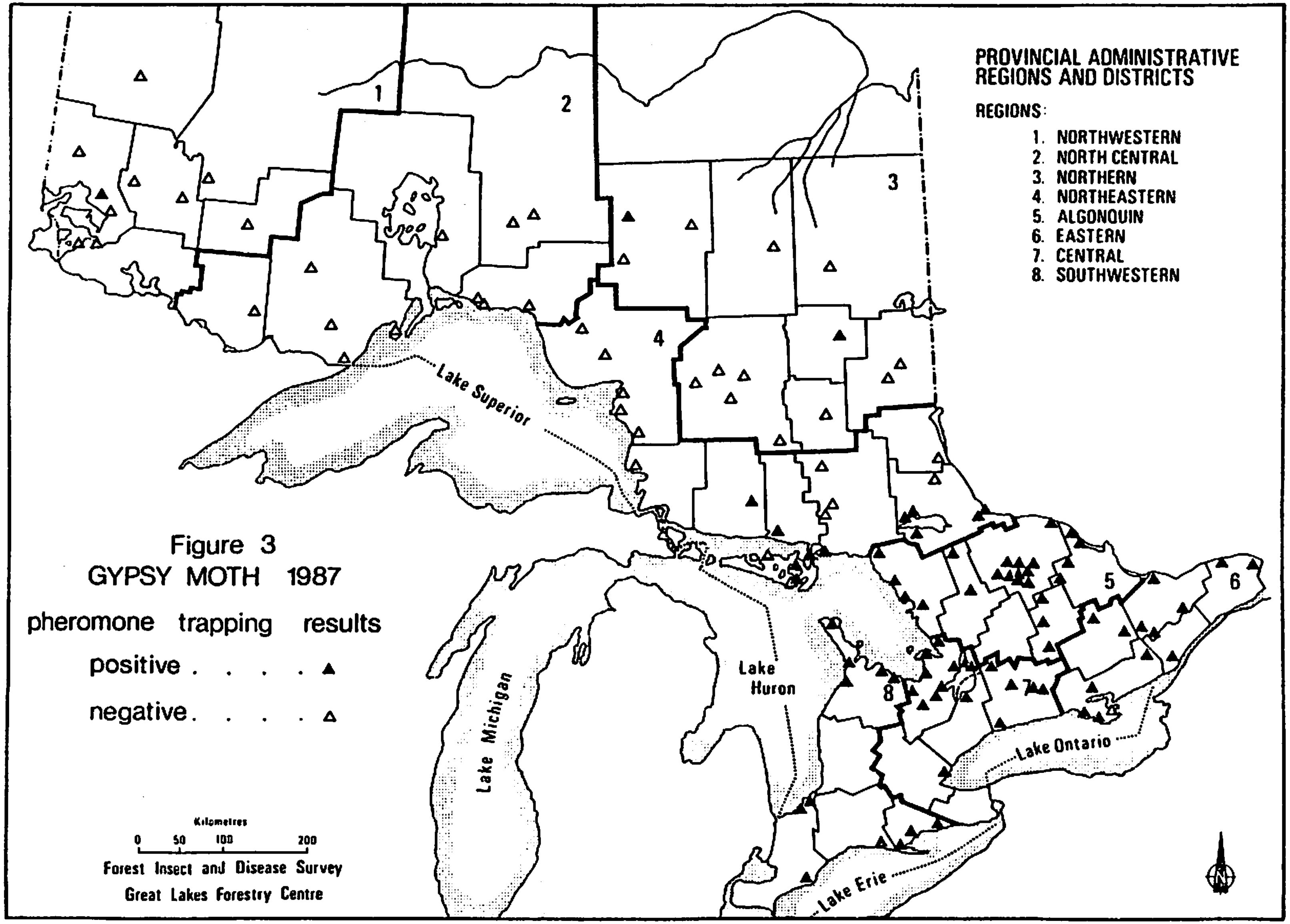


Figure 3
GYPSY MOTH 1987

Township, for the second consecutive year and three moths were captured on Birch Island in Curtin Township. The largest catches were at South Bay Resort where the average number of moths per trap increased from 1.6 in 1986 to 6.0 in 1987. In Sudbury District, additional traps at Fairbanks and Windy Lakes provincial parks failed to duplicate the positive results of 1986. However, at Killarney Provincial Park a marked increase in the number of moths caught occurred with an increase from 8 to 21 moths per trap. In North Bay District, moths were caught for the second consecutive year at Restoule and Samuel de Champlain Provincial Parks and for the third consecutive year at Antoine Provincial Park. Surveys in the remainder of northern Ontario yielded single moth catches at the following locations: Fushimi Provincial Park, Hearst District; Kettle Lakes Provincial Park, Timmins District; Mississagi Provincial Park, Blind River District, and Rushing River Provincial Park, Kenora District.

FORECASTS 1988

In October 1987, crews under the supervision of the Canadian Forestry Service conducted a survey in eastern Ontario to assess changes in gypsy moth egg-mass densities in plots established to assess the efficacy of the 1987 aerial spraying program. A total of 107 plots were surveyed in five districts in the Eastern and Algonquin regions - 74 plots were in spray blocks and 33 were checks (untreated stands). Comparisons of egg-mass counts in 1986 and 1987 are presented in Tables 4 and 5. Overall, egg-mass densities declined by some 58% with significant reductions in all five districts. However, when plots in sprayed and unsprayed areas are analyzed separately, overall changes are -68% and -40%, respectively.

Based on the CFS egg-mass survey results only, it would appear that further reductions in the area of moderate-to-severe defoliation can be expected in 1988. Small scattered pockets of defoliation may persist in some areas such as Kaladar, Marble Rock and Kashabog Lake, but large extensive areas of heavy defoliation are not likely.

It should be noted that the Ontario Ministry of Natural Resources conducted a more extensive egg-mass survey in eastern Ontario this fall, but that the final results of this survey are not yet available.

Table 4. Gypsy moth: Comparison of egg-mass densities in 1986 and 1987 in eastern Ontario.

District	No. plots	Average egg-mass count per .01 ha 1986	Average egg-mass count per .01 ha 1987*	% Change
Tweed	44	23.1	11.5	-50
Carleton Place	23	26.4	8.8	-67
Brockville	10	42.8	26.1	-39
Napanee	7	27.4	4.3	-84
Pembroke	23	16.2	4.6	-72
Overall	107	24.5	10.3	-58

* includes 74 plots sprayed with B.t. in 1987.

Table 5. Gypsy moth: Egg-mass counts in sprayed and unsprayed areas in eastern Ontario in 1987.

District	SPRAYED				CHECKS			
	No. plots	Average egg-mass count per .01 ha 1986	Average egg-mass count per .01 ha 1987	% Change	No. plots	Average egg-mass count per .01 ha 1986	Average egg-mass count per .01 ha 1987	% Change
Tweed	25	23.5	5.4	-77	19	22.6	19.4	-14
Carleton Place	20	14.6	7.0	-52	3	105.3	20.3	-81
Brockville	8	47.2	17.7	-62	2	25.0	59.5	+138
Napanee	3	14.0	2.7	-81	4	37.5	5.5	-85
Pembroke	18	20.6	5.7	-72	5	0.4	0.8	+100
Overall	74	22.6	7.1	-68	33	28.7	17.4	-40

RESULTS OF SPRAYING OPERATIONS

In 1987, the Ontario Ministry of Natural Resources aerially sprayed 40,249 ha of forest in eastern Ontario to protect stands from gypsy moth defoliation. As in previous years, the 1987 program involved both crown land spraying (26,310 ha) and a private land component (13,939 ha). Both fixed-wing aircraft and helicopter were used to apply the three B.t. formulations used in the program - Dipel 132, Thuricide 48 LV and Futura XLV. All spray block received at least two treatments approximately 5-10 days apart and some received a third application. Each application was at a rate of 30 BIU/ha but volumes varied from 2.1 to 6.1L/ha. A small experimental program was also carried out. Dipel 176 was applied at two rates: 30 BIU/4.4L/ha (two applications) and 50 BIU/3.0L/ha (one application).

Survival of overwintering gypsy moth egg-masses has been found to be quite variable in Ontario. In some years a high proportion of egg-masses may be killed by a combination of cold winter temperatures and a lack of snow cover. To assess the impact of this past winter on the gypsy moth, egg-masses were collected from five locations within the proposed spray area and reared in individual containers in the quarantine facility at Great Lakes Forestry Centre. The proportion of egg-masses producing larvae and the average number of larvae hatching at each location is presented in Table 6. It is apparent from Table 6 that survival of egg-masses laid on the ground was consistently high ($\bar{x}$ = 98%) and that the proportion of eggs hatching per egg-mass was also high. Survival of egg masses laid above ground on the boles of trees was much more variable, however, averaging 48% with a range of 4-100%. A comparison of egg hatch from 1983-1987 (Table 7) shows a general decline in average egg-mass size in recent years corresponding to the recent decline in the size of the infestation and reduced levels of defoliation.

Gypsy moth egg hatch was first observed in the field in mid-April, some two or three weeks earlier than normal. This is undoubtedly related to the abnormally warm and dry weather conditions experienced throughout most of Ontario in March and April (Fig. 4). The month of May was generally cooler than normal in eastern Ontario and had the effect of slowing larval development. A comparison of larval development at three locations within the spray area is presented in Figure 5.

The spray program started on May 14 when most larvae were second instars. That same day, however, the entire Ontario B.t. spray program was put on hold until reports of contaminants in the B.t. formulations could be investigated. The program was not resumed until May 22 when many third instar larvae were present. Spraying was completed June 15.

The effectiveness of the 1987 gypsy moth aerial spraying program was assessed by comparing changes in egg-mass density and defoliation rates in plots established in sprayed and unsprayed (check) areas. Results of these surveys for both the operational and experimental programs are presented in tables 8 to 10.

Table 6. Gypsy Moth: Overwintering egg survival in eastern Ontario, 1987.

	GROUND			BOLE		
Location	Egg-mass hatch (%)	Eggs per mass ($\bar{x}$)	Larvae per egg-mass ($\bar{x}$)	Egg-mass hatch (%)	Eggs per mass ($\bar{x}$)	Larvae per egg-mass ($\bar{x}$)
Coxvale	100	231	230	10	260	15
Stirling	100	267	266	100	296	256
Frontenac	98	144	140	4	180	8
Charleston	98	232	201	83	244	120
Joes Lake	96	213	197	15	265	18
Overall	98	217	207	48	285	108

Table 7. Gypsy Moth: Overwintering egg survival from 1983 to 1987 in eastern Ontario.

	GROUND			BOLE		
Year	% Hatch	Eggs per mass ($\bar{x}$)	Larvae per mass ($\bar{x}$)	% Hatch	Egg per mass ($\bar{x}$)	Larvae per mass ($\bar{x}$)
1983	100	285	274	100	241	223
1984	96	356	327	22	354	40
1985	84	375	315	45	276	125
1986	99	259	247	89	270	166
1987	98	217	207	48	285	108

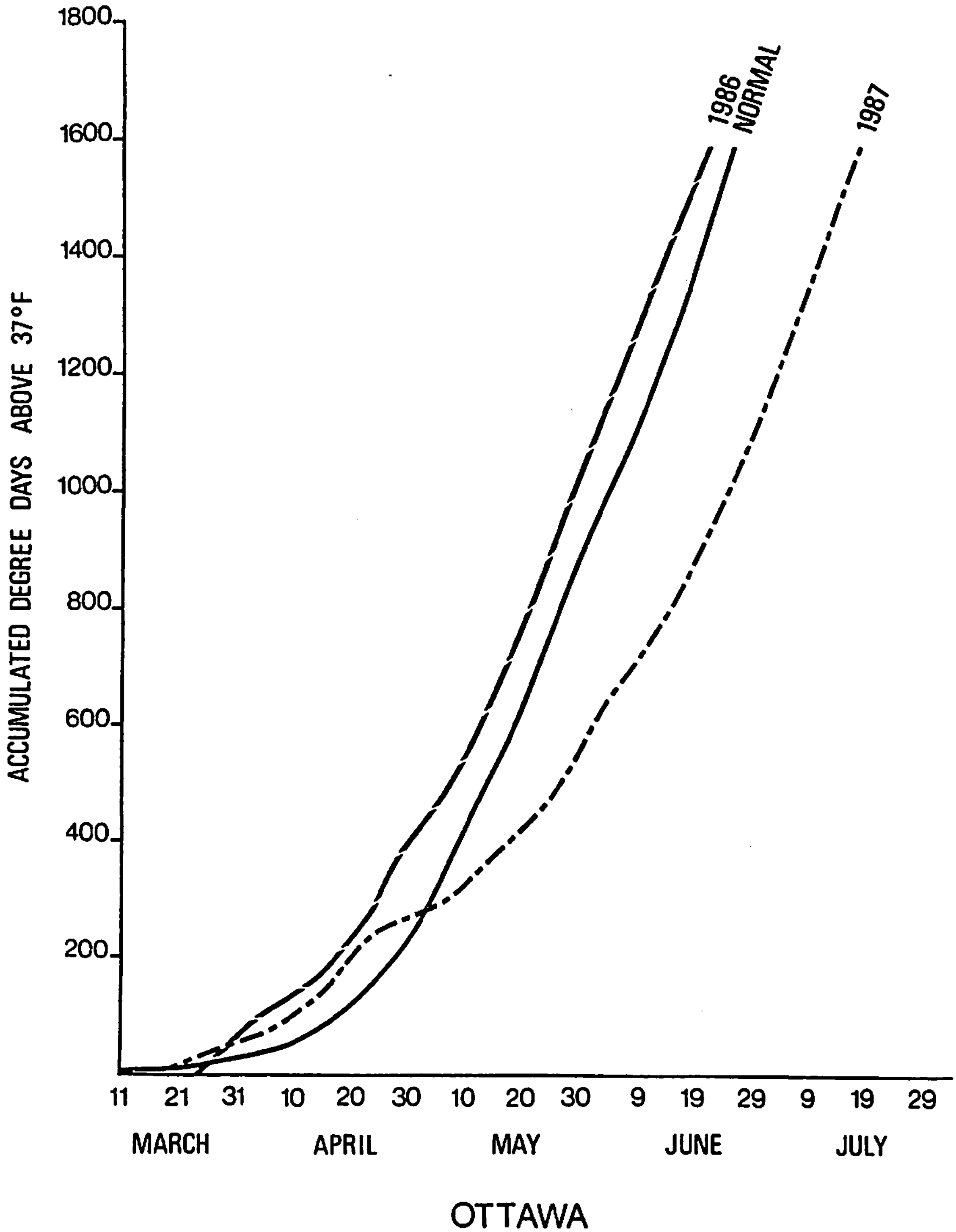


Figure 4. Heat accumulation in degree days for Kingston, Ontario, 1987.

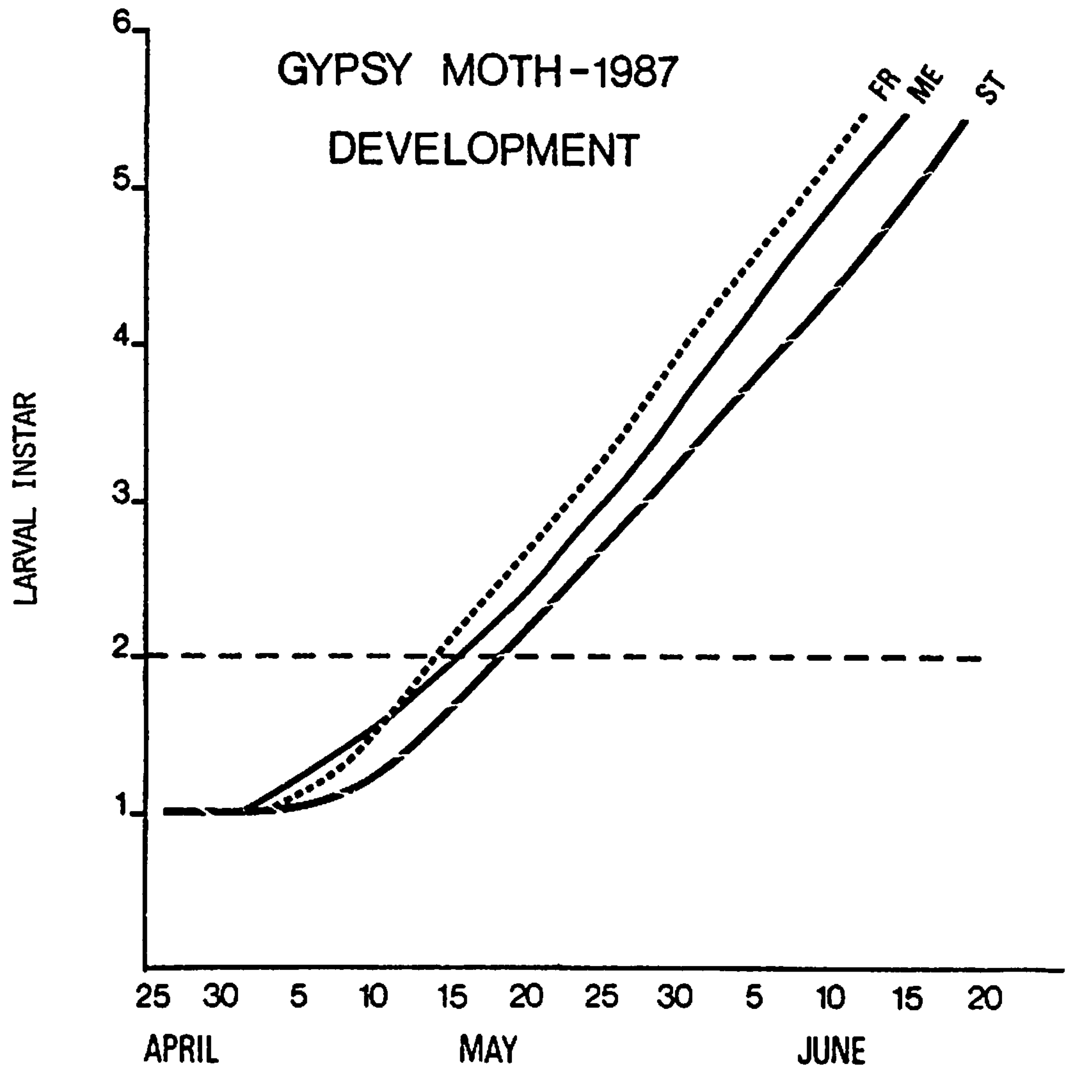


Figure 5. Gypsy moth larval development in eastern Ontario, 1987 (FR = Frontenac Provincial Park, Napanee District; ME = Methuen Township, Bancroft District; ST = Sterling, Napanee District).

In 1986, a somewhat unexpected decline in gypsy moth populations occurred throughout much of the infestation. It appeared that a variety of natural control factors, such as disease and parasitism, were the main causal agents in the decline. The reduction in populations, and consequently defoliation, in both sprayed and unsprayed areas made it extremely difficult to assess the efficacy of the 1986 control program. This situation repeated itself in 1987 (Table 8). Defoliation rates were, on average, only slightly higher in the unsprayed check plots. There was, on the other hand, a 28% difference in the change in egg-mass densities between spray plots and checks suggesting some effect of the spray program on populations (Table 5).

OMNR conducted a small experimental program involving two spray blocks in 1987. Dipel 176 was applied at two rates and in single and double applications (Table 9). The results are presented in Table 10 and, as in the operational program, do not show much difference between sprayed and unsprayed plots.

Table 8. Gypsy Moth: Egg-mass counts and defoliation in sprayed and unsprayed (check) plots in eastern Ontario, 1987.

District block	No. appl.	Egg-masses per .01 ha 1986	Egg-masses per .01 ha 1987	% Change	Defoliation (%) r0	Defoliation (%) v0
Sprayed						
Tweed						
I-32	2	0.7	0	-100	12	-
I-35	2	15.1	7.1	-53	13	20
I-42	2	83.2	7.2	-91	12	25
T-11	2	9.0	0	-100	15	17
Carleton Place						
W-016	1	0.7	0	-100	3	-
W-017	2	0	0	0	11	8
W-018	2	1.3	23.7	+1875	17	22
I-13	2/3	24.4	0	-100	10	-
Brockville						
W-009	2	3.3	0	-100	17	-
Napanee						
I-44	2	14.0	2.7	-81	8	11
Pembroke						
I-3	1	27.4	2.2	-92	11	-
I-8	3	14.0	17.0	+21	26	-
Checks						
Tweed						
Kennebec		5.5	6.0	+9	19	-
Bon Echo		24.0	1.0	-96	15	-
Madoc		53.0	12.3	-77	13	11
Kaladar		5.8	79.0	+1274	20	23
Tamworth		19.7	0	-100	-	20
Coxvale		32.0	1.0	-97	13	-
Carleton Place						
Joe's Lake		105.3	20.3	-81	23	-
Brockville						
Marble Rock		25.0	59.5	+138	43	-
Napanee						
Frontenac		23.0	0	-100	18	21

Table 9. Gypsy moth: Experimental spray program, 1987.

Trial 1

Location:	Skunk Lake, Carleton Place District
Area:	82 ha
Material:	Dipel 176 50 BIU/3.0L/ha
Date:	May 25
Time:	PM
Temperature:	14°C
Relative humidity:	63%
Wind speed:	0-2 km/h
Aircraft:	Bell 206
Larval Development:	2.6

Trial 2

	1st Application	2nd Application
Location:	Burnstown, Pembroke District	
Area:	146 ha	142 ha
Material:	Dipel 176 30 BIU/4.4L/ha	same
Date:	May 26	June 4
Time:	AM	AM
Temperature:	2° - 6°C	12°C
Relative humidity:	100%	80%
Wind speed:	0-2 km/h	5 km/h
Aircraft:	Bell 206	same
Larval development:	2.6	4.1

Table 10. Gypsy moth: Results of aerial applications of an experimental *B.t.* formulation, Dipel 176, at two locations in eastern Ontario, 1987.

Location & Dose	Plot	Egg-masses per .01 ha 1986	Egg-masses per .01 ha 1987	% Change	Defoliation (%) r0	Defoliation (%) w0
Skunk Lake 50 BIU/3.0 l/ha	1	24	7	-71	25	-
	2	11	30	+173	25	-
	3	52	17	-67	27	35
	4	5	9	+80	24	-
	5	72	7	-90	20	-
Burnstown 30 BIU/4.4 l/ha	1	0	3	+	8	6
	2	13	3	-77	11	10
	3	37	10	-73	18	11
	4	3	13	+333	15	11
	5	2	0	-100	12	7
Checks	1	29	2	-93	11	-
	2	32	1	-97	11	-
	3	11	0	-100	23	-
	4	3	57	+1800	21	17
	5	12	53	+342	10	20
	6	58	2	-97	11	-
	7	18	82	+356	45	-
	8	32	37	+18	40	-

GYPSY MOTH CONTROL OPERATIONS
IN ONTARIO - 1987

J. J. Churcher
Pest Control Section
Ministry of Natural Resources

A reduction in the area of moderate to severe defoliation of all major insect pests resulted in a smaller aerial control program than in the previous year. On November 13, 1986, the Minister of Natural Resources announced that, once again, Ontario would use only the biological insecticide *Bacillus thuringiensis* (B.t.) in its aerial insecticide programs. Because of this decision early in the planning process, our extensive open house and media briefing programs of previous years and the public's acceptance of forest insect control and the use of B.t., large scale public information centres were not deemed necessary. Local district offices that were proposing aerial spray projects held one day open houses in the district office and provided display material for public review for 30 days. Media briefings were held but drew little interest.

In 1986 the gypsy moth infestation located in the southeastern portion of Ontario decreased significantly, mainly due to natural mortality factors (Figure 1). As a result, the size of the 1987 control program was reduced from that of the previous year, treating only 40,249 hectares of both Crown (26,310 hectares) and private (13,939 hectares) land (Figure 2). Three types of B.t. were used in this operation, Dipel 132, Thuricide 48 LV and Futura XLV. Double, and in some cases triple, applications of the insecticide were used at a rate of 30 BIU/ha. A range of dilutions were used, resulting in total volumes of 2.4 L/ha (for 'neat' applications) up to 6.0 L/ha (when mixed with water). Two experimental applications were also made, both with Dipel 176. In Carleton Place District, one block was given a single application at a rate of 50 BIU/3.0 L/ha (neat). In Pembroke District, one block received two applicaiton of the product at a rate of 30 BIU/ 4.4 L/ha (mixed 40:60 with water).

Two stationary airstrips and three mobile operations employed nineteen rotary and fixed-wing spray craft and twelve pointer aircraft. Districts with spray blocks included Tweed, Napanee, Brockville, Carleton Place, Pembroke, Bancroft and Lindsay.

The private land program was conducted in cooperation with the nine counties affected by the gypsy moth. Administrative details and organization of private landowners was handled by a coordinator hired by the county with funding from the province. Landowners wishing to have their property treated with a double application of B.t. paid $20/hectare, with a minimum block size of 4 hectares. A number of contiguous properties (i.e. cottage lots) could be pooled together to make up the minimum block size.

There were two minor incidents associated with this program. A Sikorsky S-55 helicopter lost power, crashed and burned. The pilot was able to leave the helicopter and was treated for cuts and bruises. During take-off, a Piper Pawnee flipped over at the end of the runway; the pilot suffered a bruised shoulder.

Two other problems, both related to Dipel 132, caused some concern during the gyspy moth program. Reports of the presence of alien bacteria in the B.t. formulation forced the Ministry to place its spray program temporarily on hold. Spraying for gypsy moth had already begun, and was thus delayed for approximately one week until the B.t. could be sampled and tested and the decision to resume spraying be made. This problem did not appear to affect the results of our program.

The second issue arose shortly after, as the temperatures became unseasonably high. When mixing the Dipel 132 with water (40:60 ratio) an invert emulsion occurred. Representatives from Abbott Labs visited the site and resolved the problem. This, too, caused further delays in the program, but all planned spray blocks were eventually treated.

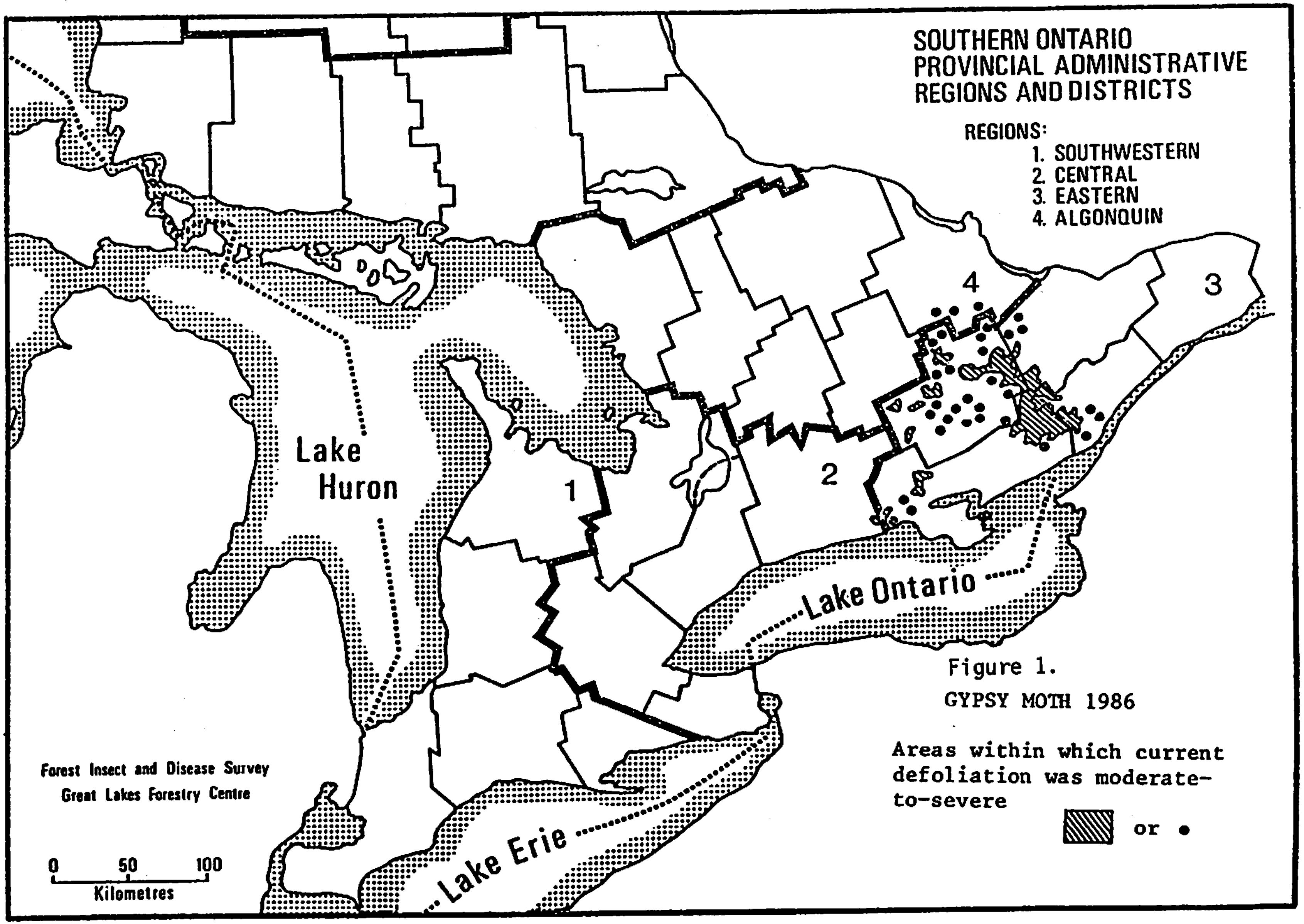


Figure 1.
GYPSY MOTH 1986

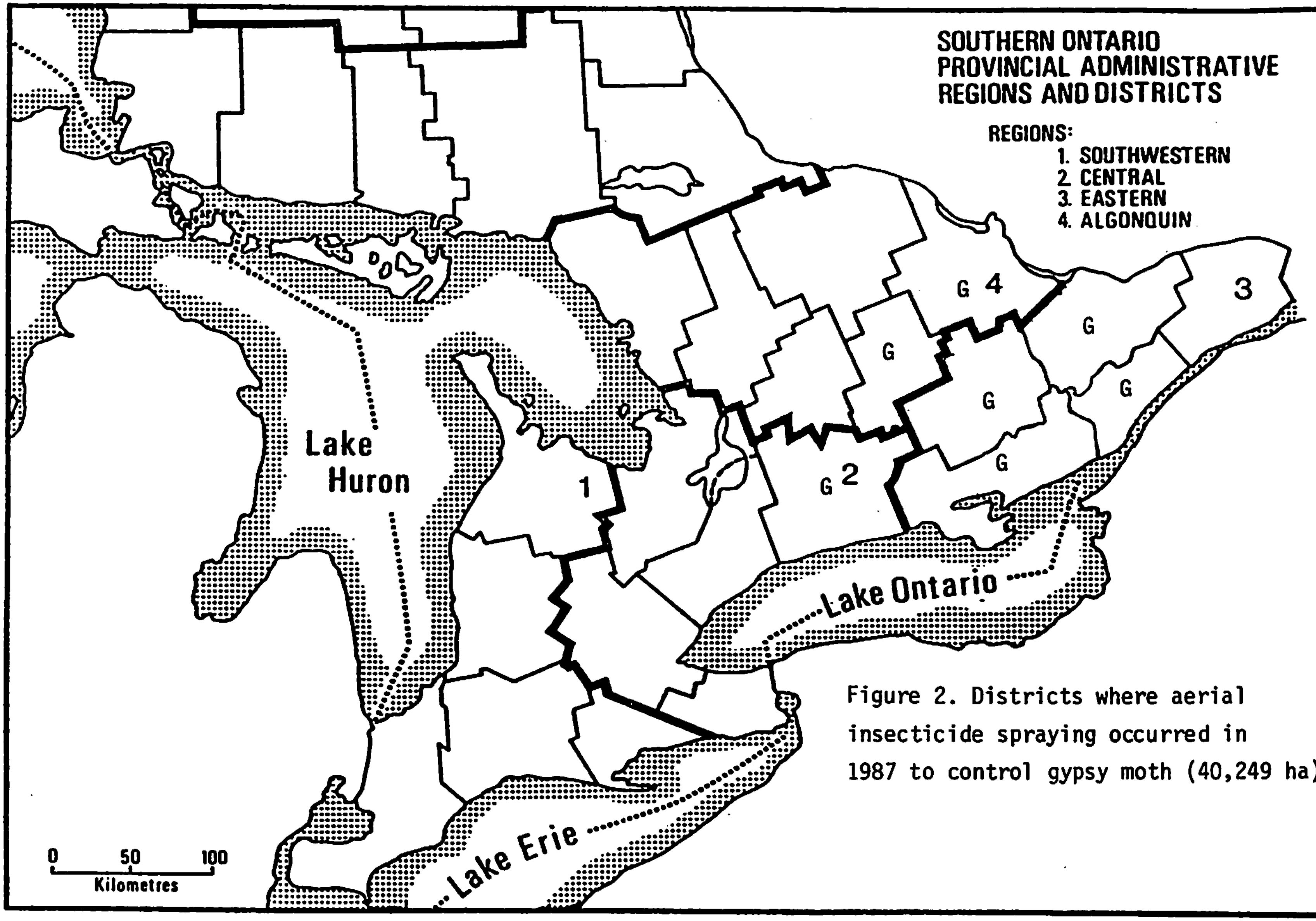


Figure 2. Districts where aerial insecticide spraying occurred in 1987 to control gypsy moth (40,249 ha)

GYPSY MOTH DEFOLIATION AND SUPPRESSION
IN THE NORTHEASTERN UNITED STATES
1987 - 1988

Gypsy moth defoliation occurred on 538,103 ha throughout the Northeastern United States IN 1987, down from 976,528 ha in 1986 (Figure 1). Defoliation decreased significantly in Connecticut, Michigan, New Jersey, New York, and Rhode Island. However, insect populations remain vigorous along the advancing front of defoliation in Maryland, Western Pennsylvania, Virginia, and West Virginia. In Michigan, where gypsy moth populations and defoliation increased the last four years, defoliation has dropped from a high of 24,836 ha in 1986 to 15,962 ha in 1987.

In 1987, cooperative State/Federal gypsy moth suppression projects were conducted in Delaware, Maryland, Michigan, New Jersey, Pennsylvania, Virginia, and West Virginia. A total of 259,725 ha was treated with chemical or biological insecticides. About 58 percent of the treatments involved the application of the insect growth regulator dimilin and 42 percent involved application of Bacillus thuringiensis (B.t.).

Plans are underway for cooperative State/Federal suppression projects on about 349,000 ha in 1988 in Delaware, Maryland, Michigan, New Jersey, Pennsylvania, Rhode Island, Virginia, and West Virginia. Gypsy moth

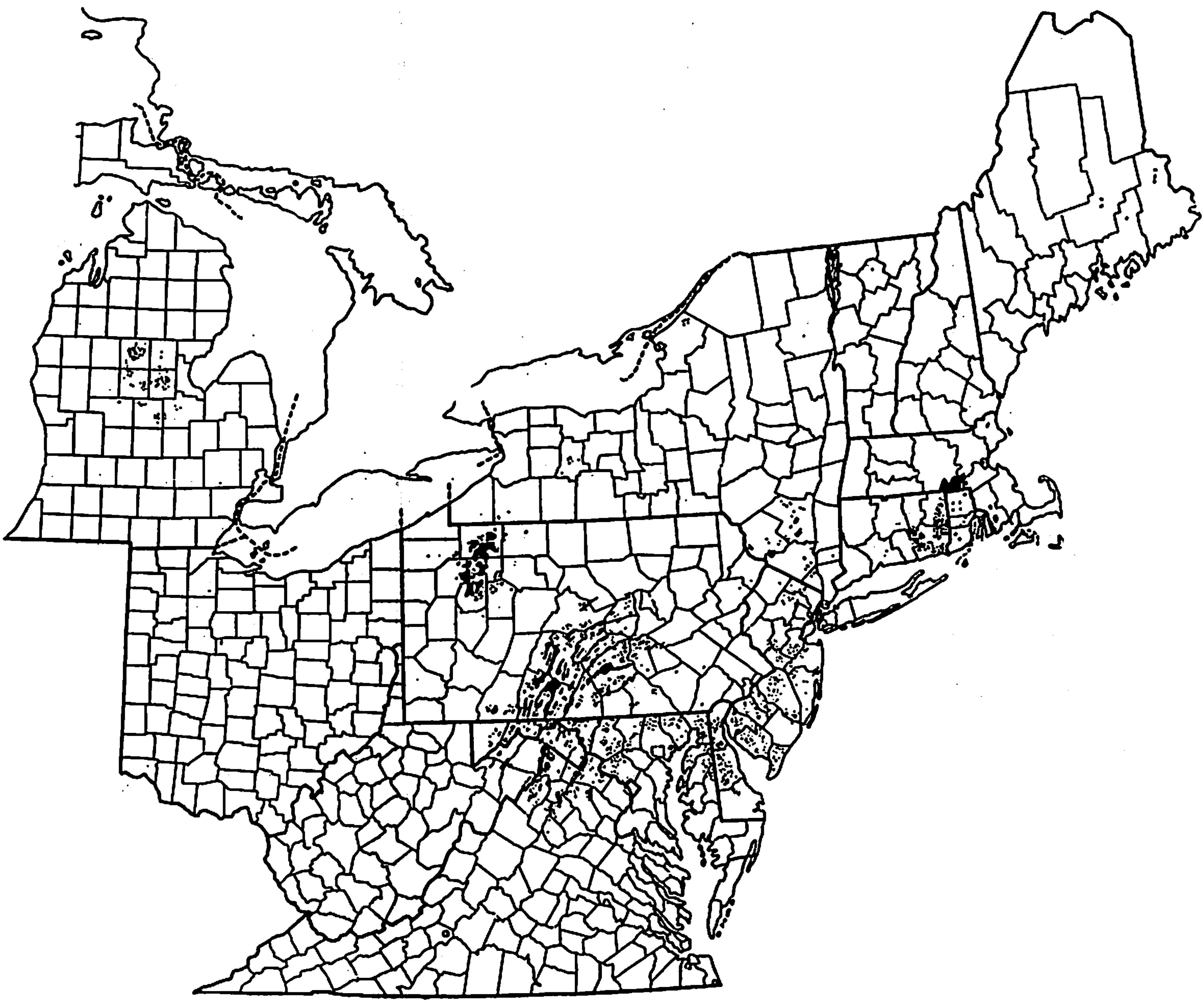
suppression projects have been proposed 8,094 ha on the Allegheny National Forest in Pennsylvania, the Seneca Indian Nation in New York (2,024 ha), and the Narragansett Indian Nation in Rhode Island (486 ha). Additional Federal suppression projects are proposed for various National Park sites in the eastern United States, but details on the areas to be treated have not been determined yet.

Presented by Peter W. Orr, Assistant Director, Northeastern Area, State and Private Forestry, USDA Forest Service, Broomall, Pennsylvania at the Forest Pest Forum, Ottawa, Ontario, November 18-19, 1987.

GYPSY MOTH DEFOLIATION AND SUPPRESSION BY STATE
1987 - 1988

STATE	1987 SUPPRESSION	1987 DEFOLIATION	PROPOSED 1988 SUPPRESSION	PROPOSED INSECTICIDES
	-------Hectares-------			
Connecticut	0	26,452	0	
Delaware	20,886	1,024	16,188	B.t., Dimilin
Maine	0	262	0	
Maryland	56,488	31,082	56,657	B.t., Dimilin
Massachusetts	0	11,630	0	
Michigan	13,778	15,962	44,112	B.t.
New Hampshire	0	117	0	
New Jersey	25,167	38,488	32,780	B.t.
New York	0	22,319	0	
Pennsylvania	91,757	356,267	107,244	B.t., Dimilin
Rhode Island	0	2,044	12,140	B.t.
Vermont	0	0	0	
Virginia	16,441	27,396	28,329	B.t., Dimilin
West Virginia	34,399	5,055	50,587	Dimilin
Dist. of Columbia	809	5	809	B.t.
Total	259,725	538,103	348,846	

GYPSY MOTH DEFOLIATED AREAS IN THE USA – 1987



THE STATUS OF SCLERODERRIS CANKER IN NEWFOUNDLAND IN 1987

Hudak, J., G.R. Warren and G.C. Carew

REPORT TO THE 15TH ANNUAL FOREST PEST CONTROL FORUM, OTTAWA, 17-19 NOVEMBER 1987.

NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
ST. JOHN'S, NEWFOUNDLAND
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THE STATUS OF SCLERODERRIS CANKER IN NEWFOUNDLAND IN 1987

by

Hudak, J., G.R. Warren and G.C. Carew

Scleroderris canker was first recorded in Newfoundland in 1979 on five ornamental Austrian pine trees near St. John's. In 1980 and 1981 several new infections were found on ornamental pines throughout the city. In cooperation with Agriculture Canada, these trees were pruned or cut and burnt in an effort to eradicate the disease. An Island-wide intensive survey did not detect the disease outside of the St. John's area and the Provincial Department of Forest Resources and Lands established a quarantine area in 1980 (Figure 1). A severe outbreak of the disease occurred in 1981 in a 2 ha experimental red pine plantation near Torbay in the vicinity of St. John's. Disease development was extremely rapid and nearly all trees, about 6 000, in the plantation showed severe reddening throughout their crowns. All trees were cut and burnt in the fall of 1981 in an effort to eradicate the disease. Regular inspection of the area since 1981 showed no infection of any other adjacent tree species which include planted Sitka spruce, Norway spruce, and natural regeneration of black spruce and balsam fir. In 1982 the disease was found on ornamental Scots pine, Jack pine and red pine on the Salmonier Line, about 30 km west of St. John's. This was the first record of the disease outside the quarantine area. The trees were cut and burnt. The disease recurred on other trees in 1984 and these were cut and burnt. Subsequent inspections showed no new infections in the area.

A branch sample taken in late 1985 from a Sitka spruce grown in an experimental provenance plantation established in 1969 near Roddickton was confirmed in early 1986 to be damaged by Scleroderris canker. In 1969 and 1970 eight other provenance plantations were also established throughout the Island using the same stock of seedlings imported from New Brunswick (Figure 1). The examination of these plantations in 1986 showed various amounts of old mortality, recent branch dieback and topkill. The development of these symptoms appeared to be very gradual. Branch samples were taken from these plantations for cultural identification of the disease and subsequent determination of its race. However, these isolation attempts to date proved to be positive only for the Roddickton plantation. All trees in this plantation were examined in June 1987 and infection of the various provenances varied from 90-100%. The infected trees were pruned or cut in an attempt to eradicate the disease in this area.

The incidence of Scleroderris canker increased in and around St. John's in 1987. Continued surveys in 1987 also recorded four new locations of this disease. Three of these are in St. John's involving Scots pine and Austrian pine and one in an old Scots pine plantation on the Salmonier Line. This pine plantation was examined in previous years but no symptoms of infection were recorded. This is the third time that Scleroderris canker was found on the Salmonier Line, outside the quarantine area.

In 1987 additional efforts were made to locate all Sitka spruce plantations established using seedlings from New Brunswick. To date 19 additional plantations have been identified (Figure 1). Some of these plantations have been inspected briefly and many of the trees are in poor condition. All Sitka spruce plantations will be examined for Scleroderris canker in 1988 and samples will be collected for cultural identification of the disease.

Cultures of all Scleroderris isolates in Newfoundland made before 1987 were serologically diagnosed as the European race. Cultures obtained in 1987 have not been tested for race identification. Following the results of the culturing, the damaged trees will be pruned or cut and burnt.

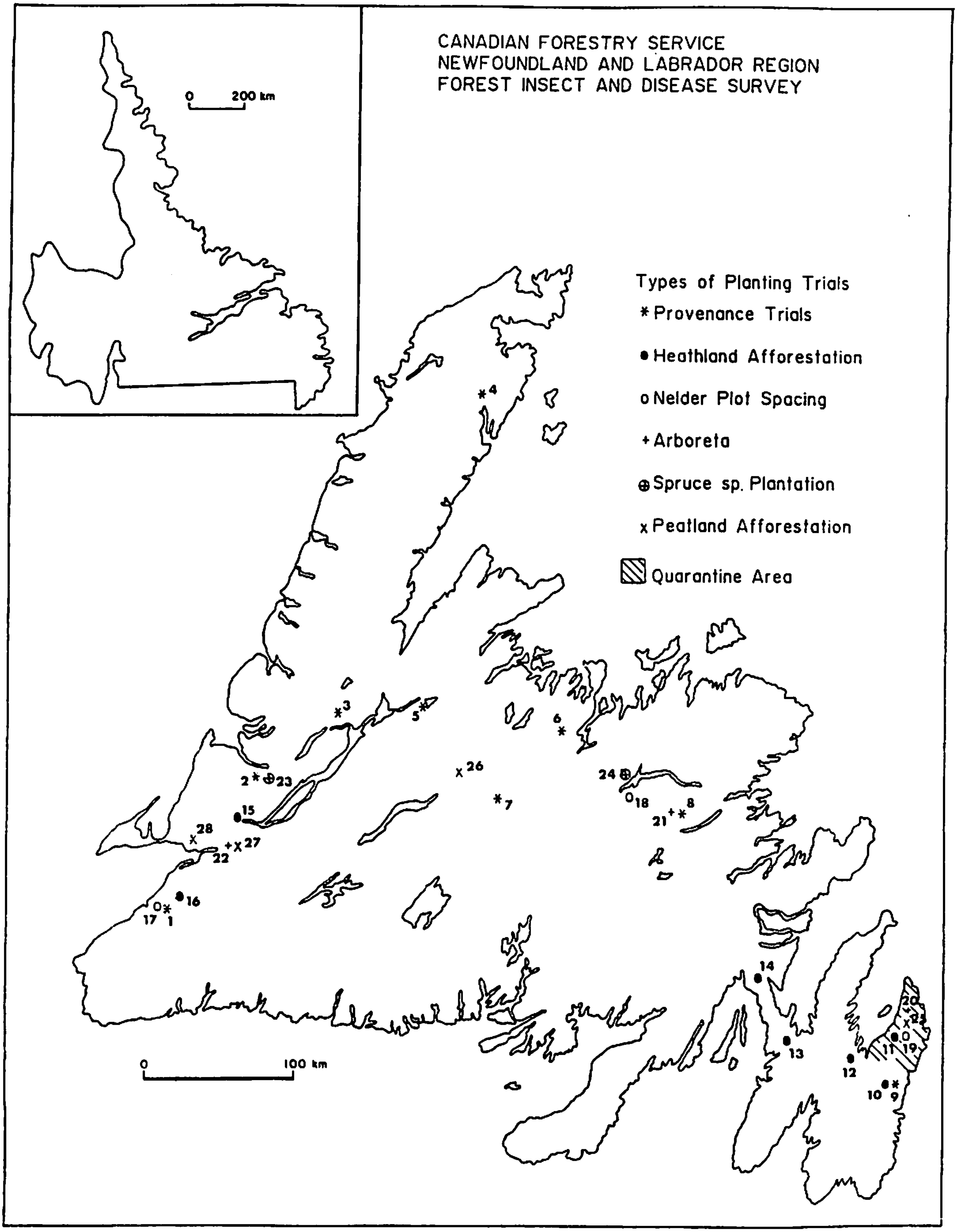


Figure 1. Locations of Scleroderris canker quarantine area and the Sitka spruce experimental plantations in Newfoundland using seedlings from Acadia Forest Nursery, N.B.

SCLERODERRIS CANKER IN QUEBEC IN 1987

Denis Lachance

Report to the 15th Annual Forest Pest Control Forum Ottawa,

17-19 november 1987

Laurentian Forestry Centre
Canadian Forestry Service
Ste-Foy, Québec

SCLERODERRIS CANKER IN QUEBEC, 1987

Denis Lachance

Laurentian Forestry Centre, Ste-Foy, Quebec

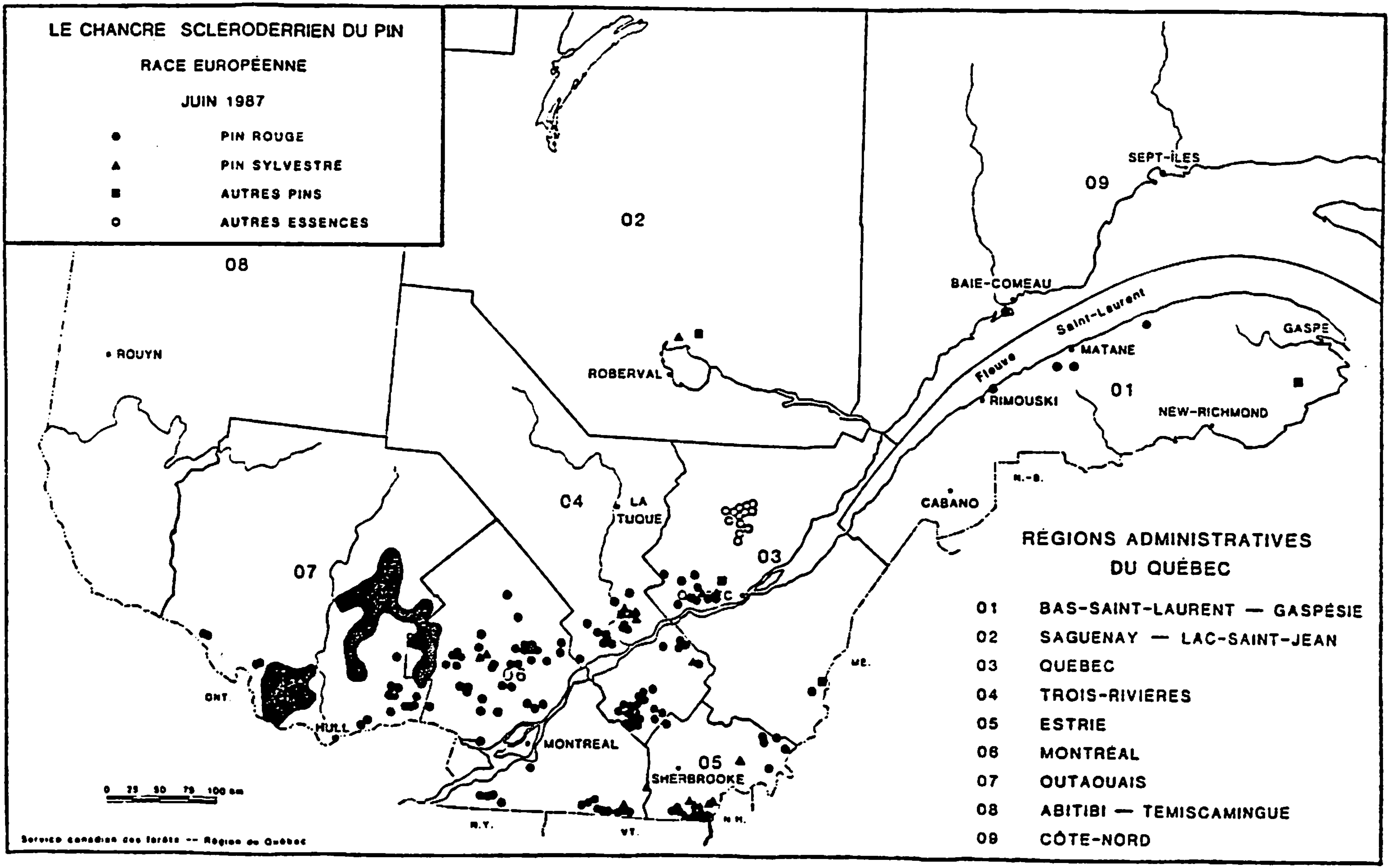
In 1987, le "Service de protection contre les insectes et les maladies" of the Quebec Department of Energy & Resources surveyed all pine plantations that could be localized in the Administrative Region 05, Estrie. Close to 300 plantations were visited. In addition, sanitation and eradication efforts againts the european race of the fungus are continuing in southern Quebec. Fifty-five plantations known to harbor the european race from the 1986 survey were revisited in 1987. Symptoms of the disease were recorded in only 29 of them. Pruning of the lower branches of the trees as well as clipping diseased branches was performed in these plantations. Infected branches were gathered and burned. A similar program is planned for 1988 for those plantations that will be shown to be infested with the european race of the fungus from this year's survey.

To date, from the general and special surveys, approximately 140 isolates of *G. abietina* have been made. These isolates are being tested as to their race by the electrophoretic method on polyacrilamide gels, as developed by Dr. G.B. Ouellette and colleagues at the Laurentian Forestry Centre. Preliminary results on 40 isolates show that more than half are testing european race.

Generally, the disease has not spread noticeably in the Province in 1987. But, this still leaves us with a worrisome situation. As of June 1987, the european race of the fungus has been isolated from 335 locations throughout the Province. (See map #1)

Two different location may mean adjacent plantations of different age or tree species or they may be locations 100 km apart. However, in several of these locations, the fungus may now have been eradicated or have altogether disappeared naturally. This high number of identified european race locations can be attributed in part to the considerable survey efforts provided by LFC in 1984 and by the Quebec MER in 1985 and 1986 toward this disease. Respectively 1200, 1600 and 1000 pine plantations were surveyed during these three years. Isolates of the fungus were made from all infected plantations where possible. Systematic race determination was done at LFC on these isolates. It is again worrisome to note that approximately one third of all the new and randomly collected isolates made during 1985 and 1986 were of the european race.

In conclusion, although overall the disease has not spread or intensified noticeably in the last two years, we know that the fungus, and particularly the european race of the fungus, is scattered throughout the Province. For the time being, close monitoring of the disease as well as widespread sanitation and eradication measures seem to give us a good hand on the disease. Let us hope it remains that way.



Carte #1 Situation de la race européenne de Gremmeniella abietina au Québec, Juin 1987

STATUS OF THE DUTCH ELM DISEASE IN SASKATCHEN IN 1987

MADAN PANDILA
SASKATCHEWAN PARKS, RECREATION AND CULTURE

BACKGROUND:

For the last six years, Saskatchewan Parks, Recreation and Culture has spearheaded surveillance of elm trees to identify any incidence of Dutch Elm Disease (DED) in Saskatchewan. So far only one case of DED has been detected in Regina - in the Regina Cemetery at Broad and Fourth Avenue - in 1981. Immediate removal of the infected tree checked further spread of the disease.

At present, DED surveillance has developed into a co-operative program. The co-operative agencies are: PFRA, Saskatchewan Agriculture, Canadian Forestry Service and the cities of Regina, Saskatoon, Prince Albert, Moose Jaw, North Battleford, Swift Current, Estevan, Weyburn, Melville and Yorkton. All these agencies are members of the Saskatchewan Dutch Elm Disease Advisory Committee (DEDAC), and also representatives from Saskatchewan Urban Municipalities Association (SUMA), Saskatchewan Association of Rural Municipalities (SARM), and companies involved with tree care.

Dutch Elm Disease is a pest under the Pest Control Act.

CURRENT STATUS:

DEDAC met on March 30, 1987 in North Battleford and developed a plan for a survey. Later on, due to budget restraint and cutbacks in summer staff for the surveillance program, an emergency meeting of DEDAC was held on May 12th, 1987 in Regina. Extra responsibilities for the surveillance and beetle monitoring program was passed on to the co-operating agencies. All agencies conducted the DED surveillance program and submitted their reports at the DEDAC meeting in Regina on October 15, 1987.

The highlights of various reports are:

A. <u>Elm Survey</u>

- Saskatchewan Parks, Recreation and Culture and PFRA staff conducted surveillance of natural elms along the Souris River and Qu'Appelle River Valley. Also, they checked elms in 35 communities and six regional parks in the critical zone along the Saskatchewan/Manitoba border in the east and the North Dakota/Saskatchewan border in the south.

- All ten co-operating cities conducted their city elm survey.

- Samples from suspected trees were sent to the Plant Disease Labratory of Saskatchewan Agriculture in Regina. Twenty-nine samples were tested for DED fungus and they were all negative. Fifteen samples showed Dothiorella Wilt and four samples were of Verticillium wilt.

- Staff from Manitoba Natural Resources, while doing their aerial survey along the Manitoba/Saskatchewan border and the Souris River in Manitoba, also surveyed the Souris River Valley near Estevan. They reported noticing some suspicious trees near Estevan.

B. Beetle Survey

- Saskatchewan Parks, Recreation and Culture distributed pheromone traps to the cities to monitor the presence of European elm bark beetle (EEBB) (Scolytus multistriatus).

- The City of Regina reported capturing eight European elm bark beetles in three pheromone traps. The presence of these beetles is of great concern to the city. Regina has launched a campaign to locate any elm firewood which could be the source of these beetles.

- All other cities reported no European elm bark beetles in their traps.

C. Public Awareness Program

- The Saskatchewan Parks, Recreation and Culture public display of DED was shown in shopping malls of the co-operative cities during July - August, 1987. Cities reported good response from the public.

- DED information and guidelines were distributed to the cities and parks.

THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1987

Hudak, J., A.G. Raske, P.L. Dixon and L.J. Clarke

EPORT TO THE 15TH ANNUAL FOREST PEST CONTROL FORUM,
OTTAWA, 17-19 NOVEMBER 1987

NEWFOUNDLAND FORESTRY CENTRE
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THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1987

by

Hudak, J., A.G. Raske, P.L. Dixon and L.J. Clarke

Larval Development and Defoliation - Population levels remained relatively high and caused moderate to severe defoliation in three isolated infestations; one at South Branch, one on the Baie Verte Peninsula and the third near Ten Mile Lake on the Northern Peninsula (Figure 1). Generally larval numbers increased throughout western Newfoundland. The area of moderate and severe defoliation covered about 4 000 ha. Light defoliation occurred on about 2 000 ha.

Control Program - There was no operational or experimental control program conducted against the spruce budworm in 1987.

Biological Mortality Factors - In 1987 spruce budworm samples were collected from near Baie Verte. The main larval parasitoids were *Glypta fumiferanae* and *Meteorus trachynotus*, causing about 19% mortality and *Ephialtes ontario*, the most common pupal parasitoid causing 62% mortality. Several tachinid parasitoids also emerged from large larvae and pupae.

The most commonly detected fungal pathogen was *Paecilomyces farinosus* causing about 1% infection. *Entomophaga aulicae* occurred less frequently. Less than 1% of the samples were infected by Nosema fumiferanae.

In addition about 3% of the budworm samples were infected by a fungus tentatively identified as Aureobasidium pullulans. The pathogenicity of this fungus is being investigated.

Pheromone Trapping of Moths - Pheromone traps were placed at 50 permanent locations throughout the Island, and moths were caught at 58% of these. Moths were trapped at every location throughout western Newfoundland. The highest numbers were recorded on the Port-au-Port Peninsula (118) and near the infestation in the Codroy Valley (87). The number trapped at Sally's Cove (52) remains high for the third year in spite of a lack of a local infestation. Very few moths were trapped in central and eastern Newfoundland, and the number of moths trapped decreased from 1986 to 1987.

Forecast of Spruce Budworm Defoliation for 1987 - Sampling was conducted in conjunction with the hemlock looper egg survey in late October. The forecast will be provided after the completion of processing of samples.

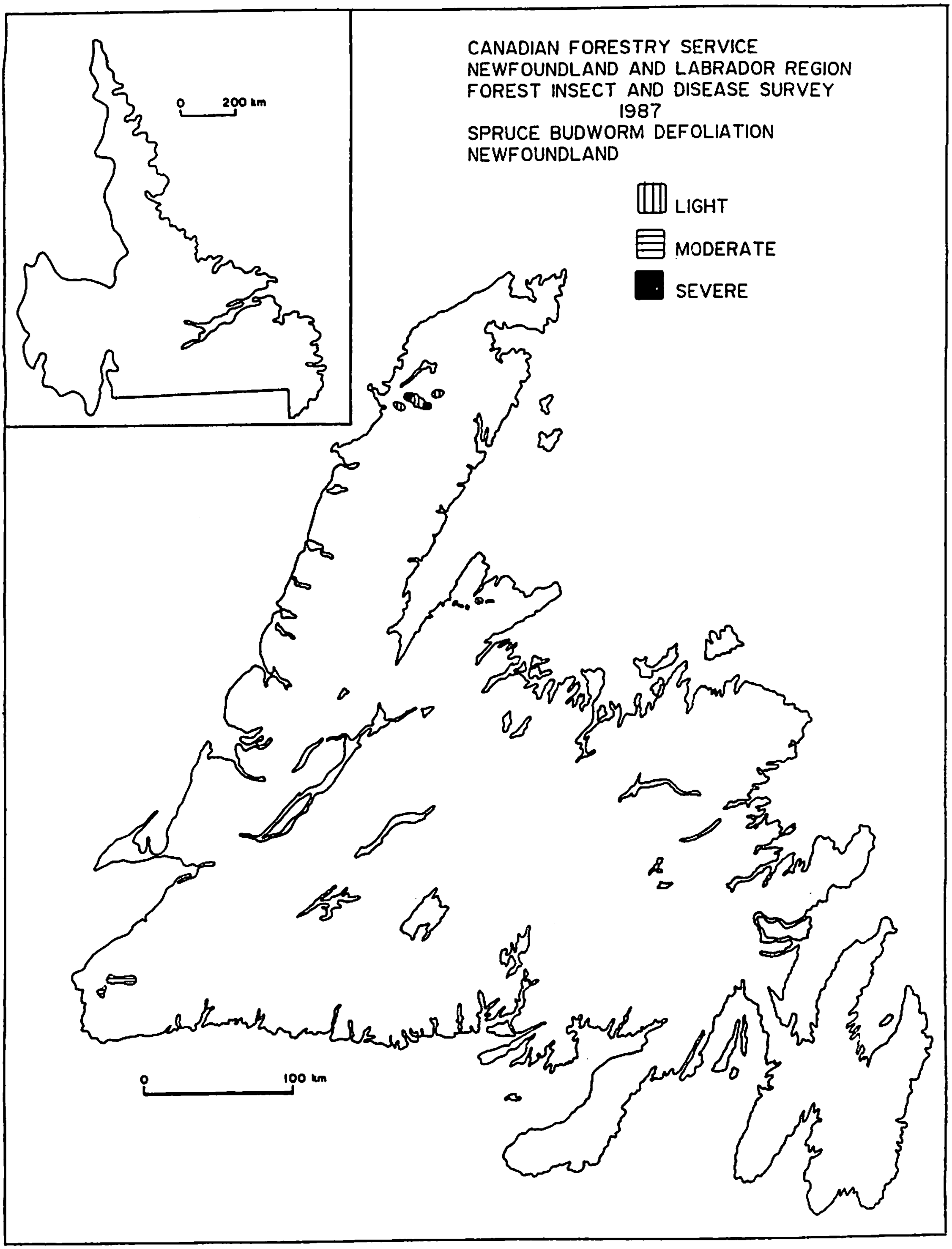

Figure 1. Areas of defoliation caused by the spruce budworm in Newfoundland in 1987.

Government of Canada / Gouvernement du Canada
Canadian Forestry Service / Service Canadien des forêts

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Canadian Forestry Service-Maritimes
TECHNICAL NOTE

NURSERIES
PLANTATIONS
SILVICULTURE
UTILIZATION
ECONOMICS
TREE IMPROVEMENT
INSECTS AND DISEASES

SPRUCE BUDWORM DEFOLIATION IN NOVA SCOTIA - 1987

Defoliation by the spruce budworm in Nova Scotia is assessed annually through an aerial survey of the degree of redness of spruce and fir foliage. The 1987 survey, conducted during the first two weeks of July, was a cooperative project of the Forest Insect and Disease Survey of the Canadian Forestry Service and the Nova Scotia Department of Lands and Forests.

Survey Results

For the first time since 1968, almost 20 years, there was no defoliation due to the spruce budworm in Nova Scotia, which could be detected from the air. During the 1980s, defoliation levels in the Province have fluctuated but with an overall downward trend. A marked reduction in severe defoliation levels was seen in 1986, although the area of moderate and light defoliation was up (Table 1). That defoliation was restricted to north-central Nova Scotia; concentrated in the west in Cumberland County and gradually lessening towards Antigonish County. No aerially detectable defoliation has been found in the Annapolis Valley and Cape Breton Island since 1984 and 1983 respectively.

During the last 50 years Nova Scotia has been essentially defoliation free on three occasions. The longest period lasted from the early 1930's until 1949. A short period occurred during 1958 and 1959 and a 6-year period lasted from 1963 to 1968. Peak defoliation years were 1953 and 1976. In 1976 over 1 335 000 ha of defoliation were recorded, with an additional 153 000 ha of trees in a moribund condition from defoliation in the previous few years.

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Table 1. Areas of spruce budworm defoliation as determined from aerial surveys, by region since 1982 ('000 hectares)

Region of Province	Year	Light	Moderate[2]	Severe[1]	Total
Cumberland and Colchester	1982	13.6	92.0	48.9	154.5
	1983	6.4	18.9	158.6	183.9
	1984	15.9	23.5	13.7	53.1
	1985	25.6	25.5	154.2[1]	205.3
	1986	109.7	231.7[2]	3.8	345.2
	1987	*0.0*	*0.0*	*0.0*	*0.0*
Pictou, Antigonish and Guysborough	1982	11.0	28.7	0.8	40.5
	1983	21.8	16.5	38.2	76.5
	1984	4.2	9.3	12.2	25.7
	1985	0.7	6.5	132.6[1]	139.8
	1986	33.0	51.0[2]	2.1	86.1
	1987	*0.0*	*0.0*	*0.0*	*0.0*
Annapolis Valley and Hants County	1982	0.0	4.1	0.0	4.1
	1983	34.7	14.4	29.9	79.0
	1984	6.3	0.0	0.0	6.3
	1985	0.0	0.0	0.0	0.0
	1986	0.0	0.0	0.0	0.0
	1987	*0.0*	*0.0*	*0.0*	*0.0*
Cape Breton Island	1982	12.3	0.4	0.0	12.7
	1983	0.5	2.2	15.5	18.2
	1984	0.0	0.0	0.0	0.0
	1985	0.0	0.0	0.0	0.0
	1986	0.0	0.0	0.0	0.0
	1987	*0.0*	*0.0*	*0.0*	*0.0*
Total	1982	36.9	125.2	49.7	211.8
	1983	63.4	52.0	242.2	357.6
	1984	26.4	32.8	25.9	85.1
	1985	26.3	32.0	286.8[1]	345.1
	1986	142.7	282.7[2]	5.9	431.3
	1987	*0.0*	*0.0*	*0.0*	*0.0*

[1] 1985 severe with some moderate patches.

[2] 1986 moderate with severe patches.

B. A. Pendrel and L.P. Magasi
Forest Insect and Disease Survey
Canadian Forestry Service-Maritimes

November, 1987

Canada

Spruce Budworm Population
In Nova Scotia, 1987

by

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Mr. E. Georgeson

Entomological Services, Nova Scotia Lands and Forests
P.O. Box 68, Truro, Nova Scotia, Canada B2N 5B8
Misc. Publication

Deputy Minister
Mr. J. Mullally

Minister
Hon. Jack MacIsaac

November 1987

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SPRUCE BUDWORM POPULATIONS IN NOVA SCOTIA

I. INTRODUCTION

There are three major surveys of spruce budworm (*Choristoneura fumiferana* (Clemens, 1865)) in Nova Scotia. These surveys are both descriptive and predictive in nature. The three surveys are (1) Aerial Defoliation Survey, (2) Moth Flight Survey, and (3) survey of overwintering larvae (L-2 survey). In 1985 the L-2 survey superceded the spruce budworm egg-mass survey.

The L-2 survey of 1986 noted the continuation of the infestation along the Northumberland Coast and Central Cumberland County (Figure 1).

II. AERIAL DEFOLIATION SURVEY

The aerial defoliation survey is conducted by the Forest Insect and Disease Survey of the Canadian Forestry Service - Maritimes - Truro with assistance from the Department of Lands and Forests. The detailed results of this survey is published as a separate CFS-M Technical Note. In summary, no visible defoliation was noted by aerial observers.

III. MOTH FLIGHT SURVEY

The Department in conjunction with Agriculture Canada, Environment Canada, Ministry of State Forestry and Mines, Transport Canada, Nova Scotia Department of Education and

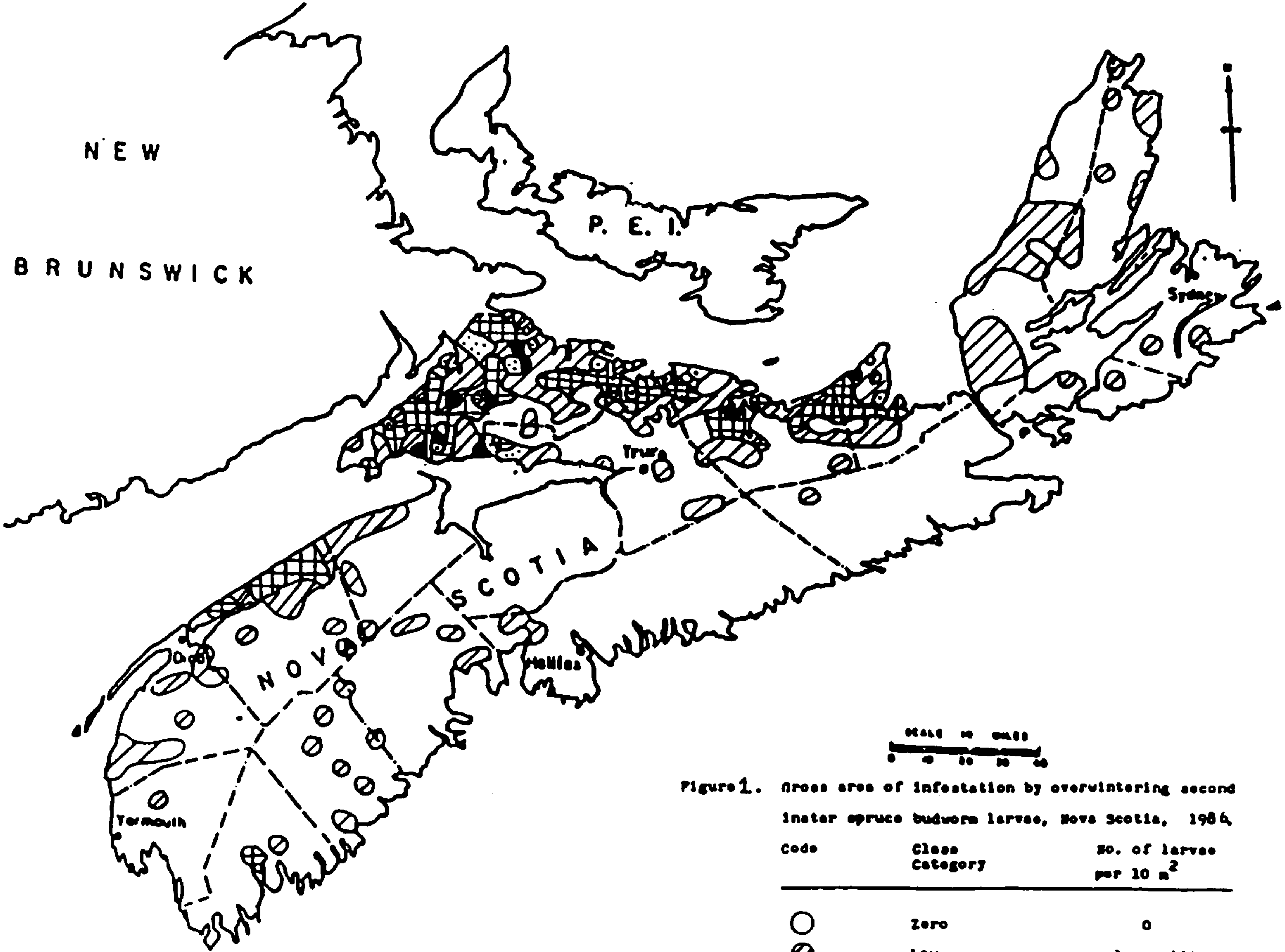

Figure 1. Gross area of infestation by overwintering second instar spruce budworm larvae, Nova Scotia, 1986.

Code	Class Category	No. of larvae per 10 m^2
○	Zero	0
⊘	Low	1 - 100
⊕	Moderate	101 - 300
◌	High	301 - 650
●	Extreme	651 +

Nova Scotia Agriculture and Marketing operate a system of light traps to sample photopositive night flying insects. The Department's light traps are operated during the time of moth flights of spruce budworm. This year weather conditions were favourable for adult migration. Two local moth flights were noted - one, via a light trap at Diligent River and the other, via a spruce budworm phermone trap, at Springhill, both areas are in Cumberland County. Moth flights of hemlock looper were noted in Diligent River, Cumberland County, Economy Point, Central New Annan, Millbrook and Balfron in Colchester County (Figure 2).

IV. L-2 SURVEY

The objective of the L-2 survey is predictive in nature. The data from this survey are used to forecast expected population densities and define areas of risk. The spruce budworm larvae migrate after eclosion and before hibernation. For this reason the L-2 data are better estimators of the current population than are those data of the egg-mass survey. This year the L-2 survey has replaced the egg-mass survey for Nova Scotia.

A. Methods

1. Field

There were 453 L-2 sample points used for this year's survey. Field samples from 403 (89%) locations were collected by Departmental personnel and samples from 50 (11%)

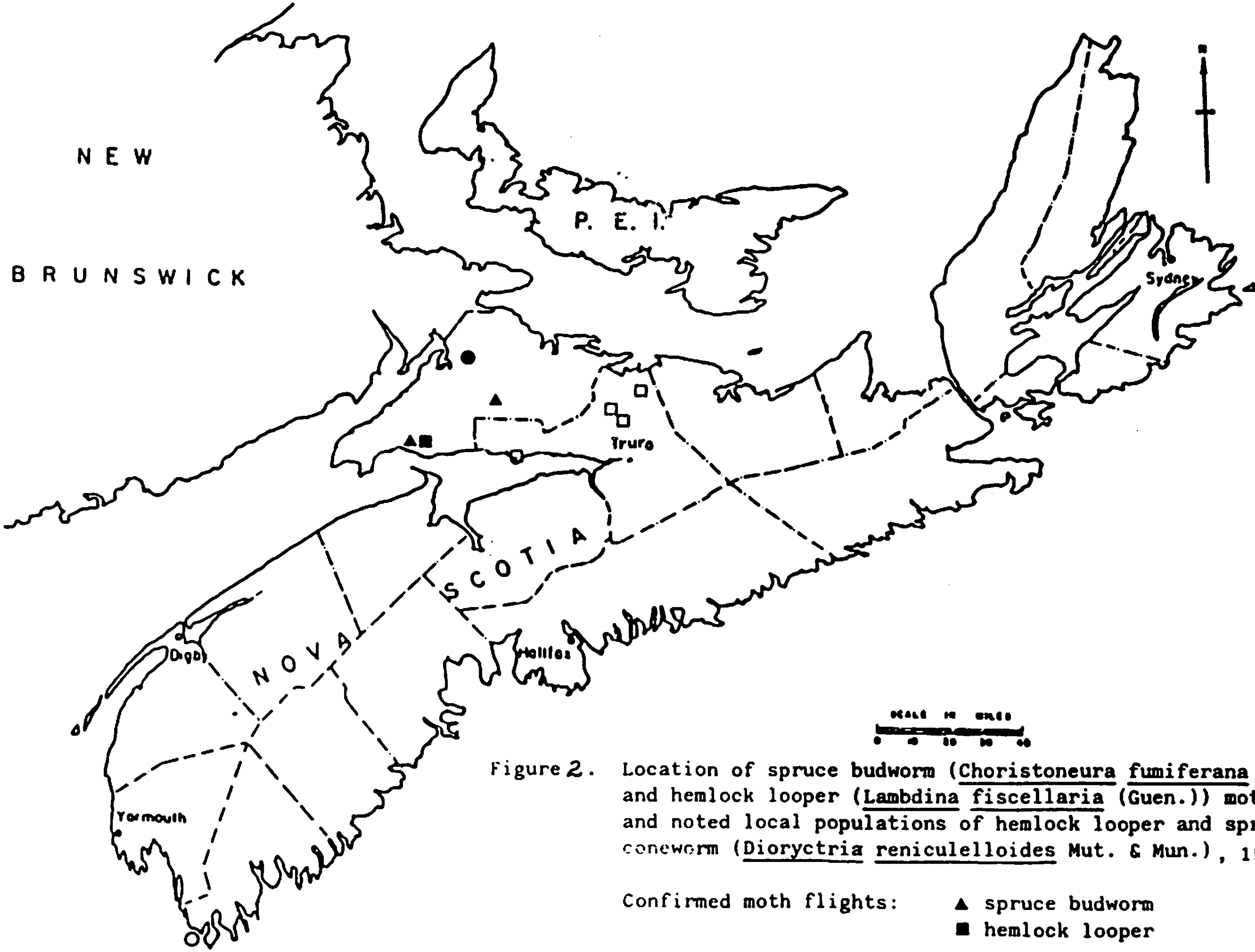

Figure 2. Location of spruce budworm (Choristoneura fumiferana (Clemens)) and hemlock looper (Lambdina fiscellaria (Guen.)) moth flights; and noted local populations of hemlock looper and spruce coneworm (Dioryctria reniculelloides Mut. & Mun.), 1987.

Confirmed moth flights: ▲ spruce budworm
■ hemlock looper

Noted moth flights □ hemlock looper

Noted local populations ○ hemlock looper
● spruce coneworm

locations were collected by Bowater-Mersey personnel. In order to compensate for long leader growth on spruces the length of the branch samples was 75 cm. This year paired samples were collected from sprayed areas and adjacent unsprayed areas (Smith and Georgeson 1986) to examine local population differences. All samples were submitted on time. In these areas for higher population densities were mapped. Thus 430 points were used to develop the L-2 map.

2. Laboratory

The Insectary at Debert has been modified to process L-2 samples. Hibernating spruce budworm larvae are removed from foliage by treating softwood foliage with a hot (66°C) solution (1.5 percent volume) of sodium hydroxide. Larvae were separated from plant debris by differential wetting technique using hexane. Larvae were enumerated on gridded filterpapers under a Wild-Leitz M5 stereo microscope (Miller et al 1971, Miller and Kettela 1982, Dorais and Kettela 1982, and Trail 1984).

In the Maritimes L-2 data have been traditionally expressed on number of larvae per 45 cm mid-crown brnach usually from balsam fir. When dealing with spruce species it is more convenient to sample longer branches (75 cm) and express the data as number of larvae per 10 m^2 as does Maine, Quebec, and Newfoundland (Dorais and Kettela, 1982).

Table 1. Population assessment and infestation levels of second instar spruce budworm larvae.

Regions	Population Assessment Larvae/branch	Larvae/10 m^2	Infestation Level
Maritimes	1-6	-	Low
	7-20	-	Medium
	21-40	-	High
	41	-	Extreme
Ontario	1-25	-	Low
	26-65	-	Medium
	66	-	High
Maine, Quebec, Newfoundland	-	0	None
	-	1-100	Low
	-	101-300	Medium
		301-650	High
		651	Extreme

(Dorais and Kettela 1982)

Sample areas of similar population densities are mapped to produce the L-2 map (Figure 3) (Appendix 1). The L-2 map for 1986 is presented for comparison (Figure 1).

3. Results

In general the current spruce budworm epidemic in Nova Scotia has collapsed. However, in some areas it remains at low levels. Overall there is significant change in the total area mapped for 1986 and 1987. There are significant reductions in all categories i.e. extreme (72.8%), high (82.1%), moderate (87.3%), and low (26.4%) (Appendices 2,3).

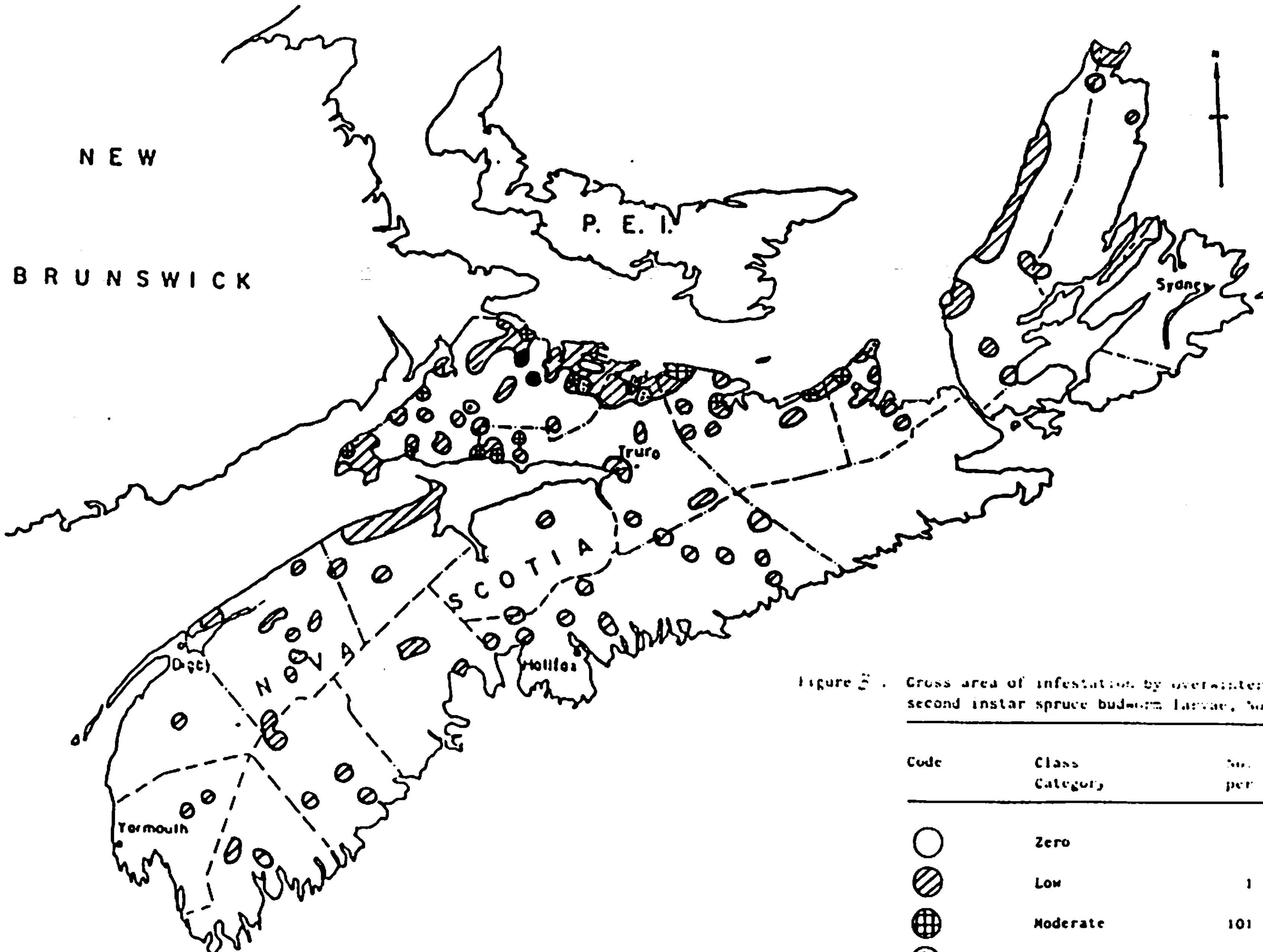

Figure 5. Gross area of infestation by overwintering (1987-1988) second instar spruce budworm larvae, Nova Scotia, 1987.

Code	Class Category	No. of larvae per 10 m²
	Zero	0
	Low	1 - 100
	Moderate	101 - 300
	High	301 - 650
	Extreme	651 +

The incidence of the microspordian parasite *Nosema fumiferana* was monitored as a part of the Aerial Foliage Protection Program. High populations of this gut parasite were positively associated with collapsed populations of spruce budworm larvae. Population collapses occurred during late fifth larval and pupal stadia.

A. Cape Breton

There has been an increase in the frequency of the number of samples with low and trace populations on the Cape Breton Highlands. The populations that were persisting at low levels for the past few years has declined.

B. Mainland Nova Scotia

(i) Southern Counties

The situation remains similar to that of 1986 with pataches of low populations noted through the Southern Counties. The area of moderate population on the North Mountain is persisting (Appendix 2).

(ii) Northern Counties

The decline in intensity of the number of second instar larvae noted in 1985 and 1986 continued (Tables 2-6). In most areas the poulation has declined to low or trace levels (Appendix 3).

C. Other Pests

Care must be taken to monitor possible range overlaps and combined effects of defoliation by the spruce budworm and other spruce-fir defoliators. Population declines

Table 2. Frequency of the number of occurrences of L-2 class categories for Antigonish County, Nova Scotia, 1984-1987.

Frequency of the Number of Occurrences

Class Category	1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%
Zero	0	0.0	2	10.5	6	23.1	12	44.4
Low	0	0.0	7	36.8	12	46.2	13	48.1
Moderate	1	16.7	5	26.3	6	23.1	1	3.7
High	3	50.0	4	21.1	1	3.8	1	3.7
Extreme	2	33.3	1	5.3	1	3.8	0	0.0
Total	6	100.0	19	100	26	100	27	100

Table 3. Frequency of the number of occurrences of L-2 class categories for Colchester County, Nova Scotia, 1984-1987.

Frequency of the Number of Occurrences

Class Category	1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%
Zero	0	0.0	7	23.3	10	27.0	18	45.0
Low	0	0.0	10	33.3	16	43.2	17	42.5
Moderate	3	18.8	5	16.7	6	16.2	3	7.5
High	4	25.0	1	3.3	5	13.5	2	5.0
Extreme	9	56.3	7	23.3	0	0.0	0	0.0
Total	16	100.0	30	100	37	100	40	100

##

Table 4. Frequency of the number of occurrences of L-2 class categories for Cumberland County, Nova Scotia, 1984-1987.

##

Frequency of the Number of Occurrences

Class Category	1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%
Zero	0	0.0	11	14.1	14	13.7	52	51.5
Low	5	13.9	23	29.5	40	39.2	39	38.6
Moderate	11	30.6	18	23.1	28	27.5	6	5.9
High	5	13.9	9	11.5	13	12.7	2	2.0
Extreme	15	41.7	17	21.8	7	6.9	2	2.0
Total	36	100.0	78	100	102	100	101	100

##

##

Table 5. Frequency of the number of occurrences of L-2 class categories for Pictou County, Nova Scotia, 1984-1987.

##

Frequency of the Number of Occurrences

Class Category	1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%
Zero	0	0.0	3	11.5	12	29.3	27	61.4
Low	1	4.5	4	15.4	13	31.7	11	25.0
Moderate	0	0.0	4	15.4	11	26.8	6	13.6
High	6	27.3	3	11.5	3	7.3	0	0.0
Extreme	15	68.2	12	46.2	2	4.9	0	0.0
Total	22	100.0	26	100	41	100	44	100

##

##

Table 6. Comparsion of the gross areas of infestation by overwintering spruce budworm larvae for Antigonish, Colchester, Cumberland and Pictou Counties, Nova Scotia, 1986 and 1987.

##

County	Low	Moderate	High	Extreme	Total
	Area (ha) per L-2 Class Category				
Antigonish					
1986	48250	22000	2500	2000	74750
1987	35000	2500	2500	0	40000
Diff.	-13250	-19500	0	-2000	-34750
%Diff(86)	-27.46	-88.64	0.00	-100.00	-46.49
Colchester					
1986	69750	22500	18500	0	110750
1987	84750	10250	4750	0	99750
Diff.	15000	-12250	-13750	0	-11000
%Diff(86)	21.51	-54.44	-74.32	0.00	-9.93
Cumberland					
1986	165000	139250	47500	18750	370500
1987	138000	13000	6250	6250	163500
Diff.	-27000	-126250	-41250	-12500	-207000
%Diff(86)	-16.36	-90.66	-86.84	-66.67	-55.87
Pictou					
1986	77250	48750	6750	4250	137000
1987	42000	11250	0	0	53250
Diff.	-35250	-37500	-6750	-4250	-83750
%Diff(86)	-45.63	-76.92	-100.00	-100.00	-61.13
Total					
1986	360250	232500	75250	25000	693000
1987	299750	37000	13500	6250	356500
Diff.	-60500	-195500	-61750	-18750	-336500
%Diff(86)	-16.79	-84.09	-82.06	-75.00	-48.56
Total for moderate + high + extreme					
1986					332750
1987					56750
Diff.					-276000
%Diff(86)					-82.95

1. %Diff(86) = @IF(C14=0,0((C15-C14)*100/C14))

##

throughout the northern Mainland were noted for the spruce coneworm (Dioryctria reniculelloides Mut & Mun. However, a small population persists at moderate levels north of Amherst (Figure 2). Populations of spruce budmoth (Zeiraphera canadensis) Mut and Free and allied species tended to increase on white spruce through the norther Mainland.

The hemlock looper (Lambdina fiscellaria (Guen.)) occupies a similar ecological niche as the spruce budworm. It does, however, utilize a greater variety of host and feeds from mid-July to mid-August. Eclosion (egg-hatch) usually spread over a three week period thus different larval instars frequently occur at the same time. A limited egg-mass survey in the moth flight areas is ongoing. The population on Ile Bon Portage appears to be declining.

V. SUMMARY

The spruce budworm population in Nova Scotia is collapsing with scattered patches of moderate to higher in small areas. The high incidence of the microspordium parasite (Nosema fumiferana was positively associated with collapsing populations of spruce budworm larvae. Studies on this gut parasite are ongoing.

Two spruce budworm and five hemlock looper moth flights were noted in 1987. The hemlock looper vies with the spruce budworm for food and can cause significant defoliation and tree mortality in a short period of time. The monitoring of these two important forest pests is ongoing.

VI. REFERENCES

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Appendix 1

Population densities of overwintering second instar spruce budworm larvae by county, Nova Scotia, 1987.

ANNAPOLIS COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains ANNAPOLIS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
29(2)495(7)	NORTH MTN. RANGE	42	LOW	rs bs
33(1)494(7)	LITTLE BEAR LAKE	28	LOW	bf
33(2)498(1)	DOUGLAS RD.	23	LOW	ws
32(4)495(8)	BIRCH HILL LAKE	22	LOW	bf
33(0)493(3)	SNOWSHOE LAKES	22	LOW	bf
31(7)495(4)	GOLDSMITH LAKE	20	LOW	bf
32(3)494(4)	LONG LAKE	15	LOW	bf
33(5)495(3)	DALHOUSIE HILL	8	LOW	bf
30(9)495(0)	PEROTTE	7	LOW	bf
30(0)494(5)	PRINCE DALE	0	ZERO	bf
30(1)496(2)	GRANDVILLE	0	ZERO	ws
30(2)493(7)	VICTORY	0	ZERO	bf
30(2)495(3)	LAKE LA ROSE	0	ZERO	ws
30(7)493(4)	SUNDOWN LAKE	0	ZERO	bf
30(7)496(5)	BELLEISLE	0	ZERO	ws
31(3)493(2)	BUSTIN LAKE	0	ZERO	bf
31(6)497(3)	HAMPTON	0	ZERO	bf
32(1)492(6)	THOMAS MEADOW	0	ZERO	bf
32(2)496(0)	DALHOUSIE LK.	0	ZERO	ws
32(3)495(4)	WEST DALHOUSIE	0	ZERO	bf
32(5)492(3)	MAITLAND BRIDGE	0	ZERO	bf
32(5)494(7)	BEAR LAKE	0	ZERO	bf
32(5)497(7)	EAST ARLINGTON	0	ZERO	ws
32(9)492(1)	KEMPT	0	ZERO	bf
33(3)495(9)	MEDWAY LAKE	0	ZERO	bf
33(5)496(6)	WEASEL HILL	0	ZERO	ws
33(8)495(7)	TROUT LAKE	0	ZERO	bf
33(9)497(5)	NICTAUX FALLS	0	ZERO	ws
34(1)495(4)	ALBANY CROSS	0	ZERO	bf
34(9)494(2)	SPRINGFIELD	0	ZERO	bf

ANTIGONISH COUNTY

File: L.2 DATA Page 1

Report: L-2 SURVEY 'OCT/87

Selection: District contains ANTIGONISH

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
58(2)507(8)	BALLANTYNES COVE	326	HIGH	ws
56(4)506(6)	ARISAG	140	MODERATE	ws
56(2)506(4)	McARRAS BROOK	50	LOW	ws
58(2)505(6)	HARBOUR RD.	38	LOW	ws
58(3)506(8)	WEST LAKE VALE	24	LOW	ws
59(0)505(3)	POMQUET	24	LOW	ws
57(7)507(4)	GEORGEVILLE	23	LOW	ws
57(4)506(5)	MARYVALE	22	LOW	ws
56(8)505(3)	BROWNS MTN.	20	LOW	ws
57(6)505(5)	LWR.NORTH GRANT	20	LOW	ws
57(4)507([illegible])	GEORGEVILLE	19	LOW	ws
58(4)506(2)	ANTIGONISH HBR.	19	LOW	ws
56(2)506(1)	KNOYDART	1[illegible]	[illegible]	ws
57(5)505(8)	NORTH GRANT	11	LOW	ws
59(4)504(4)	BLACK [illegible]ON	11	LOW	ws
56(1)506(4)	McARRAS BROOK	0	ZERO	ws
56(4)506(6)	ARISAG	0	ZERO	ws
56(6)505(9)	HIGHFIELD	0	ZERO	ws
56(9)504(4)	ADDINGTON FORKS	0	ZERO	bf
57(8)507(2)	GLEBE RD.	0	ZERO	ws
57(2)506(9)	MALIGNANT PT.	0	ZERO	ws
57(3)504(9)	WEST RIVER	0	ZERO	ws
57(6)503(6)	GLEN ALPINE	0	ZERO	[illegible]
58(0)506(6)	BROPHY	0	ZERO	ws
58(2)505(9)	ANTIGONISH HARBOUR BL	0	ZERO	ws
58(3)504(2)	DUNMORE	0	ZERO	ws
58(5)504(9)	LWR.SOUTH RIVER	0	ZERO	ws
60(7)505(0)	MONASTERY	0	ZERO	ws
61(5)505(8)	HAVRE BOUCHER	0	ZERO	ws

CAPE BRETON COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains CAPE BRETON

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
68(4)508(0)	MIDDLE CAPE	0	ZERO	bf
68(4)510(6)	POINT CLEAR	0	ZERO	bf
69(2)507(8)	NORTH GLEN	0	ZERO	bf
69(6)509([illegible])	BEN EOIN	0	ZERO	bf
70([illegible])508([illegible])	STEVER MINE	0	ZERO	bf
70(0)510(9)	MCLEANVILLE	0	ZERO	bf
70(5)513(2)	McCREADYVILLE	0	ZERO	bf
70(9)507(6)	UPPER GRAND MIRA	0	ZERO	bf
71(2)509(5)	MARION BRIDGE	0	ZERO	bf
71(3)508(8)	CAMPBELL DALE	0	ZERO	bf
72(0)508(4)	OCEANVIEW	0	ZERO	bf
72(4)510(6)	MORRISON LAKE	0	ZERO	bf
7[illegible](6)509(1)	LORRAINE	0	ZERO	bf

COLCHESTER COUNTY

File: L.2 DATA | Page 1

Report: L-2 SURVEY | OCT/87

Selection: District contains COLCHESTER

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
48(3)505(6)	BALMORAL MILLS	364	HIGH	rs/bs
47(8)506(3)	BARRACHOIS	325	HIGH	rs bs
41(3)503(5)	LYNN	242	MODERATE	rs bs
43(0)503(9)	ECONOMY LAKE	159	MODERATE	rs/bs
47(7)506(0)	TATAMAGOUCHE	132	MODERATE	rs bs
42(2)503(0)	BEAVER BROOK	111	MODERATE	rs bs
47(1)505(6)	MILL BROOK	45	LOW	rs bs
47(6)505(3)	CENT.NEW ANNAN	43	LOW	ws
48(7)506(0)	DENMARK	42	LOW	rs bs
47(9)505(6)	BALFRON	40	LOW	ws
41(5)503(0)	SHAD BROOK BLOCK #?0	33	LOW	rs bs
44(3)504(3)	GLEASON BROOK	27	LOW	ws
48(0)503(7)	McCALL? SETTLEMENT	27	LOW	ws
50(7)500(9)	NEWTON MILLS	27	LOW	ws
46(6)506(1)	MATTATALL LAKE	26	LOW	ws
47(1)502(5)	ONSLOW	24	LOW	rs bs
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
49(0)505(7)	EAST EARL TOWN	10	LOW	rs bs
47(5)499(7)	STEWIACKE	6	LOW	bf
47(8)502(0)	MILLBROOK	8	LOW	rs rs
47(8)504(3)	SILICA LAKE	6	LOW	rs bs
43(1)502(4)	ECONOMY PT.	0	ZERO	rs bs
43(8)503(2)	UPPER BASS RIVER	0	ZERO	rs bs
44(4)503(0)	MONTROSE	0	ZERO	ws
45(0)503(5)	LORNEVALE	0	ZERO	rs bs
45(6)503(6)	FOLLY MTN.	0	ZERO	ws
46(5)503(5)	DEBERT	0	ZERO	ws
47(0)506(1)	FRENCH RIVER	0	ZERO	rs bs
47(7)505(5)	NEW TRURO RD.	0	ZERO	rs bs
48(1)500(8)	BROOKFIELD	0	ZERO	bf
48(1)504(4)	NUTTBY	0	ZERO	bf
48(4)505(0)	SPIDELL HILL	0	ZERO	ws
48(4)505(9)	WAUGHS RIVER BLOCK #1	0	ZERO	rs/bs

COLCHESTER COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains COLCHESTER

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
48(5)502(5)	VALLEY	0	ZERO	ws
48(7)505(0)	EARLTOWN	0	ZERO	bf
49(2)504(8)	BERICHAN	0	ZERO	bf
49(2)505(2)	NORTH EARLTOWN	0	ZERO	ws
49(8)500(6)	OTTERBROOK	0	ZERO	bf
50(5)502(8)	LANSBERG	0	ZERO	rs/bs

CUMBERLAND COUNTY

File: L.2 DATA

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Report: L-2 SURVEY

OCT/87

Selection: District contains CUMBERLAND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
43(2)507(4)	BECKWITH	1571	EXTREME	rs/bs
43(6)506(2)	WEST HANSFORD	920	EXTREME	rs/bs
41(1)505(4)	SPRINGHILL	371	HIGH	rs/bs
38(3)505(6)	TWO RIVERS	341	HIGH	rs/bs
45(8)505(7)	WENTWORTH CENTRE	324	HIGH	rs/bs
38(1)503(2)	FOX RIVER	161	MODERATE	rs/bs
43(3)508(5)	LINDEN #69	128	MODERATE	rs/bs
35(4)503(4)	RUDSEY POINT	125	MODERATE	rs/bs
45(6)506(5)	ANGEVINE LAKE	122	MODERATE	ws
38(5)505(8)	RAGGED REEF	103	MODERATE	rs/bs
43(1)507(8)	LK.KILLARNEY	100	LOW	ws
42(1)505(7)	SALT SPRINGS	77	LOW	ws
42(3)508(9)	BEECHAM SETTLEMENT	74	LOW	rs/bs
41(8)508(9)	GREEN HI.	72	LOW	rs/bs
44(4)506(9)	CONNS MILLS	70	LOW	rs/bs
[illegible]	NEW BRITAIN	65	LOW	rs/bs
[illegible]	BROOKDALE	49	LOW	rs/bs
39(2)504(0)	HALFWAY RIVER	45	LOW	rs/bs
39(6)503(6)	LAKELANDS	[illegible]	LOW	rs/bs
36(2)503(2)	ADVOCATE	39	LOW	rs/bs
35(4)502(8)	EATONVILLE	36	LOW	rs/bs
42(8)508(5)	CHAPMAN SETTLEMENT	33	LOW	ws
42(3)506(2)	CHASE LAKE	32	LOW	rs/bs
39(3)503(7)	HALFWAY RIVER	31	LOW	rs/bs
44(3)506(6)	CONNS MILLS	30	LOW	rs/bs
41(2)508(0)	TYNDAL RD.	26	LOW	rs/bs
36(5)502(7)	BEECH HILL	25	LOW	rs/bs
37(4)504(8)	SHULIE	23	LOW	rs/bs
43(0)508(4)	LWR. SHINIMCAS	23	LOW	rs/bs
36(6)503(9)	EAST APPLE RIVER	22	LOW	rs/bs
41(8)507(8)	TRUEMANVILLE	22	LOW	rs/bs
44(6)507(7)	PUGWASH	22	LOW	rs/bs
42(3)508(4)	BEECHAM ROAD	19	LOW	rs/bs
36(2)503(8)	EAST APPLE RIVER	18	LOW	rs/bs

CUMBERLAND COUNTY
File: L.2 DATA
Report: L-2 SURVEY
Selection: District contains CUMBERLAND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
41(2)504(5)	EAST MAPLETON	18	LOW	rs/bs
39(5)507(1)	MINUDIE BLOCK #5	15	LOW	rs/bs
40(1)505(4)	BARREN BROOK BLOCK #1	15	LOW	rs/bs
45(3)506(0)	MAHONEY'S CORNER	14	LOW	rs/bs
45(4)507(8)	GULF SHORE	12	LOW	ws
38(4)505(1)	CHIGNECTO	11	LOW	rs/bs
45(8)507(0)	KERRS MILL RD.	11	LOW	ws
46(9)506(9)	MALAGASH	11	LOW	rs/bs
47(8)507(1)	MALAGASH PT.	11	LOW	ws
38(2)503(8)	WELTON LAKE	10	LOW	rs/bs
40(7)506(7)	FENWICK	10	LOW	ws
46(2)505(4)	EAST WENTWORTH	10	LOW	rs/bs
46(5)506(6)	MALAGASH STN.	10	LOW	rs/bs
42(9)503(1)	BEAVER MEADOW	[illegible]	LOW	rs/bs
46(5)507(5)	NORTH WALLACE	7	LOW	rs/bs
35(9)502(3)	WEST ADVOCATE	0	ZERO	rs/bs
36(6)503(4)	ADVOCATE	0	ZERO	rs/bs
36(8)504(2)	SAND RIVER	0	ZERO	rs/bs
37(5)504(1)	SHULIE RIVER	0	ZERO	rs/bs
37(8)503(1)	NORTH GREVILLE	0	ZERO	rs/bs
37(8)505(1)	SHULIE BLOCK #4	0	ZERO	rs/bs
38([illegible])503(1)	GLASGOW MTN.	0	ZERO	rs/bs
38(4)504(4)	FORTY PUDDLE LAKE	0	ZERO	rs/bs
38(6)502(8)	DILIGENT RIVER	0	ZERO	rs/bs
38(6)502(6)	DILIGENT RIVER	0	ZERO	rs/bs
39(1)504(1)	HALFWAY RIVER	0	ZERO	rs/bs
39(1)506(7)	MILL CREEK	0	ZERO	rs/bs
39(3)503(1)	KIRKHILL	0	ZERO	rs/bs
39(3)505(6)	RIVER HEBERT	0	ZERO	rs/bs
39(4)502(6)	PARRSBORO #23	0	ZERO	rs/bs
39(4)505(0)	BOARS BACK	0	ZERO	rs/bs
39(5)505(1)	THUNDER HILL	0	ZERO	rs/bs
39(6)506(5)	LOWER MACCAN	0	ZERO	rs/bs
40(1)503(0)	NEW PROSPECT	0	ZERO	rs/bs

CUMBERLAND COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains CUMBERLAND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
40(1)506(5)	HARRISON RD.	0	ZERO	rs/bs
40(2)504(4)	STH. BROOK	0	ZERO	rs/bs
40(5)508(1)	FT.LAWRENCE #52	0	ZERO	rs/bs
40(5)508(2)	FORT LAWRENCE	0	ZERO	rs/bs
40(8)505(0)	MAPLETON	0	ZERO	rs/bs
40(9)502(9)	MOOSE RIVER	0	ZERO	rs/bs
40(9)506(3)	LITTLE FORKS	0	ZERO	rs/bs
41(0)505(8)	SPRINGHILL	0	ZERO	rs/bs
41(0)507(4)	BROOKDALE	0	ZERO	rs/bs
41(1)504(8)	SOUTH HAMPTON	0	ZERO	rs/bs
41(2)507(1)	WEST LEICESTER	0	ZERO	rs/bs
41(3)503(6)	LYNN MTN.	0	ZERO	rs/bs
41(3)508(1)	MACLELLANS BRK.	0	ZERO	rs/bs
41(4)506(6)	STANLEY	0	ZERO	rs/bs
41(5)508(8)	TIDNISH	0	ZERO	ws
41(6)507(5)	BEAVERBROOK #49	0	ZERO	rs/bs
41(8)502(7)	FIVE ISLANDS	0	ZERO	rs/bs
41(9)506(3)	LEICESTER	0	ZERO	rs/bs
42(1)505(7)	SALT SPRINGS	0	ZERO	rs/bs
42(1)509(1)	TIDNISH BRIDGE	0	ZERO	rs/bs
42(5)508(8)	SHINIMICAS #65	0	ZERO	rs/bs
43(0)504(5)	FARMINGTON	0	ZERO	rs/bs
43(0)507(3)	RIPLEY LOOP	0	[illegible]	[illegible]
43(2)505(9)	OXFORD JUNCTION	0	ZERO	rs/bs
43(3)508(1)	WEST LINDEN	0	ZERO	rs/bs
43(6)507(1)	RIVERVIEW	0	ZERO	rs/bs
43(7)504(8)	SUGARLOAF MTN.	0	ZERO	rs/bs [illegible]
43(7)505(7)	THOMSON STN.	0	ZERO	rs/bs
43(9)506(6)	ROSLIN	0	ZERO	rs/bs
44(4)505(2)	WESTCHESTER STN.	0	ZERO	rs/bs
44(7)504(1)	SUTHERLANDS LAKE	0	ZERO	bf
45(0)504(9)	WESTCHESTER	0	ZERO	rs/bs
45(0)505(6)	WEST WENTWORTH	0	ZERO	rs/bs
45(3)507(2)	HD.WALLACE BAY	0	ZERO	bf

Selection: District contains CUMBERLAND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
45(4)506(8)	MIDDLEBORO	0	ZERO	rs bs
46(6)506(4)	MILLARD CREEK	0	ZERO	ws

DIGBY COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains DIGBY

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
24(9)489(0)	CLARE	0	ZERO	bf
25(3)490(3)	LWR. CONCESSION	0	ZERO	rs/bs
26(3)490(3)	FIRMAIN	0	ZERO	bf (2-bf
26(4)489(6)	WENTWORTH LAKE	0	ZERO	bf
26(5)491(7)	SCOTS LAKE	0	ZERO	rs/bs
26(7)492(4)	MALLETTES MEADOWS	0	ZERO	bf
27(3)493(0)	NORTH RANGE	0	ZERO	rs/bs
27(4)489(8)	BARNS DEADWATER	0	ZERO	bf
27(4)492(0)	FIRE TOWER	0	ZERO	rs/bs
27(5)491(0)	BARN BROOK	0	ZERO	bf
27(6)490(7)	BARNS BROOK	0	ZERO	bf
27(8)491(3)	DOYLES LAKE	0	ZERO	bf
28(1)490(0)	TOAD LAKE	0	ZERO	bf
28(3)493(0)	BIG TOM WALLACE LAKE	0	ZERO	bf
28(6)491(2)	BIRCH LAKE	0	ZERO	bf
28(8)493(9)	BEAR RIVER	0	ZERO	bf
28(9)493(0)	LINT LAKE	0	ZERO	bf
29(0)493(4)	MORGANVILLE	0	ZERO	bf
29(5)492(8)	LAKE JOLI	0	ZERO	bf

GUYSBOROUGH COUNTY

File: L.2 DATA

Page 1

Report: L-2 SURVEY

OCT/87

Selection: District contains GUYSBOROUGH

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
54(8)501(4)	CALIDONIA	0	ZERO	ws
56(8)501(4)	SMITHFIELD	0	ZERO	ws
57(7)499(6)	GOLDENVILLE	0	ZERO	bf
59(0)501(8)	NELSON LAKE	0	ZERO	bf
60(7)502(2)	OGDEN	0	ZERO	bf
61(3)504(0)	LINCOLNVILLE	0	ZERO	bf
61(5)503(1)	MILFORD HAVEN	0	ZERO	bf
62(5)504(8)	PIRATE HARBOUR	0	ZERO	bf
6[illegible]([illegible])503(3)	MacPHERSON LAKE	0	ZERO	bf
6[illegible]([illegible])504(4)	MIDDLE MELFORD	0	ZERO	ws

HALIFAX COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains HALIFAX

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
45(9)497(3)	OLDHAM	68	LOW	bf
50(2)498(6)	MOOSE RIVER	46	LOW	bf
51(9)497(4)	MOOSELAND	29	LOW	bf
41(2)495(1)	INDIAN HILL	26	LOW	bf
42(5)495(7)	MUSKRAT LAKE	21	LOW	bf
45(4)495(8)	WAVERLEY	17	LOW	bf
53(3)500(0)	LISCOMBE	15	LOW	bf
47(3)495(6)	PORTER'S LAKE	10	LOW	bf
43(3)495(0)	STILLWATER LAKE	9	LOW	bf
51(1)496(2)	SHIP HARBOUR	9	LOW	bf
46(8)496(2)	EAST LAKE	8	LOW	bf
48(8)499(1)	GLENMORE	-	LOW	bf
42(2)495(2)	POGWA IS.	0	ZERO	rs/bs
42(8)495(1)	MILL LAKE	0	ZERO	rs/bs
48(0)495(6)	CONRAD SETTLEMENT	0	ZERO	bf
48(2)496(7)	GILBRALTER	0	ZERO	bf
53(6)497(8)	SHEET HBR	0	ZERO	bf
52(8)499(5)	HORSE LAKE	0	ZERO	bf

HANTS COUNTY

File: L.2 DATA

Report: L-2 SURVEY OCT/87

Selection: District contains HANTS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
43(8)500(4)	WET MEADOW	39	LOW	bf
40(1)497(6)	CASTLE FREDRICK	0	ZERO	bf
40(2)496(8)	VAUGHAN	0	ZERO	bf
41(2)500(6)	STARRATT PT.	0	ZERO	ws
41(6)496(7)	SHADY LAKE	0	ZERO	bf
42(2)497(4)	STILLWATER	0	ZERO	bf
42(6)500(0)	PINNACLE HILL	0	ZERO	rs/bs
43(0)501(3)	CAPE TENNY	0	ZERO	bf
43(2)497(2)	MT.UNIACKE	0	ZERO	bf
43(4)496(4)	POCHWOCK	0	ZERO	bf
43(9)498(9)	RAWDON GOLD MINES	0	ZERO	bf
44(4)501(6)	DENSMORES MILLS	0	ZERO	rs/bs
44(9)500(6)	UPPER KENNETCOOK	0	ZERO	bf
46(7)500(2)	ADMIRAL ROCK	0	ZERO	bf

INVERNESS COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains INVERNESS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
66(2)517(8)	COVE RIVER	38	LOW	bf
64(8)514(5)	BELLE COTE	23	LOW	ws
68(0)518(8)	FOX LAKE	12	LOW	ws
64(3)506(8)	MARSHES	11	LOW	ws
63(2)511(6)	KENLOCK	10	LOW	ws
63(4)510(7)	HAYS RIVER	10	LOW	ws
64(5)513(2)	MARGAREE FORKS	10	LOW	ws
65(1)511(3)	GIL:LANDERS MTN.	10	LOW	bf
65(2)516(1)	PLATEAU	10	LOW	ws
66(6)518(7)	PLEASENT BAY	10	LOW	ws
62(3)510(9)	MABOU HIGHLANDS	9	LOW	bf
63(4)508(2)	UPPER RIVER DENYS	9	LOW	bf
65(7)516(7)	PETIT ETANG	9	LOW	ws
61(5)509(8)	PORT HOOD	0	ZERO	ws
61(8)507(4)	LONG POINT	0	ZERO	ws
61(8)508(9)	LITTLE JUDIQUE	0	ZERO	ws
62(9)506(3)	CREIGNISH HILLS	0	ZERO	ws
62(6)511(4)	NTH. CAPE HIGHLANDS	0	ZERO	bf
63(2)507(2)	MAPLE BROOK	0	ZERO	bf
63(5)512(1)	CAMBELLTON ROAD	0	ZERO	ws
63(8)509(6)	STEWARTDALE	0	ZERO	bf
64(9)509(9)	HUME	0	ZERO	bf
65(4)513(1)	NE MARGAREE	0	ZERO	bf
65(5)512(2)	SECOND LAKE	0	ZERO	bf
65(5)515(2)	PEMBROOK LAKE	0	ZERO	bf
65(6)514(0)	PORTREE	0	ZERO	bf
65(7)512(6)	FIRST LAKE O LAW	0	ZERO	ws
65(9)513(6)	FRASER'S MTN	0	ZERO	bf
66(7)515(1)	SECOND FORKS BR. RD.	0	ZERO	bf
66(7)515(8)	CAMPBELLS BARREN	0	ZERO	bf

KINGS COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains KINGS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
38(5)501(3)	ARLINGTON	63	LOW	ws
35(3)499(5)	VICTORIA HBR.	49	LOW	ws
35(8)499(4)	VIEWMOUNT	41	LOW	ws
39(3)501(3)	BLOMIDON	34	LOW	bf
36(6)500(1)	WHITES CORNER	31	LOW	ws
35(0)497(5)	TORBROOK EAST	24	LOW	bf
39(2)501(7)	SCOTT S BAY	23	LOW	bf
35(1)497(9)	ROCKVILLE NOTCH	17	LOW	bf
37(4)500(2)	W. HALLS HARBOUR RD.	14	LOW	ws
36(7)497(0)	LAKE PAUL	13	LOW	rs/bs
34(3)498(9)	BISHOPS MTN.	0	ZERO	ws
35(5)496(6)	FROG LAKE	0	ZERO	rs/bs
36(0)495(1)	EAST DALHOUSIE	0	ZERO	bf
36(9)498(1)	AYLESFORD LK.	0	ZERO	rs/bs
37(9)498(6)	SOUTH A[illegible]CH	0	ZERO	ws
36(0)497(5)	FOREST HOME	0	ZERO	ws
39(3)498(9)	FOREST HILLS	0	ZERO	ws

LUNENBURG COUNTY

File: L-2 DATA | Page 1

Report: L-2 SURVEY | OCT/87

Selection: District contains LUNENBURG

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
37(6)494(8)	HARLOW LAKE	64	LOW	rs/bs
40(3493(8))	LABRADOR LAKE	31	LOW	rs/bs
35(9)491(0)	UPPER CHELSEA	12	LOW	rs/bs
38(3)495(2)	LAKE DARLING	12	LOW	rs/bs
35(8)492(8)	NINEVEN	9	LOW	bf
36(0)494(0)	STANBURNE	0	ZERO	bf
37(1)491(2)	HEBBVILLE	0	ZERO	rs/bs
37(4)489(8)	MIDDLEWOOD	0	ZERO	rs/bs
37(5)490(2)	BIG WHITFORD LAKE	0	ZERO	rs/bs
37(8)492(1)	LOWER BRANCH	0	ZERO	bf
39(8)495(1)	SHERWOOD	0	ZERO	bf
39(9)493(8)	MARIOTTS MEADOW	0	ZERO	rs/bs
40(8)494(2)	BIG WHITFORD LK.	0	ZERO	rs/bs

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
49(2)507(0)	CAPE JOHN	239	MODERATE	ws
55(3)505(5)	BAILEY'S BROOK	191	MODERATE	ws
55(1)505(7)	LWR.BARNEYS RIVER	142	MODERATE	ws
51(7)505(4)	LOCH BROOM	132	MODERATE	ws
50(2)506(9)	SEAFOAM	125	MODERATE	ws
49(5)506(8)	CAPE JOHN BLOCK #150	113	MODERATE	ws
51(7)506(4)	WATERSIDE	87	LOW	rs/bs
53(2)507(3)	PICTOU ISLAND	83	LOW	ws
53(3)505(6)	BLACK PT. BLOCK #162	53	LOW	ws
55(7)505(9)	PONDS	53	LOW	ws
50(3)505(1)	DIAMOND BRK.	50	LOW	rs/bs
54(8)505(0)	MERIGOMISH	22	LOW	ws
50(0)505(0)	GRANTON	12	LOW	ws
49(7)506(0)	MINE BROOK	11	LOW	bf
54(4)504(6)	FRENCH RIVER	11	LOW	ws
50(0)503(8)	MT.THOM	9	LOW	bf
51(0)504(0)	MILL BROOK	9	LOW	bf
49(6)505(2)	LOGANVILLE	0	ZERO	bf
49(8)506(6)	FITZPATRICK	0	ZERO	ws
49(9)504(5)	DALHOUSIE SETTLEMENT	0	ZERO	ws
50(1)505(2)	DIAMOND BROOK	0	ZERO	ws
50(1)505(6)	BLACK RIVER	0	ZERO	bf
50(2)506(2)	ROGERS	0	ZERO	bf
50(5)504(6)	DALHOUSIE MTN.	0	ZERO	ws
50(5)506(2)	POPLAR HILL	0	ZERO	rs/bs
50(7)505(8)	PLAINFIELD	0	ZERO	bf
50(8)506(4)	POPLAR HILL	0	ZERO	bf
51(2)505(6)	HARDWOOD HILL	0	ZERO	ws
51(4)504(3)	GREENHILL	0	ZERO	ws
51(6)503(7)	ROCKLIN	0	ZERO	ws
51(8)504(6)	ALMA	0	ZERO	rs/bs
52(4)506(3)	CARIBOU FERRY	0	ZERO	rs/bs
52(4)506(3)	PICTOU BLOCK #157	0	ZERO	rs/bs
52(5)503(0)	ELGIN	0	ZERO	ws

PICTOU COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains PICTOU

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
52(7)503(9)	FORBES LK.	0	ZERO	rs/bs
52(9)503(6)	IRISH MTN.	0	ZERO	ws
53(2)505(1)	TRENTON	0	ZERO	ws
53(7)505(6)	ROY ISLAND	0	ZERO	ws
53(9)504(6)	TELFORD	0	ZERO	ws
54(0)505(0)	WEST MERIGOMISH	0	ZERO	ws
54(2)502(5)	SUNNYBRAE	0	ZERO	bf
55(5)505(4)	AVONDALE BLOCK #171	0	ZERO	ws
55(6)504(5)	ROSSFIELD	0	ZERO	ws
56(2)504(8)	MAPSHYHOPE	0	ZERO	bf
56(5)502(7)	EAST RIVER ST.MARYS	0	ZERO	ws

QUEENS COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains QUEENS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
32(7)488(5)	COADE LK.	73	LOW	bf
35(6)488(4)	MILTON	42	LOW	rs/bs
31(8)491(2)	KEJI. PARK	11	LOW	ws (2-ws
32(2)490(1)	SAND LAKE	11	LOW	bf
34(3)489(6)	BLACK LAKE	9	LOW	bf
31(3)490(0)	LITTLE PINE LAKE	0	ZERO	bf
33(5)490(8)	WHITEBURN MINES	0	ZERO	ws
33(8)491(4)	CALEDONIA	0	ZERO	rs/bs
34(0)486(4)	WILKINS	0	ZERO	bf
34(3)492(6)	CRANBERRY LAKE	0	ZERO	bf
34(5)491(3)	MALEGA	0	ZERO	rs/bs
34(8)488(6)	NINE MILE BROOK	0	ZERO	bf
35(0)486(8)	RIVER HEAD	0	ZERO	rs/bs
35(3)489(4)	MIDDLE FIELD	0	ZERO	bf
35(7)487(8)	MILTON	0	ZERO	rs/bs
36(5)489(3)	RIVERSDALE	0	ZERO	bf

RICHMOND COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains RICHMOND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
65(0)504(6)	PORT ROYAL	0	ZERO	bf
66(2)506(4)	OBAN	0	ZERO	bf
67(2)506(0)	BARRA HEAD	0	ZERO	bf
67(9)507(5)	IRISH COVE	0	ZERO	bf
68(6)506(6)	HD.LOCH LOMOND	C	ZERO	bf
70(1)506(7)	NORTH FRAMBOISE	0	ZERO	bf

SHELBURNE COUNTY

File: L.2 DATA

Report: L-2 SURVEY

Selection: District contains SHELBURNE

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
30(4)487(2)	PHILIP LK.	76	LOW	bf
32(6)485(7)	BLUE HILL BOG	70	LOW	bf
32(0)486(1)	STH.BLUE HILL	45	LOW	bf
30(3)486(2)	UP.CLYDE RIVER	10	LOW	bf
30(8)485(2)	WELSHTOWN	0	ZERO	bf

VICTORIA COUNTY
File: L.2 DATA
Report: L-2 SURVEY
Selection: District contains VICTORIA

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
69(4)518(0)	BRANCH POND	26	LOW	ws
69(2)520(6)	ST.MARGARET'S VILLAGE	25	LOW	ws
65(8)510(6)	WEST MIDDLE RIVER	13	LOW	ws
68(6)520(9)	MEAT COVE	10	LOW	ws
65(7)511(2)	GAIRLOCH	0	ZERO	bf
66(4)511(2)	HUNTERS MTN.	0	ZERO	bf
66(6)509(4)	ST.COLUMBO	0	ZERO	bf
66(7)513(8)	FIRE CAMP	0	ZERO	bf
66(8)512(0)	CROWDIS AIR	0	ZERO	bf
67(1)511(8)	NEW GLEN	0	ZERO	ws
67(6)515(7)	WRECK COVE	0	ZERO	bf
68(5)513(6)	TARBOTUOLE	0	ZERO	ws
68(9)515(9)	WRECK COVE	0	ZERO	rs/bs
68(1)515(8)	INDIAN BROOK	0	ZERO	bf
69(1)512(4)	KELLY MTN.	0	ZERO	bf
69(4)514(6)	LITTLE RIVER	0	ZERO	ws
69(5)518(9)	MICA H[illegible]	0	ZERO	ws
69([illegible])515(5)	WRECK COVE PT.	0	ZERO	ws
69(7)517(0)	INGONISH CENTRE	0	ZERO	rs/bs
70(1)518(1)	GREEN COVE	0	ZERO	rs/bs

YARMOUTH COUNTY

File: L.2 DATA

Report: L-2 SURVEY

OCT/87

Selection: District contains YARMOUTH

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
27(2)488(1)	KEMPTVILLE	34	LOW	bf
28(7)488(8)	FIRST BEAR LK.	13	LOW	bf
25(8)487(8)	LAKE JESSIE	0	ZERO	bf
26(0)486(2)	TUSKET FALLS	0	ZERO	bf
26(3)487(1)	PRISCILLA LAKE	0	ZERO	bf
26(3)488(3)	LAKE EDWARD	0	ZERO	bf
27(0)485(5)	ARGYLE HEAD	0	ZERO	bf
27(6)486(7)	FRANK'S LAKE	0	ZERO	bf
27(8)484(4)	CRANBERRY BOG	0	ZERO	bf

Appendix 2

Gross area of infestation by overwintering second instar spruce budworm larvae, by County, Nova Scotia, 1986-87.

Gross area of infestation by overwintering second instar spruce budworm larvae by County, Nova Scotia, 1986 and 1987.

County	Low		Moderate		High		Extreme		Total	
	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
A. Cape Breton Island										
Cape Breton	19000	0	0	0	0	0	0	0	19000	0
Inverness	157750	93500	0	0	0	0	0	0	157750	93500
Richmond	13750	0	0	0	0	0	0	0	13750	0
Victoria	58500	21250	0	0	0	0	0	0	58500	21250
B. Mainland										
Southern										
Annapolis	41500	46500	50250	0	0	0	0	0	91750	46500
Digby	96500	5750	0	0	0	0	0	0	96500	5750
Guysborough	7500	0	0	0	0	0	0	0	7500	0
Halifax	22500	56250	0	0	0	0	0	0	22500	56250
Hants	10750	5750	0	0	0	0	0	0	10750	5750
Kings	43250	56000	0	0	0	0	0	0	43250	56000
Lunenburg	56000	28250	0	0	0	0	0	0	56000	28250
Queens	31250	29750	0	0	0	0	0	0	31250	29750
Shelburne	6000	30750	6500	0	0	0	0	0	12500	30750
Yarmouth	6000	11500	0	0	0	0	0	0	6000	11500
Northern										
Antigonish	48250	35000	22000	2500	2500	2500	0	0	72750	40000
Colchester	69750	84750	22500	10250	18500	4750	0	0	110750	99750
Cumberland	165000	138000	139250	13000	47500	6250	18750	6250	370500	163500
Pictou	77250	42000	49750	11250	6750	0	4250	0	138000	53250
Total Area (ha)	930500	685000	290250	3[illegible]	75250	13500	23000	6250	1319000	741750
% change 1986		-26.38		-87.25		-82.06		-72.83		-43.76

Infestation class category area (ha)

Appendix 3

The frequency of the number of occurrences of L-2 class categories by County for Nova Scotia, 1986-87.

Frequency of the number of occurrences of L-2 class categories by County, Nova Scotia, 1986-1987.

Frequency of the Number of Occurrences

Class Category	Annapolis 1986 No.	Annapolis 1986 %	Annapolis 1987 No.	Annapolis 1987 %	Antigonish 1986 No.	Antigonish 1986 %	Antigonish 1987 No.	Antigonish 1987 %
Zero	16	55.2	20	69.0	6	23.1	12	44.4
Low	7	24.1	9	31.0	12	46.2	13	48.1
Moderate	6	20.7	0	0.0	6	23.1	1	3.7
High	0	0.0	0	0.0	1	3.8	1	3.7
Extreme	0	0.0	0	0.0	1	3.8	0	0.0
Total	29	100.0	29	100	26	100.0	27	100

Frequency of the Number of Occurrences

Class Category	Cape Breton 1986 No.	Cape Breton 1986 %	Cape Breton 1987 No.	Cape Breton 1987 %	Colchester 1986 No.	Colchester 1986 %	Colchester 1987 No.	Colchester 1987 %
Zero	9	69.2	13	100.0	10	27.0	18	45.0
Low	4	30.8	0	0.0	16	43.2	17	42.5
Moderate	0	0.0	0	0.0	6	16.2	3	7.5
High	0	0.0	0	0.0	5	13.5	2	5.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	13	100.0	13	100	37	100	40	100

Frequency of the Number of Occurrences

Class Category	Cumberland 1986 No.	Cumberland 1986 %	Cumberland 1987 No.	Cumberland 1987 %	Digby 1986 No.	Digby 1986 %	Digby 1987 No.	Digby 1987 %
Zero	14	13.7	52	51.5	6	33.3	18	94.7
Low	40	39.2	39	38.6	12	66.7	1	5.3
Moderate	28	27.5	6	5.9	0	0.0	0	0.0
High	13	12.7	2	2.0	0	0.0	0	0.0
Extreme	7	6.9	2	2.0	0	0.0	0	0.0
Total	102	100.0	101	100	18	100	19	100

Frequency of the Number of Occurrences

Class Category	Guysborough 1986 No.	Guysborough 1986 %	Guysborough 1987 No.	Guysborough 1987 %	Halifax 1986 No.	Halifax 1986 %	Halifax 1987 No.	Halifax 1987 %
Zero	8	88.9	10	100.0	15	78.9	6	33.3
Low	1	11.1	0	0.0	4	21.1	12	66.7
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	9	100.0	10	100	19	100	18	100

Appendix 3. continued

Frequency of the Number of Occurrences

Class Category	Hants 1986 No.	Hants 1986 %	Hants 1987 No.	Hants 1987 %	Inverness 1986 No.	Inverness 1986 %	Inverness 1987 No.	Inverness 1987 %
Zero	10	90.9	13	92.9	11	39.3	17	58.6
Low	1	9.1	1	7.1	17	60.7	12	41.4
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	11	100.0	14	100	28	100	29	100

Frequency of the Number of Occurrences

Class Category	Kings 1986 No.	Kings 1986 %	Kings 1987 No.	Kings 1987 %	Lunenburg 1986 No.	Lunenburg 1986 %	Lunenburg 1987 No.	Lunenburg 1987 %
Zero	10	58.8	7	41.2	4	30.8	8	66.7
Low	7	41.2	10	58.8	9	69.2	4	33.3
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	17	100.0	17	100	13	100	12	100

Frequency of the Number of Occurrences

Class Category	Pictou 1986 No.	Pictou 1986 %	Pictou 1987 No.	Pictou 1987 %	Queens 1986 No.	Queens 1986 %	Queens 1987 No.	Queens 1987 %
Zero	12	29.3	27	61.4	13	76.5	12	70.6
Low	13	31.7	11	25.0	4	23.5	5	29.4
Moderate	11	26.8	6	13.6	0	0.0	0	0.0
High	3	7.3	0	0.0	0	0.0	0	0.0
Extreme	2	4.9	0	0.0	0	0.0	0	0.0
Total	41	100.0	44	100	17	100	17	100

Frequency of the Number of Occurrences

Class Category	Richmond 1986 No.	Richmond 1986 %	Richmond 1987 No.	Richmond 1987 %	Shelburne 1986 No.	Shelburne 1986 %	Shelburne 1987 No.	Shelburne 1987 %
Zero	4	66.7	6	100.0	4	66.7	1	20.0
Low	2	33.3	0	0.0	1	16.7	4	80.0
Moderate	0	0.0	0	0.0	1	16.7	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	6	100.0	6	100	6	100	5	100

Appendix 3. continued

Frequency of the Number of Occurrences

Class Category	Victoria 1986 No.	Victoria 1986 %	Victoria 1987 No.	Victoria 1987 %	Yarmouth 1986 No.	Yarmouth 1986 %	Yarmouth 1987 No.	Yarmouth 1987 %
Zero	10	52.6	15	75.0	8	88.9	7	77.8
Low	9	47.4	5	25.0	1	11.1	2	22.2
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	19	100.0	20	100	9	100	9	100

Frequency of the Number of Occurrences

Class Category	Nova Scotia 1986 No.	Nova Scotia 1986 %	Nova Scotia 1987 No.	Nova Scotia 1987 %	Blank 1986 No.	Blank 1986 %	Blank 1987 No.	Blank 1987 %
Zero	170	40.5	262	60.9		0.0		0.0
Low	160	38.1	145	33.7		0.0		0.0
Moderate	58	13.8	16	3.7		0.0		0.0
High	22	5.2	5	1.2		0.0		0.0
Extreme	10	2.4	2	0.5		0.0		0.0
Total	420	100.0	430	100	0	0	0	0

AERIAL FOLIAGE PROTECTION PROGRAM

NOVA SCOTIA, 1987

by

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NOVA SCOTIA, 1987

I. INTRODUCTION

In 1987 the spruce budworm continued to pose a serious threat to the forests of the northern Mainland of Nova Scotia (Figure 1) (Smith and Georgeson, 1986). Spruce and fir stands supporting moderate and higher numbers of overwintering larvae were expected to have noticeable defoliation in 1987. This year's program reflects both the persistance of the infestation along the northern Mainland and the desire of 3000 individuals to maintain healthy trees.

II. OBJECTIVE

The primary objective of the aerial foliage protection program is to protect foliage from being eaten and/or killed by spruce budworm larvae. A second objective of the program is to protect cone bearing trees in designated cone production areas in Cape Breton Island.

III. TREATMENT AREAS

A. Area

The goal of this year's program was to protect spruce and fir trees on 50 000 ha. A variety of forest holdings were included in this year's program (Table 1). The majority of the treated area was in Cumberland County (Table 2). Spraying began on 2 June, 1987 and ended on 23 June, 1987.

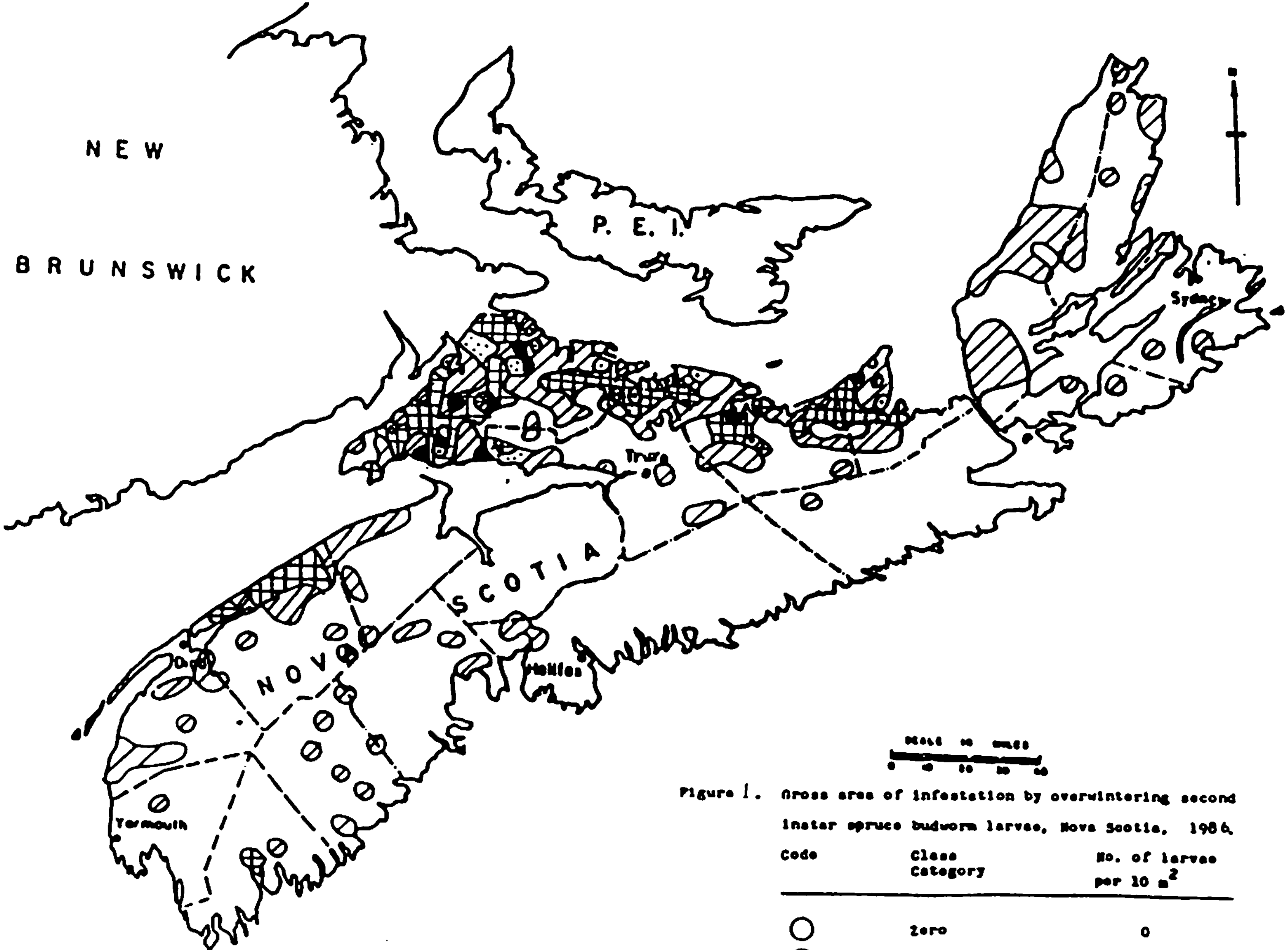

Figure 1. Gross area of infestation by overwintering second instar spruce budworm larvae, Nova Scotia, 1986.

Code	Class Category	No. of larvae per 10 m^2
○	Zero	0
⊘	Low	1 - 100
⊕	Moderate	101 - 300
◌	High	301 - 650
●	Extreme	651 +

Table 1. Area treated by applicants in the Aerial Foliage Protection Program, Nova Scotia, 1987.

Applicants	Area (ha) Treated	%
Large Land owners		
Eddy	290.0	0.9
Scott	774.3	2.5
Stora	51.2	0.2
Crown		
Provincial		
L&F Parks	222.0[1]	0.7
District	3 860.9	12.4
N.S. Environment	26.3	0.1
Federal		
Indian and Northern Affairs	90.0	0.3
Subtotal	5 314.2	17.1
Small Land owners		
Woodlots	25 765.6	82.9
Total	31 080.3	100.0

Applicants	ha	Area Σ ha	%	Σ %
Crown				
Federal	90.0		0.3	
Provincial	4 109.2	4 199.2	13.2	13.5
Private				
Large	1 115.5		3.6	
Small	25 765.6	26 881.1	82.9	86.5

1. 98 ha from ground and 125.0 ha from air

Table 2. Area treated by County, Aerial Foliage Protection Program, Nova Scotia, 1987.

	County			
Parameters	Antigonish	Colchester	Cumberland	Pictou
Total (ha)	412.4	6 270.0	23 102.6	1 295.3
Mean (ha)	103.1	216.2	262.5	49.8
± 1 sd. (ha)	75.2	246.0	323.1	42.2
Max. (ha)	199.8	1 024.8	1 429.7	128.0
Min. (ha)	14.9	5.0	9.2	1.0
Count No.	4.0	29.0	88.0[2]	26.0
Percent	1.3	20.2	74.3	4.2

2. Three areas in common with Colchester County but areas included in Cumberland County as majority of area in Cumberland County.

The spray program is subject to the vagaries of nature as a total area of 18 883.0 ha was deleted from the program (Table 3). This is a similar figure to that of 1986 - 20 643.1. In 1986, 12 527.2 ha were dropped due to the onset of pupation by larvae in the treatment areas, and 6 066.5 ha were dropped due to illness of the larvae. In 1987 the illness, a microspordian gut parasite was active and an area of 18 022.0 ha or 36% of the proposed program was deleted. In 1986 population collapse due to the gut parasite was limited to 6 066.5 ha in the Chignecto Management Unit in Cumberland County. Whereas, it was pandemic through the northern Mainland in 1987. The onset of larval mortality appeared to begin about 9 June, 1987 (Figure 2, Table 4).

No spraying was done on Cape Breton Island due to low population densities of overwintering larvae in the seed production areas.

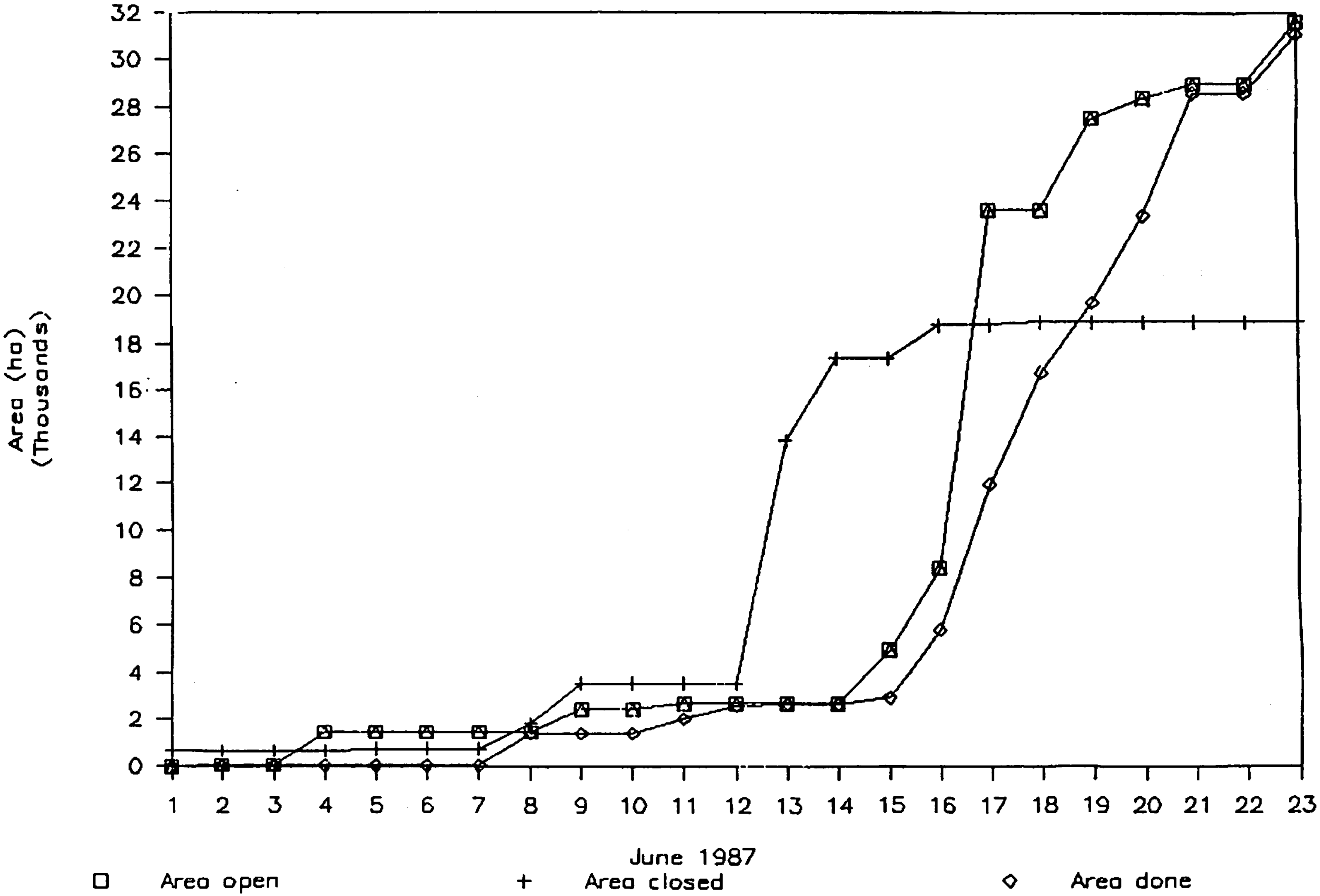

Figure 2. Graph of areas open, done, and closed, aerial foliage protection program, Nova Scotia, 1987.

Table 3. Area deleted from the Aerial Foliage Protection Program, Nova Scotia, 1987.

Reason	Area ha	% Area del.	% Program
Buffer Zone Restriction	453.1	2.4	0.9
Owners Request	263.0	1.4	0.6
Timber Harvesting	30.3	0.2	0.1
Larval Development 40% 6th Instar	122.9	0.6	0.2
Diseased Larvae	18 022.6	95.4	36.0
Total	18 892.8	100.0	37.8

B. Environmental Parameters

The environmental parameters for the program were the same as those in 1986.

i.e. wind speeds between 0 and 15 km/hr for aircraft and from 0 to 10 km/hr for the mist blower; relative humidity between 35 and 95%; and no spraying if rain expected between four to six hours.

C. Applicator

This year the Department functioned both as the proponent and applicator of the Aerial Foliage Protection Program. In previous years the spray contractor functioned as the applicator of the program.

IV. AIRPORT

Four airports were used for this year's program: Parrsboro, Nappan, Debert and Trenton (Figure 3). Parrsboro was

##

Table 4. Comparsion of areas open closed and done, Aerial Foliage Protection Program, Nova Scotia, 1987.

##

DATE	AREA					
June	Open[1]		Closed		Done	
	ha	Sum	ha	Sum	ha	Sum
1[2]		0.0	689.6	689.6		0.0
2	72.9	72.9		689.6	62.2	62.2
3		72.9		689.6		62.2
4	1409.9	1482.8		689.6		62.2
5		1482.8	57.7	747.3		62.2
6		1482.8		747.3		62.2
7		1482.8		747.3		62.2
8		1482.8	1106.6	1853.9	1359.8	1422.0
9	954.4	2437.2	1667.3	3521.2		1422.0
10	3.0	2440.2		3521.2		1422.0
11	264.1	2704.3		3521.2	607.4	2029.4
12		2704.3		3521.2	574.2	2603.6
13		2704.3	10283.9	13805.1	52.6	2656.2
14		2704.3	3539.6	17344.7	3.0	2659.2
15	2237.1	4941.4		17344.7	273.8	2933.0
16	3432.8	8374.2	1425.2	18769.9	2856.0	5789.0
17	15228.9	23603.1		18769.9	6138.7	11927.7
18	25.0	23628.1	122.9	18892.8	4795.9	16723.6
19	3884.1	27512.2		18892.8	2971.5	19695.1
20	849.1	28361.3		18892.8	3668.3	23363.4
21	603.4	28964.7		18892.8	5184.0	28547.4
22		28964.7		18892.8		28547.4
23	2619.8	31584.5		18892.8	2532.9	31080.3

1. Areas open include buffer zones at the ends and sides of the treatment areas.
2. Data summed per day

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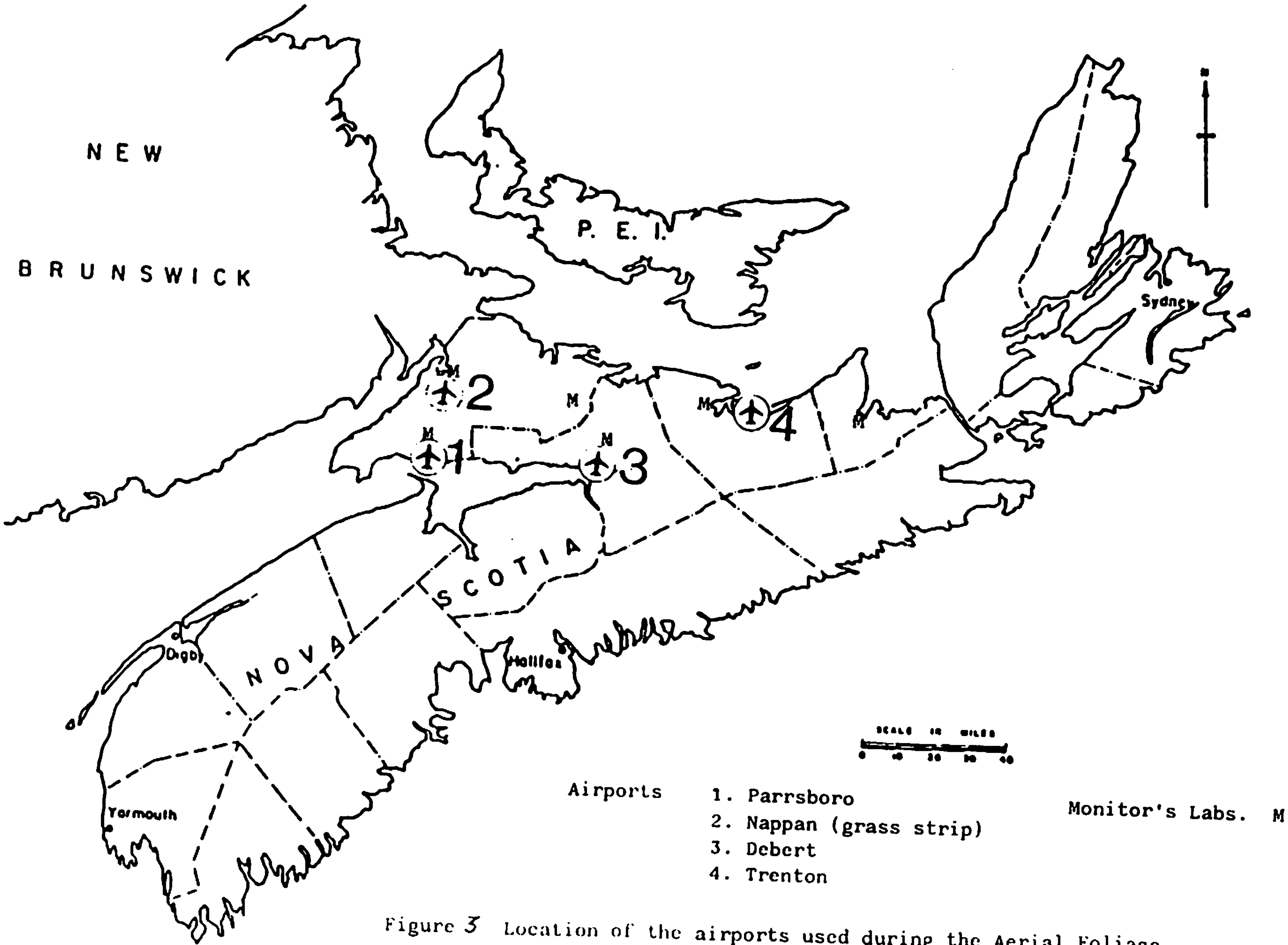

Figure 3 Location of the airports used during the Aerial Foliage Protection Program, Nova Scotia, 1987.

the main base of operations and the others were used as satellite airports. A mobile ground crew was used to service aircraft at satellite airports. Also, the mobile ground crew operated a truck mounted micronair mist blower used to treat park lands.

Summary data for area, volume of biocide, time, wind velocity, relative humidity and temperature are presented in Table 5. The times presented in Table 5 do not include flying time from airports to treatment areas and return or flying time between treatment areas. The summary of sessional times i.e. travel time plus spray time, pooled for the program and by individual airport is presented in Tables 6 and 7 respectively.

V. AIRCRAFT

The spray aircraft used on the program were seven Grumman Ag-Cats. The aircraft were divided into three teams, two of three aircraft and one of a single aircraft. The teams of multiple aircraft were each accompanied by two guidance aircraft; and the single spray aircraft by a guidance helicopter. This latter team was used to treat small areas in sensitive situations. The mean area treated by each spray aircraft was 4 426.0 $\pm$ 430.8 ha (r = 3 482.0 ha - 4 874.0 ha).

Table 5. Summary of area, volume of biocide, spraying time, mean wind speed, relative humidity, and temperature for each airport, Aerial Foliage Protection Program, Nova Scotia, 1987.

AIRPORT	AREA HA	VOLUME BIOCIDE L	SPRAYING TIME FOR EACH AREA HOURS(DECIMAL)	MEAN WIND SPEED KM/HR	RH %	TEMPERATURE CELSIUS START	END
Debert:							
TOTAL	2865.4	6297.1	6.35				
MEAN	136.4	299.9	0.30	1.9	70.0	13.0	13.0
STD	131.4	308.5	0.55	1.6	15.3	4.8	4.8
COUNT	21	21	21	21	21	21	21
MAX	540.6	1317.6	1.95	4.0	91.0	18.0	18.0
MIN	7.8	18.6	<0.01	0.0	51.0	5.0	5.0
Ground:							
TOTAL	98.0	249.0	5.25				
MEAN	12.3	31.1	0.66	2.9	81.6	8.3	8.3
STD	13.5	23.9	0.56	2.4	8.0	1.6	1.6
COUNT	8	8	8	8	8	8	8
MAX	45.0	87.0	1.75	7.0	90.0	10.0	10.0
MIN	1.0	3.0	0.08	0.0	65.0	6.0	6.0
Nappan:							
TOTAL	2865.5	6757.1	3.97				
MEAN	119.4	281.5	0.17	2.8	77.1	11.5	11.6
STD	116.8	297.8	0.11	2.6	9.3	1.8	1.5
COUNT	24	24	24	24	24	24	24
MAX	550.5	1422.7	0.49	7.0	95.0	17.0	18.0
MIN	9.2	21.3	0.02	0.0	55.0	6.0	7.0
Parrsboro:							
TOTAL	23917.1	50137.8	17.02				
MEAN	323.2	677.5	0.23	2.6	71.1	11.7	11.6
STD	151.3	721.4	0.19	2.4	13.4	1.4	1.1
COUNT	74	74	74	74	74	74	74
MAX	1429.7	2730.0	0.70	9.0	93.0	23.0	23.0
MIN	11.8	27.1	0.01	0.0	42.0	6.0	6.0
Trenton:							
TOTAL	1334.1	2672.3	1.44				
MEAN	66.7	133.6	0.07	6.9	76.6	12.5	[illegible]
STD	53.1	99.0	[illegible]	2.7	5.5	2.8	[illegible]
COUNT	20	20	20	20	20	20	20
MAX	199.8	362.9	[illegible]	11.0	83.0	18.0	18.0
MIN	6.4	13.8	[illegible]	1.0	65.0	8.0	[illegible]

Table 6. Summary analysis of flight times for all airports, Aerial Foliage Protection Program, Nova Scotia, 1987

DATE June	TIME				FLIGHTS PER TEAM			
	AM/PM	DEPT.	ARR.	DIFF.	TEAM NO. 1.[1]	2.[1]	3.[2]	TOTAL
02	PM	19.07	21.02	1.95		1	1	2
08	AM	5.58	7.70	2.12			1	1
11	AM	7.42	9.08	1.66	1		1	2
12	AM	5.83	7.50	1.67	1		1	2
13	PM	19.67	20.20	0.53			1	1
15	PM	19.62	21.57	1.95	1			1
16	PM	19.65	21.38	1.73	1	1	1	3
17	AM	5.33	9.85	4.52	2	2	2	6
17	PM	19.93	20.87	0.94	1	1		2
18	PM	19.52	21.55	2.03	2	2	3	7
19	AM	5.53	7.58	2.05	2	1	1	4
20	AM	7.75	9.00	1.25			1	1
20	PM	19.75	21.50	1.75		1	2	3
21	AM	5.50	8.33	2.83		1	2	3
21	PM	19.72	21.27	1.55	1	1		2
23	AM	5.60	7.13	1.53		1	1	2
TOTAL				30.06	12.00	12.00	18.00	42.00
AVERAGE				1.88	1.33	1.20	1.38	2.63
STD				0.85	0.47	0.40	0.62	1.69
COUNT				16	9	10	13	16
MAX				4.52	2.00	2.00	3.00	7.00
MIN				0.53	1.00	1.00	1.00	1.00

1. Three aircraft per team
2. Single aircraft

Table 7. Summary of session times by airport for AFPP, Nova Scotia, 1987.

Parameter	Session Time (0.0 hrs)			
	Debert	Nappan	Parrsboro	Trenton
Total	5.93	7.98	22.05	4.48
Mean	1.98	1.60	2.00	1.12
± 1 sd.	0.51	0.20	0.86	0.55
Min.	1.36	1.25	0.04	0.53
Max.	2.62	1.81	4.32	1.67
No. of Sessions	3	5	11	4

1. Session time is the interval of time between the departure of the first spray aircraft and the arrival of the last spray aircraft.

VI. BIOCIDE

The biocide used this year was Dipel 132 applied neat at 30 BIU•ha^{-1} having an application rate of 2.4 l•ha^{-1}. The atomisers used were Micronair AU 5000 miniatomisers. The atomisers were inspected and if necessary cleaned after each flight. Summary of biocide used is presented in Table 5.

VII MONITORING

A. Laboratory Locations

The host and insect life stages are monitored by field crews. These people were located at mobile laboratories in Chignecto Management Unit, Nappan, Wentworth Centre, Debert, and Scotsburn (Figure 2). The crew from Scotsburn was temporarily relocated in Antigonish while spraying was ongoing in Antigonish County. The crew at Debert was used to examine the potential for our use of a feeding inhibition technique, using dosed food, as an indicator of spray efficacy; monitoring presence of microspordia in spruce budworm larvae; and as a supply depot and support crew for the other mobile laboratories.

B. Other Insects

Three other species of insects caused defoliation in the treatment areas. Populations of spruce coneworm (Dioryctria renicullelloides Mut. and Mun.) were noted in the Amherst area. The range of this species has both shifted and shrunk in size since 1986. However, the populations of spruce budmoth were noted through the entire northern Mainland as compared to limited areas in the Gulf Shore and Cape George areas in 1986.

Several moth flights of hemlock looper (<u>Lambdina fiscellaria</u> (Guen.)) were noted this year in Cumberland County (Diligent River), Colchester - Economy Point and three areas in northern central part of Colchester County.

Two moth flights of spruce budworm were noted - one detected by a light trap in Diligent River and the other by a phermone trap in Springhill (Figure 4).

C. Non-target Effect

Monitoring of the non-target effect is the responsibility of the Nova Scotia Department of the Environment.

VIII RESULTS

A. Microspordia

The principal species scheduled for foliage protection were red spruce (<u>Picea rubens</u> spp. complex) and white spruce (<u>Picea glauca</u>). The occurrence of the gut parasite has compromised the efficacy and foliage protection obtained from spraying where the intensity of the gut parasite (number of spores per milligram of body mass) reached or approached lethal levels (Table 5) then these areas were dropped from the program (Appendix 1).

In red spruce sprayed areas and their associated check areas microsporidia were found in 73.5 ± 9.7 percent of larvae sampled and at mean intensity, for fourth instar larvae, of $21.0 \cdot 10^5 \pm 35.6 \cdot 10^5$ spores per milligram of tissue. Similarly for white spruce the mean percent occurrance was 71.4 ± 13.6 and the mean intensity was $31.3 \cdot 10^5 \pm 24.3 \cdot 10^5$ spores per milligram of tissue.

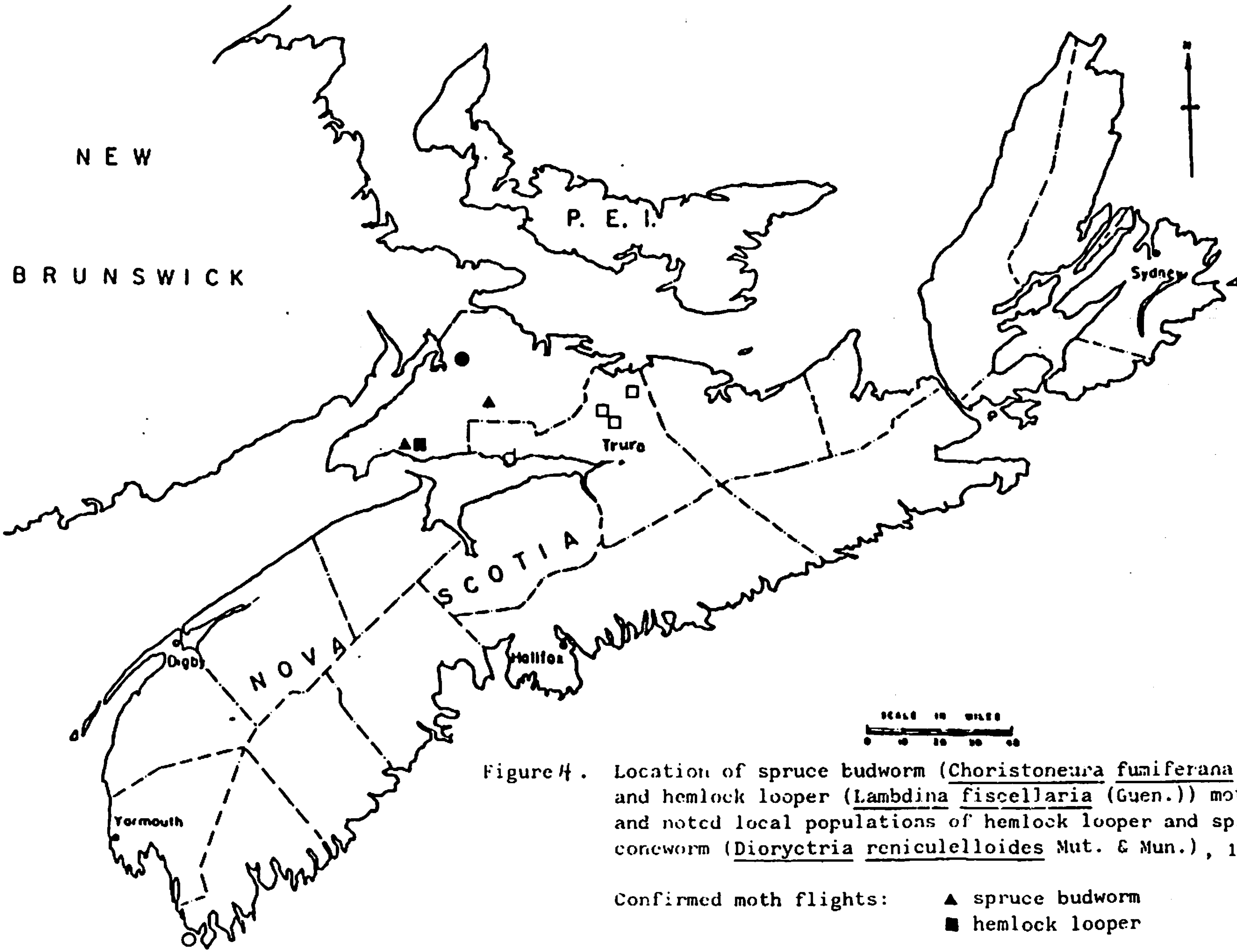

Figure 4. Location of spruce budworm (*Choristoneura fumiferana* (Clemens)) and hemlock looper (*Lambdina fiscellaria* (Guen.)) moth flights; and noted local populations of hemlock looper and spruce coneworm (*Dioryctria reniculelloides* Mut. & Mun.), 1987.

Confirmed moth flights: ▲ spruce budworm
■ hemlock looper

Noted moth flights □ hemlock looper

Noted local populations ○ hemlock looper

Table 8. Lethal dose of microspordia *Noesma fumiferanae* (Thompson) for spruce budworm (*Choristoneura fumiferana* (Clemens) larval instars.

Instar	LD_{50} Spores/Mg
2	1.5×10^5
3	1.1×10^6
4	2.8×10^6 (per larvae)[1]
5	?[2]
6	?[2]

1. Wilson pers. comm.
2. Data unavailable for these instars.

B. Development

Spraying of a proposed area is scheduled on maximum exposure of the larvae to the spray prior to its maximum damaging stage - the sixth instar (Appendix 2). Spruces retain their budcaps longer than balsam fir thus the time for spraying spruce is later and shorter than fir. The mean larval index for spraying on red spruce was 4.8 ± 0.2 with a mean bud flush of 91.1 ± 11.5 percent. Similarly the mean larval index for spraying on white spruce was 4.4 ± 0.3 and the mean bud flush was 97.1 ± 1.5 percent. Weather conditions were favourable for larval development and host development and both were in synchrony this year.

C. Foliage Protection

Due to the effects of microspordia in both the sprayed and unsprayed area the degree of foliage protection achieved was less than expected. For red spruce the mean absolute foliage protection was 1.0 ± 1.2 percent and the relative foliage protection was 40.8 ± 29.4 percent. For white spruce the mean absolute foliage protection was 3.8 ± 5.0% and the mean relative protection was 36.5 ± 19.6 percent. The calculations of relative foliage protection and reduction of survival are chi square functions as the values in chi square approaches zero the chi square loses continunity (Downie and Heath 1970). This is to be noted while interpreting these relative data (Appendix 3).

D. Reduction in Survival

The mean reduction in survival for red spruce was 31.7 ± 38.0 percent and for white spruce was 30.0 ± 30.0 percent. There is no correlation between efficacy and foliage protection as sublethal doses of B.t.k. will at times afford adequate foliage protection and, equally, the converse is true (Smith and Georgeson, 1980) (Appendix 4).

IX. COSTS

The estimated cost of this year's program is 1.115 million dollars and the cost per hectare flown is $35.87 (Table 9). The cost in 1986 was $33.57. The increase in cost is primarily due to increase in the cost of biocide and decrease in size of the program.

Table 9. Expected budget for the Aerial Foliage Protection Program, Nova Scotia, 1987

Group	$	%	$/HA	$/SEC
SALARIES (CASUALS)				
Monitors	222000	19.91	7.14	2.05
Administration	17500	1.57	0.56	0.16
Loaders	7800	0.70	0.25	0.07
Navigators	19700	1.77	0.63	0.18
Miscellaneous	23000	2.06	0.74	0.21
Overtime	17000	1.52	0.55	0.16
Fringe Benefits	14500	1.30	0.47	0.13
Total Saleries	321500	28.83	10.34	2.97
TRAVEL				
Within Province	25000	2.24	0.80	0.23
Out of Province	2000	0.18	0.06	0.02
Total Travel	27000	2.42	0.87	0.25
SUPPLIES AND SERVICES				
General Office				
Administration	400	0.04	0.01	0.00
Operating Account	2500	0.22	0.08	0.02
Miscellaneous	18000	1.61	0.58	0.17
Total Gen. Off.	20900	1.87	0.67	0.19
General Operating				
Administration	1000	0.09	0.03	0.01
Chemicals	287300	25.77	9.24	2.65
Restaurants	40000	3.59	1.29	0.37
Accomodation	39000	3.50	1.25	0.36
Miscellaneous	37300	3.35	1.20	0.34
Total Gen. Oper.	404600	36.29	13.02	3.74
Equipment Rep. & Maint.	9000	0.81	0.29	0.08
Other Services				
Ct. #1 Spray Aircraft	177100	15.88	5.70	1.64
Ct. #2 Guidance Ac.	49800	4.47	1.60	0.46
Ct. #3 Airports & Fuel	38400	3.44	1.24	0.35
Ct. #4 Other Services	5200	0.47	0.17	0.05
Total Others	270500	24.26	8.70	2.50
Total Supplies & Services	705000	63.23	22.68	6.51
OTHER				
Equipment Rentals				
Equipment	1500	0.13	0.05	0.01
Trucking	3000	0.27	0.10	0.03
Vehicles	37000	3.32	1.19	0.34
Total Equip. Rentals	41500	3.72	1.34	0.38
Equipment Purchases				
Approved Account	12000	1.08	0.39	0.11
Purchase-Monitors/PDO	4000	0.36	0.13	0.04
Purchase Orders	4000	0.36	0.13	0.04
Total Equip. Pur.	20000	1.79	0.64	0.18
Total Others	61500	5.52	1.98	0.57
SUMMARY Total Budget	1115000	100.00	35.87	10.30

X. DISCLAIMER STATEMENT

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement or approval of any product or service to the exclusion of others which may be suitable.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate Provincial and/or Federal agencies before they can be recommended.

XI. REFERENCES

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Appendix 1

Microspordia

MICROSPORIDIA LEVELS

File: BUDWORM.2.87

Report: MICROSPORIDIA

TREATMENT AREA	BLOCK/CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	REMARKS	MICRO INTENSITY	MICRO %
1	CAPE D'OR	-	-	-	-	DROPPED LOW COUNTS	-	-
2,3	ADVOCATE	-	-	-	-	DROPPED LOW COUNTS	-	-
4,6	FLAT BROOK	0.92	0.00	1.14	0.00		4.36*10^5	57.6
5	MINUDIE	1.40	0.00	1.23	0.00	-	7.03*10^5	74.0
7-9	SPRINGHILL	1.01	0.00	6.99	0.03	-	2.93*10^5	95.5
10-12	BARREN BROOK	1.05	0.00	1.79	0.00	-	5.39*10^5	70.0
13	LAWRENCE	-	-	-	-	DROPPED LOW COUNTS	-	-
14	THUNDER HILL	-	-	-	-	DROPPED LOW COUNTS	-	-
15-16	CHIGNECTO	-	-	-	-	DROPPED LOW COUNTS	-	-
17-21	HALFWAY RIVER	2.48	0.03	0.74	0.00	-	9.4*10^6	84.[illegible]
22	DILIGENT RIVER	1.02	0.00	0.20[illegible]	0.01	-	9.61*10^6	78.3
2[illegible]	PARRSBORO	-	-	-	-	PLOTS NOT SPRAYED	-	-
25,30-31	SHAD BROOK	-	-	-	-	PLOTS NOT TREATED	1.09*10^6	9[illegible]
26-29	LYNN MOUNTAIN	18.92	0.50	7.99	0.52	-	[illegible].86*10^5	[illegible]
32	FIVE ISLANDS	-	-	-	-	DROPPED LOW COUNTS	-	-
34-41	ECONOMY	2.69	0.01	10.19	0.03	-	[illegible]	--
42-44	LEICESTER	[illegible]	[illegible]	[illegible]	0.00	-	[illegible]	8[illegible]
47	BROOKDALE	-		-	-	[illegible]	-	-
46,48	BROOKDALE	3.36	0.75	0.94	0.00	-	[illegible].69*10^5	79.[illegible]
49-50,53-55	BEAVER BROOK	0.97	0.00	0.79	0.00		[illegible].41*10^6	6[illegible]
51-52	FORT LAWRENCE	8.65	0.025	[illegible]	0.00	-	5.76*10^5	99.4
56-60	TIGNISH		-		-	[illegible]		-
61-64	TIGNISH	-	-	-	-	PLOTS NOT SPRAYED	-	-
65-68	SHINIMICAS					PLOTS NOT SPRAYED		
69-70	LINDEN	4.25	0.05	5.[illegible]	0.025	-	[illegible]	79
71-76	AMHERST	2.18	0.00	0.79	0.00	-	[illegible]	6[illegible]
77-87	MOUNT PLEASANT	1.78	0.00	0.18	0.00	-	[illegible].99*10^5	80.5
86,87,89,90,92	HANSFORD	-	-	-	-	LOW COUNTS	-	-
88	HANSFORD	-	-	-	-	CLEAR CUT	-	-
9[illegible]	HANSFORD	6.69	[illegible]	[illegible]	0.5	[illegible] SPRAY	[illegible].99*10^5	7[illegible]
93-96	SOUTH VICTORIA	-	-	-	-	DROPPED LOW COUNTS	-	-
97-100	PUGWASH JUNCTION	-	-	-	-	DROPPED LOW COUNTS	-	-
~~101-107~~	~~MIDDLEBORO~~	~~8.72~~	~~0.25~~	~~9.84~~	~~0.20~~	~~-~~	~~2.3*10^5~~	~~76.3~~
108	WENTWORTH	10.8	2.9	8.6	.6		6.21*10^4	75.2
109,111,112,113	WENTWORTH	-	-	-	-	LOW COUNTS	-	-

MICROSPORIDIA LEVELS

File: BUDWORM.2.87 Page

Report: MICROSPORIDIA

TREATMENT AREA	BLOCK CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	REMARKS	MICRO INTENSITY	MICRO %
110	WENTWORTH	4.4	.15	4.7	.4	-	-	-
114-119	MALAGASH	2.30	0.025	17.25	1.85	-	1.98+10 5	86.[illegible]
120-121	BLOCKHOUSE POINT	-		-		COMBINED MALAGASH	-	-
122-125,127,128	TATAMAGOUCHE	6.7[illegible]	0.16	4.95	0.06	-	[illegible]	[illegible]
126	TATAMAGOUCHE	-	-	-	-	DROPPED ENVIRONMEN	-	-
129	OLIVER	-	-	-	-	CLOSED ENVIRONMENT	-	-
130-132	OLIVER	13.[illegible]	1.[illegible]	12.[illegible]	0.45	-	2.9+10 4	65
133-139	WAUGHS RIVER	3.03	0.00	8.59	0.00	-	4.43+10 5	58.[illegible]
140-146	EAST BRANCH		-		-	DROPPED LOW COUNTS	-	-
147,149-152	CAPE JOHN	2.82	0.00	1.98	0.00	-	4.41+10 6	50
148	CAPE JOHN	-	-	-	-	CLOSED [illegible]	-	-
153	WATERSIDE	-	-	-	-	NO PLOTS	-	-
154-157,166	PICTOU	[illegible]	[illegible]	[illegible]	0.00	-	[illegible]	
158	LOCH BROOM	10.[illegible]	[illegible]	5.53	0.55		[illegible]	[illegible]
159-165	GREEN HILL	1.48	0.03	0.506	0.00	-	5.1[illegible]	46.[illegible]
167,168	BLACK POINT	-	-	-	-	NO PLOTS	-	-
[illegible]	DIXON MOUNTAIN	-		-	-	DROPPED LOW COUNTS	-	-
[illegible]	AVONDALE	4.45	[illegible]	[illegible]	0.0[illegible]		[illegible]	[illegible]
177-178	ARISAIG	0.51	[illegible]	[illegible]	0.25	-	[illegible]	45
179-180	ANTIGONISH HARB	1.9[illegible]	[illegible]	0.66	0.005	-	[illegible]	[illegible]
181	POMQUET PARK	-	-	-	-	DROPPED [illegible]	-	-

##
Summary of microspordia data
Microspordia, aerial foliage protection program
Nova Scotia, 1987
##

ITEM	CONTROL L-4	CONTROL PUPAE	TREATED AREAS L-4	TREATED AREAS PUPAE	MICROSPORDIA % INFESTED	MICROSPORDIA INTENSITY NO./mg *10^5
Red spruce: data from all plots used in calculations						
MEAN	3.9	0.1	4.0	0.0	66.4	18.8
STD	4.3	0.3	4.3	0.2	22.9	33.9
MAX	18.9	2.0	13.6	1.0	95.5	110.0
MIN	0.0	0.0	0.0	0.0	0.0	0.0
COUNT	102.0	102.0	102.0	102.0	101.0	101.0

##
Red spruce: unsprayed plot data deleted

MEAN	4.4	0.1	4.6	0.0	73.5	21.0
STD	4.3	0.4	4.4	0.2	9.7	35.6
MAX	18.9	2.0	13.6	1.0	95.5	110.0
MIN	0.9	0.0	0.2	0.0	57.6	0.3
COUNT	90.0	90.0	90.0	90.0	89.0	89.0

##
White spruce: data from all plots used in calculations

MEAN	2.6	0.2	6.0	0.6	71.4	31.3
STD	2.6	0.6	7.1	0.9	13.6	24.3
MAX	12.3	2.9	17.2	2.0	86.1	64.5
MIN	0.0	0.0	0.0	0.0	50.0	0.6
COUNT	29	29	29	29	26	26

##
White spruce: unsprayed plot data deleted

MEAN	2.9	0.2	6.7	0.7	71.4	31.3
STD	2.6	0.6	7.2	0.9	13.6	24.3
MAX	12.3	2.9	17.2	2.0	86.1	64.5
MIN	1.5	0.0	0.5	0.0	50.0	0.6
COUNT	26	26	26	26	26	26

##

Appendix 2

Development

DEVELOPMENT AT SPRAY

File: BUDWORM.2.87

Report: DEVELOPMENT

TREATMENT AREA	BLOCK/CLUSTER	DATE SPRAYED	LARVAE INDEX	% BUD FLUSHED	BUD DENSITY	DROPS/cm^2	REMARKS	TREE SPP
1	CAPE D'OR	-	-	-	-	-	DROPPED LOW COUNTS	WHITE SPRUCE
2,3	ADVOCATE	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
4,6	FLAT BROOK	Jun 23 87	4.7	96	896	17.7		RED SPRUCE
5	MINUDIE	Jun 21 87	4.9	99	307	9.3	-	RED SPRUCE
7-9	SPRINGHILL	19-21 JUNE 87	4.9	97.5	1027	3.2	-	RED SPRUCE
10-12	BARREN BROOK	Jun 18 87	4.6	97	639	9.0	-	RED SPRUCE
13	LAWRENCE	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
14	THUNDER HILL	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
15-16	CHIGNECTO	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
17-21	HALFWAY RIVER	18-21 JUNE 87	4.8	75	800	14.6	-	RED SPRUCE
22	DILIGENT RIVER	Jun 21 87	4.6	87	434	34.6	-	RED SPRUCE
23	PARRSBORO	Jun 21 87	-	-	-	0.0	PLOTS NOT SPRAYED	RED SPRUCE
25,30-31	SHAD BROOK	Jun 17 87	-	-	-	0.0	PLOTS NOT TREATED	RED SPRUCE
26-29	[illegible] MOUNTAIN	20-21 JUNE87	4.7	77	455	10.7	-	RED SPRUCE
32	FIVE ISLANDS	-	-	-	-	-	DROPPED LOW COUNTS	WHITE SPRUCE
34-41	ECONOMY	Jun 17 87	5.0	80	649	13.7	-	RED SPRUCE
42-44	LEICESTER	20-21 JUNE	5.[illegible]	99.[illegible]	1009	11.2	-	RED SPRUCE
47	BROOKDALE	-	-	-	-	-	DEVELOP.[illegible] HIGH	RED SPRUCE
46,48	BROOKDALE	Jun 17 87	4.6	97.8	838.8	7.4	-	RED SPRUCE
49-50,53-55	BEAVER BROOK	20-21 JUN 87	5.0	86.0	590	15.7	-	RED SPRUCE
51-52	FORT LAWRENCE	Jun 18 87	4.8	99.5	1138	8.5	-	RED SPRUCE
56-60	TIGNISH	-	-	-	-	-	CLOSE [illegible]DEVELOPMENT	RED SPRUCE
61-64	TIGNISH	Jun 17 87	-	-	-	-	PLOTS NOT SPRAYED	RED SPRUCE
65-68	SHINIMICAS	Jun 19 [illegible]	-	-	-	-	PLOTS NOT [illegible]	RED SPRUCE
69-70	LINDEN	Jun 16 87	4.9	97.7	840	10.6	-	RED SPRUCE
71-76	AMHERST	20-21 JUNE 87	4.6	98.6	804.5	5.0	-	RED SPRUCE
77-85	MOUNT PLEASANT	Jun 16 87	4.6	99.9	750.3	3.0	-	RED SPRUCE
86,87,89,90,92	HANSFORD	-	-	-	-	-	LOW COUNTS	RED SPRUCE
88	HANSFORD	-	-	-	-	-	CLEAR CUT	RED SPRUCE
91	HANSFORD	Jun 19 87	4.7	100	130	-	ONLY TA # 91 SPRAYED	RED SPRUCE
93-96	SOUTH VICTORIA	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
97-100	PUGWASH JUNCTION	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
101-107	MIDDLEBORO	Jun 19 87	5.2	99	154	3.0	-	RED SPRUCE
108	WENTWORTH	Jun 19 87	4.8	99.2	125	3.7		WHITE SPRUCE
109 111 112 119	[illegible]							

DEVELOPMENT AT SPRAY

File: BUDWORM.2.87

Report: DEVELOPMENT

TREATMENT AREA	BLOCK/CLUSTER	DATE SPRAYED	LARVAE INDEX	% BUD FLUSHED	BUD DENSITY	DROPS/cm 2	REMARKS	TREE SPP
110	WENTWORTH	Jun 19 87	4.8	99.2	125	3.7	-	RED SPRUCE
114-119	MALAGASH	Jun 8 87	4.7	98.9	172.5	7.8	-	WHITE SPRUCE
120-121	BLOCKHOUSE POINT	Jun 2 87	-	-	-	1.9	COMBINED MALAGASH	WHITE SPRUCE
122-125,127,128	TATAMAGOUCHE	16-17 JUN 87	4.7	60.8	166	6.1	-	RED SPRUCE
126	TATAMAGOUCHE	-	-	-	-	-	DROPPED ENVIRONMENT	RED SPRUCE
129	OLIVER	-	-	-	-	-	CLOSED ENVIRONMENT	RED SPRUCE
130-132	OLIVER	15-16 JUNE	5.0	90	215	0.81	-	RED SPRUCE
133-139	WAUGHS RIVER	Jun 21 87	4.5	99.3	95.4	2.5	-	RED SPRUCE
140-146	EAST BRANCH	-	-	-	-	-	DROPPED LOW COUNTS	RED SPRUCE
147,149-152	CAPE JOHN	Jun 12 87	4.0	96.1	41.2	1.9	-	WHITE SPRUCE
148	CAPE JOHN	-	-	-	-	-	CLOSED APP	WHITE SPRUCE
153	WATERSIDE	Jun 22 87	-	-	-	-	NO PLOTS	WHITE SPRUCE
154-157,166	PICTOU	Jun 21 87	4.5	98.8	91	3.7	-	RED SPRUCE
158	LOCH BROOM	Jun 8 87	4.3	93.6	84	0.66	-	WHITE SPRUCE
159-165	GREEN HILL	Jun 12 [illegible]	4.5	96.2	46.6	[illegible]	-	WHITE SPRUCE
167,168	BLACK POINT	Jun 12 87	-	-	-	-	NO PLOTS	WHITE SPRUCE
169,174-176	EIGG MOUNTAIN	-	-	-	-	-	DROPPED LOW COUNTS	WHITE SPRUCE
170-173	AVONDALE	Jun 11 [illegible]	4.5	95.0	[illegible]	[illegible]	-	RED SPRUCE
177-178	ARISAIG	Jun 11 87	4.3	95.9	87.8	[illegible]	-	WHITE SPRUCE
179-180	ANTIGONISH HARB	Jun 11 87	4.1	96.3	57	5.6	-	WHITE SPRUCE
181	POMQUET PARK	-	-	-	-	-	DROPPED [illegible]	WHITE SPRUCE

##
Summary of development data
Development, aerial foliage protection program,
Nova Scotia, 1987
##

ITEM	LARVAL INDEX	% BUDS FLUSHED	BUD DENSITY	DROPS /CM^2
Red spruce: all plot data used in calculations				
MEAN	4.2	80.4	451.7	6.6
STD	1.6	31.3	352.0	5.9
MAX	5.2	100.0	1138.0	34.6
MIN	0.0	0.0	0.0	0.0
COUNT	102.0	102.0	102.0	102.0

##
Red spruce: unsprayed plot data deleted

MEAN	4.8	91.1	511.9	7.5
STD	0.2	11.5	331.0	5.7
MAX	5.2	100.0	1138.0	34.6
MIN	0.0	0.0	0.0	0.0
COUNT	90.0	90.0	90.0	90.0

##
White spruce: all plot data used in calculations

MEAN	4.0	87.0	83.1	2.9
STD	1.4	29.6	60.4	2.8
MAX	4.8	99.2	172.5	7.8
MIN	0.0	0.0	0.0	0.0
COUNT	29	29	29	29

##
White spruce: unsprayed plot data deleted

MEAN	4.4	97.0	92.7	3.3
STD	0.3	1.5	56.4	2.8
MAX	4.8	99.2	172.5	7.8
MIN	4.0	93.6	41.2	0.7
COUNT	26	26	26	26

##

Appendix 3

Defoliation

FOLIAGE PROTECTED

File: BUDWORM.2.87

Report: DEFOLATION

TREATMENT AREA	BLOCK/CLUSTER	DEFOL % CHECK	DEFOL % SPRAY	DEFOL % SPRAY EXP	FOL SAVED METH.1	FOL SAVED METH.2
1	CAPE D'OR	-	-	-	-	-
2,3	ADVOCATE	-	-	-	-	-
4,6	FLAT BROOK	.1	.3	1.0	.7	70.0
5	MINUDIE	1.0	.6	1.1	.5	45.4
7-9	SPRINGHILL	.9	2.3	4.7	2.4	51.1
10-12	BARREN BROOK	.1	.1	1.4	1.3	92.9
13	LAWRENCE	-	-	-	-	-
14	THUNDER HILL	-	-	-	-	-
15-16	CHIGNECTO	-	-	-	-	-
17-21	HALFWAY RIVER	1.5	.2	.8	.6	75
22	DILIGENT RIVER	.3	0	.4	.4	100
23	PARRSBORO	-	-	-	-	-
25,30-31	SHAD BROOK	-	-	-	-	-
26-29	LINN MOUNTAIN	5.7	10.1	5.4	0	0
32	FIVE ISLANDS	-	-	-	-	-
34-41	ECONOMY	2.6	4.2	6.7	2.5	37.3
42-44	LEICESTER	2.1	.1	.6	.5	83.3
47	BROOKDALE	-	-	-	-	-
46,48	BROOKDALE	3.6	.3	.9	.6	66.7
49-50,53-55	BEAVER BROOK	0	.3	.8	.5	62.5
51-52	FORT LAWRENCE	5.8	4.5	9.0	4.5	50.0
56-60	TIGNISH	-	-	-	-	-
61-64	TIGNISH	-	-	-	-	-
65-68	SHINIMICAS	-		-	-	-
69-70	LINDEN	2.6	2.4	5.7	3.3	57.9
71-76	AMHERST	.8	.8	.8	0	0
77-85	MOUNT PLEASANT	.9	.2	.4	.2	50
86,87,89,90,92	HANSFORD	-	-	-	-	-
88	HANSFORD	-	-	-	-	-
91	HANSFORD	8.2	2.4	1.5	0	0
93-96	SOUTH VICTORIA	-	-	-	-	-
97-100	PUGWASH JUNCTION	-	-	-	-	-
101-107	MIDDLEBORO	3.3	6.8	6.6	0	0
108	WENTWORTH	26.3	20.7	15.0	0	0

FOLIAGE PROTECTED

File: BUDWORM.2.87 Page

Report: DEFOLATION

TREATMENT AREA	BLOCK/CLUSTER	DEFOL % CHECK	DEFOL % SPRAY	DEFOL % SPRAY EXP	FOL SAVED METH.1	FOL SAVED METH.2
110	WENTWORTH	.5	2.1	3.3	1.2	36.4
114-119	MALAGASH	10.6	14.8	27.6	12.8	46.4
120-121	BLOCKHOUSE POINT	-	-	-	-	-
122-125,127,128	TATAMAGOUCHE	6.8	4.7	3.4	0	0
126	TATAMAGOUCHE	-	-	-	-	-
129	OLIVER	-	-	-	-	-
130-132	OLIVER	17.8	6.5	8.2	1.7	20.7
133-139	WAUGHS RIVER	2.2	3.1	5.8	2.7	46.6
140-146	EAST BRANCH	-	-	-	-	-
147,149-152	CAPE JOHN	2.2	3.0	4.8	1.8	37.5
148	CAPE JOHN	-	-	-	-	-
153	WATERSIDE	1.4	-	-	-	-
154-157,166	PICTOU	1.1	.1	.4	.3	75
158	LOCH BROOM	13.4	13.7	10.1	0	0
159-165	GREEN HILL	2.7	1.2	2.6	1.4	53.8
167,168	BLACK POINT	-	-	-	-	-
169,174-176	EIGG MOUNTAIN	-	-	-	-	-
170-173	AVONDALE	3.7	.7	1.0	.3	30.0
177-178	ARISAIG	3.2	6.7	7.2	.5	6.9
179-180	ANTIGONISH HARB	5.4	1.5	2.8	1.9	46.4
181	POMQUET PARK	-	-	-	-	-

##
Summary of defoliation data
Defoliation, aerial foliage protection progran,
Nova Scotia, 1987
##

ITEM	% DEFOLIATION CHECK	OBS	EXP	FOLIAGE SAVED % ABS	% REL
Red spruce: data from all plots used in calculations					
MEAN	2.6	2.4	2.8	0.8	36.0
STD	3.3	3.0	2.8	1.1	30.6
MAX	17.8	10.1	9.0	4.5	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	102.0	102.0	102.0	102.0	102.0
Red spruce: unsprayed plot data deleted					
MEAN	2.9	2.7	3.2	1.0	40.8
STD	3.4	3.0	2.8	1.2	29.4
MAX	17.8	10.1	9.0	4.5	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	90.0	90.0	90.0	90.0	90.0
White spruce: data from all plots used in calculations					
MEAN	5.2	5.6	8.7	3.4	32.7
STD	5.6	6.3	10.1	4.8	21.6
MAX	26.3	20.7	27.6	12.8	53.8
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	29	29	29	29	29
White spruce: data from unsprayed plots deleted					
MEAN	5.8	6.3	9.7	3.8	36.5
STD	5.6	6.4	10.2	5.0	19.6
MAX	26.3	20.7	27.6	12.8	53.8
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	26	26	26	26	26

##

Appendix 4

Reduction of Survival

% POPULATION REDUCTION

File: BUDWORM.2.87

Report: REDUCT OF SURVIVAL

TREATMENT AREA	BLOCK/CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	POPUL REDUCTION
1	CAPE D'OR	-	-	-	-	-
2,3	ADVOCATE	-	-	-	-	-
4,6	FLAT BROOK	0.92	0.00	1.14	0.00	0
5	MINUDIE	1.40	0.00	1.23	0.00	0
7-9	SPRINGHILL	1.01	0.00	6.99	0.00	100
10-12	BARREN BROOK	1.05	0.00	1.79	0.00	0
13	LAWRENCE	-	-	-	-	-
14	THUNDER HILL	-	-	-	-	-
15-16	CHIGNECTO	-	-	-	-	-
17-21	HALFWAY RIVER	2.48	0.03	0.74	0.00	17.3
22	DILIGENT RIVER	1.02	0.00	0.204	0.01	0
23	PARRSBORO	-	-	-	-	-
25,30-31	SHAD BROOK	-	-	-	-	-
26-29	LYNN MOUNTAIN	18.92	0.50	7.98	0.52	0
32	FIVE ISLANDS	-	-	-	-	-
34-41	ECONOMY	2.88	0.01	10.13	0.29	54
42-44	LEICESTER	1.19	0.08	0.42	0.00	0
47	BROOKDALE	-	-	-	-	-
46,48	BROOKDALE	3.36	0.075	0.94	0.00	0
49-50,53-55	BEAVER BROOK	0.87	0.00	0.79	0.00	0
51-52	FORT LAWRENCE	8.65	0.025	13.63	0.00	100
56-60	TIGNISH		-		-	-
61-64	TIGNISH	-	-	-	-	-
65-68	SHINIMICAS					
69-70	LINDEN	4.05	0.05	8.49	0.005	93.8
71-76	AMHERST	2.18	0.00	0.79	0.00	0
77-85	MOUNT PLEASANT	1.78	0.00	0.18	0.00	0
86,87,89,90,92	HANSFORD	-	-	-	-	-
88	HANSFORD	-	-	-	-	-
91	HANSFORD	6.63	0.30	1.84	0.15	0
93-96	SOUTH VICTORIA	-	-	-	-	-
97-100	PUGWASH JUNCTION	-	-	-	-	-
101-107	MIDDLEBORO	8.72	0.25	9.84	0.20	59.2
108	WENTWORTH	10.8	2.9	8.8	.6	0

% POPULATION REDUCTION

File: BUDWORM.2.87

Report: REDUCT OF SURVIVAL

TREATMENT AREA	BLOCK CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	POPUL REDUCTION
110	WENTWORTH	4.4	.15	4.7	.4	0
114-119	MALAGASH	2.30	0.025	17.25	1.85	32.9
120-121	BLOCKHOUSE POINT	-		-		-
122-125,127,128	TATAMAGOUCHE	6.71	0.16	4.95	0.06	68.4
126	TATAMAGOUCHE	-	-	-	-	-
129	OLIVER	-	-	-	-	-
130-132	OLIVER	13.77	1.95	12.44	0.45	29.7
133-139	WAUGHS RIVER	3.03	0.00	8.59	0.00	100
140-146	EAST BRANCH		-		-	-
147,149-152	CAPE JOHN	2.82	0.00	1.98	0.00	100
148	CAPE JOHN	-	-	-	-	-
153	WATERSIDE	-	-	-	-	-
154-157,166	PICTOU	1.11	0.00	0.16	0.00	0
158	LOCH BROOM	12.33	1.28	5.53	0.55	30.4
159-165	GREEN HILL	1.48	0.03	0.506	0.00	0
167,168	BLACK POINT	-	-	-	-	-
169,174-176	EIGG MOUNTAIN	-	-	-	-	-
170-173	AVONDALE	4.45	0.07	[illegible]	0.01	0
177-178	ARISAIG	2.51	0.01	3.60	0.25	37.5
179-180	ANTIGONISH HARB	1.90	0.35	1.68	0.025	0
181	POMQUET PARK	-	-	-	-	-

##
Summary of reduction of survival data
Reduction of survival, aerial foliage protection program Nova Scotia, 1987
##

ITEM	CONTROL L-4	CONTROL PUPAE	TREATED AREAS L-4	TREATED AREAS PUPAE	POP. REDUCTION
Red spruce: all plot data used in calculations					
MEAN	3.9	0.1	4.0	0.1	27.6
STD	4.3	0.3	4.3	0.1	37.0
MAX	18.9	2.0	13.6	0.5	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	102.0	102.0	102.0	102.0	102.0
Red spruce: unsprayed plot data deleted					
MEAN	4.4	0.1	4.6	0.1	31.7
STD	4.3	0.4	4.4	0.1	38.0
MAX	18.9	2.0	13.6	0.5	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	89.0	89.0	89.0	89.0	89.0
White spruce: all plot data used in calculations					
MEAN	2.4	0.2	4.8	0.4	27.7
STD	2.7	0.6	6.6	0.8	36.2
MAX	12.3	2.9	17.2	1.9	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	29	29	29	29	29
White spruce: unsprayed plot data deleted					
MEAN	2.7	0.2	5.4	0.5	30.9
STD	2.7	0.6	6.7	0.8	36.9
MAX	12.3	2.9	17.2	1.9	100.0
MIN	0.0	0.0	0.0	0.0	0.0
COUNT	26.0	26.0	26.0	26.0	26.0

##

1987 NEW BRUNSWICK PROTECTION PROGRAM AGAINST SPRUCE BUDWORM

(Annual Forest Pest Control Forum, November 17-19, 1987)

1987 Spray Program

The 1987 Spruce Budworm Spray Program (Figure 1) conducted by Forest Protection Limited, in New Brunswick covered approximately 478 300 hectares. This is slightly less than the 496 000 ha treated in 1986. Of the total area treated, about 90 percent was in the industrial part of the program (i.e. beyond 1.6 km from habitation) and the balance was in the non-industrial sector consisting primarily of small private woodlot.

Of the total area treated by FPL, 75% received a double application of fenitrothion (Sumithion) and 5.9% received one application of aminocarb (Matacil 180F) followed by one application of fenitrothion. About 17% of the area received a single treatment of bacterial insecticide, Bacillus thuringiensis var. kurstaki (B.t.). The remaining 2% of the area received a single application of fenitrothion followed by a single application of B.t. (Table 1).

Spray aircraft included TBMs and single-engine agricultural-type small spray planes (SSPs). TBMs were used to treat 85% of the total treatment area. This year's program was characterized by the operational use of rotary atomizers (Micronair AU4000) on some of the TBMs and the application of lower volume and lower dosage rates of insecticides.

The first spray blocks were biologically ready for spraying with chemicals on May 22nd and spray operations commenced on that morning. This commencement date was four days earlier than the past three years. Other blocks were declared biologically ready on subsequent days. The first areas slated for B.t. treatment were declared ready for spraying on May 24th. Spraying with B.t. was delayed, however, due to the discovery of another bacteria called Streptococcus in the spray material. The use of B.t. was delayed until a definite clearance was received from both provincial and federal health and environment authorities. This approval was received on May 28th and the first B.t. was applied on the morning of May 29th. Also, on May 28th all blocks, both B.t. and chemical, were declared biologically ready for treatment. The project was completed on the evening of June 18th.

The development of both insects and tree foliage in 1987 was different from the expected progression of development from south to north, from low ground to high ground; and delays due to proximity of the cold Northumberland Strait did not occur. Northern and southeastern coastal areas developed almost as rapidly as those in the central Grand Lake region.

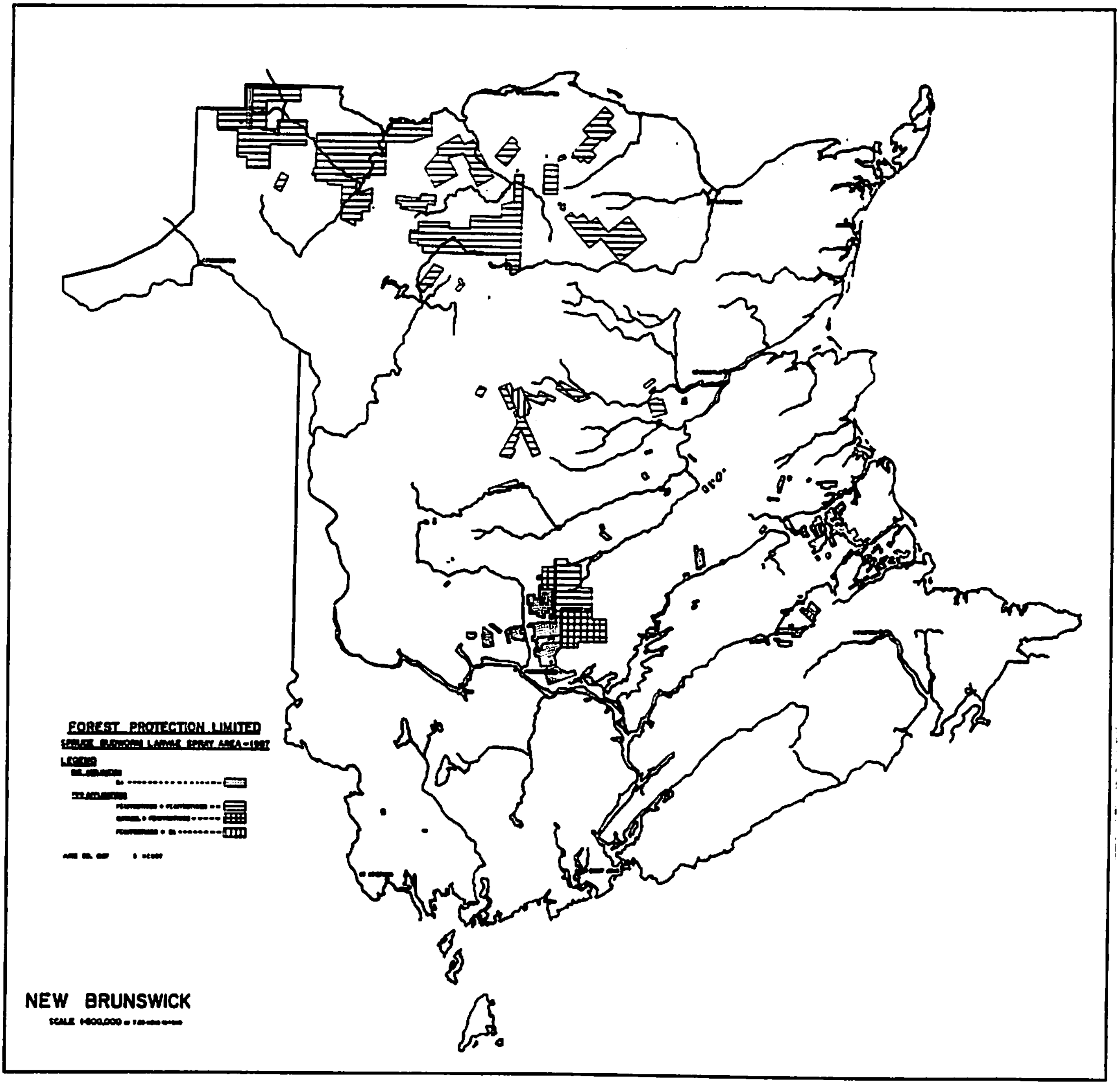

Figure 1. Areas sprayed by FPL for spruce budworm control in New Brunswick in 1987. (Does not include J.D. Irving program).

Table 1. Areas sprayed by Forest Protection Limited for spruce budworm control in 1987 in New Brunswick*. (Does not include J.D. Irving program).

Treatment	Hectares Thousands	(%)	Acres Thousands	Aircraft Type
One Application				
15 B.I.U./ha B.t. (Dipel)	2.4	(0.5)	6.1	Ag Truck
30 B.I.U./ha B.t. (Dipel or Futura)	79.3	(16.6)	195.9	Ag Cat, Ag Truck TBM
SUB-TOTAL	81.7	(17.1)	202.0	
Two Applications				
(a) 210 g/ha Fenitrothion+ 210 g/ha Fenitrothion	265.7	(55.5)	656.6	TBM Ag Truck
(b) 140 g/ha Fenitrothion+ 140 g/ha Fenitrothion	41.8	(8.7)	103.4	TBM
(c) 210 g/ha Fenitrothion+ 140 g/ha Fenitrothion	20.5	(4.3)	50.6	TBM
(d) 140 g/ha Fenitrothion+ 210 g/ha Fenitrothion	30.7	(6.4)	75.9	TBM
(e) 70 g/ha Matacil+ 210 g/ha Fenitrothion	28.3	(5.9)	69.9	TBM
(f) 210 g/ha Fenitrothion+ 30 B.I.U./ha B.t.	9.6	(2.0)	23.6	TBM
SUB-TOTAL	396.6	(82.9)	980.0	
GRAND TOTAL	478.3	(100.0)	1182.0	

*Source: Forest Protection Ltd.

Excellent spray weather occurred from May 22nd until May 27th, during which period only limited areas were ready for spraying. From then on only marginally acceptable weather for short periods occurred through to the end of the project. In fact, due to the marginal weather and the uniform and rapid development of the insect, most of the second application of chemical was delayed beyond the optimum five-day interval after first application. Also, due to questions surrounding approval of B.t. and the weather, much of the B.t. application was delayed five days and more beyond the optimum treatment date.

Results of Spray Program

Objectives of the program were to limit budworm defoliation and retain 60% or more of the current year's needles on balsam fir (Abies balsamea (L.) Mill.) and 50% or more on red-black spruce (Picea rubens Sarg.-P. mariana (Mill.) B.S.P.). Differences between expected levels of defoliation of balsam fir were detected between the north and south with more severe feeding occuring in the north (Table 2). In the north only 34% of sampled trees from untreated check areas had defoliation less than 40% compared to 87% in the check samples in the south. In the north, 65% of the fir samples (range 41-99%) from TBM blocks and 77% (range 27-94%) of fir samples from SSP blocks had defoliation less than 40%. In the south, 92% (range 90-100%) of the fir samples from TBM blocks and 95% (range 87-96%) of the fir samples from SSP (B.t.) blocks had defoliation less than 40%. Results on red-black spruce were less demonstrable because 93% of the check trees in the southern region had defoliation within accepted levels (Table 2). A subset of the data revealed that average defoliation levels on both species in treatment blocks was greatly reduced below that observed in check areas when based on equal pre-spray populations.

Based on the aerial defoliation survey there were about 75 121 ha of moderate and severe defoliation detected within all spray areas. This represented 17.5% of the total Province-wide moderate and severe defoliation, or 15.7% of the total area treated by all insecticides.

Spruce Budworm Conditions in 1987

The 1987 aerial defoliation survey was conducted in the standard manner and revealed an estimated 88 000 ha of light, 189 000 ha of moderate, and 241 000 ha of severe defoliation (Figure 2). Approximately 82.5% of the M-S defoliation was outside the treated areas. Defoliation was again scattered around the Province similar to 1986, with largest concentrations found throughout the north-central, northwest and in the central areas. The western border, most of the south, and northeastern parts of the Province were undamaged. The 430 000 ha of M-S defoliation represent a 54% decrease from 1986, and a significant 79% decrease from the 2.03 million ha in 1983.

Table 2. Number of balsam fir and red-black spruce trees sampled and percent meeting foliage protection objectives in Northern and Southern New Brunswick.

Treatment*	Number	(%)		Number	(%)
NORTHERN	balsam fir			balsam fir	
TBM			SSP		
F210b + F210b	815	(65)	F210 + F210	309	(94)
F210m + F210m	238	(41)	A70 + A70 (JDI)	87	(84)
F140m + F140m	339	(53)	F210 + F210 (JDI)	56	(27)
F210m + F210b	158	(99)	F210 + A70 (JDI)	75	(41)
F210b + F140m	39	(77)		527	(77)
F140m + F210b	156	(90)			
F210b + B.t.	81	(73)	CHECKS	270	(34)
	1826	(65)			

Treatment*	Number	(%)	Number	(%)
SOUTHERN				
TBM	balsam fir		red-black spruce	
F210b + F210b	-	-	78	(100)
A70 + F210b	131	(90)	203	(100)
1 X B.t.	20	(100)	78	(100)
TBM/SSP				
F210 + F210b	78	(95)	-	-
	229	(92)	359	(100)
SSP				
1 x B.t.	682	(96)	1133	(100)
A70 + A70 (JDI)	125	(87)	75	(100)
	807	(95)	1208	(100)
CHECKS	176	(87)	274	(93)

* F = fenitrothion; A = aminocarb (= Matacil), M = Micronair AU4000
b = boom and nozzle; JDI = J. D. Irving Ltd..

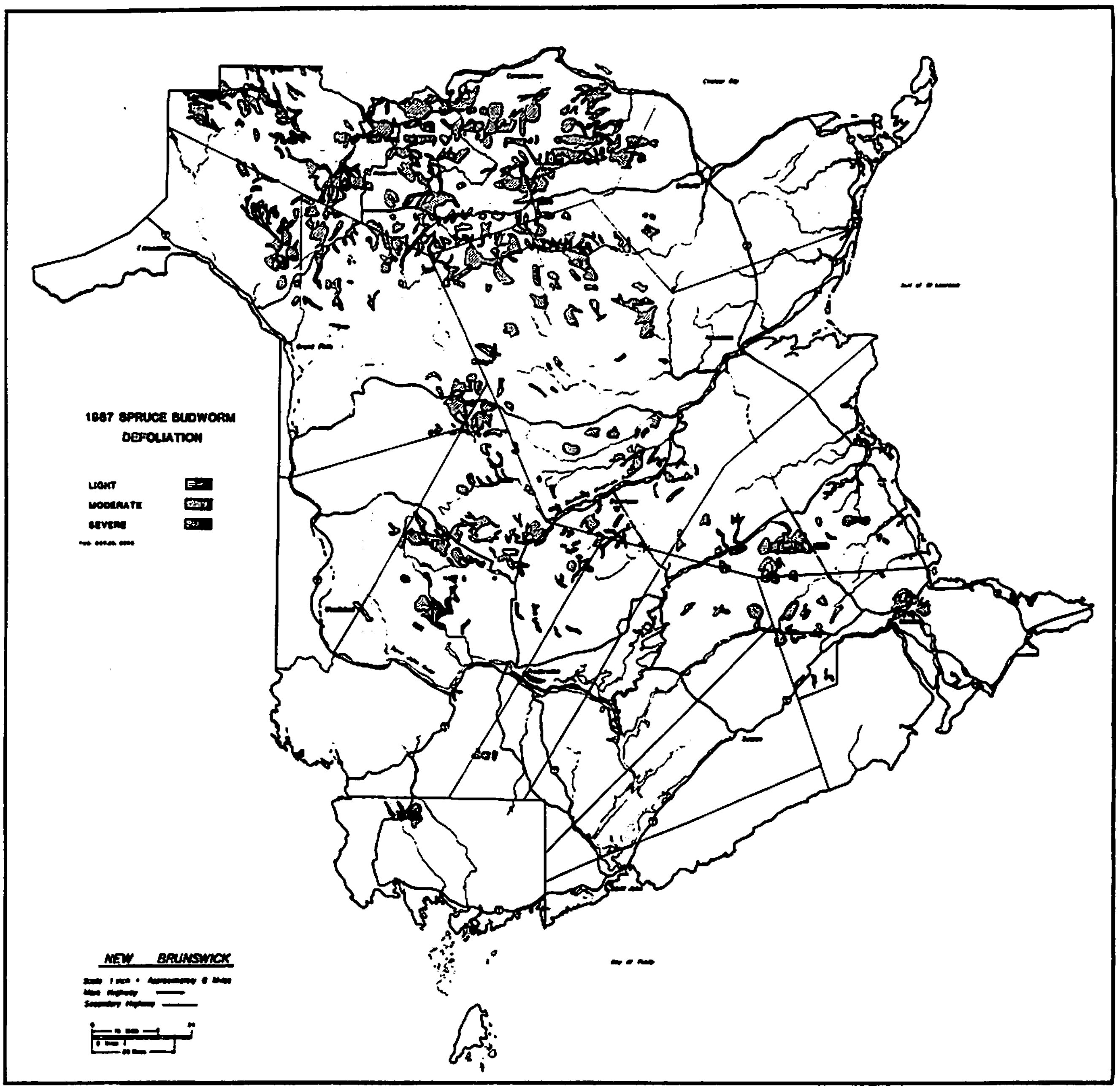

Figure 2. Area of light, moderate and severe defoliation based on 1987 aerial defoliation survey.

Forecast of Infestation for 1987

The spruce budworm egg mass survey was replaced by the L2 survey in 1985 as the method of forecasting infestation levels in New Brunswick. Supplementary L2 sampling is also conducted throughout the winter months to assist in planning the protection program. Table 3 compares the proportion of sample points within each infestation category used in the forecasts from 1981 to 1987. This table indicates an increasing trend in the percent of points in the Low category with a corresponding decreasing trend for the High category since 1982. In 1987, however, there was a three-fold increase in the proportion of points in the High category. This intensification occurs in the North-central to North-western parts of the Province where virtually all of these high points were found.

In light of these changes in population intensity, the forecast for 1988 is for 1.505 million ha (Figure 3) of moderate to high infestation a 12% reduction from last year's forecast (Table 4). The most severe damage is expected in the northern part of the Province. No significant damage is expected in the southern third of the Province or throughout most of the western, eastern, and northeastern areas.

Plans for 1987

Spray plans for 1987 have not been formulated at this time. Nevertheless, it does appear that a protection program will be required in New Brunswick next year. We anticipate that a combination of chemical insecticides and B.t. will again be used though the relative amounts are not known. Tentative spray plans should be known by mid-December.

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Dept. Natural Resources & Energy
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E3B 5H1

Table 3. Comparison of Spruce Budworm Forecast Infestation Levels 1981-1987.

	FORECAST INFESTATION LEVEL			
YEAR	LOW	MODERATE	HIGH	LOCATIONS
1981 egg-mass	591 (34%)	441 (25%)	708 (41%)	1740
1982 egg-mass	458 (26%)	512 (29%)	783 (45%)	1753
1983 egg-mass	636 (48%)	257 (20%)	423 (32%)	1316
1984 egg-mass	747 (51%)	331 (22%)	398 (27%)	1476
1985 L2	833 (56%)	503 (32%)	185 (12%)	1521
1986 L2	1216 (77%)	322 (20%)	48 (3%)	1586
1987 L2	1198 (76%)	230 (15%)	144 (9%)	1572

Table 4. Comparison of Forecast Area (ha) of Moderate and High Infestations 1982-1987.

YEAR (N)	(N + 1) FORECAST
1982	5.30 million ha
1983	4.10 million ha
1984	3.57 million ha
1985	3.15 million ha
1986	1.71 million ha
1987	1.50 million ha

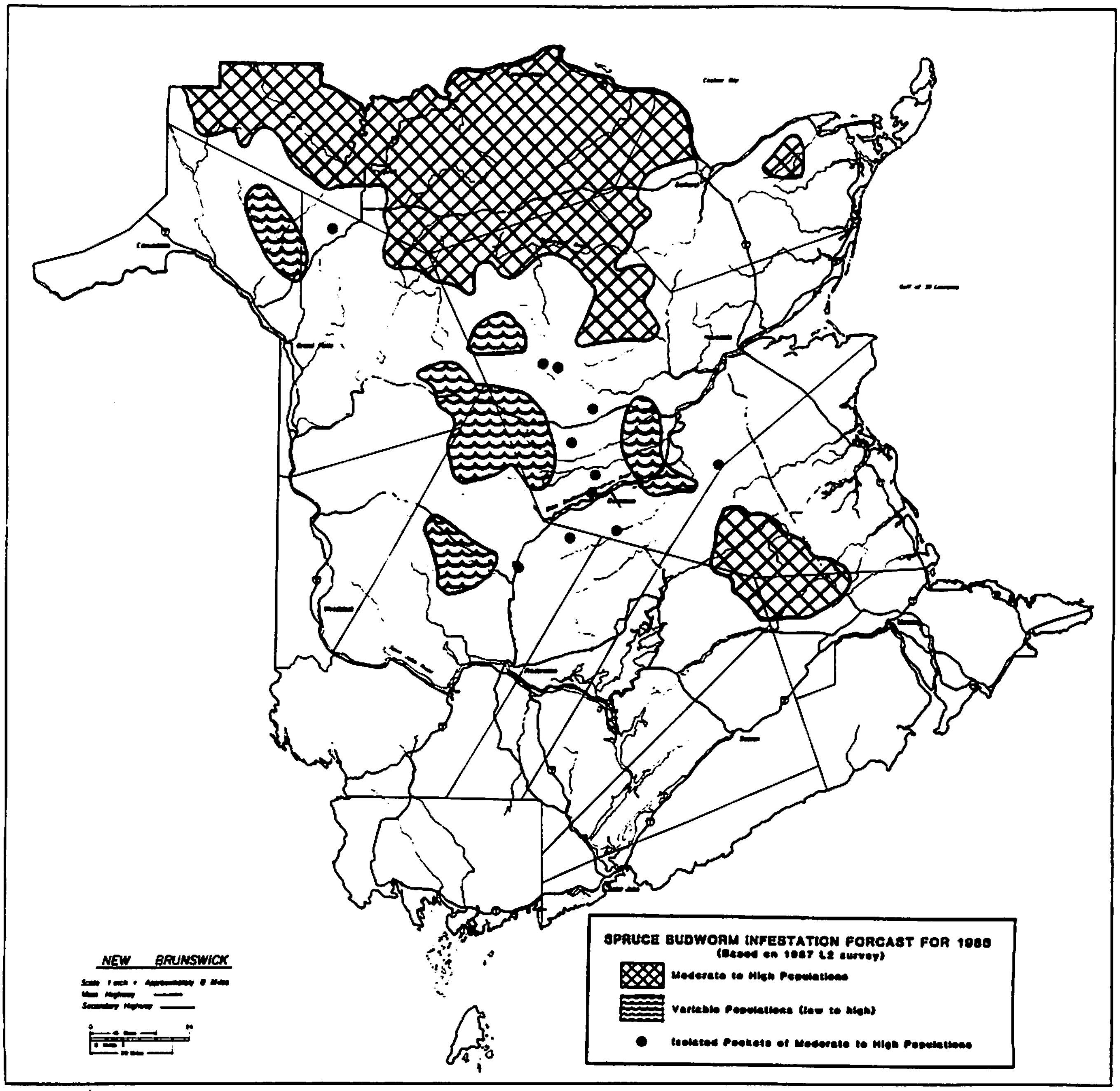

Figure 3. Areas forecast to have moderate and high infestation levels in 1988 based on the 1987 L2 survey.

Aerial Insecticide Spraying Against the Spruce Budworm in Québec, 1987

by Michel Auger, Forest Engineer

MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
DIRECTION DE LA CONSERVATION
SERVICE DE LA PROTECTION CONTRE LES INSECTES ET LES MALADIES

Report presented at the Annual Insect Pest Control Forum

Ottawa, November 1987

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I - 1987 SPRAY PROGRAM

1. Introduction

In 1987, the ministère de l'Énergie et des Ressources carried out its eighteenth insecticide spray program against the spruce budworm, **Choristoneura fumiferana** (Clem.). The program covered a total area of 197 992 hectares (Figure 1), which represents an increase of 74% over 1986. The Bas-Saint-Laurent - Gaspésie region, reintegrated into the program because of an intensification of the infestation, accounted for 89% of the area treated in 1987. Infestation in the Côte-Nord region having dropped somewhat over its 1986 level, the spray program there was reduced by half for 1987.

For the first time since the beginning of the spray programs, in 1969, the only insecticide used in 1987 was a biological product, **Bacillus thuringiensis**.

2. Insecticide and dosage

The biological insecticide **Bacillus thuringiensis** Var. **Kurstaki** was applied undiluted at a rate of 30 billion international units (BIU) per hectare, for a total volume of 2.37 liters per hectare. Dipel 132, a product manufactured by Laboratoires Abbott Ltée, was used over the entire spray area, with the exception of 927 hectares which were treated with Dipel 176. The results of this test will be discussed in a future report.

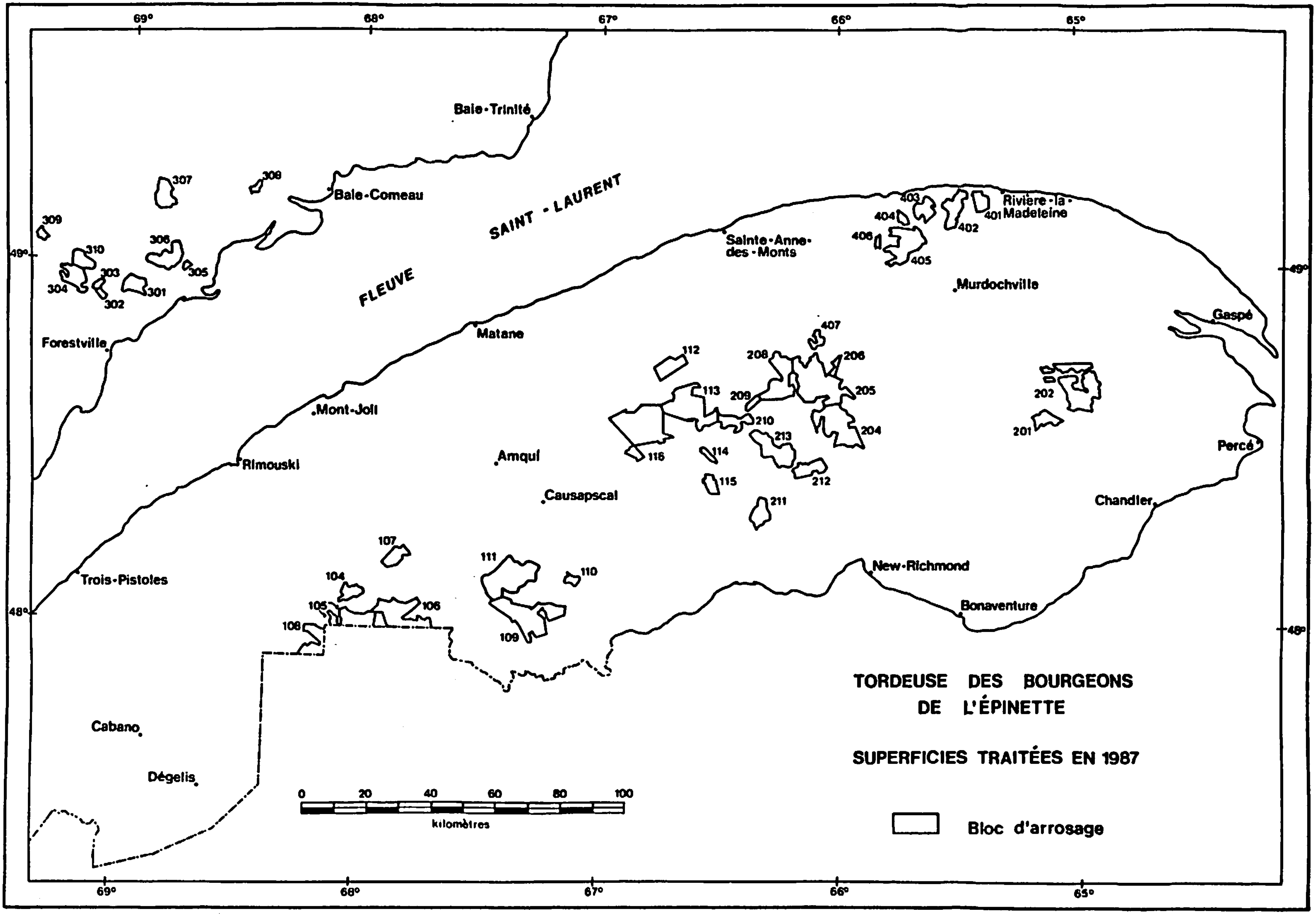


FIGURE 1 Areas treated against the Spruce Budworm in Quebec in 1987 (HA)

Quality control tests carried out by the Service des études environnementales made it possible to detect the unusual presence of pollutants in the B.T. stocks that were deliverd. However, following favourable medical advice, the insecticide was sprayed as scheduled.

3. Spray aircraft

The spray program was carried out with four four-engine (DC-4) and four single-engine aircraft: two Bull Thrushes and two Turbo Thrushes. Two days before the program ended, two additional single-engine Bull Thrushes were added to those already operating out of Forestville Airport.

Fractioning the insecticide into fine droplets was made possible by installing 110 "Spraying System^tm^" open jets on the four-engine aircraft. The single-engine craft were equipped with Micronair AU 5000 fitted with long blades (12 cm) and with flowmeters to ensure optimum control of the volume sprayed. The characteristics of the 1987 spray aircraft are given in Table 1.

The four-engine aircraft were navigated using an inertial system (LTN-51), while the single-engine planes were navigated visually with the help of a bird-dog plane.

The airports at Mont-Joli, Bonaventure, Rivière-Madeleine and Forestville were used as bases for the spraying of 469 241 liters of biological products.

TABLE 1: Characteristics of the spray aircraft

Type	Speed (km/h)	Capacity (1)	Swath (m)	Vol/ha (1)	Ha/min	Ha/trip	Flow (1/min)	Duration
DC-4	280	8 300	305	2,37	142,33	3 502	337,32	24 min 36 s
BULL THRUSH	200	1 500	122	2,37	40,66	633	96,36	15 min 34 s
TURBO THRUSH	200	1 500	122	2,37	40,66	633	96,36	15 min 34 s

4. Insect and shoot development

Monitoring of budworm activity and bud flare was done on a series of semi-permanent sites in the Bas-Saint-Laurent - Gaspésie and Côte-Nord regions.

The unusually warm weather in April hastened both the spring thaw and the emergence of larvae. The spruce budworm larvae were completely emerged by May 8, thus setting a record over the past seven years (Figure 2). Compared to recent years, budworm activity began two weeks earlier in 1987.

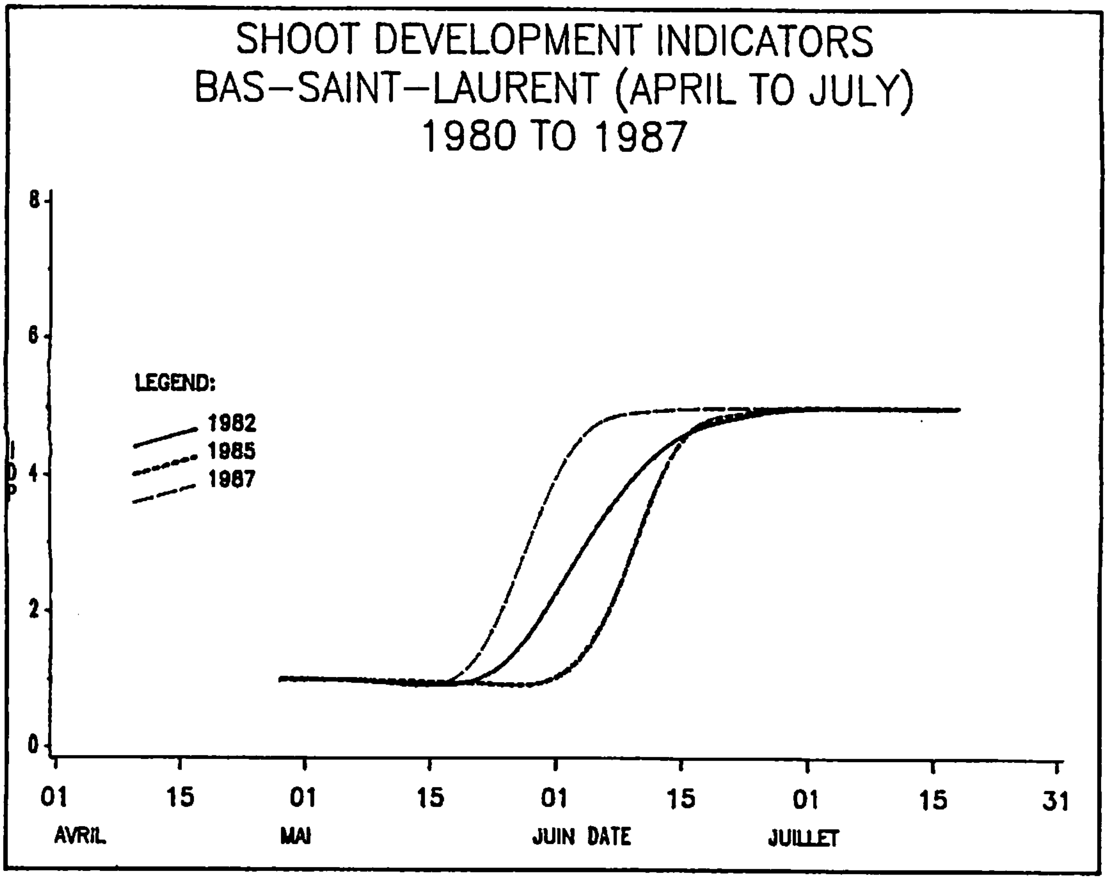
Subsequently influenced by near-normal climatic conditions, the insect developed in a way similar to that of previous years, except for a slowdown at the end of June, between the 6th instar and the adult stage.

Bud flare was very early, it was ten days ahead of that observed in recent years.

5 Spray timing

Spraying began on May 31 and continued until June 18. For the vast majority of the areas treated (94%), the shoot development indicator was greater than 4.5 when the insecticide was applied (Table 2). More than 75% of the areas treated were sprayed between the 3rd and 5th instar, while only 10% were sprayed during the 6th instar.

In the Bas-Saint-Laurent sector, where larval populations were dense, 30% of the areas treated were sprayed after the 5th instar.


SHOOT DEVELOPMENT INDICATORS
BAS-SAINT-LAURENT (APRIL TO JULY)
1980 TO 1987
LEGEND:
1982
1985
1987
IDP
0
2
4
6
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01
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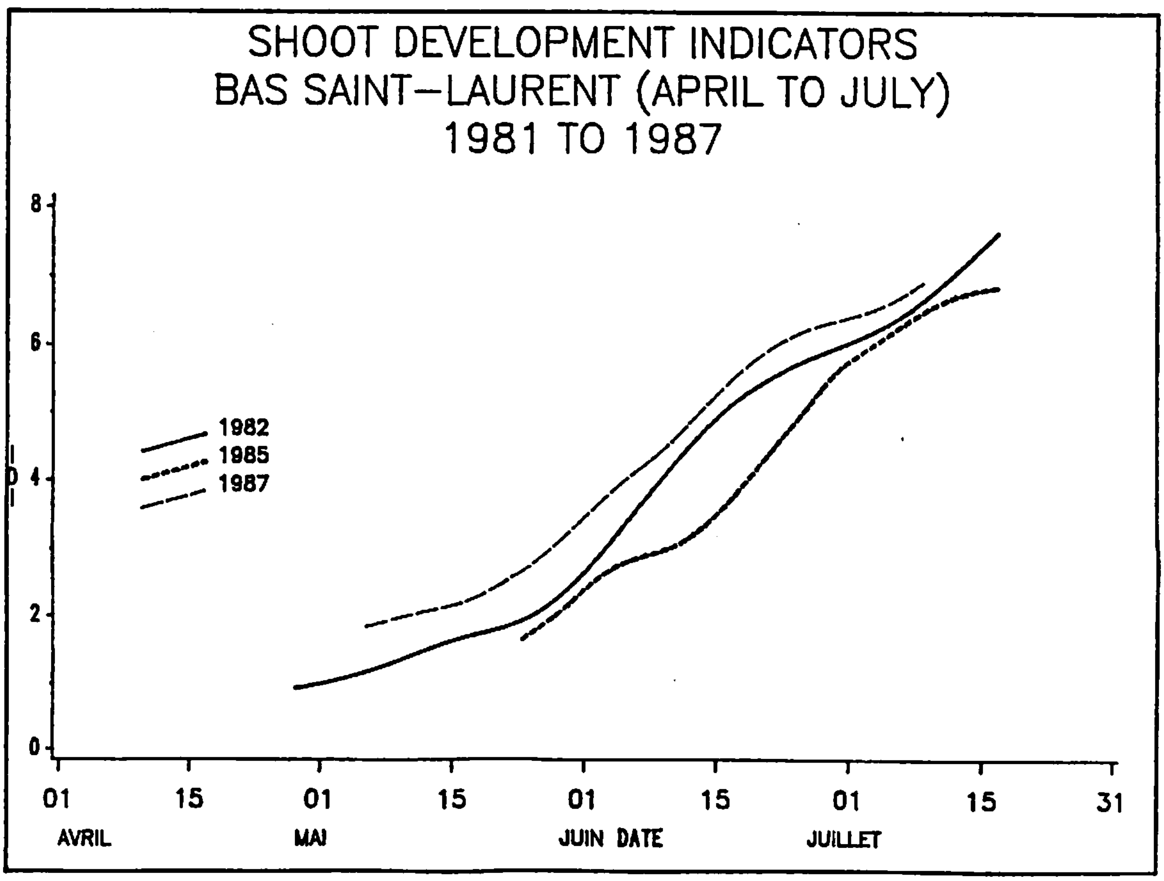
SHOOT DEVELOPMENT INDICATORS
BAS SAINT-LAURENT (APRIL TO JULY)
1981 TO 1987
1982
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FIGURE 2

TABLE 2: Timing of bioligical insecticide applications against the spruce budworm in 1987

Bud flare

Indicator	Baie-des-Chaleurs	Bas-Saint-Laurent	Côte-Nord	Chic-Chocs	TOTAL
2.5-3.0					
3.1-3.5					
3.6-4.0		9%*			3%
4.1-4.5		7%	15%		3%
4.6-5.0	100%	84%	86%	100%	94%

Insect development

Indicator	Baie-des-Chaleurs	Bas-Saint-Laurent	Côte-Nord	Chic-Chocs	TOTAL
2.5-3.0					
3.1-3.5		8%	4%		4%
3.6-4.0		7%	10%		5%
4.1-4.5	63%	29%	86%	44%	45%
4.6-5.0	17%	26%		27%	21%
5.1-5.5	22%	10%		29%	15%
5.6-6.0		20%			10%

* Percentage of the area treated

6. Larval populations

An assessment of the 3rd instar populations was done in 1987 in 243 sample plots determined within the treated areas. This type of assessment is aimed at eliminating those stands whose larval population is less than 5 larvae per branch.

In more than half the sample plots (52.5%), the larval population was greater than 10 larvae per 45-cm branch while, in 25% of the plots, it was greater than 20 larvae per branch (Figure 3). Outside the treated areas, the populations generally tended to be weaker although they were greater than 10 larvae per branch in 136 of the sites sampled (31.5%).

7. Treatment efficacy

In the areas treated, the average population was 13.7 larvae per branch. The Bas-Saint-Laurent and Baie-des-Chaleurs sectors, which constituted 71% of the treated area, were the most heavily infested, with average infestation levels of 17 and 16.4 larvae per branch respectively.

Treatment was very effective (92.7%) in reducing spruce budworm populations: colonies at the chrysalid stage were reduced to one larva per branch (Table 3). The average level of defoliation was 36%, and only 8% of the area treated was severely defoliated (Table 4). In fact, more than 70% of the sites sampled showed a defoliation level of less than 5% (Figure 4). Treatment made it possible to save from 19% to 55% of the annual foliage, depending on the sector. The most spectacular effect of the treatment was the significant reduction in the larval populations expected for 1988 in sectors treated in 1987. Compared to 1986, a drop in the hibernating larval populations has been noted on more than 90% of the sites treated in 1987 whereas, in 90% of the sample plots outside the spray blocks, the density of

DISTRIBUTION DES POPULATIONS LARVAIRES

DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE
1987

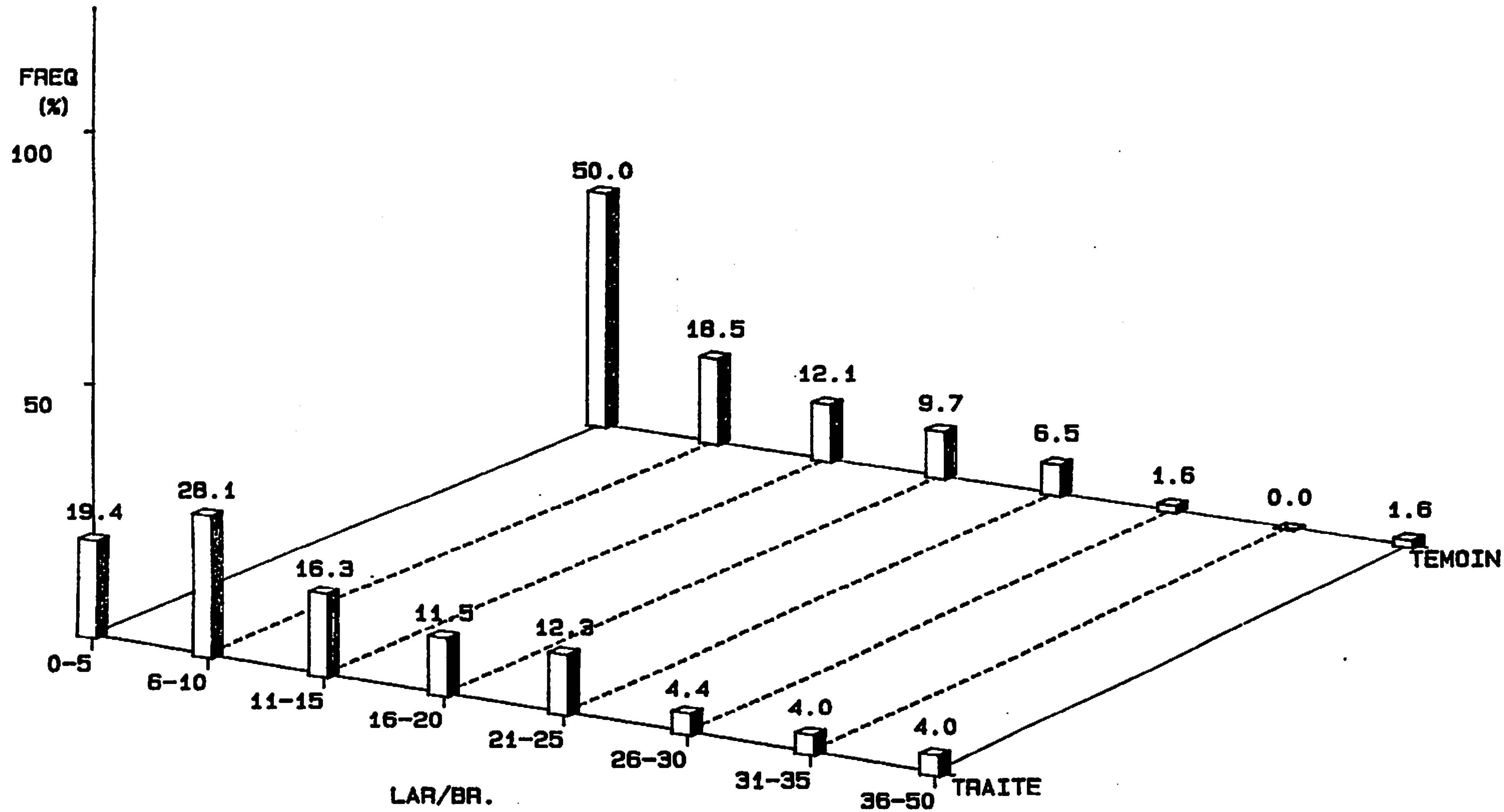


FIGURE 3 : Distribution of Spruce Budworm larval populations 1987

DISTRIBUTION OF SPRUCE BUDWORM LARVAL POPULATIONS

1987

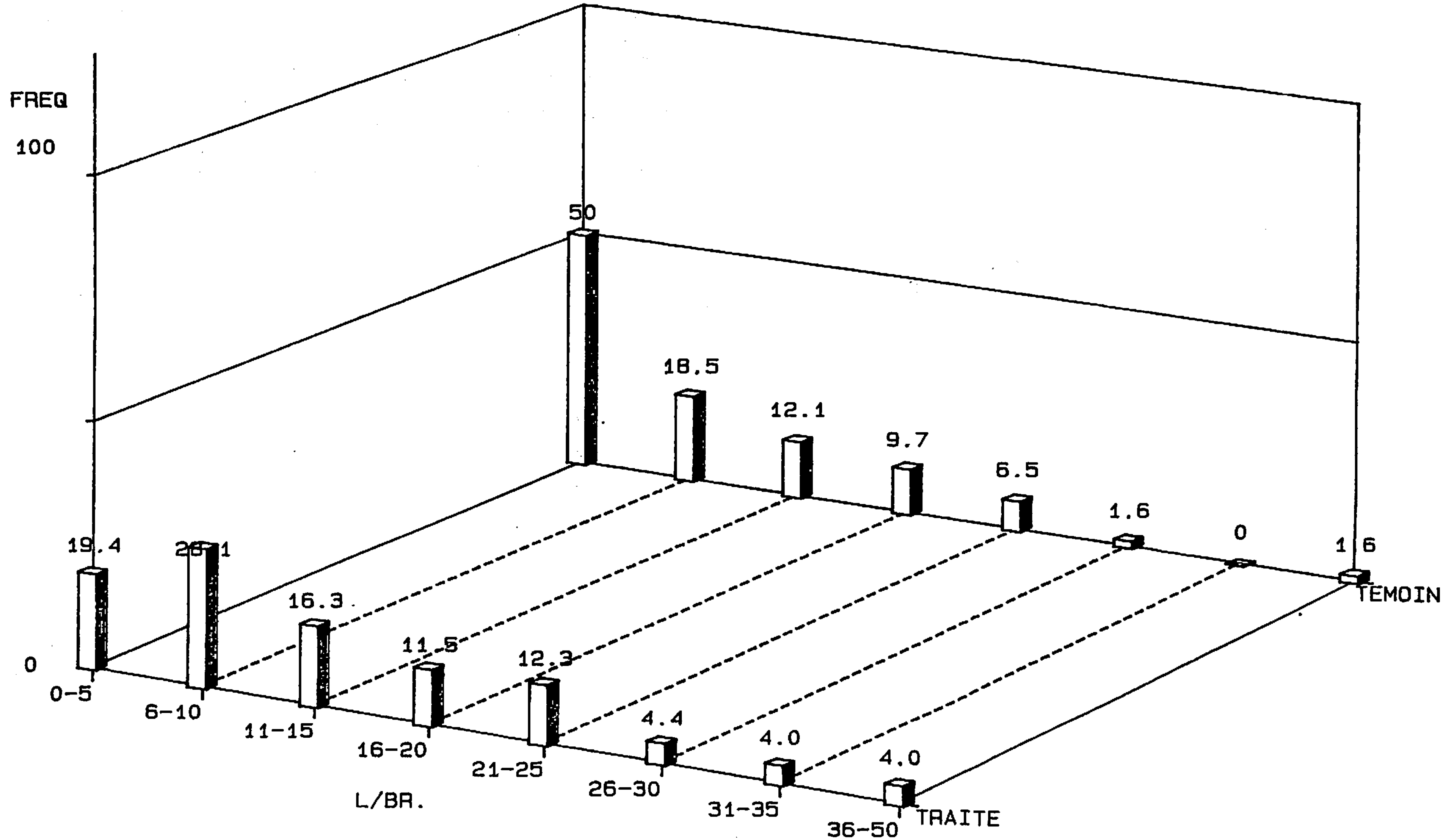


FIGURE 3

TABLE 3: **Larval mortality and needle protection resulting from the 1987 biological insecticide spraying against the spruce budworm**

Blocks	No. of sample plots	Larval populations Pre-spray Larva/branch	Larval populations Pre-spray Larva/bud	Post-spray	Total mortality (%)	Defoliation Observed	Defoliation Expected	Protection[1]	Abbott[2] Mortality
Bas-Saint-Laurent sector									
104	4	20.0	0.25	0.4	98.0	39	64		
105	4	23.1	0.35	3.8	83.5	79	72		
106	6	25.6	0.38	2.1	91.7	65	74		
107	5	9.9	0.11	0.6	93.9	10	39		
108	4	9.1	0.11	0.9	90.1	22	39		
109	10	13.2	0.17	0.7	94.7	15	53		
110	3	6.3	0.06	0.7	88.9	18	19		
111	7	23.9	0.30	2.7	88.7	42	69		
SUBTOTAL	**43**	**17.0**	**0.21**	**1.5**	**91.2**	**35**	**60**	**42**	**56**
CONTROL GROUPS	**23**	**7.3**	**0.10**	**1.3**	**82.2**	**21**	**--**		
Baie-des-Chaleurs sector									
112	4	8.6	0.13	0.4	94.3	26	44		
113	10	20.4	0.34	1.4	93.1	59	72		
114	3	6.3	0.13	0.3	95.2	11	44		

TABLE 3: (CONT.)

Blocks	No. of sample plots	Larval populations: Pre-spray Larva/branch	Larval populations: Pre-spray Larva/bud	Larval populations: Post-spray	Total mortality (%)	Defoliation: Observed	Defoliation: Expected	Protection[1]	Abbott[2] Mortality
(Baie-des-Chaleurs sector (cont.)									
115	3	22.9	0.44	0.5	97.8	45	77		
116	14	18.0	0.30	1.4	92.2	52	69		
204	9	17.2	0.27	2.0	88.8	48	66		
205	10	12.8	0.32	0.4	96.9	75	71		
206	3	13.6	0.22	0.6	95.7	93	61		
208	7	15.4	0.29	1.4	90.9	64	68		
209	3	13.3	0.15	1.9	85.7	45	49		
210	4	12.9	0.24	1.9	85.3	88	63		
211	6	30.6	0.47	3.4	88.9	63	78		
212	7	14.8	0.23	0.7	95.3	24	62		
213	12	14.6	0.30	2.3	84.2	60	69		
407	3	15.4	0.25	0.7	95.4	48	48	65	
SUBTOTAL	**98**	**16.4**	**1.4**	**91.5**	**55**	**68**	**19**	**59**	
CONTROL GROUPS	**56**	**9.6**	**0.15**	**2.7**	**71.9**	**39**	**--**		
Gaspésie sector									
201	4	13.9	0.22	0.2	98.6	30	61		
202	16	13.9	0.28	0.2	98.6	34	68		
SUBTOTAL	**20**	**13.9**	**0.26**	**0.2**	**98.6**	**30**	**66**	**55**	**60**
CONTROL GROUPS	**10**	**9.6**	**0.16**	**0.6**	**93.8**	**44**	**--**		

TABLE 3: (CONT.)

Blocks	No. of sample plots	Larval populations Pre-spray Larva/branch	Larval populations Pre-spray Larva/bud	Post-spray	Total mortality (%)	Defoliation Observed	Defoliation Expected	Protection[1]	Abbott[2] Mortality
(Chic-Chocs sector)									
401	5	5,2	0,04	0,7	86,5	11	12		
402	6	4,4	0,04	0,0	100	4	12		
403	4	9,6	0,08	0,4	95,8	20	28		
404	3	9,4	0,11	0,3	96,8	29	39		
405	10	7,1	0,11	0,2	97,2	11	35		
SUBTOTAL	**28**	**6,7**	**0,07**	**0,3**	**95,5**	**13**	**23**	**43**	**76**
CONTROL GROUPS	**16**	**4,8**	**0,05**	**0,2**	**95,8**	**18**	**--**		
Côte-Nord sector									
301	6	6,3	0,05	0,1	98,4	5	13		
302	3	6,5	0,04	0,1	98,5	12	8		
303	3	14,0	0,11	0,0	100,0	11	39		
304	8	10,8	0,12	1,2	88,9	30	42		
305	4	11,8	0,07	0,3	97,5	9	23		
306	9	5,6	0,04	0,0	100,0	7	9		
307	7	15,7	0,16	0,1	99,4	30	51		

TABLE 3: (CONT.)

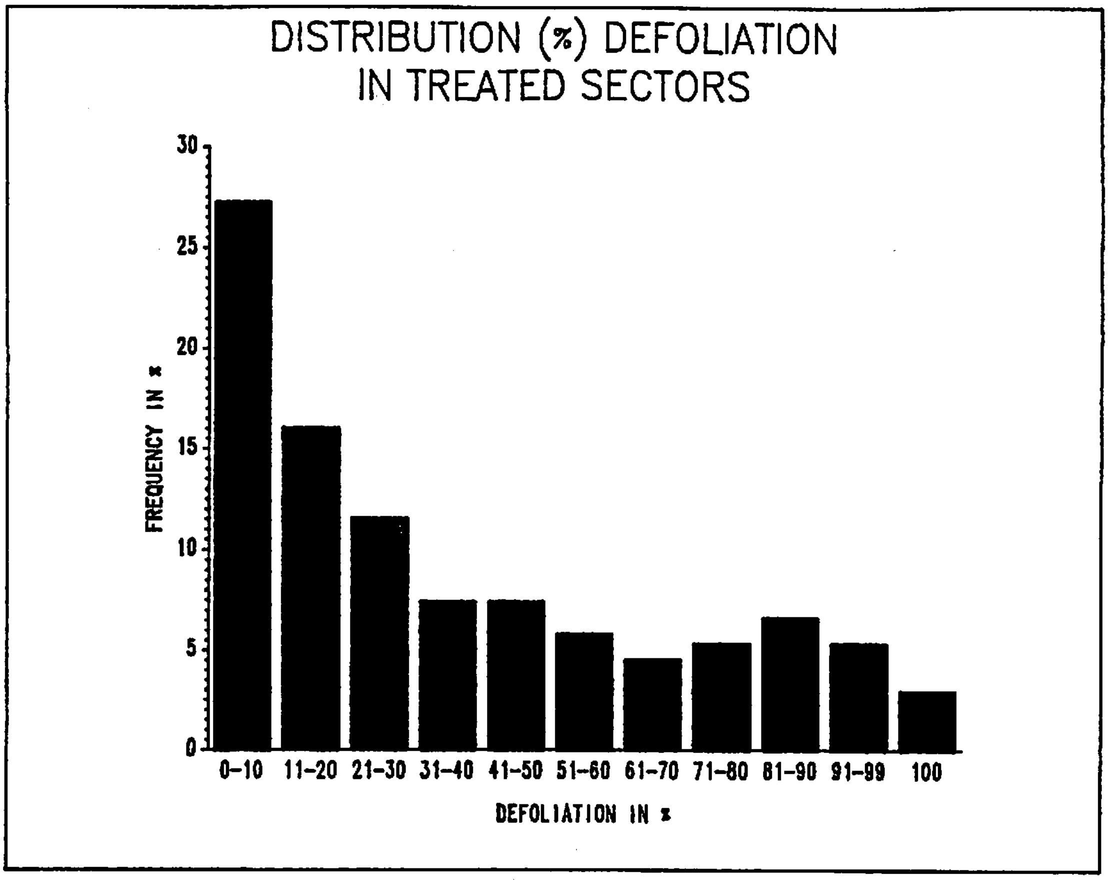
Blocks	No. of sample plots	Larval populations Pre-spray Larva/branch	Larval populations Pre-spray Larva/bud	Post-spray	Total mortality (%)	Defoliation Observed	Defoliation Expected	Protection[1]	Abbott[2] Mortality
(Côte-Nord sector (cont.)									
308	4	17,3	0,19	1,5	91,3	38	57		
309	4	2,5	0,03	0,2	92,0	8	4		
310	5	9,7	0,11	0,9	90,7	27	39		
SUBTOTAL	**53**	**9,8**	**0,09**	**0,4**	**95,9**	**18**	**32**	**44**	**77**
CONTROL GROUPS	**31**	**9,5**	**0,10**	**1,4**	**85,3**	**34**	**--**		
GRAND TOTAL	**243**	**13,7**	**0,18**	**1,0**	**92,7**	**36**	**55**	**34**	**68**
CONTROL GROUPS	**136**	**8,6**	**0,12**	**1,7**	**80,2**	**33**	**--**		

1 Protection: (Expected defoliation - Observed defoliation) - Expected defoliation) X 100.

2 Abbott mortality: (Untreated population survival - Treated population survival) - Untreated population survival X 100

Table 4: Areas infested with the spruce budworm, within the 1987 spray blocks (ha)

Sector	None	Light	Moderate	Severe	TOTAL
Bas-Saint-Laurent	279	32 855 (64%)	14 759 (29%)	3 478 (7%)	51 371 (26%)
Baie-des-Chaleurs	131	34 846 (39%)	43 739 (49%)	10 712 (12%)	89 428 (45%)
Chic-Chocs	--	20 357 (100%)	--	--	20 357 (10%)
Côte-Nord	--	10 588 (49%)	10 080 (47%)	895 (4%)	21 563 (11%)
Gaspésie	--	13 066 (86%)	2 207 (14%)	--	15 273 (8%)
TOTAL	**410**	**111 712 (56%)**	**70 785 (36%)**	**15 085 (8%)**	**197 992**


DISTRIBUTION (%) DEFOLIATION
IN TREATED SECTORS
FREQUENCY IN %
30
25
20
15
10
5
0
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-99
100
DEFOLIATION IN %

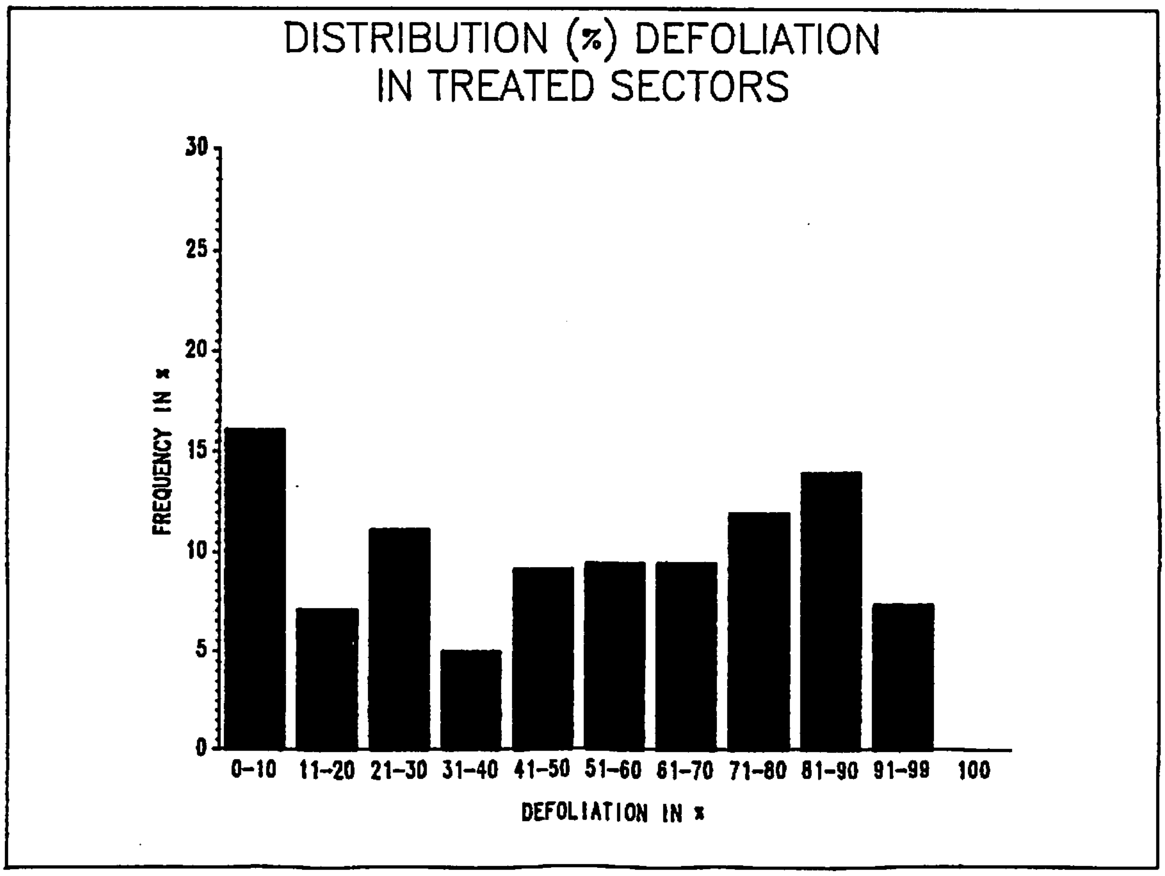

DISTRIBUTION (%) DEFOLIATION
IN TREATED SECTORS
FREQUENCY IN %
30
25
20
15
10
5
0
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-99
100
DEFOLIATION IN %

FIGURE 4

hibernating larval populations has increased. The impact of the treatment on the coming season is far from negligible. Because of this population decrease, it will be possible to safely exclude certain stands from the 1988 spray program.

Despite these results, almost half the treated areas received only weak protection and, in this aspect, the 1987 spray program was disappointing. In the majority of cases, reduced effectiveness was related to very dense local larval populations, to tardiness in insecticide application, to the use of too little insecticide and to a possible decrease in the budworm's vitality. This loss of vitality is shown by the defoliation curves obtained in the last few years (Figure 5).

For a given population, these curves show a constant decrease of the annual defoliation. In 1982, a larval population of 0.2 larva per bud was responsible for an annual defoliation of 90%; an equivalent larval population caused a 41% annual defoliation in 1987.

Given the wide range of population levels characterizing this terminal stage of the epidemic, it is essential to adjust our approach in such a way as to provide adequate protection for heavily infested stands. The biological insecticide doses currently used are not strong enough given such dense populations or the budworm's loss of vitality, and they should therefore be reevaluated and increased. Where necessary, a second application of insecticide should be effected; and application delays should be reduced to a minimum. Given the importance of certain natural factors at the end of an epidemic, more care must be exercised in selecting the stands which require insecticide spraying. Stand selection, based on expected dense populations, should reflect the progress of the current epidemic.

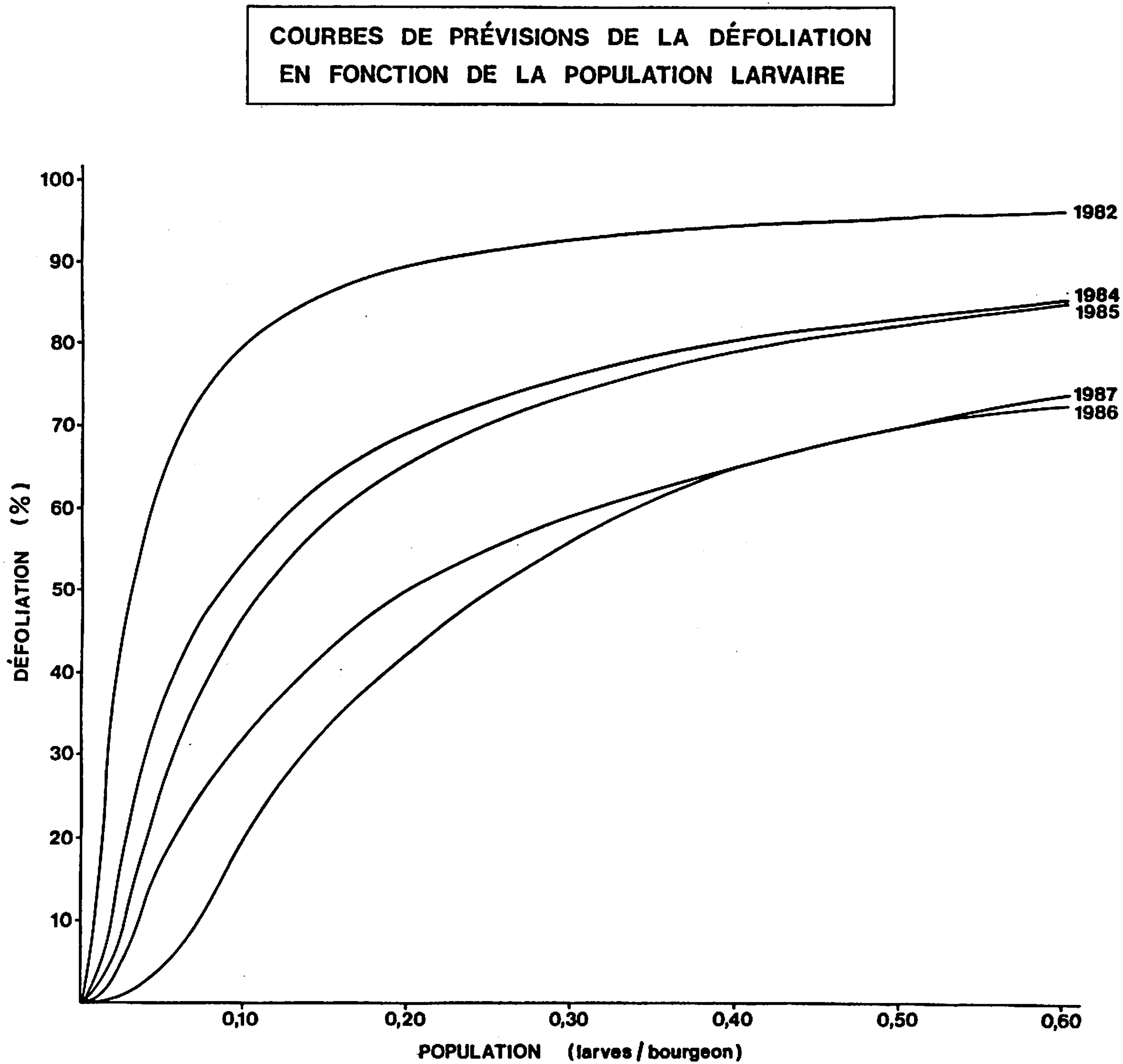


FIGURE 5 Defoliation curves expected according to larval populations

II - THE SPRUCE BUDWORM INFESTATION IN QUÉBEC, 1987

In 1987, the spruce budworm infestation affected a total area of 1.04 million hectares compared to 2.83 million hectares in 1986. The total area affected has thus decreased by 63%. Damage was light on 0.30 million hectares, moderate on 0.35 million hectares and severe on 0.39 million hectares. The infestation has decreased significantly in all regions except in the Bas-Saint-Laurent - Gaspésie, where the total infestated area was the same as in 1986. No damages were observed in the Estrie, Outaouais, Abitibi-Témiscamingue and Saguenay - Lac-Saint-Jean regions (Table 5 and Figure 6).

Table 5: **Areas affected by the spruce budworm, excluding mortality zones, in the administrative regions of Québec in 1987 (ha)**

Administrative region	Infestation level: Light (ha)	Moderate (ha)	Severe (ha)	TOTAL (ha)
Bas-Saint-Laurent - Gaspésie (01)	315 314 240 344	322 032 232 267	56 094 93 722	693 440* 566 335
Saguenay - Lac-Saint-Jean (02)	26 662 --	32 656 --	13 282 --	72 600* --
Québec (03)	36 721 156	100 782 --	41 095 --	178 598* 156
Trois-Rivières (04	274 208 29 063	440 980 8 594	81 814 --	797 002* 37 657
Estrie (05)	-- --	-- --	-- --	-- * --
Montréal (06)	43 281 2 969	255 626 1 094	35 313 --	334 220* 4 063
Outaouais (07)	-- --	-- --	-- --	-- * --
Abitibi-Témiscamingue (08)	-- --	-- --	-- --	-- * --
Côte-Nord (09)	55 558 29 340	199 694 111 957	500 835 292 146	756 087* 433 443
Provincial totals	751 744 301 872	1 351 770 353 914	728 433 385 868	2 831 947* 1 041 654

* Areas affected in 1986

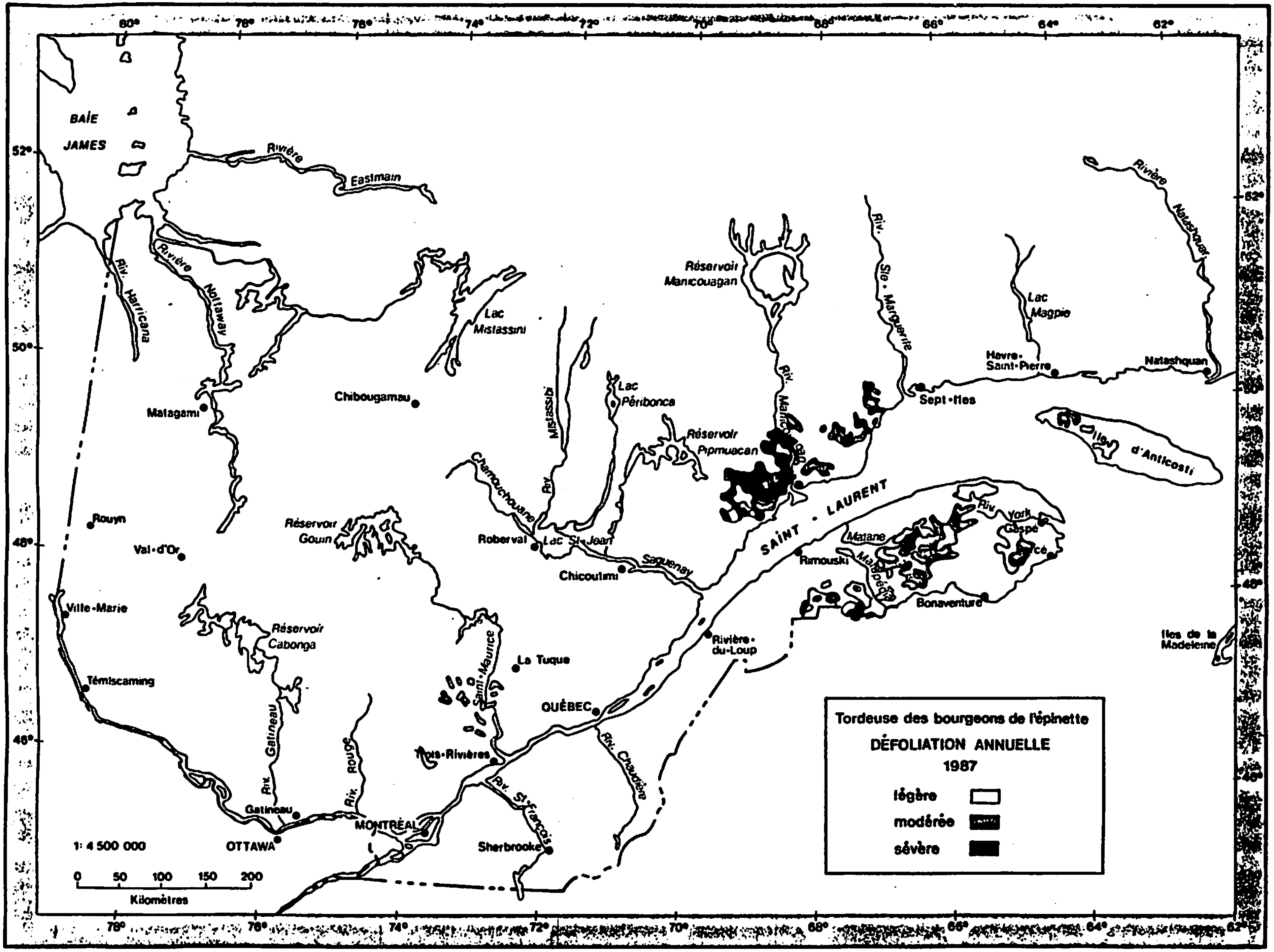


FIGURE 6 Defoliation in the areas affected by the Spruce Budworm in 1987

III - 1988 FORECASTS

The spruce budworm infestation forecasts for 1988 are based on an intensive survey of the populations hibernating in 1 500 sample plots, and on the use of a series of pheromone traps set up on 260 sites distributed throughout the province.

In almost all regions of Québec, the epidemic continued to decline, and larval populations will be very weak. Even if the spruce budworm infestation is generally on the decrease, the Bas-Saint-Laurent - Gaspésie region will be severely hit. Two other small sectors, one near Baie-Comeau in the Côte-Nord region and the other near Grand'Mère in the Trois-Rivières region, will also be moderately or severely affected.

Infestation noted last year in two large zones in the Bas-Saint-Laurent - Gaspésie region has spread and intensified. One of these zones, located in the middle of the Gaspé Peninsula, is delimited by the Chic-Chocs Mountains to the north, the Nouvelle River to the west and the Cascapédia River to the east. The other zone lies along the New Brunswick border, stretching between the Rimouski River to the east and the Matapédia Valley to the west (Figure 7).

As a result of the resurgence of the epidemic in the Bas-Saint-Laurent region, the ministère de l'Énergie et des Ressources plans to protect a total area of 200 000 hectares there in 1988.

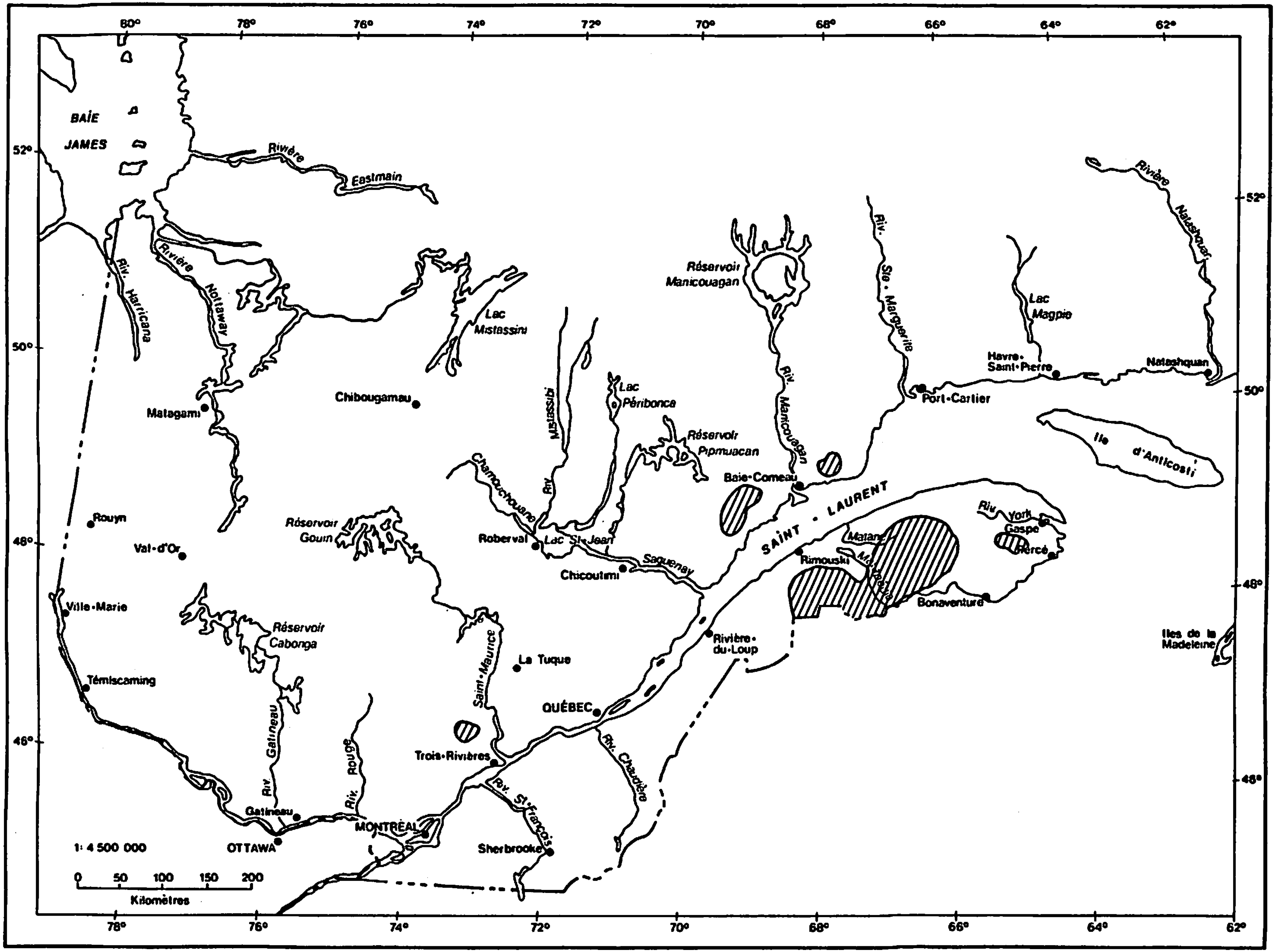


FIGURE 7: Areas that should be affected by the spruce budworm, in 1988, according to the survey of hibernating populations (L2)

PULVERISATION AERIENNE
DE <u>BACILLUS THURINGIENSIS</u>
EN FORET PRIVEE
DANS L'EST DU QUEBEC

Résultats, saison 1987

OTTAWA LES 17-19 NOVEMBRE 1987

PRÉSENTÉ AU QUINZIÈME COLLOQUE ANNUEL

SUR LA LUTTE CONTRE

LES RAVAGEURS FORESTIERS

ANDRÉ JUNEAU

SERVICE CANADIEN DES FORÊTS

DÉVELOPPEMENT FORESTIER

C.P. 10 225, SAINTE-FOY

QUÉBEC, G1V 4H5

INTRODUCTION

La forêt privée de l'Est du Québec a subi les effets néfastes de l'épidémie de la tordeuse des bourgeons de l'épinette. Suite aux demandes répétées des propriétaires de cette forêt privée, le Service canadien des forêts (SCF) a mis sur pied un programme de protection par le biais du Plan de développement de l'Est du Québec, programme forestier. L'exécution de ce programme a par la suite été confiée par contrat aux trois Offices ou Syndicats de producteurs de bois (OPB/SPB) de la région concernée.

Après une pulvérisation expérimentale de Bacillus thuringiensis (B.t.) sur 3 800 hectares de forêt en 1984, dont le but était de mettre au point les méthodes, trois dispersions opérationnelles sur 30 925 hectares en 1985, sur 14 629 hectares en 1986 et sur 7 100 hectares en 1987 ont été réalisées.

Le présent rapport résume les résultats du programme de pulvérisation aérienne de 1987.

RESSOURCES EN MATERIEL ET SERVICES

Afin de réaliser l'opération avec succès et fort de l'expérience acquise, on a retenu le matériel et les services suivants:

Insecticide

La préparation de Bacillus thuringiensis Futura[md] de Chemagro Limited, Mississauga, Ontario.

Le dosage utilisé à l'hectare fut de 2,5 litres, soit:

1,5 litre de Futura[md]

1,0 litre d'eau

1,56 mL de l'adhésif Chevron[md]

Avions

Deux AgCat[md], 450 HP, qui ont été fournis par Agric-Air Inc. Ste-Cécile de Milton, Québec.

Plans de mélange

Un plan de mélange mobile a été fourni par le ministère de l'Énergie et des Ressources, Québec. Le SPB du Bas-Saint-Laurent a utilisé un plan de mélange de sa fabrication.

Système de dispersion

Longerons et 24 buses (Teejet Flat Fan 8004).

Navigation et balisage

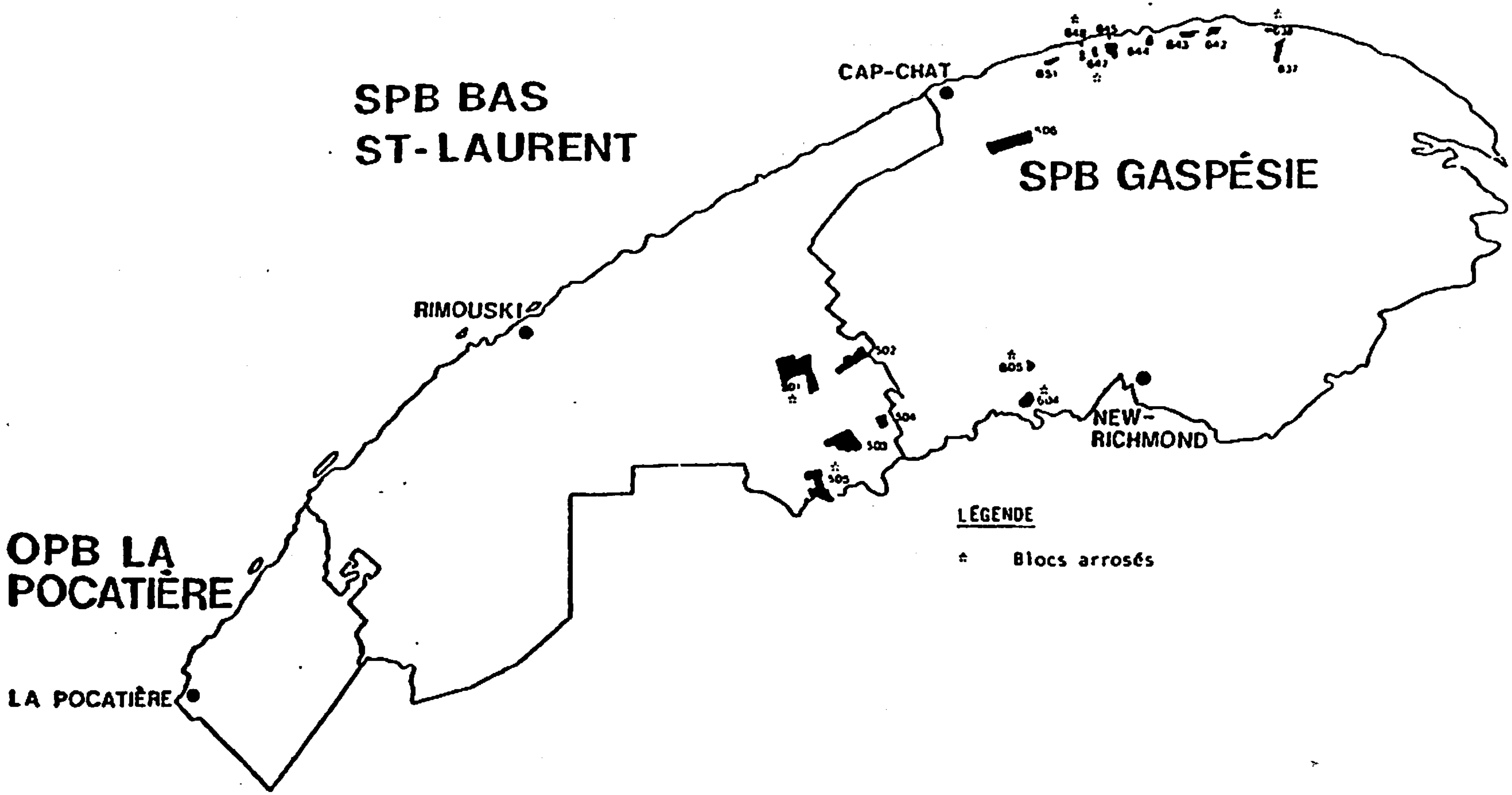
Nous avons utilisé des ballons gonflés à l'hélium dans les secteurs accessibles par route et un hélicoptère Hughes 500-C^{md} dans les autres cas.

BILAN DES SUPERFICIES TRAITÉES

Les pulvérisations se sont déroulées du 31 mai au 13 juin inclusivement sur 7 100 hectares (Figure 1). Le tableau 1 résume les informations concernant les superficies traitées. Ainsi, sur l'ensemble des superficies retenues à l'automne 1986, soit 15 530 ha, 8 430 hectares n'ont pas été traités. Les principales raisons motivant le retrait de cette superficie du programme d'arrosage ont été une insuffisance d'insectes au printemps et la contamination de certains lots de *B.t.* Effectivement, une mortalité hivernale importante dans certains secteurs, particulièrement sur la rive nord de la Gaspésie, a amené le retrait de plusieurs blocs du programme. Par ailleurs, la direction du Service canadien des forêts, à Québec, a interdit l'utilisation des lots de *B.t.* contaminés, compte tenu du caractère particulier de la forêt privée et de nos engagements vis-à-vis les propriétaires. Par ailleurs, notons que le programme de 1987 a touché quelque 398 propriétaires de boisés qui avaient tous reçu leur certificat d'autorisation du ministère de l'Environnement du Québec.

Programme de pulvérisation de B.t. en forêt privée dans l'Est du Québec-1987

Figure 1: Localisation des blocs du programme de pulvérisation du Plan de développement de l'Est du Québec, 1987.



PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1987

TABLEAU 1 - BILAN DES SUPERFICIES TRAITÉES ET NON TRAITÉES

BLOC	SUPERFICIE (HA)			RAISON DE L'ÉCART	SUPERFICIE (HA)	EXPLICATION
	RETENUE AUTOMNE 1986	AJOUTÉE OU ÉLIMINÉE	RETENUE PRINTEMPS 1987		TRAITÉE	
			B A S S A I N T - L A U R E N T			
501	4 100	0	4 100	Secteur propice à l'arrosage	1 347	1+2
502	1 000	+ 100	1 100	Secteur propice à l'arrosage	0	1
503	1 100	+ 100	1 200	Secteur propice à l'arrosage	0	2
504	200	+ 100	300	Secteur propice à l'arrosage	0	1
505	3 000	+ 1 400	4 400	Secteur propice à l'arrosage	3 858	3
506	600	+ 600	1 200	Secteur propice à l'arrosage	0	2
TOTAL Bas St-Laurent	10 000	+ 2 300	12 300		5 205	
			G A S P É S I E			
604	700	+ 330	1 030	Remesurage du bloc	810	3
605	340	- 55	285	Coupes de bois	285	
637	200	+ 15	215	Remesurage du bloc	0	1
638	300	+ 5	305	Remesurage du bloc	250	3
642	770	+ 40	810	Secteur propice à l'arrosage	0	1
643	780	0	780		0	1
644	330	+ 10	340	Remesurage du bloc	0	1
645	900	- 130	770	Coupes de bois	0	1
647	350	- 70	280	Remesurage du bloc	190	1
648	360	0	360		360	
651	500	+ 140	640	Remesurage du bloc	0	1
TOTAL Gaspésie	5 530	+ 293	5 815		1 895	
GRAND TOTAL	**15 530**	**+ 2 593**	**18 115**		**7 100**	

1 Bas niveau des populations d'insectes
2 Manque d'insecticide
3 Conditions météorologiques défavorables

RÉSULTATS

Dispersion

Un réseau de boites de Pétri contenant de la gélose nutritive, disposées à tous les 30 mètres, a permis d'évaluer le nombre de gouttelettes de mélange tombées au sol par cm^2, exprimé en nombre de colonies de B.t./cm^2. Au stade opérationnel, on cherche à couvrir uniformément la superficie traitée d'un dépôt minimal au sol de 6 colonies par centimètre carré. La dispersion a été évaluée sur cinq (5) blocs (505-604-638-647 et 648) et les normes minimales ont été atteintes dans chaque cas.

Mortalité larvaire

Les populations pré-traitement étaient particulièrement importantes dans la partie sud de la Vallée de la Matapédia (bloc 505), atteignant en moyenne 28,8 larves par branche de 45 cm avec une culmination à 90,0 larves/45 cm. L'efficacité du traitement établi suivant la formule d'Abbott a été de 42,2 %. Dans le même secteur, la mortalité intermédiaire (15 jours après le traitement) dans les parcelles traitées fut de 67,0 % et de 43,0 % dans les parcelles témoins. Le deuxième secteur en importance pour la population larvaire a été celui de Nouvelle (bloc 605) avec 27,0 larves par branches de 45 cm. Dans ce même secteur, l'efficacité du traitement a atteint 64,2 %. La mortalité larvaire intermédiaire fut de 73,3 % dans le secteur traité par rapport à 25,5 % dans les témoins (tableau 2).

Défoliation de la pousse annuelle

Dans la Vallée de la Matapédia (bloc 505), la défoliation de la pousse annuelle dans les parcelles traitées par rapport aux témoins fut de 34,9 % et 71,8 % respectivement. Ces mêmes valeurs sont de 22,0 et 35,3 % dans le secteur de Nouvelle en Gaspésie (Tableau 2). Dans les autres secteurs, les pulvérisations ont maintenu un écart appréciable entre traités et témoins mais le bas niveau de population a rendu le rendement des traitements moins significatif.

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1987

TABLEAU 2 - MORTALITÉ LARVAIRE, EFFICACITÉ DU TRAITEMENT ET DÉFOLIATION

NO. DU BLOC	PARCELLE ÉCHANTILLON	POPULATION PRÉTRAITEMENT larves/branche	POPULATION INTERMÉDIAIRE larves/branche	Mortalité (%)	Efficacité (%)	POPULATION RÉSIDUELLE Larves/branche	Mortalité (%)	DÉFOLIATION 1987 (%)
				BAS ST-LAURENT				
501	traitée	11,0	2,7	67,5	48,1	0,1	98,3	10,1
	témoin	2,3	2,1	75,0	-	0,4	71,4	10,5
505	traitée	32,0	8,5	67,0	42,2	3,4	85,7	34,9
	témoin	17,1	9,6	43,0	-	3,9	76,9	71,8
				GASPESIE				
604	traitée	10,8	2,0	80,0	48,1	0,8	92,0	7,3
	témoin	7,8	3,0	61,5	-	0,8	89,7	15,9
605	traitée	27,0	7,2	73,3	64,2	2,6	90,4	22,0
	témoin	11,9	6,9	25,5	-	3,2	57,3	35,3
638	traitée	10,8	3,2	70,0	56,3	0,4	96,3	6,2
	témoin	3,2	2,2	31,3	-	0,2	93,8	7,2
647	traitée	11,5	2,5	73,9	70,9	0,0	100,0	11,7
	témoin	6,2	4,9	20,0	-	0,7	84,2	9,8
648	traitée	11,0	0,1	95,5	82,0	0,0	100,0	11,0
	témoin	1,0	0,2	75,0	-	0,0	100,0	2,6

Coûts du programme

Le coût total du programme 1987, excluant l'inventaire d'automne, a été de 433 610$ au total, ce qui représente 61,07$ par hectare traité (Tableau 3). Toutefois, ce dernier chiffre est loin de correspondre au coût unitaire réel de l'opération puisqu'il a été considérablement influencé par le retrait de 8 430 hectares du programme en raison d'une faible population d'insecte au printemps et d'un manque de B.t. exempt de contaminant. Pour obtenir le coût unitaire, il faut tenir compte du nombre d'hectares planifiés faisant l'objet des contrats, soit 15 530 ha. Ainsi, on obtient un coût unitaire de 34,68$/ha. Par ailleurs, le tableau 3 nous informe sur le pourcentage des coûts afférents à chaque phase du programme. On note, entre autre, que les coûts directs de l'opération sont responsables de 66,4 % des coûts totaux.

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1987

TABLEAU 3 - ANALYSE DES COÛTS

SUPERFICIES TRAITÉES	OPB LA POCATIÈRE Coûts $	BAS ST-LAURENT Coûts $	SPB GASPÉSIE Coûts $	Coûts totaux $	Répartition des coûts %	Coût/ha traité (7 100 ha)	Coût/ha planifié (15 530 ha)
1. Coûts sociaux							
- information, recrutement et demande de permis	----	13 990	9 480	23 470	5,4	3,32	1,51
- impression et distribution des rapports (estimé)	9 340	11 610	2 390	23 340	5,3	3,28	1,50
SOUS-TOTAL	9 340	25 600	11 870	46 810	10,7	6,60	3,01
2. Coûts directs de l'arrosage							
- avion	----	64 840	22 880	87 720	20,3	12,36	7,76
- produit	----	57 550	20 460	78 010	17,9	10,99	8,97
- calibration, balisage, plan de mélange, radio mobile	----	71 070	50 550	121 620	28,2	17,12	8,54
SOUS-TOTAL	----	193 460	93 890	287 350	66,4	40,47	25,27
3. Suivi biologique et encadrement							
- phase préarrosage	----	8 060	5 620	13 680	3,2	1,92	0,88
- phase postarrosage	----	12 970	6 740	19 710	4,6	2,77	1,27
- laboratoire	28 960	----	----	28 960	6,6	4,08	1,86
SOUS-TOTAL	28 960	20 930	12 360	62 250	14,4	8,77	4,01
TOTAL	38 300	239 990	118 120	396 410	91,5	55,84	32,29
4. Coûts internes SCF				30 000	6,9	4,22	1,93
Section foresterie							
Inform. & communication				7 200	1,6	1,01	0,46
GRAND TOTAL				433 610	100,0	61,07	34,68

CONCLUSION

L'analyse des résultats obtenus pour l'ensemble du programme démontre que celui-ci a rencontré les objectifs fixés au départ.

Ainsi, les défoliations et les mortalités larvaires observées dans les blocs traités confirment que les territoires pulvérisés ont bénéficié d'une meilleure protection du feuillage et une diminution des populations larvaires.

Une inspection des blocs à faibles populations ayant été mis à l'écart du programme a démontré qu'ils n'ont pas subi de dommages marqués, confirmant ainsi la justesse de nos décisions. Ces retraits ont d'ailleurs fourni aux OPB/SPB l'opportunité de compléter le programme en presque totalité dans les secteurs à fortes populations, malgré le déficit en insecticide qui n'aurait pas permis le traitement de tous les blocs si les populations s'étaient maintenues au niveau initialement appréhendé.

Les différentes étapes de l'opération se sont en général bien déroulées. Bien que des conditions météorologiques défavorables aient ralenti l'exécution du programme sans entraîner toutefois de délais majeurs.

En terminant, il faut bien conserver à l'esprit que nous travaillons dans les derniers boisés privés vivants de la Gaspésie et du Bas-Saint-Laurent, d'où l'importance d'une intervention rapide. La vigueur et le niveau élevé des populations dans la partie au sud de la Vallée de la Matapédia et près de Nouvelle suscitent de nombreuses inquiétudes car une expansion de ces foyers signifierait le retour en force de l'épidémie de tordeuse et sans un programme de protection efficace, une perte considérable du potentiel de résineux en forêt privée.

AERIAL SPRAYING WITH *__BACILLUS THURINGIENSIS__* *ON PRIVATE WOODLOTS IN EASTERN QUEBEC*

1987, Season

OTTAWA, NOVEMBER 17-19, 1987

PRESENTED AT THE FIFTEENTH ANNUAL

INSECT PEST CONTROL FORUM

ANDRE JUNEAU

CANADIAN FORESTRY SERVICE

FOREST DEVELOPMENT BRANCH

P.O. BOX 10 225, SAINTE-FOY

QUEBEC, GIV 4H5

INTRODUCTION

The private forest of eastern Quebec has been seriously affected by spruce budworm outbreaks. In trying to answer repeated requests from private woodlot owners in eastern Quebec, the Canadian Forestry Service (CFS) developed a protection program through the Eastern Quebec Development Plan, Forest Program. Three Wood Producer Associations from the region agreed to carry out the program.

Two phases of the program were carried out: an experimental spraying with *Bacillus thuringiensis* (*B.t.*) over 3 800 hectares in 1984, which aimed at developing methods, and two operational dispersions over 30 925 hectares in 1985 and 14 629 hectares in 1986.

The present paper summarizes the 1987 spraying program conducted over 7 100 hectares.

MATERIAL AND SERVICES

The experience acquired during the previous years suggested the use of the following material and services.

Insecticides

The *Bacillus thuringiensis* preparation Futura[R] from Chemagro Limited, Mississauga, Ontario.

The dosage used was 2.5 litres/ha:

1.5 litre of Futura[R]

1.0 litre water

1.56 mL Chevron sticker[R]

Aircrafts

Two AgCats[R], 450 H.P., supplied by Agric-Air Inc., Ste. Cecile de Milton, Quebec.

Mix plants

A mobile unit was kindly supplied by the Quebec Department of Energy and Resources. The Wood Producer Association of the Lower St. Lawrence used its own mixing plant.

Spray system

Boom and 24 nozzles (Teejet Flat Fan 8004).

Navigation system

Helium-inflated balloons were used where road access was available. Otherwise, a Hughes 500-C[R] helicopter was used.

TREATED AREA

Some 7 100 ha were treated between May 31 and June 13 1987 inclusively (Figure 1). Table 1 summarises the information on the area treated. Of the 15 530 ha proposed for treatment the previous fall, some 8 430 ha were not treated. The main reasons for withdrawing these areas from the program were lower insect population than expected in the spring and contamination of several B.t. lots. Winter mortality was high in some regions, especially on the northern side of the Gaspe Peninsula, allowing us to evaluate several spray blocks in this region. Also, the regional directorate of the CFS in Quebec did not authorized the use of contaminated lots of B.t. because of the particular character of the private forest and our commitment to owners. The 1987 program involved 398 woodlot owners.

RESULTS

Deposit

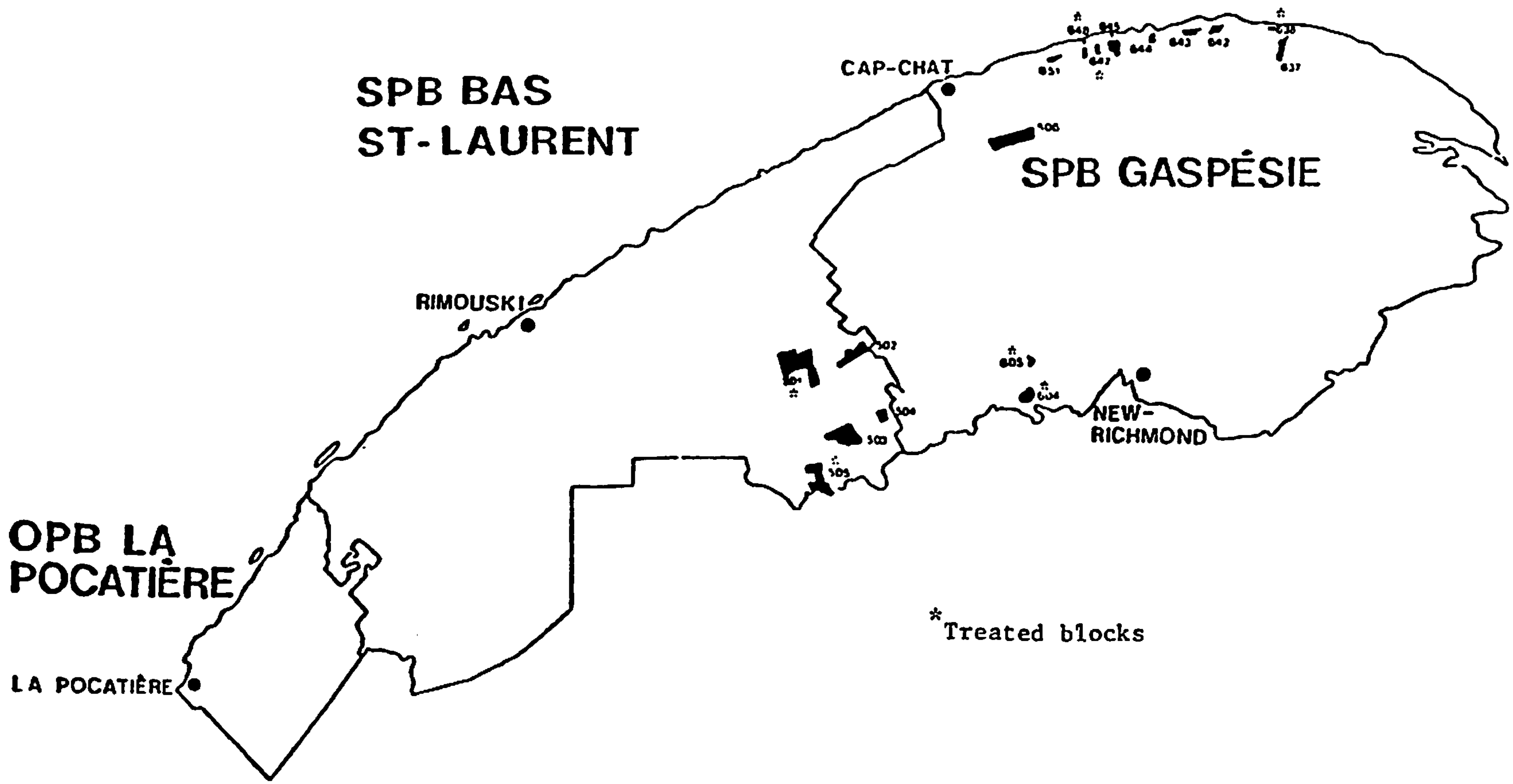
Petri dishes containing nutrient agar medium placed at every 30 m on lines perpendicular to flight paths were used to determine deposit in terms of number of droplets/cm^2, which corresponds to the number of colonies/cm^2. During an operation, the target was a minimum of 6 colonies/cm^2 throughout the sprayed territory. Deposit assessment was done on 5 blocks (505, 604, 638, 647 and 648) and the minimum deposit was obtained each time.

Larval mortality

Pretreatment populations were particularly important in the southern part of the Matapedia River Valley (block 505), reaching 28.8 larvae/45 cm branch

Treatment Program with B.t. on Private Woodlots in Eastern Quebec

Figure 1: Localization of treated blocks.



TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1987

TABLE 1 - A SUMMARY OF THE TREATED AND UNTREATED AREA

BLOCK	AREA (HA)			REASONS FOR THE DEVIATION	AREA (HA)	REASON
	PROPOSED FALL 1986	ADDED OR SUBSTRACTED	PROPOSED SPRING 1987		TREATED	
LOWER ST. LAWRENCE						
501	4 100	0	4 100	Area needing treatment	1 347	1+2
502	1 000	+ 100	1 100	Area needing treatment	0	1
503	1 100	+ 100	1 200	Area needing treatment	0	2
504	200	+ 100	300	Area needing treatment	0	1
505	3 000	+ 1 400	4 400	Area needing treatment	3 858	3
506	600	+ 600	1 200	Area needing treatment	0	2
TOTAL Lower St-Lawrence	10 000	+ 2 400	12 300		5 205	
GASPE PENINSULA						
604	700	+ 330	1 030	Block measurement	810	3
605	340	- 55	285	Total cuts	285	
637	200	+ 15	215	Block measurement	0	1
638	300	+ 5	305	Block measurement	250	3
642	770	+ 40	810	Area needing treatment	0	1
643	780	0	780		0	1
644	330	+ 10	340	Block measurement	0	1
645	900	- 130	770	Total cuts	0	1
647	350	- 70	280	Block measurement	190	1
648	360	0	360		360	
651	500	+ 140	640	Block measurement	0	1
TOTAL Gaspé	5 530	+ 293	5 815		1 895	
GRAND TOTAL	**15 530**	**+ 2 593**	**18 115**		**7 100**	

1 Low insect population level
2 Insecticide shortage
3 Unfavourable meteorological conditions

tip in average with a peak at 90.0 larvae/45 cm. Treatment efficiency determined with the Abbott formula was 42.2 %. In the same area, intermediate larval mortality (15 days after treatment) was 67.0 % in treated plots and 43.0 % in untreated ones. The second highest pretreatment larval population was registered in Nouvelle (block 605) with 27,0 larvae/45 cm branch tip. Treatment efficiency was 64.2% and intermediate larval mortality 73.3 % in treated and 25.5 % in untreated plots (Table 2).

Current year growth defoliation

In the Matapedia River Valley area current year growth defoliation was 34.9 % in treated plots and 71.8 % in untreated ones. The same values were 22.0 and 35.3 % in the Nouvelle area (Table 2). In the other areas, there was a valuable difference between defoliation in treated and untreated plots. However, the lower population levels in these areas have made the treatment effects less significant.

Information on program costs

The final cost of the 1987 spray program, excluding the fall survey, reached $433 610, which represents $61.07 per treated hectare (Table 3). However, this figure is far from representing the real cost per unit since cost was considerably affected by the withdrawal of 8 430 hectares because of low insect populations and contaminated B.t.. Thus, the cost per unit should be established using the planned area which had served for preparing the contracts; 15 530 hectares. Based on this, the cost per unit would be $34.68 per hectare. Also, table 3 outlines the costs relevant to each phase of the program. The spray operation was responsible for 66.4 % of the total costs.

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1987

TABLE 2 - LARVAL MORTALITY, TREATMENT EFFICIENCY AND DEFOLIATION

BLOCK NO	SAMPLING PLOT	PRETREATMENT POPULATION larvae/branch	INTERMEDIATE POPULATION larvae/branch	Mortality (%)	Efficiency (%)	RESIDUAL POPULATION larvae/branch	Mortality (%)	DEFOLIATION 1986 (%)
			L O W E R S T. L A W R E N C E					
501	treated	11.0	2.7	67.5	48.1	0.1	98.3	10.1
	untreated	2.3	2.1	75.0	-	0.4	71.4	10.5
505	treated	32.0	8.5	67.0	42.2	3.4	85.7	34.9
	untreated	17.1	9.6	43.0	-	3.9	76.9	71.8
			G A S P E P E N I N S U L A					
604	treated	10.8	2.0	80.0	48.1	0.8	92.0	7.3
	untreated	7.8	3.0	61.5	-	0.8	89.7	15.9
605	treated	27.0	7.2	73.3	64.2	2.6	90.4	22.0
	untreated	11.9	6.9	25.5	-	3.2	57.3	35.3
638	treated	10.8	3.2	70.0	56.3	0.4	96.3	6.2
	untreated	3.2	2.2	31.3	-	0.2	93.8	7.2
647	treated	11.5	2.5	73.9	70.9	0.0	100.0	11.7
	untreated	6.2	4.9	20.0	-	0.7	84.2	9.8
648	treated	11.0	0.1	95.5	82.0	0.0	100.0	11.0
	untreated	1.0	0.2	75.0	-	0.0	100.0	2.6

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1987

TABLE 3 - COSTS ANALYSIS

TREATED AREA	OPB LA POCATIÈRE Costs $	BAS ST-LAURENT Costs $/ha	SPB GASPÉSIE Costs $	TOTAL COSTS $	COSTS REPARTITION %	COST/ TREATED HA (7 100 ha)	COST/ PLANIFIED HA (15 530 ha)
1. Social costs							
- information, recruting and request for authorization	-	13 990	9 480	23 470	5.4	3.32	1.51
- printing and distribution of the final reports	9 340	11 610	2 390	23 340	5.3	3.28	1.50
SUB-TOTAL	**9 340**	**25 600**	**11 870**	**46 810**	**10.7**	**6.60**	**3.01**
2. Treatment costs							
- aircraft	-	64 840	22 880	87 720	20.3	12.36	7.76
- product	-	57 550	20 460	78 010	17.9	10.99	8.97
- calibration, navigation, mix plant, mobile radio	-	71 070	50 550	121 620	28.2	17.12	8.54
SUB-TOTAL	**-**	**193 460**	**93 890**	**287 350**	**66.4**	**40.47**	**25.27**
3. Biological assessment and advice							
- pretreatment	-	8 060	5 620	13 680	3.2	1.92	0.88
- post-treatment	-	12 970	6 740	19 710	4.6	2.77	1.27
- laboratory	28 960	-	-	28 960	6.6	4.08	1.86
SUB-TOTAL	**28 960**	**20 930**	**12 360**	**62 250**	**14.4**	**8.77**	**4.01**
TOTAL	**38 300**	**239 990**	**118 120**	**396 410**	**91.5**	**55.84**	**32.29**
4. Internal costs CFS Forestry section				30 000	6.9	4.22	1.93
Inform. Communication				7 200	1.6	1.01	0.46
GRAND TOTAL				**433 610**	**100.0**	**61.07**	**34.68**

CONCLUSION

The results obtained showed that the spray program met its objectives. Defoliation in treated areas was considerably reduced when compared to untreated areas, particularly in high larval populations. Also, residual populations were much lower in treated areas.

Blocks with low populations, which were not retained in the spring, were not damaged by spruce budworm, confirming the decisions taken. These withdrawals provided the possibility for Wood Producer Associations to spray most of the areas with sufficient larval populations. If the insect population would have met original forecasts, the lack of insecticide, due to contamination of some lots, would have not permitted us to carry out the whole program.

The different phases of the program have been carried out with success. The adverse meteorological conditions encountered during spray period have delayed the operation, but without major effects.

It should be emphasized that we are working in the last living private woodlots of the Lower St. Lawrence and Gaspe regions which required a fast action. The vigour and high level of the spruce budworm populations in the Matapedia River and Nouvelle regions is of great concern since a major expansion of these centers would mean the return of the outbreak and loss of an important softwood potential in private woodlots if no protection program is carried out.

A SUMMARY of SPRUCE BUDWORM CONDITIONS in MAINE: 1987
presented to the Fall Meeting of the Eastern Spruce Budworm Council
by

Thomas Rumpf - Maine State Entomologist

INTRODUCTION

The spruce budworm infestation in Maine is at its' lowest level since 1969. Nearly the entire 1970's-80's outbreak area is now free of noticeable defoliation. Operational spraying has not been conducted since 1985 and none is planned for the foreseeable future. Host trees damaged by the outbreak are showing recovery in nearly all areas but scattered losses due to Stillwell's Syndrome and spruce bark beetle continue in some previously heavily damaged areas. The outbreak does not show any sign of resurgence at this time.

POPULATION LEVELS

The Maine budworm program has been scaled down to a point where large scale assessments of spring larval populations are no longer possible. Attempts were made in 1987 to collect larvae for parasite and microsporidian disease assessment but these surveys were discontinued after early larval reconnaissance showed a total lack of insects in all but southeastern Maine. Microsporidian assessment samples were collected in southeastern Maine where scattered moderate to heavy populations were found. The only noteworthy aspect of the 1987 larval assessment other than the lack of larvae in the north was a sharp decline in larval numbers in the southeast between the 4th and 6th instars. This observation is only supported by a small amount of data, but does correspond with similar observations made in parts of northern Maine in 1986 where the infestation has now collapsed.

DEFOLIATION SURVEY

The 1987 aerial and ground defoliation survey was greatly reduced due to the low larval populations found. A defoliation map showing moderate to severe defoliation was produced (Figure 1). The area of moderate to severe defoliation in 1987 was estimated to be 210,000 acres with an additional 40,000 acres of light defoliation detected during ground evaluations. The entire defoliated area is in the southeastern portion of the state. Defoliation was so variable that the boundaries of the defoliation area were determined, but no attempt was made to delineate each patch of damage within the area.

POPULATION PREDICTIVE SURVEYS

Most of the 1987 predictive survey was done with pheromone traps placed throughout the northern 2/3's of Maine. Pheromones were used because populations were expected to be too low for assessment with the L-II method. Moth catch was evaluated on over 250 locations and in most locations no moths were trapped (Figure 2). Obviously northern and central Maine budworm populations are very low or non-existent. Traps placed in the southeastern portion of the state did catch moths, but only 1 location caught more than a 100 moths per trap. A small number of L-II collections were made in the southeast. These collections showed a highly variable low to moderate L-II population.

HAZARD FORECAST

Without an active budworm population hazard predictions are quite meaningless. Hazard was calculated only for the residual population area in the southeast and was found to be relatively high but variable. The worst of the southeastern area still has high and extreme hazard, but this is less than 150,000 acres and is due mainly to past accumulated damage.

HOST MORTALITY

No host mortality surveys were conducted in 1987. Losses did increase in the southeast in small scattered areas, but losses due to past stress in the north seem to be much reduced. Stillwell's Syndrome losses were much reduced in 1987 compared to 1986.

ADMINISTRATIVE MATTERS

All Maine Forest Service personnel previously assigned to the Spruce Budworm Management Program have either been reassigned or cut with the last employees leaving the program in September. Many former budworm employees are now assigned to the Insect and Disease Management Division and much of Maine's budworm expertise remains in the Maine Forest Service.

All spray equipment has been sold. The Forest Service had intended to retain a core of spray equipment but, due to financial needs and a change in the mood of forest landowners who funded spray projects, the equipment was eventually sold.

The Maine Forest Service will attempt to keep current on budworm research and spray technology, especially through contact with the Eastern Spruce Budworm Council. Surveillance surveys and impact studies will continue and the Maine Forest Service has contracted with consultants to document the 70's outbreak in Maine.

SUMMARY of 1987 INFESTATION CONDITIONS

	CATEGORY	ACRES	1986-87 TREND
Defoliation	Moderate-Severe	0.21 Million	Down Sharply
Hazard	High-Extreme	0.13 Million	Down Sharply
1987 Population Prediction	High-Extreme	0.12 Million	Down Sharply
Host Mortality	25% or More Dead	0.3 Million	Unchanged

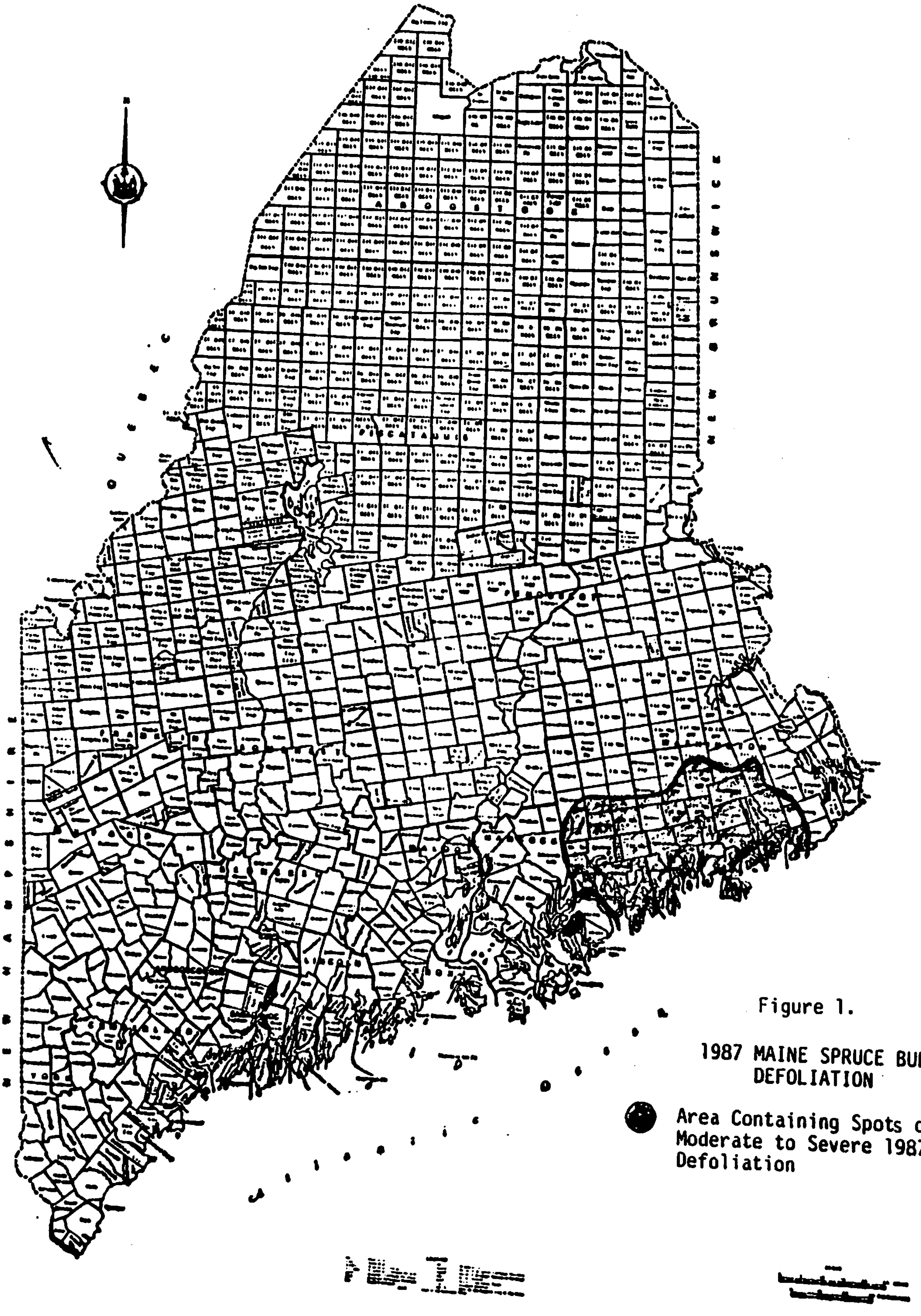


Figure 1.

1987 MAINE SPRUCE BUDWORM DEFOLIATION

Area Containing Spots of Moderate to Severe 1987 Defoliation

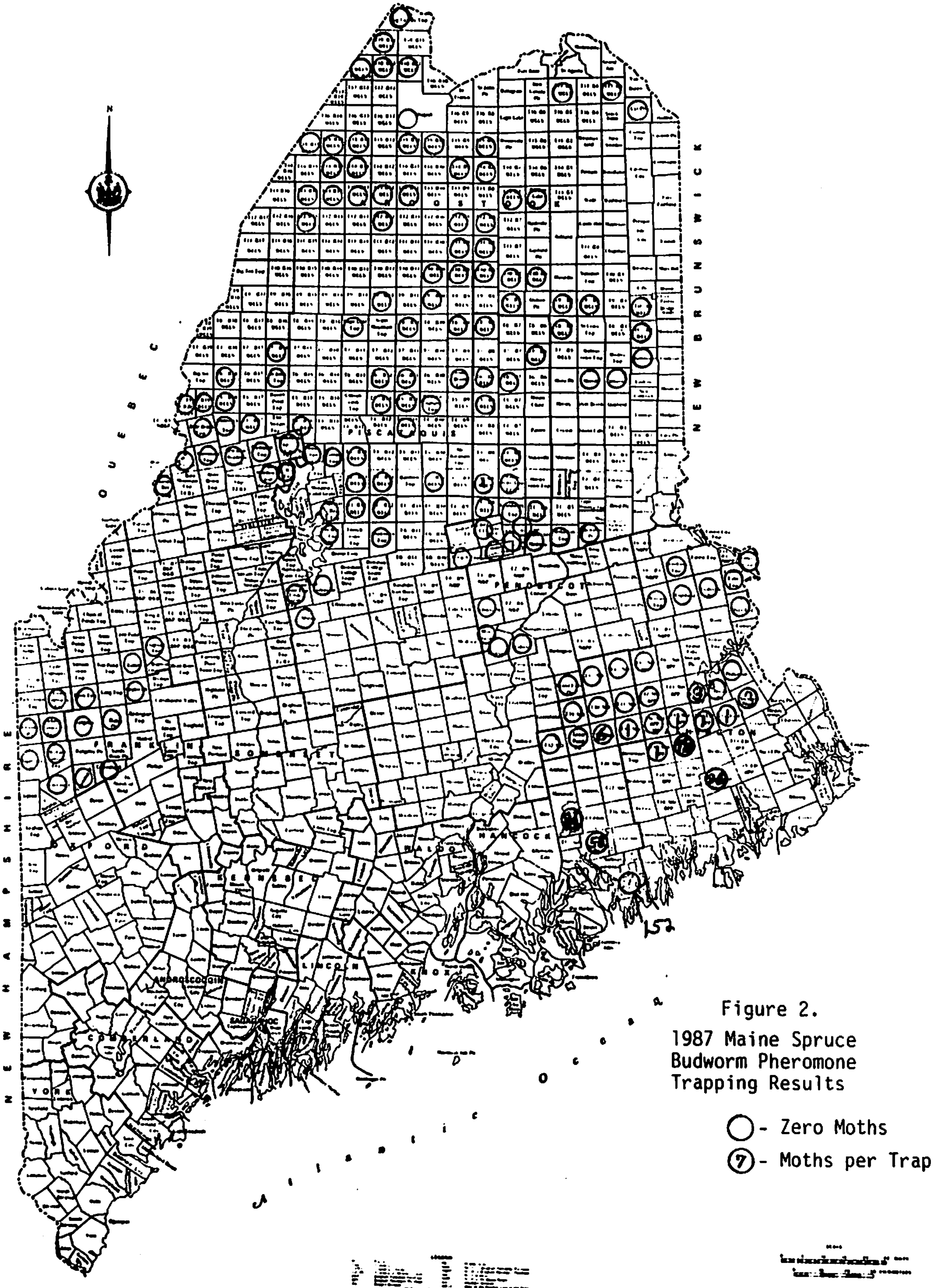


Figure 2.
1987 Maine Spruce Budworm Pheromone Trapping Results

SPRUCE BUDWORMS CONDITIONS IN THE UNITED STATES 1987

EASTERN SPRUCE BUDWORM

LAKE STATES

Eastern spruce budworm populations continued to decline throughout the Lake States area in 1987. Michigan and Wisconsin reported negligible defoliation while Minnesota reported 174,018 ha, a 2 percent decrease from defoliation reported in 1986. The current population collapse in Michigan and Wisconsin and a downward trend in Minnesota are expected to continue through 1988.

NORTHEAST

Extremely low spruce budworm populations continued throughout the Northeastern United States in 1987 and this trend is expected to continue through 1988. No defoliation was observed in New Hampshire, New York, or Vermont. In Maine, a total of 101,173 ha of defoliation (20,234 ha of light, 80,939 ha of moderate to severe) was reported in 1987, down from 248,820 ha in 1986. Pheromone trap catches of male moths were extremely low throughout the area.

No suppression was conducted in the Northeast in 1987 and none is planned for 1988.

WESTERN SPRUCE BUDWORM

REGION 1 (Northern Region)

Regionwide western spruce budworm defoliation declined from 1,018,500 ha in 1986 to 757,400 ha in 1987, representing the lowest level of defoliation reported since 1981.

Northern Idaho reported an increase of over 20,000 ha of budworm defoliation during 1987. The most significant increase was 6,000 ha of new damage on the Nez Perce National Forest , north of Riggins, Idaho. This is the first major defoliation increase in this area since the large outbreak of the 1970's. An increase in defoliation was reported on the Bitterroot National Forest and along the Montana border.

Presented by Peter W. Orr, Assistant Director, Northeastern Area, State and Private Forestry, USDA Forest Service, Broomall, Pennsylvania at the Forest Pest Forum, Ottawa, Ontario, November 18-19, 1987.

Damage throughout Montana in 1987 was well below the 1986 level, except for a small increase on the Bitterroot National Forest and the Flathead Indian Reservation.

In Yellowstone National Park, defoliation decreased from 3,200 ha in 1986 to 1,800 ha in 1987.

In 1988, defoliation is expected to increase in Southern Idaho and the Nez Perce National Forest. In Montana, the downward trend in defoliation is expected to continue through 1988. No suppression is planned in Idaho or Montana in 1988.

REGION 2 (Rocky Mountain Region)

Western spruce budworms populations declined for a fourth consecutive year in Colorado and Wyoming. An estimated 343,181 ha were visibly defoliated. No direct control projects were conducted on Federal lands in 1987 but some spraying, both aerial and ground, was conducted in mountain communities along the Front Range in Colorado.

The Douglas-fir beetle, _Dendroctonous pseudotsugae_, ia a continuing problem in areas that were heavily defoliated in the recent past. In some areas, the beetle is attacking trees which were not defoliated.years.

REGION 3 (Southwestern Region)

Western spruce budworm defoliation declined from 188,000 ha in 1986 to 120,200 ha in 1987. The downward trend of defoliation is expected to continue through 1988 in both New Mexico and Arizona.

A suppression project on the Carson National Forest in northern New Mexico treated 5,425 ha of National Forest and adjoining private lands with _B.t._ (Dipel 6L). Nine campgrounds within the project area were also treated with a combination of ground applications of _B.t._ and acephate systemic tree implants.

No suppression of western spruce budworm is anticipated in Mexico or Arizona in 1988.

REGION 4 (Intermountain Region)

Throughout the Region, conifers on 353,560 ha were defoliated by western spruce budworm in 1987. This is a decrease of about 916,000 ha from the 1,269,500 ha of defoliation reported in 1986.

A State by State breakdown of the 1987 defoliation indicates 337,700 ha in southern Idaho, 15,300 ha in Utah, and 560 ha in western Wyoming.

The downward trend in western spruce budworm defoliation which began in 1986 is expected to continue through 1988.

No suppression is currently being considered in 1988 as long as the downward trend in defoliation continues.

REGION 5 (Pacific Southwest Region)

The Modoc budworm (*C. retiniana*) defoliation of white fir in northern California declined from 20,235 ha in 1986 to 10,000 ha in 1987.

Since the 1985 collapse of western spruce budworm, the Modoc budworm populations have continued at endemic levels through 1987 and are expected to remain low in 1988.

REGION 6 (Pacific Northwest Region)

Defoliation by the western spruce budworm continued to expand in 1987. Early estimates indicate about 2,225,800 ha of defoliation, up from the 1986 total of 202,350 ha. Seventy-five percent of the defoliation was reported from Oregon with the remainder in Washington.

In 1987, western spruce budworm suppression projects involved the treatment of 17,807 ha in Washington and 38,247 ha in Oregon, with the biological insecticide *B.t.* Field sampling indicated very good results were obtained.

Plans are currently underway for a *B.t.* suppression project in 1988 that may involve treatment of 263,051 ha, with *B.t.* About 95 percent of the effort will be directed toward hard-hit areas in Oregon. A pilot test of various *B.t.* formulations involving on about 20,200 ha is in the planning stages.

REGION 10 (Alaska Region)

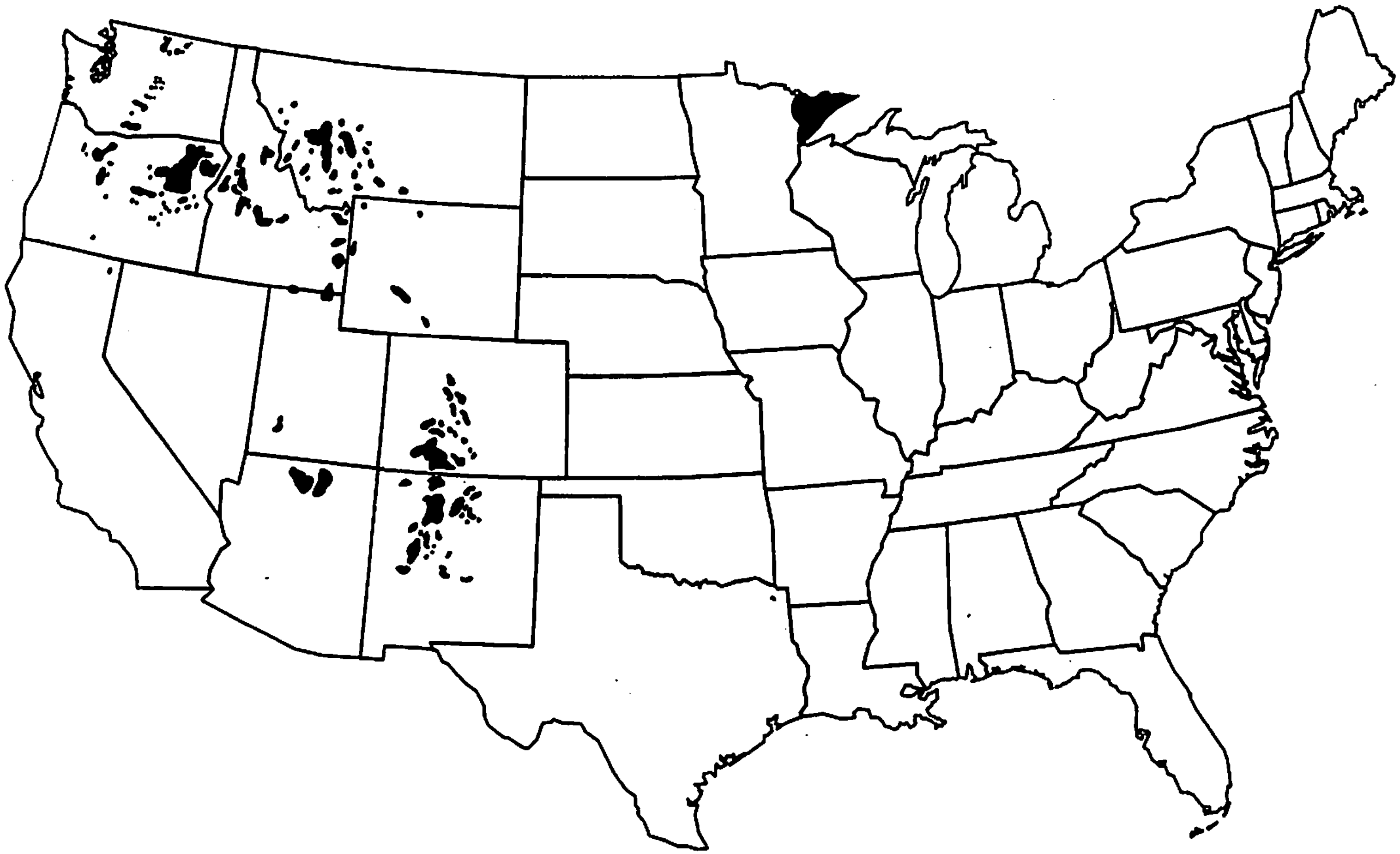
In southcentral Alaska, budworm (*C. orae*) defoliation was reported in the Bodenheimer Bute area near Palmer (81 ha) and from the Copper Center area northeast of Anchorage (405 ha). Populations in both areas are expected to decline in 1988.

In southeast Alaska, budworm damage was minimal and populations are expected to remain at endemic levels through 1988.

ESTIMATED DEFOLIATION BY SPRUCE BUDWORMS
IN 1986 AND 1987

REGION/STATE	AREA DEFOLIATED 1986 (Hectares)	AREA DEFOLIATED 1987 (Hectares)
Eastern Spruce Budworm		
Lake States		
Michigan	628	0
Minnesota	176.000	174,018
Wisconsin	0	0
Northeast		
New Hampshire	0	0
New York	0	0
Maine	248,820	101,173
Vermont	0	0
Subtotal	425,448	275,191
Western Spruce Budworm		
R-1	1,018,500	757,400
R-2	400,000	343,181
R-3	188,000	120,200
R-4	1,269,500	353,560
R-5	20,235	10,000
R-6	2,225,850	2,225,800
R-10	97	486
Subtotal	5,122,182	3,810,627
Total	5,547,630	4,085,818

Spruce Budworm Defoliation – 1987



SPRUCE BUDWORM IN ONTARIO, 1987[1]

- Outbreak Status, 1987
- Forecasts, 1988
- Results of Spraying Operation, 1987

by

J.H. Meating[2], G.M. Howse[2] and R.A. Lessard[3]

[1] Report prepared for the Fifteenth Annual Forest Pest Control Forum, Ottawa, November 17-19, 1987.

[2] Canadian Forestry Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario.

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OUTBREAK STATUS 1987

Egg-mass surveys in 1986 indicated substantial reductions in the area of moderate-to-severe defoliation would likely occur in 1987, especially in the eastern portion of the infestation. Aerial surveys conducted in July, 1987, revealed significant reductions in the area and intensity of budworm defoliation in Hearst, Wawa, Geraldton, Terrace Bay and Thunder Bay districts (Table 1 and Figure 1). Overall a total of 7,189,763 ha of moderate-to-severe defoliation was mapped in Ontario in 1987, a reduction of 1,665,924 ha from the 1986 total of 8,855,687 ha.

Northeastern Ontario, consisting of the Northern and Northeastern regions, was completely free of budworm defoliation for the first time in many years. The same is true of southern Ontario with the exception of three very small pockets of defoliation totaling 350 ha in Bracebridge District.

Despite the decline in the size of the infestation in the North Central Region, more than 3.6 million ha of defoliation remained in 1987. Most of this defoliation (2.3 million ha) was found in an area stretching from the eastern portion of Thunder Bay District to the western part of Geraldton and Terrace Bay districts and from the shore of Lake Superior to the north shore of Lake Nipigon. Little defoliation was observed in the central and southern portions of Thunder Bay District. West of Thunder Bay District, the infestation was much the same as in 1986 with nearly 4.4 million ha of defoliation mapped in Kenora, Red Lake, Fort Frances, Ignace, Sioux Lookout, Dryden and Atikokan districts.

FORECASTS 1988

Spruce budworm egg-mass samples were collected from a total of 463 locations throughout the province in 1987. A comparison of egg-mass densities at 346 locations sampled in 1986 and 1987 shows an overall decrease of 47% (Table 2). This reduction in egg-mass densities is consistent in all regions of the province and, indeed, in all districts except Ignace and Red Lake in the Northwestern Region. These results indicate that further reductions in the total area of moderate-to-severe defoliation can be expected in 1988.

Spruce budworm populations are extremely low in southern Ontario and in the Northern and Northeastern regions, and little, if any, defoliation is expected in these areas in 1988. In the North Central Region, where egg-mass densities have declined an average of 55%, further reductions in the area of infestation are expected, especially east of Lake Nipigon in Geraldton and Terrace Bay districts. Here, defoliation levels in 1988 are expected to be generally light-to-moderate with pockets of heavy defoliation in some areas. Moderate-to-severe defoliation will likely continue in the area immediately west of Lake Nipigon and south of the lake to Black Bay. In Thunder Bay District the size and intensity of the infestation will continue to decline although heavy defoliation will likely persist

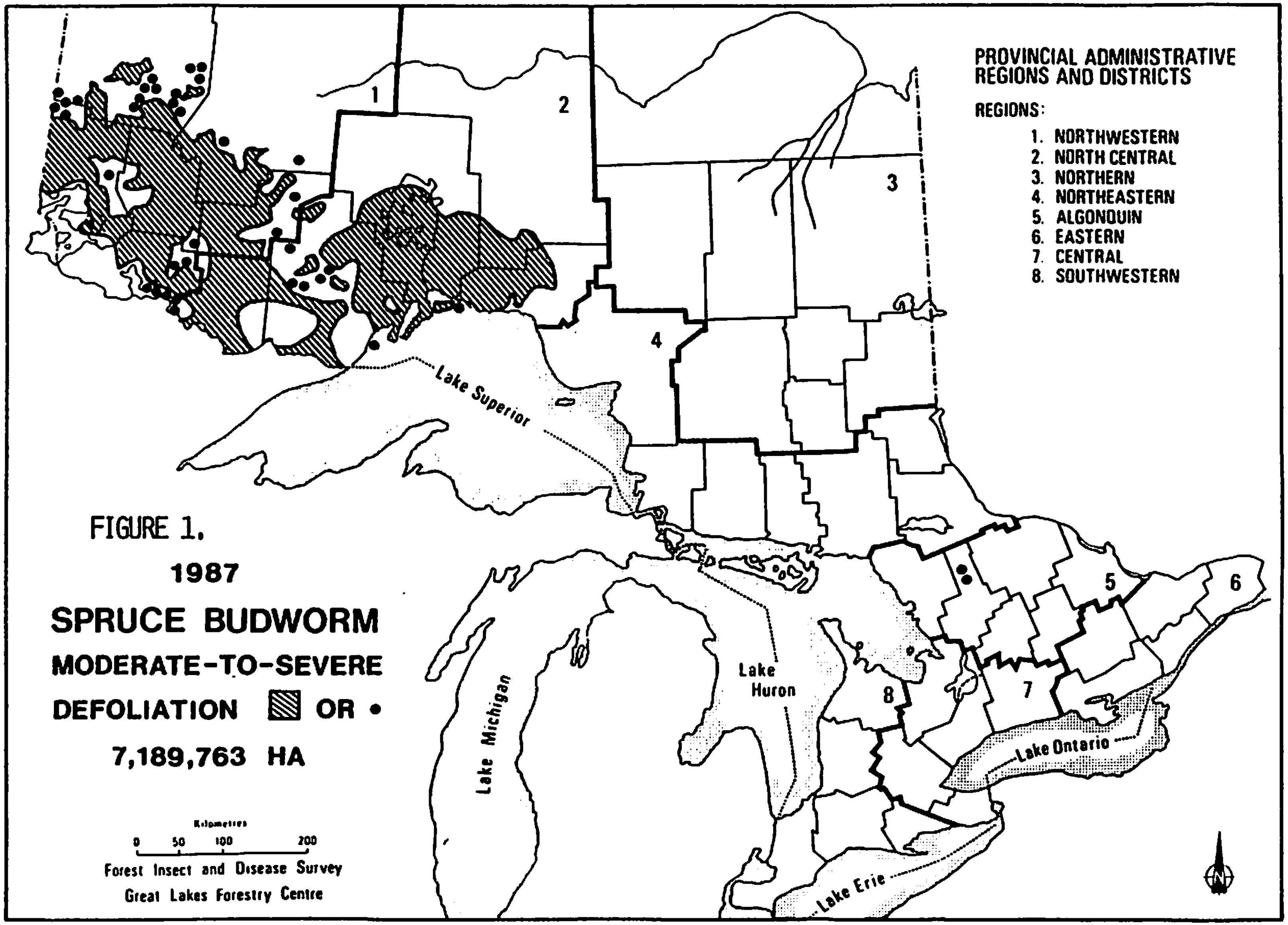

FIGURE 1.
1987
SPRUCE BUDWORM
MODERATE-TO-SEVERE
DEFOLIATION ▨ OR •
7,189,763 HA

Table 1. Gross area (ha) of current moderate-to-severe defoliation by spruce budworm in Ontario from 1984 to 1987.

Region District	Area of moderate-to-severe defoliation (ha) 1984	1985	1986	1987
Algonquin				
Bracebridge	28,606	720	436	350
Algonquin Park	44,234	800	206	0
	72,840	1,520	642	350
Northeastern				
Blind River	4,935	0	0	0
Espanola	42,278	1,980	408	0
North Bay	345,062	20,305	1,802	0
Sault Ste. Marie	30,255	7,875	0	0
Sudbury	250,483	105,805	455	0
Temagami	241,901	245	0	0
Wawa	1,288,475	1,386,547	11,839	0
	2,203,389	1,522,757	14,504	0
Northern				
Chapleau	0	6,120	70	0
Cochrane	85,358	600	0	0
Gogama	11,906	11,570	428	0
Hearst	784,202	1,173,734	32,384	0
Kapuskasing	6,827	0	0	0
Kirkland Lake	35,633	1,125	0	0
	923,926	1,193,149	32,882	0
North Central				
Atikokan	918,500	918,500	890,691	808,508
Geraldton	189,863	683,178	400,486	211,954
Nipigon	235,372	1,125,751	985,961	987,526
Thunder Bay	1,809,741	2,315,563	2,005,718	1,101,963
Terrace Bay	726,420	1,168,400	1,023,773	528,555
	3,879,896	6,211,392	5,306,629	3,638,506
Northwestern				
Dryden	454,099	952,385	891,997	835,308
Fort Frances	566,831	700,172	542,176	497,579
Ignace	456,526	599,895	530,761	584,322
Kenora	63,314	911,037	906,917	821,074
Red Lake	200	10	200,349	256,167
Sioux Lookout	126,831	240,048	428,830	556,457
	1,667,801	3,403,547	3,501,030	3,550,907
	8,747,852	12,332,365	8,855,687	7,189,763

around Lac des Milles Lacs, along the Minnesota border and in other scattered pockets in the district. Moderate-to-severe defoliation will probably continue in areas currently infested in the rest of northwestern Ontario and, in fact, some expansion of the infestation is possible south of Trout Lake in Red Lake District.

Table 2. Comparison of spruce budworm egg-mass densities in Ontario in 1986 and 1987.

OMNR Region	No. of locations sampled in 1987	No. of locations common to 1986 and 1987	Average egg-mass density per 9.29 m^2 1986	Average egg-mass density per 9.29 m^2 1987	% Change
Northwestern	147	98 (2)*	647	382	-41
North Central	220	160 (13)*	248	112	-55
Northern	47	39	17	1	-94
Northeastern	29	29	16	2	-89
Southern Ontario	20	20	7	5	-27
Overall	463	346	301	160	-47

* Includes 15 locations aerially sprayed with B.t. in 1987.

RESULTS OF SPRAYING OPERATIONS

In 1987, the Ontario Ministry of Natural Resources aerially sprayed a total of 76,689 ha in the North Central (76,526 ha) and Northwestern (163 ha) regions to protect stands of balsam fir and white spruce from spruce budworm defoliation. As in previous years, the 1987 program included commercial stands as well as "high value" stands such as provincial parks and plantations. All blocks were treated with single or double applications of Dipel 132 at rates of either 20 BIU/1.6L/ha or 30 BIU/2.3L/ha. Both fixed-wing aircraft and helicopter were used in this year's program. A small experimental program, 130 ha, was conducted at Sandbar Provincial Park in Ignace District, Northwestern Region, using Dipel 176 applied at a rate of 30 BIU/1.6L/ha.

Unseasonally warm and dry weather occurred throughout most of northern Ontario in April and early May (Fig. 2) thus raising the possibility of early budworm emergence and rapid development. However, shortly after emergence began in late April and early May weather conditions changed and were generally cooler than normal for the rest of May. Indeed, sub-zero temperatures accompanied by snow or freezing rain were observed in many areas across the north on May 22 and 23. This had the

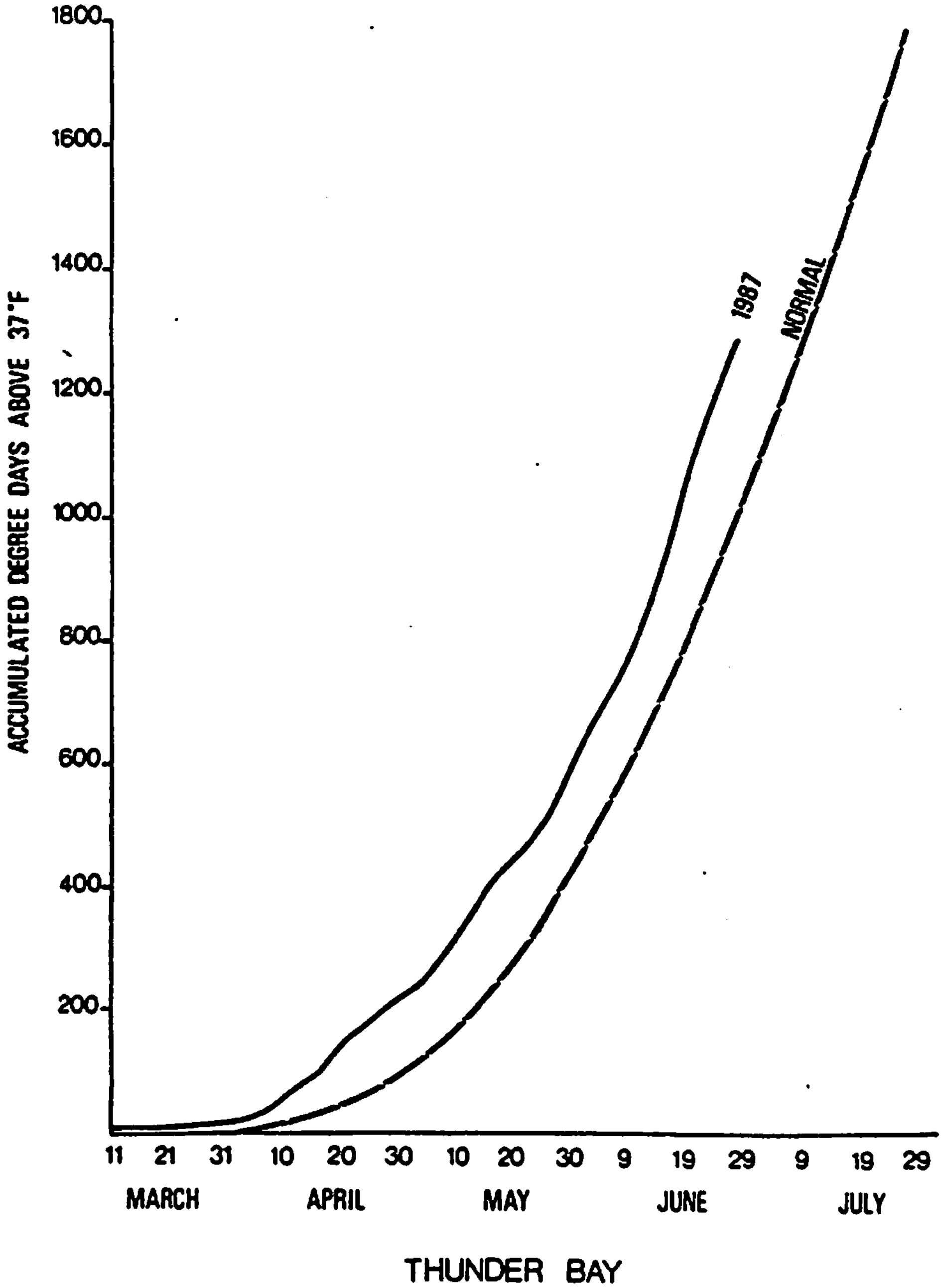

Figure 2. Heat accumulation in degree days for Thunder Bay, Ontario, 1987 (threshold 2.8°C).

effect of slowing budworm and host development throughout the region. The direct effects of the freezing temperatures on budworm larvae did not appear to be significant as most were still second and third instar and seemed to survive quite well. However, the indirect effects resulting from damage to the host foliage are much more difficult to assess and may not be evident for some time. Frost damage to the young balsam fir and white spruce shoots was extremely variable but in many locations more than 90% of the new shoots were killed.

Budworm and host development were most advanced in the northwest and spraying began at Ojibway Provincial Park in Sioux Lookout District on May 23. Spraying began on May 25 in western Thunder Bay District and all areas were open for spraying by June 1. The spruce budworm control program was completed June 13. Insect and host development curves from four locations in the North Central Region are presented in Figure 3.

Approximately 400 balsam fir and white spruce plots (five trees per plot) were established to assess the effectiveness of this year's spruce budworm spray program. Results, in terms of population reduction due to treatment and foliage protection are presented by spray block in tables 3 to 5. Average defoliation rates in sprayed and unsprayed plots are presented in Fig. 4. Generally, defoliation rates in spray plots were 50% less than those in check plots of comparable larval density. Survival rates (pooled data) in sprayed and unsprayed plots are presented in Table 6.

On the morning of May 24, 1987, some 130 ha of balsam fir stands in Sandbar Provincial Park, Ignace District, were treated with a single application of the experimental B.t. formulation Dipel 176. The material was applied at a rate of 30 BIU/1.6L/ha with a Bell 206 helicopter. Results and additional details of this experimental trial are presented in Table 7. In this instance this formulation proved to be highly effective in reducing larval populations and thereby limiting defoliation.

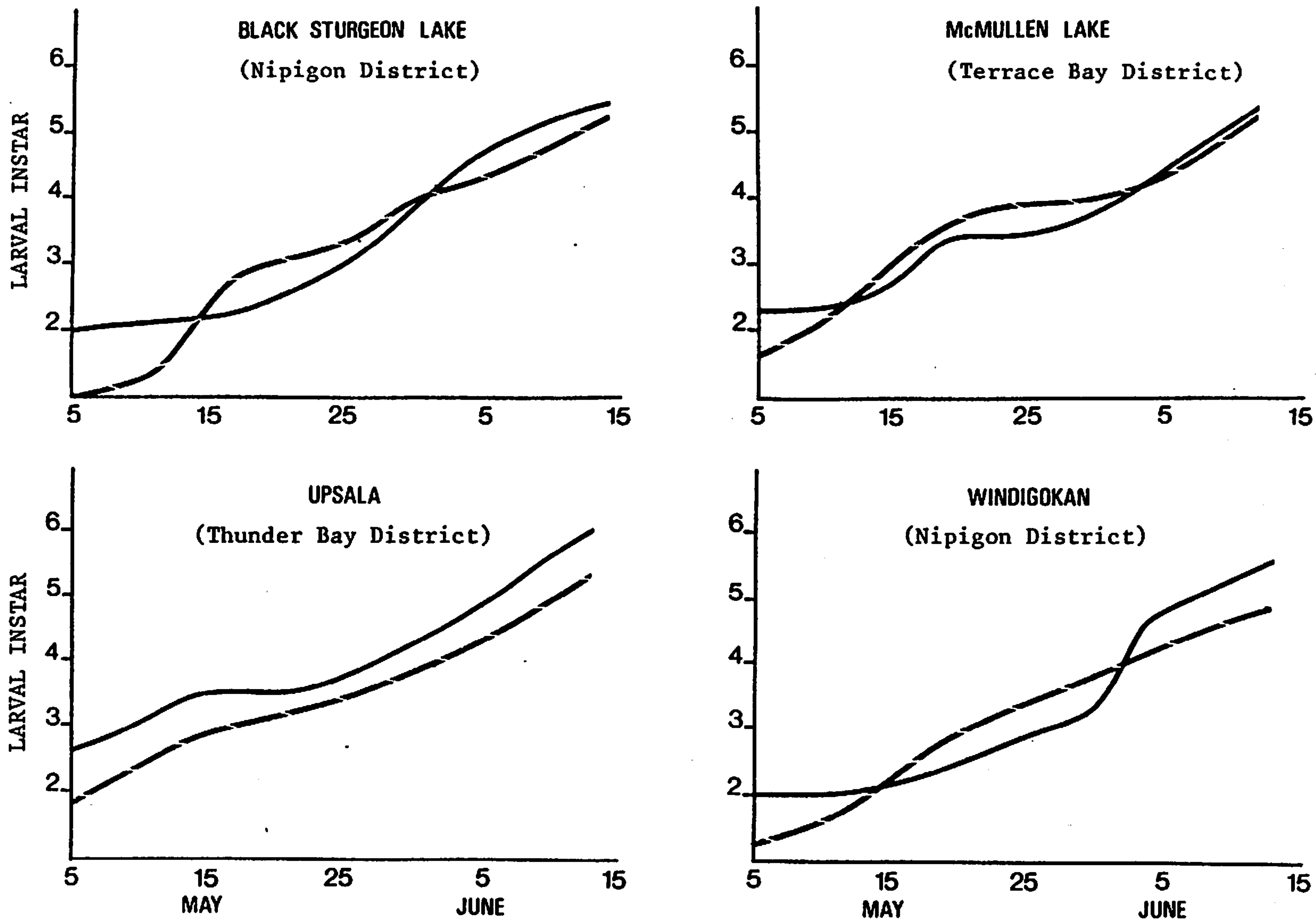

Figure 3. Spruce Budworm: Larval and balsam fir development rates in the North Central Region of Ontario, 1987.

(larvae _____, balsam fir __ __ __)

Table 3. Spruce Budworm: Population reduction and foliage protection attributable to the aerial application of Dipel 132 in Nipigon District, North Central Region, 1987.

Location	Host	Prespray larvae per 46 cm branch tip	Population reduction due to treatment (%)	1987 defoliation (%)
Cameron Falls Block-0	bF	28.2	66	46
Checks		25.8		74
Cameron Falls Block-0	wS	55.7	0	61
Checks		59.3		74
Sandra Twp Block -9	wS	5.0	0	16
Checks		7.5		19
Windigokan Block-10	bF	5.5	80	23
Checks		5.5		33
Windigokan Block-10	wS	15.8	94	15
Checks		15.7		43
Block-13	bF	3.2	100	21
Checks		2.9		26
Block-13	wS	5.0	33	4
Checks		7.5		19
Block-14	bF	3.4	87	16
Checks		2.9		26
Nonwatin Block-C	bF	20.4	99	15
Checks		22.2		73
Nonwatin Block-C	wS	63.9	49	37
Checks		59.3		74
Nonwatin Block-D	bF	21.5	87	32
Checks		22.2		73
Nonwatin Block-D	wS	52.1	73	37
Checks		50.1		62
Nonwatin Block-E	bF	16.4	70	26
Checks		17.5		67
Nonwatin Block-E	wS	48.9	57	48
Checks		50.1		62

(cont'd)

Table 3. Spruce Budworm: Population reduction and foliage protection attributable to the aerial application of Dipel 132 in Nipigon District, North Central Region, 1987 (concl.)

Location	Host	Prespray larvae per 46 cm branch tip	Population reduction due to treatment (%)	1987 defoliation (%)
Blacksands Prov. Pk	bF	9.7	83	41
Checks		9.7		65
Blacksands Prov. Pk	wS	14.2	49	29
Checks		14.4		45
Black Sturgeon	bF	14.5	84	20
Checks		14.3		68
Black Sturgeon	wS	31.6	65	50
Checks		31.1		69
Black Sturgeon South	bF	8.4	89	5
Checks		8.3		48
Black Sturgeon South	wS	19.0	64	22
Checks		20.1		62
Black Bay Block-S	bF	3.0	47	10
Black Bay Block-U	bF	2.7	86	6
Black Bay Block-V	bF	3.2	91	6
Black Bay Block-W	bF	3.5	0	8
Checks	bF	2.9		26

Table 4. Spruce Budworm: Population reduction and foliage protection attributable to the aerial application of Dipel 132 in Thunder Bay District, North Central Region, 1987.

Location	Host	Prespray larvae per 46 cm branch tip	Population reduction due to treatment (%)	1987 defoliation (%)
Athelstane N.	bF	6.3	86	5
Checks		6.2		58
Athelstane N.	wS	9.4	100	5
Checks		9.7		35
Disraeli Lake	bF	13.2	90	42
Checks		13.6		56
Disraeli Lake	wS	46.0	75	53
Checks		42.1		72
Muskrat Lake	bF	8.4	96	8
Checks		8.2		46
Muskrat Lake	wS	23.3	96	20
Checks		22.4		65
Kearns Lake E.	bF	6.1	82	23
Checks		6.2		58
Kearns Lake E.	wS	12.9	74	18
Checks		13.2		36
Eaglehead Lake	bF	8.6	56	27
Checks		8.7		60
Eaglehead Lake	wS	21.9	51	26
Checks		22.4		65
Sibley Prov. Pk	bF	19.8	45	17
Checks		20.0		42

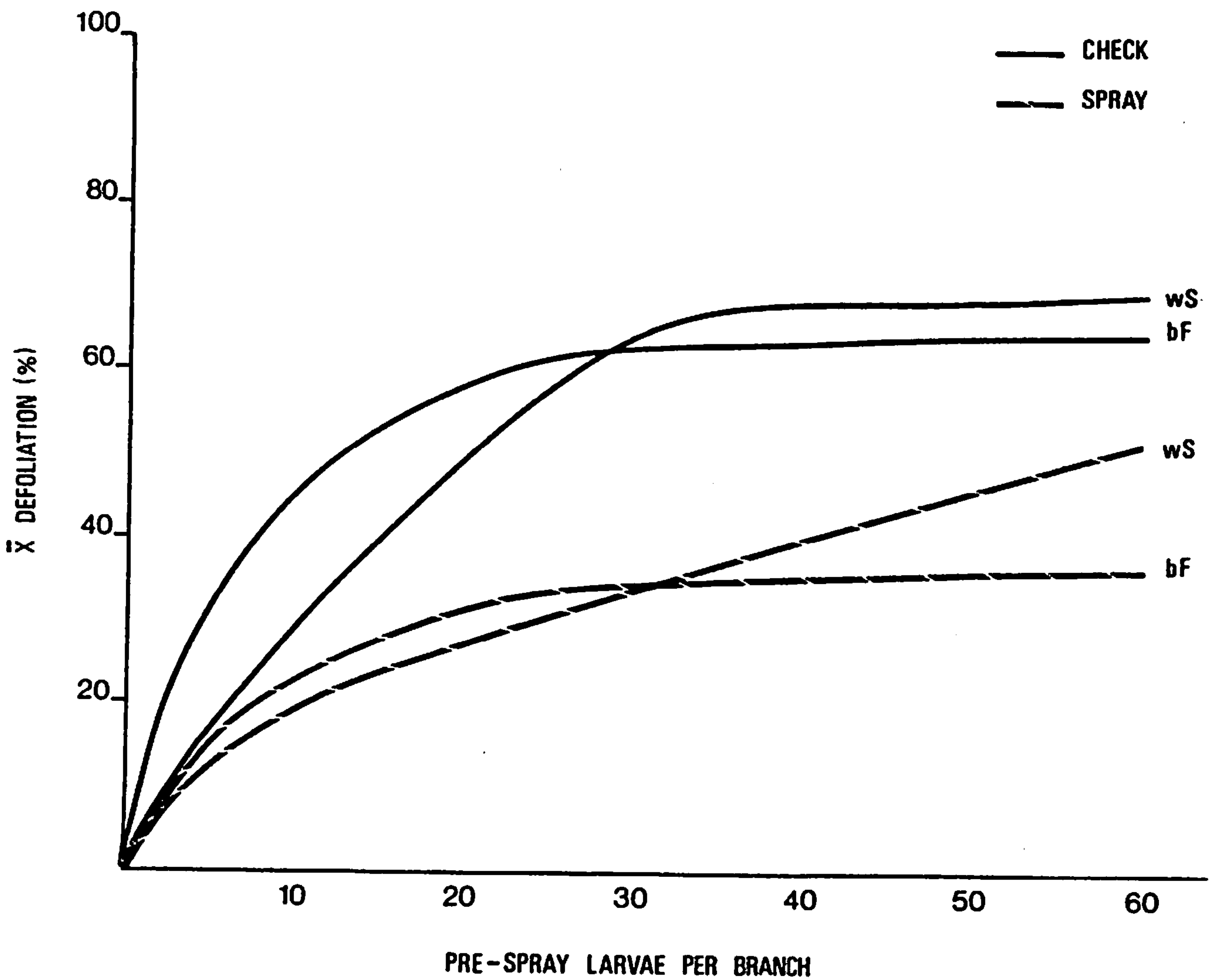

Figure 4. Spruce Budworm: Defoliation on balsam fir (bF) and white spruce (wS) in sprayed and unsprayed check plots in the North Central Region of Ontario, 1987.

Table 5. Spruce Budworm: Population reduction and foliage protection attributable to a single application of Dipel 132 on balsam fir in Sioux Lookout District, Northwestern Region, 1987.

Location	Prespray larvae per 46 cm branch tip	Population reduction due to treatment (%)	1987 defoliation (%)
Ojibway Provincial Park	24.0	0	31
Checks	28.2		88

Table 6. Spruce Budworm: Survival rates in sprayed and unsprayed (check) plots in the North Central Region, 1987.

	Host	Prespray living larvae per 46 cm branch tip	Postspray living budworm per 46 cm branch tip	Survival rate
Spray plots	bF	10.6	0.5	.046
Checks	bF	12.8	2.6	.203
Spray plots	wS	31.2	1.7	.055
Checks	wS	28.7	3.4	.118

Table 7. Spruce Budworm: Results of an aerial application of an experimental *B.t.* formulation, Dipel 176, at Sandbar Provincial Park, Ignace District, Northwestern Region, 1987.

	Prespray larvae per 46 cm branch tip	Population reduction due to treatment (%)	1987 defoliation (%)
Spray Plots	28.2	87	16
Checks	28.2		88

LOCATION: Ignace District, Sandbar Prov. Pk

MATERIAL: Dipel 176, 30BIU/1.6L/ha

DATE: May 24, 1987

TEMP: 3°C

RH: 60%

AC: Helicopter - 206

INSECT: 3.7 (nearly peak of IV instar)

HOST: 4.3 buds flushed

TREE: bF

AREA: 130 ha

SPRUCE BUDWORM CONTROL OPERATIONS IN ONTARIO - 1987

J.J. Churcher
Pest Control Section
Ministry of Natural Resources

A reduction in the area of moderate to severe defoliation of all major insect pests resulted in a smaller aerial control program than in the previous year. On November 13, 1986, the Minister of Natural Resources announced that, once again, Ontario would use only the biological insecticide *Bacillus thuringiensis* (B.t.) in its aerial insecticide programs. Because of this decision early in the planning process, our extensive open house and media briefing programs of previous years and the public's acceptance of forest insect control and the use of B.t., large scale public information centres were not deemed necessary. Local district offices that were proposing aerial spray projects held one day open houses in the district office and provided display material for public review for 30 days. Media briefings were held but drew little interest.

A reduction in the area of moderate to severe defoliation caused by the spruce budworm in 1986 (Figure 1), and predicted further declines for the following year, resulted in a reduced spray program in 1987. Most blocks were located in the North Central Region, to the north of Lake Superior; in addition two provincial parks in the Sioux Lookout and Ignace Districts received protection (Figure 2). A total of 76,819 hectares were sprayed with B.t. (Dipel 132). Treatments included undiluted single and double applications at rates of 20 BIU/1.6L/ha and 30 BIU/2.4L/ha. An experimental application of Dipel 176 undiluted, single application at 30 BIU/1.6L/ha was made at Sandbar Provincial Park in Ignace District.

Three airstrips and three mobile operations were located in Terrace Bay, Nipigon, Thunder Bay, Ignace and Sioux Lookout Districts - sixteen rotary and fixed-wing spray aircraft were guided by eight pointer aircraft.

There were no problems or incidents associated with the aircraft in this project. However, the reported presence of alien bacteria in the B.t. formulations delayed the start of the program. The two provincial parks in Sioux Lookout and Ignace Districts could not be treated until after the B.t. had been tested and cleared and the temporary hold on spray operations lifted. This delay did not appear to affect the results of our programs in these two parks, as reported elsewhere in these proceedings.

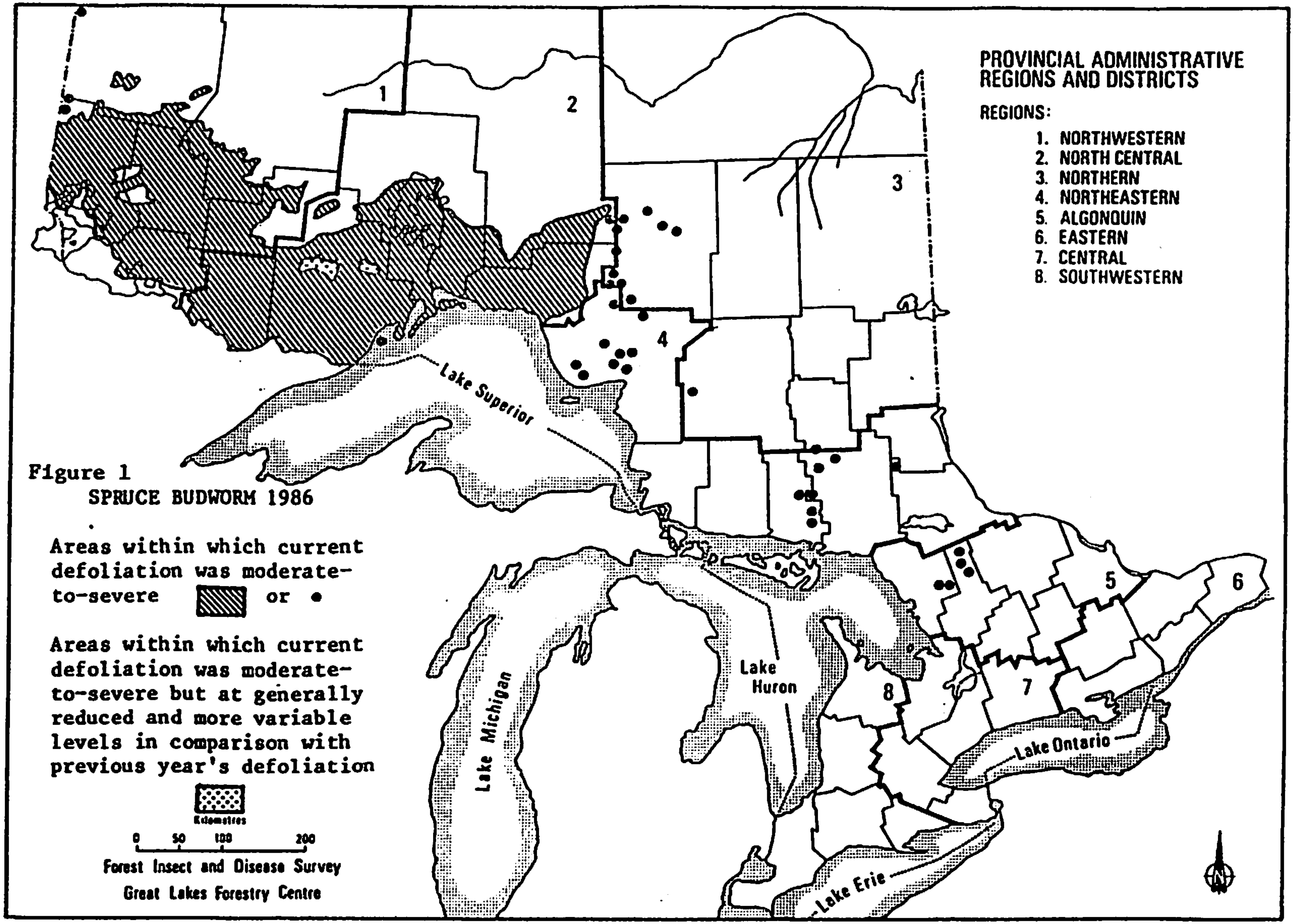

Figure 1
SPRUCE BUDWORM 1986

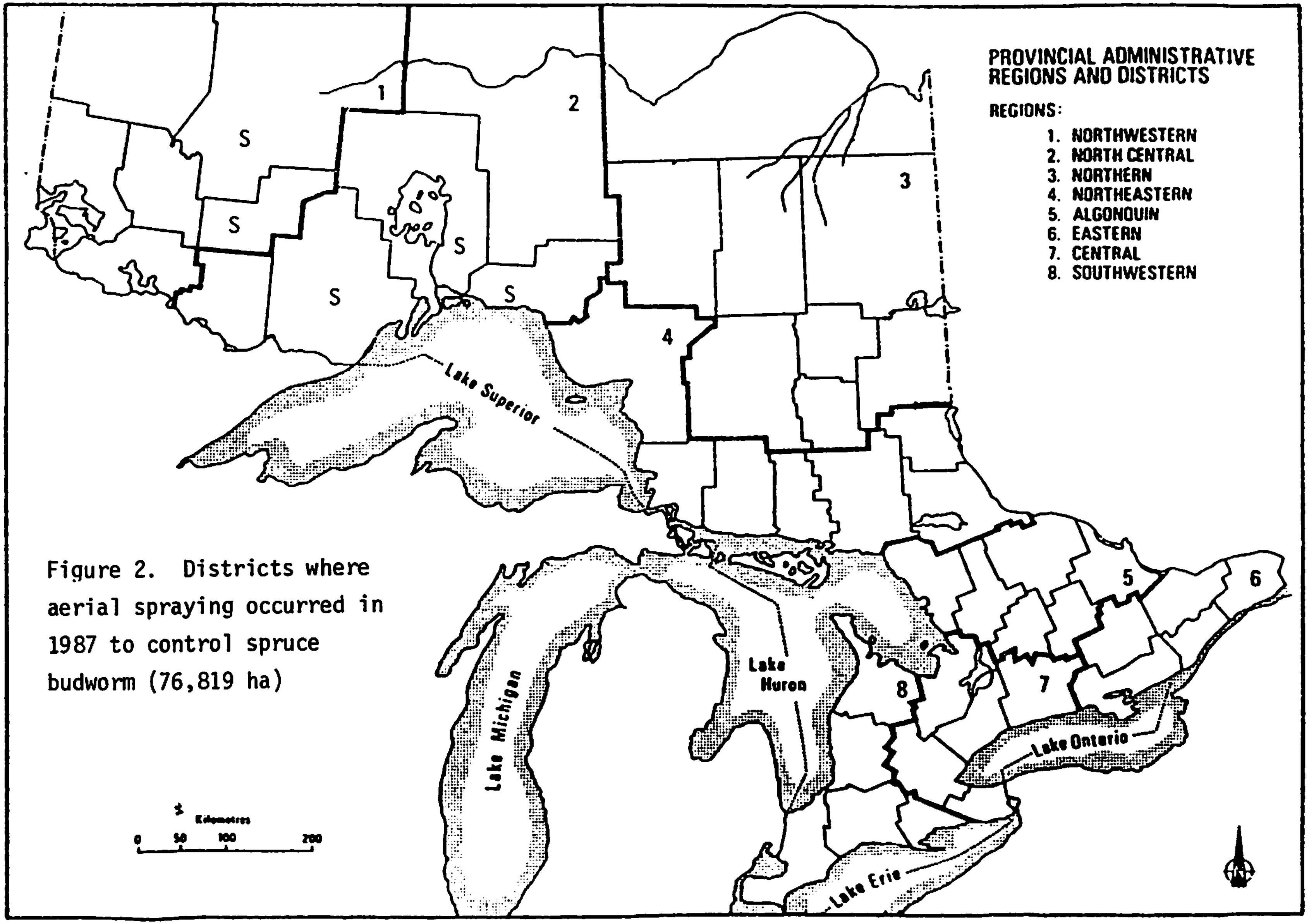

Figure 2. Districts where aerial spraying occurred in 1987 to control spruce budworm (76,819 ha)

FPMI REPORT ON STAFFING, PROGRAM CHANGES AND AREAS OF CONCERN

Report to The 15th Annual Forest Pest Control Forum

G.W. Green

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November 1987

15TH ANNUAL PEST CONTROL FORUM

FPMI Report on Staffing and Program Changes and Areas of Concern

G.W. Green, Director
Forest Pest Management Institute

This report summarizes briefly staff and program changes at FPMI since the 1986 Forum that may be of interest to Forum attendees and areas of concern in pest management as seen from the FPMI perspective.

1. Staff Changes

There have been a number of staff changes at FPMI since last year at this time that Forum attendees may not be aware of. They are as follows:

- Linda MacDonald, previously with Gary Grant in Pheromones, joined Dean Thompson's staff as Field and Laboratory Technician in Herbicide Chemical Accountability expanding our efforts in this field;
- Doug Pitt, formerly with K.C. Irving in New Brunswick, joined the staff of our Herbicides Application Study as a Forestry Officer under Phil Reynolds replacing Tim MacKay who joined Dow Chemical Co. last year;
- John Studens, formerly with the Ontario Ministry of Natural Resources, replaced Dal Travnick who retired, as technician to Raj Prasad in Herbicide Screening and Toxicology;
- Roger Scharbach joined Leo Cadogan's staff as a technician in Insecticide Field Efficacy replacing Peter Ebling who transferred to technical duties with Bill Kaupp in Viral Epizootiology;
- David Curry joined the staff as technician to Nick Payne in Pesticide Atomization and Dispersal replacing Jim Beveridge who was transferred to Technical Services;
- Terry Wright was added to the technical staff in Bacterial Pathogens to enhance our activities in biotechnology-related research with B.t.;
- Paul Fast, Project Leader, Bacterial Pathogens retired on 2 October, 1987 and has moved to the west coast. His replacement is under consideration;
- and last, but certainly not least, Terry Ennis Program Director, Biorational Control Agents was the successful contender for Cal Sullivan's position as Director of Research at GLFC when Cal retired this year.

2. Program Changes

There have been few program changes at the Institute this year other than a general strengthening of our efforts in the biotechnologically oriented aspects of *B.t.* and a strengthening of our capability in herbicide chemical accountability, both of which were predicted in last year's report to the Forum and are reflected in some of the staff changes noted above. With no new accruals in our PY resource base likely in the near future our program is expected to remain fairly stable for the next few years and our efforts are being directed towards increasing the capabilities of existing staff in a number of fields including Bacterial Pathogens, Environmental Impact, Pesticide Formulations and Insect Pathogens *in vitro*.

In this regard:

- Peter de Groot is continuing his Ph.D. research on seed and cone insects at Simon Fraser University.
- Dean Thompson, our herbicide chemist is pursuing a Ph.D. at the University of Guelph on the aquatic impact of the herbicide Ally.
- We are supporting Ross Milne on educational leave at Laurentian University to obtain an M.Sc. in molecular biology thus enhancing his input into *B.t.* biotechnology-related R&D.
- Steve Holmes and Rhonda Millikin of our Environmental Impact project have completed M.Sc. residence requirements at Queen's University and the University of British Columbia, respectively, and are now writing their theses on various aspects of fenitrothion impact on birds.
- Dave Kreutzweiser, an Environmental Impact technician, will be taking courses at Lake Superior State College this year to enhance his knowledge in the environmental impact field.
- John Leung of our Pesticide Formulations project is on LWOP at the University of Manitoba to expand his knowledge of the chemistry and physics of pesticide formulations
- and Guido Caputo is being supported at Queen's University to enhance his knowledge of insect virology.

All of these thrusts will better equip the institute to maintain high level research in priority areas in the face of person-year constraints.

3. Areas of Concern

There are a number of concerns from the FPMI perspective that I think are worth airing.

i) *B.t.*

Last year, I warned of the folly of putting all of our eggs in the *B.t.* basket where protection activities against important lepidopteran defoliators was concerned. This very nearly landed us in an untenable situation this year when both Dipel and Futura formulations were found to include small amounts of both Streptococcus faecalis and S. faecium. Luckily, no provincial operational sprays were abandoned because of this, though some were delayed until the issue was resolved. Futura applications planned on private woodlots in the Gaspê were, however, significantly curtailed. Had cooler heads not prevailed and had the contamination with these organisms been higher than it was, provincial operational spraying operations against the spruce budworm, and other important pests, or very significant proportions of them depending upon the province concerned, would not have taken place. This is exactly the situation that can arise if we place our dependance on only one option and, in my estimation, it is only a matter of time before it will occur again with very serious setbacks where forest protection is concerned.

On the same vein, it is extremely important in my mind, that between now and the next spray season, realistic and objectively arrived at criteria be established and accepted by all jurisdictions for the level of occurrence of such contaminants that will be accepted in B.t. product formulations. I don't think that the zero level is either realistic or warranted where a product produced by fermentation is concerned, and where living spores are contained in the formulation!

ii) Status of Chemical Insecticides

At the risk of sounding like a broken record, I feel compelled to bring to the Forum's attention, once more, the very weak position forestry is in with respect to the availability of registered chemical insecticides for use against the budworms and other major forest insect pests. As it stands right now, we're really reduced to one tried and true product - fenitrothion. While aminocarb, one of the best products we ever had, is still registered for use, it is not readily available and will only be manufactured if major quantities are ordered well ahead of time.

By the same token, Zectran, which two years ago was in the final stages of registration in Canada, has been put on hold by the new owners, May & Baker, and we simply do not know, at the present time, what the company's plans are for this excellent product.

This is indeed, a deplorable situation, all the more so because of the recent resurfacing of the bird impact issue with fenitrothion and pressure to have this product's registration reevaluated because of this concern.

It doesn't take much of a crystal ball to picture the position that forestry would be in if, for some reason, fenitrothion were withdrawn from use. We would be left with B.t. which, itself, is not devoid of problems and certainly would not meet all of forestry's needs even if it were.

iii) Ban on the Research Application of Insecticides on Crown Lands

For the second year in a row, Ontario has seen fit to ban research applications of chemical insecticides on Crown Lands in the province and, so far, there seems to be no indication that this attitude is likely to change in the future. This attitute and approach not only militates against much needed research with chemical insecticides but indicates a mind set among political decision makers in the province that very clearly states that the operational use of chemical insecticides on these same Crown Lands will not be permitted in the future. This is a very serious situation that warrants consideration and whatever influence can be brought to bear via this Forum. If it is not resolved, Ontario will find itself between a rock and a hard place when they have a serious insect problem that B.t. is not appropriate for and the very real danger exists that the example set by Ontario might spread to other provinces.

iv) Failure to Have Permethrin (Aerial Application) Registered for Woodland Use

Permethrin, and indeed other synthetic pyrethroids, has great promise for use in Woodland Category situations against a variety of plantation pests existing now and others that will inevitably assume importance in the future. The synthetic pyrethroids have achieved registration via aerial application in agriculture but not in forestry despite a great deal of research that indicates that a 100m buffer zone is more than sufficient to protect aquatic habitats. This failure rests in part on reluctance by the forestry community to push for something they believe in the face of unproven concerns expressed by other sectors. This past year, for example, plans had been laid for research applications of permethrin against the spruce budmoth in New Brunswick. This was to be a cooperative approach that would assess efficacy against the budmoth but perhaps even more importantly, in the longer run, to validate the model which suggests 100m as a biologically sound buffer zone about aquatic habitats for the aerial application of this material. In the face of concerns expressed by other renewable resource sectors and pesticide regulators, this well-planned research trial was abandoned at the last moment. As a result, registration of permetrhin for Woodland Use (aerial application) has been set back again or perhaps stymied completely.

These are all very real concerns facing forestry where the management of important forest insect pests is concerned and, to a very large extent, the same sort of situation exists with respect to herbicide research and operational use. I don't profess to know what the answer to these problems is, but I do know that, if the situation is not turned around and soon, forestry's ability to ensure an adequate wood supply into the future will be lost with very serious socio-economic consequences.

Somehow some real perspective, some balance and some objectivity must be brought to bear where this whole issue of pest management is concerned. It is an issue that this Forum cannot disregard!

Well that's the down side and I would like to conclude my remarks on a more positive note.

Biological Control Production Facility

As some of you may know, FPMI has for sometime now been wrestling with the idea of a Biological Control Production Facility for Canada. Our concern has been that we are in the business of developing insect pathogens for use against important forest insect pests. We have recently received full registration for Lecontvirus, an NPV which is tremendously effective against the red-headed pine sawfly, and Virtuss, another NPV very effective against the Douglas fir tussock moth and with good potential for use against the white and rusty tussock moths. We have submitted a registration package for Sertifer virus, an NPV very effective against the European pine sawfly, and soon will be submitting a registration package for an NPV against the gypsy moth. The problem is that there are no Canadian commercial producers for these materials and FPMI, we do not feel, should, as an R&D agency, be charged with producing them for operational use. Nor, without very strong government subsidies, are there likely to be commercial producers in Canada until such time as we have enough such pathogens developed or the host ranges of existing ones expanded through genetic engineering that commercial production becomes economically attractive.

Just recently we had occasion at FPMI to meet with the president of a new company in the U.S. called Espro Inc. This company was formed after discussions with the U.S. Forest Service about the feasibility of commercial production of Gypcheck (gypsy moth virus) and TM Biocontrol-1 (Douglas fir tussock moth virus).

The approach conceived is a novel one. The company has determined, through computer modelling, that they could achieve the economic break-even point if they could produce and sell a combined total of 200,000 acre equivalents of the two viruses per year. This is apparently about 20 per cent of the total areas treated against both gypsy moth and the Douglas-fir tussock moth in the U.S. annually. Their approach will be to convince federal and state agencies to buy into a virus pool - a sort of futures approach. For example, if they could convince 20 such agencies to buy 10,000 acre equivalents each year they could achieve their economic break even point. Say, for example that, in the first year, none of the agencies required any virus but bought into the pool again for another 10,000 acre equivalent the next year. There would then be enough virus available to treat 400,000 acres.

When the time came to use the virus, each agency that bought into the pool would be assured of their share of the 400,000 acre virus equivalents but it would be unlikely that each agency would require virus at the same time. In any one year some agencies would take none, some would take a bit and some a great deal. They would then pay up for replacement on the basis of what they drew from the pool and the pool would be maintained at a predetermined level.

This sharing of the economic load approach is interesting and innovative. It would put in place a commercial enterprise equipped for and dedicated to the production of quality products, something that the U.S. approach of contracting out to ill equipped and temporary contractors has failed to achieve. It is not without its problems but is something that we will follow with great interest both from the standpoint of adopting a similar approach when the time is ripe in Canada and/or licensing of Espro Inc. to produce pathogens that FPMI holds the Canadian registration for.

G.W. Green
2/11/87

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W.E. STEWART
PESTICIDES DIRECTORATE
AGRICULTURE CANADA

REPORT TO:

15TH ANNUAL FOREST PEST CONTROL FORUM

November 17-19, 1987.

PE[illegible]

1. Guidelines:

The Issues, Planning and Priorities Section in conjunction with the Directorate Biotech Committee is presently working on several important and interesting documents.

(a) The guidelines for the registration of naturally occurring microbial/biological organisms are being redrafted to incorporate the comments and changes resulting from the comment period. It is anticipated that a "T" memorandum will be published by the end of 1987.

(b) Guidelines are being drafted for the data requirements for biotech and genetically altered organisms. Draft anticipated for early 1988.

(c) Research Permit Guidelines are being developed specifically for the biological organisms and will include directions for genetically altered material. A working draft is expected by the end of 1987 or very early 1988 - in time for the 1988 experimental field season.

2. Re-evaluation:

A plan for the re-evaluation of pesticide products has been developed (R-1-226, May 20, 1986), and a list of priority candidate active ingredients has been developed. The following have been slated for re-evaluation beginning in December:

- all fumigants
- all repellants
  - oil of citronella
  - dimethyl phthalate
  - deet plus related active toluamides
  - ethylhexanediol
  - citronyl
  - oil of lavender
  - Lethane
  - MGB = 2,3,4,5-bis,(2-butylene)tetrahydro-2-furfural
  - MGD = di-n-propyl isoinchomeronate
  - MGH = 2-hydroxyethyl N-octyl sulfide plus related active compounds
  - MGK = n-octyl bicycloheptene dicarboximide

- Insecticides
  - carbaryl
  - dimethoate
  - endrin
  - malathion
  - methoxychlor
  - methomyl
  - trichlorfon
  - lindane
  - carbofuran
  - aldecarb
  - temphos
  - BTH-14

3. National Pesticide Call Line: 1-800-267-6315

The call line (4 members) has proved to be very successful and now operates year round. A total of 5,500 inqueries were handled during the first half of the year, with (approx) 40% originating from the Urban sector, 27% from the affiliated Profession sector and 16% from the Industrial sector, 8% from the Farm sector, 4% from Media, 2% from Special Interest Groups.

REGISTRATIONS:

-No new forestry products have been registered (to date) in 1987.
-The outstanding data have been received and reviewed - allowing the two viruses (Douglas Fir Tussock Moth & Red Headed Pine Sawfly) to be granted full registration status.
-UULV rates have been approved for FEM and registration is pending label amendments.
-We are awaiting Environment Canada's review of data on Dimilin. This is the only outstanding factor(s) for the registration of the forestry uses of Dimilin. We expect the review to be completed by the beginning of December 1987.
-An application to register Zectran has been received but since the active has changed hands, it is uncertain whether registration will be actively pursued.

There are presently 35 forestry-related submissions under review of which only 7 are for new registrations - the others are amendments of one sort or another to existing registered products.

RESEARCH PERMITS:

Fifty-nine forestry-related research permits were reviewed in 1987 (out of a total of 98 handled) (Total of 390 for the Directorate). RP's were from provinces, research establishments and/or researchers for work in:

Province	# of Permits
NFLD	8
NS	1
NB	11
QUE	5
ONT	34

BT:

There are presently 20 formulations of BT registered in Canada (See list attached).

As you are aware, the events of last summer concerning BT and microcontamination specifically centered on fecal streptococcus. The first that Agriculture Canada or our advisors became aware of the existence of Streptococcus microcontamination in BT was in May of 1987. Agriculture Canada carried out an extensive sampling program of representative batches of BT that were being used in the major forestry operations across Canada. These samples were analysed for fecal streptococci by our Laboratory Services and results were compared to those carried out be several provinces and by one of the Health and Welfare Canada laboratories. Discussions regarding the significance of the levels of Strep. indicated that these organisms are common in many non-sterile foods and in the natural environment; represented either non- or low-order pathogenicity and that exposure under typical forestry use applications would not likely produce adverse health effects. We advised the various provinces of the findings/conclusions in a letter dated May 29, 1987.

As a result of the experiences of last summer, the Pesticides Directorate, the CFS and our advisors in Health and Welfare have been collecting information and reviewing with Industry, the BT manufacturing process and the methods of controlling/preventing microcontamination. The practicality and possibility of setting standards (in the future) is also being addressed. (Industry has been asked to assist in identifying specific organisms which may be of concern and therefore tested for).

Ag Canada expects to complete the initial review at the federal level and to be able to issue details of a proposed plan of action by the end of 1987. Consultation with the provinces is considered essential.

The proposal for the 1988 season will center around Industry being monitored and asked to test at various stages of the manufacturing and formulating process. At the same time, Ag Canada will undertake an extensive sampling and testing program. Support, cooperation and participation will be required from the provinces. Any program will depend on the ability of all concerned to collect timely, accurate, clean samples and to work together.

We look forward to working with you to resolve any difficulties concerning BT.

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REGISTERED PEST CONTROL PRODUCTS

tv	Acnm	Guar	Regt	Regn	Mark	Prnm	Form	Renw
R	BACILLUS THURINGIENSIS BERLINER VAR KURSTAKI	16 BIU/KG	ABC	13299.00	R	DIPEL F BIOLOGICAL INSECTICIDE	WP	90
		16 BIU/KG	ABT	11252.00	C	DIPEL WP BIOLOGICAL INSECTICIDE	WP	90
		6.454 BIU/L	ABT	16873.00	R	DIPEL 88	EC	87TU
		12.7 BIU/L	ABT	17954.00	R	DIPEL 132	EC	87TU
		100	ABT	19316.00	M	DIPEL TECHNICAL POWDER	NA	90
		8.64 BIU/L	BIP	17133.00	R	NOVABAC-3	SU	90
		4.2 BIU/L	CHP	12663.00	D	C-I-L ORGANIC INSECT KILLER LIQUID	SU	90
		8.64 BIU/L	CYC	15084.00	R	NOVABAC - 3 BIOLOGICAL INSECTICIDE	SU	90
		14.4 BIU/L	DPR	17778.00	R	FUTURA SUSPENSION BIOLOGICAL INSECTICIDE	SU	90
		9.68 BIU/L	DPR	17781.00	C	BACTOSPEINE SUSPENSION	SU	90
		16 BIU/KG	PFF	18333.00	C	ENVIROBAC WP BIOLOGICAL INSECTICIDE	WP	90
		8.454 BIU/L	PFF	18334.00	R	PFIZER ENVIROBAC ES	SU	90
		4.2 BIU/L	SAZ	12360.00	R	THURICIDE 16B AQUEOUS CONCENTRATE FOR AERIAL APPLICATION	SU	90
		4.2 BIU/L	SAZ	12579.00	D	THURICIDE R-HPC FOR HOME GARDENS	SU	90
		4.2 BIU/L	SAZ	13912.00	C	THURICIDE 16B BIOLOGICAL INSECTICIDE AQUEOUS CONCENTRATE FOR GROUND A	SU	90
		8.4 BIU/L	SAZ	17199.00	R	THURICIDE 32B	SU	90
		4.2 BIU/L	ZOE	11302.00	C	THURICIDE HPC	SU	90
		8.4 BIU/L	ZOE	17200.00	R	THURICIDE 32LV	SU	90
		8.4 BIU/L	ZOE	17917.00	R	THURICIDE 32F	SU	90
		12.0 BIU/L	ZOE	17980.00	R	THURICIDE 48LV	SU	90

STUDIES CARRIED OUT BY THE BIORATIONAL CONTROL AGENTS PROGRAM, FOREST PEST MANAGEMENT INSTITUTE - 1987

Report to The 15th Annual Forest Pest Control Forum

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November 1987

Summary of Activities for the Biorational Control Agents Program - 1987

Dr. Green has provided an overall introduction to staff changes that have occurred in this program, so this presentation will be limited to highlights of progress. More specific details are available in the handouts, and some staff members are present for discussion.

FP-10 Bacterial Agents. The BIOCIDE cooperative research network, initiated in 1984, continues to function well, and now has participants from three NRC establishments, FPMI and three universities. FPMI's roles in this network includes overall coordination of activities and dissemination of information and conduct of *in vivo* and *in vitro* bioassays of single and recombinant gene products as well as of crystals that had been irradiated to determine structure-function relationships. Progress on a number of fronts has been good, with publications in several areas, and results to date have stimulated interest by at least one commercial company in cooperative work.

Studies in *B.t.*-host interactions have continued to emphasize development of a thorough understanding of the interaction between foliar deposit, the target insect, and the host tree as affected by post spray matter, identification of the relative susceptibilities of major forest insect pests to various strains of *B.t.*, and to assess the effects of weather and adjuvants on post-spray efficacy. Progress has been made on identifying the interrelated effects of temperature, density and potency of formulations on efficacy. Effects of stickers on residual efficacy of *B.t.* applications were also investigated. Field studies against the gypsy moth indicated that, for this insect as well, ultra-low volume application of undiluted *B.t.* formulation results in a more uniform distribution of droplets than high volume application, and the higher concentrations in the droplets achieved equal or higher larval mortality.

FP-11 Fungal Pathogens. Due to the loss of the professional position in fungal epizootiology, field-related research in this project was limited to disease diagnosis in the collaborative spruce budworm population studies being carried out by GLFC. Complementary laboratory studies centered on continuing study of the conditions which promote sporulation in liquid media, determination of the effect of photoperiod on fungal growth *in vivo*, and further development and refinement of a technique that permits the use of dried, infected cadavers for storage and subsequent dissemination of the fungus.

FP-13 Viral Pathogens. Research in this program was carried on along three interrelated fronts. Biochemical and biophysical studies centered on the analysis of viral replication cycles as well as the production of recombinants between spruce budworm NPV and *Autographa californica* NPV, both aimed at a best understanding of the functions of viruses that could, in future, be manipulated for enhanced control effectiveness.

With the absence of Dr. Cunningham on Career Development Leave, Dr. Kaupp was responsible for both field and epizootiological studies. As a result, some proposed work, such as testing of NPV against gypsy moth in

Ontario, had to be postponed. However, an aerial application of the Douglas-fir tussock moth NPV, Virtuss, was made against white-marked tussock moth in Newfoundland. A 25 ha plot was sprayed, and the resulting epizootic virtually eliminated insects from the treated plot and spread to an adjacent untreated check area.

With acceptance of additional safety testing data by Agriculture Canada, full registration has now been obtained for Lecontvirus, the redheaded pine sawfly NPV, and Virtuss and TM-Biocontrol 1, the Canadian and U.S. Douglas fir tussock moth virus preparation, respectively.

FP-30 Pheromones. Intensive effort has continued in this project on the identification of pheromones and attractive compounds for use in monitoring insect populations using pheromone traps. This is proving to be a very effective means of determining presence and distribution of species of interest, as well as a means of providing early warning of potentially damaging pest build-ups. For these techniques to be fully effective, trap catches must be correlated to such other population indices as egg and larval densities and/or defoliation. In his report, Dr. Grant has provided details of such a study with the Large Aspen Tortrix, *Choristoneura conflictana*.

FP-31 Insect Growth Regulators. Following renewed interest in the development of this class of compounds by industry, FPMI has been carrying out extensive laboratory and field research into their use against a range of insect pests including gypsy moth, spruce budmoth, hemlock looper and white pine weevil. Except for spruce budmoth trials in Quebec, where timing and dosage problems were encountered, results have been very promising, and it appears that for gypsy moth, Dimilin could be one of the most effective control agents.

Other research not reported in detail but complementary to that described is in the areas of: Insect Pathogens *In Vitro*, the use of cell culture to propagate viruses in pure form and to provide sensitive bioassays; Immunochemistry, to provide sensitive identification and analysis techniques for the study of microbial pathogens; and Biological Systems Analysis, to provide the analytical concepts and tools for the design interpretation and integration of research.

On a more general note, we have been involved in several initiatives that should have a positive effect on microbial control research at the Institute. The first of these is the cooperative *B.t.* research network, BIOCIDE, which brings together expertise from FPMI, NRC and several Canadian universities. Based on its significant progress to date, we see this network as being an effective method of accelerating the application of Biotechnology to the improvement of *B.t.* as a pest control option, as well as a means of transferring this technology to Canadian industry.

A second area is our involvement in the CFS Task Force on Biotechnology. This group is reviewing Biotechnology-related research in the CFS, with the aim of making recommendations about its future directions, identifying individual establishment responsibilities, and producing a Strategic Plan that can form a basis for resourcing both with current funds and with additional funds to be sought through initiatives to Treasury Board.

A third area is active involvement in a working group chaired by Agriculture Canada whose purpose is to produce guidelines for the registration of microbial control agents, for the registration of genetically manipulated control agents, and for research permits required to test these agents. The target date for completion of the microbial guidelines is January 30, 1988, with guidelines for genetically manipulated organisms to follow shortly thereafter. We salute this initiative as one that is long overdue, but our concern continues to be that the guidelines are sufficiently strict to ensure safety but not so strict that they will stifle future development.

STUDIES CARRIED OUT BY THE CHEMICAL CONTROL AGENTS PROGRAM, FOREST PEST MANAGEMENT INSTITUTE - 1987

Report to The 15th Annual Forest Pest Control Forum

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November 1987

Summary of Activities for the Chemical Control Agents Program - 1987

Introduction

Major issues and constraints affecting the research effort of the program have not changed significantly since last year's Forum.

With the exception of continued interest in the development of several promising herbicides for forestry use (i.e. Garlon, Velpar aerial uses, Ally etc.), the number of new products being developed by Industry for forest uses has slowed to a trickle. As indicated last year, uncertainty with the future plans for registration of Zectran by its new owners May and Baker, uncertainty over the future manufacture and interest in continuing the registration for Matacil by Chemagro, and a lack of new insecticide products for future development have placed a huge question mark over the entire future of forest insect management with chemical insecticides. In conjunction with recent calls for reevaluation of the registration status for fenitrothion based on concerns for avian impact, forest managers aren't left with too many (if any) choices with regard to insect control. Even biologicals like B.t. aren't immune from concern and criticism as the 1987 experience has demonstrated. Something must be done to try to reverse this trend, perhaps through concerted efforts of the Forum, forest professional and industrial agencies and organizations. As a consequence of the lack of new products, FPMI program efforts will continue to concentrate heavily on improving the use and application of currently available insecticide active ingredients for the foreseeable future.

Once again in 1987, as in 1986, we were forced to abandon aerial efficacy trials for reduced dosages of Sumithion 20% Flowable against spruce budworm in N. Ontario as a result of no decision from the Ontario Government to our request for approval of the use of provincial crown forests for this trial. Without a complete change in philosophy on the part of the Ontario Government regarding aerial application of chemical insecticides, particularly as pertains to research, our input into that province's pest management strategies will be severely limited. The Ontario forest manager and forest industry will be the ultimate loser. To date, there is no indication of a change in political direction in this regard.

At last year's Forum, we reported on a planned trial with permethrin in New Brunswick in the spring of 1987 to assess drift potential of permethrin and efficacy against spruce budmoth. This trial was to have included as a major component, validation of FPMI's recommendation for a 100 m. buffer zone in order to protect sensitive aquatic organisms from effects of aerial drift. The trial was intended to be a cooperative venture with FPMI, CFS Maritimes and other agencies involved as much as possible. Our request for a provincial permit was denied by the Pesticides Advisory Board in New Brunswick on the basis that permethrin represented too great a risk to aquatic organisms. FPMI thus was victim of a catch-22 situation where we were denied the opportunity to assess potential for aquatic impact because of concerns for aquatic impact. Because of the concerns expressed and after conferring with regional cooperators, we decided to delay our plans for

1987. We are hopeful that we'll be able to obtain the necessary provincial permit for a 1988 trial. Regardless of what occurs, it is extremely frustrating to see numerous aerial registrations for a number of synthetic pyrethroids being allowed for agricultural crops with a 100 m. buffer (such as the one we proposed for forest plantation uses), and yet be denied the opportunity to perform research which we feel is essential to extend similar use patterns to limited high value forest areas such as seed orchards, Christmas tree plantations, seed production areas, etc. that are sufficiently removed from sensitive water bodies. This apparent double standard in the regulation of agricultural vs. forestry use of synthetic pyrethroids is something that we as forest pest managers, must continue to argue against.

At last year's Forum, I mentioned the production of a video on FPMI's program and the overall need for forest pest management, entitled "Forest Protection, A Challenge for the Future". This video will be available for showing during day 3 of the Forum or by request after hours for those who have not had an opportunity to see it already. In addition, the CPPA and FPMI have produced a number of technical references for B.t., NPV's, Dimilin and a listing of all insecticides registered for Forest and Woodlands use. Copies of these are available from FPMI or the CPPA. Other joint technical references are planned including Matacil, minor use insecticides and herbicides and other topics of interest to the forest pest control community.

In spite of constraints operating against our research program, we have had a very productive year at FPMI. Individual reports from research staff are available for those wishing to be updated over the past year's activities and a number of staff will be making short presentations during this session. At this time however, I'd like to quickly review some of the highlights of our program research efforts for 1987.

FP-50 Insecticide Toxicology and Screening - Blair Helson

Spruce budworm - two microencapsulated formulations of permethrin were tested

- toxicities of fenitrothion and aminocarb at 10° and 25°C were determined
- residual toxicities of fenitrothion on balsam fir and white spruce were assessed
- residual toxicity of mexacarbamate after weathering on white spruce was investigated

Jackpine budworm - residual toxicities of fenitrothion and aminocarb to 6th instar larvae was determined and studies were performed to assess whether mortality to fenitrothion and aminocarb could be related to contact or ingestion.

Eastern hemlock looper - tests were performed with fenitrothion to determine if a differential exists between toxicities to each larval instar.

White pine weevil - tests with synthetic pyrethroids have shown that these materials are potentially more effective in weevil control than currently registered methoxychlor.

Hylobius congener - preliminary tests have shown that permethrin, chlorpyrifos and fenitrothion have potential for controlling debarking weevils when used as seedling dips.

Gypsy moth - contact toxicities of permethrin, SAN 811-I mexacarbate, carbaryl, acephate and trichlorfon were established against 2nd instar larvae.

Red pine cone beetle - bioassay methods are being developed and to date permethrin has been tested topically.

UC 84572 - bioassay tests with mosquito larvae with this experimental IGR have shown it to be more persistent in outdoor tests performed in small pools than diflubenzuron. Another trial is in progress at cooler temperatures.

FP-51 Insecticide Field Efficacy - Leo Cadogan

Sumithion 20% flowable - efficacy studies against spruce budworm were cancelled for the second year in a row in N. Ontario when the Ontario government failed in giving permission for the use of Crown forests for this trial. No further attempts at performing these trials are planned at present.

Studies with *B.t.* formulations

Products tested for efficacy against spruce budworm in N. Ontario included Futura XLV, Dipel 8AF, Dipel 12L and the registered product Dipel 8L. All products at 30 BIU provided good reductions of budworm populations. All products at 30 BIU provided good foliage protection except for Futura which was marginal. The Dipel 8AF product at 20 BIU did not provide for suitable population reduction. Both Futura and Dipel 8AF formulations handled exceptionally well and atomized most efficiently.

Permethrin - plans for trials against spruce budmoth in New Brunswick were cancelled when provincial permits were denied.

FP-52 Plantation Pest Management - J. Turgeon, P. de Groot

Spruce budmoth - cooperative research with UNB is continuing in order to identify families of white spruce less susceptible to budmoth. Pheromone studies to establish a population monitoring system is continuing. Results of past research on biology and damage assessment etc. are being published.

Cone and Seed Insects - Black spruce studies are underway to determine cone and seed mortality factors, seed maturity and to develop non-destructive sampling procedures.

- Studies with Jackpine are continuing in order to establish Jackpine cone life tables, and to support Peter de Groot's Ph.D. thesis on biosystematics and life cycle of Conophthorus spp. on pines.

- Cooperative trials with Blair Helson wil continue in order to identify insecticides potentially effective against pests of seeds and cones.

FP-54-1 Herbicide Field Efficacy - Phil Reynolds, Doug Pitt

Carnation Creek, B.C. - third and final year vegetation analysis of a glyphosate conifer release trial in this watershed was completed. Results will be presented along with watershed environmental impact data at a workshop to be held in Nanaimo in December.

New Brunswick studies - a number of site preparation studies have been initiated in New Brunswick in cooperation with J.D. Irving Ltd. Some of these efficacy studies have been underway for up 4 years and involve the herbicides Velpar L, Velpar ULW, Ally, Oust, and Pronone. Weed efficacy, crop tolerance, crop growth response and plant succession following herbicide treatments are all under study. Some of the data generated will be submitted in support of product registrations.

N. Ontario studies - site preparation studies with Pronone and Velpar on coarse-textured soils were carried out cooperatively with GLFC on company freehold lands. FPMI input into this study is almost complete.

FP-54-2 Herbicide Toxicology and Screening - Raj Prasad

Herbicide adjuvants - greenhouse and small scale field plot studies with adjuvants Enhance, Ethokem, Tween 20, ammonium sulphate, LI-700, Frigate, Triton XR were carried out using glyphosate applied to alder, aspen, white birch and poplar. Based on field studies alone, Enhance, Ethokem, Frigate, Triton XR and ammonium sulphate appear to have some potential in increasing the effectiveness of the Vision formulation of glyphosate.

Influence of Droplet Size - tests performed under greenhouse conditions with glyphosate, hexazinone and trichlopyr have shown that smaller droplets (155-365) are more effective in controlling weed species than larger droplets and provide better coverage of leaf surfaces. Under field conditions, trials with glyphosate and hexazinone in an aspen/poplar stand have shown a general trend of greater efficacy with smaller droplets. However, a great deal of variability in results was experienced and these trials will continue in future.

FP-54-3 Herbicide Chemical Accountability - Dean Thompson

Carnation Creek - glyphosate studies - the analysis and reporting of glyphosate residues in soil, water, sediments and leaf litter in relation to glyphosate environmental fate and distribution in the Carnation Creek watershed in B.C. have been completed. The results will be presented at the Carnation Creek Workshop in Nanaimo in December. Generally results favour the environmental acceptability of this herbicide for forest operations consistent with registered forest use patterns.

Trichlopyr (Garlon) - in cooperation with Dow Chemical, FPMI is involved in assessing the environmental fate and behaviour of trichlopyr in a N. Ontario watershed. Specifically, FPMI is responsible for quantifying residues of trichlopyr and its metabolites in water, sediments and on deposit collectors. The data will be used by Dow in support of forestry registrations for Garlon formulations.

Metsulfuron methyl (Ally) - as part of his Ph.D. thesis at the University of Guelph, Dean Thompson is initiating studies to determine the behaviour of metsulfuron in terrestrial and aquatic substrates of boreal forest environments.

FP-61 Pesticide Formulations - Alam Sundaram

- spray atomization and deposition patterns of a Newtonian formulation (Dimilin) and two pseudoplastic formulations (Futura XLV and Thuricide 48 LV) were studied in a cooperative trial with the NeFC
- droplet size patterns and spectra for Thuricide 48 LV were determined in a N. Ontario spruce plantation in cooperation with Kees van Frankenhuyzen of FPMI as well as GLFC.

FP-62 Pesticide Atomization and Dispersal - Nick Payne

- reports on the estimation of buffer zones for permethrin and glyphosate aerial applications to protect aquatic organisms from the effects of drift have been published.
- results of 1986 glyphosate trials with the TVB application system in N. Ontario under a variety of meteorological conditions are being analysed.
- a COFRDA research project was designed and initiated under contract to U. of Guelph to estimate no-effect-levels of glyphosate using rotary and hydraulic application systems to riparian vegetation and to gather data for determining appropriate buffer zones for NOEL's.

FP-70 Environmental Impact - Peter Kingsbury, Steve Holmes, Rhonda Millikin

Most of the studies performed in 1987 were located at the Icewater Creek research watershed N. of Sault Ste. Marie.

Aquatic impacts - an in-depth aquatic impact study evaluated brook trout responses to permethrin induced disturbances of invertebrate food supplies. Permethrin was injected directly into the stream and invertebrate population responses and aquatic residues determined over time to assess the impact of reduced food supplies to resident trout populations.

Terrestrial Invertebrate Impacts - baseline studies of forest wildflower fruit production continued in 1987 in order to develop a monitoring system to assess the impact of forest insecticides on pollinators.

Avian Impacts - intensive field studies initiated at Icewater Creek in 1983 were completed in 1987. The objective was to develop a new approach to monitoring insecticide impacts to songbirds that are non-destructive in nature. Several trials with fenitrothion were carried out in 1985 (aerial) and 1986 (ground). Slight changes in feeding behaviour were noted in some of the species observed but the significance of these changes could not be determined due to the small sample size used.

- laboratory experiments are currently in progress as part of Steve Holme's M.Sc. thesis to investigate sublethal effects of cholinesterase inhibiting forestry insecticides on bird behaviour and reproduction using Zebra finch as the test animal.

FP-71 Insecticide Chemical Accountability - Somu Sundaram

Fenitrothion - a cooperative study with NeFC was performed to assess droplet deposition and residues on conifer foliage for Dowanol based formulations of fenitrothion in total volumes of .4 and 1.5 ℓ/ha. Foliar residue levels were similar at both volumes and hence the application of fenitrothion in Dowanol at low volume rates may have potential for further development and use.

Permethrin - in cooperation with FP-70, the fate and behaviour of permethrin was determined after injection into Icewater Creek. Water, sediment, fish, crayfish, aquatic insects, plants, stream duff etc. were all analysed for permethrin residues over time. Initial residue levels dissipated rapidly in aquatic samples taken with stream duff and aquatic plants acting as potential sinks for permethrin residues. Residue dissipation in fish was rapid and sediment residues were low presumably because of rapid water flow and quick dilution of initial injected material.

This concludes the presentation of Program Highlights for 1987.

MINOR USE SUBMISSIONS REGISTERED 1987

Sub.#	Pesticide	Pest	Crop	Province
86-009	chlorpyrifos	mountain pine beetle	lodgepole pine	British Columbia
86-013	iprodione	alternaria leaf blight	ginseng	Ontario
86-015	anilazine	alternaria leaf blight	ginseng	Ontario
86-010	carbaryl	mountain pine beetle	lodgepole pine	British Columbia
85-013	disulfoton	asparagus aphid	asparagus	British Columbia
85-011	oxydemeton-methyl	asparagus aphid	asparagus	British Columbia
86-019	oxydemeton-methyl	cone and seed insects	Douglas-fir cones	British Columbia
84-024	oxamyl	root lesion nematode	raspberry	British Columbia
84-025	permethrin	cutworm	asparagus	Ontario
86-029	lindane	flea beetles	cole crops	Alberta
82-503	linuron	annual broad-leaved weeds	chokecherry	
86-508	linuron	annual broad-leaved weeds & grasses	saskatoon	
86-018	ferbam	spruce cone rust	spruce cones	British Columbia
86-014	mancozeb	alternaria leaf blight	ginseng	Ontario
84-021	malathion	riceworm	wild rice	Manitoba

86-027	malathion	aphids	canaryseed	Saskatchewan
84-010	dimethoate	tarnished plant bug	eggplant	Ontario
85-022	dimethoate	grasshoppers	safflower	Alberta
86-026	dimethoate	aphids	canaryseed	Saskatchewan
87-004	anilazine	anthracnose	blueberry	Nova Scotia
86-030	lindane	flea beetles	rutabagas	Alberta

Submitted by Dr. Harry Krehm
SIRS

October 28, 1987

LABORATORY EVALUATION OF THE TOXICITY OF INSECTICIDES TO FOREST INSECT PESTS AND NON-TARGET INSECTS IN 1987

[Project No. FP-50 - Insecticide Toxicology]

Report to The 15th Annual Forest Pest Control Forum

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Laboratory Evaluation of the Toxicity of Insecticides to Forest Insect Pests and Non-Target Insects in 1987

Introduction

During the past year, the insecticide toxicology project has conducted a number of major studies on the development of insecticides for forest insect control. Studies with spruce budworm include the evaluation of microencapsulated formulations of permethrin, the effects of temperature on the foliar toxicity of fenitrothion and aminocarb, the relative residual toxicity of fenitrothion on balsam fir and white spruce and the relationship of Zectran residues in foliage to larval mortality after weathering. We have examined the toxicity of fenitrothion and aminocarb to jackpine budworm when already established on jackpine shoots and have evaluated the relative contribution of different insecticide exposure routes by this bioassay method. A similar bioassay method was used to determine the relative toxicity of fenitrothion to different instars of eastern hemlock looper. Studies were continued to assess the potential of pyrethroids for white pine weevil control and to evaluate insecticide dips of seedlings for *Hylobius congener* control. New studies were initiated with gypsy moth larvae and red pine cone beetle adults. Research was also continued to determine the persistence of the new insect growth regulator UC84572 relative to Dimilin in aquatic systems.

Results

Spruce Budworm

Two microencapsulated formulations of permethrin appear to be less toxic than an emulsifiable concentrate by both contact exposure and exposure to treated balsam fir foliage.

The toxicity of fenitrothion and aminocarb on treated balsam fir foliage was determined at 10° and 25°C. With both insecticides, mortality occurred more slowly at 10°C. However, after 20-24 days, the final toxicity of both insecticides at 10° was very similar to their toxicity at 25° after 7 days.

The residual toxicity of fenitrothion on balsam fir and white spruce was compared at several dosages under natural weathering conditions. Initially, the toxicity of fenitrothion on balsam fir appeared to be only slightly higher than on white spruce. However, after 2, 3 and 5 days of weathering, residual toxicity was 2-3x higher on balsam fir than white spruce. These results are similar to those obtained with aminocarb last year. White spruce and balsam fir shoots were also weighed each sample day after treatment. The increase in weight of white spruce shoots over the 5-day period was greater than balsam fir shoots. Perhaps this results in a greater dilution of insecticide on white spruce which could account in part for the lower apparent residual toxicity.

In cooperation with FP-71 the residual toxicity of mexacarbate on potted white spruce trees was compared with foliar residues remaining after weathering in a greenhouse. As in a previous test, mexacarbate concentrations in foliage declined sharply to low levels (0.04 ppm) by 5 days after treatment. Mortality of spruce budworm larvae exposed to shoots from these trees was still 66% at this time and mortality was still evident when mexacarbate residues were below detectable limits 10 days after treatment. The metabolite, methylamino mexacarbate was present in foliage at much higher quantities than the parent compound later in the weathering period. The possible significance of the presence of this metabolite to the observed mortality of larvae is being investigated.

Jackpine Budworm

The residual toxicity of fenitrothion and aminocarb to 6th instar jackpine budworm larvae on potted jackpine trees appeared to be similar to their residual toxicity to 5th instar spruce budworm larvae on white spruce trees.

Both fenitrothion and aminocarb were tested by spraying jackpine budworm larvae which were established beforehand on jackpine shoots in the Potter's tower. This technique should provide exposure by all possible routes, namely direct contact, crawling contact and ingestion. The toxicity of both insecticides using this technique was not greatly different from their toxicity either by direct contact alone (treated larvae on untreated foliage) or by crawling contact and ingestion (untreated larvae on treated foliage). The relative contribution of these 2 exposure routes was then determined by spraying several groups of larvae established on foliage. One group was left this way. In another group the larvae were removed and placed on untreated foliage while untreated larvae were placed on the treated foliage in the third group. With both insecticides, the mortality of untreated larvae on the treated foliage was similar to the 'treated' larvae left on treated foliage. Very little mortality of 'treated' larvae on untreated foliage occurred. This indicates that direct exposure of larvae to the spray contributed very little to the overall mortality of larvae established on jackpine shoots.

Eastern Hemlock Looper

To determine if there is a potentially optimal time for applying fenitrothion based on larval age, larvae of each instar (I to IV) of eastern hemlock looper were established on balsam fir foliage and sprayed in the Potter's tower to simulate the type of exposure in the field. After preliminary tests the toxicity of fenitrothion to each instar was very similar by this exposure method. The contact toxicity of fenitrothion to first instars was also similar to third instars.

White Pine Weevil

As reported last year, the contact toxicities of permethrin and other pyrethroids are much higher than methoxychlor which has been used to control white pine weevil. Deltamethrin is most toxic followed by cypermethrin. The contact toxicity of the new pyrethroid, SAN 811-I appeared to be similar to permethrin. In preliminary tests with untreated weevils exposed to treated white pine twigs, the trends in relative toxicity appeared to be similar to those for contact toxicities but further tests are necessary for verification. Mortality due to pyrethroid treatments by exposure to treated twigs generally occurred very slowly and may be due to repellent action. Trials with potted white pine trees have also been initiated to estimate the dosages of permethrin required to control white pine weevil adults when present on the trees at the time of spraying or when exposed to treated trees after spraying.

Hylobius congener

Debarking weevil adults were received from B. Pendrel, FIDS, CFS Maritimes. Black spruce seedlings were dipped in aqueous solutions of 0.5% permethrin (Ambust 25% WP and Ambush 500 EC), 2.5% chlorpyrifos (Dursban 4E) 2.5% fenitrothion (Sumithion 20F) and 1.0% lindane (Gardo 10.7% EC) as a standard. These seedlings were potted and placed outdoors. The lindane formulation used was very phytotoxic. After 33 days, weevils were exposed to three trees treated with each insecticide. Although control mortality was excessive and feeding activity on untreated trees was light, all insecticides appeared to provide complete control at this time. No damage was observed on the treated trees. Another bioassay on a group of these trees is planned before winter with weevils which are still in storage. The remaining trees will be left outside overwinter for bioassays next season to determine if any of these insecticides at the concentrations tested can potentially provide more than one season's control.

Gypsy Moth

Research was initiated to determine the contact toxicity of different insecticides to 2nd instar larvae compared to carbaryl, to compare the susceptibility of the standard Otis strain to an Ontario strain of gypsy moth and to compare the toxicity of different Sevin formulations. Results are preliminary but the susceptibility of the two strains appear to be similar. Sevin XLR in water appears to be slightly less toxic than Sevin 4 Oil in ID585. Permethrin is very toxic to larvae and the new pyrethroid SAN 811-I also appears to have high activity. The order of toxicity for insecticides with replicated tests to date appears to be: permethrin > SAN 811-I>> mexacarbate ≥ Sevin 4 OIl > acephate > trichlorfon. A bioassay method is being developed to assess the toxicity of insecticides on treated oak leaf discs to untreated larvae.

Red Pine Cone Beetle

Bioassay methods are being developed to select candidate insecticides for the control of Conopthorous resinosae in cooperation with FP-52-2. The toxicity of permethrin to adults has been established by topical application. The 7-day LD50 and LD95 are 0.013 and 0.0495 μg/beetle respectively. One test has also been conducted where beetles are exposed to red pine twigs dipped in different concentrations of permethrin.

UC84572

Last year we reported that an experiment was being conducted in October to determine the relative persistence of the new insect growth regulator, UC84572 compared to Dimilin in sod-lined wading pools using bioassays with *A. aegypti* mosquito larvae. Both compounds were highly toxic to *A. aegypti* with LC50 values of 0.4 ppb and 0.18 ppb for UC84572 and Dimilin respectively. UC84572 appeared to be more persistent than Dimilin under the conditions tested. Another trial was performed in June at much higher water temperatures. Toxicities of the two compounds were similar to those in the first trial. UC84572 again was more persistent than Dimilin but appeared to be shorter lived than in the previous test. Another trial is currently in progress at cooler temperatures. The significance of these findings regarding the use of UC84572 cannot at present be assessed until such information as dosage rates and selectivity to aquatic invertebrates are known.

SUMMARY OF 1987 FIELD AND LABORATORY RESEARCH REGARDING THE USE OF B.t. FOR CONTROL OF FOREST INSECT PESTS

[Project No. FP-10-2 - Bacterial Applications]

Report to The 15th Annual Forest Pest Control Forum

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Summary of 1986 Field and Laboratory Research Regarding the Use of B.t. for Control of Forest Insect Pests

Introduction

Bacillus thuringiensis (*B.t.*) is now widely used for effective control of the eastern spruce budworm in Canada. Goals of the Applications Research Project at FPMI are to further improve the effectiveness of *B.t.* for spruce budworm control and to transfer the knowledge and experience gained from work with this species to other defoliating forest insect pests. The research program comprises three major components:

1. To obtain a thorough understanding of the interaction between foliar deposits, the target insects and the host tree as affected by post spray weather,

2. To ascertain the relative susceptibility of major forest insect pests to various strains of *B.t.* in order to assess control potential,

3. To quantify residual activity of currently used *B.t.* formulations in relation to weather conditions and to assess spray adjuvants to increase the foliage life of *B.t.*

During 1986 work was conducted in each of these areas and is summarized below.

1. *B.t.*-target insect-weather interactions

   Earlier studies with *B.t.* incorporated into artificial diet indicated that temperature had no effect on the level of toxicity but that larval mortality progressed more rapidly with increasing temperature. A similar effect of temperature was observed in assays with balsam fir foliage sprayed with 0.5, 2.0 and 5.0 droplets per needle (40-50 μm drops, Thuricide 32 LV).

   I also examined the effect of temperature on the exposure time required for ingestion of a lethal dose by larvae feeding on sprayed foliage. Groups of larvae were transferred to untreated diet after 1,2,3,5,7,9 and 14 days of feeding on foliage with 1.5 drops per needle at 13, 19 and 25°C. More than 50% of the larvae had ingested a lethal dose after an exposure of only one day, regardless of temperature. These data suggest that temperature has very little effect on the probability that a larva ingests a lethal dose, provided that density and potency of the droplets are sufficiently high. The data also suggest that events most critical to spray efficacy occur within the first few days following spray application.

2. Susceptibility of defoliators to B.t.

Laboratory bioassays are conducted continuously to assess the effectiveness of new B.t. products against various defoliating lepidopterans. These products are provided by industry and include recently discovered natural strains as well as genetically-engineered gene products (heat-killed preparations of E. coli and Pseudomonas with unaltered genes of existing B.t. strains).

3. Residual toxicity of B.t.

Residual toxicity of Thuricide 48LV was studied on sprayed balsam fir seedlings placed outside in various enclosures, permitting full exposure to sun and rain and exposure to sun only (rain excluded). A control group was sheltered from both sun and rain. Residual toxicity on the foliage was determined by daily bioassay against spruce budworm larvae. The effectiveness of two stickers (3% RA1990, Monsanto and 3% Rhoplex, Rohm and Haas) was evaluated on exposed seedlings. Data analysis is not yet complete. However, under sunny conditions with very little rain (June trial) 50% of original activity remained after 5 days as compared with 1-2 days under rainy conditions (July trial). The two stickers did not substantially improve residual toxicity. Inactivation by sunlight does occur but has a relatively long-term effect. It appears that washoff by rain is more critical to the success of a spraying operation, especially in the first few days after application.

1987 Field Study: ULV application of B.t. against gypsy moth

Current use of B. thuringiensis against gypsy moth involves application of diluted formulations in 6 to 9.5 L/ha. Recent experience with spruce budworm control indicates that efficacy of B.t. is improved by applying undiluted formulations in 1.5 to 2.5 L/ha. We compared spray deposition in an oak forest canopy resulting from two volume application rates (1.8 versus 6.4 L/ha) and related spray deposits on the foliage to gypsy moth mortality in bioassays. The study was conducted in cooperation with C.J. Wiesner and C.M. Riley of New Brunswick Research and Productivity Council. Three 35 ha blocks of oak forest were treated with Dipel 8AF (aqueous flowable, 12.6 BIU/L) at 30 BIU/ha in 1.8 L (undiluted) and 6.4 L (diluted), using a Cessna 188 equipped with four Micronaire AU4000 atomizers. Spray deposits were assessed on 20 trees per block by collecting 1 branch from upper, middle and lower canopy. Microscopic assessment of drop density and size was done on 20 leaves of each branch. Of the same branches 3 twigs were taken for bioassay against second-instar gypsy moth larvae. Total spray deposition decreased with increasing canopy depth. This decrease was less noticeable in the 1.8 L/ha spray at 50% leaf expansion. In the 1.8 L/ha and 6.4 L/ha at 70% leaf expansion, total spray deposition in mid and lower canopies was about 40% of deposition in upper canopies. Mean drop densities on upper leaf surfaces were always higher than on lower leaf surfaces and were greatest in the upper canopy. Volume median diameter (VMD) of droplet spectra on both leaf surfaces decreased with increasing canopy depth indicating better penetration of the canopy by smaller droplets. Number median diameter (NMD) of droplet spectra on both leaf surfaces were consistently in the 30-50 µm range. Total mortality reached the same level in all blocks. Mortality was positively correlated with spray deposits and decreased with increasing canopy depth. Smaller droplets of undiluted B.t. caused at least as much mortality as larger droplets of diluted B.t. at about four-fold lower drop densities. Thus, ultra-low-volume application of undiluted B.t resulted in more uniform spray deposition within the canopy than high volume application. Drop densities in the low volume blocks were substantially lower, but the higher B.t. concentration in the smaller droplets led to equivalent or higher larval mortality. Application of undiluted B.t. could thus offer equal or improved foliage protection at much lower treatment costs.

RESEARCH ON INSECT VIRUSES

(Project No FP-13 Virus Applications)

Report to the 15th Annual Forest Pest Control Forum

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Summary

Three viral products, Lecontvirus, Virtuss and TM BioControl-1 received full registration status in Canada in 1987. Virtuss was aerially sprayed on whitemarked tussock moth in Newfoundland. A 25-ha plot was treated with an aqueous suspension of $2.5X10^{11}$ polyhedral inclusion bodies/ha in 9.4 L/ha when larvae were in the second and third instars. A viral epizootic resulted which virtually eliminated the insect population from the treated plot and spread to an adjacent untreated check area.

Introduction

FPMI holds the only registrations for viral insecticides in Canada. Lecontvirus, Virtuss and TM BioControl-1 were granted temporary registrations in 1983. A registration package for Sertifervirus (European pine sawfly NPV) is currently under review. It is intended to prepare a package for Disparvirus (gypsy moth NPV) in the near future.

Dr. J.C. Cunningham was on a Career Development Assignment in UK from September 1986 to August 1987 where he studied the commercial development and formulation of biocontrol agents with Microbial Resources Ltd and application technology at the Institute of Virology, Oxford.

Douglas-fir tussock moth

Following the submission of more toxicological data, two NPV products, Virtuss and TM BioControl-1, were upgraded from temporary to full registration status. Virtuss is the FPMI product which uses whitemarked tussock moth as the host insect for virus production and TM BioControl-1 is the USDA Forest Service product. A large quantitiy of TM BioControl-1 has been purchased by the province of British Columbia. The last outbreak of Douglas-fir tussock moth collapsed in 1983 and, based on pheromone trapping and surveys by PFC staff, an outbreak is not expected in 1988.

Whitemarked tussock moth

Douglas-fir tussock moth NPV also infects whitemarked tussock and rusty tussock moth. It is desirable to add these species to the Virtuss label. An outbreak of whitemarked tussock moth in Newfoundland provided an opportunity to conduct efficacy tests on this species. Ground spray trials were undertaken in 1986.

On June 10, 1987, Virtuss was aerially applied to 25 ha of predominantly white birch and balsam fir forest infested with whitemarked tussock moth near Bottom Brook, Newfoundland. A Piper Pawnee equipped with six AU 4000 Micronair units was used to apply a dosage of $2.5X10^{11}$ polyhedral inclusion bodies (PIB)/ha in 9.4 L/ha in an aqueous formulation containing 60g/L Orzan LS (a UV protectant) on second and third instar larvae. A similar infested stand was located nearby as an untreated check area.

Pre-spray population counts indicated a mean of 92 larvae/m^3 birch foliage in the treatment plot compared to 86/m^3 in the check. Pre-spray levels of naturally occurring NPV were 1.8 and 2.6% in the treatment and check plots,respectively. At 4 weeks post-spray, a population count of 68 larvae/m^3 was recorded in the treated plot compared to an increase to 100/m^3 in the check plot. Microscopic examination of larvae indicated 91% and 68% infection in the treated and check plots, respectively. At 6 weeks post-spray only 2 larvae were found in the treated plot compared to $3/m^3$ foliage in the check area; all larvae collected at this time were infected with NPV.

From these results, it appears that an aerial application of Virtuss at the dosage of $2.5X10^{11}$ PIB/ha, recommended on the label for Douglas-fir tussock moth control, is also effective for control of whitemarked tussock moth larvae. The relative roles of (a) spread of Virtuss from the treated to the check plot and (b) naturally occurring whitemarked tussock moth NPV in the decline of the check plot population, have yet to be assessed.

Redheaded pine sawfly

The FPMI product Lecontvirus received full registration status under the Pest Control Products Act after further toxicological data were submitted. This NPV has been extensively used by OMNR personnel since 1980, but just prior to use in 1987, it was noted that, due to an oversight, Lecontvirus was not scheduled in Ontario. This omission was rectified, but unfortunately it was done too late to use any Lecontvirus in 1987. It is expected that normal use patterns of Lecontvirus will recommence in 1988 with FPMI staff supplying material to OMNR district staff who require it.

Gypsy moth

Gypsy moth NPV was produced during the winter months of 1986/87 and sufficient material obtained to treat 350 ha at the American recommended dosage of two applications of $2.5X10^{11}$ polyhedral inclusion bodies (PIB)/ha. However, our experience from field trials in 1986 indicates that a higher dosage is desirable. A method of preparing a finely-ground wettable powder formulation has been developed, but no field trials were conducted in 1987.

Two companies have expressed interest in the commercial production of gypsy moth NPV, Calliope in France and Espro Inc. based in Maryland. Widescale use of NPV for gypsy moth population regulation depends upon a reliable commercial source at a cost similar to B.t. Using data from the US Gypchek registration petition, a Canadian registration document will be prepared by FPMI staff and submitted in 1988.

Plans for 1988

1. To prepare a petition for the registration of gypsy moth NPV (Disparvirus) in Canada.
2. To conduct field trials with FPMI-produced gypsy moth NPV and any commercial samples of this virus made available to us and to attempt to establish the minimum dosage of NPV giving acceptable control and foliage protection.
3. To conduct a survey at several sites in Ontario to determine if NPV is, in fact, the major factor in the current gypsy moth population decline.
4. To supply Lecontvirus to OMNR staff as required.

SEX PHEROMONES OF FOREST INSECT PESTS: MONITORING THE LARGE ASPEN TORTRIX, *Choristoneura conflictana*

[Project No. FP-30 - Pheromones]

Report to The 15th Annual Forest Pest Control Forum

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Sex Pheromones of Forest Insect Pests: Monitoring the Large Aspen Tortrix, *Choristoneura conflictana*

Monitoring insect populations with pheromone traps is an efficient and effective means of determining the presence and geographical distribution of pest species, and for providing an early warning of potentially damaging population build-ups. When trap catches are strongly correlated with other measures of population levels such as larval densities, egg densities, or defoliation, pheromone traps could be used to replace these sampling methods, which are generally more time-consuming, labour-intensive and expensive. A greater benefit accrues if the pheromone trap catch indexes the following year's larval population; in this case, the trap catch has predictive value.

Reported here is some of our progress toward developing a pheromone monitoring system for the large aspen tortrix, *Choristoneura conflictana*, that can be used to determine the current year's population level and indicate the level of the following year's larval population. The monitoring system also serves as a model for other deciduous defoliators.

Sampling of larvae, eggs and moths was initiated in 1986 and expanded in 1987. The 1986 effort was exploratory and involved only 13 sites near Sault Ste. Marie, Ont. Sampling in 1987 was increased to 18 sites (the maximum that could be handled by the available manpower) and there was an increase in the number of larval and egg samples taken at each site. Pheromone trap dosage was reduced from 30 μg/trap in 1986 to 10 μg/trap in 1987 to increase trapping sensitivity and reduce the number of moths that needed to be counted. Because 12 sites were common to both years, it was possible to test whether trap catch in the current year (1986) would correlate with the larval population in the following year (1987).

Larval sampling during late May and early June involved taking three 80 cm branches from the mid-crown of each of 6 trees/site in 1986 and from each of 8 trees/site in 1987. Moth sampling was carried out with 3 Multi-Pher nonsaturating traps/site containing a 2x2 cm piece of Vapona to kill trapped insects. Traps were baited with (Z)-11-tetradecenal, a known sex pheromone component of this species, and were placed on trees near the edge of a stand and as clear of foliage as possible to avoid interference with the catch. Traps were deployed before moth flight commenced in mid-June and were taken down in early July after moth flight was completed. Egg sampling commenced in early July and involved counting egg masses on 3 branches from each of 6 trees/site in 1986 and from each of 8 trees/site in 1987. In 1987, leaf bunches/branch were counted so that insect density could also be expressed as larvae or eggs per leaf bunch.

All data were regressed using a common logarithim transformation of $\bar{x}$ larvae/branch (or larvae/leaf bunch), $\bar{x}$ eggs/branch (or eggs/leaf bunch) and $\bar{x}$ moths/trap for each site. Table 1 lists the R^2 (coefficient of determination) values obtained for some of the regressions between the three life stages for both 1986 and 1987.

As the table shows, the within-year correlations between trap catch and larval populations (expressed as larvae/branch) were quite good for both years considering the small number of sites involved and the exploratory nature of the sampling methods. When larval density was expressed as larvae/leaf bunch instead of larvae/branch, there was little change in the R^2 values (not shown). Figure 1 illustrates the within-year relationship between trap catch and larvae/branch for the 1987 data and provides the regression equation for the relationship. Interestingly, in 1987 parasitism was high in the plot with the highest larval population. Because parasitism would produce a lower than expected moth population (which was indeed the case), the data for the parasitised site was removed from the data set and the data reanalysed. The resulting R^2 value increased to 74.6%. This suggests that some caution is needed when interpreting moth catch in areas where high insect density is expected.

The correlations between egg masses and moth catch for 1986 and 1987 were not as good as those obtained for larvae vs moths, although the relationship obtained for 1987 was satisfactory. Similarly the relationship between egg masses vs larval populations were also lower but still reasonable. Because egg masses are fewer and harder to find than larvae, it is possible that relationships involving egg masses are subject to greater variability leading to weaker correlations. More or better egg sampling may be required to achieve better correlations.

The results described here suggest that pheromone trap catches adequately reflect larval and egg mass densities in the current year and, therefore, could replace either of these sampling methods to estimate populations of the large aspen tortrix. Attempts to correlate defoliation with trap catch were confounded by the fact that defoliation in the various sites was usually caused by more than one insect species (the forest tent caterpillar, Enargia decolor, several leaf rollers, along with the large aspen tortrix). Obviously monitoring with pheromone traps avoids any confusion that can occur when multiple species are responsible for defoliation at a given site.

The predictive value of pheromone trap catch is illustrated in Figure 2 where one year's trap catch (1986) is regressed with the following year's (1987) larval population. The R^2 value of 51.1% is quite good when one considers that only 12 sites are involved in the analysis, that larval and egg sampling methods were worked out as the study went along, and that optimum trapping conditions were still under study. When the 1986 eggs mass densities were regressed against the 1987 larval population, the R^2 value (63.0%) was somewhat better indicating that there is room for improvement as far as pheromone monitoring is concerned. Since the entire exercise will be repeated in 1988 using standardized sampling methods worked out in 1986 and 1987, we should have a pretty good idea of how useful pheromone monitoring will be for predicting future larval populations of the large aspen tortrix and whether it can reliably replace the more traditional sampling methods. The results so far are encouraging.

Table 1. The R^2 (coefficient of determination) values for within-year regressions of various life stages of the large aspen tortrix, *Choristoneura conflictana*.

Relationship between	R^2 for Sampling Year 1986	1987
Larvae/Branch vs Moths/Trap	72.4	69.1
Eggs/Branch vs Moths/Trap	47.5	57.5
Larvae/Branch vs Eggs/Branch	55.0	53.1

Note: All data normalized using Log_{10} transformation. There were 13 sites for 1986 and 18 sites for 1987 sampling.

FIG. 1

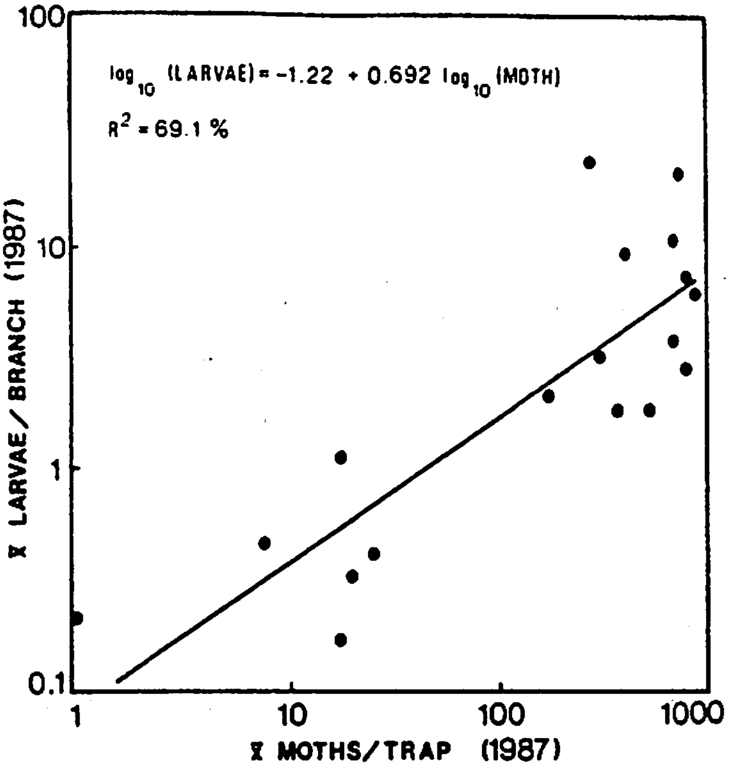

FIG. 2

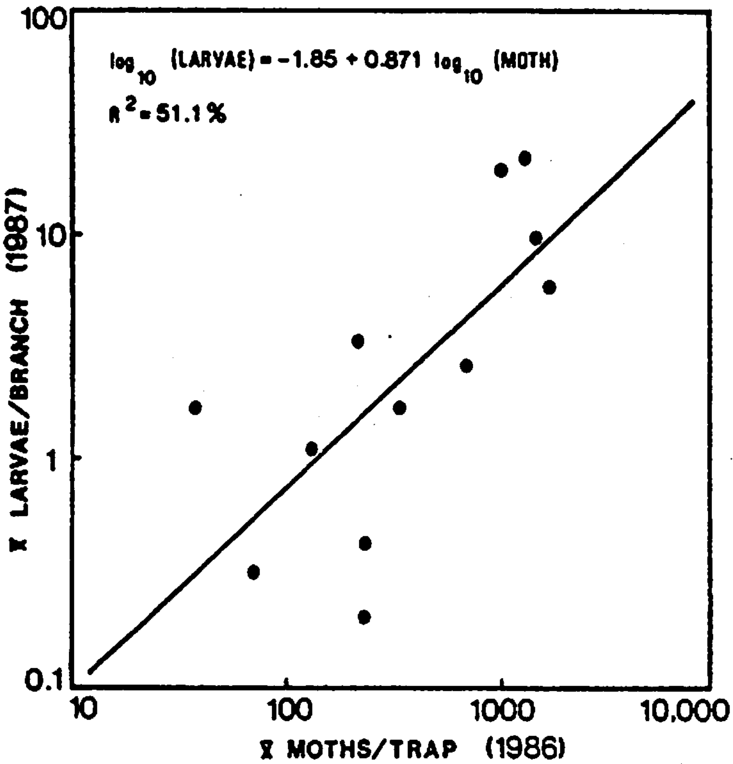

Fig. 1. Relationship between the number of Choristoneura conflictana moths caught in Multi-Pher traps and the larval density in the same year (1987).

Fig. 2. Relationship between the number of Choristoneura conflictana moths caught in Multi-Pher traps in the previous year (1986) and the larval density in the following year (1987).

FIELD TRIALS OF DIFLUBENZURON AND OTHER BENZOYLPHENYL UREA - INSECT GROWTH REGULATORS AGAINST THE GYPSY MOTH, THE SPRUCE BUDMOTH, AND THE WHITE PINE WEEVIL IN ONTARIO AND QUEBEC

[Project No. FP-31 - Insect Growth Regulators]

Report to The 15th Annual Forest Pest Control Forum

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Field Trials of Diflubenzuron and Other Benzoylpehnyl Urea - Insect Growth Regulators Against the Gypsy Moth, the Spruce Budmoth, and the White Pine Weevil in Ontario and Quebec

Interest in developing Benzoylphenyl urea - Insect Growth Regulators that act by selective inhibition of chitin synthesis in juvenile insects has been steadily increasing among chemical companies. We have been actively involved in screening many new IGRs against forest insects in addition to developing materials such as diflubenzuron for practical use as control agents.

1. Gypsy moth trials in Ontario

Diflubenzuron WP-25 and 48% flowable were tested at 70 g AI/ha on 30 ha plots of oak forests infested with gypsy moth, Porthetria dispar, near Mazinaw Lake (Tweed), Ontario. The WP-25 was sprayed at 2.5 and 5 L/ha and the 48% flowable at 5L/ha. The results are shown in Table 1.

As expected, total control was achieved in all 3 plots. Judging from our experience in Newfoundland where we found that 2.5L/ha was not nearly as efficient as 5L/ha, we feel that 5L/ha is perhaps a more prudent volume to use for gypsy moth. The flowable was better for mixing and spraying. Early application when the buds are just beginning to open and the gypsy moth eggs have not yet hatched provides total control. We are convinced that for gypsy moth diflubenzuron is the best control agent. In the U.S. most of the control operations for gypsy moth is carried out with diflubenzuron (or Dimilin).

2. Spruce budmoth trials in Quebec

Two Insect Growth Regulators, Diflubenzuron and Teflubenzuron were sprayed at the rate of 70 and 140 g in 10L/ha on 15 ha white spruce plantations infested with the spruce budmoth, Zeiraphera canadensis using a helicopter. The work was performed in collaboration with Dr. Luc Jobin (LFC) and the Quebec Ministry of Energy and Resources.

The material was sprayed before egg hatch when the bud cap was still intact and after egg hatch when the bud was open. Also, the helicopter sprayed at 40 KMH and 50 KMH to simulate back-pack spraying and fixed-wing aircraft spraying respectively. Because of helicopter problems the developmental timing did not coincide with the actual spray dates. The results of the spray were disappointing. We feel that in addition to the timing being off, the dosage was too low. We have planned to perform some laboratory testing during this winter and later conduct a field trial in Matapedia in 1988 in collaboration with Dr. Jobin and the Quebec Ministry of Energy and Resources.

3. White pine weevil trials in Ontario

The tangle-foot and chevron sticker treatments resulted in inconsistent results on the white pine weevil, Pissodes strobi, and were therefore abandoned. Instead we embarked on an ovicidal control program. It is known that weevils are particularly sensitive to ovicidal effects of diflubenzuron. The females pick the material up either by wandering on contaminated foliage or feeding on the material and transferring it to the eggs during oviposition. Also, contaminated males can transfer the material to the female during copulation. The eggs that have been smeared with diflubenzuron develop normally but embryos are unable to eclose. It was felt that if the trees are sprayed with diflubenzuron prior to weevil emergence, then there is a high probability of getting the material on the weevils as they wander around.

Spray timing of the material is very critical. Since the weevils are active even at 0.5°C, the only factor that prevents weevil emergence in early spring is the snow cover. Therefore diflubenzuron has to be sprayed even when the snow is on the ground. Conversely, because diflubenzuron persists on the foliage and leaders, the material can be sprayed in late fall (Nov.) after the weevils had entered diapause.

We conducted back-pack spray trials in Thessalon and in Tweed in collaboration with Mr. Tim Gray, Ontario Ministry of Natural Resources. We sprayed 250 g AI in 10L per ha of 25-WP on scots pine and white pine infested with the weevil. One set of plots were sprayed in late fall and another in early spring when the ground was still covered with snow. All the damaged leaders in the treatment and control plots were removed prior to spraying. The plots were examined in late July and the effect of the treatment was evaluated by counting the number of weevil-damaged leaders. The control plots had 30 to 40% damaged leaders whereas the treated plots has < 1% damage. While we are cautiously optimistic, we are reserving judgement until we can repeat the results next year. We are repeating the trials in Thessalon, Tweed (in collaboration with Mr. Tim Gray, OMNR) and in Quebec city (in collaboration with Drs. Jobin and Ashambault).

4. Laboratory and greenhouse trials

Several new IGRs are being tested on a variety of forest insect in the laboratory and in the greenhouse.

TABLE 1. Results of aerial application of Dimilin against the gypsy moth, *Porthetria dispar* near Mazinaw Lake, Ontario (1987).

	PRE-SPRAY			POST-SPRAY		
Plot No.	Treatment	Egg Mass Per Tree	Larvae Per Tree	Healthy Larvae And Pupae Per Burlap Trap	Parasitized And Virus Infected Insects Per Trap	Total Number Per Trap
1.	25 WP 70 g AI/2.5L/ha	12	0.5	0	--	< 1
2.	25 WP 70 g AI/5L/ha	1	0.03	0	--	< 1
3.	Flowable-48% 70 g AI/5L/ha	1	0.02	0	--	< 1
4.	Control-1	6	0.3	3	1	4
5.	Control-2	7	0.2	14	3	17
6.	Control-3	19	0.9	31	8	39

Experimental Applications of four *B.t* Formulations to Control Spruce Budworm in 1987: A Summary of Preliminary Results

Report to the 15th Annual Forest Pest Control Forum

(Ottawa, Ontario 17-18 November 1987)

B.L. Cadogan, B.F. Zylstra and R.S. Scharbach

Project No FP-51 - Insecticide Field Efficacy

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Preamble

The winter of 1986-87 in the Thunder Bay district was unusually mild with subnormal precipitation (see Appendix 1). These conditions not only advanced the development of the insect and host tree, they also precipitated extremely high fire hazards in the research area. Thus activities i.e., plot preparations, spray application and biological sampling were subjected to, and limited by, the guidelines that govern restricted fire zones.

Early prespray assessments showed that budworm numbers ranged from 45 to 109 larvae per 46 cm branch. Then a heavy frost occurred. The damage inflicted and the resultant larval mortality and foliage deterioration were sporadic but nevertheless appeared to affect one check area more signigicantly than the treated areas.

Experimental Applications of four *B.t* Formulations to Control Spruce Budworm in 1987: A Summary of Preliminary Results

B.L. Cadogan, B.F. Zylstra and R.S. Scharbach

Four *Bacillus thuringiensis* formulations, three Dipel [Abbott Laboratories, Chicago] and one Futura [Chemagro Ltd., Mississauga] were sprayed experimentally in 1987 to determine their efficacies against spruce budworm *Choristoneura fumiferana* (Clem.).

Dipel 8AF (16.8 BIU/) is an aqueous formulation and Dipel 12 L's reputed advantage is its high potency (25.2 BIU/) (Table 1.). Both of these are not registered in Canada and require definitive data before registration is accomplished. Thus the two unregistered products were compared against Dipel 8L (16.8 BIU/) which is registered for use in Canada.

Futura XLV (extra low viscosity) is registered for use against jack pine budworm *C. pinus pinus* Free. but not against *C. fumiferana* thus the necessity for data that are necessary for objective evaluation of the product.

Materials and Methods

The research was conducted in the Nipigon area, Ontario (Fig. 1). Seven 50 ha blocks were used and in each block 81 to 90 balsam trees *(Abies balsamea* L.) were selected as sample trees.

All the formulations were dyed with Erio acid red dye (CIBA Gergy, Dorval, Quebec) to facilitate droplet assessments. Details pertinent tothe spray applications, weather at the time of spray, etc. are presented in Table 1 and the methods re sampling etc. used in the study are detailed in a previous report (Cadogan et al 1984).

Results and Discussion

Deposit. The deposit data are summarized in Table 2. Thirty minutes after each spray, foliage was collected and examined but it was not possible to objectively and/or accurately count or measure droplets (stains?) on the balsam fir needles. Judging from the deposit on kromekote cards, Dipel 8AF appeared to atomize as satisfactorily as Dipel 8L. Dipel 12L was very viscous at 5°C and pumped slowly. This material will probably require powerful diaphragm pumps if quick loading is required. Nevertheless, after the formulation was circulated repeatedly within the aircraft, Dipel 12L atomized satisfactorily.

Futura XLV exhibited excellent physical characteristics and atomized efficiently.

At the time of writing, characterization of the 5 spray-spectra is incomplete, thus no VMD NMD's are presented.

Population reduction and defoliation. The budworm populations in Check block B were seriously affected by a frost which destroyed most of the foliage in the block. Consequently the larval morality in this block was unusually high due to starvation and could not be called "natural". Therefore, this block was not used for "correcting" mortalities in the treatment blocks.

All the *B.t* treatments at 30 BIU/ha were satisfactory in reducing budworm populations (Table 2). However, Dipel 8AF at 20 BIU/ha did not satisfactorily reduce populations. These data will require closer examination before we can determine why this is so.

The Dipel treatments apparently prevented excessive defoliation of the host trees; but Futura XLV did not exhibit satisfactory foliage protection.

These very preliminary data suggest that both Dipel and Futura XLV at 30 BIU/ha were successful in controlling spruce budworm. The Dipel treatments satisfactorily protected balsam fir from heavy defoliation while Futura XLV in this trial was only marginal in protecting foliage.

Literature Cited

Cadogan, B.L., B.F. Zylstra, P. de Groot & C. Nystrom. 1984. The efficacy of aerially applied Matacil to control spruce budworm *Choristoneura fumiferana* in Bathurst, New Brunswick. FPMI Information Report FPM-X-64.

Table 1. Details pertinent to the application of Dipel and Futura XLV. Nipigon, Ontario 1987.

Treatment	Dipel 8L (16.8 BIU/ℓ)	Dipel 8AF (16.8 BIU/ℓ)	Dipel 8AF (16.8 BIU/ℓ)	Dipel 12L (25.2 BIU/ℓ)	Futura XLV (14.4 BIU/ℓ)
Spray date (time)	30/5(0850h)	5/6(0922h)*	30/5(0705h)	5/6(0640h)	6/6(0636h)
Appl. rate (BIU/ha)	30	30	20	30	30
(ℓ/ha)	1.78	1.78	1.18	1.18	2.08
A/C height above canopy (m)	18	18	18	18	18
A/C speed (km/h)	160	160	160	160	160
Emission rate (ℓ/min)	21.4	21.4	14.2	14.2	25
Swath width (m)	45	45	45	45	45
Atomizers	4-AU3000	4-AU3000	4-AU3000	4-AU3000	4-AU3000
Atomizer blade setting (°)	30	30	35	30	30
<u>Weather at spray time</u>					
Temperature °C	20.7±.7	12.7±.6	18.0±.4	6.5±1.5	5.2
% RH	80	50*	90	95	93
Wind speed (km/h)	7.1±2.3	9.3±2.4	11.1±2.1	6.6±1.7	3.0±1.4
Wind direction °AZ	256±23	263±26	256±12	238±12	117±24
Block orientation °AZ	127	88	118	105	40
Weather stability	small lapse	small lapse	small lapse	strong inversion	strong inversion

* Due to a delay caused by aircraft spray problems.

Table 2. Spray deposit, spruce budworm population reductions and host tree defoliation following applications of Dipel and Futura XLV. Nipigon, Ontario 1987.

Treatment	Application rate/ha		No. of Samples	Spray deposit ($\bar{x}$±SD)		Population reduction[1]			% defoliation
						Larvae/46 cm branch($\bar{x}$±SD)		% corr. mortality	
	BIU	ℓ		drops/cm^2	ℓ/ha	Prespray	Final post spray		
Dipel 8L	30	1.78	90	12.1±9.9	.68± .37	7.3±5.3	0.9±1.0 21	81	29
Dipel 8AF	30	1.78	87	7.3±6.4	.85± .22	10.8±5.9	0.4±0.6 19	94	25
Dipel 8AF	20	1.18	90	9.4±7.1	.77± .32	10.1±5.9	2.8±2.2 24	54	18
Dipel 12L	30	1.18	81	8.8±5.9	.55± .15	3.2±2.0	0.5±0.8 19	75	13
Futura XLV	30	2.08	90	11.9±0.91	.70±1.86	15.7±9.4	3.0±3.2	7[1]	58
Check Block A			90			4.8	3.2	N/A	27
Block B			90			13.7	3.0	N/A	76

[1] Block B not used for correcting mortality due to heavy frost damage.

Appendix 1
Temperatures and precipitation for normal winter months versus months of the 1986-1987 winter. Thunder Bay Ontario.

Month	Mean Temp. °C	Total rainfall (mm)	Total snowfall (cm)	Total Precip. (mm)
Nov 1986	- 5.4	41.4	24.2	62.7
Normal	- 2.6	25.3	29.8	52.9
Dec 1986	- 7.2	trace	16.8	9.8
Normal	-11.1	4.1	46.2	41.7
Jan 1987	-10.5	0.4	30.04	23.3
Normal	-15.4	1.9	48.4	40.9
Feb 1987	- 6.0	0	21.6	14.1
Normal	-13.0	1.9	30.7	28.3
March 1987	- 3.0	2.6	9.8	11.2
Normal	- 6.3	13.7	34.2	45.0
April 1987	6.1	4.2	0.2	4.4
Normal	2.5	35.4	16.2	50.7
May 1987	9.6	65.4	0	65.4
Normal	8.8	69.2	4.2	73.4

Supplied by Environment Canada, Thunder Bay, Ontario

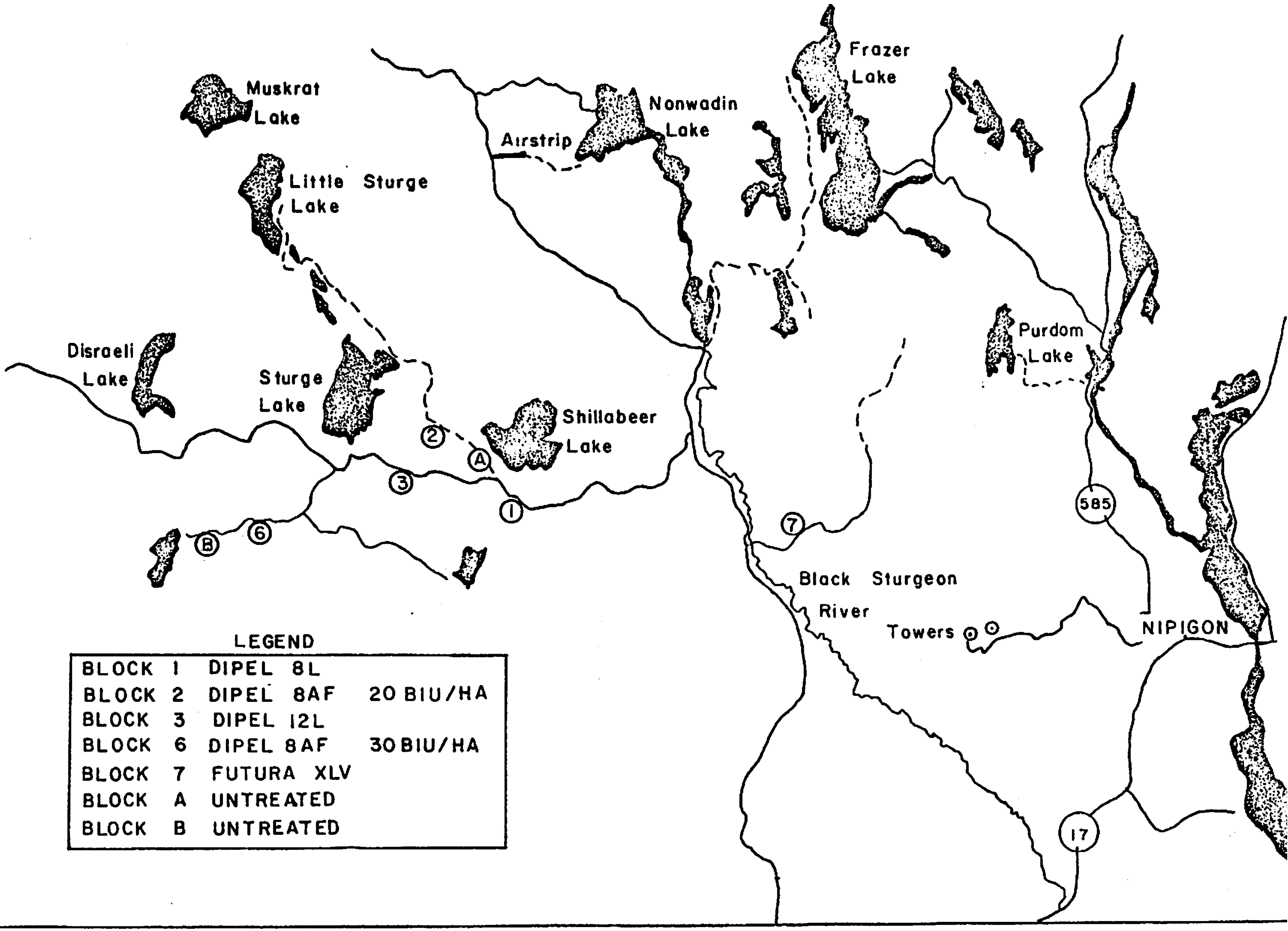

Fig. 1: Map of Research Sites, Nipigon, 1987

OPERATIONAL HERBICIDE RESEARCH CONDUCTED BY FPMI IN 1987

[Project No. FP-54-1 - Herbicide Applications]

Report to The 15th Annual Forest Pest Control Forum

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Operational Herbicide Research Conducted by FPMI in 1987

New operational herbicide research carried out by FP-54-1 in 1987 was conducted in northwestern New Brunswick in cooperation with DuPont Canada, Inc. and J.D. Irving, Ltd. This work involved research with VELPAR ULW, a new dry-flowable granule formulation of hexazinone. In addition FP-54-1 installed treatment blocks for a proposed brush herbicide trial, also in New Brunswick. This proposed trial is targeted to proceed in the summer of 1988.

Finally, FP-54-1 continued to collect follow-up data (i.e. weed efficacy, crop tolerance and crop growth) for herbicide trials previously established in 1984 and 1986. These included VELPAR L (liquid hexazinone) and VISION (glyphosate) trials established in New Brunswick and British Columbia in 1984 and hexazinone (PRONONE and VELPAR L), metsulfuron-methyl (ALLY) and sulfometuron-methyl (OUST) trials established in New Brunswick and Ontario in 1986. PRONONE is a granular formulation of hexazinone.

VELPAR ULW Research:

VELPAR ULW is DuPont's newest formulation of hexazinone, consisting of ultra low weight dry flowable granules of the herbicide. A comparative weed efficacy, crop tolerance, crop growth trial of VELPAR ULW versus VELPAR L (liquid formulation) was initiated near the Boston Brook airstrip (J.D. Irving, Ltd. freehold land) in late June 1987. VELPAR L is temporarily registered for ground forestry applications, and is expected to receive a permanent registration, inclusive of aerial, soon. The purpose of the trial was to compare the overall desirability of the two formulations when applied aerially. Because of its light weight, the ULW formulation is expected to be less costly to apply operationally than VELPAR L. Data collected in 1987 (Pitt et al., 1988a), 1988 and 1989 will be used to support registration of the ULW formulation.

OUST, ALLY, PRONONE Research:

After two full growing seasons, soil-applied OUST continued to show acceptable levels of raspberry and grass control, whereas control of these species declined markedly after one growing season for soil-applied ALLY (Reynolds et al., 1988a). PRONONE, a granular formulation of hexazinone, continued to perform in a comparable manner to VELPAR L (Reynolds et al., 1988b). Fall soil treatments of both hexazinone formulations as well as summer foliar treatments with OUST and ALLY resulted in acceptable weed efficacy after one growing season. None of the herbicide treatments resulted in unacceptable crop injury. Although further evaluations are needed for 1988, preliminary results suggest that OUST (300 g ai/ha) is a viable alternative to hexazinone as a soil-applied site preparation herbicide and to glyphosate as a foliar-applied conifer release herbicide for raspberry and/or grass control.

Enhanced Crop Tree Growth Resulting from VELPAR L Treatment:

Bareroot white spruce trees planted in 1985 following a 1984 soil-applied VELPAR L treatment (i.e. cooperative study with DuPont Canada and J.D. Irving, Ltd.) grew dramatically in response to the treatment (Pitt et al., 1988b). Trees planted in treated and untreated plots were compared statistically for their health, condition, total height, height increment and basal stem diameter. Results of this analysis confirmed that those trees planted in treated plots were healthier and grew significantly more for all growth parameters measured than their counterparts planted in untreated plots. Enhanced growth of trees planted in VELPAR treated plots was positively correlated with the establishment of fireweed and the displacement of raspberry caused by VELPAR treatment. By contrast, untreated plots were characterized by a presence of raspberry and an absence of fireweed. Enhanced tree growth is probably attributable to fireweed mediated nitrogen fixation. In addition, once established, fireweed may also act to biologically control raspberry by making the microsite environment less suitable for the survival of this species. Further research on actual nitrogen fixation rates and on the effects of eliminating fireweed cover (i.e. half of the research site was retreated with glyphosate in August 1987) is planned for 1988. Crop tree growth will continue to be monitored in 1988 and thereafter to establish whether the elimination of fireweed cover leads to a decrease in crop growth.

Carnation Creek Glyphosate Research:

The 1987 field season for FP-54-1 concluded with a third year vegetation assessment of the Carnation Creek watershed, located on the west coast of Vancouver Island. The watershed was treated in 1984 with glyphosate. Data collected in 1987 will be incorporated into a silviculture paper (Reynolds et al., 1988c) to be presented at the Third Carnation Creek Workshop to be held this December 8-10 in Nanaimo, B.C. The workshop will focus on glyphosate environmental impact research conducted at the watershed since September 1984.

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Tween-20 did not. (A clear enhancement in phytotoxicity could not be distinguished in the adjuvant + Vision series at 0.25 kg/ha prior to the onset of autumn leaf fall.)

In a separate field trial, north of Iron Bridge, Ont., the inorganic additive, ammonium sulphate, was tested for its affect on Vision efficacy in a stand of balsam poplar. Four 40 sq m plots were laid out to include: a control plot, ammonium sulphate alone, Vision alone and a plot treated with the herbicide + adjuvant mixture. Treatment levels were 2.5 kg. product/180L/ha for ammonium sulphate and 0.5 kg A.I./180L/ha for Vision. The applications were made August 21, 1987 using the "solo" backpack hand sprayer. Evaluations were conducted three weeks later. Results from this preliminary study suggest the possibility of some enhancement of brush control by the addition of ammonium sulphate to Vision.

(ii) Effects of Nozzle types on Efficacy of Forest Herbicides

Two nozzle types (i) CDA-Herbi, emitting a droplet spectrum with a median droplet size ca. 250 um and (ii) a modified CDA nozzle with lower rotatory speed and widened orifice, and emitting a droplet spectrum with a median droplet size ca. 550 um, were used to assess the influence of small and large size droplets on efficacy of Velpar-L and Vision @ 2 kg/40 L/ha. The experiment was conducted in a stand of aspen poplar ca. 1-2 m tall. The volume (40 L/ha) and the dosage (2.0 kg/ha) was kept constant and the plots (5x5 m) were sprayed on 15 August/86. Again the design of the experiment was a randomised block layout with small buffer zones. To minimize variability, treatments were replicated three times and a total of 120 individual weeds were assessed for phytotoxicity. Kromekote cards were used to monitor the distribution pattern and size of droplets emitted by each type of nozzle. Observations made in early Sept. (12/86) were inconclusive due to high variability. The data from Velpar treated plots did indicate that the CDA-Herbi nozzle (droplet size-250 m) produced greater mortality of weeds than the modified CDA rotary nozzle with widened orifice (droplet size-550 m). However, the effects of Vision were not so clear, because being a systemic herbicide, its effects are somewhat delayed. In a followup round of observations taken in July (8/87) on the same plots, results for Vision agreed with those found for Velpar and demonstrated that smaller size droplets (250 m) were more potent than large ones (550 m). Again the variability was high and efforts are being made to minimize this variability.

(iii) Collaborative Field Research

a) No observation effects levels, (NOEL), of Vision:

To determine a suitable buffer zone for aerial application of Vision, a collaborative research program involving the University

SUMMARY REPORT OF THE STUDIES ON HERBICIDES TOXICOLOGY AND SCREENING

[Project No. FP-54-2 - Herbicide Toxicology]

Report to The 15th Annual Forest Pest Control Forum

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November 1987

Summary Report of the Studies on Herbicide Toxicology and Screening

Introduction

The aims of the Herbicide Toxicology and Screening Study are to determine the toxicological and physiological properties of herbicides and their formulations and other chemicals on forest weed species and selected crop trees and for those that show potential for use, to provide possible dosage levels and use patterns for further field testing. This is accomplished by carrying out extensive studies in the greenhouse as well as under natural forestry situations employing small (field) plot techniques.

A. Greenhouse Studies

(i) Evaluation of Adjuvants on Herbicide Efficacy and Crop Tolerance

Spray adjuvants are a class of chemicals which, when added to herbicide formulations, modify and facilitate the effectiveness of the active ingredients. In so doing they reduce the cost of application and chemical burden in the environment. The additives LI-700 and ammonium sulphate were evaluated for their impact on the crop tolerance and efficacy of Vision. Tests were conducted on three forest crops (balsam fir, jack pine and white spruce) and three forest weeds (alder, aspen and white birch). Dosage rates were ammonium sulphate: 2.5 and 4.0 kg/ha; LI-700:0.5% v/v. It had previously been found that, at field dosage levels (2.0 kg/ha), Vision tended to mask any effect on phytotoxicity produced by the adjuvant. Reducing the Vision concentration to 1.1 kg/ha allowed a more sensitive assessment of additive activity. As usual, different spp. reacted differently to each combination of herbicide and adjuvant but, in general, all adjuvants appeared to facilitate foliar penetration of herbicides and thereby increased their efficacy. This was confirmed by feeding C^{14} glyphosate to weed species in the presence and absence of an adjuvant (G3780A). All 3 conifer spp. tolerated the mixture of herbicides and adjuvants and no phytotoxicity was apparent. At higher concentration (4.0 kg/ha), ammonium sulphate caused some injury (burn-down) to aspen and birch foliage.

(ii) Influence of Droplet Size on Herbicide Efficacy

Considerable controversy exists in regard to droplet size, volume and dosage rates on herbicide efficacy; some believe that smaller droplets are more potent than larger ones while others hold the opposite view. Because newer herbicides (Vision, Garlon and Velpar) are more expensive than 2,4-D, any economy in their use *via* droplet behaviour research would be of great benefit. A controlled study using 4-month old white birch seedlings grown under constant conditions of light, temp., relative humidity and nutrition was carried out. A monosize droplet generator was used to deposit droplets (155, 335, 465, 665 m) of uniform sizes on <u>single</u> leaf surfaces. Solutions of Vision (2 kg/ha), Garlon (1.8 kg/ha) and Velpar (2.1 kg/ha) with 0.1% rhodamine dye were prepared and then homogeneous droplets of above sizes were applied on the 3rd leaf. Evaluation of necrosis, epinasty, bleaching and phytotoxicity were made after 3 and 6 weeks by a standard procedure both on the individually treated leaves as well as on untreated (translocated) areas. Results demonstrated that irrespective of the type of herbicide or the weed species tested, the smaller the size of droplets (155-365 m), the greater was the phytotoxicity; the largest size droplets (665 m) proved to be least efficacious. Larger droplets induced localized "islands" of phytotoxicity on the treated leaves and thereby impeded penetration and translocation of the herbicides. Smaller droplets of translocated herbicides (Vision and Garlon) caused severe damage to shoot apices, petioles and younger leaves and complicated evaluation procedures. It seems that a better coverage of the target with finer droplets was responsible for enhanced phytotoxicity. A number of factors could come into play in the plant's response to droplet size. Variables such as leaf age and position on the plant, the type of weed and type of herbicide may have some impact on the degree or rate of phytotoxicity of a particular droplet size. For example, Velpar behaved like a contact herbicide on white birch and provided a better correlation with droplet size vs efficacy than the other two systemic herbicides. Despite this variability, these factors do not appear to alter the basic relationship. One significant influence on droplet size response is that of herbicide dosage. Even though smaller droplets (179 m) at three concentrations were more toxic than large ones (627 m), there was an interaction at the highest concentration (4.0 kg/ha) where the effect of size was completely masked and nullified. This research was carried out jointly with Leo Cadogan (FP-51).

B. Field Studies

(i) Effects of Adjuvants on Efficacy of Forestry Herbicides under Small Plot Conditions

As a followup to the previous year's work, the effectiveness of 6 adjuvants: Enhance, Ethokem, Frigate, LI-700, Triton-XR and Tween-20 was tested, this time with Vision at concentrations of 0.25 and 1.1 kg/180L/ha. The trials were conducted north of Thessalon, Ont. employing the small plot technique. Plots were arranged in a stand of trembling aspen using the randomized block layout with appropriate buffer zones and three replications. Application of treatments took place at the beginning of August, 1987. All adjuvants were applied at 0.5% v/v with two concentrations of Vision (0.25 and 1.1 kg/ha) by "solo" backpack hand sprayer. (An additional dosage for LI-700 of 0.25% v/v was also included in the series.) Evaluations were carried out after three and six weeks. Results showed that Enhance, Ethokem, Frigate and Triton-XR all increased the efficacy of Vision at 1.1 kg/ha while LI-700 and of Guelph, FP-62 (Nick Payne) and the OMNR was initiated under the aegis of COFRDA. Field plots of aspen and pincherry with red pine, north of Thessalon, Ontario were sprayed with different levels of Vision and the relevant data are being collected and processed for publication for next year.

b) Field evaluation of Nalcotrol and Vision formulation:

This work was carried out jointly with FP-61 (Alam Sundaram) to test the behavior of Nalcotrol + Vision formulation on small stands of poplar, north of Iron Bridge, Ont. Due to its physico-chemical properties (relatively high density), Nalcotrol is regarded as an anti-drift agent and holds potential as a useful adjuvant with Vision formulations.

SUMMARY REPORT OF THE STUDIES ON HERBICIDE CHEMICAL ACCOUNTABILITY

[Project No. FP-54-3 - Herbicide Chemical Accountability]

Report to The 15th Annual Forest Pest Control Forum

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1987 PEST CONTROL FORUM REPORT

HERBICIDE CHEMICAL ACCOUNTABILITY (FP-54-3)

Study Leader: D. Thompson (CH-2)
Technical Staff: B. Staznik (EG-5)
L. MacDonald (EG-6)
Contract Staff: T. Buscarini (DSS-contract)

Study Objective:

To develop and/or improve analytical methodologies for registered or developmental forestry herbicides. To implement analytical methods developed in determination of herbicide residues in terms of fate and persistence in forest ecosystems, so as to provide information pertaining to risk-benefit analysis for individual herbicides.

Progress and Achievements During 1986-87:

Owing to a change of study leaders and termination of completed projects, the herbicide chemical accountability study is presently in a transitional phase. The transitional phase has been marked by a termination of projects relating to the registered herbicidal compounds hexazinone and glyphosate and initiation of work on experimental chemicals triclopyr and metsulfuron. During 1987, a technical support staff position (EG-6) has been filled and a new analytical laboratory established. In addition to supervision of the herbicide chemical accountability study, the study leader is pursuing a doctoral degree on a part-time basis an functions as a member of the joint GLFC-FPMI safety committee as well as the seminar committee.
Research conducted within this study can be divided into distinct projects according to study site location and herbicide. Projects and achievement within the study will be presented in this context.

Carnation Creek - Glyphosate Project

During 1986 analytical methods were developed for determination of trace residues of glyphosate and it major metabolite AMPA, in soil, sediment and leaf-litter substrates of the Carnation Creek watershed. Following validation, the analytical methods were utilized to quantify residues in samples of these various substrates. A CFS information report is planned for 1988 to document the analytical methods developed for use on forest substrates.
Results of residue determinations in environmental samples have been summarized, statistically analyzed and used to prepare two manuscripts pertaining to the persistence and behaviour of glyphosate in this coastal rainforest ecosystem. The research effort will be documented as two papers incorporated into proceedings of the Carnation Creek Symposium, scheduled for December 1987 in Nanaimo, British Columbia. Journal publications planned for 1988, will mark the completion of this research project.

Dora Creek - Triclopyr Project

Late in 1986, the Herbicide Chemical Accountability (HCA) study became involved in a cooperative environmental fate and impact study on Triclopyr (GARLON) with the DOW Chemical Company as lead agency. The experiment is designed to provide information required to support registration of GARLON for silvicultural use in Canada. The HCA study has been involved in review of experimental design and protocols and also aided in initiation of the project in August 1987. Analytical methods developed by DOW researchers are currently being modified and validated by HCA staff. Valdiation of methods for determination of the butoxyethyl ester of triclopyr in water and deposit collector extracts is complete. The HCA study group is providing analytical support to the research project by utilizing the validated methods to quantify residues of triclopyr as the butoxyethyl ester, free acid and pyridinol metabolite in water, sediments and deposit collector samples from the study site. Completion of sample analyses is expected by summer of 1988. The data is to be summarized and prepared for review by the HCA study staff and subsequently submitted for journal publication in 1989, with joint authorship by DOW researchers.

Nassau Township - Metsulfuron Project

The HCA study leader is currently pursuing a doctoral degree in environmental biology at the University of Guelph on a part-time basis. A research program which focuses on analytical chemistry, as well as the aquatic fate and impact of metsulfuron methyl (ALLY) in boreal forest ecosystems, was proposed and accepted in principle during the spring of 1987 by the supervisory committee, FPMI management and DuPont Inc. officials. Subsequently, modifications to the original proposal, site selection and negotiations for financial and logistical support from DuPont Inc. have been completed, with funding received in summer of 1987. The two-year research program, involves laboratory studies to be conducted during the winter period (1987-1988) with the major field studies scheduled for summer of 1988. The central focus of the research project, as noted above, will be complimented by additional research studies designed to investigate the behaviour of metsulfuron in terrestrial substrates of boreal forest environments. Meetings with DuPont analytical chemists were recently completed. The final proposal is presently in preparation and initial investigations relating to analytical chemistry is imminent. The research project will culminate in a doctoral dissertation and journal publications, tentatively scheduled for 1990-1991.

Other Responsibilities

PRUF, COFRDA and DSS Contract Supervision

The HCA study leader has continued to function as a scientific authority for three PRUF contract research programs held by D.N. Roy at University of Toronto. Two of the three research projects, dealing with fate of hexazinone and glyphosate in boreal forest soils respectively, are now complete with final reports available through either the authors or CFS-FPMI (Errol Caldwell). The third project which deals with the persistence of glyphosate in edible forest berries is currently stalled owing to problems in developing an adequate analytical method. Barring inability to solve the problem, the project is scheduled for completion in the spring of 1988.

The HCA study leader is also acting in a supervisory capacity with Dr. N. Payne (FP-62) to provide analytical facilities and logistical support to a COFRDA contract held by Ms. V. Manniste-Squire. Validation of the analytical methods for determination of residues on deposit collector substrates is in progress and analyses of the field samples is imminent. The project is expected to be completed by 1989-90.

A DSS contract was sought and awarded to Ms. T. Buscarini, to provide technical assistance for the Dora Creek - Triclopyr research project. Ms. Buscarini began work under the contract as of September 1, 1987. The contract termination date is August 31, 1988.

Scientific Meetings

In July 1987, the HCA study leader attended an Environmental Impact Assessment Committee Meeting on the Use of Herbicides in Newfoundland. The study leader presented a review of information pertaining to environmental fate and impact of the herbicide glyphosate in forest ecosystems. The subcommittee subsequently approved a Newfoundland CFS request for experimental application of glyphosate for weed control in forestry.

Ph.D. Program - University of Guelph

As previously noted the HCA study leader is currently pursuing a doctoral degree in the Department of Environmental Biology, University of Guelph on a part time basis. Education leave was taken by Mr. Thompson during the spring of 1987, during which residency and course work requirements were fulfilled. The comprehensive qualifying examinations required of all candidates was also completed during this period. Dr. K.M.S. Sundaram was appointed as an adjunct professor within the department and became a member of the supervisory committee in 1987. A full supervisory committee meeting was held in the spring of 1987 to review the draft research proposal and a revision of the proposal was requested. and is currently in preparation. The final proposal will be submitted to all parties prior to December 1987.

RESEARCH STUDIES ON PHYSICOCHEMICAL ASPECTS OF PESTICIDE PERFORMANCE (CONDUCTED IN 1987)

[Project No. FP-61 - Pesticide Formulations]

Report to The 15th Annual Forest Pest Control Forum

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Research Studies on Physicochemical Aspects of Pesticide Performance (Conducted in 1987)

Introduction

During 1987, the Pesticide Formulations Project at FPMI undertook two cooperative studies involving field investigations that are related to forestry spray activities:

1. Spray Atomization and Deposition Patterns of One Newtonian and Two Pseudoplastic Formulations after Aerial Application Over a Mature Conifer Forest in Newfoundland

The field aspects of this study were completed in 1985. The laboratory determinations of deposits, droplet analysis, contact angle measurements of encapsulated droplets, etc. were all carried out in 1987, together with data reduction and the final write-up. This cooperative study was undertaken in collaboration with Drs. R.J. West, A.G. Raske and A. Retnakaran.

Summary: Spray atomization and deposition patterns of three formulations were investigated in five aerial spray trials in Newfoundland, to understand the inter-relationships between physical properties, drop size spectra and recovery of the spray volume at ground level. Diflubenzuron was sprayed at 30 g active ingredient in 2.0 L/ha. Futura® XLV and Thuricide® 48LV, spray formulations of Bacillus thuringiensis, were both applied undiluted at 30 BIU/ha, but in volume rates of 2.1 L/ha and 2.36 L/ha respectively. Each of the three formulations was applied over a 15 ha plot using a Piper Pawnee aircraft fitted with 6 Micronair® AU5000 atomizers. Spray drops were sampled with Kromekote® cards and deposits were collected on glass plates. Physical properties measured were: viscosity at variable shear rates, volatility and surface tension. The viscosities increased progressively from low for diflubenzuron tank mix, moderate for Thuricide 48LV, to high for Futura XLV, indicating a gradual increase in pseudoplastic behaviour of the three formulations. The volatility data indicated an inverse relationship to the viscosities, but the surface tensions were similar for all three formulations.

The highly pseudoplastic Futura XLV atomized into the least wide drop size spectrum. The Newtonian formulation of diflubenzuron, on the other hand, atomized into the widest drop spectrum; and the moderately pseudoplastic Thuricide 48LV, into an intermediate drop spectrum. Thus viscosity and volatility were more important factors in liquid atomization and drop deposition, than surface tension. Among the three meteorological factors measured, relative humidity appeared more important in drop deposition than did wind speed and temperature, within the range measured.

2. Droplet Size Spectrum and Deposit Pattern of Thuricide® 48LV Sprayed Aerially Over a Spruce Plantation in Ontario

Atomization characteristics, drop size spectrum and deposit pattern of a commercial *Bacillus thuringiensis* formulation, Thuricide® 48LV were studied following aerial application in a 60-ha white spruce plantation in northern Ontario. Spray was applied undiluted at 30 BIU in 2.4 L/ha using a Bell 206 helicopter fitted with four Micronair® AU5000 atomizers. Spray deposits were sampled at ground level using Kromekote® cards and glass plates. Foliar droplets were counted on trees in the vicinity of the ground sampling units. The formulation had optimum physical properties and atomized uniformly, producing a narrow droplet size spectrum on the sampling cards. Droplet distribution was also uniform, with a high number of 85 droplets per cm^2 on the cards. Spectrophotometric analysis of deposits on glass plates indicated an average spray recovery of about 90% at ground level. Foliar deposits ranged from 0 to 7 droplets per needle, with a mean of 2.5 droplets per needle. Our deposit and recovery estimates are among the highest values reported in the literature todya.

The field aspects of this study were completed in 1986. The foliar droplet assessment was also carried out in 1986. However, droplet analysis on the sampling cards, contact angle determinations, spectrophotometric measurements of deposits on glass plates, physicochemical investigations of the tank mix, etc. were all carried out in 1987 under the responsibilities of the Pesticide Formulations Project. This cooperative study was undertaken in collaboration with Drs. K. van Frankenhuyzen, J.H. Meating and G.M. Howse.

SUMMARY REPORT ON STUDIES OF PESTICIDE IMPACTS ON FOREST ECOSYSTEMS

[Project No. FP-70 - Environmental Impact]

Report to The 15th Annual Forest Pest Control Forum

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Summary Report on Studies of Pesticide Impacts on Forest Ecosystems

Introduction

Field studies by FPMI's Environmental Impact Project in 1987 focused on an in-depth aquatic impact study evaluating brook trout responses to insecticide induced disturbances of their prey populations as well as continuing baseline studies of fruit production in pollinator-dependent forest wildflowers. The aquatic study involved the direct injection of permethrin into a portion of Icewater Creek where brook trout and aquatic invertebrate populations have been studied intensively since 1984. Wildflower fruit-production studies were also carried out in the Icewater Creek research area but did not involve any pesticide treatments. Songbird studies focused on reporting and laboratory activities in 1987. The intensive songbird program carried out in the Icewater Creek research area from 1983 to 1986 (including aerial and ground applications of fenitrothion in 1985 and 1986 respectively) was completed. A M.Sc. thesis on the study has been prepared and will be defended by R. Millikin at U.B.C. by year end. A laboratory study investigating the sublethal effects of cholinesterase inhibiting forestry insecticides on the behavior and reproductive activities of Zebra finch, a small cage bird, was initiated by S. Holmes. This work will form the basis of a M.Sc. thesis through Queen's University.

Aquatic Studies

On 3 June, 1987 a dilute mix of permethrin (Ambush EC) in water was dripped into Icewater Creek for a 15 minute period to induce a major disturbance of aquatic invertebrates so that the subsequent responses of resident brook trout could be evaluated. Expected permethrin concentrations in the creek should have reached 16.7 ppb based on stream discharge at the application site. This is considerably higher than levels (2 to 7 ppb) found to cause 50% mortality of a wide range of aquatic invertebrates after 1 hour exposures in flow through bioassays previously conducted at Icewater Creek.

The treatment induced massive drift increases of aquatic invertebrates at sites up to 2 km below the injection site. Despite this, a study of mortality of caged aquatic invertebrates conducted by a M.Sc. student from the University of Guelph indicated that extensive mortality among the eight species of invertebrates exposed in cages at five points downstream of the injection site was limited to the two most sensitive genera. Caged brook trout fry appeared unaffected while most invertebrates showed initial signs of stress with rapid recover. Initial observations during benthos and fish sampling indicated that severe declines in stream benthos populations were only noticeable close to the injection site. Some recovery of numbers was evident within a matter of 6 to 8 weeks. Complete analysis of benthos response will not be available for some time. There was little indication of either decreased abundance or increased movement among brook trout throughout the season of treatment. Intensive sampling will continue through 1988 to enable a detailed evaluation on brook trout response to the treatment. An extensive residue analysis program was carried out by FPMI's Chemical Accountability project as part of this study.

Terrestrial Invertebrate Studies

The Ontario Pesticides Advisory Committee again supported baseline studies of forest wildflower fruit production in 1987. Such studies allow the identification and selection of pollinator-dependent and self-incompatible species to be monitored for depressions in fruit-set that can be attributable to depressions in principle pollinator populations.

Emphasis was placed on extending the preliminary investigations of 1986 with *Polygonatum pubescens* (Hairy Solomon's Seal). Fruit-set was confirmed to be dependent upon exposure to insect visitors although the expression of self-incompatibility was less dramatic than in the previous year. A more extensive list of insect visitors was compiled but bumblebees (*Bombus* spp.) and hoverflies (Syrphidae) were the most prevalent with primary floral rewards being nectar and pollen, respectively. Flowers visited by bumblebees accounted for a high proportion of fruits produced whereas those visited by any other species rarely produced fruit. *Polygonatum pubescens* has thus been demonstrated to be useful in relating relative fruit-set to relative size or activity of bumblebee populations and awaits testing in an operational spray impact situation. Comparative data for natural levels of fruit-set at three additional sites has yet to be analyzed. In other studies, *Lonicera canadensis* (American Fly Honeysuckle) was determined to be insect-dependent and highly self-incompatible. The major pollinators again appear to be bumblebees. Qualitative sampling of the Icewater Creek insect fauna was continued.

Songbird Studies

Field studies: Intensive bird studies initiated at Icewater Creek in 1983 were completed this past field season (1987). The major objective of the program was to develop a new approach to monitoring insecticide impacts on forest songbirds. This approach utilized censuses and territory mapping of singing males; mist-netting to colour band individuals, determine their breeding condition, and the population structure and territorial species within the area; and time-budget observations of the behaviour of these marked individuals.

The experiment involved 2 separate treatments: An aerial application of fenitrothion (280 g AI/ha) in 1985, and a ground application of the same formulation (water emulsion) in 1986. Results indicate that behavioural responses of the bird species studied in detail (magnolia warbler, chestnut-sided warbler and white-throated sparrow) were slight and restricted to changes in feeding behaviour. The significance of these changes could not be determined due to the small sample size and the requirement of nonparametric statistics. Population responses were observed the year following the aerial application as a reduced abundance of the total community of territorial birds. However, abundance was back to levels expected from the control results the subsequent year.

Although this approach is sensitive to sublethal and long-term effects of insecticides, it would have limited use as an operational monitoring method due to the intensive effort required and the need for considerable expertise.

Laboratory studies: Experiments are in progress using a common cage bird (Zebra Finch) to investigate the sublethal effects of cholinesterase (ChE) inhibiting forestry insecticides on bird behaviour and reproduction. Three groups of test birds (16 mated pairs per group) were orally dosed: two dosage groups with fenitrothion dissolved in soya bean oil 1(1.04 and 3.80 mg/kg body weight) and one group with just soya bean oil (control). Ethograms and activity profiles are presently being constructed for the mated pairs in each treatment group. Changes in behaviour and activity over time, relative to controls, will be correlated with the temporal patterns of ChE inhibition and recovery in three other groups of birds dosed at the same rates. In addition, each pair of birds will be followed through a complete breeding cycle to assess differential reproductive success among treatment groups. The behavioural assay developed in this study could be useful in screening new forestry insecticides for their potential impact on forest songbirds, bridging the existing gap between traditional laboratory LD50 trials and small-scale field trials. It could also be used to identify potential problems with currently registered insecticides and to point out areas where further field research might be appropriate. These experiments are supported in part by grants from World Wildlife Fund Canada (Wildlife Toxicology Fund), the American Museum of Natural History (Frank M. Chapman Memorial Fund) and Queen's University.

STUDIES ON THE PERSISTENCE AND FATE OF FENITROTHION AND PERMETHRIN IN FOREST ECOSYSTEMS

[Project No. FP-71 - Chemical Accountability]

Report to The 15th Annual Forest Pest Control Forum

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Persistence and Fate of Fenitrothion and Permethrin in Forest Ecosystems

Introduction

In 1986, two cooperative projects - one with the scientists at Newfoundland Forestry Centre using fenitrothion and the other with the scientists in Environmental Impact project at the Forest Pest Management Institute using permethrin were undertaken to investigate their fate and persistence in forest ecosystems. Both projects have been completed successfully and the raw data are summarized in this report. Further fine tuning of the data and discussions based on them will emerge in the form of journal publications on a later date.

Fenitrothion Study

In an aerial spraying operation in Newfoundland, blocks of balsam fir [*Abies balsamea* (L.) Mill.] at risk to damage from larvae of hemlock looper (*Lambdina fiscellaria fiscellaria*, Guen.) were treated twice with oil (Dowanol®) based formulations of fenitrothion at a dosage rate of 210 g A.I./ha but at two volume rates *viz*, 0.4L/ha and 1.5L/ha (Table 1).

Analysis of droplets on kromekote cards and deposits on glass plates showed that at the higher volume rate (1.5 L/ha), droplet density, $D_{V.5}$, $D_{N.5}$, volume deposit (ml/ha), amount reached the forest flow etc. were higher compared to the low volume rate (0.4L/ha) (Table 2). The metal simulators at the canopy level also received higher deposits at 1.5 L/ha (Table 3). The variation in deposits on Al simulators corresponding to the years of growth was not statistically significant although the mean deposit levels on the simulator and the computed values of µg of fenitrothion/cm^2 on the simulator showed a progressively increasing amount from 1980/81 to 1986/7 growths indicating that branch tips in the crown periphery tend to get higher deposit levels compared to the inner ones.

Analysis of chemical collection by fir needles showed that those exposed to 1.5L/ha collected only slightly higher active ingredient that those exposed to 0.4L/ha rate (Table 4). The half-life of the chemical at 1.5L/ha was slightly higher compared to the low volume rate but the pattern of degradation in both cases were almost similar. Since foliar residues obtained in this study were comparable to the conventional application rate of 1.5L/ha (dosage 2 x 210 g A.I./ha), spraying fenitrothion mixed with Dowanol® at 0.4L/ha appears to be economical and environmentally safe compared to the high volume rate provided that the effectiveness of the chemical to looper is the same in both volume rates. This ultra ultra low volume (UULV) application should be examined further because of the associated benefits.

Permethrin Study

Permethrin (Ambush® -EC 0.26%, Rhodamine® WT 1.8%, water 97.94%) formulation (1.275L) was applied to the surface of a forest stream near Searchmont, Ontario at 85 ml/min for 15 min resulting in an initial concentration of 16.7 ppb to the body of water at application site. Water samples were collected at different sites in the down stream at intervals of time, to examine the mobility and dissipation of the chemical. At a convenient sampling site (280 m down stream), in addition to water, sediment, fish, crayfish, aquatic insects, aquatic plants, stream duff etc. were collected at different intervals of time following application to examine the partition of the chemical to these substrates as well as to study its persistence in them. Drifting insects were also collected at different locations in the downstream to examine whether they acted as scavengers for permethrin.

The analytical procedure involved C_6H_{14} extraction, C_6H_{14}/CH_3CN partition, clean-up by micro-column chromatography (Florisil, Al_2O_3, Nuchar® /cellulose), successive elution by CH_2Cl_2, CH_2Cl_2-C_6H_{14} and CH_2Cl_2 and finally quantification of permethrin isomers by EC-GLC. Results are recorded in Tables 5 to 7.

The highest concentration of the chemical found in the top 1 cm of water (Table 5) varied according to the sampling station. In station 1 (30 m from application site), it was 11.804 ppb at 5 min after application whereas in station 6 (730 m from application site) the maximum concentration was only 0.104 ppb at 360 min post injection. Permethrin residues disappeared rapidly from water due to dilution and mixing. Residue accumulations were high in aquatic plants (17.55 ppb) and stream duff (39.30 ppb) (Table 6) and persisted beyond 420 min after injection indicating that such substrates could act as sinks for permethrin. Crayfish and brook trout (both caged) absorbed permethrin from the surrounding water up to a maximum level of 13.95 and 10.50 ppb respectively. The dissipation of the chemical was rapid in fish compared to crayfish (Table 6). The residue accumulation in bottled sediment, contrary to the expectation, was not significant probably because of the rapid flow of water. Because of the unfavourable caging conditions, the insects did not pick up any permethrin. Drifting invertebrates collected at different intervals of time and at different down stream locations contained significant amounts of permethrin (Table 7) indicating that these organisms acted as effective scavengers for the chemical present in the stream water.

Table 1. Composition of Formulations, Application Rates, etc.

Formulation and Block	Percent Comp. (v/v)	Application Rate		Time of Application	
		Dosage (g/ha)	Volume (L/ha)	1st	2nd
F-1	Fen. 40, Dowanol 59 Automate Red 1	210	0.4	June 24, 1987 2050 h	July 4, 1987 2040 h
F-2	Fen. 40, Dowanol 59 Automate Red 1	210	0.4	July 4, 1987 2015 h	July 9, 1987 0510 h
F-3	Fen. 11, Cyclosol-63 40, I.D. 585 48, Automate Red 1	210	1.5	June 24, 1987 2130 h	July 5, 1987 2050 h

Table 2. Droplet and Deposit Data on Collection Units

Formulation and Block	Droplet Data*+										Deposit Data**			
	1st Application					2nd application					g A.I./ha		% A.I. deposited	
	D_{min}-D_{max}	Droplet density (drops/cm^2)	(µm)	(µm)	Vol. deposit (mL/ha)	D_{min}-D_{max}	Droplet density (drops/cm^2)	(µm)	(µm)	Vol. deposit (mL/ha)	1st Appln.	2nd Appln.	1st Appln.	2nd Appln.
F-1	5-74	17	24	43	48.6	5-65	11	29	42	31.9	24	17	11	8
F-2	5-67	6.5	23	39	15.0	5-65	19	28	50	86.6	7	34	3	16
F-3	5-86	32	32	57	173	5-84	51	26	54	197	43	68	20	32

*Average of 21 Kromekote cards. **Average of 7 samples analysed by GLC; each sample contained 3 pooled glass plate rinses each placed at 15m intervals in the sprayline

+Droplet data were provided by Dr. A. Sundaram.

Table 3. Fenitrothion Deposits on Metal Simulators

Location of simulator on the branch in tree crown*	Fenitrothion deposit (g/simulator)			
	F-1 (1st Application)		F-3 (1st Application)	
	Range	Mean ± S.D. (n = 16)	Range	Mean ± S.D. (n = 16)
1986/87 growth	0.87 - 3.66	2.85 ± 0.81 (0.0546 ± 0.0155)	7.98 - 21.43	15.28 ± 10.61 (0.2927 ± 0.2033)
1983/84 growth	1.47 - 3.28	2.64 ± 0.48 (0.0506 ± 0.0092)	8.20 - 19.77	15.11 ± 10.09 (0.2895 ± 0.1933)
1980/81 growth	1.19 - 3.37	2.52 ± 0.53 (0.0483 ± 0.0102)	7.21 - 17.23	13.94 ± 8.17 (0.2670 ± 0.1565)

*Tree simulators per location per tree; total trees = 8. Average surface area of simulator = 52.2 cm^2. (The values in parentheses represent g of fenitrothion per cm^2 area of simulator).

Table 4. Fenitrothion Concentrations (μg/g-Fresh weight) in Balsam Fir Foliage

Time after spray application	F-1 (0.4 L/ha)		F-2 (0.4 L/ha)		F-3 (1.5 L/ha)	
	1st Appln.	2nd Appln.	1st Appln.	2nd Appln.	1st Appln.	2nd Appln.
Prespray	N.D.*		N.D.		N.D.	
1 h	4.51	4.24		5.13	5.11	8.96
1.5 h			2.22			
2 h	3.20					
3 h				4.47		
6 h				3.23		
7 h	2.91	2.84	1.66		4.18	7.02
12 h	2.26	2.18	1.03	2.68	3.13	6.39
1 d		1.92	0.81	1.87		5.17
1.5 d	0.79				1.74	
2 d	0.68	1.60	0.42	1.41	0.88	3.49
3 d	0.55	1.11	0.20	1.04	0.64	2.63
5 d	0.47	0.77		0.68	0.52	1.42
8 d		0.60		0.49		0.93
12 d		0.41		0.33		0.62
15 d		0.32		0.27		0.46

*N.D. Not detected; detection limit 0.02 ppm.

Table 5. Permethrin Concn. (ppb) in Water

Time (min)	Sampling station 1 (30m)	2 (220m)	2A (370m)	3 (120m)	4 (280m)	5 (540m)	6 (730m)
0	1.993			N.D.			
5	11.804			N.D.			
10	5.441			1.535			
15	N.S.			N.S.	N.D.		
20	1.742			8.641			
25	N.S.			N.S.	N.D.		
30	0.193	N.D.		2.264	N.S.		
35	N.S.	N.D.	N.D.	N.S.	N.S.		
40	N.S.	0.061	N.S.	0.948	1.673		
45	0.086	N.S.	N.D.	N.S.	0.721	N.D.	
60	0.052	0.174	N.D.	0.287	0.315	0.353	
90	N.S.	0.025	T	N.S.	0.121	0.348	
120	0.019	0.022	0.017	0.139	0.075	0.159	0.091
180	T	0.010	T	0.062	0.031	0.063	0.064
240	N.D.	0.005	T	0.044	0.029	0.039	0.081
300	N.D.	T	N.D.	0.036	N.D.	0.035	N.S.
360		N.D.	N.D.	N.S.	N.D.	N.S.	0.104
420		N.D.		N.S.	N.D.	0.027	N.S.
480						N.S.	0.024

N.S. - Not sampled; N.D. - Not detected (0.002 ppb); T - Traces (0.002 - 0.005 ppb); MQL - Minimum quantification level 0.005 ppb. Values in parentheses represent the down stream distance from application site.

Table 6. Permethrin Residues (ppb) in Stream Substrates (Stn 4-280 m)

Time (min)	Aq. plants*	Leaves (duff)	Crayfish (caged)	Fish+ (caged)	Sediments	Insects
15	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
25	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
40	9.50	16.70	13.95	10.50	2.25	N.D.
60	17.55	18.18	7.03	5.55	2.75	N.D.
90	9.98	16.18	6.80	7.60	1.96	N.D.
120	7.60	19.53	6.20	4.20	T	N.D.
180	11.88	39.30	5.80	3.08	N.D.	N.D.
240	12.60	23.10	5.28	1.98	N.D.	N.D.
300	11.03	28.53	4.20	T	N.D.	N.D.
360	8.33	17.45	3.05	N.D.	N.D.	N.D.
420	6.78	11.75	2.60	N.D.	N.D.	N.D.
660	N.S.	N.S.	1.01			
840	N.S.	N.S.	0.80			

*Water Arum, *Calla palustris* L.
+Brook trout, *Salvelinus fontinalis*
N.S. - Not sampled
T - Traces 0.5 to 1.0 ppb
N.D. - Not detected 0.5 ppb

Table 7. Permethrin Residues in Drifting Invertebrates

Distance from application (m)	Sampling time (min)	Concn. (ppb)
280 (Stn 4)	25-50	357
	50-70	90.1
	120-180	21.5
	180-240	13.0
	240-300	71.1
	300-360	98.2
730 (Stn 6)	170-175	133.2
	220-250	98.2
	330-360	42.7
1200 (T)*	310-320	16.8
	320-325	20.1
1700 (TL)**	360-375	1.1
	390-405	8.9

* Trailer
** Trib lake

Progress Report of 1987 Field Experiments on UULV Fenitrothion Deposition in Budworm Microhabitat and Budworm Larval Behaviour

by

P.C. Nigam and S.E. Holmes

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Progress Report of 1987 Field Experiments on UULV Fenitrothion Deposition in Budworm Microhabitat and Budworm Larval Behaviour

by

P.C. Nigam and S.E. Holmes

INTRODUCTION

Budworm larvae in the balsam fir live within the confines of webbed microhabitats at the time of 1st and 2nd spraying of fenitrothion (Nigam 1986). In the summer of 1986, it was found that 210 g AI/ha of fenitrothion in ultra ultra low volume (UULV) was more effective for foliage protection and larval mortality than the same amount of active ingredient per hectare of emulsion (E.C.) formulation (Kettela, E.G. personal communication). When the webbing from treated microhabitats was chemically analysed about 2 to 10 times more fenitrothion was found in samples from the UULV plot than from the E.C. plot (Nigam 1987).

In 1987, the droplet spectrum of UULV droplets reaching the webbing was characterized and webbing was analysed chemically for the presence of fenitrothion; preliminary results and observations are summarized in this report.

METHOD AND MATERIAL

The experiments were carried out at Dunphy, N.B. Thirty-two trees were selected in treatment and check plots. There were sixteen trees in the fenitrothion UULV treatment plot and 16 trees in the check plot (Fig. 1 & 2). There were 4 replications and one tree was used for each quadrant. One 45 cm branch was sampled from each quadrant and 10 microhabitats with webbing were selected randomly for extraction of webbing for chemical analysis and 4 webbed microhabitats were used for counting and sizing of droplets on the webs. The webbed microhabitat samples for physical measurements of droplets were taken after 30 minutes of spraying and sampling was finished within an hour or earlier. Fenitrothion formulation, spraying parameters, population level and weather details are given in Table 1. Spraying was carried out by Forest Protection Ltd. under the technical supervision of Mr. E.G. Kettela of Canadian Forestry Service - Maritimes. Chemical analysis was carried out by New Brunswick Research and Productivity Council using Hewlett Packard 5840 gas chromatograph equipped with NP detector and autosampler.

The examination and sizing of droplets on webbing within the budworm microhabitat were done by using an operating microscope and video-microscaler. Some droplets were video taped.

RESULTS AND DISCUSSION

Results of chemical and physical analyses of fenitrothion deposits are summarized in Table 2. Both types of analysis show the same trend in deposit and results appear to be complementary. Droplet spectrum observed on webbing of the microhabitat is given in Fig. 3.

Droplets 6-85 µm were found on webbing. In Spray 1 more droplets were in the range of 20-45 µm and in Spray 2, 15 to 40 µm, with peak appearing between 35-40 and 20-25 µm in Sprays 1 and 2 respectively. The mean amount of fenitrothion per microhabitat was approximately 39 ng in Spray 1 and 10 ng in Spray 2. On the average, there were approximately 2.2 droplets per microhabitat in the first spray and 1.2 droplets in the second spray.

Budworm larvae during the first spray were at the base of swelling buds, and during the second spray they were inside the growing buds which were heavily webbed. Larvae had more chance of coming into contact with fenitrothion on contaminated webbing than on contaminated needles, because they live within the webbing and constantly rub their cuticle and setae against them. Fenitrothion deposits on webbing should be more effective in population reduction than deposits on old foliage.

REFERENCES

Nigam, P.C. 1986. Budworm behaviour and their microhabitats in balsam fir during spray operations. Proc. 46th Ann. Meet. Acadian. Ent. Soc. p. 15.

Nigam, P.C. 1987. Dose transfer and spruce budworm behaviour during operational application of fenitrothion. Proc. Symp. on Aerial Appl. Pesticide in Forestry (in press).

Table 1. Details of UULV application (Block 142, 1987)

Block size:	354 ha	
Formulation:	40% fenitrothion + 60% Dowanol with 1% Dupont oil red dye	
Application rate:	210 g AI in 0.45 L/ha	
Aircraft		
Type:	C-188 Ag truck (1)	
Speed:	160 km/h	
Atomizers:	4 x Micronair AU4000, set for maximum RPM	
	Spray 1	Spray 2
Date and time:	May 26, 0704-0736h	June 2, 0811-0840h
Wind direction and velocity (canopy level)	NW, 1-6 km/h	E, 1-7 km/h
Temperature (canopy level)	9-13°C	10-15°C
R.H.	n.a.	80-90%
Larval/branch	7.2 (pre spray)	-
Instar distribution		
Pupae/branch	-	0.2 (post spray)
Percent survival	-	7.2 (post spray)
Percent defoliation	-	12 (post spray)
Defoliation (1986)	-	-

Table 2. Fenitrothion deposits in spruce budworm microhabitats (Balsam fir, 1987).

Sample	Plot	Chemical analysis			Physical analysis	
		Number of branches	Number of micro-habitats	Mean fenitrothion concentration (ng/ml) per 10 microhabitats	Number of micro-habitats	Number of droplets observed
Pre Spray 1	UULV	3	25	5.9		
Spray 1	UULV	16	154	77.9	64	141
	CONTROL	16	152	1.8		
Pre Spray 2	UULV	3	30	1.7		
Spray 2	UULV	16	149	20.9	64	79
	CONTROL	16	156	1.3		

Fig. 1 LOCATION OF TREES IN 1987 FENITROTHION ULTRA LOW VOLUME PLOT (DUNPHY,N.B.)

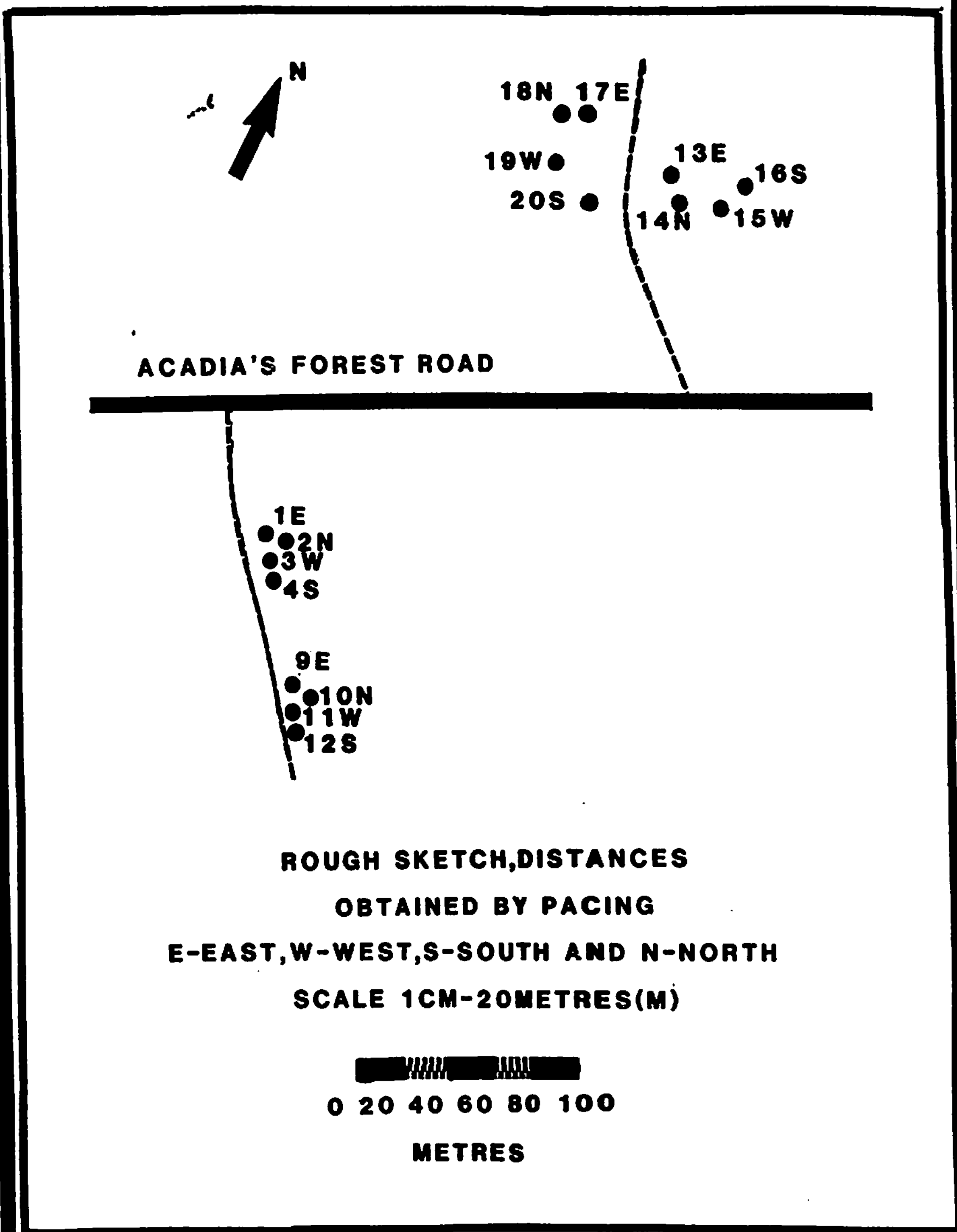


Fig. 2. LOCATION OF TREES IN 1987 CONTROL PLOT (DUNPHY, N.B.)

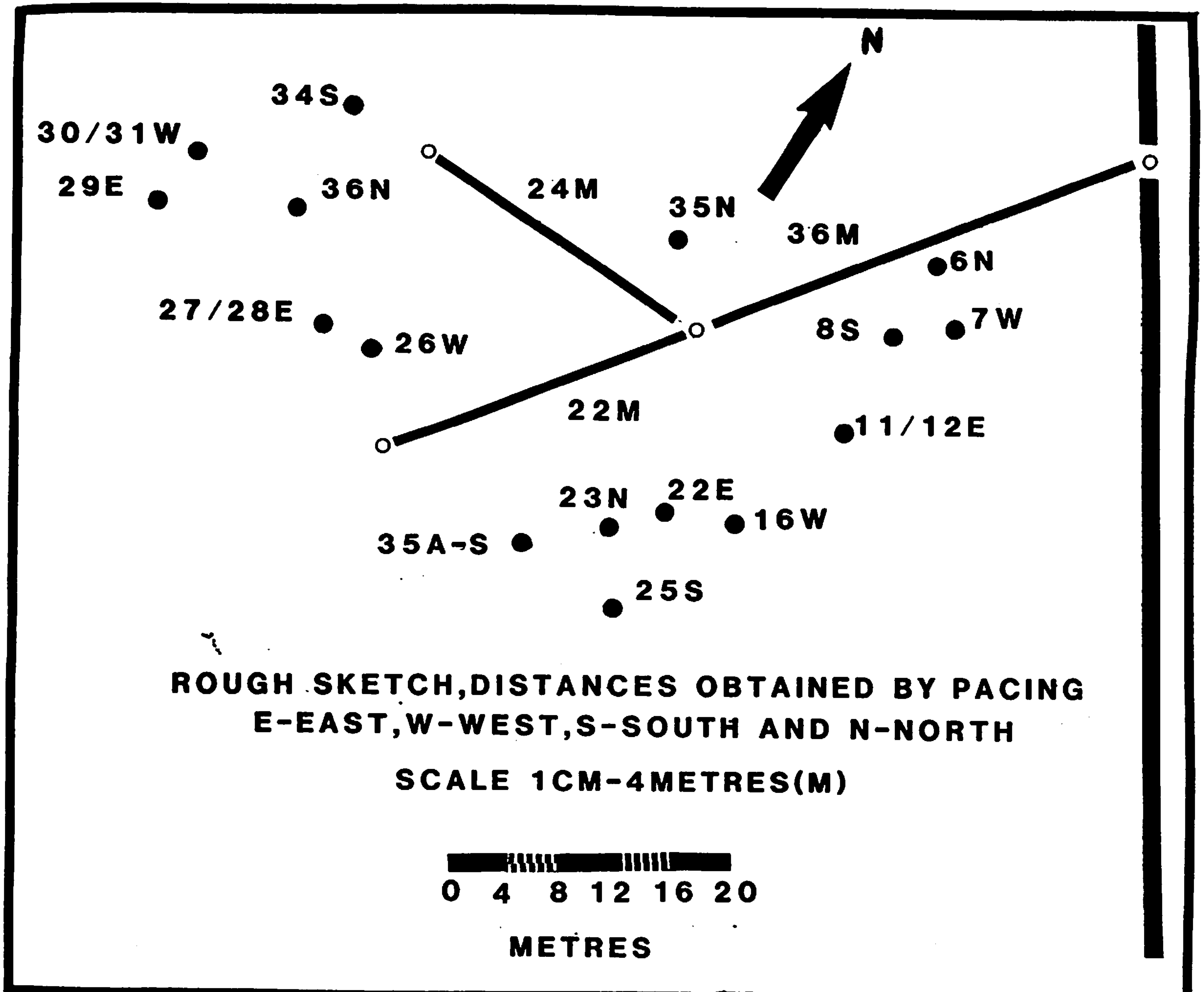
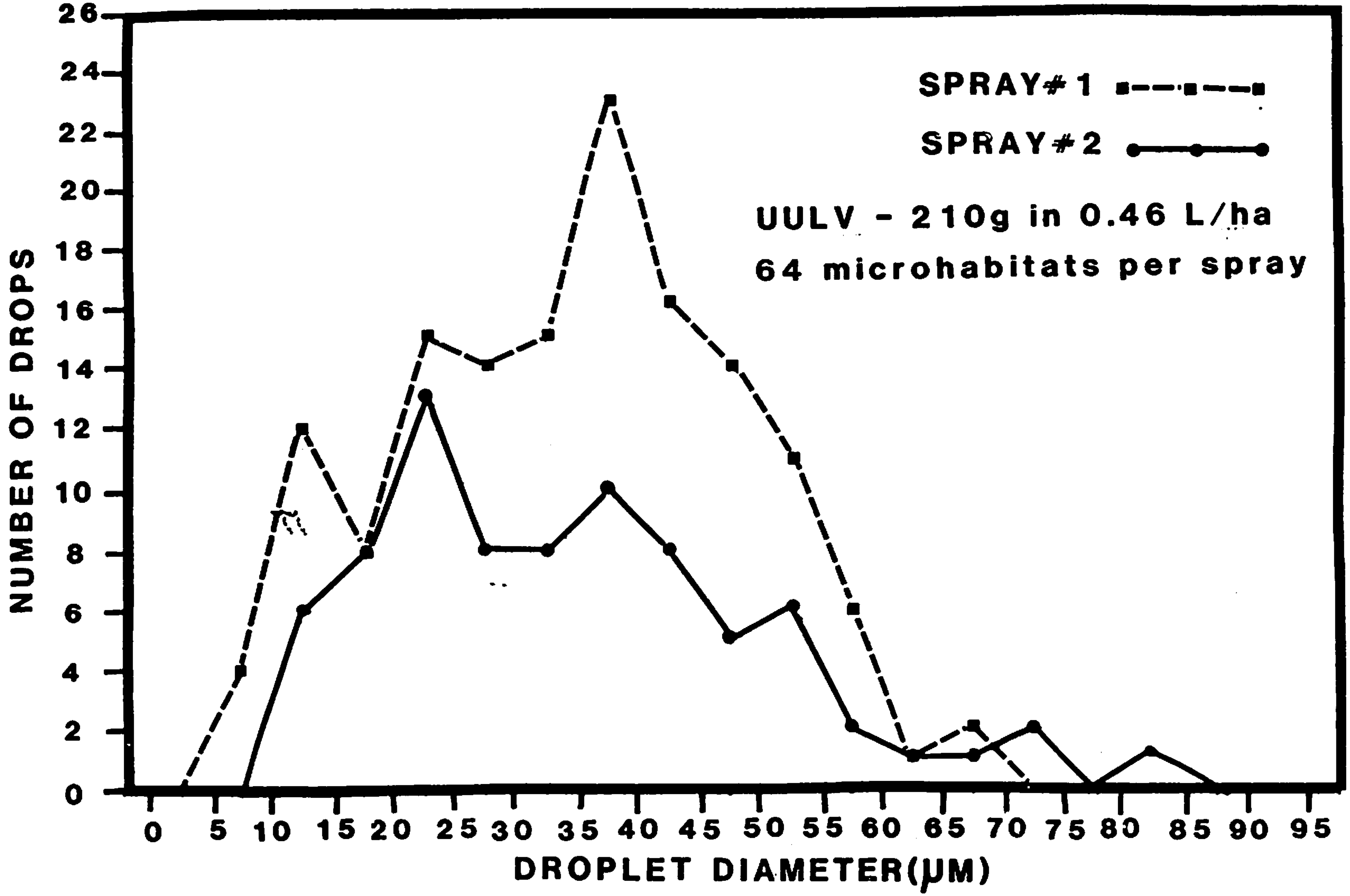


Fig. 3. Fenitrothion droplets observed on webbing in microhabitats after UULV application. (Balsam fir, 1987)



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SURVEILLANCE ENVIRONNEMENTALE ET CONTRÔLE DE QUALITÉ RÉALISÉS DANS LE CADRE DES PULVÉRISATIONS AÉRIENNES D'INSECTICIDES BIOLOGIQUES EFFECTUÉES AU QUÉBEC EN 1987 CONTRE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE

RAPPORT PRÉPARÉ POUR LE QUINZIÈME COLLOQUE ANNUEL
SUR LA LUTTE CONTRE LES RAVAGEURS FORESTIERS À OTTAWA
DU 17 AU 19 NOVEMBRE 1987

PAR: PIERRE-MARTIN MAROTTE, BIOL.
JEAN CABANA, MICROBIOLOGISTE
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GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

INTRODUCTION

Le ministère de l'Énergie et des Ressources (MER) a pulvérisé en 1987 du Dipel 132* (B.t.) sur 197 992 ha à l'aide de quadrimoteurs et de monomoteurs afin de lutter contre la tordeuse des bourgeons de l'épinette. À l'instar des années précédentes, le MER a élaboré une surveillance des opérations et un suivi environnemental devant être effectué lors des pulvérisations d'insecticides. Les travaux reliés à ce programme visent principalement à vérifier, à l'intérieur et à l'extérieur des aires traitées, les concentrations d'insecticides dans différents milieux. Les études réalisées en 1987 concernent surtout la persistance des insecticides et le suivi environnemental lors des pulvérisations. Des prélèvements ont été effectués dans des milieux lotiques et lentiques, des sédiments, des bassins d'approvisionnement en eau potable, du sol forestier et une pisciculture. Parallèlement à ces récoltes, une étude a été réalisée afin d'évaluer la contamination de l'air dans certaines municipalités situées au voisinage des aires traitées. Pour l'ensemble de ces projets, 834 analyses ont été effectuées par le laboratoire de microbiologie du MER. Une surveillance visuelle des opérations a été réalisée sur plus de 15% des périodes d'opérations.

De plus, le laboratoire de microbiologie a procédé à un contrôle de la qualité des préparations à base de *Bacillus thuringiensis* (B.t.) pour vérifier la présence indésirable de microorganismes pathogènes et pour confirmer la potentialité de l'insecticide. Ce travail a été réalisé avant les pulvérisations et 141 échantillons ont été analysés.

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* Un seul bloc fut traité expérimentalement avec du Dipel 176 (927 ha).

Surveillance et suivi

Un premier groupe de projets a porté sur l'étude de la persistance des spores viables de *B.t.* dans l'environnement. Après avoir constaté une persistance évidente des spores même après un an et selon les résultats de 1987, nous croyons qu'après ce délai de deux ans, l'étude de la persistance (stations permanentes) sera complétée.

Des 82 stations échantillonnées en 1987, 20 ruisseaux, 14 lacs et 27 stations de sol se trouvaient à l'intérieur des aires traitées en 1985, alors que 9 rivières, 6 lacs et 6 stations de sol étaient situées à l'extérieur. Mentionnons pour les rivières qu'une partie appréciable de leur bassin versant était traitée. Au total, 184 échantillons ont été récoltés pour compléter cette étude.

En 1987, les analyses préliminaires montrent que les concentrations ont diminué d'environ 10 fois par rapport à celles de 1986 dans la plupart des lacs situés à l'intérieur des aires traitées. Les concentrations étaient inférieures à 0,112 X 10^4 U.F.C./ℓ. Dans les ruisseaux traités en 1985 et les rivières situées à l'extérieur des blocs d'arrosage, on retrouve après deux ans des concentrations inférieures à celles observées un an après la pulvérisation. Cependant, cette diminution est moins importante qu'avec les lacs. C'est au niveau de la persistance dans la partie organique des sols forestiers qu'apparaît présentement les diminutions les plus faibles. On retrouve des concentrations presque semblables à celles observées après 11 mois (de 1,2 X 10^4 à 29 X 10^4 U.F.C./g poids sec).

Dans le cadre du suivi environnemental de 1987, 58 stations ont été établies afin de suivre l'évolution des spores de *B.t.* dans différents substrats soit l'air, l'eau, les sédiments et le sol forestier. Un total de 594 échantillons ont été prélevés.

En 1986, nous avions noté la présence de concentrations importantes de spores de *B.t.* dans les sédiments de deux lacs. Ces concentrations étaient du même ordre que celles observées dans le sol forestier immédiatement après une pulvérisation. Devant ce fait, nous avons récolté en 1987 des sédiments dans treize lacs. Cinq lacs, compris dans des aires ayant fait l'objet de trois années de traitement ont été choisis, et les huit autres n'ayant jamais été compris dans des aires d'arrosage au B.t.

Trois prises d'eau potable et une pisciculture provinciale ont fait l'objet d'un suivi pendant toute la durée des opérations. De plus, étant donné l'utilisation d'un B.t. à base d'huile cette année, un échantillonnage de sol forestier a été réalisé afin de comparer ces résultats avec nos données antérieures (formulations de B.t. à base d'eau). Soulignons que des échantillons d'air ont été prélevés dans quatre municipalités afin d'évaluer la dérive des spores et d'estimer les concentrations auxquelles les citoyens ont pu être exposés. Les premières analyses révèlent l'absence de spores ou leur présence en de très faibles quantités (de non-détectable à 59,5 U.F.C./m^3).

Soulignons qu'aucun déversement ou fuite de produit ne s'est produit.

Contrôle de la qualité des préparations à base de Bacillus thuringiensis en 1987

Avant le début de la pulvérisation, tous les lots d'insecticide ont été échantillonnés et vérifiés au niveau de leur potentialité insecticide et de la présence d'espèces pathogènes. Tous les lots ont démontré une potentialité insecticide acceptable selon l'étiquette.

D'autre part, plus de 20 espèces différentes de microorganismes autres que B.t. ont été identifiées et certaines (notamment divers CLOSTRIDIA et les Streptocoques fécaux) nous ont paru susceptibles de poser un risque pour la santé humaine.

Des consultations ont alors été menées auprès de divers organismes oeuvrant dans le domaine de la santé publique et les efforts du laboratoire se sont accrus afin de s'assurer de l'innocuité des CLOSTRIDIA retrouvés et de quantifier les niveaux des streptocoques fécaux.

Les résultats obtenus ont montré que les concentrations de streptocoques fécaux retrouvées dans les échantillons variaient de 330 U.F.C./ml à 5 250 U.F.C./ml et que les CLOSTRIDIA isolés n'étaient pas pathogènes. La permission d'utiliser ce matériel fut alors accordée par le ministère de l'Environnement du Québec.

Néanmoins, le laboratoire a surveillé le comportement des streptocoques fécaux dans les sept lots ayant démontré les concentrations les plus élevées. Ainsi, un échantillonnage fut effectué sur ces lots à tous les 3 jours entre le 31 mai et le 18 juin 1987.

Les résultats des décomptes effectués sur ces échantillons indiquent qu'il y a eu croissance de ces bactéries dans les réservoirs d'entreposage et que dans un de ceux-ci, la concentration maximale a atteint 81 500 U.F.C./ml.

Ces mêmes échantillons ont été conservés à la température de la pièce et ont fait l'objet d'un nouveau décompte en septembre et d'un autre au début de novembre. Les derniers résultats obtenus confirment qu'après 5 mois, il y a eu dans l'ensemble une conservation de la contamination au même niveau qu'en juin dernier. Un seul des lots a démontré une augmentation importante de la croissance depuis ce temps.

SURVEILLANCE ENVIRONNEMENTALE RÉALISÉE DANS LE CADRE DES PULVÉRISATIONS DE PHYTOCIDES EFFECTUÉES AU QUÉBEC EN 1987

RAPPORT PRÉPARÉ POUR LE QUINZIÈME COLLOQUE ANNUEL SUR LA LUTTE CONTRE LES RAVAGEURS FORESTIERS À OTTAWA DU 17 AU 19 NOVEMBRE 1987

PAR: LUC LABERGE, BIOL.
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GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

Historique de l'utilisation des phytocides au Québec

Au Québec l'utilisation des phytocides en milieu forestier a débuté sur une base expérimentale en 1971 (Tableau 1). Toutefois c'est à partir de 1977 que les phytocides ont été utilisés à une plus grande échelle. Au début (1977 et 1978) c'est le 2,4-D / 2,4,5-T qui était le phytocide le plus utilisé. Par la suite, de 1979 à 1981, le 2,4-D / 2,4-DP a succédé à ce dernier pour être ensuite remplacé à son tour par le 2,4,5-T en 1982 et 1983. En 1984, aucun projet d'arrosage n'a été mené. En effet un moratoire a été imposé suite à des audiences publiques sur l'utilisation des phénoxys dans l'entretien des plantations. En 1985, les pulvérisations ont repris et le glyphosate a remplacé les phénoxys. L'utilisation du glyphosate n'a cessé d'augmenter depuis. L'hexazinone a fait l'objet d'essais en 1986 et 1987 mais c'est le glyphosate qui constitue encore le principal phytocide utilisé par le MER au Québec en 1987.

Précisons qu'avant 1982 les pulvérisations étaient surtout effectuées par voie aérienne. En 1982, l'utilisation au sol du barillet (Boomjet) a pris de l'importance (80% des travaux) étant donné l'incertitude entourant l'obtention des permis de pulvérisations aériennes auprès du MENVIQ. Si bien qu'en 1983, toutes les opérations ont été réalisées par voie terrestre. Les pulvérisations aériennes sont réapparues en 1987 de façon expérimentale (600 ha). Présentement l'utilisation de ce mode d'intervention sur de vastes superficies exige l'élaboration d'une étude d'impact et la participation à des audiences publiques au niveau provincial. Le MER est actuellement en discussion avec le MENVIQ pour essayer de diminuer les exigences relatives à l'utilisation aérienne des phytocides en milieu forestier.

Surveillance

Bien que les pulvérisations de phytocides par voie terrestre en milieu forestier ne soient pas soumises à l'obtention de permis auprès du ministère de l'Environnement du Québec, le MER effectue un suivi environnemental de ces projets. De 1980 à 1984, les phénoxys ont fait l'objet de nombreuses études et plusieurs rapports permettant d'en évaluer les impacts sur l'environnement sont disponibles. À partir de 1985, le suivi environnemental a été axé sur le glyphosate. Des études préliminaires sur l'hexazinone ont aussi été effectuées depuis deux ans. Les suivis environnementaux dont il est question précédemment couvrent le milieu physique (eau, sol, air, sédiments) et le milieu biologique (végétation, homme).

En 1987, près de 12 000 ha ont été traités soit un peu plus que le double de 1986. La plupart des travaux forestiers consistait à dégager les plantations de la végétation compétitive alors que les autres concernaient la préparation du terrain en vue du reboisement. Les travaux de dégagement chimique ont eu lieu du début août à la mi-septembre alors que ceux pour préparer le terrain avant plantation ont eu lieu principalement en mai et juin.

Le suivi environnemental de 1987 a surtout été axé sur l'échantillonnage des résidus retrouvés dans les milieux traités au glyphosate par voie aérienne et lors des opérations d'application de l'hexazinone à l'aide de pistolets. Ces priorités étaient motivées par le fait que c'était la première fois que le Ministère utilisait ces modes d'intervention avec les produits précités.

Les composante physiques qui ont été échantillonnées en 1987 sont l'eau, le sol, les sédiments et l'air. Les composantes biologiques étudiées sont la végétation (feuillage, fruits, ramilles) et l'homme. De plus, on a vérifié l'importance de la dérive et la répartition du dépôt lors des pulvérisations aériennes à l'aide de substrats artificiels.

En plus du suivi environnemental, une attention particulière a été accordée à l'étude de l'exposition professionnelle des travailleurs. Un contrat étendu sur trois ans a été accordé à des toxicologues d'un centre hospitalier universitaire (Université Laval). Près de 450 échantillons d'urine ont été prélevés dans le cadre de cette étude. Celle-ci devra se terminer en mars 1988.

L'évaluation des résidus de glyphosate dans l'environnement a entraîné la récolte d'environ 200 échantillons alors que l'étude du dépôt et de la dérive en a requis 325. Pour l'hexazinone près de 140 prélèvements ont été récoltés dans l'environnement et ce principalement en milieu physique. Toutes ces analyses sont effectuées par notre laboratoire. Ce dernier a dû développer, dans le cadre de ce projet, de nouvelles techniques d'analyse pour ces produits.

Jusqu'à présent, aucune étude des résidus dans la faune n'a été effectuée par le MER. Cependant, certaines sont prévues chez le gibier exposé au glyphosate en 1988.

TABLEAU 1: Historique des traitements de phytocides au Québec par le MER

		APPLICATION	
1971-76	ESSAIS DE DIFFÉRENTS PHYTOCIDES	AÉRIENNE	TERRESTRE
1977	2,4-D / 2,4,5-T	surtout	-
1978	2,4-D / 2,4,5-T	surtout	-
1979	2,4-D / 2,4-DP	surtout	-
1980	2,4-D / 2,4-DP	surtout	-
1981	2,4-D / 2,4-DP	75%	25%
1982	2,4,5-T	20%	80%
1983	2,4,5-T	20%	80%
1984	moratoire	0	0
1985	Glyphosate (Round-up^{MD})	0	100%
1986	Glyphosate (Round-up^{MD}) Hexazinone (expérimental)	0	100%
1987	Glyphosate (Vision ^{MD}) Hexazinone (expérimental)	5%	95%

ENVIRONMENTAL MONITORING AND QUALITY CONTROL CARRIED OUT FOR THE AERIAL SPRAYING OF BIOLOGICAL INSECTICIDES AGAINST THE SPRUCE BUDWORM IN QUÉBEC IN 1987

REPORT PREPARED FOR THE
FIFTEENTH ANNUAL PEST CONTROL FORUM IN OTTAWA
NOVEMBER 17 - 19, 1987

BY PIERRE-MARTIN MAROTTE, BIOLOGIST
JEAN CABANA, MICROBIOLOGIST
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GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

INTRODUCTION

In 1987, the ministère de l'Énergie et des Ressources (MER), using single and four-engine planes, sprayed 197,992 ha with Dipel 132* **(B.t.)** in order to combat the spruce budworm. As in previous years, the MER established a program of environmental monitoring and follow-up to be carried out in conjunction with the spraying program so as to determine the concentrations of insecticides in various environments both inside and outside treated areas. The studies carried out in 1987 were mainly focused on the persistence of insecticides after spraying and the environmental follow-up. Samples were taken from lotic and lentic environments, sediments, forest soils, drinking-water outlets and a fish hatchery. As well, a study was done to determine possible contamination of the air in municipalities situated near the areas treated. The MER's microbiology laboratory carried out a total of 834 analyses in connection with these projects. Visual monitoring of operations was carried out during more than 15 % of the applications.

The laboratory also carried out quality control tests on preparations of **Bacillus thuringiensis (B.t.)** to determine the presence of pathogenic microorganisms, and to assess the insecticide's potential effectiveness. This was done prior to spraying, and a total of 141 samples were analyzed.

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* A single plot was experimentally treated with Dipel 176 (927 ha).

Environmental Monitoring and Follow-up

A first group of projects was related to the persistence of viable B.t. spores in the environment. The persistence of spores was evident a year after spraying. We are thus planning to complete the persistence study at the end of next year (permanent stations).

Of the 82 stations sampled in 1987, 20 streams, 14 lakes and 27 soil stations were located inside the areas treated in 1985, whereas 9 rivers, 6 lakes and 6 soil stations were located outside these areas. It should be noted that a considerable area of the rivers watershed was treated. A total of 184 samples were collected for the study.

After two years, preliminary analyses indicate that concentrations have decreased approximately tenfold in most of the lakes situated inside the areas treated in comparison with the 1986 results. The concentrations found this year were lower than 0,112 X 10^4 C.F.U./l. In streams treated in 1985, and in the rivers situated outside spray blocks, concentrations were lower after two years than after the first year, but the decrease was less marked than that observed in lakes. Concentrations in the organic sections of forest soils are those which decreased the least: some of them were almost equal to those observed after the first 11 months (from 1,2 X 10^4 to 29 X 10^4 C.F.U./g).

As part of the 1987 program of environmental follow-up, 58 stations were established in order to monitor the evolution of B.t. in different substrates (air, water, sediments and forest soil). A total of 594 samples were taken.

In 1986, significant concentrations of B.t. spores were observed in the sediments of two lakes. These concentrations were equal to those found in the forest soil immediately after spraying. In view of these facts, sediment samples from thirteen lakes were taken in 1987. Five of these lakes had been treated with B.t. over a three-year period, while the remaining eight lakes were situated in areas which had never been sprayed with B.t.

Three drinking-water outlets and a provincial fish hatchery were monitored throughout the duration of operations. Given that an oil-based B.t. was used this year, samples of forest soil were taken to be compared with those of previous years, when a water-based B.t. was used. It should also be noted that air samples were taken in four municipalities in order to determine the drift of B.t. spores and estimate the concentrations to which people might be exposed. Initial analyses reveal either an absence of spores or their presence in extremely small quantities (from non-detectable to 59,5 C.F.U./m^3).

It should be noted that there were no leaks or spills of the product in 1987.

1987 Quality Control of Preparations Using **Bacillus Thuringiensis**

Before spraying, all B.t. lots were sampled and tested for insecticide effectiveness and for the presence of pathogenic organisms. All lots showed an acceptable level of effectiveness.

More than 20 different micro-organisms other than B.t. were identified in the lots, and some of these (fecal streptococci and various **Clostridia**) seemed to present a possible hazard to human health.

Consultations were then undertaken with different public health agencies, and our laboratory stepped up its efforts in order to ensure the non-pathogenicity of the **Clostridia** and to determine the quantity of fecal streptococci present in the lots.

The findings showed that concentrations of fecal streptoccoci in the samples varied from 330 C.F.U./ml to 5 250 C.F.U./ml, and that the **Clostridia** were not pathogenic.

Permission to use the material was subsequently granted.

The laboratory nonetheless continued to monitor the evolution of fecal streptococci in the seven lots showing the highest concentrations. Samples were taken from these lots every three days between May 31 and June 18, 1987.

The results showed that the quantities of bacteria increased as lots lay in storage containers. In one container, concentrations reached a high of 81 500 C.F.U./ml.

The same samples, stored at room temperature, were the object of another count in September and early November. The November results confirmed that after five months the level of contamination was equal to that observed in June. In one of the lots, the concentration of fecal streptococci had increased significantly.

ENVIRONMENTAL MONITORING OF PHYTOCIDE SPRAYING CARRIED OUT IN QUEBEC IN 1987

REPORT PREPARED FOR THE FIFTEENTH
ANNUAL PEST CONTROL FORUM IN OTTAWA
NOVEMBER 17 - 19, 1987

BY LUC LABERGE, BIOLOGIST
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MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

The History of Phytocide Use in Québec

The use of phytocides in Québec forests began on an experimental basis in 1971 (Table 1). However, it was not until 1977 that phytocides began to be used more extensively. In 1977 and 1978, 2,4-D / 2,4,5-T was the phytocide most often used. Subsequently, from 1979 to 1981 inclusively, this was replaced by 2,4-D / 2,4-DP, which was in turn replaced by 2,4,5-T in 1982 and 1983. In 1984, a moratorium was declared following public hearings on the use of phenoxy preparations in the maintenance of planted areas; consequently, no spraying projects were undertaken. Spraying was carried out again in 1985, with glyphosate replacing phenoxy preparations. The use of the former has been increasing ever since. Hexazinone was used on a trial basis in 1986 and 1987, but glyphosate remains the main phytocide used by the MER in 1987.

It should be noted that before 1982, aerial spraying was the method most frequently used. In 1982, the Boomjet was used in 80% of ground operations, given the uncertainty surrounding the obtention of aerial spraying licences from the MENVIQ. Indeed, by 1983 all operations were being carried out on the ground. Aerial spraying was used again in 1987, on an experimental basis (600 ha). Aerial spraying of large areas now requires an impact study, as well as public hearings on a province-wide scale. The MER and the MENVIQ are currently discussing the possibility of reducing the requirements which govern aerial spraying of forests with phytocides.

Monitoring

Phytocide spraying of forests, when carried out on the ground, does not require a permit from the ministère de l'Environment du Québec. The MER nonetheless carries out environmental follow-up with respect to such activities. Between 1980 and 1984, a number of studies and reports made it possible to evaluate the impact of phenoxy preparations on the environment. Since 1985, environmental follow-up has been concentrated on the effects of glyphosate. In the past two years, preliminary studies on hexazinone have also been carried out. Environmental follow-up includes both the physical environment (water, air, soil, sediments) and the biological environment (vegetation, man).

In 1987, almost 12,000 ha of forest were treated, or slightly more than twice the area treated in 1986. Most activities involve clearing away competitive species of vegetation from planted areas, or preparing the ground for reforestation. Chemical clearing operations are generally carried out between early August and mid-September, while ground preparation prior to planting takes place mainly in May and June.

Environmental follow-up consisted largely in the analysis of residues observed in areas which had been sprayed from the air with glyphosate, and in areas which had been treated with hexazinone applied from the ground with spray-guns. This type of environmental follow-up was necessary given that the MER was using these particular combinations of methods and products for the first time.

In 1987, samples of water, soil, sediments and air were taken. The biological components studied were vegetation (leaves, fruit, branches) and man. As well, artificial substrates were used to determine the extent and distribution of the deposit during aerial sprayings.

Apart from the environmental follow-up, particular attention was paid over the years to the possible exposure of workers to the chemical. A three-year contract ending in 1988 was granted to toxicologists working at the Université Laval hospital centre. Almost 450 urine samples were collected for this study.

Almost 200 samples were required to evaluate glyphosate residues in the environment, while the study of drift and deposit demanded 325 samples. Approximately 140 samples, taken mainly in the physical environment, were used in the study of hexazinone. All the above-mentioned analyses were carried out by the MER laboratory which had to develop new techniques of analysis for this purpose.

No study of residues in fauna has yet been undertaken by the MER. However, studies on game animals exposed to glyphosate are being planned for 1988.

Table 1: History of Phytocide Treatments Carried Out by the MER

		Application	
		Aerial	Ground
1971-1976	Various phytocides used on a trial basis	100%	0
1977	2,4-D / 2,4,5-T	mostly	-
1978	2,4-D /2,4,5-T	mostly	-
1979	2,4-D / 2,4-DP	mostly	-
1980	2,4-D / 2,4-DP	mostly	-
1981	2,4-D / 2,4-DP	75%	25%
1982	2,4,5-T	20%	80%
1983	2,4,5-T	20%	80%
1984	Moratorium	0	0
1985	Glyphosate (Round-up^{tm})	0	100%
1986	Glyphosate (Round-up^{tm}) hexazinone (experimental)	0	100%
1987	Glyphosate (Vision^{tm}) hexazinone (experimental)	5%	95%

LISTE DES DOCUMENTS DISPONIBLES AU SERVICE DES ÉTUDES ENVIRONNEMENTALES

- Documents disponibles relatifs à l'utilisation des <u>insecticides</u> en milieu forestier

- Documents disponibles relatifs à l'utilisation des <u>phytocides</u> en milieu forestier

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Le 21 octobre 1987

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Le 22 octobre 1987

DETERMINATION OF THE FREQUENCY OF GREATER THAN INTENDED DEPOSIT DURING AERIAL PESTICIDE APPLICATIONS IN NEWFOUNDLAND FORESTS

The purpose of this project was to document the occurance of greater than intended deposit during the operational application of fenitrothion in the Newfoundland forests. Spray deposit was measured at (10) locations per spray block evenly spaced across 3 spray swaths (4 flight lines) during the first spray application. Samples consisted of new growth (1987 foliage) taken from four sides (upwind, downwind and each side) of the crown (10-15 m above ground) of balsom fir. These four sub-samples were pooled to make one of the ten block samples. Sampling was carried out as soon as possible the day of spraying. Six operational blocks were sampled for deposit. The blocks were sprayed by DC-6 aircraft using boom and nozzle. Technical details of the spray application are attached in Table 1.

A meteorological station with a 10 meter mast was assembled in each block to record wind speed and direction and air temperature at the time of spraying. Relative humidity measurements were also taken using a sling psychrometer.

In addition to sampling in operational blocks an overswath situation was simulated to establish a baseline value for the operational sampling. Two flight lines (250 meters long) were flown over five transects of four (4) evenly spaced sample stations. Each transect extended from the centre of the flight line to the edges of the effective swath. One flight line received a single application of fenitrothion while the other received a double application (two flights down the same line). Samples were collected in the same manner as in the operational blocks.

The resulting data (Table 2) is presently being assessed and a report on the project is expected to be available by early 1988.

Wayne Pierce
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TABLE 1

Technical details of spray application and formulation for the 1987 hemlock looper control program.

Spray Application

Aircraft: DC-6
Aircraft height: 61 m
Aircraft Speed: 305 km/h
Spray Apparatus: Boom with 200 nozzles with #8010 spray tip
Swath Width: 610 m

Spray Mixture

Insecticide:	fenitrothion (Folithion®)
Mixture by Volume:	11% fenitrothion
	40% Cyclosol 63
	49% ID 585 (Insecticide Diluent)

Application Rate

210 g active ingredient per 1.5L per ha in 2 applications

Table 2

Fenitrothion Deposit, Operational Blocks - 1987

(ug/g Wet wt.)

Sample \ Block	102	103a	103b	103c	105	107
#1	1.20	5.35	0.47	0.61	5.66	0.33
#2	1.98	4.70	0.75	3.13	3.58	0.38
#3	3.66	1.13	3.31	1.69	6.50	0.53
#4	54.1	2.09	2.48	0.55	7.54	0.53
#5	11.24	0.43	0.58	1.42	4.43	0.66
#6	5.32	0.12	0.65	2.46	5.69	2.76
#7	1.26	0.64	0.13	1.87	4.35	2.85
#8	0.89	0.54	0.10	2.30	3.27	0.50
#9	1.10	1.34	0.15	1.29	5.67	2.29
#10	1.44	4.0	1.00	19.40	2.56	1.88
Mean	8.21	2.03	0.96	3.47	4.93	1.27
SD	16.44	1.93	1.08	5.65	1.55	1.05
$S\bar{x}$	5.2	0.61	0.34	1.79	0.49	0.33

Mean for 6 blocks = 3.48

S.D. = 7.33

$S\bar{x}$ = 0.95

Appendix 2 (con't)

Fenitrothion Deposit, Experimental Double Swath Block

(ug/g Wet wt.)

Distance from C.L \ Line	1	2	3	4	5
0	1.14	0.22	0.22	0.58	2.59
150m	4.65	2.17	2.33	0.57	3.63
300m	1.50	1.79	0.71	0.85	3.58
450m	1.09	-	0.97	1.38	1.57
Mean	2.16	1.39	1.06	0.85	2.84
S.D.	1.67	1.03	0.90	0.38	0.97
S$\bar{x}$	0.83	0.60	0.45	0.19	0.49

Mean - 1.67
S.D. - 1.23
S - - 0.28

Fenitrothion Deposit - Experimental Single Swath Block

(ug/g wet/wt

Distance to C.L. \ Line	1	2	3	4	5
0	0.05	0.07	<0.01	0.01	-
150m	0.07	0.05	0.01	<0.01	-
300m	1.67	0.02	<0.01	-	-
450m	0.16	0.02	-	-	-

Mean = 0.16
S.D. = 0.45
S $\bar{x}$ = 0.13

<u>**Review of Fenitrothion Environmental Effects**</u>

For the past twenty years, fenitrothion has been the pesticide of choice in Eastern Canadian spray programs aimed at controlling the spruce budworm. Field and laboratory investigations conducted in association with these spray programs have indicated that fenitrothion has a wide range of non-target environmental effects. The last comprehensive review of available information was conducted in 1975 by the NRCC Associate Committee on Scientific Criteria for Environmental Quality (ASCSCEQ). The review indicated that the most sensitive or critical environmental components to fenitrothion effects included birds, pollinators and aquatic fauna. The review concluded that there was not sufficient information available to accurately assess the long-term effects of fenitrothion in the environment. In a subsequent symposium on fenitrothion long-term effects spronsored by the NRCC ASCSCEQ, many authors made similar statements.

In the ten years that have ensued since the NRC review there has been a considerable amount of effort directed at further defining fenitrothion environmental impacts. It would therefore be most useful and timely to review and analyze the accumulated data base on fenitrothion environmental effects, to determine if more definitive statements can now be made.

Accordingly, Environmental Protection, Atlantic Region, has initiated reviews of the fenitrothion data base for aquatic effects as well as effects on pollination processes. These reviews will be completed by March 31, 1988 and when combined with a similar review being undertaken by Canadian Wildlife Service for bird impacts, will form the basis of an Environment Canada, Atlantic, position statement on the use of fenitrothion in forestry.

Bill Ernst.
C&P/EP.
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Fenitrothion Avian Impact

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Fenitrothion Avian Impact

In March of 1987 the chairman of the Atlantic Region Pesticide Advisory Committee (ARPAC) wrote to the New Brunswick and Newfoundland and Labrador Environment Departments to express concerns regarding the continued use of fenitrothion as a forestry insecticide. The primary concern raised was the impact of fenitrothion on songbirds, and the letter was accompanied by a two page "Fenitrothion Review" prepared by the Fredericton office of the Canadian Wildlife Service (CWS). The Forest Pest Management Institute responded to this development by preparing and distributing in April 1987 a position paper reviewing this issue (copy attached). I would like to briefly summarize for this forum the situation as we perceive it today at FPMI.

The stimulus for the ARPAC letter was a report prepared by Fudge, Lane & Associates Ltd. (1986) on the results of songbird brain cholinesterase studies carried out in a fenitrothion spray block during the 1986 hemlock looper control program in Newfoundland. This study reported that a large proportion of the birds shot in this block after each of two fenitrothion sprays had brain cholinesterase (ChE) activity levels lower than birds of the same species collected from unsprayed areas. When data from both sprays were combined, 71% of the birds showed over 20% brain ChE depression and 38% showed over 50% depression. Comparing these results to previous studies (Table 1), it is apparent that they indicate a much greater degree of ChE inhibition than has generally been found after fenitrothion sprays applied at the same or even higher application rates elsewhere. Of particular interest is the difference between these results and those reported by Strong and Wells (1986) who carried out similar studies during the 1985 hemlock looper spray program in Newfoundland. They found only 7% of birds with 50% brain ChE depression after fenitrothion was applied at the same rate and with the same type of aircraft and spray emission equipment as in 1986.

What can we make of these unusual results? The authors themselves draw the conclusion that "the results from fenitrothion spraying events are largely descriptive of the individual spray event and evidence suggests that caution should be taken before making broad predictions of all fenitrothion spraying events from one monitored event" (Fudge, Lane & Associates, 1986). This is supported by a comparison of results from different studies (Table 1). This table shows that substantially different degrees of brain ChE depression have been reported among songbirds sampled from spray blocks treated with the same nominal rate of fenitrothion. Higher application rates have not always been accompanied by greater cholinesterase depression than found after applications at lower rates. This brings into question the validity of statements by CWS Fredericton researchers in their "Fenitrothion Revue" which suggest that overswathing causes major impacts on songbirds. Such statements ignore the host of other factors such as weather conditions, topography, height of spray release, height and nature of the forest cover, degree of canopy closure, activity of the songbird population at the time of and following spraying, and others. All of these can greatly influence the degree of exposure of birds to fenitrothion as much or more than an unintentional elevation of the application rate by overswathing.

Table 1
Songbird Cholinesterase Responses following Forest Sprays with Fenitrothion

		No. of species studied	% of birds with ChE depression of: 20%	50%
N.B. 1980 - Busby *et al.* 1981				
280 g/ha	B+N	4	30	5
280 g/ha	RA	4	16	5
N.B. 1978/79 - Busby *et al.* 1983b				
210 g/ha	B+N	1	58	0
210 g/ha	B+N	1	50	7
210 g/ha	B+N	1	83	6
420 g/ha	B+N	1	95	25
Nfld. 1985 - Strong & Wells 1986				
210 g/ha	B+N	?	?	7
Nfld. 1986 - Fudge, Lane & Assoc. 1986				
unsprayed control		6	9	0
210 g/ha	B+N	3	76	55
210 g/ha	B+N	3	73	19
350 g/ha	B+N	2	71	43
N.B. 1986 - Busby *et al.* 1987b				
210 g/ha	RA	4	16	1

RA - rotary atomizer; B+N - boom and nozzle

Although it may be difficult to predict the extent to which a given fenitrothion application will depress the brain ChE activity of songbirds within a spray block, it is well established that many birds often experience a 20% reduction, and some birds experience a 50% reduction in the activity of this enzyme. The key question would then appear to be...What are the consequences to the survival and fitness of an affected bird of depressions to these extents? Brain ChE determination requires sacrificing the bird to remove its brain, so it is impossible to determine the cholinesterase inhibition in the bird and still measure the ability of that individual to recover from this effect. Cholinesterase inhibition is reversible and has been found to recover after exposure ends. Recovery is similar in a variety of bird species (Fleming and Grue 1981) and after single oral doses or prolonged dietary doses (Fleming 1981). Initial recovery of cholinesterase activity to about 50% normal levels is rapid, after exposure to organophosphates has ceased, following which recovery proceeds at a slower rate (Fleming 1981). Cholinesterase inactivated by carbamate insecticides will spontaneously reactivate quite rapidly once free inhibitor is no longer present (Martin *et al.* 1981), and consequently, recovery of cholinesterase activity is more rapid following exposure to carbamates than organophosphates. This is supported by Canadian field studies showing little evidence of inhibition of forest songbird brain cholinesterase following carbamate sprays (Table 2).

Table 2
Songbird Cholinesterase Responses following Forest Sprays with Aminocarb and Mexacarbate

		No. of species studied	% of birds with ChE depression of: 20%	50%
Aminocarb (MATACIL)				
N.B. 1981 - Busby *et al.* 1982				
70 g/ha	RA	5	4	0
N.B. 1982 - Busby *et al.* 1983a				
70 g/ha	B+N	5	9	0
Mexacarbate (ZECTRAN)				
N.B. 1984 - Busby *et al.* 1987a				
unsprayed control		7	11	0
70 g/ha	RA	7	11	1
140 g/ha	RA	6	19	0

RA - rotary atomizer; B+N - boom and nozzle

The majority of research examining the effects of cholinesterase inhibition on birds has been done using oral or dietary dosing of laboratory species such as starlings, quail or ducks. Two widely cited criteria have evolved from this body of work:

> Cholinesterase depression of 20% or more in birds is considered to be indicative of exposure to organophosphate pesticides.
>
> (Ludke *et al.* 1975, Grue *et al.* 1983)
>
> Cholinesterase depression of 50% suggests a "life-threatening situation".
>
> (Zinkl *et al.* 1980).

Although these statements have been widely cited, neither is definitive. Many authors have failed to report the proportion of unsprayed control birds whose cholinesterase level is 20% lower than the mean for all unsprayed individuals, but two different Canadian field studies show about 10% of unsprayed birds fell into this category (see Tables 1 and 2). Zinkl *et al.* (1980) expanded on their statement of 50% depression being indicative of a "life threatening situation", adding that inhibition of at least 80% is required before birds will be killed by a single oral dose of an organophosphate insecticide, although death may occur with only 50% inhibition when continuous exposure through contaminated feed occurs. Other authors have shown that although birds that die from exposure to a cholinesterase inhibitor usually show at least 50% depression, similar inhibition in living birds does not necessarily mean those individuals will die. (Ludke *et al.* 1975, Grue *et al.* 1983). Fleming (1981), in fact, turns the criteria around by stating that 50% inhibition is a minimum effect level in birds, as it also appears to be in mammals. He goes on to contend that since recovery to 50% normal activity occurs rapidly, effects are limited to a short period following significant exposure.

Does this mean that all birds whose brain cholinesterase is depressed by 50% or more exhibit severe behavioral effects. Again, a number of studies show this not to be the case. Even prolonged inhibition of over 50% may not be accompanied by symptoms, Miyamoto (1977) reports a study where female Japanese quail feeding on a high dose (50 mg/kg) fenitrothion diet for four weeks had their brain cholinesterase activity depressed by over 50%, but suffered no behavioural or weight gain effects except for a temporary reduction in egg production. Fleming (1981) reviews a number of studies where dosed birds recover from peak inhibitions of cholinesterase activity of up to 90%. Evidence that forest passerines may also tolerate significant inhibition is implicit in that of the many birds found to have 50% ChE depression or greater following forest sprays with fenitrothion (Table 1), none were reported to be displaying symptoms of distress and most were territorial males who were collected when they indicated their location by their apparently normal singing activities.

Given that it is impossible to precisely state the biological consequences of the levels of cholinesterase depression measured following fenitrothion sprays, what do we know about the effects of this insecticide on birds from other types of studies? Fenitrothion has had an extensive use pattern for controlling spruce budworm in Eastern Canada since the late 60's (Table 3). Over this period, a wide range of studies have been carried out by federal, provincial, university and private industry researchers. These studies have been reviewed and reported elsewhere (Peakall and Bart 1983, the appended FPMI position statement), but I will briefly summarize their general findings.

Early studies by CWS Fredericton reported that the threshold application rate at which dead birds began to be found by post-spray casualty searches lay between 280 and 420 g/ha (Pearce 1968, Peakall and Bart 1983). In the mid to late 70's, when fenitrothion use was greatest and large monitoring programs were in place in a number of jurisdictions, almost all of the researchers involved failed to find any dead songbirds following operational programs applying 210 to 280 g/ha. A number of reports of songbird casualties during this period were investigated, but were found to be due to causes other than fenitrothion sprays (migration stresses coupled with severe weather, ingestion of ice-melting chemicals along roads). Following an application of 1400 g/ha of fenitrothion in an experimental block in Quebec, only three sick birds and no spray casualties were found in 25 hours of searching by experienced observers (Lehoux *et al.* 1982), despite foliage residues five times higher than normally found in operational spray blocks (Morin *et al.* 1986).

Table 3
Operational Use of Insecticides to Control Spruce Budworm in Eastern Canada, 1965-1987[a]

		1000's of hectares sprayed[b]				
Insecticide	Period used	65-69	70-74	75-79	80-84	85-87
DDT	1944-1969	1,800	-	-	-	-
Phosphamidon	1963-1977	750	2,550	3,950	-	-
Fenitrothion	1967-1987	1,400	12,800	13,900	7,900	916
Aminocarb	1970-1987	-	650	8,500	4,100	680
B.t.	1974-1987	-	5	40	520	1,383
Hectares sprayed per year		790	3,201	5,278	2,504	993

[a]approximate figures compiled form Forest Pest Control Forum reports
[b]much of the area sprayed received a second application of the same or a different material

The main method employed in studying fenitrothion effects on songbirds has been short-term population censuses of breeding birds by territorial mapping or singing male counts. These studies have found that operational fenitrothion sprays do not cause major impacts on overall songbird populations. Furthermore, an extensive review by Peakall and Bart (1983) concluded that although moderate decreases in some species sometimes occurred at 280 g/ha, many canopy feeding species which would be exposed to the highest residue levels do not show significant decreases in areas treated with up to 560 g/ha. Lehoux *et al.* (1982) could not, in fact, find significant differences in pre-spray to post-spray changes in bird populations on a 1400 g/ha fenitrothion treated plot and an untreated control plot by either singing male counts or territorial mapping methods.

In addition to the evidence from short-term census studies indicating little impact, an analysis by CWS Fredericton of breeding bird surveys in New Brunswick for ten forest songbird species for the period 1967 to 1976 showed no downward trends during this period (Pearce *et al.* 1979). The authors conclude that any short-term impacts of fenitrothion had been compensated for by the natural resilience of songbird populations.

In light of the large body of accumulated evidence that fenitrothion has little effect on songbird populations, why the ongoing concern over this issue? It is true that songbird census techniques are strongly influenced by a number of factors which may limit their sensitivity for detecting pesticide impacts. It is also true, however, that songbird populations are highly resilient and easily capable of compensating for any losses which might occur undetected by census techniques. These levels of losses would, in fact, be modest in terms of losses from other natural and man-made causes such as migration mortality, collisions with automobiles,buildings or power lines, illegal hunting activities, loss of forest habit through timber harvesting, urbanization or agricultural activities, and the actions of fire, insects and disease. It is highly questionable in view of the scientific evidence collected to date to suggest that the effects of fenitrothion spraying, undetectable at the population level as they are, might be the one additional stress which when combined with all others pushes songbird populations to the point of collapse.

In the "Fenitrothion Review" by CWS Fredericton, great emphasis is placed on research carried out by CWS in New Brunswick since 1978 on the effects of fenitrothion on White-throated Sparrows. These studies have focused on reproductive success and nestling growth and survival following operational or experimental sprays or after oral dosing of nestling or parent birds. Several conclusions are drawn from this work. Conventional 210 g/ha applications are claimed to have a "minimum impact of reduced growth and development of nestlings, which although apparently not sufficient to reduce fledging success, is adequate reason to cast doubt on post-fledging survival". The evidence for this statement appears to be a study carried out in 1978, summarized in an EMOFICO report (EMOFICO 1980) and cited in that report as Peters (1979). This undergraduate thesis (Peters 1979) is not available from the University of New Brunswick, where the work was carried out, or from any other source aside from directly from people involved in the work. Although it represents an ambitious attempt to look at spray effects on nestling growth, critical review reveals major flaws in drawing the conclusion that it demonstrates such an effect. No significant difference in mean weight of chicks from sprayed and unsprayed plots was found at the end of the nestling growth period. The significant difference in growth rate claimed is only true for selected periods of growth for some clutches of birds (days 0 to 6 of the 8 to 9 day nestling period for first and unknown clutches, but not for second or first and second clutches combined). No significant differences in hatching or fledging success were found between sprayed and unsprayed plots. In short, the report does not support the claim made in the "Fenitrothion Review" that there is reason to doubt the post-fledging survival of nestlings because fenitrothion is retarding the growth of nestlings. Unless such research has been published in an openly available peer reviewed format, it should not be used in assessments of pesticide issues or the development of stances by advisory boards or panels.

Likewise, statements in the "Fenitrothion Review" of percent reductions in nesting success linked to a given level of cholinesterase depression have never been published with supporting data, or subjected to peer review, despite the fact that the conclusions were first made public in 1980. The authors have suggested that these studies are not suitable for publication in the open scientific literature, due to limitations in sample size, adequate controls and statistical validity. If this is the case, these findings should not be cited in regulatory positions without appropriate acknowledgments of their limitations. All these points aside, it would still seem the effects they claim accompany overswathing are of such a magnitude that it is highly improbable they would have gone undetected over the long period of fenitrothion use.

The Forest Pest Management Institute's Environmental Impact Project has been actively studying the effects of fenitrothion on forest avifauna since the early 1970's. Two recent and current major studies utilizing new methods to look at this question have confirmed our opinion, formed and tested over many years of census studies in experimental and operational spray blocks, that conventional fenitrothion applications do not significantly affect songbird population dynamics in treated forests. Current laboratory studies with a small cagebird species (Zebra finch), comparable in size to many forest passerines, are exploring the effects of various degrees of fenitrothion induced cholinesterase inhibition on behavior and reproduction. Results to date have confirmed that only slight or transient effects, expressed as reduced activity and no mortality, were associated with induced depression of ChE of 50%. In a second group of mated pairs whose ChE was depressed by 70%, mortality was limited to 2 of 48 birds. Although activity in this group was severely depressed for a period of about two days, reproductive success was not severely affected. These studies are ongoing and will form the basis of a M.Sc. thesis to be completed in the near future. In a second study carried out in the field from 1983 to 1987, census, netting, banding, time-budget, food availability and residue studies were combined to evaluate effects of 280 g/ha fenitrothion applications. Despite the intensity of these stuides, little evidence of impact was found. The results of this study have been presented in a M.Sc. thesis which was successfully defended in December of 1987, and publication of this work is currently being pursued.

In summary, thre is a great deal of evidence to show that fenitrothion does not pose a major threat to the stability of forest songbird populations. There remains, however, conclusive field evidence that fenitrothion sprays routinely reduce brain cholinesterase levels in some individuals. The biological significance of these depressions remains an area of question, and reasonable concerns over this effect are valid considerations for researchers and regulators alike. Considerable action has been taken to limit this area of potential hazard by reducing both the amounts and proportions of fenitrothion spraying relative to the use of other insecticides (*B.t.* and aminocarb) which are known to pose less hazard to songbirds (Table 4). Unfortunately, the list of alternatives available is short, and with the current lack of availability of aminocarb, is limited to *B.t.* Fenitrothion remains the most effective, practical and economic control option for some forest pests. FPMI supports the use of alternative control measures in situations where they can meet forest protection objectives with more limited hazard to songbirds. On the other hand, in situations where fenitrothion is the most suitable control option, we feel that the degree of hazard to songbirds posed by its use is insufficient to preclude its choice and application.

Table 4
Operational Use of Forest Insecticides in Eastern Canada in Recent Years[a]

	1000's of hectares sprayed[b]				
	1983	1984	1985	1986	1987
Spruce budworm only					
B.t.	64	376	644	336	403
Fenitrothion	1,553	687	352	222	342
Aminocarb	1,162	930	455	197	28
Total	2,779	1,993	1,451	755	773
All major forest insect pests[c]					
B.t.	64	376	868	906	551
Fenitrothion	1,553	687	475	301	504
Aminocarb	1,162	930	455	197	28
Total	2,779	1,993	1,798	1,404	1,083

[a]approximate figures compiled from Forst Pest Control Forum reports
[b]much of the area sprayed received a second application of the same or a different material
[c]spruce & jack pine budworms, gypsy moth, hemlock looper

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The effect of fenitrothion, applied by rotary atomizer-equipped TBM aircraft, on brain cholinesterase activity in forest songbirds.

Report to the fifteenth Annual Forest Pest Control Forum

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Advances in spraying technology to enhance the effectiveness of forest insecticides, particularly when there is a potential for significantly reducing the dosage rates of active material, are to be encouraged. It is desirable that the control advantages conferred are accompanied by decreased hazards to the environment. Fenitrothion has been used for many years in aerial spray operations against spruce budworm. Departures from the traditional mode of fenitrothion use in New Brunswick have included experiments involving different spray aircraft types, emission hardware, and manner of insecticide formulation. Since, at least in the view of CWS, there are questions concerning the acceptability of fenitrothion because of hazards to forest songbirds, it was deemed important to be assured that significant changes from the traditional manner in which fenitrothion has been used did not further compromise the welfare of birds. Thus it was that in 1987 CWS undertook a study in New Brunswick to assess responses of birds to fenitrothion delivered by rotary atomizer-equipped TBM aircraft. The work was done in the context of efficacy studies conducted by NBDNRE.

Spray impact was evaluated by comparing brain cholinesterase (ChE) activities of exposed and control birds.

Study Area and Methods

The study area was located in northwestern New Brunswick, near Kedgwick. Two areas within two specific spruce budworm spray blocks were selected for investigation: Block A-4, flight lines 41 to 55, which was scheduled to receive two treatments at the AI rate of 210 g/ha, and Block A-6, flight lines 11 to 22, which was to receive two treatments at the AI rate of 140 g/ha.

Four species of songbirds were studied in each area: Tennessee Warblers, representative of the upper canopy foragers; Bay-breasted Warblers, representative of the mid-to-upper canopy foragers; Magnolia Warblers, representative of the mid-to-lower canopy foragers; and White-throated Sparrows, a low canopy-to-ground level forager. Birds were collected for ChE analyses by shooting (.410 shotgun). Sampling was to have been done, for each of the four sprays (i.e. two sprays in each of the two blocks), on the day of spray (Day 0), the day following the spray (Day 1), and Day 3. However, due to same-day spraying in the two blocks and to last minute changes in spray plans by Forest Protection Limited, our field crew was able only to incompletely sample Block A-6. A sampling objective of ten birds of each species on each day of collecting was achieved on all but five samplings, and on three of those nine birds were collected.

Results

Brain cholinesterase activity in all species and for all samples was inhibited (Table 1). Mean ChE activities were significantly lower than controls in 26 of the 32 post spray samples. The limited data from Block A-6 (the low dosage block) indicate that

Table 1. Mean brain cholinesterase activity (mU/mg brain) in forest songbirds: comparison of means of unsprayed samples and samples collected in two blocks sprayed with UULV fenitrothion.

Species	Controls	Block	Exposed Day 0	Exposed Day 1	Exposed Day 3	Exposed Day 0	Exposed Day 1	Exposed Day 3
Tennessee Warbler	29.7	A-4	27.0	19.5[1]	18.6	26.5	26.7	22.5
		A-6	--	21.1	19.3	--	--	--
Bay-breasted Warbler	29.7	A-4	29.4	23.1	23.7	25.9	24.7	21.0
		A-6	--	20.2	22.3	--	--	--
Magnolia Warbler	30.3	A-4	28.0	20.9	22.9	26.8	24.4	25.3
		A-6	--	25.9	24.3	--	--	--
White-throated Sparrow	30.2	A-4	24.0	19.3	11.3	25.6	19.8	17.4
		A-6	--	19.5	20.1	--	--	--

[1] Underlined figures are statistically different ($P<0.05$) from controls, Mann-Whitney U-test.

birds were affected to approximately the same degree as in Block A-4. The percent of individual birds exhibiting ChE inhibition in excess of 20% and 50% of the control means is given in Table 2.

Table 2. The percent of songbirds collected from Blocks A-4 and A-6 exhibiting 20% and 50% inhibition compared to control means.

Species	Block A-4 20%	Block A-4 50%	Block A-6 20%	Block A-6 50%
Tennessee Warbler	46	13	67	19
Bay-breasted Warbler	39	6	75	10
Magnolia Warbler	34	20	35	15
White-throated Sparrow	70	29	83	26
All Species	48	17	66	18

Discussion

Although the results of this study are only preliminary, they indicate that both spray dosages caused an impact on songbirds that exceeded any other seen by us in an operational context in New Brunswick since 1978, when ChE analysis became the standard for impact assessment. The levels of ChE depression in this study are comparable to those found in an earlier study which indicated severe effects on the reproduction and behaviour on White-throated Sparrows (Pearce and Busby 1979).

The specific cause of the high level of impact can only be speculated upon. The UULV approach is probably not responsible as a previous study (Busby et al. 1987) found that UULV fenitrothion applied by Cessna aircraft equipped with rotary atomizers induced only minor effects on brain ChE activity in songbirds. The two differences in the 1987 work are that the spray was applied by TBM aircraft and the formulation was altered (in 1986 60% Dowanol® and 40% technical fenitrothion; in 1987 40% water and 60% emulsifiable concentrate consisting of 79% technical fenitrothion, 10.5% Dowanol®, and 10.5% Atlox®). Other causes may relate simply to atmospheric events which caused higher-than-normal deposition to occur. Unpublished data (E. Kettela, pers. comm.) indicate that deposition in parts of Block A-4 were somewhat high although not statistically significantly different from other spray blocks with the same application regimes.

Although efforts to reduce amounts of active ingredients in spray formulations are desireable from an environmental standpoint the results of the present study indicate that those changes will not necessarily lower the hazard to songbirds. Further, regardless of the precise causes of the impact, the results presented here reenforce our view that fenitrothion's margin of safety to songbirds is narrow.

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THE EFFECTIVENESS OF STEM IMPLANTS OF ACEPHATE AGAINST CONE INSECTS OF BLACK SPRUCE IN NEWFOUNDLAND

Richard J. West

REPORT TO THE 15TH ANNUAL FOREST PEST CONTROL FORUM, OTTAWA, 17-19 NOVEMBER 1987.

NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
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THE EFFECTIVENESS OF STEM IMPLANTS OF ACEPHATE AGAINST CONE INSECTS OF BLACK SPRUCE IN NEWFOUNDLAND

by

Richard J. West

Introduction:

Stem implants of insecticide are attractive as a control option because they are target-specific and contained within the tree. Unlike aerial or ground sprays, the implant method is very target-specific and avoids contaminating the surrounding environment with insecticide. As a result, small volumes of a concentrated insecticidal formulation are used and, where systemics are employed, insecticidal effects may last for several months. Thus little impact on the environment and long-term protection are the advantages of using stem implants of insecticide. The present study examined the impact of stem implants of the organophosphate, acephate (Acecaps^{R}, Creative Sales Inc., Nebraska), on cone insects of black spruce. The amount of insect infestation, extractable seed and seed viability in cones of treated and untreated black spruce trees was examined.

Methods:

Sixty black spruce trees (dbh = 8.8 $\pm$ 0.1 cm (S.E.); height = 5.4 $\pm$ 0.1 m (S.E.)) were selected for study. One-third was implanted with Acecaps, one-third with blank implants while the other third was left untreated. Three implants (Acecaps or blanks) were inserted per tree into 3/8" (0.95 cm) holes drilled into the base of the tree trunk. Trees were implanted 3-4 June 1986 when cones were flushing and just beyond their receptive stage.

Cones were collected 27-28 August 1986 and 11-23 September 1987, examined for external insect damage and processed individually for seed extraction. After extraction cones were bisected and examined for internal insect damage. Extracted seeds were held for three weeks in a seed germinator maintained under a 16:8 L:D photoperiod, 95% RH and temperatures of 27°C (day) and 20°C (night). The number of extracted and germinated seeds per cone was recorded. Ungerminated seeds were dissected to determine the presence or absence of seed-destroying insects.

Results and Discussion:

Trees implanted with Acecaps had significantly less insect-damaged cones (Table 1). Externally-feeding insects (including the fir coneworm, spruce coneworm, spruce bud moth and cone moth) and the internally feeding cone maggot were responsible for most of the damage. Only a few cones from the Acecap trees were externally damaged and there was essentially no internal damage. Extracted seed yields were significantly higher for the cones obtained from the Acecap-implanted trees, however the percent germination of extracted seeds was lower than that for the control trees without implants (Table 2). This was probably due to a release of unviable seeds from the basal and apical area of the cones from the Acecap-implanted trees. The Acecap-treated cones probably released more seed because there was less insect damage to interfere with cone opening. The percentage of cones opening during the extraction process was much higher for the Acecap-treated trees and overall the viable seed yield was greatest for this group (Table 2).

In 1987 few cones were left on the trees at the time of collection due to predation by squirrels. No significant difference between the treatment and control groups was observed, however this may have been due to the small sample sizes available. It is possible that the cones from the Acecap-implanted trees that were collected by the squirrels may have been superior. The long-term effect of Acecap implantation is still in question.

Table 1. Insect damage to black spruce cones in trees with stem implants of Acecaps or blanks and trees without any implants, North Pond, Newfoundland 1986.

Treatment	Mean No. Cones/Tree (± S.E.)*	Mean No. Cones/tree (± S.E.)*			
		Insect damaged	Externally chewed	Cone maggot	Seed midge
No implant	28.2 ± 5.1a	19.7 ± 3.6a	14.0 ± 2.6a	9.1 ± 2.0a	0.2 ± 0.1a
Blank implant	27.8 ± 7.0a	21.3 ± 5.2a	12.0 ± 2.6a	12.5 ± 2.7a	1.7 ± 1.7a
Acecap implant	20.3 ± 6.8a	3.8 ± 1.2b	3.4 ± 1.2b	0.05 ± 0.05b	0a

*Duncan's multiple range test, means followed by the same letter are not significantly different.

Table 2. Seed extractibility and germination from cones obtained from black spruce trees with stem implants of Acecaps or blanks and trees without any implants, North Pond, Newfoundland 1986.

Treatment	Number Cones Processed	Number Cones Opened	Mean No. Seeds Extracted Per Cone (± S.E.)*	Mean No. Seeds Germinated Per Cone (± S.E.)*	Percent of Extracted Seeds Germinating
No implant	423	278	23.3 ± 1.2b	14.2 ± 0.8b	60.7
Blank implant	555	301	18.8 ± 1.0c	9.1 ± 0.6c	48.0
Acecap implant	366	354	43.0 ± 1.1a	20.5 ± 0.8a	47.7

*Duncan's multiple range test, means followed by the same letter are not significantly different.

THE EFFECTIVENESS OF INSECT GROWTH REGULATORS AGAINST THE BALSAM WOOLLY APHID IN NEWFOUNDLAND IN 1987

Bowers, W.W. and A. Retnakaran

REPORT TO THE 15TH ANNUAL FOREST PEST CONTROL FORUM,
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THE EFFECTIVENESS OF INSECT GROWTH REGULATORS AGAINST THE BALSAM WOOLLY APHID IN NEWFOUNDLAND IN 1987

by

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The balsam woolly aphid, Adelges piceae (Ratz.), has caused considerable damage and tree mortality of balsam fir, Abies balsamea (L.) Mill., in Newfoundland. Population levels and damage increased in recent years particularly in western Newfoundland. The potential damage to thinned stands is of major concern to forest managers.

In 1987, a cooperative project was initiated between the Newfoundland Forestry Centre and the Forest Pest Management Institute to assess the potential use of insect growth regulators (IGRs) against the balsam woolly aphid. Four IGRs were tested in a small scale field trial at Bottom Brook, Newfoundland.

Ten trees in each of five treatment groups were used in the spray trial. Individual trees were selected following a preliminary screening to detect trees with current aphid infestation. Within the study area each treatment group was spaced at least 10 m apart. Treatments included groups of 10 trees sprayed with 1.0% S-31183, 1.0% Methoprene, and because of limited quantities, 0.1% Fenxocarb, and 0.1% Buprofezin, as well as an untreated control group. Test materials were diluted with water and applied as aqueous sprays to the point of run-off from a backpack mist blower. Treatment effects were evaluated by pre- and post-spray branch sampling. Pre-spray samples were collected on 7 July and post-spray samples on 14, 21 July and 4 September. For each of 50 trees, two branches were removed from the subapical crown and the second node on the secondary twig examined for aphids. The node sample unit was chosen because most first instar nymphs settle, feed and develop at first and second position nodes in the apical three-year growth portion of a branch. At each node bud scales were removed and aphid stadia counted under 25 magnifications. The percent population reduction due to treatment effects was computed using Abbott's (1925) formula.

The majority of aphids encountered in the study were sistentes aphids that moult through three nymphal instars to the adult stage. At the time of pre-spray sampling, sessile first, second, and third instar nymphs comprised 81.8% of the total stadia present (Table 1). The numbers of eggs, motile first instar neosistentes, and adults represented 10.1, 3.9 and 4.2% of the stadia, respectively. Consequently, Figure 1 presents the total numbers of sessile nymphs before and after spray application. The performance of all four analogues appears promising with IGR activity evident within the first week for each of the test materials. Percent population reduction is presented in Table 2. The relatively high proportion of aphid mortality within a short period suggests direct toxic effects on sessile nymphs.

The pre-spray population count for the control trees was nearly identical to that of Methoprene- and Fenxocarb-treated trees and therefore provide an unbiased estimate of percent population reduction. Pre-spray counts of S-31183 and Buprofezin were lower, however, and so the estimates for both treatment effects may be slightly conservative.

While the results of our research are encouraging from a pest management standpoint, much work is needed to determine if deleterious effects result from application of IGRs to aphid eggs, motile first instar neosistentes and adults. Additional knowledge is also needed to define dose-response relationships, proper timing of application, and biological effects. Accordingly, further studies are planned for next year.

Table 1. Pre-spray developmental stages present on balsam fir trees in each treatment group.[a]

	Number and Percent of Stadia								
	Eggs		Motile neosisentes		Sessile nymphs		Adults		
Treatment	No.	%	No.	%	No.	%	No.	%	Total
S-31183	11	9.4	9	7.7	89	76.1	8	6.8	117
Methoprene	33	13.2	2	0.8	204	81.6	11	4.4	250
Fenxocarb	14	5.7	8	3.3	218	89.0	5	2.0	245
Buprofezin	17	13.2	10	7.7	89	69.0	13	10.1	129
Control	25	10.1	10	4.1	208	84.2	4	1.6	247
Total	100	10.1	39	3.9	808	81.8	41	4.2	988

[a] For each treatment; 1 node/branch x 2 branches/tree x 10 trees = 20 node units.

Table 2. Insect growth regulator efficacy trial for the control of BWA sessile nymphs infesting balsam fir, Bottom Brook, NF, 1987.

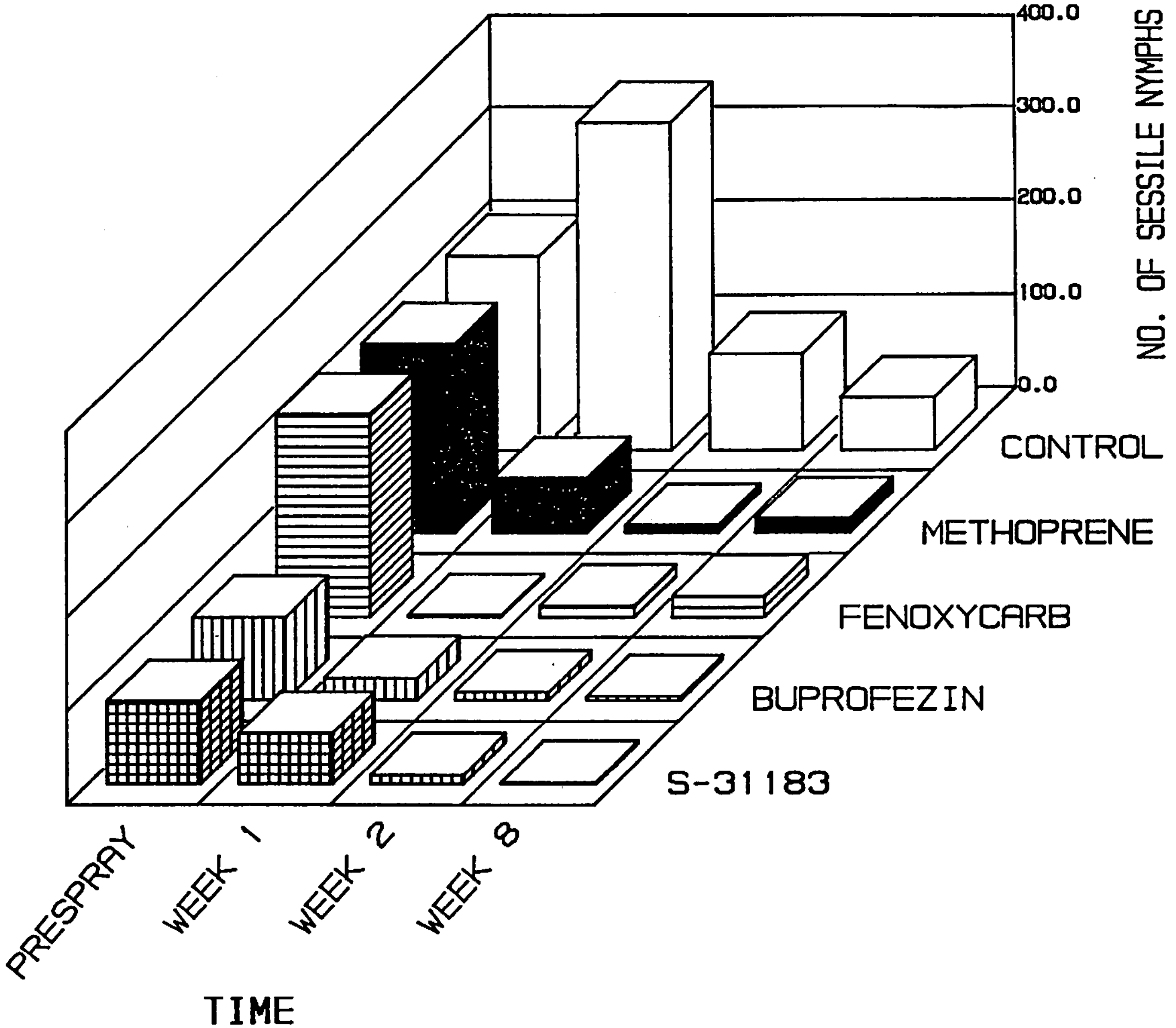
Treatment	Pre-spray count[a]	Post-spray Count			% Population Reduction[b]		
		Week 1	Week 2	Week 8	Week 1	Week 2	Week 8
S-31183	89	54	10	2	64.4	99.8	91.8
Methoprene	204	59	8	15	82.8	99.9	99.8
Fenxocarb	218	2	12	22	99.9	89.0	99.6
Buprofezin	89	24	9	4	99.8	79.8	83.6
Control	208	350	104	57	-	-	-

[a] For each treatment; 1 node/branch x 2 branches/tree x 10 trees = 20 node units.

[b] % Population reduction:

$$1 - \frac{\text{Post-spray count in treatment}}{\text{Pre-spray count in treatment}} \times \frac{\text{Pre-spray count in control}}{\text{Post-spray count in control}} \times 100$$

Fig. 1. IGR efficacy trial against balsam woolly aphid, Bottom Brook, NF, summer 1987



THE EXPERIMENTAL SPRAY PROGRAM AGAINST THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1987

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NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
ST. JOHN'S, NEWFOUNDLAND
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THE EXPERIMENTAL SPRAY PROGRAM AGAINST THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1987

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Summary

Early applications of improved formulations and dosages of *B.t.* and fenitrothion applied with an improved delivery system in 1987 provided good larval reduction of the hemlock looper and excellent foliage protection. Results from early applications of Dimilin were variable; a single treatment did not provide foliage protection and a double application provided less than expected larval reduction and foliage protection.

Objectives: Test new formulations

Test new dosages

Test earlier applications

Test a new type of spray nozzle

Insecticide, Formulations, Dosage and Timing*

1)	*B.t.* (oil)	Dipel 132	2 x 30 BIU in 2.36 ℓ/ha early [Also used in operational program]
		Dipel 176	2 x 30 BIU in 1.78 ℓ/ha early
		Dipel 176	1 x 40 BIU in 2.36 ℓ/ha late
		Dipel 264	1 x 40 BIU in 1.58 ℓ/ha late
		Dipel 264	2 x 30 BIU in 1.18 ℓ/ha early

*Timing: early = peak L_1; 99% L_1, 1% L_2.
late = peak L_2; 60% L_2, 20% L_1, 20% L_3.

2) Dimilin (water) 1 x 70 g ai/ha in 5.0 ℓ/ha (flowable) early

2 x 70 g ai/ha in 5.0 ℓ/ha (W.P.) early

2 x 70 g ai/ha in 2.5 ℓ/ha (W.P.) early

1 x 70 g ai/ha in 2.5 ℓ/ha (W.P.) early

1 x 70 g ai/ha in 5.0 ℓ/ha (W.P.) early

3) Fenitrothion (oil) 2 x 210 g ai/ha in 0.4 ℓ/ha (dowanol) early

2 x 210 g ai/ha in 0.4 ℓ/ha (dowanol) late

2 x 210 g ai/ha in 1.5 ℓ/ha (cyclosol) early [Also used in operational program]

Spray Equipment: Micronair AU 4000 nozzles.

Results

Weather for all sprays was good to excellent and all applications were followed by a rain-free period of more than 24 hours.

Deposit - Deposit for all *B.t.* was excellent. For fenitrothion it was acceptable to excellent for four out of six applications. For Dimilin it was acceptable for one out of seven applications.

Population reduction - *B.t.* reduced larval populations by 74% and 97% for the single applications, and by more than 95% for all double applications. Pupal numbers were reduced by 97% to 100% for all applications.

Fenitrothion reduced larval populations from 86% to 99%. Pupal numbers were reduced by 100% for the early applications and by 79% for the late application. After the first application of fenitrothion, populations of the looper were reduced by more than 84%. Therefore, one application probably would have been sufficient to give adequate foliage protection.

Dimilin reduced larval numbers by 47% to 63% with a single application and by 59% to 86% for double applications. Pupal numbers were reduced by 44%, 63% and 88% for the single applications and by more than 95% for the double applications.

Defoliation - Defoliation was very low or nil in plots sprayed with B.t. and fenitrothion. The general green color of trees contrasted sharply to the red of defoliated trees just outside the plot whenever populations outside the plot were sufficient to cause defoliation. The very small amount of foliage lost in one B.t. treatment (Dipel 176 single application) and for the late application of fenitrothion was mostly lost before the plots were sprayed.

Defoliation in plots with double applications of Dimilin was less severe than in unsprayed areas. However it appeared almost equally severe in and outside the plots receiving single applications.

Foliage saved - The early applications of fenitrothion and B.t. treatments saved all of the current and old foliage. The 'late' applications of B.t. and fenitrothion resulted in some foliage loss but this loss occurred before the plots were sprayed.

Double applications of Dimilin provided some foliage protection, but single applications did not.

Conclusions:

1. The new nozzle, Micronair AU 4000 provided good deposit on foliage.
2. Earlier application of B.t. and fenitrothion was effective and gave better results than 'late' applications did in 1987, 1986 and 1985.
3. A single application of B.t. sprayed early at peak first instar provided good larval reduction and foliage protection.
4. B.t. and fenitrothion formulations and dosages tested were oil based and provided good to excellent larval reduction and foliage protection.
5. Application of water-based formulations of Dimilin provided generally poor deposit on foliage during suitable spray conditions. Consequently single applications provided inadequate larval reduction and no foliage protection. Double applications gave acceptable but delayed larval reduction and therefore foliage protection was less than expected.

Hemlock Looper Experimental Spray
Hawkes Bay, Newfoundland, 1987

Average number of spray droplets/needle.

Plot No.	Treatment	First application	Second application
B.t. 1*	Dipel 132 2 x 30 BIU	1.01	8.11
B.t. 2	Dipel 176 2 x 30 BIU	1.24	3.57
B.t. 3	Dipel 176 1 x 40 BIU	1.54	-
B.t. 4	Dipel 264 1 x 40 BIU	1.90	-
B.t. 5	Dipel 264 2 x 30 BIU	1.45	1.41
F1	2 x 210 in 0.4 ℓ/ha	.09	0.52
F2	2 x 210 in 0.4 ℓ/ha	0.23	0.48
F3*	2 x 210 in 1.5 ℓ/ha	0.48	1.77
D1	1 x 70 in 5.0 ℓ/ha (flow.)	0.17	-
D2	2 x 70 in 5.0 ℓ/ha	0.33	1.12
D3	2 x 70 in 2.5 ℓ/ha	0.20	0.35
D4	1 x 70 in 5.0 ℓ/ha	0.16	-
D5	1 x 70 in 2.5 ℓ/ha	0.42	-

* These treatments were also used in the operational program.

Hemlock Looper Experimental Spray
Hawkes Bay, Newfoundland, 1987

Population Reduction Following Aerial Application of Insecticides.

Treatment Plot and Matched Control Plot			Average Number Larvae Per Tree			Avg no.	% Population Reduction		
			Pre-spray	Mid-spray	Post-spray	pupae per tree	Mid-spray	Post-spray	Pupal
				B.t. (DIPEL)					
B.t. 1*	2 x 132	30 BIU	111.6	21.5	1.2	0.1	82.0	98.2	100
A	Control		90.7	97.0	54.4	196.7			
B.t. 2	2 x 176	30 BIU	228.3	47.1	1.0	0.4	79.0	99.5	100
C	Control		246.5	241.4	216.8	372.0			
B.t. 3	1 x 176	40 BIU	107.0	-	6.5	4.7	-	85.0	97.3
D	Control		104.3		42.3	167.8			
B.t. 4	1 x 264	40 BIU	151.5	-	1.9	0.0	-	97.0	100
B	Control		165.7	-	69.7	133.1			
B.t. 5	2 x 264	30 BIU	95.4	26.1	2.6	0.6	74.4	95.5	99.7
A	Control		90.7	97.0	54.4	196.7			
				FENITROTHION					
F 1	2 x 0.4 ℓ/ha - early		53.5	7.7	0.5	0.7	92.1	98.7	100
D	Control		57.0	104.3	42.3	167.8			
F 2	2 x 0.4 ℓ/ha - normal		195.7	40.6	15.7	30.3	84.3	86.4	78.7
E	Control		140.6	186.2	83.0	137.4			
F 3*	2 x 1.5 ℓ/ha - early		39.6	5.3	0.5	0.4	92.7	98.3	100
D	Control		57.0	104.3	42.3	167.8			
				DIMILIN					
D 1	1 x Flow. 5 ℓ/ha		190.2		45.5	53.5		46.7	61.9
E	Control		186.2		83.0	137.4			
D 2	2 x 5 ℓ/ha		84.5		7.7	2.1		83.7	98.8
A	Control		97.0		54.4	196.7			
D 3	2 x 2.5 ℓ/ha		232.2		56.7	7.9		58.6	96.5
E	Control		140.6		83.0	137.4			
D 4	1 x 2.5 ℓ/ha		640.5		207.5	118.9		63.2	87.7
C	Control		246.5		216.8	372.0			
D 5	1 x 5 ℓ/ha		256.1		104.9	139.1		58.1	44.4
E	Control		140.6		83.0	137.4			

* These treatments were also used in the operational program.

Hemlock Looper Experimental Spray
Hawkes Bay, Newfoundland, 1987

Percent foliage saved.

	CURRENT GROWTH		OLD GROWTH	
Plot No.	% Foliage saved (control)**	% Foliage saved (boundary)***	% Foliage saved (control)**	% Foliage saved (boundary)***
B.t. 1*	100	100	100	100
B.t. 2	100	100	100	100
B.t. 3	62.7	87.5	96.8	98.9
B.t. 4	100	100	100	100
B.t. 5	100	100	100	100
F1	100	100	100	100
F2	6.6	46.2	74.6	81.0
F3*	100	100	100	100
D1	23.1	47.4	59.6	66.5
D2	66.2	68.6	92.0	91.6
D3	41.0	51.0	94.3	94.6
D4	0	14.5	1.0	31.3
D5	0	3.2	0	18.8

*These treatments were also used in the operational program.

**Foliage saved by treatment in comparison to its matched control plot.

***Foliage saved by treatment in comparison to trees just outside the plot.

Report of the New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations

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Report of the N.B. Committee for Environmental Monitoring of Forest Insect Control Operations

W. A. Sexsmith

Abstract

This report from the New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO) lists the environmental research and monitoring projects, including herbicide projects, carried out in New Brunswick in 1987, and presents briefly the regulatory activities of the N.B. Department of Municipal Affairs and Environment as they relate to forest spray programs. A project investigating the off-target ground deposition of glyphosate is outlined.

Summary

The New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO) under the aegis of the N.B. Department of Municipal Affairs and Environment is an informal association of biologists, foresters, environmental specialists and chemists from federal and provincial governments, industry and universities. Its prime objective is to exchange information on the impact of operational spray programs on non-target organisms and ecological processes in forest and adjacent ecosystems. This includes efficacy as it relates to environmental effects, experimental sprays and laboratory studies. The potential consequences of forest spray programs for human health are beyond the Committee's terms of reference. The Committee's focus is on spray activities in New Brunswick, but it seeks to be aware of forest insect control operations and related environmental studies in the Atlantic region as well as in Quebec and Maine.

This year, as a result of a consensus reached at the annual meeting held in the spring of 1987, the mandate of EMOFICO has been extended to include forest herbicides, based on the increased use of herbicides in forestry, and the increased awareness of the need for research in the area of forest herbicides, both in application technology, and environmental impact.

Six studies were conducted by six agencies in 1987 (Table 1).

Reported in brief below are: (1) the regulatory activities in New Brunswick and (2) a research project involving the forest herbicide glyphosate carried out by the N.B. Department of Municipal Affairs and Environment.

(1) Regulatory Activities

The New Brunswick Department of Municipal Affairs and Environment has the mandate to regulate pesticide application in the Province, including both the spruce budworm spray program and the forest herbicide spray program. The total number of man hours spent monitoring these programs for permit compliance was 234 and 139 respectively, with 6 and 9 incidents respectively (complaints, etc.) investigated. Four spills or jettisoned loads occurred, all relating to the spruce budworm program (Table 2). No significant environmental impact was reported.

All municipal drinking water supplies situated in watersheds that had insecticide spray activity were sampled before and after (for aminocarb and fenitrothion only) applications took place. As in previous years, no evidence of pesticide residues (detection limits: aminocarb 0.1 ppb, fenitrothion 0.01 ppb) in these water supplies was found in 1987. No such sampling was done for the herbicide program.

Setbacks or buffer zones, have been used as a regulatory tool over the years in New Brunswick as a means to protect designated sensitive areas from impact of spray operations. Setbacks that were in place for 1987 for the forest insecticide spray program are indicated in Table 3 and for the forest herbicide spray program, Table 4.

Setbacks for research applications, not indicated in the tables, were 8 km from human habitation for a new (unregistered) active ingredient, and 3.2 km from human habitation for a previously registered active ingredient.

These buffer zones, although there have been few changes in the past few years, are not meant to be static but are such that they may change as the information available changes.

Table 1. Research and monitoring activities in New Brunswick

Responsibility	Agency	Leader	Study
Birds	CWS	P. Pearce	Innovative spraying impacts on forest songbirds of TBM/micronair delivered fenitrothion.
Aquatic fauna	UNB/CFS	W. Fairchild	Effects of forest insecticide spraying on the invertebrate community of bog ponds. Conclusions.
Insecticide Residues	CFS	C. Nigam	Progress report of 1987 experiments on UULV fenitrothion deposition in budworm microhabitat and budworm behaviour.
Experimental Insecticides	CFS	E. Kettela	Review of research and development programs conducted in New Brunswick in 1987 to evaluate pesticides and tactics against the spruce budworm and the spruce budmoth.
Herbicide drift	ENB/EPS/ RPC	W. Sexsmith	Estimating off -target ground deposition of helicopter-applied glyphosate sprays in forestry.
Regulation	ENB	W. Sexsmith	Forest spray program monitoring.

Table 2. Pesticide spills/jettisoned loads in operational forestry programs in 1987.

Date	Agency	Product	Amount	Location	Cause
June 6	Forest Protection Ltd.	Fenitrothion	200 U.S. gal	Boston Brook	TBM crash
June 10	Forest Protection Ltd.	Fenitrothion	625 U.S. gal	Boston Brook	TBM dump door tripped
June 16	Forest Protection Ltd.	Dipel 132 B.t.	112 U.S. gal	Coal Branch	engine problems
Aug. 11	J.D. Irving Ltd.	Fenitrotion/aminocarb	10 U.S. gal	Boston Brook	residual insecticide in hose

Table 3. Setbacks for the 1987 Spruce Budworm Spray Program in New Brunswick

	Woodlands*	Woodlots**	
	H20***	H20	B.t.
Habitation	1.6 km	300 m	155 m
Lakes (> 40 ha)	400 m		
Designated major Rivers	400 m		
Open water bodies		65 m	0
Ecological reserves	400 m	65 m	65 m
Municipal water (point of extraction)	3.2 km	3.2 km	3.2 km
Blueberry fields	3.2 km	3.2 km	0

* TBM aircraft
** Agricultural type aircraft
*** Water-based chemical formulation

Table 4. Setbacks for the 1987 Forest Herbicide Spray Program in New Brunswick

Habitation	155 m
Open water bodies	65 m
Municipal water (point of extraction)	3.2 km

(2) Estimating Off-target Ground Deposition of Helicopter Applied Glyphosate Sprays in Forestry

Background: Current regulations demand that a 65 m no-spray buffer zone must be observed around watercourses when applying silvicultural herbicides by helicopter. This figure of 65 m is based on a swath width of an agricultural fixed-wing aircraft spraying insecticide rather than upon application-specific experimental results. Recent work by Payne et àl. (unpublished data) suggests that for some application systems, a 25 m buffer zone would be adequate; however, the systems tested do not include those currently used in New Brunswick.

Objectives: The main objective of this study will be to assess off-target ground deposition of glyphosate up to a maximum 200 m downwind of blocks sprayed by helicopter under typical New Brunswick operating conditions. A total of three individualo sprays will be sampled. The effectiveness of the existing 65 m watercourse buffer zone will be determined and the potential for its reduction assessed.

Statement of work:

Spray Design: Off-target deposits of glyphosate will be collected on 30 cm X 40 cm polyethylene ground deposit samplers. The ground deposit samplers will be laid out in five transects downwind of the target area. Transects will be spaced approximately 30 m apart and have stations at: -10 meters (within the spray block); 0 meters (edge of the effective swath); and at exponentially increasing intervals up to a maximum of 200 meters for a total of eleven stations. Meteorological conditions to be monitored during each spray application will include:

(a) relative humidity

(b) air temperature profile to 10 meters

(c) wind speed and direction at heights of 10 m, 3 m and 1 m or a turbulence measurement.

Deposited droplet spectra will be assessed on water-sensitive cards placed at selected sampling stations during each application.

Analysis: In one of the three spray applications, glyphosate deposits on plates located at five sites (to be determined) will be analysed individually in order to assess within-site deposit variation. The remainder of the samples, including those in the second and third sprays, will be "bulked" by site and analysed together to provide a mean deposit for each site with no measure of variation.

Glyphosate deposits will be determined either by gas chromatography or another suitable method.

Recovery/loss studies with aged and unaged ground samplers will be assessed during the method development stage of the study. Twenty percent of the deposit samples will be analysed for both the parent compound and the major metabolite aminomethyl phosphoric acid (AMPA).

<u>Reporting:</u> A report will be presented which documents the decrease in ground deposition of aerially applied glyphosate with increasing distance downwind of the target site. The results from three individual spray applications will be compared. The adequacy of the current 65 m watercourse buffer zone in reducing incidental ground deposition will be determined and the potential for a reduction in the buffer zone assessed.

<u>Deposit Modelling:</u> Data will be given to Bob Mickle, Atmospheric Environment Service, in order that he may compare observed results with predictions from one of the currently available computer models for predicting downwind deposit.

THE ROLE AND MANDATE OF THE NATIONAL FOREST PEST CONTROL FORUM

The National Forest Pest Control Forum has been in existence since 1973 and represents the only national meeting when all forest pest management and pesticide specialists can meet to exchange information and discuss issues concerning their current year and forecast programs. The Forum replaced the long-standing Interdepartmental Committee on Forest Spraying Operations which carried out a similar function but with little or no provincial representation. The Interdepartmental Committee was originally formed to review and recommend federal involvement in and funding of pest control operations carried out in the late 1950's and 1960's.

In recent years, the Forum has permitted an exchange of information concerning pest management operations and research. This has been the principal function of the Forum.

At the Forum meeting at Ottawa, November 19-21, 1985, a Forum Mandate Review Committee was proposed because there were several attendees who felt that the Forum could and should be more than an information exchange session. The committee, consisting of B. H. McGauley (OMNR), G. Munro (MDNR), L. Dorais (QMER), G. M. Howse (CFS) and E. Kettela (CFS) was subsequently endorsed by the Director General, Research and Technical Services. The terms of reference for the committee as outlined in a letter dated December 17, 1985 from the Program Manager, Protection, to the Director General were as follows:

- i) examine the mandate of the Annual Forest Pest Control Forum,
- ii) consider a change in the mandate of the Forum,
- iii) if a change to the mandate is considered necessary, make recommendations for implementation of a change,
- iv) discuss and make recommendations for broadening of the Forum to include vegetation management research.

The committee met in May and August 1986 to address the terms of reference and prepare a proposed goal and mandate statement for presentation at the 1986 Forum. The proposal was debated at length and modified to take into consideration the comments of the attendees. The modified role and mandate as agreed upon at the 1986 National Forest Pest Control Forum are outlined in this paper.

1.0 National Forest Pest Control Forum:

A National Forest Pest Control Forum will be conducted each year under the aegis of the Canadian Forestry Service.

2.0 Goal:

The goal of the Forum is to review significant pest conditions, pest control operations and pest management/pesticide related issues.

The word "pest" is interpreted in its broader context and includes insects, diseases and weeds. Pesticides include insecticides, fungicides and herbicides.

3.0 Activities of the Forum:

The National Forest Pest Control Forum will undertake the following activities:

1. exchange information on significant insect and disease distribution and forecast spread in Canada;
2. review the pest management activities, environmental monitoring, assessment of current year insect and disease control programs, overview of the herbicide program and outline of issues relating to any pesticides;
3. outline pest control operations proposed for the next calendar year;
4. apprise of current research relating to pesticide application, pesticide and silvicultural or other research which would reduce future pest outbreak potential;
5. receive an annual update on forestry pesticides which are registered and pending registration and discuss product by product the gaps preventing full registration by Agriculture Canada;
6. gather statistical information from each province in a standardized format (to be developed federally and agreed to by the provinces) on the operational forest pesticide use (ground and aerial);
7. debate specific pest management/pesticide issues and present recommendations in an Executive Summary.

4.0 Membership:

A significant change in the activity of the Forum is point #7 in Section 3.0. A Steering Committee will be needed to prepare issue statements for discussion. The Forum attendees will debate the issues openly and then vote. Motions which are carried will constitute recommendations which will be included in the Executive Summary which attendees can subsequently use as they see fit.

4.1 STEERING COMMITTEE MEMBERS:

Provincial forestry representatives:	. 1 from each of 10 provinces
Canadian Forestry Service:	. 1 from each of 2 institutes . 1 from each of 6 regional establishments . 2 from CFS Headquarters
Executive Secretary:	. FIDS - CFS Headquarters

5.0 Attendance at the Forum:

The following will be invited:

- provincial pest control staff
- provincial and federal government health, wildlife, fisheries and oceans, and environment staff
- border-state and federal U.S. pesticide/pest control staff
- federal government survey, research and pesticide regulatory staff
- representatives of the forest industry, both at the organizational and company level
- researchers - provincial government
  - private research labs
  - universities and colleges
- others as approved by the voting membership (e.g. Eastern Spruce Budworm Council representative, forestry consultants).

The following will not be invited:

- media
- environmentalist groups
- pesticide industry representatives.

6.0 Forum Outputs:

6.1 Annual Report:

The Forum provides an opportunity for information exchange and as such, will continue to produce an Annual Report. The Annual Report will contain detailed written submissions by participants, a list of attendees and addresses and an executive summary with recommendations (see below). Each member of the steering committee will receive 2 copies of the Annual Report (one copy catalogued in a library and the other retained by the member) and one copy will be sent to each attendee. Those who are absent but entitled to an invitation (see Section 5.0) will receive a copy if a written request is received.

6.2 Executive Summary:

An executive summary (2-3 pages) will be prepared each year by the steering committee and include a brief overview of insect/disease distribution, pest management programs, and proposed pest management programs, plus a significant treatment of issue statements with recommendations. The executive summary will be distributed to Forum attendees and be included in the Annual Report.

7.0 Modus Operandi:

The Forum program will be chaired cooperatively by the federal and provincial program assistants (see Section 8.0).

8.0 Program:

Detailed reports of pest control programs and research will be required for the Annual Report. However, the Forum program will be streamlined to permit additional time for discussion. The existing time frame of 3 days of reports and workshops will be retained. The 3-day program will include a half-day on operational pest control reports, half-day on pest distribution, half-day on research, environmental monitoring and health concerns, and a half-day on issue debate and preparation of recommendations. With this tight time frame, it will be necessary for speakers to be focused and brief. Speakers will touch on highlights and identify issues which could be discussed during the issue debate period.

The program will be prepared by the Executive Secretary with assistance from the provincial representative and corresponding CFS representative. It is recognized that some CFS organizations span several provinces and may be called upon more frequently than others. The Ontario Ministry of Natural Resources and Great Lakes Forestry Centre will assist the Executive Secretary in 1987. Future program organizers are proposed as follows:

YEAR	ORGANIZERS	CFS
1	Ontario	Sault Ste. Marie
2	British Columbia	Victoria
3	Quebec	Quebec
4	Alberta	Edmonton
5	New Brunswick/P.E.I.	Fredericton
6	Saskatchewan	Edmonton
7	Nova Scotia	Fredericton
8	Manitoba	Edmonton
9	Newfoundland	St. John's

9.0 Location:

The Forum will remain in Ottawa in 1987 and 1988. However, in 1988 serious consideration should be given to holding the Forum in other provinces on an annual basis beginning in 1989.

10.0 Date:

The Forum should continue to be held during the third week of November.

11.0 Budget:

The Forum will continue to function under the aegis of the Canadian Forestry Service and incidental expenses (e.g. postage, publication of proceedings, meeting room) will be covered by the Federal government.

RÔLE ET MANDAT DU FORUM NATIONAL SUR LA RÉPRESSION DES RAVAGEURS FORESTIERS

Le Forum national sur la répression des ravageurs forestiers, créé en 1973, est la seule occasion, pour tous les spécialistes de la lutte antiparasitaire au pays, de se rencontrer pour échanger des renseignements et discuter de leurs programmes en cours et prévus. Il remplace l'ancien Comité interministériel des pulvérisations forestières qui remplissait des fonctions semblables, mais au sein duquel les provinces étaient peu ou pas représentées. À l'origine, le Comité avait pour mission d'étudier et de recommander la participation du gouvernement fédéral à la lutte antiparasitaire et à son financement, durant la fin des années 1950 et les années 1960.

Ces dernières années, le Forum a permis d'échanger des données sur les ravageurs, la lutte qu'on leur fait et la recherche dans le domaine; il s'agit de sa principale fonction.

Lors du Forum qui s'est tenu à Ottawa du 19 au 21 novembre 1985, les participants ont proposé la création d'un comité d'étude du mandat du Forum, car, pour plusieurs d'entre eux, la recontre pouvait et devait être plus qu'une séance d'information. Le comité, formé de B.H. McGauley (MRNO), de L. Dorais (MERQ), de G.M. Howse (SCF) et de E. Kettela (SCF), a ensuite été appuyé par le directeur général, Services techniques et recherche; d'après la lettre (du 17 décembre 1985) du gestionnaire du Programme de protection au directeur général, il était chargé:

(i) d'étudier le mandat du Forum annuel sur la répression des ravageurs forestiers;

(ii) d'envisager sa modification;

(iii) si elle est nécessaire, de faire les recommandations pertinentes;

(iv) de discuter de la possibilité d'étendre le mandat du Forum à la recherche sur l'aménagement des végétaux et de faire les recommandations pertinentes.

Le Comité s'est recontré en mai et en août 1986 pour étudier la question; il a préparé un énoncé provisoire des objectifs et du mandat du Forum, énoncé qui a été débattu en 1986 et modifié en fonction des observations des participants. Voici donc un aperçu du rôle et du mandat nouveaux.

1.0 Forum national sur la répression des ravageurs forestiers:

Il sera tenu, chaque année, sous les auspices du Services canadien des forêts.

2.0 Objet:

Étudier les principaux ravageurs, la lutte qu'on leur fait et les questions connexes (lutte/pesticides).

Le mot "ravageur" est utilisé dans son acception la plus large et englobe les insectes, les maladies et les mauvaises herbes; les pesticides incluent les insecticides, les fongicides et les herbicides.

3.0 Activités:

Les activités du Forum sont les suivantes:

1. Échanger des renseignements sur la répartition et la progression prévue des infestations et des maladies importantes au Canada;
2. Passer en revue la lutte antiparasitaire, la surveillance de l'environnement, l'évaluation des programmes de lutte contre les insectes et les maladies (année en cours), les grandes lignes du programme d'épandage d'herbicides et l'aperçu des questions relatives au pesticides;
3. Énoncer les mesures de lutte proposées pour la prochaine année civile;
4. Évaluer la recherche actuelle (épandage de pesticides, pesticides comme tels, sylviculture, etc.) qui permettrait de réduire les possibilités d'infestations futures;
5. Recevoir une mise à jour annuelle des pesticides forestiers homologués et en voie de l'être; discuter, dans chaque cas, des points qui empêchent leur homologation complète par Agriculture Canada;
6. Recueillir, de chaque province, des statistiques (présentation normalisée établie par le gouvernement fédéral et approuvée par les provinces) sur l'usage de pesticides dans les forêts (épandage au sol et aérien);
7. Discuter de questions précises de lutte antiparasitaire et présenter des recommandations dans un sommaire.

4.0 **Composition:**

Le point n° 7 de la section 3.0 représente une grande modification des activités du Forum. Il faudra charger un comité directeur de rédiger des énoncés des questions dont les participants au Forum se serviront pour en discuter ouvertement, avant de passer au vote. Les motions adoptées deviendront les reommandations du sommaire que les participants pourront ensuite utiliser à leur gré.

4.1 MEMBRES DU COMITÉ DIRECTEUR:

Représentants des services forestiers provinciaux:	- 1 par province (10)
Représentants du Service canadien des forêts:	- 1 par institut (2) - 1 par bureau régional (6) - 2 de l'administration centrale
Secrétaire de direction:	- RIMA - administration centrale du SCF

5.0 **Participants invités:**

Pourront participer au Forum:

- les préposés à la lutte antiparasitaire au palier provincial
- les fonctionnaires fédéraux et provinciaux (santé, faune et flore, pêches et océans, environnement)
- le personnel chargé de la lutte antiparasitaire au gouvernement américain et dans les États avoisinants
- les préposés fédéraux aux relevés, à la recherche et à la réglementation des pesticides
- les représentants de l'industrie forestière (sociétés individuelles et regroupées)
- les chercheurs:
  - des gouvernements provinciaux,
  - des laboratoires privés de recherche,
  - des établissements post-secondaires
- d'autres personnes, comme approuvé par les membres votants (par ex.: représentants du Conseil de la tordeuse des bourgeons de l'épinette, experts-conseils en foresterie).

N'y seront pas conviés:

- les médias,
- les groupes écologiques,
- l'industries des pesticides.

6.0 **Produits:**

6.1 RAPPORT ANNUEL:

Le Forum permet l'échange de renseignements. Par conséquent, on continuera de produire un rapport annuel qui contiendra les exposés écrits détaillés des intervenants, leur nom et leur adresse et un sommaire incluant des recommandations (voir ci-dessous). Chaque membre du comité directeur en recevra deux copies (une cataloguée pour la bibliothèque, une pour son usage personnel); tous les autres participants en recevront une: les invités absents (voir liste, section 5.0) en recevront une également, s'ils en font la demande par écrit.

6.2 SOMMAIRE:

Un sommaire (2-3 pages) sera rédigé chaque année par le comité directeur et donnera en bref la répartition des insectes et des maladies, les programmes en cours et proposés de lutte antiparasitaire ainsi qu'un énoncé des questions et des recommandations. Il sera remis aux participants et inclus dans le rapport annuel.

7.0 **Fonctionnement:**

Le Forum sera présidé conjointement aux paliers fédéral et provincial (voir section 8.0).

8.0 **Ordre du jour:**

Pour le rapport annuel, il faut des exposés détaillés des programmes et de la recherche en matière de lutte antiparasitaire. Toutefois, l'ordre du jour sera rationalisé pour allouer plus de temps aux discussions. Le Forum continuera à durer trois jours (exposés et ateliers), mais on consacrera une demi-journée aux comptes-rendus sur la lutte antiparasitaire opérationnelle, une demi-journée à la répartition des ravageurs, une demi-journée à la recherche, à la surveillance environnementale et aux questions de santé ainsi qu'une demi-journée aux discussions et à la préparation des recommandations. Vu ce calendrier très chargé, les exposés devront être à propos et brefs, donner les grandes lignes et souligner des points de discussion, pour la période prévue à cette fin.

L'ordre du jour sera établi par le secrétaire de direction, de concert avec le représentant provincial et celui du bureau correspondant du SCF, soit le ministère des Ressources naturelles de l'Ontario et le Centre de foresterie des Grands-lacs, en 1987. Évidemment, certains bureaux du SCF regroupent plusieurs provinces; par conséquent, on y aura probablement recours plus souvent. Les responsables provisoires des forums à venir sont donc les suivants.

ANNÉE	ORGANISATEUR	SCF
1	Ontario	Sault Ste Marie
2	Colombie-Britannique	Victoria
3	Québec	Québec
4	Alberta	Edmonton
5	Nouveau-Brunswick/ Île-du-Prince-Édouard	Frédéricton
6	Saskatchewan	Edmonton
7	Nouvelle-Écosse	Frédéricton
8	Manitoba	Edmonton
9	Terre-Neuve	St. Jean

9.0 Lieu:

Le Forum se déroulera encore à Ottawa en 1987 et en 1988, mais on envisagera sérieusement de le tenir dans d'autres provinces, tous les ans, à compter de 1989.

10.0 Dates:

Elles devraient continuer à tomber durant la troisième semaine de novembre.

11.0 **Budget:**

Le Forum continuera à se tenir sous les auspices du Services canadien des forêts, et les frais accessoires (par ex.: affranchissement, publication de comptes-rendus des rencontres, salle de réunion) seront supportés par le gouvernement fédéral.

Executive Summary
Forest Pest Control Forum, November 17 - 19, 1987

The Forest Pest Control Forum Steering Committee met from 3:00 - 5:00 p.m. on November 16, 1987 to discuss the mandate, issues and recommendations to be presented to the Forum. A list of the membership is attached. Ed Kondo was elected Steering Committee Chairperson and Geoff Munro, Issue-Debate Chairperson. It was also decided that Forum members should be encouraged to bring forward issues and recommendations to the committee before the Forum.

The attendees of the Forum were honored for the second consecutive year by the presence of Mr. Jean Claude Mercier, Associate Deputy Minister, who gave the introductory remarks. Dr. Jack Armstrong also made a brief appearance to discuss the book entitled "Control of Forest Insects in Canada". Jack is the editor of the book, and most of the articles are being written by the attendees to the Forum.

The Forum agenda was divided into four (4) main sessions each with a session chairman, and included:

1) General Forest Pest Status and Pest Management

Papers presented indicated that infestation and damage by the major pests: mountain pine beetle, jack pine budworm and the Gypsy moth had declined generally. The Pinewood Nematode was discussed not because it is a problem in Canada but because of its effect on the softwood markets, e.g. the Nordic Countries ban.

2. Spruce Budworm Distribution and Pest Management

Papers presented for each province and state, indicated that infestations of the eastern spruce budworm have declined in most provinces and states, with the possible exception of the western provinces of Saskatchewan, Alberta and British Columbia.

3. Research, Environmental Monitoring and Health Concerns

The professional staff of the Forest Pest Management Institute gave an overview of their Biorational and Chemical Programs and the status of insecticide and herbicide research. Plant Health, Agriculture Canada, presented information on registration of forestry pesticides and on minor use of pesticides. Provincial and federal researchers presented papers on fenitrothion spray impact; avian impact; spray technology; environmental monitoring; experimental spray against a number of pests including the spruce budworm, hemlock looper, balsam wooly aphid and cone and seed insects; the status of growth regulators in research; and the monitoring of herbicide applications in Quebec.

4. Issue Debate and Recommendations

Under the guidance of the Issue Debate Chairperson, several issues and recommendations were openly debated. The outcome of the debate was that six (6) resolutions/statements (attached) were developed and ratified by over 80% of the attendees. These six issues were:

1) Registration of Velpar and Dimilin
2) Pesticide Research on Provincial Crown Land
3) Fenitrothion Avian Impact
4) Lack of Forestry Insecticides
5) Contamination of *Bacillus thuringiensis* with microorganisms
6) Gypsy Moth Control in the Maritimes

Forest Pest Control Forum
Colloque sur la répression des ravageurs forestiers

Conference Centre, Ottawa

Centre de conférences, Ottawa

December 15, 1987

Dr. J.B. Morrissey
Assistant Deputy Minister
Food Production and Inspection Branch

Mr. L. Goulet
Assistant Deputy Minister
Conservation and Protection

At the Fifteenth Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 17 - 19, 1987, the following issue was openly debated during the Issues Debate Session.

The issue, "data supporting the full registration of Velpar for forestry use have been submitted to Agriculture Canada. The data have been reviewed by Agriculture Canada and its consultants in the registration review process, with the exception of the Environmental Protection Service (EPS), which has not even initiated its review yet. A comprehensive data package for the full registration of Dimilin for use against the gypsy moth has been submitted to Agriculture Canada. This data package contained information relative to environmental concerns expressed by EPS. The EPS representative at the 1987 Forum indicated that EPS still had concerns about Dimilin that they were not prepared to air at the Forum. It was interpreted by the Forum that these concerns might further delay the registration of this pesticide..."

The outcome of the debate was that the following recommendation was developed and ratified by over 80% of the attendees who participated in the Issues Debate Session:

- "That letters be sent to the ADM Agriculture Canada and Environment Canada requesting that they identify the problems delaying the registration of Velpar and Dimilin for forestry use with the view of expediting the early registration of these much needed pesticides."

Since issues are openly debated, the wording of the recommendation reflects the wishes and serious concerns of the majority (80% or greater) of the participants.

As Chairmen of the Steering Committee and the Issues Debate Session of the Forum, we respectfully submit to you the recommendations. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

Forest Pest Control Forum
Steering Committee
Chairman
Edward S. Kondo

Forest Pest Control Forum
Issue Debate Chairman
Geoffrey Munro

Secretariat/Secrétariat: Canadian Forestry Service/Service canadien des forêts
Hull, Quebec K1A 1G5

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December 15, 1987

The Honourable Vincent G. Kerrio, M.P.P.
Minister of Natural Resources

Dear Mr. Kerrio:

At the Fifteenth Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 17 - 19, 1987, the following issue was openly debated during the Issues Debate Session.

The issue, "in 1986 and 1987, the Ontario provincial government did not allow research involving aerial application of chemical insecticides on provincial crown forests. This resulted in cancellation of research programs including those of Forest Pest Management Institute of Canadian Forestry Service, planned to investigate environmental impacts as well as reduced dosage rates for forestry chemical insecticides. Such restrictions have serious long term implications on forest pest management and environmental research in Ontario and perhaps other provinces including research designed to improve the environmental safety of pest control products and technologies for their safe and effective use."

The outcome of the debate was that the following recommendation was developed and ratified by over 80% of the attendees who participated in the Issues Debate Session:

- "The Forum (with the notable abstention of the Ontario Ministry of Natural Resources representative) recommends that the Ontario government seek a permanent solution for allowing the aerial application of chemical pesticides to provincial crown forests for research activities deemed acceptable by federal and provincial pesticide regulatory authorities."

Since issues are openly debated, the wording of the recommendation reflects the wishes and serious concerns of the majority (80% or greater) of the participants.

As Chairmen of the Steering Committee and the Issues Debate Session of the Forum, we respectfully submit to you the recommendations. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

Forest Pest Control Forum
Steering Committee
Chairman
Edward S. Kondo

Forest Pest Control Forum
Issue Debate Chairman
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Forest Pest Control Forum

Conference Centre, Ottawa

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Dr. David Havers
Vice President, Agrichemical Division
May and Baker Company Canada

Mr. Peter McMullin
Technical Products Manager
Chem Agro

At the Fifteenth Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 17 - 19, 1987, the following issue was openly debated during the Issues Debate Session.

The issue, "at present, Bacillus thuringiensis (B.t.), fenitrothion and aminocarb are the only practical considerations for operational use against eastern spruce budworm; aminocarb, due to lack of sales is no longer being manufactured and concerns have been expressed by wildlife authorities over perceived impacts of fenitrothion to songbirds. B.t. is a fully operational protection option but does not constitute a complete replacement for other control products should the availability of these be further restricted. Mexacarbate is an environmentally acceptable insecticide for budworm control yet plans for its future registration are in doubt..."

The outcome of the debate was that the following recommendation was developed and ratified by over 80% of the attendees who participated in the Issues Debate Session:

- "That the manufacturers of mexacarbate, May and Baker, be requested to actively pursue forestry registration for this insecticide.

- That the Bayer Chemical (Germany) and Mobay Chemical Company, manufacturers of aminocarb, be urged to maintain the current registration status for future forest insect control operations.

- That letters be sent to all appropriate provincial forestry agencies urging that serious provincial consideration be given to the inclusion, whenever practical, of a full range of registered insecticide products in all future provincial protection operations."

Since issues are openly debated, the wording of the recommendation reflects the wishes and serious concerns of the majority (80% or greater) of the participants.

As Chairmen of the Steering Committee and the Issues Debate Session of the Forum, we respectfully submit to you the recommendations. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

Forest Pest Control Forum
Steering Committee
Chairman
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Forest Pest Control Forum
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December 15, 1987

Dr. R. Roy
Director General
Plant Health and Plant Products Directorate

Dear Dr. Roy:

At the Fifteenth Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 17 - 19, 1987, the following issue was openly debated during the Issues Debate Session.

The issue, "i) The presence of micro-organisms other than Bacillus thuringiensis (B.t.) represents a possible risk to human health. ii) The presence of such micro-organisms necessitates extensive and costly research which could delay spraying operations. iii) The level of undesirable micro-organisms continued to increase in certain lots of B.t. preparations, thus indicating the possibility of further and more serious contamination after prolonged storage. iv) Several types of pesticides using micro-organisms as the active ingredient will be on the market in the near future."

The outcome of the debate was that the following recommendation was developed and ratified by over 80% of the attendees who participated in the Issues Debate Session:

- "That Agriculture Canada recognize the need for an acceptable level of biological purity of registered and experimental B.t. preparations;
- That a national program of quality control compliance be implemented with regard to the registered and experimental preparations of B.t. to be used in forests;
- That standards be developed at the federal level for immediate implementation."

Since issues are openly debated, the wording of the recommendation reflects the wishes and serious concerns of the majority (80% or greater) of the participants.

As Chairmen of the Steering Committee and the Issues Debate Session of the Forum, we respectfully submit to you the recommendations. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

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Dr. R. Roy
Director General
Plant Health and Plant Products Directorate
Agriculture Canada

Dear Dr. Roy:

At the Fifteenth Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 17 - 19, 1987, the following issue was openly debated during the Issues Debate Session.

The issue, "whereas both Nova Scotia and New Brunswick have had populations of gypsy moth since 1981, and whereas both provinces and the Canadian Forestry Service have taken major roles in monitoring and supressing this alien pest..."

The outcome of the debate was that the following recommendation was developed and ratified by over 80% of the attendees who participated in the Issues Debate Session:

"That Agriculture Canada - Plant Health seriously fulfills its mandate to prevent the spread into, spread within, and spread from Canada of this alien pest as it is required to do by the Plant Quarantine Act."

Since issues are openly debated, the wording of the recommendation reflects the wishes and serious concerns of the majority (80% or greater) of the participants.

As Chairmen of the Steering Committee and the Issues Debate Session of the Forum, we respectfully submit to you the recommendations. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

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Chairman
Edward S. Kondo
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Forest Pest Control Forum
Issue Debate Chairman
Geoffrey Munro

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Steering Committee Members
Forest Pest Control Forum, 1987

Location	Provincial Representative	Federal Representative
British Columbia	R.F. DeBoo	G.A. Van Sickle
Alberta	J. Benson	H. Cerezke
Saskatchewan	M. Pandila	H. Cerezke
Manitoba	G. Munro	H. Cerezke
Ontario	J. Churcher	G.M. Howse
Quebec	M. Auger L. Dorais	D. Lachance
New Brunswick	N.E. Carter	L. Magasi
Nova Scotia	T. Smith	L. Magasi
Newfoundland	H. Crummey	J. Hudak
FPMI		E. Caldwell
PNFI		M. Power
CFS Headquarters		E.S. Kondo, Chairperson (D.M. Shrimpton)
Executive Secretary		B.H. Moody