Report of the Twenty-second Annual Forest Pest Control Forum

Government Conference Centre
Ottawa, Ontario

November 15–17, 1994

Rapport du vingt-deuxième colloque annuel sur la répression des ravageurs forestiers

Centre de conférences du Gouvernement
Ottawa (Ontario)

Du 15 au 17 novembre 1994

Not for publication / Ne pas diffuser

Natural Resources Canada
Canadian Forest Service

Ressources naturelles Canada
Service canadien des forêts

Canada

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The Forest Pest Control Forum is held under the aegis of Natural Resources Canada, Canadian Forest 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 se déroule sous l'égide de Ressources naturelles Canada, 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
Natural Resources Canada/Ressources naturelles Canada
Canadian Forest Service/Service canadien des forêts
Ottawa, Ontario / Ottawa (Ontario)
March 1995 / mars 1995

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List of Attendees
Liste des personnes présentes

United States Forest Service
Dan R. Kucera, Radnor, PA

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

Nova Scotia Department of Natural Resources
Eric Georgeson

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

Ontario Ministry of Natural Resources
J. Churcher, Sault Ste. Marie

Manitoba Department of Natural Resources
R. Westwood, Winnipeg

Alberta Land and Forest Service
H. Ono, Edmonton

Canadian Pulp and Paper Association
Jean-Pierre Martel, Montreal

SOPFIM
Denise Moranville

N.B. Forest Protection Ltd.
P. Amirault

University of Toronto
Andrew Moody, Toronto

Environment Canada
Ian Nicholson, Pesticides Division, Ottawa

Vazout-USA-IUC
George Green, Sault Ste. Marie

Novo Nordisk
Stephen A. Nicholson, Hartington, Ontario
A. Temple Bowen Jr., Danburg, CT

Abbott Laboratories Ltd.
Bary Tyler, Orton, Ontario
Keith C. Farnsworth, Chicago

Canadian Wildlife Service
Bruce D. Pauli, Hull

Agriculture Canada
D. Walter, Plant Health Division, Ottawa
Greg Stubbings, Plant Health Division, Ottawa
R. Favrin, Plant Health Division, Ottawa
E. Dobesberger, Plant Health Division, Ottawa
M. Dawson, Plant Health Division, Ottawa
T. Caunter, Plant Industry Directorate, Ottawa
Mary-Jane Kelleher, Plant Industry Directorate, Ottawa
Terry James, Plant Industry Directorate, Ottawa
J.E. Irvin, Plant Industry Directorate, Ottawa
Lesley Cree, Diagnostic Services Division, Ottawa
Al Schmidt, Biosystematics, Ottawa

Canadian Forest Service, Natural Resources Canada
Allan Van Sickle, Victoria
W.J.A. Volney, Edmonton
James Brandt, Edmonton
Les Magasi, Fredericton
J.E. Hurley, Fredericton
S.E. Holmes, Fredericton
P.C. Nigam, Fredericton
Bruce Pendrel, Fredericton
D. Lachance, Ste. Foy, Quebec
José Valero, Ste. Foy, Quebec
G.M. Howse, Sault Ste. Marie
J. Meating, Sault Ste. Marie
B.V. Helson, Sault Ste. Marie
Bert Zylstra, Sault Ste. Marie
D.B. Lyons, Sault Ste. Marie
Eileen Harvey, Sault Ste. Marie
John McFarlane, Sault Ste. Marie
Errol Caldwell, Sault Ste. Marie
Craig Howard, Sault Ste. Marie
Larry Marshall, PNFI
J. Hudak, St. John's, Nfld.
R. West, St. John's, Nfld.
Les Carlson, Ottawa
J. Peter Hall, Ottawa
P. Singh, Ottawa

Canadian Forest Service, Natural Resources Canada (Cont'd)

B.H. Moody (Secretariat)
G. Miller, Ottawa
Y. Hardy, Ottawa

NOTICE OF 1995 MEETING

The Twenty-third Annual Forest Pest Control Forum

will be held in

Sussex Room, 1st Floor

Government Conference Centre

2 Rideau Street, Ottawa, Ontario

November 21, 22, 23, 1995

(8:30 a.m. - 5:00 p.m.)

AVIS DE LA RÉUNION DE 1995

Le vingt-troisième colloque annuel

sur la répression des ravageurs forestiers

aura lieu dans le

Salon Sussex, 1er étage

Centre de conférences du Gouvernement

2, rue Rideau, Ottawa (Ontario)

du 21 au 23 novembre 1995

(de 8 h 30 à 17 h 00)

Agenda

Twenty-second Annual Forest Pest Control Forum

Government of Canada Conference Centre

2 Rideau Street
Centennial Room, 5th Floor
Ottawa, Ontario

November 15, 16, 17, 1994
8:30 a.m. - 5:00 p.m.

Tuesday, November 15

Session I - Introduction

8:30 - 9:00

1.1 Introductory Address
- Dr. Yvan Hardy, ADM, Canadian Forest Service

1.2 Remarks and Introductions
- B.H. Moody, Forum Secretary

Session II - **Forest Insect and Disease Status and Control Operation Summaries**
-B.H. Moody/G. Miller (Session Chairpersons)

9:00 - 10:00 - This Session will consist of round-the-table summary reports from each regional FIDS head on all pests of significance and control operation summaries from provincial representatives. (Presenters should limit their talks to max. of 15 minutes).

	Pest Conditions FIDS Report	Control Operations/Pest Management Summary	
2.1	B.C. & Yukon - G. Van Sickle		- British Columbia
2.2	Prairies and Northwest Territories - J. Volney	R. Westwood	- Manitoba - Saskatchewan
		H. Ono	- Alberta
2.3	Ontario - G. Howse	J. Churcher	- Ontario

2.4 Québec - D. Lachance — C. Bordeleau, M. Auger- Québec

Pest Conditions (cont'd)	**Control Operations/Pest Management (cont'd)**	
2.5 Maritimes - L. Magasi	N. Carter	- New Brunswick
		- New Brunswick
	E. Georgeson	- Nova Scotia
	L. Magasi	- P.E.I.
2.6 Newfoundland - J. Hudak	H. Crummey- Newfoundland	
2.7 United States - D. Kucera		
2.8 Other		

10:00 - 10:15 - COFFEE

10:15 - 12:00 - **Session II Forest Insect and Diseases Status and Control Operation Continues**

12:00 - 1:00 - LUNCH

1:00 - 2:30 - **Session II Continues**

Session III

Vegetation Management Summaries

- E. Caldwell/C. Howard (Session Chairpersons)

3.1 Round-the-table regional summaries of vegetation management problems and control operations - provincial and regional Forestry Canada representatives British Columbia, Prairies, Ontario, Québec, Maritimes, Newfoundland, United States.

3.2 General Discussion

Session IV **Management of Exotic Forest Pests or Quarantine Issues**

4.1 Update on Forest Pest Management (Quarantine) Committee - G. Miller

4.2 Overview of How Quarantine Works
- Greg Stubbings

4.3 The Exotic Pest List Program & Recent Pest Risk Assessments
- Doreen Watler

3:00 - 3:15 - COFFEE

Session IV continues **Management of Exotic Forest Pests or Quarantine Issues**

4.4 Update on Quarantine Pests Issues - Marcel Dawson
- Gypsy Moth Policy
- Asian Gypsy Moth
- Tomicus sp. Pine Shoot Beetle
- DED Recommendations
- Proposed Wood Products Import Regulations

Issues/Resolutions

4:30- Issues Debate, Chairperson - Richard Westwood

- Discussion and debate on selected items.

NOTE: Forum members should ensure that issues/recommendations for debate are properly documented and submitted to the Forum Secretary before the Forum so that these can be discussed at the Steering Committee meeting the day prior to the Forum.

Wednesday, November 16

Session IV **Management of Exotic Forest Pests continues**

4.5 Other
- Management of Exotic Pests - J. Hudak
  European Pine Sawfly
  Scleroderris Canker

Session V -

Research, Environmental Monitoring and Other Reports

Experimental and Semi-operational Applications of RH-5992 against Spruce Budworm in 1994
- B.L. Cadogan

Protection Against Defoliation by the Spruce Budworm for Two Years - Evidence for Lethal Effect of RH-5992 on 2nd Instars
- Arthur Retnakaran

10:00 - 10:15 COFFEE

Session V - continues **Research, Environmental Monitoring and Other Reports**

"The Potential of Neem for Sawfly Management"
- Blair Helson

Overview of Integrated Forest Pest Management Research, Maritimes Region
- Steve Holmes

Other

12:00 - 1:00 LUNCH

Session V **Research, Environmental Monitoring and Other Reports continues**

Session VI **Pest Management Regulatory Considerations**
- Craig Howard (Session Chairperson)

6.1 User Requested Minor Use Registration Program
- Eileen Harvey

6.2 URMUR - Label Expansion - Craig Howard

6.3 Tebufenozide (Mimic)/CUSTA - C.Howard

6.4 Update on Fenitrothion
- C. Howard

6.5 Triclopyr (herbicide) - C. Howard

6.6 Gypsy Moth Virus
- E. Caldwell

3:00 - 3:15 COFFEE

3:15 - 4:30 **Pest Management Regulatory Considerations Continues**

6.7 Buffer Zone Workshop - C. Howard

6.8 Forest Pest Management Alternative Project - C. Howard

6.9 Overview Report on the Regulatory System - C. Howard/ I. Krupka

6.10 Advanced Forest Pest Management Training Program - C. Howard/E. Harvey

6.11 Other

Issues Debate - Chairperson - Richard Westwood

4:30 -

WORKSHOPS

Sunday, November 13, Novotel Hotel

- Biological Control Working Group Meeting
  - Vince Nealis
    8:30 a.m. - 4:30 p.m. - Novotel

Monday, November 14, Conference Centre, 2 Rideau Street

- Biological Control Working Group Meeting
  8:30 a.m. - 4:30 p.m. Room 511

- Forest Protection Technology Committee
  - G. Howse (Chairperson)
    8:30 a.m. - 4:30 p.m. - Centennial Room

- Pest Control Forum Steering Committee
  - B.H. Moody/R. Westwood (Chairpersons)
    4:30 p.m. - 6:30 p.m. - Centennial Room

Thursday, November 17, Conference Centre, 2 Rideau Street

- Pheromone Trapping Working Group
  - R. West (Chairperson)
    8:30 a.m. - 1:00 p.m. - Centennial Room

- Forest Pest Management Caucus
  - J.P. Martel
    9:00 - 11:00 a.m. - Room 511

- FIDS Heads Meeting
  - P. Hall (Chairperson)
    2:00 p.m. - 5:00 p.m. - Room 511

Friday, November 18, Conference Centre, 2 Rideau Street

- FIDS Heads Meeting (closed session)
  - P. Hall (Chairperson)
    8:30 a.m. - 3:00 p.m. - Centennial Room

NOTE 1) Other workshops can be scheduled if required. Please inform the Secretary of requirements.

2) Time allotment per session is not firm and may vary.

POSTER SESSION (There will be a Poster Session this year for the first time and attendees are encouraged to submit Posters).

- Four Posters from Newfoundland - R. West and W. Bowers
- Other

INTERPRETATION SERVICES

Only for November 15 and 16, 1994 - 8:30 - noon and 1 P.M. - 5:30 P.M.

Ordre du jour

Vingt-deuxième Forum annuel sur la répression des ravageurs forestiers

Centre de conférence du gouvernement du Canada

2, rue Rideau
Salle Centennial 5e étage
Ottawa (Ontario)

Les 15, 16 et 17 novembre 1994
8 h 30 à 17 h 00

Le mardi, 15 novembre

Séance I - Ouverture

8 h 30 - 9 h 00 1.1 Allocution d'ouverture
- Dr Yvan Hardy, SMA

1.2 Observations et présentations
- B.H. Moody, secrétaire du Forum

Séance II - **État des populations d'insectes et des maladies des arbres et résumés des activités de lutte**
- B.H. Moody/G. Miller (présidents de la séance)

9 h 00 - 10 h 00 - Table ronde au cours de laquelle les chefs régionaux du RIMA présenteront un rapport récapitulatif sur tous les ravageurs d'importance et les représentants des provinces résumeront les activités de lutte menées sur leur territoire. Les présentations ne devront pas excéder 15 minutes.

Rapports des chefs du RIMA		Résumés des activités de lutte
2.1 C.-B. & Yukon - G. Van Sickle		- C.-B.
2.2 Prairies et Territoires du Nord-Ouest - J. Volney	R. Westwood H. Ono	- Manitoba - Saskatchewan - Alberta
2.3 Ontario - G. Howse	J. Churcher	- Ontario

2.3	Ontario - G. Howse	J. Churcher	- Ontario
2.4	Québec - D. Lachance	C. Bordeleau M. Auger	- Québec - Québec
2.5	Maritimes - L. Magasi	N. Carter E. Georgeson	- Nouveau-Brunswick - Nouvelle-Écosse - Î.-P.-É.
2.6	Terre-Neuve - J. Hudak	H. Crummey	- Terre-Neuve

2.7 États-Unis
- D. Kucera

2.8 - Autres

10 h 00 - 10 h 15 - Pause-café

10 h 15 - 12 h 00 - Suite de la séance II

12 h 00 - 13 h 00 - Déjeuner

13 h 00 - 14 h 30 - Suite de la séance II

<u>Séance III</u> - **<u>Résumés - Activités de gestion des végétaux</u>**
- E. Caldwell (président de la séance)

3.1 Résumés sur les problèmes de gestion des végétaux et les activités de lutte - représentants des provinces, du Service Canadien des Forêts (Régions de la Colombie-Britannique, des Prairies, de l'Ontario, du Québec, des Maritimes et de Terre-Neuve) et des États-Unis

3.2 Discussion générale

<u>Séance IV</u> - **<u>Gestion des ravageurs forestiers exotiques ou problèmes de quarantaine</u>**

4.1 Comité de la gestion des ravageurs forestiers (quarantaine)
- G. Miller

4.2 Survol du fonctionnement de la quarantaine
- Greg Stubbings

4.3 Le Programme de l'établissement de la liste des ravageurs exotiques; évaluation des estimations récentes du risque
- Doreen Watler

3 h 00 - 3 h 15 - Pause-Café

Séance IV - **Suivi de la séance**

4.4 - Comité de la gestion des ravageurs forestiers (quarantaine)
- Marcel Dawson

- Politique sur la spongieuse
- La spongieuse asiatique
- Hylésine du pin
- Recommandations
- Propositions de règlement sur l'importation de produits ligneux concernant la maladie hollandaise de l'orme

16 h 30 - **Débat sur certaines grandes questions**
- Richard Westwood (président)

Discussion et débat sur certaines questions

REMARQUE : Les participants doivent s'assurer que les questions/recommandations qui seront débattues sont bien documentées et sont présentées suffisamment tôt au secrétaire, de manière à ce qu'elles puissent être examinées à la réunion du Comité directeur la journée précédant la tenue du Forum.

Le mercredi, 16 novembre

Séance IV - **Suite de la séance**

4.5 - Autres

- Gestion des ravageurs exotiques
  - J. Hudak
- Le diprion du pin sylvestre
- Le chancre scléroderrien

SÉANCE V - **Rapports sur la recherche, la surveillance environnementale et autres sujets**
- E. Caldwell (président de la séance)

L'efficacité expérimentale et semi-opérationnelle contre les larves de la tordeuse des bourgeons de l'épinette.
- B.L. Cadogan

Protection contre la défoliation par la TBE pendant 2 ans - Preuves de l'effet léthal du RH-5992 pour le 2[e] instar.
- Arthur Retnakaran

10 h 00 - 10 h 15 - Pause-café

<u>SÉANCE V</u> - **<u>Le potentiel du neem pour la gestion du diprion</u>**
- Blair Helson

Lutte intégrée contre les ravageurs, Service canadien des forêts, Maritimes
- Steve Holmes

Autres rapports de recherche

12 h 00 - 13 h 00 Déjeuner

<u>SÉANCE V</u> - **<u>Suite de la séance</u>**

<u>SÉANCE VI</u> - **<u>Considérations sur la réglementation</u>**
- Craig Howard (président de la séance)

6.1 - Programme d'extension du mode d'emploi pour usages limités demandés par les utilisateurs (PEEUDU)
- Craig Howard

6.3. - Tebufenozide (Mimic) CUSTA
- Craig Howard

6.4 Suivi sur le Fénitrothion

6.5 Triclopyr (herbicide)
- Craig Howard

6.6 Virus de la spongieuse
- E. Caldwell

6.7 Atelier sur la zone-tampon
- C. Howard

6.8 Le Programme de réglementation de la lutte contre les ravageurs forestiers
- C. Howard

6.9 Revision du rapport sur le système de réglementation
- C. Howard/I. Krupka

6.10 Advanced Forest Pest Managment training Program
- C. Howard/E. Harvey

6.11 Autres

Débats sur les résolutions - président

ATELIERS

Dimanche, le 13 novembre, Novotel Hotel

- Groupe de travail sur la lutte biologique
  - Vince Nealis

08 h 30 - 16 h 30 - Novotel

Lundi, le 14 novembre, Centre de conférences, 2, rue Rideau

- Groupe de travail sur la lutte biologique

08 h 30 - 16 h 30 - Pièce 511

- Comité des techniques de protection des ressources forestières
  - G. Howse (président)

08 h 30 - 16 h 30 - Salle Centennial

- Comité directeur du Forum sur la répression des ravageurs forestiers
  - B.H. Moody/R. Westwood (présidents)

16 h 30 - 18 h 30 - Salle Centennial

Jeudi, le 17 novembre, Centre de conférences, 2, rue Rideau

- Groupe de travail sur les pièges à phéromones
  - R. West (président)

8 h 30 - 13 h 00 - Salle Sussex

- Réunion des chefs du RIMA
  - P. Hall (président)

14 h 00 - 17 h 00 - Salle Centennial

Vendredi, le 18 novembre, Centre de conférences, 2, rue Rideau

- Réunion des chefs du RIMA (à huis clos)
  - P. Hall (président)

8 h 30 - 15 h 00 - Salle Centennial

REMARQUES 1) D'autres ateliers peuvent être ajoutés au besoin. Veuillez informer le secrétaire de vos besoins.

2) La durée des séances n'est pas inflexible et pourrait être modifiée.

Affiches: Pour la première fois, des affiches seront présentées et les déléguée sont invités à y participer.

- Quatre affiches de Terre-Neuve - R. West and W. Bowers.

Autres

SERVICE D'INTERPRÉTATION

Seulement pour le 15 et le 16 novembre 1994 - 8 h 30 - 12 h 00 et 1 h 00 à 5 h 30.

Mot de bienvenue, résumé

Vingt-deuxième colloque annuel sur la répression des ravageurs forestiers du 15 au 17 novembre 1944, Ottawa

M. Yvan Hardy, sous-ministre adjoint du Service canadien des forêts, Ressources naturelles Canada, ouvre le colloque. Il déclare que c'est toujours un plaisir pour lui que d'assister au colloque car il peut y discuter avec les personnes présentes qui s'occupent des activités de recherche et de lutte contre les ravageurs, domaine auquel il a déjà collaboré de près.

M. Hardy poursuit en indiquant qu'il est heureux de constater qu'en pleine période de restrictions budgétaires, les groupes de travail et les comités tiennent leurs réunions au cours de la même semaine, avec le colloque comme toile de fond. La collaboration entre les participants dans le domaine des activités de lutte intégrée est très bien vue et jugée très importante.

Les activités commerciales et de gestion des forêts ont connu un essor marqué au cours des dix dernières années; cela se répercutera sur nos façons de faire. Les événements à l'échelle planétaire comme, par exemple, les problèmes de quarantaine liés au nématode du pin, apparus en Suède il y a dix ans, ont touché les exportations de bois Canadien et ont modifié nos façons de faire ainsi que le commerce international.

Les personnes présentes optent pour la bonne démarche en unissant leurs efforts pour faire face aux problèmes complexes du monde qui nous entoure. Nous devrons relever de grands défis comme, par exemple, accélérer le processus d'homologation des produits de lutte contre les ravageurs et préparer des règlements pour ces produits.

En ce qui concerne le développement durable, le grand public désire savoir comment cela devrait s'appliquer à la foresterie. Nous devons mettre au point de nouveaux outils de lutte intégrée comme des virus qui, jugés inutiles il y a dix ans, sont maintenant devenus des moyens de prédilection.

Enfin, bonne nouvelle pour certains peut-être, les infestations de ravageurs sont généralement faibles dans l'Est du Canada. Nous devrions donc en profiter pour revoir notre façon de procéder pour l'avenir.

Étant donné que de nombreux participants au colloque sont des fonctionnaires fédéraux, M. Hardy assure au groupe que la protection des forêts et la lutte contre les ravageurs relèvent, avec l'exploitation durable des forêts, de la plus grande priorité.

Summary of Opening Remarks

Twenty-second Annual Forest Pest Control Forum
November 15-17, 1994 Ottawa

Dr. Yvan Hardy, Assistant Deputy Minister, Canadian Forest Service, Natural Resources Canada, opened the Forum by saying that he was always pleased to be at the Forum for a chat with the attendees working in pest research and control/management, a field that he was closely involved with.

Dr. Hardy went on to say that in these times of financial constraints, he was pleased to see a number of Workings Groups and Committees holding their meetings during the same week and "piggy-backing" on the Forum. The cooperation between the group of Forum attendees in pest management activities is regarded highly and importantly.

Trade and forest management activities increased significantly over the last 10 years and will affect how we do business. Global events for example, in Sweden, pinewood nematode quarantine problems which started 10 years ago have affected Canadian timber exports and have impacted how we do business and international trade.

The Forum attendees are on the right tract by working together to deal with the complexities of the world. Great challenges lie ahead such as, the speeding up of the registration process for pest control products and the development of regulatory guidelines for these products.

On the question of sustainable development, the general public wants to know how it should be applied to forestry. We have to develop new tools for pest management such as, viruses which appeared to be useless 10 years ago and are now coming into the forefront.

Finially, good news maybe for some, pest infestations are generally low in eastern Canada. This would therefore be a good time or opportunity to sit back and see how we can do things better or differently in the future.

As many of the Forum attendees are employees of the federal government, Dr. Hardy assured the group that forest protection and pest control/management are subjects of highest priority along with sustainability of the forests.

Abstracts/Résumés

Pacific and Yukon Region in 1994
Status of Important Forest Pests Experimental Control Projects

G.A. Van Sickle, B. Callan, T. Gray, P.M. Hall, L. Humble and C. Wood

The status of about 24 economically significant forest pests active in the Pacific and Yukon Region in 1994 is presented, with some forecasts for 1995. These include the increasing levels of spruce beetle, phantom hemlock looper, satin moth and poplar rusts, and continuing populations of mountain pine and Douglas-fir beetles, eastern and western budworms, western hemlock looper, forest tent caterpillar, and large aspen tortrix which caused significant damage, and small numbers of European and Asian gypsy moths. Black army cutworm and rhizina root disease declined, and Douglas-fir tussock moth collapsed.

Current research and control trials of some of these pests include: pheromone confusion trials against Douglas-fir tussock moth; pheromone development trials against western blackheaded budworm, phantom hemlock looper, and western oak looper; Btk trials against western spruce budworm; calibration of a pheromone trapping system for western hemlock looper; testing susceptibility of western hemlock to woodborer vectors of pinewood nematode; decision support system and biological controls for mountain pine beetle; hazard rating for spruce and Douglas-fir beetles; and screening for resistance to terminal weevils and white pine blister rust.

Forest Insect and Disease Management Programs
1994 Summary Report
Alberta and Forest Services

H. Ono

Eastern spruce budworm, *Choristoneura fumiferana* (Clemens), infestations in Alberta increase during 1994, reversing the declining trend observed in 1993. There were four infestations covering 126,735 ha in the northern part of the province. A water-based Btk formulation (Foray 48B[R]) was aerially sprayed over 14,253 ha of moderately to severely infested stands in northwestern Alberta.

Mountain pine beetle populations were at their lowest level in recent years in southwestern Alberta where beetle activity is normally encountered.

Spruce beetle outbreak continued in northwestern Alberta where an estimated 1,350 ha were infested in the Peace River Forest. In the Footner Lake Forest, spruce beetle activity was less pronounced but still hovered around levels where green trees could get attacked.

Several other surveys and impact assessment studies were conducted in 1994 including regeneration pest surveys, white pine weevil survey and impact assessment, dwarf mistletoe survey and impact assessment, and armillaria root rot impact assessment.

Forest Pests in Manitoba in 1994

A.R. Westwood, et al.

This report summaries the following pest conditions and pest management activities in Manitoba in 1994: spruce budworm, jack pine budworm, western gall rust resistant jack pine study, permanent silvicultural plot pest impact program, other forest diseases, Dutch elm disease, 1994 renewed forest pest survey, and pest specific assessments.

Northwest Region
Status of Important Forest Pests in 1994

James Brandt (presented by W.J. Volney)

This report summarizes information on the current status of important tree damaging pests within the Northwest Region in 1994. Information gathered on the various pests was contributed substantially by provincial forest agencies in Manitoba, Saskatchewan and Alberta, and by the Department of Renewable Resources in the Northwest Territories.

Abstract

Spruce Budworm and Gypsy Moth in Ontario in 1994

G.M. Howse, J.H. Meating, M.J. Applejohn, H.D. Lawrence and T. Scarr

In 1994, the area of moderate to severe defoliation caused by the spruce budworm decreased to 4,266,656 ha, down from 8,991,177 ha mapped in 1993. The area within which host tree mortality occurred increased by some 2,750,411 ha to 7,783,336 ha this year. Egg-mass surveys indicate little change in the infestation in 1995.

The gypsy moth outbreak continued to decline in 1994. The gross area of moderate to severe defoliation was 5,645 ha, down from 9,784 ha in 1993. Based on historical trends increases in the area affected are likely in the next few years.

There were no aerial spraying operations against the spruce budworm or the gypsy moth conducted by the Ontario Ministry of Natural Resources in 1994.

Jack Pine Budworm in Ontario in 1994

J.H. Meating, H.D. Lawrence, G.M. Howse, M.J. Applejohn and T. Scarr

The total area affected by the jack pine budworm increased from 282,247 ha in 1993 to 419,344 ha in 1994. However, the intensity of defoliation within many of the affected stands decreased in 1994. Results of egg-mass and L_2 surveys showed a high degree of variability within the outbreak area, but suggest that the overall area and intensity of the outbreak should decline somewhat in 1995. Moderate to severe defoliation should still occur in many stands, however.

In June, an aerial spraying operation was conducted by E.B. Eddy Forest Products Ltd. and the Ontario Ministry of Natural Resources in Sudbury District. Some 21,499 ha were treated with single application of Foray 76B (*Bacillus thuringiensis*) at a rate of 30 BIU/1.5L/ha. the program was very effective in reducing jack pine budworm populations and protecting foliage. An experimental program involving the insect growth regulator RH5992 MIMIC (Rohm and Haas Canada Inc.) was also conducted.

1994 Joint E.B. Eddy-OMNR Jack Pine Budworm Foliage Protection Program in Ontario

Taylor Scarr and Joe Churcher

An aerial spray program was conducted in 1994 by the Ontario Ministry of Natural Resources and E.B. Eddy Forest Products to protect jack pine stands from defoliation by jack pine budworm. This marked the first time in Ontario that: a forest company paid directly for a portion of a spray program; stands were protected in their first year of defoliation; an economic impact model was used to analyze the costs and benefits of forest protection; and FORAY 76 was used operationally.

The total area sprayed was 21,499 ha with a single application of FORAY 76B applied neat at 30 BIU/ha (1.4 l/ha) using a single Dromader aircraft mounted with rotary atomizers and a Cessna 172F pointer.

Efficacy of Single and Double Applications of RH5992^{R} on Jack Pine Budworm in Ontario in 1994

J.H. Meating, H.D. Lawrence, A. Robinson and G.M. Howse

In June, 1994, the experimental insect growth regulator RH5992 (MIMIC) was tested against the jack pine budworm in two blocks (50 ha each) in Sudbury District. One block was treated with a single application of RH5992 at a rate of 70 g/2.01/ha. The second block was treated with two applications five days apart (2 x 70 g/2.0 l/ha).

Both treatments were effective in reducing budworm populations. Defoliation in the single treatment block was variable, but in plots that had good deposit, defoliation levels, were less than 20%. Average defoliation levels in the double treatment block were less than 5%.

Forest Insect and Disease Conditions in Newfoundland and Labrador in 1994

J. Hudak, K.E. Pardy, G.C. Carew, L. Oldford, D.S. O'Brien, D.M. Stone and W.J. Sutton

This report covers the status of major forest pests in Newfoundland and Labrador in 1994 and includes: eastern hemlock looper, balsam fir sawfly, balsam woolly adelgid, European pine sawfly, scleroderris canker and other pests.

Generally, the hemlock looper infestations continued to increase in distribution and severity. The total area of defoliation was about 14 000 ha including 11 000 ha in the moderate and severe category.

The Balsam Woolly Adelgid in Newfoundland in 1994

W.W. Bowers and J. Luther

Management of young balsam fir stands and Christmas tree plantations in eastern Canada is complicated by balsam woolly adelgid (BWA). Development and implementation of a decision support system for BWA remains an important research priority and a joint-venture initiative is underway to provide forest managers with a reliable tool for making more informed decisions. Progressively, the project has emphasized BWA biology, bionomics, and impact. Knowledge gained from these and earlier studies form the building blocks for hazard- and risk-rating systems under development through application of remote sensing technologies.

Insect and Disease Conditions in the United States in 1994

Dan Kucera

This report covers the following pests in U.S.A. in 1994: spruce budworms, jack pine budworm, gypsy moths, Douglas-fir tussock moth, forest tent caterpillar, fruit tree leafroller, bark beetles, weed prevention and herbicide use, fire, cypress aphid, hemlock woolly adelgid, dogwood antracnose, butternut canker, fusiform rust, oak decline and other insects and diseases.

Herbicide Usage in Ontario in 1994

Joe Churcher and Dan Kott

Approximately 80,000 hectares of Crown forests were sprayed with herbicides in Ontario in 1994. Pesticide usage reports were still being compiled at the time of the twenty-second annual Forest Pest Control Forum (November 15-17), so the following figures are not final. They do, however, provide a good estimate of the amount and type of herbicide used, and the purpose.

Glyphosate (Vision) was by far the most common product used (74,313 hectares). Other herbicides were 2,4-D (4,400 ha), Velpar (495 ha), Pronone (445 ha), Release (100 ha) and Garlon (86 ha).

Experimental and Semi-operational Applications of RH5992 Against Spruce Budworm in 1994: Preliminary Results

B.L. Cadogan, A. Retnakaran, R. Scharbach, A. Robinson and W. Tomkins

A field study conducted in NW Ontario investigated the efficacy of RH5992 (MIMIC 2F) against spruce budworm *Choristoneura fumiferana* (Clem.). The material was applied aerially at 70g (AI) in either 1 L or 2 L/ha and as single or double applications. The results show that a double application of 70g (AI) in 2 L/ha was the most efficacious application strategy and that it was effective on both balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). Experimental and semi-operational sprays were equally effective in suppressing SBW populations but the experimental application was the better of the two spray techniques in protecting foliage.

Protection Against Defoliation by the Spruce Budworm for Two Years - Evidence for Lethal Effect of RH-5992 on 2nd Instars in 1994

Arthur Retnakaran

The non-steroidal ecdysteroid agonist, RH-5992 (MIMIC), induces a precocious, incomplete molt in spruce budworm larvae that results in the mortality of the insect. Within 12 hrs after ingestion, the larva stops feeding and within 48 hrs the head capsule slips exposing an untanned cuticle that is very thin and poorly formed. When applied at the rate of 70 g in 2 L per ha twice, it provides excellent population control and near perfect foliage protection.

Research in Natural Products Entomology in 1994

Blair Helson, John McFarlane and Dave Comba

Development of Natural Products for Management of Forest Insect Pests

In 1994, we focused on the development of neem extracts as a selective alternative for specific forest pests which do not currently have biological control agents (Bt, viruses) available for their control including white pine weevil, sawflies and seed and cone insects. We concentrated on evaluating a few formulation of neem from Phero Tech Inc., Delta, B.C. and compared it with Azatin which we have tested previously. The toxicological properties of these formulations to spruce budworm larvae were investigated further including residual activity and simulated efficacy on potted trees infested with larvae under natural weathering conditions outdoors. Neem's spectrum of activity on several other forest pests (forest tent caterpillar, black army cutworm, white marked tussock moth, European spruce sawfly and pine false webworm (with D.B. Lyons)) was verified. All species were susceptible, particularly the sawflies.

The mechanism for the resistance of red maple to forest tent caterpillar larvae

Feeding Ecology. In 1994, the growth and survival of forest tent caterpillar (FTC) and gypsy moth larvae on whole leaves of seven species of maples were compared from hatch to pupation.

Chemical Ecology. A major effort this year has been directed at identifying the red maple compounds responsible for feeding detergency to FTC larvae.

Studies on the Environmental Chemistry of Forestry Insecticides

K.M.S. Sundaram

Abstract

Major studies undertaken by the Environmental Chemistry (Insecticides) Group, either independently or cooperatively, are summarized briefly. The key areas encompassing the chemical and environmental behaviour of: (I) tebufenozide (MIMIC^{R} or RH-5992); (II) *Bacillus thuringiensis* (*kurstaki*) [B.t.(k)]; (III) azadirachtin (AZ-A); and (IV) the analytical methods necessary for the studies in I to III are highlighted. Rain-washing of foliar deposits of Dimilin^{R} WP-25 formulated in four different carrier liquids is also outlined.

Résumé

Les études majeures entreprises par le groupe de Chimie de l'Environnement (Insecticides), indépendamment ou en coopération, sont résumées brièvement. Les domaines principaux comprenant le comportement chimique et environnemental de: (I) tebufenozide (MIMIC^{R} ou RH-5992); (II) *Bacillus thiringiensis (kurstaki)* [B.t.(k)] et (III) azadirachtin (AZ-A); ainsi que (IV) les méthodes analytiques nécessaires pour les études de (I) à (III) sont passés en revue. Le lessivage par la pluie des dépôts foliaires de quatre formules liquides différentes de Dimilin^{R} WP-25 est aussi rapporté.

Preliminary results of the efficacy and timing of Azadirachtin, an extract of neem, against white pine weevil in young jack pine plantations

B.F. Zylstra and P. de Groot

This research is a continuation of field trials to develop cost-effective, yet environmentally safe methods of preventing white pine weevil, *Pissodes strobi*, damage to young jack pine plantations, especially high value stands such as family and stand tests.

The natural product, Neem, derived from the seeds of the neem tree, has been shown to be effective against such enclosed insect feeders. We decided to try a Neem derivative, Azadirachtin, (Phero Tech. Inc., 7572 Progress Way, Delta, B.C.) as a topical spray on jack pine to determine if this product would prevent white pine weevil feeding, and hence, subsequent leader mortality.

This report presents the efficacy data of a Azadirachtin formulation applied by a back pack sprayer directly to the leaders to control white pine weevil damage in young jack pine trees. These data clearly show that very good leader protection can be achieved using this product, especially when timed to treat young larvae.

Update of Integrated Pest Management Research Maritimes Region

S.E. Holmes

Highlights of 1994 Investigations by the Integrated Forest Pest Management Project at the Canadian Forest Service - Maritimes Region include:

- Evaluation of Quantity of Quality of B.t. Deposit on White Spruce,
- Field Trials of Several Potential Control Agents: Nematodes, *Bacillus thuringiensis tenebrionis*, and Parasite/predator complex, against the Elm Leaf Beetle
- Baseline study of Lepidoptera Biodensity in a New Brunswick Fir Spruce Forest: Impact of Forest Practices,
- Naturally Occurring Compounds and their Efficacy Against Spruce Budworm, and
- Demonstration Trials with Pheromones for management of the Spruce Budmoth (*Zeiraphera canadensis*) - 3 ha Treated.

Concerns of New Brunswick Department of Natural Resources and Energy and the Forest Industry Regarding Forest Protection in Relation to Future Pest Control Options

Forest protection against spruce budworm has been an annual commitment in new Brunswick more so than in any other jurisdiction faced with serious outbreaks. For instance, in Ontario and Quebec combined, there are dead and dying softwood forests over areas equal to four times the size of all New Brunswick. While such losses might be acceptable to them, protection in New Brunswick is more critical to preserving our wood supply, providing industrial growth, and maintaining a high standard of living for our residents.

Over the years many control options have been researched and proven impractical or ineffective. Meanwhile the insecticide Fenitrothion became the mainstay of the program through its proven track record, and it has become the standard against which other controls are measured. The effective protection it has given has also retained forests which now are being identified for other purposes. such as wildlife habitat management. Although research over the years has shown some environmental side effects, the same studies also revealed recovery or ecosystem resilience over varying periods indicating that it is not a threat to long-term sustainability or biodiversity. In this context Fenitrothion has been regarded as an environmentally acceptable insecticide.

The attached sheets outline the concerns of the New Brunswick Department of Natural Resources and Energy and the forest industry, and provides independent support why the registration of Fenitrothion should be retained.

RÉSUME

La Région du Pacifique et du Yukon en 1994
État d'avancement des projets expérimentaux de lutte contre les ravageurs forestiers importants

G.A. Van Sickle, B. Callan, T. Gray, P.M. Hall, L. Humble et C. Wood

Le rapport fournit des renseignements sur plus de 24 ravageurs forestiers ayant une grande importance pour l'économie, présents dans la Région du Pacifique et du Yukon en 1994, ainsi que des prévisions pour 1995. Les populations de dendroctones de l'épinette, d'arpenteuses vertes de la pruche, de papillons satinés et de rouilles des peupliers augmentent, et les infestations continues de dendroctones du pin ponderosa de dendroctones du douglas, de tordeuses des bourgeons de l'épinette et de tordeuses occidentales de l'épinette, d'arpenteuses de la pruche de l'Ouest, de livrées des forêts et de tordeuses du tremble se poursuivent et causent d'importants dégâts. On a également observé un petit nombre de spongieuses d'origine européenne et asiatique. La population de légionnaires noires a diminué; il en a été de même pour le pourridié rhizinéen. L'infestation de chenilles à houppes du douglas a beaucoup régressé.

Pour quelques-uns de ces ravageurs, des recherches et des essais de répression sont en cours : des essais de confusion au moyen de phéromones pour la chenille à houppes du douglas; des essais de mise au point de phéromones pour la tordeuse à tête noire de l'Ouest, l'arpenteuse verte de la pruche et l'arpenteuse occidentale du chêne; des essais au moyen du B.t. k pour la tordeuse occidentale de l'épinette; l'étalonnage de pièges à phéromones pour l'arpenteuse de la pruche de l'Ouest; la détermination de la vulnérabilité de la pruche occidentale aux vecteurs xylophages du nématode du pin; le système d'aide aux décisions et la lutte biologique concernant le dendroctone du pin ponderosa; l'évaluation des risques dans les cas des dendroctones de l'épinette et du douglas; et des essais de résistance au charançon des pousses terminales ainsi qu'à la rouille vésiculeuse du pin blanc.

Les programmes de lutte contre les insectes et les maladies des arbres Rapport sommaire de 1994 Alberta et Services forestiers

H. Ono

Le nombre d'infestations de la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clemens), a augmenté en Alberta au cours de 1994, renversant ainsi la tendance observée en 1993. Quatre infestations différentes couvraient 126 735 ha dans le nord de la province. On a appliqué par pulvérisation aérienne une formulation B.t.k. à base d'eau (Foray 48B^{R}) à 14 253 ha de peuplements modérément à gravement infestés dans le nord-ouest de l'Alberta.

Dans le sud-ouest de la province, là où les dendroctones sont habituellement actifs, les populations de dendroctones du pin ponderosa ont atteint leur niveau le plus bas des dernières années.

La prolifération des populations de dendroctones de l'épinette s'est poursuivie dans le nord-ouest de l'Alberta, où l'on estime que 1 350 ha de la forêt de la rivière de la Paix sont infestés. Dans la forêt du lac Footner, l'activité de la dendroctone de l'épinette était moins marquée, mais demeurait autour des niveaux où les arbres dont le feuillage est encore vert pourraient être attaqués.

Plusieurs autres relevés et études d'évaluation des impacts ont été effectués en 1994, dont des relevés sur la régénération des ravageurs, un relevé du charançon du pin blanc et une évaluation de ses répercussions; un relevé du faux-gui et une évaluation de ses répercussions; et une évaluation des répercussions du pourridié.

Les ravageurs forestiers au Manitoba en 1994

A.R. Westwood, *et al*

Le rapport résume la situation des ravageurs et les activités de lutte contre ceux-ci au Manitoba en 1994 : la tordeuse des bourgeons de l'épinette, la tordeuse du pin gris, une étude sur le pin gris résistant à la rouille-tumeur globuleuse, une évaluation des ravageurs dans une parcelle-échantillon de sylviculture permanente, d'autres maladies des arbres, la maladie hollandaise de l'orme, un relevé des ravageurs effectué en 1994 dans la nouvelle forêt, et des évaluations de ravageurs spécifiques.

Région du Nord-Ouest
Les ravageurs forestiers importants en 1994

James Brandt (présenté par W.J. Volney)

Le rapport résume les renseignements obtenus au sujet des importants ravageurs forestiers présents dans la Région du Nord-Ouest en 1994. Ces renseignements proviennent en grande partie des services forestiers du Manitoba, de la Saskatchewan et de l'Alberta, ainsi que du ministère des Ressources renouvelables des Territoires du Nord-Ouest.

Résumé

La tordeuse des bourgeons de l'épinette et la spongieuse en Ontario en 1994

G.M. Howse, J.H. Meating, M.J. Applejohn, H.D. Lawrence et T. Scarr

En 1994, la superficie affectée par une défoliation modérée à grave causée par la tordeuse des bourgeons de l'épinette, qui était de 8 991 177 ha en 1993, a diminué pour atteindre 4 266 656 ha. La superficie de mortalité des arbres porteurs a passé de 2 750 411 ha à 7 783 336 ha cette année. Les relevés de masses d'oeufs laissent prévoir peu de changements dans l'infestation pour 1995.

L'infestation des spongieuses a continué à décliner en 1994. La superficie totale de défoliation modérée à grave était de 5 645 ha, en baisse par rapport aux 9 784 ha de 1993. Si l'on se fie aux tendances enregistrées dans le passé, il est probable que la superficie touchée augmente au cours des prochaines années.

La tordeuse des bourgeons de l'épinette et la spongieuse n'ont fait l'objet d'aucune mesure de pulvérisation aérienne de la part du ministère des Ressources naturelles de l'Ontario en 1994.

La tordeuse du pin gris en Ontario en 1994

J.H. Meating, H.D. Lawrence, G.M. Howse, M.J. Applejohn et T. Scarr

La superficie totale affectée par la tordeuse du pin gris est passée de 282 247 ha en 1993 à 419 344 ha en 1994. Toutefois, la défoliation dans de nombreux peuplement touchés a été moins intense en 1994. Les résultats de relevés des masses d'oeufs et de L_2 indiquent une grande variabilité dans la zone de prolifération, mais permettent de prévoir pour 1995 une légère diminution de la superficie totale touchée et de l'intensité de la prolifération. Il devrait toutefois y avoir une défoliation modérée à grave dans de nombreux peuplements.

Au cours du mois de juin, Produits forestiers E.B. Eddy Ltée et le ministère des Ressources naturelles de l'Ontario ont effectué une opération de pulvérisation aérienne dans le district de Sudbury. Quelque 21 499 ha ont ainsi été traités par une seule application de Foray 76B (*Bacillus thuringiensis*) à une de 30 MUI/1,5 L/ha. Grâce à ce programme, on a très bien réussi à réduire les populations de tordeuses du pin gris et à protéger le feuillage. On a également procédé à un programme expérimental d'application du régulateur de croissance des insectes RH5992 MIMIC (Rohm and Hass Canada Inc.).

Programme conjoint E.B. Eddy-MRNO de protection du feuillage contre la tordeuse du pin gris en Ontario en 1994

Taylor Scarr et Joe Churcher

En 1994, le ministère des Ressources naturelles de l'Ontario et Produits forestiers E.B. Eddy Ltée ont appliqué un programme de pulvérisation aérienne en vue de protéger les peuplements de pins gris de la défoliation par la tordeuse du pin gris. Pour la première fois en Ontario : une compagnie d'exploitation forestière payait directement une partie d'un programme de pulvérisation; des peuplements faisaient l'objet d'une mesure de protection dès la première année de leur défoliation; on a eu recours à un modèle d'impact économique pour analyser les coûts et les avantages de la protection des forêts; le FORAY 76 était utilisé à titre opérationnel.

En tout, 21 499 ha ont été traités par une seule pulvérisation aérienne de FORAY 76B non-mélangé à une dose de 30 MUI/ha (1.4 L/ha) au moyen d'un Dromader équipé de pulvérisateurs centrifuges et d'un Cessna 172F pour le pointage.

Efficacité des applications simples et doubles de RH5992[R] visant la tordeuse du pin gris en Ontario, en 1994

J.H. Meating, H.D. Lawrence, A. Robinson et G.M. Howse

En juin 1994, on a procédé à un essai du régulateur expérimental de croissance des insectes RH5992 (MIMIC) pour la lutte contre la tordeuse du pin gris dans deux secteurs (de 50 ha chacun) du district de Sudbury. Dans le premier secteur, on a procédé à une seule application de RH5992 à une dose de 70 g/2,0 L/ha. Dans le second, deux applications ont été faites à cinq jours d'intervalle (2 x 70 g/2,0 L/ha.)

Les deux traitements ont provoqué une réduction des populations de tordeuses du pin gris. Dans le secteur ayant subi une seule application, la défoliation variait, mais dans les parcelles où il y avait eu dépôt efficace, les niveaux de défoliation étaient inférieurs à 20 %. Dans le secteur ayant fait l'objet de deux applications, les niveaux moyens de défoliation étaient de moins de 5 %.

Insectes et maladies des arbres à Terre-Neuve et au Labrador en 1994

J. Hudak, K.E. Pardy, G.C. Carew, L. Oldford, D.S. O'Brien, D.M. Stone et W.J. Sutton

Le rapport porte sur la situation des principaux ravageurs forestiers à Terre-Neuve et au Labrador en 1994, soit l'arpenteuse de la pruche, le diprion du sapin, le puceron lanigère du sapin, le diprion du pin sylvestre, le chancre scléroderrien et d'autres ravageurs.

En général, les infestations de l'arpenteuse de la pruche ont continué à progresser tant pour ce qui est des zones affectées que de la gravité des infestations. La superficie totale de défoliation était d'à peu près 14 000 ha, dont 11 000 ha où les dommages étaient de modérés à graves.

Le puceron lanigère du sapin à Terre-Neuve en 1994

W.W. Bowers et J. Luther

La présence du puceron lanigère du sapin vient compliquer la gestion des peuplements de jeunes sapins baumiers et des plantations d'arbres de Noël dans l'Est canadien. La création et la mise en oeuvre d'un système d'aide aux décisions à l'égard de ce ravageur demeurent une importante priorité de recherche. On met actuellement sur pied une initiative conjointe en vue de fournir aux gestionnaires des forêts un outil fiable qui leur permettra de prendre des décisions mieux éclairées. Le projet a graduellement mis l'accent sur les aspects biologiques, bionomiques et sur l'impact du puceron lanigère du sapin. Les connaissances acquises et découlant d'études antérieures constituent la pierre d'assise de systèmes de détermination des dangers et des risques en cours d'élaboration, par l'application des techniques de télédétection.

Insectes et maladies des arbres aux États-Unis en 1994

Dan Kucera

Le rapport traite des problèmes rencontrés aux États-Unis en 1993, soit : la tordeuse des bourgeons de l'épinette, la tordeuse du pin gris, la spongieuse, la chenille à houppes du douglas, la livrée des forêts, la tordeuse du pommier, les scolytes de l'écorce et d'autres ravageurs, la lutte contre les mauvaises herbes et l'utilisation des herbicides, le feu, les scolytes de l'écorce, la livrée des forêts, les pucerons attaquant le cyprès, le puceron lanigère attaquant la pruche, l'anthracnose du cornouiller, le chancre du moyen cendré, la rouille fusiforme, le dépérissement du chêne et d'autres maladies.

L'usage des herbicides en Ontario en 1994

Joe Churcher et Dan Kott

En Ontario, des herbicides ont été pulvérisés sur environ 80 000 hectares de forêts domaniales en 1994. Les données qui suivent ne sont pas exhaustives étant donné que la compilation des rapports sur l'utilisation des pesticides n'était pas encore terminée au moment du vingt-deuxième colloque annuel sur la répression des ravageurs forestiers (du 15 au 17 novembre 1944). Toutefois, elles donnent une bonne idée de la quantité et du type d'herbicide utilisé, ainsi que des buts visés.

Le Glyphosate (Vision) était de loin le produit le plus souvent utilisé (74 313 hectares). Les autres herbicides auxquels on a eu recours étaient le 2,4-D (4 400 ha), le Velpar (495 ha), le Pronone (445 ha), le Release (100 ha) et le Garlon (86 ha) (Tableau 1).

Applications expérimentales et semi-opérationnelles de RH5992 contre la tordeuse des bourgeons de l'épinette en 1994: Résultats préliminaires

B.L. Cadogan, A. Retnakaran, R. Scharbach, A. Robinson et W. Tomkins

Dans le cadre d'une étude sur le terrain effectuée dans le nord-ouest de l'Ontario, on a examiné l'efficacité du RH5992 (MIMIC 2F) dans la lutte contre la tordeuse des bourgeons de l'épinette *Choristoneura fumiferana* (Clem). Le produit a été pulvérisé par voie aérienne à une dose de 70g d'ingrédient actif (IA) dans 1 L ou 2 L/ha, à raison d'une ou deux applications. Les résultats démontrent qu'une double application de 70g d'ingrédient actif (IA) dans 2 L/ha représente la stratégie d'application la plus efficace et qu'elle s'avère un moyen de lutte efficace pour le sapin baumier (*Abies balsamea*) et l'épinette blanche (*Picea glauca*). Les pulvérisations expérimentales et semi-opérationnelles ont été tout aussi efficaces dans la lutte contre les populations de tordeuses des bourgeons de l'épinette; toutefois, l'application expérimentale est celle des deux techniques qui offrait une meilleure protection du feuillage.

Protection contre la défoliation par la tordeuse des bourgeons de l'épinette pour deux ans - Démonstration de l'effet létal du RH5992 sur le second stade larvaire en 1994

Arthur Retnakaran

L'agoniste ecdystéroïde non stéroïdien RH-5992 (MIMIC), provoque chez la chenille de la tordeuse des bourgeons de l'épinette une mue précoce incomplète qui entraîne le décès de l'insecte. Dans les douze heures suivant l'ingestion, la chenille cesse de s'alimenter et dans l'espace de 48 heures, la capsule céphalique glisse exposant une cuticule non pigmentée, très mince et mal formée. Appliqué à deux reprises à raison de 70 g dans 2 L par ha, il constitue un excellent moyen de lutte et offre une protection presque complète du feuillage.

Recherche sur l'utilisation de produits naturels contre les insectes en 1994

Blair Helson, John McFarlane et Dave Comba

Mise au point de produits naturels pour la lutte contre les insectes ravageurs des forêts

En 1994, nous avons mis l'accent sur le développement d'extraits du margousier à feuilles de frêne comme solution de rechange sélective pour la lutte contre certains ravageurs forestiers précis pour lesquels on ne possède pas, à l'heure actuelle, d'agent de lutte biologique (B.t., virus), notamment le charançon du pin blanc, les diprions et les insectes des graines et des cônes. Nous avons concentré nos efforts sur l'évaluation d'une nouvelle formule d'extrait du margousier à feuilles de frêne de Phero Tech Inc. de Delta en C.-B. et l'avons comparée à l'Azatine que nous avions déjà mise à l'essai. On a examiné plus attentivement les propriétés toxicologiques de ces formules sur la tordeuse des bourgeons de l'épinette, y compris leur activité résiduelle et une simulation visant à démontrer leur efficacité sur des arbres en pots infestés de chenilles situés à l'extérieur, dans des conditions climatiques naturelles. On a vérifié le spectre de l'activité du Neem (extrait du margousier à feuilles de frêne) sur plusieurs autres ravageurs forestiers (la livrée des forêts, la légionnaire noire, la chenille à houppes blanches, le diprion européen de l'épinette et le pamphile à tête rouge (avec D.B. Lyons). Toutes les espèces y étaient sensibles, particulièrement les diprions.

Le mécanisme de résistance de l'érable rouge à la chenille de la livrée des forêts

Aspects alimentaires. En 1994, on a comparé la croissance et la survie, de l'éclosion à la pupaison, de la chenille de la livrée des forêts et de la chenille de la spongieuse, sur des feuilles entières de sept essences d'érables.

Aspects chimiques. Cette année, on s'est beaucoup attaché à déterminer les composés de l'érable rouge ayant un effet anti-appétant sur la chenille de la livrée des forêts.

Études sur la chimie environnementale des insecticides forestiers

K.M.S. Sundaram

Résumé

Les études majeures entreprises par le groupe de Chimie de l'Environnement (Insecticides), indépendamment ou en coopération, sont résumées brièvement. Les domaines principaux comprenant le comportement chimique et environnemental de : (I) tebufenozide (MIMIC[R] ou RH-5992); (II) *Bacillus thiringiensis (kurstaki)* et (III) azadirachtin (AZ-A); ainsi que (IV) les méthodes analytiques nécessaires pour les études de (I) à (III) sont passés en revue. Le lessivage par la pluie des dépôts foliaires de quatre formules liquides différentes de Dimilin[R] WP-25 est aussi rapporté.

Résultats préliminaires sur l'efficacité et l'utilisation synchronisée de l'azadirachtine, un extrait du margousier à feuilles de frêne, contre le charançon du pin blanc dans des plantations de jeunes pins gris

B.F. Zylstra et P. de Groot

Cette recherche fait suite aux essais effectués sur le terrain en vue de mettre au point des méthodes rentables, mais écologiques pour prévenir les dégâts causés par le charançon du pin blanc (*Pissodes strobi*) dans les plantations de jeunes pins gris, spécialement les peuplements de grande valeur, comme les essais sur les familles et les peuplements.

Le Neem, un produit naturel dérivé des graines du margousier à feuilles de frêne, a démontré son efficacité contre ce genre d'insectes qui se nourrissent de l'intérieur de l'arbre porteur. Nous avons décidé de mettre à l'essai un dérivé du Neem, l'azadirachtine, (Phero Tech. Inc., 7572 Progress Way, Delta, C.-B.) par pulvérisation topique sur le pin gris afin de déterminer si ce produit pourrait empêcher le charançon du pin blanc de se nourrir et prévenir ainsi la mort des pousses apicales.

Le rapport présente des données sur l'efficacité d'une formulation d'azadirachtine appliquée par pulvérisateur dorsal directement sur les pousses apicales en vue de lutter contre les dommages causés par le charançon du pin blanc aux jeunes pins gris. Ces données démontrent clairement que l'on peut assurer une très bonne protection des pousses apicales si l'on utilise ce produit, spécialement lorsque le traitement est synchronisée avec l'apparition des jeunes chenilles.

État d'avancement de la recherche sur la lutte intégrée contre les ravageurs dans la Région des Maritimes

S.E. Holmes

Les points saillants de la recherche effectuée en 1994 dans le cadre du Projet de lutte intégrée contre les ravageurs forestiers au Service canadien des forêts - région des Maritimes comprennent :

- l'évaluation de la quantité et de la qualité du dépôt de B.t. sur l'épinette blanche,
- des essais sur le terrain de plusieurs agents de lutte éventuels, nématodes, *Bacillus thuringiensis tenebrionis*, complexe parasite/prédateur, contre la galéruque de l'orme
- une étude de base de la densité des populations de lépidoptères dans une forêt de sapins et d'épinettes du Nouveau-Brunswick : Impact des pratiques forestières,
- les composés d'origine naturelle et leur efficacité contre la tordeuse des bourgeons de l'épinette;
- des essais de démonstration avec des phéromones pour la lutte intégrée contre la tordeuse de l'épinette (*Zeiraphera canadensis*) - 3 ha traités.

Préoccupations du ministère des Ressources naturelles et de l'Énergie et de l'industrie forestière du Nouveau-Brunswick en ce qui concerne les moyens à utiliser à l'avenir pour protéger les forêts contre les ravageurs

La protection des forêts contre la tordeuse des bourgeons de l'épinette a fait l'objet d'un engagement renouvelé d'année en année au Nouveau-Brunswick, plus que dans toute autre province aux prises avec des proliférations graves de ce ravageur. L'Ontario et le Québec, par exemple, comptent des forêts de résineux mortes ou à l'agonie qui couvrent ensemble des superficies équivalentes à quatre fois le Nouveau-Brunswick. Bien que de telles pertes puissent être acceptables pour ces provinces, la protection, au Nouveau-Brunswick, est plus critique pour la conservation de notre approvisionnement en bois, la croissance de notre industrie et le maintien du niveau de vie de notre population.

Au fil des ans, de nombreuses options de lutte ont fait l'objet de recherches et se sont avérées peu pratiques ou inefficaces. Dans l'intervalle, l'insecticide fénitrothion est devenu, par sa feuille de route, le point d'appui du programme. Il est aujourd'hui la norme à laquelle sont comparés les autres outils de lutte. Grâce à la protection efficace qu'il offre, on a pu conserver des forêts que l'on consacre aujourd'hui à d'autres buts comme la gestion de l'habitat sauvage. Bien que les recherches au cours des ans aient démontré certains effets secondaires, les mêmes études ont également fait état d'un certain rétablissement ou d'une résilience de l'écosystème au cours de diverses périodes, ce qui nous permet de croire qu'il ne s'agit pas là d'une menace à la durabilité et à la biodiversité à long terme. Dans ce contexte, le fénitrothion a été considéré comme un insecticide acceptable du point de vue de l'environnement.

Les pages qui suivent donnent un aperçu des préoccupations du ministère des Ressources naturelles et de l'Énergie et de l'industrie forestière du Nouveau-Brunswick et fournissent un appui indépendant pour le maintien de l'homologation du fénitrothion.

Mise à jour du Programme d'extension du profil d'emploi pour les usages limités demandés par les utilisateurs (PEPUDU)

E.M. Harvey et C.A. Howard

Institut pour la répression des ravageurs forestiers

Service canadien des forêts

1219 Queen Street East

Sault Ste. Marie (Ontario) P6A 5M7

Par suite des recommandation de l'Examen du processus d'homologation des pesticides, le Programme d'extension du profil d'emploi pour les usages limités demandés par les utilisateurs (PEPUDU) a remplacé le Programme des pesticides à emploi limité qui avait été créé vers la fin des années 70. Les emplois limités des pesticides sont définis comme étant «les utilisations nécessaires des pesticides ayant un volume des ventes anticipé insuffisant pour persuader le fabricant d'effectuer les recherches nécessaires pour l'homologation» (Direction de l'industrie des produits végétaux, 1993).

Le programme PEPUDU ne considère que les produits présentement homologués au Canada; le déposant doit consentir à ajouter la nouvelle utilisation sur l'étiquette du produit, et on doit pouvoir justifier l'efficacité de l'utilisation proposée. (Direction de l'industrie des produits végétaux, 1993).

On résume l'état actuel des demandes d'homologation faites pour des herbicides et des insecticides dans le cadre du programme PEPUDU.

Mise à jour des critères du Programme pilote d'homologation des usages limités demandés par les utilisateurs (PHUDU) - Gallery

E.M. Harvey et C.A. Howard

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Les critères du Programme pilote d'homologation des usages limités demandés par les utilisateurs ont été établis en 1992 (Direction de l'industrie des produits végétaux, 1994), en réponse aux Recommandations pour un système réglementaire fédéral révisé de répression des ravageurs (Équipe d'examen de l'homologation des pesticides, 1990). Quand ils seront en vigueur, ces règlements rendront possible un programme PHUDU qui permettra aux groupes d'utilisateurs de demander l'homologation d'un pesticide déjà homologué pour une utilisation particulière aux États-Unis. En décembre 1992, un groupe de travail interministériel a élaboré les critères d'un programme pilote PHUDU et en mars 1993, le Gallery 75DF (isoxaben) a été sélectionné pour le programme pilote PHUDU destiné au secteur forestier.

Afin d'être éligible pour le programme PHUDU, un produit doit satisfaire aux critères ci-dessous:

1. Ingrédient actif homologué aux États-Unis, mais non au Canada.

2. Le déposant (en l'occurrence, DowElanco) doit consentir à participer au programme et fournir l'information demandée.
3. Être parrainé par un groupe d'utilisateurs connu (dans ce cas, l'Association canadienne pour le contrôle de la végétation concurrente dans les pépinières forestières).
4. Correspondre à la définition des usages limités.
5. Répondre à un besoin défini (absence de solutions de rechange), et la possibilité de son emploi doit être une forte priorité pour le groupe d'utilisateurs.
6. Sa base de données doit avoir au moins cinq ans.
7. Il ne doit faire l'objet d'aucune préoccupation importante en rapport avec la santé ou l'environnement.
8. Son utilisation proposée et les volumes requis doivent être déterminés.

On a préparé une étiquette provisoire, changeant la désignation de la catégorie de «restreinte» à «commerciale». Cette restriction ne s'applique qu'aux arbres de la liste destinés à d'éventuelles activités de reforestration.

Aux fins du programme PHUDU, la définition d'usage limité a été changée comme suit:

-on a exempté les producteurs de leur obligation antérieure d'établir des «limites» (c'est-à-dire de superficie/volume)

-la question de la limite superficie/volume fera l'objet d'un examen au cas par cas.

À ce jour, on n'a pas noté de problèmes majeurs concernant le produit Gallery du programme pilote, et une décision réglementaire est attendue avant le 31 décembre 1994.

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Le Programme de formation avancé en répression des ravageurs forestiers (PFARRF) - un atout pour une carrière

E.M. Harvey et C.A. Howard

Institut pour la répression des ravageurs forestiers

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L'Institut pour la répression des ravageurs forestiers a répondu au besoin de formation experte en répression des ravageurs forestiers par la promotion du Programme de formation avancé en répression des ravageurs forestiers. Ce programme a préparé quatre cours avancés en répression des ravageurs forestiers, soit: 1) le cours avancé sur les herbicides forestiers, 2) le cours sur la répression des insectes forestiers, 3) le cours sur la gestion intégrée des ravageurs forestiers, 4) le cours sur la gestion intégrée des ravageurs, destiné aux professionnels des pépinières forestières. Les organismes ci-dessous participent au programme: 1) Service canadien des forêts, Ressources Naturelles Canada — Institut pour la répression des ravageurs forestiers; Région de l'Ontario (Entente de développement du Nord de l'Ontario — Programme forestier du Nord); Plan Vert — Initiative de gestion intégrée des ravageurs forestiers

2) Ministère des Richesses naturelles de l'Ontario

3) Conseil ontarien de formation et d'adaptation de la main-d'œuvre — Investissement professionnel de l'Ontario

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Les cours sont présentés en blocs de 10 jours par 30 instructeurs provenant de toutes les parties de l'Amérique du Nord et réputés dans le monde entier pour leur compétence technique et leurs qualifications pédagogiques.

Chaque cours est divisé en domaines principaux ou modules. Ceux-ci sont constitués d'ensembles pédagogiques très concentrés regroupant les meilleures informations techniques disponibles sur un sujet. Un module type utilise une équipe d'enseignement de trois à six instructeurs pendant une période d'un à six jours. À la fin des cours, les participants ont étudié les populations de ravageurs, les options de traitement, les options de prévention, les préoccupations sociales et environnementales, ainsi que d'autres facteurs, par exemple une matrice dynamique de considérations qui doivent être incorporées dans une stratégie viable de gestion intégrée des ravageurs.

Ces cours sont destinés aux professionnels expérimentés à mi-carrière et ils devraient aussi intéresser les gestionnaires des ressources forestières, les professionnels de la répression des ravageurs, les responsables de la réglementation de la gestion des pesticides, les personnes chargées de l'application de pesticides et d'autres personnes qui s'intéressent à l'amélioration de leurs connaissances en répression des ravageurs forestiers.

Pour de plus amples informations concernant le Programme de formation avancé en répression des ravageurs forestiers, veuillez communiquer avec Eileen Harvey (téléphone, (705) 949-9461;
télécopieur, (705) 759-5700).

PACIFIC AND YUKON REGION - 1994

STATUS OF IMPORTANT FOREST PESTS

AND

EXPERIMENTAL CONTROL PROJECTS

PREPARED FOR THE

22ND ANNUAL PEST CONTROL FORUM

NOVEMBER, 1994
OTTAWA

PRESENTED BY:

G.A. VAN SICKLE
PACIFIC FORESTRY CENTRE
VICTORIA, B.C.

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ABSTRACT

The status of about 24 economically significant forest pests active in the Pacific and Yukon Region in 1994 is presented, with some forecasts for 1995. These include the increasing levels of spruce beetle, phantom hemlock looper, satin moth and poplar rusts, and continuing populations of mountain pine and Douglas-fir beetles, eastern and western budworms, western hemlock looper, forest tent caterpillar, and large aspen tortrix which caused significant damage, and small numbers of European and Asian gypsy moths. Black army cutworm and rhizina root disease declined, and Douglas-fir tussock moth collapsed.

Current research and control trials of some of these pests include: pheromone confusion trials against Douglas-fir tussock moth; pheromone development trials against western blackheaded budworm, phantom hemlock looper, and western oak looper; Btk trials against western spruce budworm; calibration of a pheromone trapping system for western hemlock looper; testing susceptibility of western hemlock to woodborer vectors of pinewood nematode; decision support system and biological controls for mountain pine beetle; hazard rating for spruce and Douglas-fir beetles; and screening for resistance to terminal weevils and white pine blister rust.

SUMMARY OF IMPORTANT PESTS

The pest conditions reviewed are those most likely to be of interest to participants. Equally significant in terms of losses, but not included, are several forest diseases such as root rots, dwarf mistletoes, stem decays, rusts and cankers. These are perennial, fluctuate little from year to year ,and do not warrant annual surveys. Controls for such diseases are most practical and economical 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, the impact of pests of young stands, most quarantine matters, aesthetics, increased fire hazards, or earlier losses from white pine blister rust.

More detailed information of these and other pests active in the Pacific and Yukon Region in 1994, are presented in "Forest Pest Conditions in British Columbia and Yukon" by Natural Resources Canada's Forest Insect and Disease Survey staff, published annually by Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.

Mountain Pine Beetle

This beetle is one of the most damaging forest insects in British Columbia. The area and volume of mature lodgepole pine and some western white pine killed by the beetle declined in 1994 to about 9384 active infestations, totaling 32 900 ha from the International Border to northeast of Prince Rupert. This is down from 45 600 ha in 1993, but about 15% more than the area burned by forest fires in British Columbia in 1994

(27 465 ha). The volume lost (1.75 million m3) represents about 8% of the annual harvest of lodgepole pine in British Columbia.

The infestations mapped during 1994 aerial surveys increased in two of the six forest regions in British Columbia and declined in the remainder. Infestations in the Cariboo Region more than doubled for a second year to 1650 ha in 1174 widely scattered pockets from Clinton north to Quesnel, and infestations increased slightly (6%) in the Prince George Region to 13 575 ha. Declines in the areas of recent beetle-killed mature pine occurred in the Kamloops Region to 8865 ha, down more than half from 1993; in the Prince Rupert Region, down a third to 5585 ha; in the Nelson Region, down two thirds to 2755 ha; and in the Vancouver Region, down 12% to 465 ha.

Infestations along the British Columbia-Alberta border and including most National Parks remained at low levels for the ninth consecutive year, except in Kootenay and Glacier National Parks where pockets of recently-killed pine totalled 900 ha and 25 ha, respectively, as in 1993. No new mountain pine beetle-killed pine (faders) were located in aerial surveys in Mt. Robson Provincial Park and west of Jasper National Park, but about 68 pheromone-baited and recently-attacked trees are to be cut-and-burned in a control operation ongoing since 1985.

Overwintering brood survival was variable in 1993-94, and had little adverse affect on populations for flight and attack in July 1994. The frequency of new attacks on mature lodgepole pine in 24 previously infested stands cruised in five forest regions averaged 15%. These ranged from 27% in the Nelson Region to an average of 5% in the Kamloops Region.

Red turpentine beetle, *Dendroctonus valens*, killed mature ponderosa pine in the southwestern part of the Nelson Region for the third consecutive year. Also common in the same trees were western pine beetle, *D. brevicomis*, mountain pine beetle,. *D. ponderosae*, and pine engraver beetles, *Ips pini*, and *I. emarginata*. Additionally, beetle-killed ponderosa pine were common in small pockets east of Penticton in the Okanagan Valley and in the Ashnola River Valley. Attacks by ambrosia beetles, *Trypodendron* spp., in trees predisposed by other beetles were common at widespread locations.

The salvage of beetle-killed and adjacent susceptible pine remains a priority in beetle-infested Timber Supply Areas, particularly in the Kamloops and Nelson forest regions. More than 30 000 commercially produced semio-chemical baits were again used for beetle management, including population monitoring, containment, and single tree disposal, by the BC Forest Service and the forest industry (P.M. Hall, BCFS, Victoria, personal communication). About 95% of the lures are for mountain pine beetle, with the balance for spruce beetle and Douglas-fir beetle.

Spruce Beetle

The area of mature white and Engelmann spruce killed by spruce beetle in the Pacific and Yukon Region increased to about 98 000 ha. This followed a decline in 1993 after four consecutive years of increased tree mortality due mainly to periodic accumulations of windthrow in overmature stands. Most of the infested spruce was mapped in the Prince George Region over 61 000 ha and over 33 000 ha in the southwestern part of the Yukon Territory, particularly in Kluane National Park (42% of total) and in the Shakwak Valley north of Haines Junction. Infestations totaled 900 ha in adjacent parts of the Prince Rupert Forest Region in northwestern British Columbia near the Haines Road and upper Chilkat, Klemer, and Kalsall river valleys. Additionally, small patches of recent tree mortality were mapped in the Stikine River drainage and southwest of Houston in the Morice River drainage in the eastern part of the Prince Rupert Region.

Tree mortality in the Prince George Forest Region was mapped in numerous widely scattered pockets totaling 61 000 ha. Most mortality was in previously infested areas north of Mackenzie in the Chunamen, Blackwater, and Phillips creek drainages west of Williston Lake over 52 000 ha, an increase from 40 000 ha in 1993. As well, scattered mortality occurred over about 5000 ha on the east slopes of the Rockies near Chetwynd. Infestations in the Kamloops Region increased slightly to 2525 ha, mostly south of Merritt over 1550 ha. New infestations were mapped near Vernon over 240 ha and near Ashcroft over 100 ha, and older infestations continued in small patches west of Lillooet (30), near Princeton (5), and east of Barriere (5). Small patches were mapped in the Cariboo (60 ha) and Nelson (295 ha) regions.

Ground and aerial surveys of beetle-infested stands found increased 1994 attack in parts of the Prince Rupert Region and Yukon Territory, large broods for attack in 1995 near Golden in the Nelson Region, but very little in the Cariboo and Kamloops regions.

Douglas-fir beetle

Mature Douglas-fir was killed by the beetle in about 3421 separate pockets totaling 7665 ha in parts of five forest regions. This was down a third from last year, and the first decline in six years. Most of the recently killed trees were again in the Cariboo Region in 1728 separate groups of 2 to 50 trees, occasionally up to 250, totaling 5235 ha. This is down 25% from last year. Tree mortality in the Chilcotin Military Block near Riske Creek, west of Williams Lake, totaled 4100 ha, also down 25% from 1993. Declines in Douglas-fir mortality occurred also in the Prince George Region, down 55% to 1345 ha in previously infested areas north of Fort St. James, south of Prince George, and south of Valemount; in the Kamloops Region to 595 ha in 775 widely scattered patches in the north Okanagan and Thompson River drainages, and in the Vancouver Region over 255 ha in the Fraser and Anderson river drainages north of Hope, and in the Mid-Coast Forest District. Widely scattered pockets totaled 235 ha in the Nelson Region, mostly in the Rocky Mountain Trench and, to a lesser extent, in the Kootenay and Arrow lakes drainages.

Budworms

The area of mixed age-class Douglas-fir in three forest regions defoliated by **western budworm** in 1994 was about 16 145 ha in 144 separate areas of infestation. This was 60% less overall than in 1993, and the smallest area defoliated in 10 years. Defoliation intensities were also reduced with severe on less than 1% of the area, moderate on 47%, and light on the remainder. As forecast, defoliation was mostly in the Kamloops Region over 14 235 ha, down more than 60%, and near Boston Bar in the Vancouver Region over 1900 ha, down about half. Populations declined to endemic in the southern part of the Cariboo Region west of Clinton, where defoliation was mapped over 350 ha in 1993. Populations in the Nelson Region near Grand Forks and in the East Kootenay, remained endemic following their decline last year.

Mortality of late-instar larvae at five locations in two regions averaged 19% diseased (range 7 to 31%), down 16% from 1992. An entomopathogen, *Entomophthoraceae*, was isolated from larvae in one collection in which 20% were killed. Larval parasitism by dipterans and hymenopterans averaged 26% (range 12-57%) at all five sites sampled, up 16% from last year, but still too low to effectively reduce populations.

The average number of egg masses collected by FIDS at 26 infested stands in three regions were 9% more numerous than in 1993, indicating a slight population increase in all three regions. Defoliation is forecast to be severe in the vicinity of three of the sites, mostly near Merritt; moderate at six sites near Merritt, Lillooet, and Kamloops; light at five, mostly in the Okanagan Valley in the Kamloops Region and near Pemberton in the Vancouver Region, and trace or none at the remaining six sites.

Budworm-infested Douglas-fir stands in the Kamloops Forest Region totaling about 21 500 ha in four forest districts, were sprayed aerially with *Bacillus thuringiensis var. kurstaki,* by the BC Ministry of Forests. This followed applications over 34 000 ha in 1993 and 35 000 ha in 1992, when control was considered successful at all sites.

A study to improve and calibrate detection methods for western budworm continued in 1994, with increased numbers of traps and locations. Adult males were monitored in four regions at 28 sites with low populations and a history of budworm outbreaks. Up to 423 male adults were caught per trap (average 68/trap). This is a decrease from 1993 and indicates declining populations. In these areas, distant from the abovementioned more heavily infested stands, there is a potential to very lightly defoliate stands at only four sites in parts of the Cariboo and Kamloops regions in 1995, and none at the remainder.

Defoliation of current foliage of white spruce and, to a lesser extent, of alpine fir by **eastern spruce budworm** totaled 173 425 ha in 154 separate patches west, southeast and north of Fort Nelson and extended into the Yukon and Northwest Territories. This is similar to last year, with only light defoliation on all areas.

Protection of mature spruce seed production stands and adjacent young stands near Fort Nelson with *Bacillus thuringiensis var. kurstaki* (Dipel 132 (R)) was discontinued in 1993.

Alpine fir and spruce forests were defoliated by mature **two-year-cycle budworm** in 414 separate areas totaling about 200 000 ha, mostly in the Cariboo Region with the remainder in the Prince George and Kamloops regions. Defoliation was light over 96% of the area and moderate over the remainder. This compares with 107 000 ha last year by immature larvae, and 435 000 ha in 1992, the largest area defoliated since the 1960s. Immature "off-cycle" larvae defoliated stands over 320 ha in the Nelson Region.

Defoliation of fir-spruce stands by mature "on-cycle" two-year-budworm in the Cariboo Region totaled 110 595 ha in 260 patches from Canim Lake north to the Willow River drainage. Defoliation was most severe in the Swift and Little Swift river drainages and near Barkerville. Populations in the Prince George Region lightly defoliated stands over 62 675 ha, down a third from 1992, in about 100 patches mostly in the Bowron and Willow river drainages, and near McBride. Fir-spruce stands in the Kamloops Region were moderately defoliated over 18 200 ha in about 34 patches in the Clearwater Forest District, down from 160 000 ha in 1992. Defoliation by immature larvae is expected to occur in these areas in 1995, although less severe and widespread than this year. There was no defoliation in previously defoliated stands in the East Kootenay part of the Nelson Region, and none is forecast to occur next year.

Immature "off-cycle" larvae lightly defoliated fir-spruce stands in the Prince George Region over 8000 ha in about 16 patches north of Fort St. James, similar to 1992. There was no defoliation apparent elsewhere in the region from Mackenzie to Germanson Landing, where mature larvae defoliated stands over 97 000 ha last year. In the Kamloops Region the area of defoliation totalled only 400 ha near Keefer and Holmes lakes in the upper Kettle River drainage and near Sugar Lake north of Cherryville. Stands in the Monashee Mountains in the western part of the Nelson Forest Region were very lightly defoliated over about 280 ha, and over 40 ha in Bugaboo Creek west of Spillimacheen in the East Kootenay.

Successive years of severe defoliation of fir-spruce by the budworm in the northeastern part of the Cariboo Forest Region has resulted in mortality of an estimated 30% of the advanced regeneration trees, and top and branch dieback and growth loss of all age classes.

Western Hemlock Looper

Populations declined significantly following defoliation by the looper for up to five successive years in old growth western hemlock and western red cedar in parts of four forest regions in interior British Columbia. Defoliation totaling about 8000 ha in two regions was mostly light (2755 ha) or moderate (4635 ha) with severe over the remainder (570 ha). This included patches totaling 5000 ha east of Prince George to McBride, down from 43 000 ha last year, and 3000 ha near Arrow and Trout lakes in the western part of the Nelson Region, down from 48 500 ha last year. Populations near Clearwater in the Kamloops Region and Quesnel Lake in the Cariboo Region collapsed following major declines last year. Tree mortality resulting from successive years of severe defoliation was mapped over 60 295 ha in parts of four regions. This included 35 550 ha, 15 525 ha, and 9165 ha, in the Prince George, Kamloops, and Nelson regions, respectively.

Tree mortality in previously defoliated stands in the Cariboo, Kamloops, and Prince George regions averaged 42% (range 9-87%) of the trees killed by successive years of moderate to severe defoliation. In the Cariboo Region, about 40% of the trees were killed, as were 60% (range 15-100%) of the cedar and hemlock between Prince George and McBride. About 40% (range 34-44%) of the western hemlock and western red cedar trees at three plots near Clearwater in the Kamloops Region were killed, following consecutive years of moderate and severe defoliation. Tree mortality was 48% and 38% of the hemlock at Downie and Bigmouth creeks, respectively, north of Revelstoke in the Nelson Region. At an additional three sites where defoliation had previously been light to moderate, mortality of mostly smaller understory trees averaged 9% (range 4-17%).

The significant decline as forecast was due to naturally occurring factors which severely affected population development in late 1993 and 1994. These included overwintering egg parasitism which averaged 21% overall in 1993 and 45% at 31 sites in 1994. Infection of larvae by disease, mostly Entomphthoracae, and some *Beauvaria bassiana,* which killed about 18% (range 0-72%) of the larvae, and by parasites, mostly Hymenoptera and, to a lesser extent, Diptera, which killed an average of 10% (range 0-15%) of the larvae at 11 sites in three regions. Additionally, starvation due to competition between extremely high numbers of larvae and reduced foliage on severely defoliated trees also contributed to the decline.

Populations are forecast to decline further in 1995, with only light defoliation in reduced areas of cedar-hemlock stands in the Nelson, Prince George, and Kamloops regions, and none in the Cariboo Region where populations collapsed this year. This is based on an 88% reduction in numbers of overwintering eggs laid this year, which averaged 3 (range 0-25) eggs per sample (100 grams of lichens/site) at 25 sites in four regions. This indicates only very light defoliation at five of nine sites in the Nelson Region and at only one site in each of the Kamloops and Prince George regions, with none at the remaining 18 sites, all at or near previously defoliated stands. This compares with an average of 20 (range 1-38) eggs per sample at 34 sites last year. Only four healthy eggs were extracted from samples at six additional sites with a history but no recent population activity, in the Prince Rupert (4) and Vancouver (2) forest regions, too few to be of any significance.

A cooperative study with Simon Fraser University initiated in 1992 to develop a pheromone trapping and forecasting system for the western hemlock looper was continued by Canadian Forest Service/FIDS in 1994. Larvae samples using FIDS standard three-tree beating sampling, defoliation severity, trapping of male adults using two different trap types (Universal (U) and Multipher (M)) and two different pheromone strengths (10μ and 100μ), and overwintering egg populations were assessed at 31 sites with a history of looper activity in the Cariboo (2), Kamloops (8), Nelson (9), Prince George (5), Prince Rupert (4) and Vancouver (3) forest regions. In 1994, an average of 407 male adults (range 2-2162) occurred in 26 universal traps baited with 100μ strength pheromone. These data compare with an average of 157 moths (range 0-1069) in 57 universal traps baited with 10μ strength pheromone at 31 sites in six regions, and 61 (range 0-422) in 21 Multipher traps baited with 10μ strength pheromone at 21 sites. Trace or light defoliation occurred in 1994 at only seven sites in the Prince George, Kamloops, and Nelson regions. These trials suggest that 10μ lures should be adequate and the universal traps captured higher numbers than the Multipher traps.

Douglas-fir Tussock Moth

There was no defoliation of Douglas-fir by tussock moth in the Kamloops Region in 1994, following the decline to 1150 ha in 1993, the third year of the outbreak. The decline, as forecast, followed reduced numbers of adults and egg masses and reduced larval populations due to infection by a nuclear polyhedrosis virus in 1992 and 1993.

Populations remained at low levels on ornamental Douglas-fir and spruce in urban areas of Kamloops, Vernon, Kelowna, Penticton, in the Kamloops Region, at Abbotsford, Chilliwack, and Clearbrook in the Vancouver Region, and at Grand Forks in the Nelson Region.

The number of male adults in pheromone-baited sticky traps placed in Douglas-fir stands, with the greatest historical frequency of outbreaks mostly in the Kamloops Region, declined for the third second consecutive year. An average of 10 adult males (range 0-95) were trapped in 96 of 96 traps at 18 of 19 permanent monitoring sites in the Kamloops (16) and Nelson (2) regions. This is two-thirds less than the number trapped in 1993, when 34 males were caught per trap and indicates little or no defoliation of Douglas-fir in 1995 in or near previously defoliated stands. Despite the higher numbers of adults west of Kamloops at Battle Creek (avg. 95/trap), Monte Creek (74), Duck Range (59, range 46-71), and Heffley Creek (52) indicating continuing populations (an average of 40 or more per trap indicates a potential for defoliation), the absence of egg masses in surveys of both areas indicates that defoliation is not likely to occur in the areas in 1995.

Numbers of male moths at two sites in the western part of the Nelson Region declined to only single adults trapped in six traps at Cascade and Rock Creek. This compares with only one and two at each location, respectively, in 1993, and five and nine males in 1992. Trapping near previously defoliated trees near Chilliwack, Abbotsford and Clearbrook in the Fraser Valley, was discontinued following successful treatments in 1992, when no males were trapped.

An additional 343 male adults were trapped (average 14/trap) in the Kamloops Region, in 25 of 25 single traps located about 1 kilometer apart for detection purposes. An additional 30 traps in two areas near Winfield and Kelowna contained only nine adult males, four more than last year, and none were trapped at two sites in the Nelson Region. These data indicates a non-threatening endemic population.

A further 3401 male adults were trapped at 143 locations in a comparison of lures from different suppliers (average 10 and 14 per each of two traps/location) in the Kamloops Region monitored by BC Ministry of Forests.

Viral (NPV) treatments of tussock moth populations by the BC Ministry of Forests were discontinued this year. This followed treatments at six sites totaling 650 ha in the Kamloops Forest Region in 1993, when post-spray observations in control areas found a population reduction due to infection by a residual virus.

A pheromone-confusion trial (CheckMate DFTM) was continued by the Canadian Forest Service on populations at a single site near Kamloops. Defoliation in 1994 was minimal due to the decreasing populations, but pheromone traps averaged 70 adults per trap in three untreated stands, compared with nil captures in two treated stands.

Western Blackheaded Budworm

Increased budworm populations defoliated western hemlock in 18 separate infestations totaling 6000 ha in parts of the Kamloops and Nelson regions. Defoliation was mostly light in 11 areas totaling 4625 ha in the Nelson Region, especially in Glacier National Park, and to a lesser extent at Gray Creek near Kootenay Lake, up from about 45 ha in 1993, the second year of defoliation. New infestations lightly defoliated old growth hemlock in seven areas, totaling about 1400 ha in the eastern part of the Kamloops Region. Most were in the Eagle River Valley between Sicamous and Three Valley including Wap Creek, and near Mabel Lake.

Populations remained endemic in hemlock on the Queen Charlotte Islands and on northern Vancouver Island, where significant outbreaks occurred in the 1980's, and in the early 1990's in alpine fir and spruce near Chilkoot Pass in the northwestern part of the Prince Rupert Region.

Phantom Hemlock Looper

Douglas-fir were defoliated by the looper over several residential blocks in Burnaby near Vancouver, the first outbreak in the lower mainland since 1982. Defoliation was mostly moderate and occasionally severe with top-stripping on many trees. Native to British Columbia, outbreaks have been recorded since 1956, usually lasting two years and occasionally causing tree mortality.

Larch Casebearer, Budmoth, Sawfly

Larch casebearer populations moderately defoliated trees in four patches totaling 285 ha east of Vernon in the Kamloops Region, but remained at endemic levels in western larch stands in the Nelson Region for the fifth consecutive year.

Defoliation at most of the 18 long-term parasite release study sites in the Nelson Region was nil to trace, but light to moderate at two sites in the adjacent Kamloops Forest Region, similar to recent years.

A biological control program against larch casebearer was initiated in 1966, and up to 1987 more than 15 000 specimens of *Chrysocharis laricinellae* (Ratzburg) or *Agathis pumila* (Ratzburg) were released. No additional releases are planned.

Increased **larch budmoth** populations defoliated western larch in 18 separate patches totaling 680 ha in the eastern part of the Nelson Forest Region. Defoliation was mostly moderate (280 ha) or severe (350 ha), mostly near Fernie, and in smaller patches west of Kimberley to near Golden. Exotic larch at the University of British Columbia Research Forest near Vancouver were very lightly defoliated by **larch sawfly**, some for the seventh consecutive year. Elsewhere, populations remained endemic in previously defoliated native larch stands in B.C. and southwestern Yukon, following declines in 1992 and 1991, respectively.

Black Army Cutworm

Recently planted seedlings and ground cover were defoliated by black army cutworm at a few recently burned and planted sites in the Cariboo, Nelson, and Prince George forest regions. This was similar to the generally low levels over the past five years.

In the Cariboo Region, recently planted spruce and Douglas-fir seedlings were moderately defoliated and ground cover was severely defoliated in a plantation east of Horsefly. About 10% of the spruce seedlings were defoliated and killed, but western larch and lodgepole pine seedlings were less severely affected in patches over about 17 ha at a site on the east side of McNaughton Lake north of Golden, in the Nelson Region. Herbaceous growth was severely defoliated over about 135 ha at a second site where 688 adult males were caught in a pheromone-baited trap last year and planting was therefore delayed. Recently planted lodgepole pine seedlings and herbaceous ground cover were lightly and occasionally severely defoliated by cutworm in widely scattered patches over about 100 ha in the Stoner Creek drainage south of Prince George, where only 14-65 male adults were trapped last year. This is similar to 1993, when defoliation but no apparent mortality of defoliated seedlings occurred in the Murray River drainage south of Tumbler Ridge.

Cutworm larvae lightly to moderately defoliated ground cover but not seedlings at two of five sites resurveyed in the Prince Rupert Region this year. Traps at these sites, mostly in the Bell-Irving Valley, last year contained on average fewer than 150 adults.

Seedlings scheduled to be planted in 1995 on sites slash-burned in 1994-95 may be threatened by the cutworm, particularly where the numbers of male adults in pheromone baited non-sticky traps exceeded a threshold of 600 or more per site in 1994. This occurred only in the Prince Rupert Region (635), in one stand in the Bell-Irving river drainage north of Kitwanga. An average of 144 males/trap (range 10-370) were caught at the remaining 19 sites. Overall, at the 48 sites trapped in four regions, the average catch was 143/trap (range 10-635), up slightly from 124 in 1993.. Numbers of trapped males averaged 122/trap (range 10-340) at 15 sites in the Nelson Region, and 106/trap (range 12-320) at six sites in the Kamloops Region. This indicates the potential for very light defoliation in the Columbia river drainage north of Golden in the Nelson Region and at Cayene Creek (320) near Clearwater in the Kamloops Region, based on a threshold of about 350 per trap. Little or no defoliation is likely at the remainder of the sites in each of the Nelson and Kamloops regions (range 10-148 and 12-119, respectively), nor at seven sites in the Prince George Region (average 137, range 12-253, which are too few to cause significant damage in 1995).

A comparison of 1993 and 1994 lure batches at 13 sites in parts of four forest region found an average overall of 113 male moths per trap in traps baited with "94" lures compared with an average of 116 per trap baited with "93" lures. This indicates consistency of lures.

Rhizina Root Disease

Rhizina root disease infected and killed about 12% of the seedlings in half of the stands examined in the West Kootenay and eastern part of the Prince Rupert Region, but not in previously infected sites in the Cariboo Region. This low level was similar to the previous three years, but was the seventh consecutive year of seedling mortality by this pathogen in the Pacific and Yukon Region.

In follow-up surveys of previously infected sites in the West Kootenay, an additional 1 to 5% of the seedlings were infected and killed by the disease, where up to 30% of the seedlings had been killed last year. Surveys of an additional seven sites found new seedling mortality averaged 12% (range 1-48%), the highest at Goldstream River north of Revelstoke. New seedling mortality averaged 13% (range 4-30%) at seven sites burned in late 1993 mostly in the Nilkitkwa River drainage near Smithers, in the eastern part of the Prince Rupert Region. Surveys for the pathogen at an additional seven nearby sites were negative.

Gypsy Moth

Surveys to detect gypsy moth populations throughout British Columbia continued for the seventeenth year in a cooperative interagency (Agriculture Canada - Plant Health, Canadian Forest Service - FIDS, and BC Ministry of Forests) program.

Only 39 males (33 of the introduced European strain, 6 of the Asian strain) were recovered from 34 traps in nine municipalities in British Columbia during 1994. This is the lowest number of male captures since 1989 (27) and compares with 139 males in 100 traps at 15 municipalities last year. Most males captured in 1994 were trapped at previously active areas, including Chilliwack (15), Hope (8), Nanaimo (5), on Gabriola Island (2), and Oak Bay (2). None were trapped at Whiskey Creek (west of Parksville) or Vancouver where 33 males and 20 males and eight females, respectively, were found in 1993 and treated with *B.t.k.* this year. Elsewhere, males were also trapped on the lower mainland at Surrey (3 Asian), Burnaby (2), Langley (1 Asian), and New Westminster (1).

Male moths were caught for the fourth consecutive year in Langley (1 Asian) and Surrey (3 Asian), for the third consecutive year at Chilliwack, Hope, New Westminster, Burnaby, Nanaimo (5, including 2 Asian) and Oak Bay, and for the second consecutive year at Gabriola Island.

Increasing catches of males of the European strain during 1993 at Hope (30), Whiskey Creek (33) and Nanaimo (29), and continuing captures at Victoria (5, including 1 Asian) prompted aerial applications (678 ha) at five locations of *Bacillus thuringiensis* var. *kurstaki* (*Btk*, Foray 48B) in late April to mid May of 1994 in an effort to eradicate the populations. One 14 ha site in south Vancouver was treated from the ground with the same product. No males were caught in the post-treatment assessments at Victoria, Whiskey Creek and south Vancouver. However, additional males were trapped within the treated area at Nanaimo (2) and outside the treated areas at Hope (8) and Nanaimo (3).

Treatment with *Btk* has been proposed for the Chilliwack location in 1995, where increasing numbers of male moths have been trapped since 1992. Egg mass searches and/or delimitation trapping will be conducted at other positive locations in British Columbia.

There were no males caught this year in 278 traps deployed by FIDS in 157 provincial parks and 89 forested recreation areas in national parks, commercial campgrounds and north coast ports.

Pine Shoot Beetle/European Pine Shoot Moth

Surveys of Christmas tree plantings, particularly Scots pine, to detect the pine shoot beetle, *Tomicus piniperda*, in the Pacific and Yukon Region were negative for the third consecutive year. Surveys followed the recent introduction of this pest into North America in Ohio and five Lake States.

There has been no increase in numbers or spread of pine shoot moth in this region, and no evidence of populations in native pines, since surveys intensified in coordination with shoot beetle. Moth populations and damage remain confined in exotic pines in localized urban areas, including Victoria to Courtenay, the Fraser Valley, and the Okanagan Valley.

Balsam Woolly Adelgid

A survey to determine the distribution of balsam woolly adelgid in mature and immature stands in southwestern British Columbia was initiated this year by CFS/FIDS in cooperation with the BC Ministry of Forests and forest industry. Land managers in areas within and immediately adjacent to the 1992 BWA quarantine zone boundary were provided with sampling instructions to obtain branch samples from mature and immature *Abies* stands.

Of the more than 50 samples processed to date, active adelgid populations have been found to be frequent in the Whistler and Pemberton area, in both mature and immature stands. Adelgid populations were found on amabilis fir regeneration for the first time in the Birkenhead River drainage near Pemberton, just outside the quarantine zone in southwestern British Columbia. Infested regeneration with leader and lateral gouting were found last year on higher elevation amabilis fir near Port Alberni on Vancouver Island, near Spuzzum in the Fraser Canyon and on the Sechelt Peninsula. This resulted in increased surveys of true fir regeneration outside the zone this year.

Infested mature amabilis fir were found at Birkenhead River and in the Caycuse River drainage west of Cowichan Lake, and recent mortality of overmature amabilis fir attributed to the adelgid was mapped over about 10 ha near Mt. Arrowsmith near Port Alberni. Additional sampling near mature amabilis fir stands in the Oyster River drainage west of Campbell River, where infested trees were identified outside the quarantine zone last year, have been negative so far.

Surveys of immature *Abies* in 40 stands in the Vancouver and Kamloops regions, part of a region-wide survey of pests of young stands (POYS), found evidence of BWA damage in only two stands.

Research trials to determine the potential for adelgid crawlers to infest and be dispersed to field situations on containerized nursery stock were established at two locations, by CFS/FIDS in cooperation with the BC Ministry of Forests. In these trials seedlings grown under operational conditions have been artificially infested with balsam woolly adelgids to determine if they can survive nursery watering and fertilization regimes, as well as lifting and cold storage treatments. Gouting was noted in *Abies lasiocarpa* during preliminary examinations of 1+0 seedlings at one nursery site. More detailed evaluations for the presence of BWA will be conducted during lifting prior to cold storage in late November. This two-year trial is evaluating 1+0 and 2+0 nursery stock.

The BWA Regulations were revised by an Order in Council under the B.C. Plant Protection Act in 1992, and included an expansion of the quarantine zone to include infested areas of the mainland and islands previously outside the zone.

Tent Caterpillars

Forest tent caterpillar defoliated trees and shrubs at more than 650 locations covering 93 600 ha in the Cariboo and Prince George regions. The increase, up from 86 000 ha last year, was mostly in the Cariboo Region from Horsefly to Quesnel, and to a lesser extent from Prince George to Quesnel, near McBride, and in the Peace River area. Populations remained endemic in the northern part of the Kamloops Forest Region following their collapse last year.

The area of defoliation in the Cariboo Region increased overall for the fourth consecutive year to 52 000 ha over 471 patches in the northeastern part of the region from Horsefly to Quesnel. In the Prince George Region, trembling aspen and other deciduous trees were defoliated over 41 500 ha in 180 areas, similar to 1993. Increased populations south of Prince George to Quesnel severely defoliated stands over 33 000 ha, up from 22 000 ha in 1993. Near McBride, defoliation was severe over 4500 ha from Valemount to Rider, down from 16 000 ha in 1993. The area of mostly severe defoliation near Taylor in the Peace River area increased to 1500 ha, up from several hundred hectares in 1993.

Egg samples from 28 areas in the Cariboo and Prince George regions, indicate continuing populations in 1995 and defoliation of trembling aspen, cottonwood and other deciduous trees and shrubs from east of Williams Lake to Quesnel, south of Prince George and near McBride and Dawson Creek. An average of 21 new egg masses per tree (range 7-64), were counted at five sites near Prince George, with 10 (range 6-15) at five sites near McBride, and eight at a site near Dawson Creek. This is down from an average of 19 in the region in 1993. An average of 26 egg masses per tree (range 0-85) were counted at 10 sites in the Cariboo Region, the highest near Quesnel. Counts greater than 11 masses per tree usually result in severe defoliation.

Larval mortality from parasitism and disease at seven sites sampled in the Cariboo Region averaged 85% (range 51-99%). This was up from 76% last year, and is considered significant enough to reduce populations at some of these locations in 1995.

Northern tent caterpillar, *M. californicum pluviale*, populations increased for the second consecutive year and severely defoliated alder in east coastal areas of Vancouver Island, some Gulf Islands, and for the first time near Powell River, on Texada Island, and near Boston Bar. Defoliation of willow and other deciduous shrubs was severe again in the western part of the Prince Rupert Region near Meziadin Junction and in the Nass River drainage, but populations near Terrace remained endemic.

Defoliation of a variety of trees and shrubs, particularly alder, was again severe in widespread patches on Vancouver Island and Saturna Island. Increased numbers of larval colonies occurred at widely scattered locations from Sooke to Victoria to Campbell River, and from Buttle Lake to Gold River, particularly at Mira Creek west of Buttle Lake, at Powell River, and on Texada Island. Alder in the lower Nahatlatch River drainage and at Mohokum Creek northwest of Boston Bar on the mainland was lightly defoliated, the first record of defoliation in these areas in many years.

Increased populations severely defoliated mostly willows in three patches totaling about 100 ha between Van Dyke Camp and Meziadin Junction in the Prince Rupert Region for a second year. Light defoliation occurred for the first time in many years near Smithers. Populations were common but less damaging near Aiyansh in the Nass River Valley, and remained endemic following a population decline in and near Terrace and in the Skeena River Valley.

The numbers (more than five per tree) of overwintering egg masses commonly found on many trees and shrubs in the Saanich area, east coastal areas of Vancouver Island, Saturna Island, and at Meziadin Junction indicate continuing populations and defoliation in 1995, but not near Aiyansh.

Large Aspen Tortrix

Trembling aspen was defoliated over more than 12 000 ha by large aspen tortrix in the southwestern Yukon Territory, the Prince George Forest Region, and the western part of the Prince Rupert Region, up from 9400 ha in 1993.

Defoliation was mostly moderate and severe over 10 000 ha in about 10 patches in south-central Yukon Territory near Mayo, up threefold from 1993, and between Stewart Crossing and Dawson. Defoliation was less severe in stands near Teslin Lake and Braeburn. In the Prince George Region, defoliation increased to severe in the third year of outbreak in patches totaling about 3000 ha in the Nechako River Valley west of Vanderhoof to Fort Fraser in the western part of the region. This is similar to 1993, but down overall from 24 000 ha in 1992. Increased populations in the western part of the Prince Rupert Region severely defoliated aspen over about 7875 ha, for a second year north of Kitwanga in the Cranberry River Valley, near Telegraph Creek, southeast of Dease Lake, in the Iskut River Valley, and near Telkwa. Defoliation near Burns Lake in the eastern part of the region, adjacent to infestations in the western part of the Prince George Region, totalled about 150 ha.

Larval mortality from parasitism and disease averaged 55% at three sites in the Yukon Territory. Previous outbreaks usually collapsed due to parasitism after three years. This indicates a reduction of populations in 3- to 4-year-old infestations in 1995, but a continuance in newer infestations.

Satin Moth

Aspen, cottonwood, and willow in parts of the Kamloops and Nelson regions and for the first time in the Cariboo Region were defoliated by satin moth over 5350 ha in 127 separate areas in 1994, up from 3000 ha in 1993. Most were in the East Kootenay part of the Nelson Region over 4650 ha and the remainder in the southwestern part of the region, adjacent areas in the southeastern part of the Kamloops Region, and in the Chilcotin. Satin moth adults, but no larvae, were detected in Prince George Region for the first time. This is about 120 km north of active infestations.

Increasing populations in the northern part of the East Kootenay in the Nelson Region severely defoliated trembling aspen, particularly near Golden and in the Blaeberry River Valley in 23 patches totaling 4600 ha, up from 2650 ha last year, the second year of increase. Defoliation in the West Kootenay between Greenwood and Anarchist Mountain declined to mostly light over about 80 ha, down from 250 ha in 1993. Mortality of aspen severely defoliated since 1991 was widespread in stands totaling 360 ha between Anarchist Mountain and Greenwood.

Populations in the southeastern part of the Kamloops Region declined for a second consecutive year and lightly to moderately defoliated only three patches of trembling aspen totaling 170 ha, down from 250 ha last year. Increased populations defoliated aspen in 13 patches totaling 165 ha near Tatla Lake west of Williams Lake in the Cariboo Region. This is the first record of defoliation by the moth in this region, and about 150 km north of previously known population centers.

Moth flights indicating continuing populations occurred from Golden to Cranbrook, and for the first time on record in the Robson Valley in the Prince George Region from Valemount to McBride. Defoliation near Avola in the Kamloops Region south of Valemount in 1986 was previously the most northern recorded infestation.

Poplar Rusts

The poplar rust *M. medusae f.sp. deltoidae*, which is pathogenic to many hybrid poplar clones used in plantations but which has not yet caused measureable damage on native *P. trichocarpa*, was again found on hybrid poplars in the Fraser Valley and on Vancouver Island, where the rust was first found in British Columbia in 1993.

Damage in British Columbia plantations was severe on susceptible *P. trichocarpa x P. deltoids* (TXD) clones which were repeatedly defoliated. Commercial nurseries removed susceptible clones and replaced them with more resistant *P. trichocarpa X P. maximowiczii* hybrids. Mortality of susceptible clones has not yet been reported in British Columbia, but was reported last year in U.S. plantations where the rust has been established since 1991.

The Eurasian poplar rust, *Melampsora larici-populina*, discovered in Oregon and California in 1991 and in Washington state in 1993, is still not known to occur in Canada. Since its discovery on hybrid poplar (*P. trichocarpa x deltoides*) plantations on the lower Columbia River in Oregon and Washington, the rust has caused severe damage on susceptible hybrids, but has not yet spread to Canada.

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Forest Insect and Disease Survey

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UPDATE OF MAJOR FOREST PESTS IN 1994

by
James P. Brandt

Spruce budworm

In Alberta, areas of spruce budworm (*Choristoneura fumiferana* [Clem.]) defoliation occurred in the Peace River Region (114 335 ha), in the Athabasca and Lac La Biche forests (12 370 ha), and in the Alberta portion of Wood Buffalo National Park (64 639 ha).

In the Peace River Region, the main infestation included areas along the Zama ridge, near Sousa Creek, and adjacent to the Chinchaga River. Other infestations were along the Hay, Amber, Steen, and Yates rivers, north of Watt Mountain, along the Little Rapids Creek, and near Hawk Hills.

In the Athabasca and Lac La Biche forests, infestations occurred along the Athabasca and House rivers, and southwest of Algar Lake.

In Saskatchewan, the total area of white spruce-balsam fir forests defoliated was 52 339 ha. The defoliated areas occurred in the Prince Albert (5463 ha), Hudson Bay (28 783 ha), and La Ronge (18 093 ha) regions. New infestations were observed in Prince Albert National Park, near Pinehouse Lake, along the Smoothstone River, and north of Lac la Ronge.

In the Prince Albert Region, defoliation occurred in seven areas near Smoothstone, Beaupré, Doré, and Mirasty lakes; west of Hurtean Lake; northwest of Weyakwin; and in Prince Alberta National Park.

In the Hudson Bay Region, two major spruce budworm infestations remained active in 1994, one near Red Earth and the other near Hudson Bay. The infestation near Red Earth consisted of one area south of Highway 55. The Hudson Bay infestation consisted of three areas south and west of the townsite.

In the La Ronge Region, the infestation reported at Morin Lake near Lac la Ronge in 1993 increased in 1994 to include large areas of spruce forests between Morin, Besnard, and Egg lakes and Lac la Ronge. Other infestations were noted near Pinehouse Lake, along the Smoothstone River southeast of Pinehouse Lake, near Potato Lake, west of Wapawekka Lake, and at several locations north of Lac la Ronge near Iskwatikan, Hunt, Stroud, Sulphide, and Otter lakes.

In Manitoba, spruce budworm infestations occurred in four administrative sections: Interlake (4140 ha), Lake Winnipeg East (34 456 ha), Mountain (5946 ha), and Pineland (3995 ha). A total of 48 537 ha of white spruce and spruce–balsam fir forests were infested.

In the Interlake Section, infestations occurred on Moose Island, Deer Island, near Ebb and Flow Lake, near Moose Lake, and near Washow Bay in Management Unit 40. In Management Unit 41, an infestation was detected on an island in Lake St. George.

In the Lake Winnipeg East Section, defoliation was observed in Whiteshell Provincial Park in Management Unit 30. In Management Unit 31, defoliation was observed on the north side of Lac du Bonnet; near Long, Happy, Manigotagan, Quesnel, Oiseau, Garner, Gem, and Wanipigow lakes; near Sandy, Black, and O'Hanly rivers; and areas on the east side of Lake Winnipeg across from Black Island. Other areas of defoliation were observed in the area of Loon Bay on Lake Winnipeg in Management Unit 35.

In the Mountain Section, spruce budworm defoliation occurred near Davey, Cutbank, Little Island, Snake, Noses, and Drugstore lakes.

There were two main outbreak areas in the Pineland Section. One area was in Management Unit 23 on the south side of Lac du Bonnet between the Winnipeg River and the Pinawa Channel. The second area was in Management Unit 20 and was an extension of the infestation near Falcon Lake in the Lake Winnipeg East Section. Two other small infestations were observed north of the Boggy River.

In the Northwest Territories, the area of defoliation increased from 173 118 ha in 1993 to 370 270 ha in 1994. Main infestation areas occurred along the Slave River including areas within Wood Buffalo National Park; along the Taltson, Liard, North Nahanni, South Nahanni, Martin, Jean-Marie, Willowlake, and Mackenzie rivers; the southern slopes of the Horn Plateau; and the Ebbutt Hills. Some tree mortality was evident near the south end of the Kotaneelee River, along the Liard River south of Fort Liard, along the Mackenzie River, and on the Ebbutt and Martin hills.

Aspen Defoliators

In Alberta, aspen defoliation was caused by **forest tent caterpillar** (*Malacosoma disstria* Hbn.), **aspen leafroller** (*Pseudexentera oregonana* [Wlsm.]), and **large aspen tortrix** (*C. conflictana* [Wlk.]). Forest tent caterpillar defoliation occurred at five locations in the province (196 547 ha): north and south of Cooking Lake and in Elk Island National Park, the Peace River valley near the Peace River townsite, a few kilometres north of Guy along Highway 34, south of the Little Smoky River along Highway 34, and north of Jean Côté.

In the spring of 1994, aspen leafroller caused defoliation in the Peace River Region, and the Grande Prairie and Slave Lake forests. Most of this defoliation occurred along the Little Smoky River from just east of Highway 34 to the Smoky River confluence, and then along the Smoky River to the Peace River confluence. Additional areas of defoliation were observed along the Peace River north of the Peace River townsite and near Dunvegan. In these three areas about 72 616 ha of aspen were defoliated.

Large aspen tortrix caused defoliation at several locations in Alberta. The largest areas were located in Wood Buffalo National Park (6968 ha). Other locations were near Hinton and Sundre, and north of Peace River as well as around Red Earth Creek, where it caused defoliation in association with aspen leafroller.

In Saskatchewan, aspen defoliation was caused by large aspen tortrix and forest tent caterpillar. Large aspen tortrix defoliation (214 242 ha) occurred near Green Lake, in Meadow Lake Provincial Park and areas north, southwest of Meadow Lake, northeast of Chitek Lake, near Helene Lake, south of Red Earth Indian Reserve, north and south of Hudson Bay, and in Greenwater Provincial Park.

Forest tent caterpillar caused significant defoliation for the first time since the last outbreak collapsed in 1991. Defoliation occurred on 23 134 ha of trembling aspen in four areas south of Battleford.

In Manitoba, aspen defoliation totalled 11 396 ha in 1994. Forest tent caterpillar was responsible for this defoliation in the Interlake Section in Management Units 40 and 41, in the Lake Winnipeg East Section in Management Units 31 and 35, and in the Pineland Section in Management Unit 23. In Riding Mountain National Park, aspen twoleaf tier (*Enargia decolor* [Wlk.]) caused moderate-to-severe defoliation in several localized areas at the north end of the park.

Bark Beetles

Mountain pine beetle (*Dendroctonus ponderosae* Hopk.) infestations remained very low in the Northwest Region in 1994. Beetles were detected at several locations by means of pheromone-baited trap trees. Aerial and ground surveys also detected a few recent mountain pine beetle-killed lodgepole pine trees in Banff National Park. Surveys were concentrated in areas where dispersing beetles might invade including the foothills region in Alberta and Jasper, Banff, and Waterton Lakes national parks.

In 1994, aerial surveys were conducted over Banff and Jasper national parks to map areas of dead and dying lodgepole pine. Less than 20 recently killed trees were observed in the Bow River valley between the split in Highway 1A north to Corral Creek. Some trees were attacked in 1993; others had been strip attacked (attacked on only one side of the tree) in 1992 and then re-attacked in 1993, killing them. No mountain pine beetle-killed trees were observed in Jasper National Park.

During the winter of 1993–94 about 400 ha of dead white spruce were salvage-logged: 250 ha (70 831 m^3) near Nina Lake, and 150 ha (10 810 m^3) near Hawk Hills. These trees were killed by **spruce beetle** (*D. rufipennis* [Kby.]). More salvage cutting has been approved for the winter of 1994–95 amounting to 11 821 m^3 of spruce on about 80 ha in the Hawk Hills area. In Wood Buffalo National Park, scattered spruce beetle-killed white spruce trees were observed in six areas (13 655 ha) near the confluence of the Peace and Slave rivers, and along the Peace and Birch rivers.

Lodgepole Pine Dwarf Mistletoe

During 1994, surveys were conducted to map pine forests severely infected by lodgepole pine dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.). In Manitoba, most mistletoe infestations were mapped by Manitoba Natural Resources between 1986 and 1989. The distribution of severe infestations of dwarf mistletoe extends from southeastern Manitoba through central and northern Saskatchewan to Alberta. Jack pine is infected by this disease in Manitoba, Saskatchewan, and Alberta; lodgepole pine is infected in Alberta. In Alberta, 54 329 ha of lodgepole pine and 112 125 ha of jack pine forests are severely infected by dwarf mistletoe. In Saskatchewan and Manitoba, 123 982 and 12 000 ha of jack pine forests were infected by dwarf mistletoe, respectively.

Other Noteworthy Pests

The **spruce gall midge** (*Mayetiola piceae* [Felt]) infestation in northern Alberta and adjacent areas in the Northwest Territories first detected in 1992 continued in 1994. Moderate-to-severe infestations were located west of the Hay River north of the Meander River townsite, west of the Chinchaga River north and south of Highway 58, and near Beaver Ranch Creek. Light infestations occurred over most of the area from Wadlin Lake and Notikewin Provincial Park northwest and north into the Northwest Territories. The 1994 survey indicated that populations have decreased from levels observed in 1993.

Satin moth (*Leucoma salicis* [L.]) was discovered for the first time in Alberta in 1994. Defoliated trees were observed near the municipal airport in Edmonton in June. Subsequent surveys indicated defoliation was present at 47 sites north and south of the airport. Moths were distributed over a wider area from St. Albert to the Millwoods neighbourhood in southeast Edmonton.

FOREST INSECT AND DISEASE MANAGEMENT PROGRAMS

1994 SUMMARY REPORT

Alberta Land and Forest Services

1. HIGHLIGHTS

Eastern spruce budworm, *Choristoneura fumiferana* (Clemens), infestations in the province increased during this year, reversing the declining trend observed in 1993. There were four infestations covering an estimated 126,735 ha in the northern part of the province (Fig. 1).

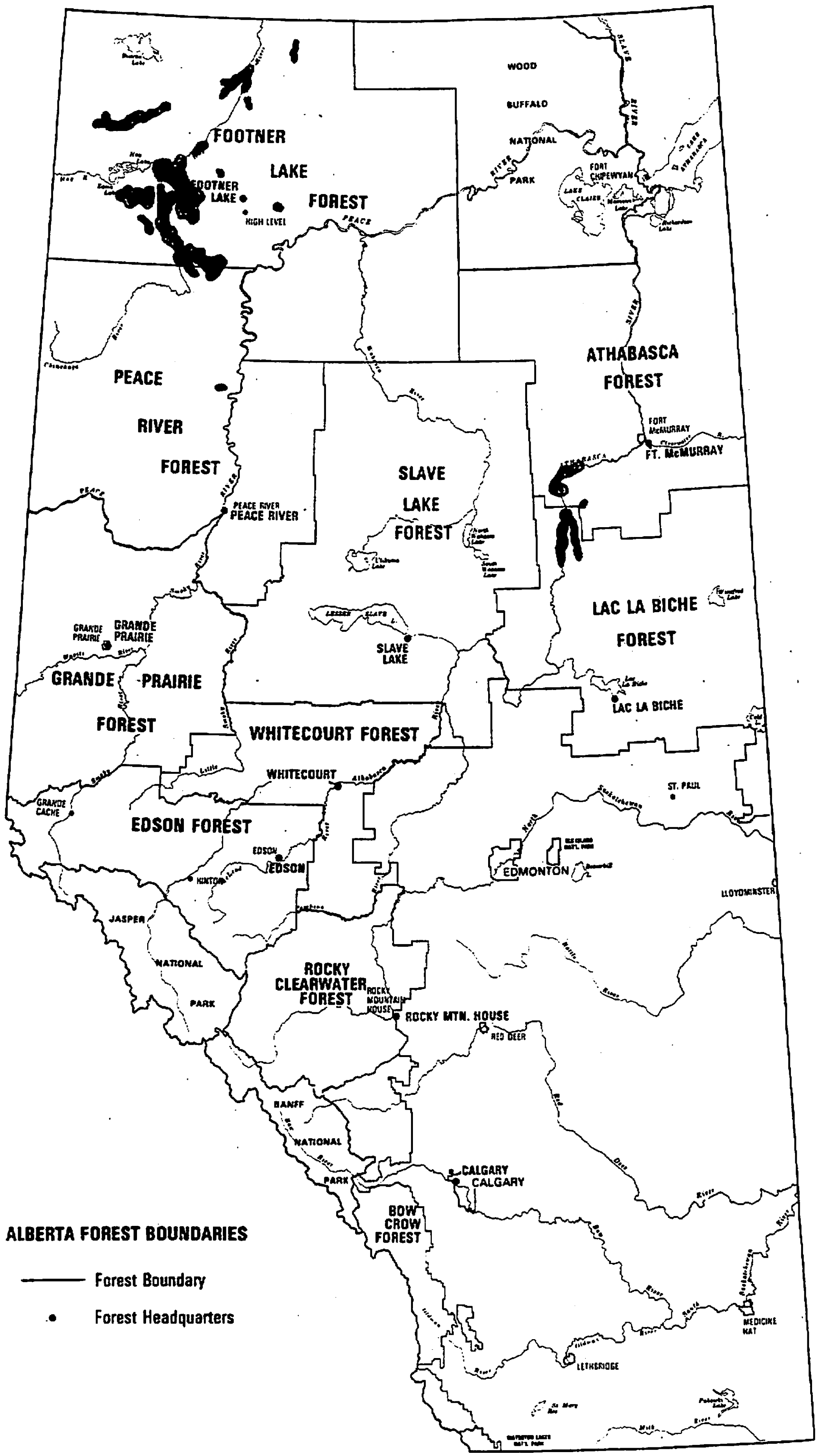
A water-based B.t.k. formulation (Foray 48B^{R}) was aerially sprayed over 14,253 ha of moderately to severely infested stands in the Footner Lake Forest in northwestern Alberta. The main objective of this spraying was to reduce the budworm population to a level that would keep the defoliation below 35%, i.e. light, in 1995.

Multipher-I type pheromone traps were deployed at 79 locations in non-defoliated, high budworm risk forest stands throughout the province. The data from these traps indicated outbreak level populations in the Peace River Region including the Footner Lake Forest in northwestern Alberta.

Mountain pine beetle populations were at their lowest level in recent years in southwestern Alberta where beetle activity is normally encountered. Only two sites in the Bow-Crow Forest had successful beetle attacks. However, in the Edson Forest, along the Alberta-British Columbia border, pheromone-baited trees at eight sites had beetle attacks and five of these sites had successful attacks.

Spruce beetle outbreak continued in northwestern Alberta where an estimated 1,350 ha were infested in the Peace River Forest. Spruce beetle indices calculated by using the Lindgren funnel trap catches indicated outbreak level populations at two monitoring locations in this forest. In the Footner Lake Forest, spruce beetle activity was less pronounced but still hovered around levels where green trees could get attacked.

Fig. 1 Spruce Budworm Infestations in Alberta, 1994



Several other surveys and impact assessment studies have been conducted in 1994 including regeneration pest surveys, white pine weevil survey and impact assessment, dwarf mistletoe survey and impact assessment, and armillaria root rot impact assessment.

2. SPRUCE BUDWORM

a) Aerial spraying of B.t.k.

Undiluted Foray $48B^R$ was sprayed over 14,253 ha of moderately to severely infested white spruce stands in the Footner Lake Forest by using small spray aircraft equipped with Micronair AU-4000 atomizer nozzles. Spraying was done when most of the budworms were in their late instars i.e. fourth instar or later, at the rate of 25.4 BIU/ha (2.0 litres per ha). B.t.k. was sprayed twice over 12,678 ha with a five day interval between the two sprays; in addition, 1,575 ha were sprayed once at the same rate. The objective of spraying was to reduce the populations to levels that would cause nil-light defoliation i.e., less than 35%, in 1995. Technical details of these sprays are given in Appendix I.

Budworm mortality caused by spraying was assessed by pre- and postspray sampling of 10 sprayed plots and two unsprayed check plots; one of the sprayed plots received only one spray. Budworm counts from two, 45 cm mid-crown branch tips from each of four sample trees per plot were recorded. Defoliation on 20 hand-picked shoots per branch tip was also recorded by using Fette's method.

Budworm counts were standardized by calculating the number of budworms per 10 m^2 of foliage. The average count of the budworms per tree before, and after spraying was used to calculate the percent budworm mortality observed in each tree; the mean of percent budworm mortalities in the four trees per plot was taken as the percent budworm mortality in that plot. The percent budworm mortality from each sprayed plot was corrected by using Abbott's formula which takes into account the percent budworm mortalities observed in the check plots.

The percent budworm mortality varied from moderate to high (55.0% - 93.6%) in the sprayed plots, and was moderate in the unsprayed check plots. The residual budworm populations in six plots sprayed twice were low i.e.,less than 120 budworms per 10 m^2 of foliage, while the residual budworm populations in the other three plots sprayed twice remained moderate. The residual budworm population in the plot sprayed once remained relatively high, despite a 46.2% spray efficacy observed in this plot. All the plots, irrespective of treatment, had severe (over 70%) defoliation.

Table 1. Pre- and postspray budworm population levels, budworm mortality and spray efficacy in the B.t.-sprayed plots and in the unsprayed check plot in the Footner Lake Forest, 1994.

Plot No.	Treatment	Budworm Population[1] Prespray	Postspray	Percent Mortality[2]	Spray Efficacy[3]
1	Sprayed twice	1,359	94	79.8	56.3
2	Sprayed twice	825	375	55.0	2.8
3	Sprayed twice	1,042	53	93.6	86.3
4	Sprayed twice	2,456	413	81.7	60.5
5	Sprayed twice	1,629	120	74.1	44.1
6	Sprayed twice	473	42	93.4	85.7
7	Sprayed twice	481	74	68.6	32.1
8	Sprayed twice	1,033	118	88.0	74.1
9	Sprayed twice	3,074	299	88.9	75.9
10	Sprayed once	2,084	518	75.1	46.2
11 and 12	Unsprayed check plots	1,586	670	53.7	n/a

[1] Spruce budworm count per 10 m^2 of foliage; average of 4 trees per plot.

[2] Percent mortality = {sum of (X - Y)/X * 100}/4 where X = Average prespray count per tree; Y = Average postspray count/tree.

[3] Spray efficacy calculated by using Abbott's formula on the percent mortality per plot.

b) Current Status of Spruce Budworm Infestations

Aerial surveys carried out by FIDS technicians, in collaboration with personnel from the relevant forests, showed a significant increase in area of spruce budworm-defoliated forest stands. These surveys also showed that forest stands sprayed with B.t. during the last two years had little or no defoliation. While budworm continued to defoliate some of the previously infested stands, most defoliation was found in new stands.

As predicted by the pheromone trap data collected in 1993, spruce budworm infestation in the Footner Lake Forest in northwestern Alberta increased. This infestation now covers an area with an estimated 111,735 ha of white spruce, a dramatic increase from the 46,000 ha infested in 1993. Similar resurgence of budworm was found in the stands sprayed in 1991 in the Peace River Forest in the same region where the infested area increased from an estimate 1,000 ha to 2,600 ha.

In northeastern Alberta, both new and resurging budworm infestations were observed along the Athabasca River. Here an estimated 3,400 ha in the Athabasca Forest and approximately 9,000 ha in the Lac La Biche Forest were moderately defoliated.

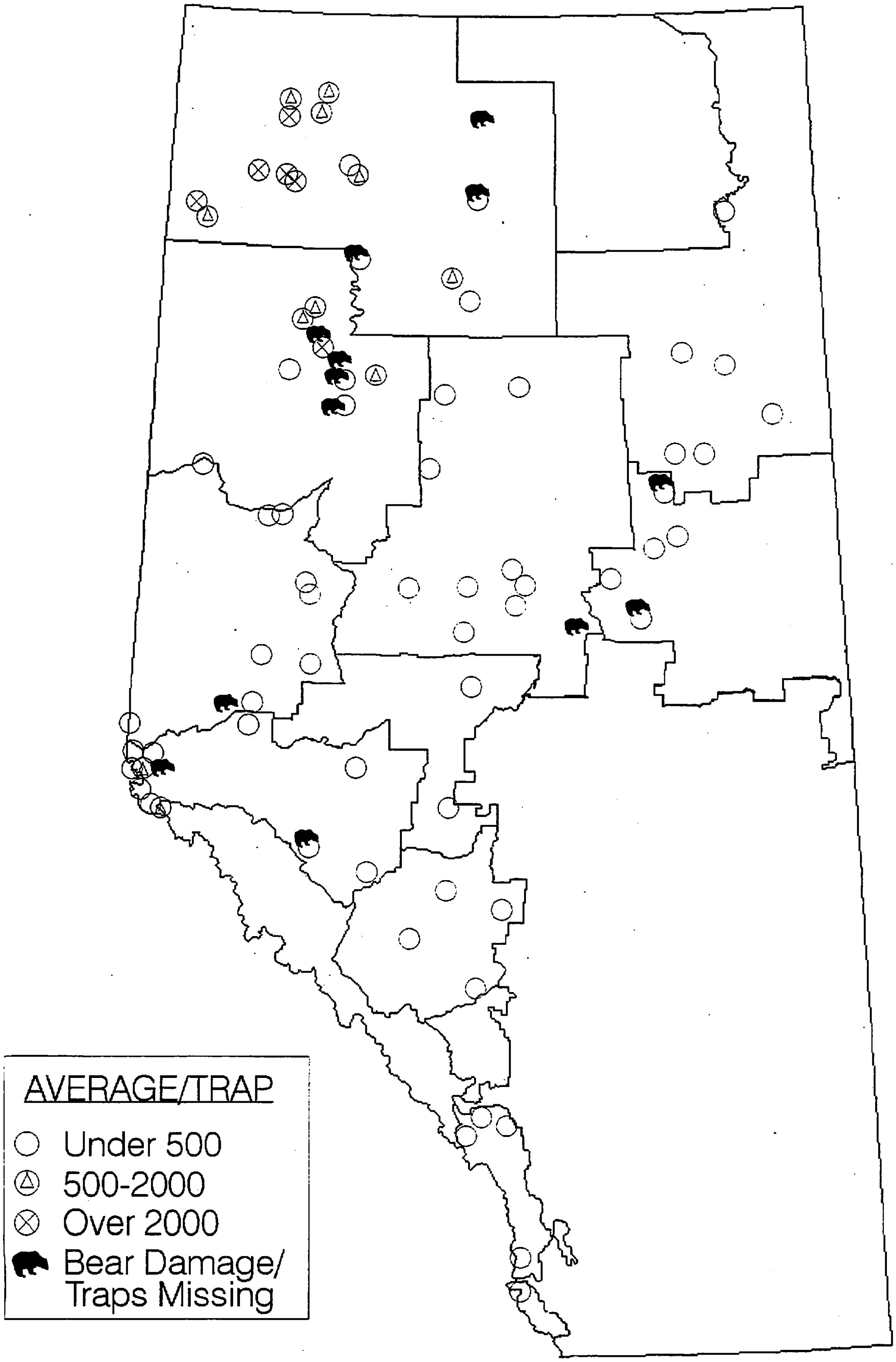
c) Future Outlook for Spruce Budworm Infestations in Alberta

Budworm populations in non-defoliated stands

Multipher-I type pheromone traps were set out at 79 sites throughout the province in non-defoliated, high budworm risk forest stands, to monitor spruce budworm moth activity. At each site, two traps were deployed in mid-June and collected in August.

High trap catches i.e., over 2,000 moths per trap, were recorded at six locations in northwestern Alberta indicating the potential continuation of the current budworm outbreak in this region. Moderate trap catches i.e., 500 - 2,000 moths per trap were found at eleven other locations throughout the province. Almost all the trap sites in northwestern Alberta had substantial increases in trap catches, compared to last year's catches, signalling the potential for expansion of the outbreaks. Trap catches were relatively low i.e., below 500 moths per trap, in the other parts of the province (Fig. 2).

Fig. 2 Spruce Budworm Moth Catches in Pheromone Traps, 1994



Budworm populations in the currently defoliated stands

Second instar budworm larval surveys (L2 survey) were carried out in currently defoliated areas and their vicinities in the Footner Lake, Athabasca and Lac La Biche Forests in northern Alberta. The objective of this survey was to predict the level of defoliation expected in these areas in 1995.

One mid-crown branch, 75 cm or longer, was collected from each of four sample trees per plot. Budworm larvae were extracted from these branch samples by using the "NaOH washing method". The counts were standardized by calculating the number of larvae per 10 m^2 of foliage area.

In the Footner Lake Forest, low second instar budworm counts which are expected to cause light defoliation in 1995 were found in nearly 90% of the sprayed plots. These data show that the spray program achieved its objective of reducing current population resulting in foliage protection in the following season.

About 70% of the unsprayed plots in the Footner Lake Forest had budworm larval counts indicative of moderate to severe i.e., 35%-100% defoliation in 1995. The other plots had budworm larval counts indicating light defoliation in 1995. Thus the budworm infestation in most of unsprayed areas in this forest is expected to continue in the same scale in 1995.

In the Athabasca Forest, based on the larval counts, moderate to severe budworm defoliation is expected in five plots representing about 70% of the infested area. The other two plots representing the remaining 30% of infestation are expected to have light defoliation in 1995.

In the Lac La Biche Forest, 60% of currently infested area i.e., three plots, are expected to have moderate defoliation and the remaining plots are expected to have light defoliation in 1995.

3. SPRUCE BEETLE

Lindgren funnel traps (8 funnel units) were deployed, two per site, at 16 sites located in four forests in northern Alberta. A three component bait was used. Traps were placed in mid-May, periodically checked to collect the beetles, and eventually collected in July-August.

Spruce beetle indices i.e., number of beetles per trap per trapping day, were calculated by using the counts in undisturbed traps. An index of 0.5 beetle per trap per trapping day is suppose to indicate beetle populations that attack live trees. An index over 0.5 is characteristic of the stands with beetle-killed trees (Cerezke, H.F., personal comm.).

In the Peace River Forest, beetle indices were over 0.5 in seven of the nine plots; and indices were at outbreak levels (over 2.5) at two of these locations. In this forest, 400 ha were salvaged in the spring of 1994. Currently 1,350 ha are infested by the spruce beetle. Additional 80 ha will be salvaged this winter. In the Footner Lake Forest, two plots had indices showing beetle populations capable of attacking live trees; the other two plots had counts indicative of endemic populations. Traps at both sites in the Athabasca Forest were damaged and were not included in the analysis.

4. MOUNTAIN PINE BEETLE

Two component pheromone baits were used to survey mountain pine beetle activity on mature lodgepole pines in three forests in western Alberta. Three trees located in an approximately 40 m triangle were baited in June, and checked periodically until September.

The declining trend of mountain pine beetle attacks continued in southwestern Alberta. In the 28 pheromone bait sites in the Bow-Crow Forest in southwestern Alberta, two sites had successful attacks and eleven other sites had unsuccessful attacks. There were no signs of beetle activity at the six sites in the Rocky-Clearwater Forest. Edson Forest monitored 26 pheromone-baited sites along the B.C. border. Trees at eight sites had numerous attacks and five of these sites had many successful attacks. (Fig. 3). All beetle infested trees were debarked or destroyed.

5. SATIN MOTH

An exotic pest, satin moth, *Leucoma salicis* (L.), was detected for the first time in Alberta in this summer. Since the initial discovery of this pest in north Edmonton, 47 defoliated sites and 81 moth sightings have been confirmed in the Edmonton and St. Albert area. It appears to be established in the area. This insect may become a serious defoliator of aspen in the provincial forested lands.

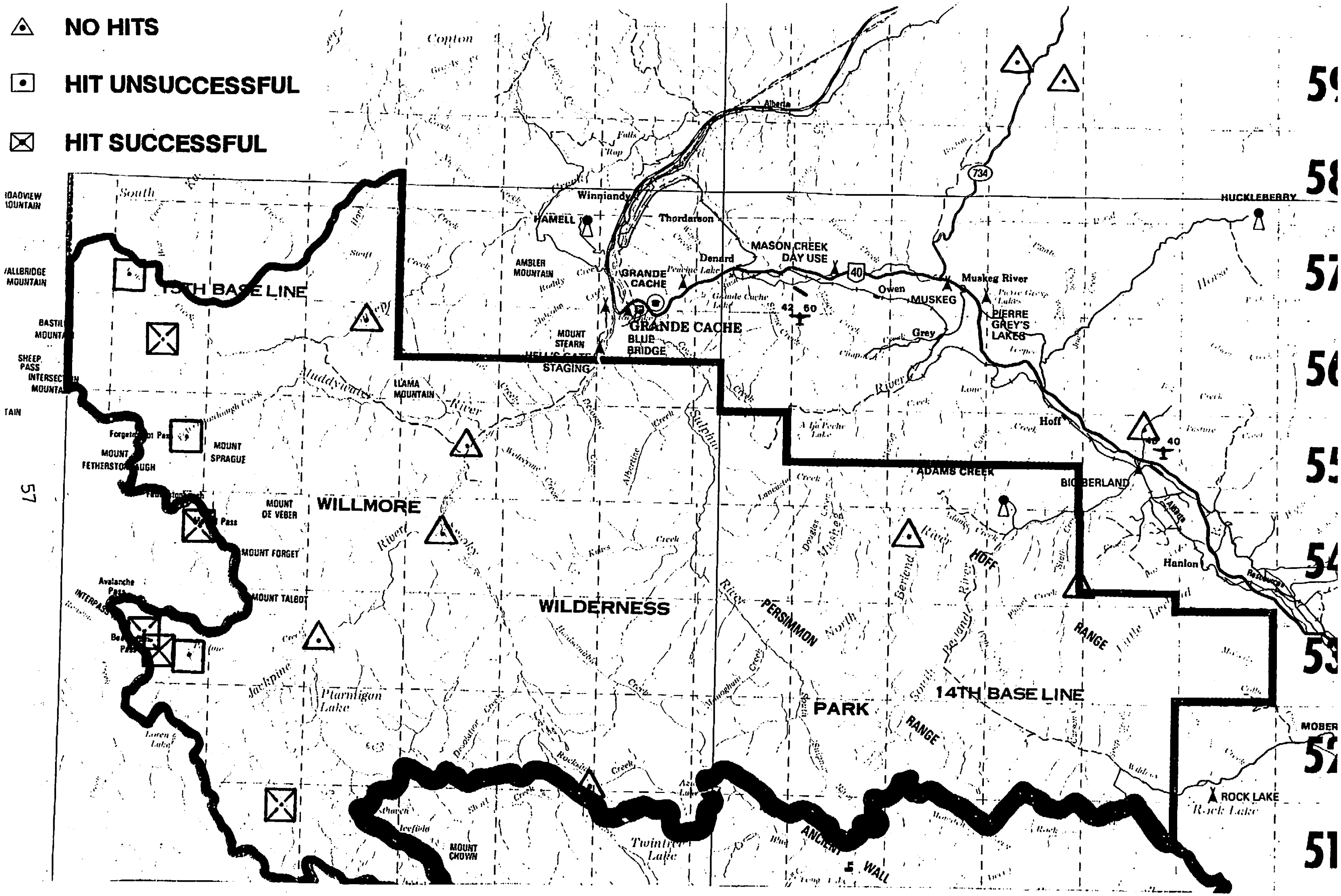


Fig. 3 Mountain Pine Beetle Pheromone Monitoring

1994

6. WHITE PINE WEEVIL

Rapidly increasing area of young white spruce blocks in Alberta (many planted) may lead to problems with this pest in the near future. Surveys to investigate the province-wide distribution of white pine weevil are currently planned with CFS.

A cooperative project with CFS is being planned to assess the impact of the weevil on height growth in an 11 year-old genetics plantation. Tree heights were assessed in 1993 and will be done again in 1998. Weevil attacks will be recorded each year until 1998.

7. DWARF MISTLETOE

A province-wide aerial survey was conducted jointly by LFS and CFS to identify areas of heavy dwarf mistletoe infection.

An in-house study on a 65 year-old jack pine stand near Slave Lake showed that:

- severely infected trees (Hawksworth rating 6) averaged 16.9 m in height versus 22.8 m for uninfected trees.
- severely infected trees (Hawksworth 5, 6) produced 4,442 potential germinant per tree versus 14,753 potential germinant for uninfected trees.
- dwarf mistletoe killed trees within 40 years of the initial infection.
- rate of progress (intensification) of the disease from each Hawksworth rating to the next, averages about 6-7 years.

The final part of the study (in conjunction with CFS) will be to assess the effect on volume.

8. DUTCH ELM DISEASE

The possible onset of Dutch elm disease (DED) in Alberta has been a concern over the recent past. The most likely source of an introduction would be the infested elm wood that is brought into the province as firewood. The volunteer firewood drop off bin at the Travel Alberta Information Centre in Lloydminster, a city bordering Saskatchewan, has collected a substantial amount of firewood this summer. In this bin, eight fresh cut elm logs were found including one with 17 bark beetle galleries. All infested logs were promptly destroyed. Firewood collecting bins at the Ports-of-Entry had a large volume of elm wood with the European elm bark beetles and their galleries.

It is only a matter of time before a DED infestation will be discovered in Alberta.

9. NEEDLE CAST

Severe needle cast, *Lophodermella concolor* (Dearn.) Darker, infection was found throughout southwestern Alberta in the Bow-Crow Forest. Tree mortality was observed in areas that have been infected for the last several years.

10. ARMILLARIA ROOT ROT

Permanent sample plots have been established in lodgepole pine regenerating blocks in Whitecourt Forest to assess the impact of *Armillaria* on stocking. We plan to establish permanent sample plots in other Forests to monitor locally important pests. Results from Whitecourt show that, over the past four years, *Armillaria* has reduced stocking levels from 2100 to 1725, and from 1780 to 1170 stems per hectare in two sample plots.

11. REGENERATION SURVEYS

The first phase of a two-year pilot project in cooperation with Weyerhauser Canada was completed. The project investigated the collection of structured pest information, i.e. on a plot-by-plot basis, as part of the Establishment Survey (5-8 years after harvest) and Performance Survey (8-14 years after harvest) in lodgepole pine regenerating blocks.

Results showed that:

- no extra time was required to collect information on five high-priority pests
- quality control checks showed that all identifications and recordings were correctly done.

The second phase of the study, beginning in 1995, will be conducted in white spruce regeneration.

FOREST PESTS IN MANITOBA - 1994

PREPARED FOR THE
22nd ANNUAL FOREST PEST CONTROL FORUM
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OTTAWA

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Spruce Budworm

The spruce budworm, *Choristoneura fumiferana*, infestation in Manitoba increased in size in 1994 to approximately 48,537 ha. Approximately 42,600 ha of white spruce and balsam fir, (*Picea glauca* and *Abies balsamea*); forest suffered moderate to severe defoliation within the Pine Falls Paper Co. Forest Management License, Nopiming, Whiteshell, and Hecla Island Provincial Parks and the Moose Creek Provincial Forest. A previously small, localized infestation in Duck Mountain Provincial Forest in western Manitoba increased from 1500 ha in 1993 to 5,946 ha in 1994.

Based on defoliation predictions derived from the 1993 egg mass surveys a small scale budworm suppression program was implemented in 1994. The 1993 egg mass survey indicated that there would be light to moderate defoliation in much of the Pine Falls Paper Co. Forest Management License and Nopiming Provincial Park. Light defoliation was expected in Whiteshell Provincial Park, with the exception of the Big Whiteshell Lake area, where moderate to severe defoliation levels persisted. There was also indications that localized "hot spots" of severe defoliation would continue over much of the outbreak area. Hazard ratings done in the Duck Mountain infestation in 1993 indicated that defoliation would expand and reach severe levels in some stands. Harvesting was redirected in these areas in 1994.

Spruce budworm - 1994 Aerial Spray Program

A small scale insecticide treatment was conducted over 411.6 ha in eastern Manitoba in 1994. Two stands of predominantly white spruce, one in the Dorothy Lake area of Whiteshell Provincial Park and the other in the Garner Lake area of Nopiming Provincial Park, were treated aerially with Mimic flowable insecticide (RH-5992). In each stand, two blocks of approximately 100 ha each were treated with one or two applications at 70 grams a.i./ha per application. The product was applied with water providing an application volume of 2.0 litres per hectare (total solution). Mimic made up 290 ml per litre of solution and rhodamine "B" dye was added for assessment of spray droplets. Product was applied using a Cessna 188 Ag-Truck at a swath width of 40 m using four AU4000 rotary atomizers.

The program was designed to suppress the overall larval budworm population rather than to concentrate strictly on foliage protection and to test the efficacy of Mimic. First applications were made when white spruce development had reached Auger's class 4. This corresponded to approximately peak 5th instar larval development. Second applications were made within 48 hours of the first applications. Average budworm larval numbers per 45 cm branch sample ranged from 15.5 to 36 at pre-spray. Each plot consisted of 12 mature white spruce trees and sampling consisted of the removal of two 45 cm branch tips at mid-crown per tree to assess larval mortality, defoliation and egg mass numbers.

Tables 1 and 2 show that overall the double application was very successful in reducing larval numbers at both locations (94% at Garner and 81% at Dorothy Lake - Corrected mortality).

TABLE 1: Spruce budworm - percent reduction in larval numbers.

LOCATION AND APPLICATION	# LARVAE PER 45 CM BRANCH (AVERAGE)		% REDUCTION
	PRE-SPRAY	POST-SPRAY	
SINGLE APPLICATION			
GARNER LAKE			
PLOT 5	26.3	5.1	80.6
PLOT 6	20.6	7.5	63.6
PLOT 7	9.6	2.5	73.9
PLOT 8	7.1	3.9	45.1
DOROTHY LAKE			
PLOT 11	36.9	11.7	68.3
PLOT 12	20.6	7.5	63.6
PLOT 13	31.3	8.4	73.2
PLOT 14	24.2	7.9	67.4
PLOT 15	25.4	5.1	79.9
DOUBLE APPLICATION			
GARNER LAKE			
PLOT 1	30.7	1.4	95.4
PLOT 2	32.7	1.0	96.9
PLOT 3	45.7	1.3	97.1
PLOT 4	35.0	0.3	99.1
DOROTHY LAKE			
PLOT 6	17.4	2.5	85.6
PLOT 7	18.9	0.4	97.9
PLOT 8	11.5	2.1	81.7
PLOT 9	15.1	0.5	96.7
PLOT 10	14.7	0.3	97.9

The single application provided approximately 31% corrected mortality in both spray locations. Tables 3 and 4 indicate that some degree of foliage protection was achieved at both locations, even with applications aimed at mid 5th instar larvae. Population suppression with both single and double applications was also evident, as egg mass densities were only half of those recorded in untreated areas. A more detailed report on the Mimic trials is available from Forestry Branch, Manitoba Natural Resources.

TABLE 2: Spruce budworm - average percent larval mortality by block.

LOCATION	UNTREATED BLOCK	SINGLE APPLICATION	DOUBLE APPLICATION
UNCORRECTED			
GARNER LAKE	50.7%	65.8%	97.1%
DOROTHY LAKE	56.9%	70.5%	91.9%
CORRECTED MORTALITY*			
GARNER LAKE	-	30.6%	94.1%
DOROTHY LAKE	-	31.5%	81.2%

* Abbott's Formula

Egg mass surveys to predict 1995 defoliation on a province-wide basis indicated that moderate defoliation is predicted for the Davey Lake areas of Duck Mountain Provincial Park and moderate to severe defoliation is predicted for much of the Pine Falls Paper Co. Forest Management License. Moderate defoliation is predicted for much of Nopiming Provincial Park and severe defoliation is predicted for parts of the Whiteshell Provincial Park.

Jack Pine Budworm

Populations of jack pine budworm, *Choristoneura pinus*, in Manitoba, have continued to remain at endemic levels throughout Manitoba's jack pine (*Pinus banksiana*) forests. Adult jack pine budworm males have been monitored with pheromone baited traps since 1985. This trapping method is being evaluated as an early warning method for outbreaks and a supplemental technique to branch collecting and egg mass prediction of population levels.

Twelve locations across Manitoba are being monitored with pheromone traps. Since 1989, two trap types, Pherocon 1C and Multipher, have been field tested for capture efficiency using a 0.03 microgram concentration of pheromone lure.

TABLE 3: Spruce budworm - percent defoliation and egg masses counts.

LOCATION AND APPLICATION	TREATED PLOTS % DEFOLIATION	TREATED PLOTS EGG MASSES/$10m^2$	1995 DEFOLIATION PREDICTIONS
SINGLE APPL.			
GARNER LAKE			
PLOT 5	75	209	MODERATE
PLOT 6	62	540	SEVERE
PLOT 7	16	64	MODERATE
PLOT 8	39	83	MODERATE
DOROTHY LAKE			
PLOT 11	17	180	MODERATE
PLOT 12	72	82	MODERATE
PLOT 13	62	429	SEVERE
PLOT 14	61	203	MODERATE
PLOT 15	79	128	MODERATE
DOUBLE APPL.			
GARNER LAKE			
PLOT 1	33	234	SEVERE
PLOT 2	36	291	SEVERE
PLOT 3	47	182	MODERATE
PLOT 4	51	131	MODERATE
DOROTHY LAKE			
PLOT 6	19	7	LIGHT
PLOT 7	47	27	LIGHT
PLOT 8	87	134	MODERATE
PLOT 9	15	7	LIGHT
PLOT 10	27	154	MODERATE

TABLE 4: Spruce budworm - average defoliation and egg mass numbers.

LOCATION AND APPLICATIONS	UNTREATED % DEFOLIATION	TREATED % DEFOLIATION	UNTREATED NUMBER OF EGG MASSES/10 m^2	TREATED NUMBER OF EGG MASSES/10m^2
SINGLE APPLICATION				
GARNER LAKE	48	48	455	224
DOROTHY LAKE	70	58	456	204
DOUBLE APPLICATION				
GARNER LAKE	48	42	455	209
DOROTHY LAKE	70	40	456	66

Jack Pine Budworm - continued

Preliminary analysis indicates the Pherocon trap to be more effective in attracting adult male moths during endemic population levels. In 1994, the total number of male moths marginally decreased across the province (Table 5).

TABLE 5: Jack pine budworm - total male moths caught in the two trap types.

TRAP TYPE	YEAR									
	1985	'86	'87	'88	'89	'90	'91	'92	'93	'94
Pherocon 1C	2060	419	229	323	391	179	73	160	241	187
Multipher					59	47	34	106	33	39

Jack pine budworm larvae feed on male pollen cones before consuming the new foliage. Current research has suggested a relationship between the presence of pollen and level of larval survival. From branches collected in the fall, the number of staminate buds present can reliably estimate the level of male flowering that will occur the following spring. Since the last outbreak in 1985, the level of flowering has fluctuated each year (Table 6).

TABLE 6: Jack pine budworm - estimated levels of jack pine male flowering averaged over the 12 trap locations.

	1986	1987	1988	1989	1990	1991	1992	1993	1994
% staminate buds	4	9	15	72	26	37	61	47	77

Since 1986, there has been no defoliation or egg masses found on the branches collected at each of the 12 sites. Results from 29 provincial permanent sample plots, where only defoliation and egg mass assessment are made, have shown the same trends with the exception of light defoliation and low egg mass numbers occurring in one Sandilands plot in 1989. Assessments for egg mass numbers, defoliation and male staminate buds on the 1994 branches are continuing.

Western Gall Rust Resistant Jack Pine Study

Western gall rust, (*Endocronartium harknessi*) is a major disease affecting jack pine in Manitoba. Resistance to western gall rust has been incorporated into the ongoing jack pine breeding program of the Eastern Breeding District. As part of cooperative project between Canadian Forest Service and Manitoba Natural Resources, Forest Protection demonstrated that the superior families ranged from very rust resistant to very rust susceptible. Reliable methods for inoculating and rating young jack pine seedlings for susceptibility to western gall rust were also developed.

Inheritance of western gall rust resistance from parent to progeny is now being investigated. Controlled crosses between rust resistant and rust susceptible families have been performed at the four Eastern Breeding District family test plantations. Sixteen crosses were performed in 1992. Seed from the crosses and four resistant and four susceptible trees were sown and inoculated with active Sandilands spores. Results from all the inoculation trials could indicate whether inheritance of resistance to western gall rust can come from one or both parent trees.

Since 1993, seedlings exhibiting no infection symptoms after inoculation have been outplanted in two areas with high levels of western gall rust activity. These outplanted seedlings are being monitored for latent gall formations at the inoculation site as well as for naturally occurring gall rust infections from the surrounding spore sources. Several seedlings have developed galls at the inoculation site one year after outplanting.

Permanent Silvicultural Plot Pest Impact Program

Since 1986, the Silviculture Section of the Manitoba Forestry Branch has established Regeneration Performance Assessment plots in recently established plantations of the major tree species. Plots are maintained by species and differentiated by planting technique and site preparation method. Forest Protection began a survey regime in 1990, within the Silvicultural plots, to assess the seedlings for pest damage and occurrence and relate these to tree growth and vigour. The trees are assessed every 3 years until age 21.

In 1994, a second pest assessment was conducted on the 1988 permanent silvicultural plots (PSP's) and some from 1987. These included 5 plantations or 68 PSP plots with white spruce, black spruce, (*Picea mariana*); and jack pine. Data from this sampling program is being entered into the recently developed MNR, Forest Protection - Forest Pest Survey System. Preliminary analysis of the combined first assessment for the 1986, 1987, and 1988 plantations was completed. Over 7,000 seedlings were examined. Eighty percent of these seedlings were healthy, and less than 20 percent mortality occurred by the age of 4 years. Of the 7,000 seedlings assessed, approximately half had some type of damage present. The crown and terminal areas of the tree had the most damage, whereas the stem and root areas had considerably less. Animals and frost were the major cause of injury to the crown and terminal. Many other pests were present, but in low numbers.

<u>Other Forest Tree Diseases</u>

The dwarf mistletoe, (*Arceuthobium americanum* Nutall ex Englemann); research project on jack pine, (*Pinus banksiana* Lamb); consists of 60 permanent sample plots within three different regions of the province. Plot assessments include tree vigor, growth measurements, severity of infection, mistletoe spread rates, tree mortality and sanitation treatments. In 1994, the Interlake and Northern region plots were assessed. Some of the mature plots (approximately 75 years old) have reached the point where mistletoe is now causing large volume losses. Four plots, which had essentially no mortality at the time of establishment in 1985, now have accumulated mortality, over the 10 year period, of 18%, 23%, 46% and 59%.

The impact of the tip dieback condition in red pine, (*Pinus resinosa*); thought to be caused by *Rhizosphaera kalkhoffii*, is being monitored in 38, 25 and 10 year old plantations. The level of infection has remained consistent in the 25 and 38 year old plantations since the time of plot initiation. In the 38 year old plantation in Sandilands Provincial Forest, infection levels have remained in the 41% to 47% range over a five year period. Infection rates in the 25 year old plantation in Belair Provincial Forest remain at approximately 25% over a two year period. In the 10 year old plantation in Agassiz Provincial Forest infection has increased from 55% to 66% between 1993 and 1994. Despite mortality being almost non existent, there is a substantial impact on growth and tree form.

Stem cankering of both red and jack pine has being monitored in Sandilands Provincial Forest since 1990. The cankering is caused by *Sphaeropsis pinea* or *Ceratocystis minor*. In the jack pine plots, the incidence of canker has increased from 34% to 60% over the five year period, while tree mortality has increased from 0% to 8.6%. Trends are similar in the red pine where canker incidence has increased from 39% to 56% and mortality from 0% to 5.5%.

Tree mortality due to Armillaria root rot, (*Armillaria ostoyae*); has been monitored in red pine plantations in Belair Provincial Forest since 1983. By 1992 cumulative mortality peaked in five permanent sample plots and has remained the same since that time. Mortality in the five plots is 46%, 36%, 19%, 15% and 21%.

Dutch Elm Disease

The objective of the Dutch elm disease (DED) program is to manage the loss of high value urban trees at less than 3% annually (Table 7). The DED program uses an integrated approach to minimize the effects of DED on Manitoba's urban forests.

The annual DED surveillance program commenced in June of 1994. This survey program encompassed 33 cost sharing communities as well as 7 buffer zone municipalities around selected towns and cities and the City of Winnipeg. Under the terms of the provincial program, the Province of Manitoba and the communities cost share DED control activities such as sanitation pruning, basal spraying with chlorpyrifos and replacement planting.

The province is responsible for the survey of diseased and dead elm trees within cost sharing agreement communities, except the City of Winnipeg. The province is also responsible for removal of infected elms from all cost sharing communities except those of Brandon and Winnipeg.

The range of the disease remained similar to 1993 extending from the Manitoba-Ontario border into Saskatchewan and northward to the Town of Swan River.

During the 1994 provincial survey (June - September 1994), 6,572 elms were marked for removal. Of this total, 295 were field diagnosed as having DED while the remaining were classified as hazards i.e. decadent to the point that they were capable of supporting elm bark beetle breeding activity. In the City of Winnipeg, 4,785 were slated for removal, 1,022 of which were diagnosed as having DED and the remaining classified as hazards. Other major urban centres with disease included Brandon, Portage la Prairie, Morden, Winkler, Dauphin, Steinbach and Selkirk.

River areas continue to have high levels of DED, especially along the Red and Assiniboine Rivers. The Boyne River near Carman and the Souris River in southwestern Manitoba remain extensively infected. Overall, elms marked for removal increased slightly over 1993.

From April 1, 1993 to March 31, 1994 the Provincial DED Sanitation crews removed 6,254 diseased and hazard elms; the City of Winnipeg removed approximately 4,300 in 1993 and the City of Brandon removed 178.

The major vector of Dutch Elm Disease in Manitoba is the native elm bark beetle (*Hylurgopinus rufipes*). However, the more aggressive smaller European elm bark beetle (*Scolytus multistriatus*), has been found in small numbers in the City of Winnipeg, since 1975.

Eight pheromone trapping locations were established across southern Manitoba, in 1982, to monitor the population and distribution of *S. multistriatus* . Two specimens were captured in rural Manitoba, in 1989, but none have been collected since.

TABLE 7: Summary of the impact of DED on Manitoba's urban elm resource.

LOCATION	# ELMS 1975[1]	# ELMS 1990	# ELMS 1994	% TOTAL LOSS TO 1994	% LOSS PER YEAR SINCE 1994[2]
MANITOBA[3]	166,460	97,314	90,112	27.9	2.6
WINNIPEG	275,000	80,651	160,417	41.7	2.8

1. Number of elms in inventories of towns and cities in 1975. Consists primarily of street, park and private property elms and does not include most elms in semi-wild areas of communities e.g. river banks.
2. Mean annual loss of elms - see Westwood (1991)
3. Represents the inventory of 28 of the provinces 33 cost-shared communities active in DED management. Accurate elm inventories for the remaining 16 communities were not developed until the late eighties.

1994 Renewed Forest Pest Survey

A Renewed Forest Pest Survey (RFPS) was implemented in 1987 to determine occurrence and distribution of major pests causing main stem deformity, growth loss and/or mortality in high-value renewed stands. The survey has detected a number of pests which are significantly impacting renewed forest stands. Preventative measures and treatments are prescribed where possible to reduce losses.

In 1994, RFPS stands were selected from the Northeast region's stand renewal records. The records were sorted by location, 5 year age class, species, renewal method, and stand tending. Stands representing each category were randomly selected. Twenty renewed stands totalling 617.3 ha and ranging from 6 to 21 years old were surveyed (Table 8). Three black spruce plantations (93.2 ha) were surveyed. The remaining 17 stands (524.1 ha) were usually mixed jack pine, black spruce and trembling aspen sites, naturally regenerated after chain scarification.

Armillaria root disease was found primarily affecting jack pine and to a lesser degree black spruce. Weevil killed trees occurred individually scattered throughout the stand or in larger pockets. Warren root collar weevil is often found occurring in combination with Armillaria. Thinning in these stands is not recommended as losses may increase over time.

Table 8: Number of surveyed stands affected (total of 20 stands = 617 ha surveyed).

Pest Problem[1]	1970-74[2]	1975-79	1980-84	1985-89
1. Armillaria root rot	1		2	
2. Competition			1	1
3. Dwarf Mistletoe		2		
4. Planting Problems				2
5. Rabbit	3			
6. Warren Root Collar Weevil		4	1	
7. Western Gall Rust	1			
8. White Pine Weevil			2	2

1. = 1. *Armillaria ostoyae*, 3. *Arceuthobium americanum*, 5. *Lepus americanus*, 6. *Hylobius warreni*, 7. *Endocronartium harknessii*, and 8. *Pissodes strobi*
2. = Renewed forest period of origin.

The density in the renewed jack pine stands infected with dwarf mistletoe has been impacted by the disease in several ways. Prior to harvesting, the stands had large pockets of mortality due to mistletoe infection. Seedling regeneration within these pockets was poor. The sites were harvested and allowed to regenerate naturally with no regard for managing the extensive dwarf mistletoe infections. Extensive edge infection along the cutblock boundaries and infection from many infected residual trees scattered throughout is causing some growth loss and mortality in the renewed stands. Due to the level of infection in these stands volume will likely be reduced at maturity. The Dwarf Mistletoe Loss Simulator Model will be utilized to determine volume loss over time in these stands.

Planting problems included j-rooting and intact paperpots which is causing very restricted root system development in the black spruce plantations. Often there is only one main lateral root which may make the trees subject to lean following heavy wind or snow.

White pine weevils appear to be increasing in recent years, particularly in the open growing black spruce plantations. They can cause significant growth loss and deformity in jack pine, black and white spruce. Black spruce appears to be the preferred host in the Northern region. These weevils tend to intensify in thinned, open growing stands especially where there is little hardwood cover. There are hundreds of hectares of weevil-susceptible renewed stands within the 10 to 20 year old range in the Northern region. Thinning and releasing of weevil susceptible stands should be approached with caution. The degree to which the hardwood cover should be removed when releasing a stand with herbicides should be considered to avoid increasing the weevil population on the site.

The Warren root collar weevil tended to occur on well-drained sites which had a thin layer of moist organic soil over rock. Jack pine and occasionally black spruce were girdled at the root collar area. This pest will impact pure jack pine plantations to a much greater degree than mixed stands. In most cases, weevil related mortality tended to occur in portions of the stand, but there were several cases where the damage was prevalent throughout. Weevils tend to remain on a site if conditions are favourable, intensifying the damage over time. Feeding wounds on older trees reduce growth and provides entrance for secondary pathogens. Thinning in stands infested with this weevil is not recommended as stocking density will be impacted throughout the life of the stand.

Pest Specific Assessments

Intensive follow up assessments were initiated in 1994 in the Belair Provincial Forest to determine the extent of damage or infestation in young stands identified by the Renewed Forest Pest Survey as having high pest infestation levels. Crews followed parallel compassed survey lines spaced 50 meters apart in a 70 hectare red pine plantation infested with Armillaria root rot, *Armillaria ostoyae*. Crews recorded the start and end position of each infection centre that intercepted their cruise line. The percentage area infected, 13.6%, was calculated by dividing total length of lines by total length of infection centres intercepted. Two similar assessments (survey lines spaced 25 meters apart) were conducted in two red pine plantations identified as having high levels of a tip dieback, suspected to be *Rhizosphaera kalkoffii*. Symptoms within the disease centres included growth loss (leader kill), deformity (main stem taper, stunting, loss of main stem dominance) and death in extreme cases. Percentage area affected was 8.1% and 17.5% respectively.

A similar pre-harvest assessment was conducted in an overmature, site 2 jack pine stand in the Sandilands Provincial Forest that had high levels of Armillaria root rot infection. Cruise lines were spaced 50 meters apart. There are several stands, which are in similar condition, which are identified in the Eastern Region's harvesting plans. Regional staff are interested in having the disease centres mapped and in knowing the extent of the infection for future reference. Forest Protection staff will do a follow-up survey after the site has been renewed to determine the activity of the disease, and to determine possible preventative strategies to minimize losses.

Vegetation Management

TABLE 9: 1994 Herbicide application summary in Manitoba.

USER	Purpose	Method	Product	Rate l/ha	Water l/ha.	Area treated (ha.)
MNR Forestry	Site prep.	Ground - Forcan 500	Velpar L	32.0	448.0	170
MNR Forestry	Release	Aerial - Fixed wing	Vision	5.0	30.0	1044
MNR Forestry	Site prep.	Ground - boom	Vision	2.5	110.0	291
Repap Manitoba	Release	Aerial - fixed wing	Vision	5.0	30.0	233
Abitibi Price Inc.	Site Prep.	Ground	Vision	2.5	110.0	340
Total						2,078

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SPRUCE BUDWORM AND GYPSY MOTH IN ONTARIO, 1994[1]

- Outbreak Status 1994
- Forecasts 1995
- Spraying Operations 1994

by

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1. Report prepared for the 22nd Annual Forest Pest Control Forum, Ottawa, November 15-17, 1994.

2. Natural Resources Canada, Canadian Forest Service - Ontario Region, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario.

3. Ontario Ministry of Natural Resources, Provincial Operations Branch, Sault Ste. Marie, Ontario.

SPRUCE BUDWORM

Outbreak Status 1994:

There was a large decline in the area of moderate-to-severe defoliation in 1994. A total of 4,266,656 ha was mapped by ground and aerial surveys compared with 8,991,177 ha in 1993. Most of the decline occurred in the Northwest Region, east of Lake Nipigon in the Nipigon and Geraldton districts. Here the infestation resulted in many small pockets of defoliation (Fig. 1). Moderate-to-severe defoliation in 1994 totaled 378,464 ha in the Nipigon District and 96,655 ha in the Geraldton District, compared with 1993 totals of 1,560,477 and 1,296,783 ha, respectively, (Table 1). Significant declines were also recorded in the Dryden, Kenora, Red Lake, Sioux Lookout, and Thunder Bay districts while an increase was recorded in the Fort Frances District. The intensity of defoliation also decreased with moderate rather than severe levels recorded in large areas of the Sioux Lookout, Kenora, and Dryden districts.

In the Northeast Region, the area of moderate-to-severe defoliation declined drastically in the Hearst and Wawa districts where large areas of contiguous defoliation broke up into numerous small patches. No defoliation was recorded in areas previously infested in the former Moosonee District, which is now part of the Cochrane District.

In the Central Region, infestations around the city of Sault Ste. Marie, in the Sault Ste. Marie District, declined. A number of small pockets of infestation in the vicinity of Warren on the Sudbury-North Bay district boundary merged to form one larger body of damage totaling 47,315 ha. Seven small patches totaling 3,030 ha were mapped between Gore Bay and Lake Manitou on Manitoulin Island. An infestation that caused moderate-to-severe defoliation on 20,405 ha in four townships in the northwest corner of the Algonquin Park District in 1993, increased to 57,505 ha in nine townships in 1994.

In the Southern Region, infestations in white spruce plantations in the Kemptville District increased from 85 to 570 ha and in the Midhurst District from 17 to 97 ha. A small, 20-ha white spruce plantation was moderately defoliated in the Cambridge District.

In 1994, the gross area of spruce budworm-associated tree mortality in Ontario increased to a total of 7,783,336 ha, compared to 5,032,925 ha in 1993. The largest increases occurred in the districts of Dryden, Kenora, Red Lake, and Sioux Lookout.

Forecasts 1995:

The results of egg-mass surveys (Table 2) overall indicate little change to be expected in 1995. The extent of tree mortality will likely increase considerably accompanied by population declines in the Northwest Region.

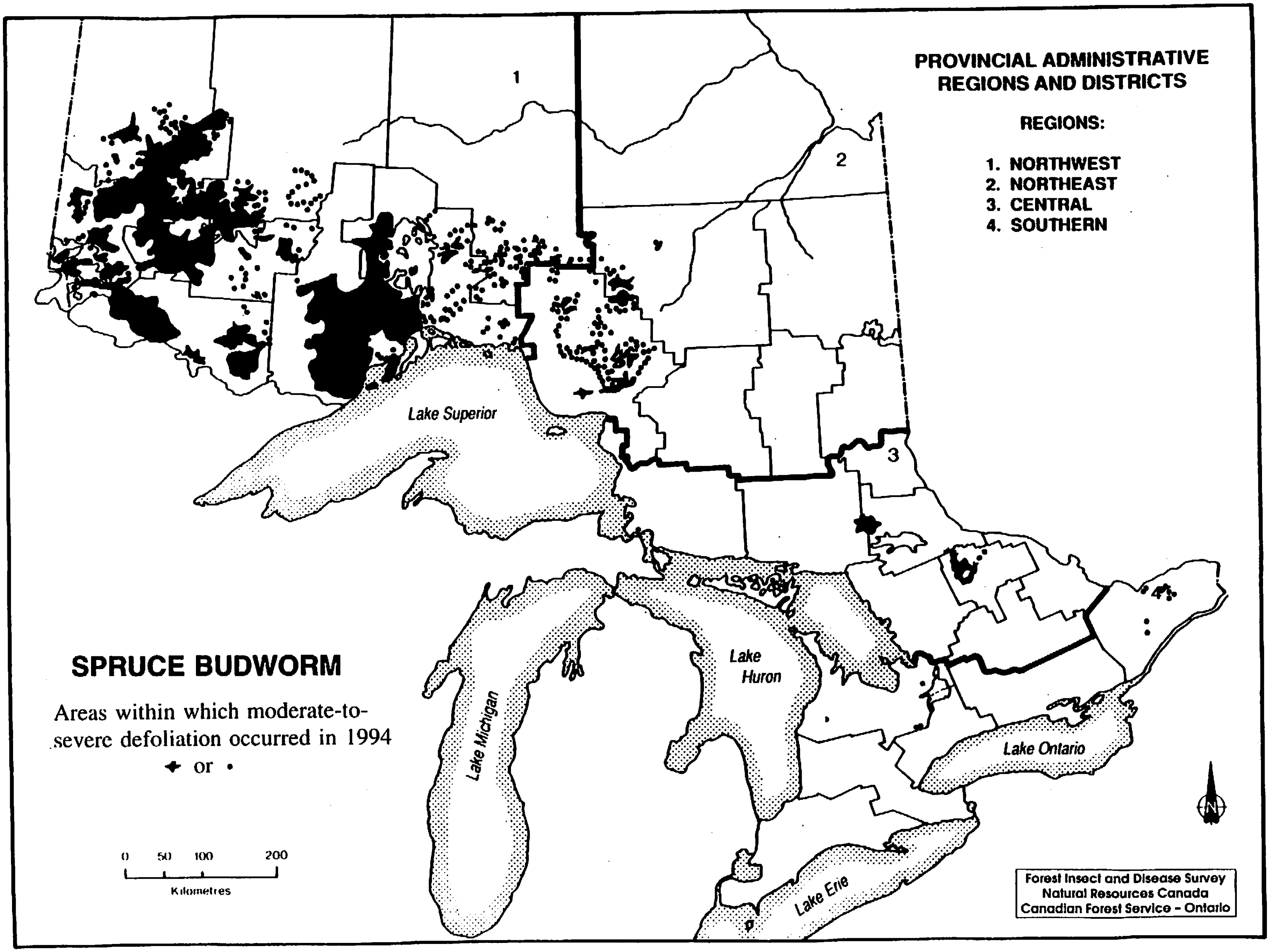

Figure 1. Eastern spruce budworm, Choristoneura fumiferana *(Clem.).*

Table 1. Gross area of moderate-to-severe defoliation by the eastern spruce budworm in Ontario, 1991-1994.

Region	Area (ha)			
District	1991	1992	1993	1994
Northwest				
Dryden	947,061	853,616	997,273	507,450
Fort Frances	590,094	424,784	422,244	506,878
Geraldton	960,702	1,138,621	1,296,783	96,655
Kenora	1,088,331	867,632	850,187	571,555
Nipigon	2,028,532	1,488,098	1,560,477	378,464
Red Lake	319,121	805,912	638,964	559,847
Sioux Lookout	479,096	533,554	556,122	367,437
Thunder Bay	1,754,081	1,361,666	973,686	885,138
	8,167,018	7,473,883	7,285,736	3,873,424
Northeast				
Hearst	34,685	458,578	268,208	42,245
Moosonee	2,360	11,205	11,647	0
Wawa	849,965	1,621,297	1,370,822	241,335
	887,010	2,091,080	1,650,677	283,590
Central				
Algonquin Park	11,640	26,900	20,405	57,505
North Bay	10	1,545	10,468	27,995
Sault Ste. Marie	0	965	4,639	915
Sudbury	70	1,365	9,150	22,640
	11,720	30,775	44,662	108,955
Southern				
Cambridge	18	0	0	20
Kemptville	0	10	85	570
Maple	6	2	0	0
Midhurst	9	12	17	97
	33	24	102	687
Total	9,065,781	9,595,762	8,991,177	4,266,656

Table 2. Comparison of spruce budworm egg-mass densities in the regions of Ontario between 1993 and 1994.

Region	No. of locations Sampled in 1994	No. of locations Common to 1993 & 1994	Average egg-mass density per 9.29 m of branch 1993	Average egg-mass density per 9.29 m of branch 1994	Change (%)
Northwest	213	179	218	222	+2
Northeast	118	90	79	63	-20
Central	89	48	7	22	+214
Southern	17	15	336	319	-5
Total	437	332	155	155	0

Spraying Operations 1994:

There were no aerial spraying operations against spruce budworm by Ontario Ministry of Natural Resources (OMNR) or forest industry.

GYPSY MOTH

Outbreak Status 1994:

Populations of the gypsy moth declined in Ontario for the third consecutive year. The gross area of moderate-to-severe defoliation stood at 5,645 ha, down from 9,784 ha recorded in 1993 (Table 3). This was the smallest area recorded since 1982 (Table 4). Most of the defoliation (5,543 ha) was again recorded in the Sudbury District, with the bulk occurring south and east of the city of Sudbury in the area between Timmins Chutes on the Wanapitei River and Makada and White Oak lakes, including the city of Sudbury itself (Fig. 2). Scattered pockets of defoliation were mapped between Lake Panache and Nairn as well as in the area between Espanola and Whitefish Falls. Most of the defoliation in these areas occurred on red oak and white birch growing on rocky ridge tops. Many trees sustained 100% defoliation. Red pine and trembling aspen suffered defoliation in the 30 to 60% range and some Manitoba maple was defoliated in the city of Sudbury.

The remainder of the defoliation this year (102 ha) was recorded in the western part of Aylmer District where the infestation declined and damage was generally moderate. Small pockets of infestation persisted in Pinery Provincial Park and southeast of Courtright in Moore Township. Several new pockets of infestation were mapped in Mosa Township about midway between the towns of Wardsville and Bothwell. Infestations that occurred in 1993 in the Sarnia Indian Reserve and in Rondeau Provincial Park collapsed this year. Small numbers of larvae were reported but no significant defoliation was observed. At one location near Lauzon Lake in Long Township, Sault Ste. Marie District, larvae were described as numerous but little or no defoliation resulted.

Table 3. Gross area of moderate-to-severe defoliation by the gypsy moth in Ontario, 1991-1994.

Region	Area (ha)			
District	1994	1992	1993	1994
<u>Central</u>				
Algonquin Park	915	591	0	0
Bancroft	61,840	13,205	0	0
Parry Sound	148,412	1,513	0	0
Pembroke	16,554	2,301	0	0
Sudbury	441	3,502	6,645	5,543
	228,162	21,112	6,645	5,543
<u>Southern</u>				
Aylmer	3,388	123	2,357	102
Cambridge	45,445	225	0	0
Kemptville	280	0	0	0
Maple	8,383	3,986	304	0
Midhurst	45,847	1,036	349	0
Tweed	15,910	7,978	129	0
	119,253	13,348	3,139	102
Total	347,415	34,460	9,784	5,645

Table 4. Gypsy Moth Infestations in Ontario, 1981-1994.

Year	Gross area of moderate-to-severe defoliation (ha)
1981	1,450
1982	4,800
1983	40,954
1984	80,624
1985	246,342
1986	160,776
1987	12,678
1988	29,693
1989	81,640
1990	77,648
1991	347,415
1992	24,460
1993	9,784
1994	5,645

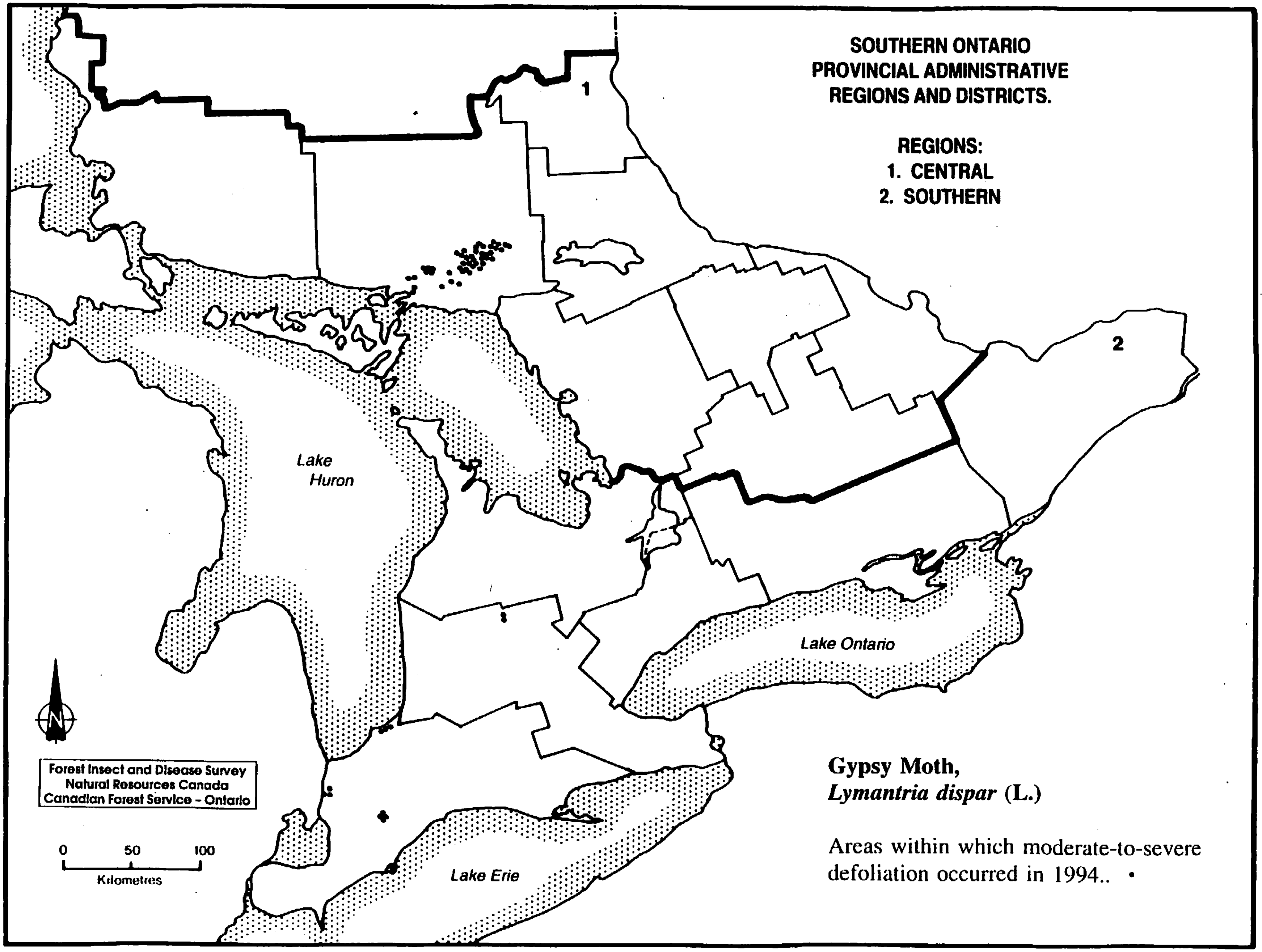

Figure 2. Gypsy moth, *Lymantria dispar* (L.)

Forecasts 1995:

Predictions for 1995 are based on historical trends and speculation since gypsy moth egg-mass surveys were not conducted in Ontario in 1994. The historical trend shows that gypsy moth populations are at their lowest levels in the past 15 years or more in southern Ontario and that increases are likely to occur in the next year or two.

Spraying Operations 1994:

There were no aerial spraying operations against gypsy moth conducted by OMNR in 1994.

JACK PINE BUDWORM IN ONTARIO, 1994[1]

- Outbreak Status 1994
- Forecasts 1995
- Results of Spraying Operations

by

J.H. Meating[2], H.D. Lawrence[2], G.M. Howse[2], M.J. Applejohn[2] and T. Scarr[3]

[1]Report prepared for the 22nd Annual Forest Pest Control Forum, Ottawa, November 15-17, 1994.

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[3]Ontario Ministry of Natural Resources, Provincial Operations Branch, Sault Ste. Marie, Ontario.

OUTBREAK STATUS 1994

For the fifth consecutive year, the area infested by the jack pine budworm continued to increase in the Central Region of Ontario (Figure 1). Aerial surveys revealed that the total area of moderate-to-severe defoliation was 419,344 ha in 1994, an increase of 137,097 ha from 1993 (Table 1). However, despite the increase in size of the outbreak, in many areas the overall intensity of the infestation decreased this summer. Defoliation rates within many of the infested stands were highly variable, but, in general, the proportion of heavily defoliated trees was lower than in 1993.

With the exception of Pembroke District, infestations in all districts affected in 1993 increased in size in 1994. The outbreak along Georgian Bay in Parry Sound District, that was first detected in 1990, affected some 106,898 ha this year, an increase of 15,253 ha from 1993. In Sudbury District, many of the small pockets of defoliation mapped in 1993 coalesced to form large contiguous areas of defoliation affecting a total of 277,129 ha in 1994. In North Bay District, 25,052 ha of defoliation occurred around the west end of Lake Nipissing. The most westerly pocket of defoliation was found in Sagard Township in Sault Ste. Marie District where 1,240 ha were affected. The area of moderate-to-severe defoliation decreased in Pembroke District from 4,202 ha in 1993 to 3,875 ha in 1994. For the first time since the mid 1980's, defoliation caused by the jack pine budworm was observed in Timmins District in the Northeast Region. A total of 3,450 ha of defoliation was mapped in three townships; Westbrook, Breadner and Battersby.

Defoliation caused by the jack pine budworm was not detected in the Northwest Region in 1994.

FORECASTS 1995

In 1994, jack pine budworm egg-mass samples were collected from a total of 221 locations throughout the province. Some 180 of these locations were established during the last two years as part of a jack pine budworm management project funded by the Northern Ontario Development Agreement (NODA). The remainder were located in areas sprayed in 1994 or in other high value areas identified by the Ontario Ministry of Natural Resources or forest industry.

In the Central and Northeast regions, 117 locations were sampled in both 1993 and 1994. A comparison of egg-mass counts from these locations shows an overall decrease of 19%. As usual, however, there was considerable variability in counts among locations. In Sudbury District for example, where most of the defoliation occurred this year, egg mass densities declined by 31% from 1993. However, of the 70 locations sampled, 37 still show a forecast of moderate or heavy defoliation in 1995. In Parry Sound District, the other major area affected in 1994, five of the six locations sampled still have heavy defoliation forecasts for 1995. The apparent large increase in egg masses in Timmins District was confined to four locations in Westbrook Township south of Gogama.

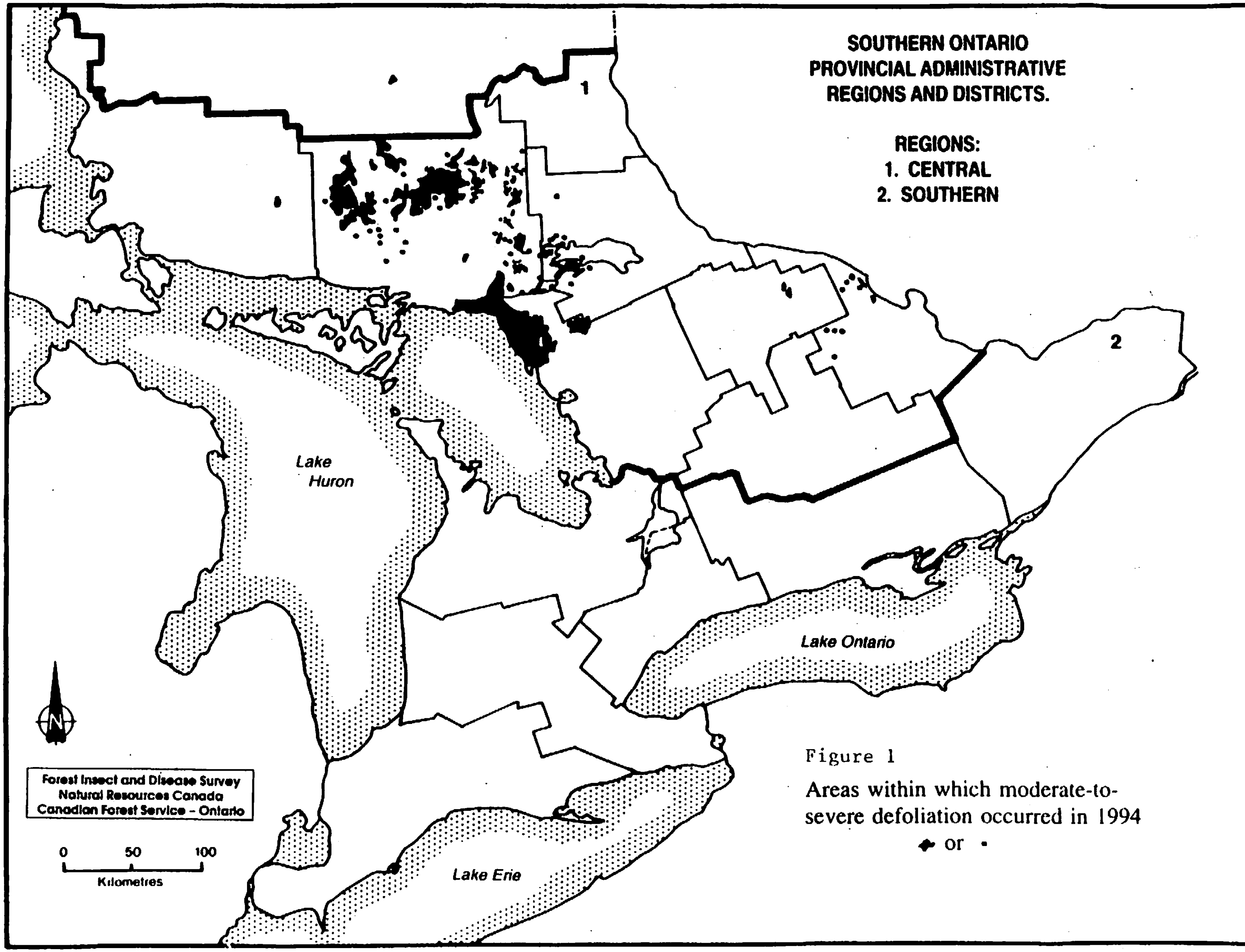


Figure 1

Areas within which moderate-to-severe defoliation occurred in 1994
◆ or ▪

Table 1. gross area of moderate-to-severe defoliation by the jack pine budworm in Ontario, 1991-1994.

Region District	Area (ha) 1991	1992	1993	1994
Northwest				
Dryden	2,591	0	0	0
Red Lake	69,903	693	0	0
Sioux lookout	20	0	0	0
	72,514	**693**	**0**	**0**
Central				
Algonquin Park	0	495	380	1,590
Bancroft	20	30	0	0
North Bay	290	16,379	19,035	25,052
Parry Sound	51,276	77,551	91,645	106,898
Pembroke	0	2,704	4,202	3,875
Sault Ste Marie	0	0	1,095	1,240
Sudbury	9,518	60,349	165,840	277,129
Temagami	0	0	50	110
	61,104	**157,478**	**282,247**	**415,894**
Northeast				
Timmins	0	0	0	3,450
	0	0	0	3,450
Total	**133,618**	**158,704**	**282,247**	**419,344**

Results of the egg-mass survey in these two regions suggest that the overall area and intensity of the outbreak should decline in 1995. Expansion of the infestation into new areas is unlikely although heavy defoliation of some stands is likely to occur in 1995 in Sagard Township in the west and Westbrook Township in the north. Once again heavy defoliation is forecast for areas affected in Parry Sound District. There may be some breakup of the large areas infested in Sudbury District, but moderate-to severe defoliation will likely occur again in 1995 in scattered pockets throughout the area.

In the Northwest Region, a comparison of 86 locations sampled in both 1993 and 1994 showed a slight increase in egg mass densities in three of the five districts. A few patches of light defoliation may occur in 1995 but no significant areas of damage are expected.

Table 2. Comparison of jack pine budworm egg-mass densities in Ontario, 1993 and 1994.

Region District	No. Locations	Total egg masses 1993	1994	Change (%)
Central				
Algonquin Park	2	15	16	+7
North Bay	3	9	10	+11
Parry Sound	6	116	114	-2
Pembroke	3	28	14	-50
Sault Ste Marie	22	45	43	-4
Sudbury	56	467	320	-31
Temagami	1	9	8	-11
Overall	**93**	**689**	**525**	**-24**
Northeast				
Chapleau	15	2	1	-50
Timmins	9	1	36	+3500
Overall	**24**	**3**	**37**	**+1133**
Northwest				
Dryden	17	1	1	0
Fort Frances	15	2	3	+50
Kenora	13	1	1	0
Red Lake	24	3	7	+133
Sioux Lookout	17	1	4	+300
Overall	**86**	**8**	**16**	**+100**

RESULTS OF SPRAYING OPERATIONS

In June, 1994, 21,499 ha of jack pine forest in the Central Region were aerially treated with the bacterial insecticide *Bacillus thuringiensis* (B.t.) to limit defoliation by the jack pine budworm. This was a co-operative program involving E.B. Eddy Forest Products Ltd., the Ontario Ministry of Natural Resources and Canadian Forest Service Ontario Region. The 1994 operation was conducted in the Lower Spanish Forest north of Espanonla and Sudbury in Sudbury District. During the last jack pine budworm outbreak in this area in the mid 1980s, more than 1.8 million hectares were infested.

A resurgence of jack pine budworm populations was first observed in Sudbury District in 1991 when nearly 4,000 ha of moderate-to-severe defoliation was mapped. By

1993 the total area affected in Sudbury, North Bay, Sault Ste. Marie and Temagami districts was over 186,000 ha. Egg mass surveys conducted in Sudbury District during this period showed an increasing trend in populations. An intensive L_2 survey was conducted in January and February 1994 to identify the most vulnerable stands. Some 185 locations were sampled and 46% were found to have populations high enough to cause moderate-to-severe defoliation this summer. Results of these surveys and information from the forest inventory were used to delineate potential spray areas.

Spring temperatures in the spray area were generally much cooler than normal. Consequently, jack pine budworm emergence and development were delayed by approximately one week. A period of warm humid weather in mid-June stimulated larval development and spraying began on June 19. At this time, jack pine budworm larvae were predominantly fourth instar and the host index was approximately 3.5. The program was completed on June 27 when larvae were peak fifth instar.

A total of 34 blocks were treated with a single application of Foray 76B (Novo Nordisk Bioindustrials, Inc.) at a rate of 30BIU/1.5L/Ha. An M-18 aircraft equipped with six Micronair rotary atomizers was used for all applications. Eighty-one percent of the area was treated during morning sessions and 19% in the evening.

Assessment plots were established in 15 of the 34 spray blocks representing 64% of the area treated. In each plot, a single midcrown branch was sampled from each of ten dominant or codominant jack pine. Prespray samples were collected approximately five days before treatment and postspray samples were collected after most insects had pupated in mid-July. One hundred spray plots and 50 unsprayed check plots were surveyed to assess spray efficacy.

Prespray surveys revealed a high degree of variability in jack pine budworm larval populations within and between plots. Previous surveys of jack pine budworm had shown that the presence of staminate flowers on host trees had a significant influence on larval densities. When prespray larval populations were compared on trees with and without staminate flowers (t-test), those on trees without staminate flowers were significantly higher ($p < .01$). Of the 1000 jack pine sampled to assess spray efficacy, approximately 31% had staminate flowers present. Table 3 presents block averages along with minimum and maximum values of prespray larval populations and 1994 defoliation rates. They show that a considerable range of prespray larval densities was found in most spray blocks. Overall, the average prespray larval density was 18.3 (SD = 26.7) on trees with flowers and 5.6 (SD = 7.2) on trees without. Tables 4 and 5 present results of the spray assessment in each spray block on trees with and without flowers respectively. In tables 6 and 7, data from all blocks have been pooled and placed in increasing prespray population classes for analysis.

Overall, the 1994 spray program was very successful in reducing jack pine budworm populations and protecting foliage. Defoliation rates in the unsprayed check plots were substantially higher than those observed in spray blocks (Tables 6 & 7). Among the blocks with relatively poor results, three (blocks 14, 23 and 38) were treated late in the program and may have had significant levels of defoliation prior to treatment. Reasons for the relatively poor results in several other blocks (eg. 6, 24 and 14) that were treated earlier in the program are unknown.

Table 3. Block summaries of prespray jack pine budworm larval densities and defoliation in stands aerially treated with a single application of Foray 76B (30BIU/1.5L/ha).

	Prespray Larvae per Shoot			Defoliation (%)		
Block	Avg.	Min.	Max.	Avg.	Min.	Max.
6	3.9	0	21	20.4	0	100
7	4.7	0	17	11.1	0	60
9	8.4	0	50	14.5	0	90
14	10.9	0	47	27.0	0	95
15	8.7	0	76	25.3	2	80
16	4.2	0	36	4.3	0	30
17	23.9	0	270	10.8	0	70
20	10.2	0	42	5.4	0	20
21	15.5	0	60	12.9	0	55
22	16.5	0	122	11.2	0	65
23	12.4	1	85	29.8	5	95
24	7.7	0	48	24.7	0	90
36	9.4	0	143	18.1	2	70
37	12.9	0	88	22.4	0	85
38	5.8	0	32	13.3	0	50
42	8.8	0	146	15.6	0	95

The success of the 1994 aerial spraying program may also be judged in terms of its impact on future jack pine budworm populations. For example, jack pine budworm egg-mass densities declined by 73% (n = 8 plots) in spray blocks between 1993 and 1994. The decline in unsprayed plots was only 17% (n = 20 plots). The average jack pine budworm L_2 density in treated plots was 21.2 larvae per branch (n = 7) in 1994, a decrease of 68% from 1993. In the unsprayed check plots, the average L_2 density was 56.4 larvae per branch, an increase of 110% (n = 19).

An analysis was carried out to evaluate the effect of spray timing on foliage protection. The spray blocks were placed into three categories based on the timing of treatment. Blocks treated on June 19-21, 22-24, and 25-27 were classified as early, mid, or late treatments respectively. Analysis of variance showed a significant difference ($p < .01$) existed between the three time periods. Blocks treated during the early time period had significantly lower defoliation rates than those treated in the mid or late periods (Figure 2).

Previous jack pine budworm spray programs were timed to coincide with specific stages of insect and host development. In order to optimize spray deposit and insect exposure to the insecticide, spraying began when most larvae were in the third and fourth instar and when the needles of host foliage had started to elongate and separate. This generally coincided with the period when larvae left staminate flowers to begin feeding on foliage. Results of the 1994 control program suggest that effective control of jack pine budworm may be possible at an earlier stage of insect or host development. However, further studies are necessary to determine the limits on spray timing.

An experimental program was also carried to assess the efficacy of the insect growth regulator RH5992 (MIMIC) on jack pine budworm. Two blocks were treated with single and double applications of this material. A report of the results of this program has been prepared under separate cover.

Table 4. Block summaries of the efficacy of a single application of Foray 76B (30BIU/1.5L/ha) against the jack pine budworm (host trees with staminate flowers).

Block	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
6	6.1	0.1	96	40
Checks	8.1	3.0		46
7	8.1	0.1	97	17
Checks	8.1	3.0		46
9	15.1	0.4	91	25
Checks	13.2	4.0		54
14	16.0	2.9	19	36
Checks	18.5	4.2		56
15	17.7	1.0	75	27
Checks	18.5	4.2		56
16	8.2	0.6	80	3
Checks	8.1	3.0		46
17	40.1	0.6	90	16
Checks	42.2	6.6		68
20	15.3	0.3	93	6
Checks	13.2	4.0		54

cont'd.

Table 4 cont'd.

Block	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
21	23.3	0.5	90	15
Checks	23.4	5.2		57
22	28.3	0.4	94	20
Checks	23.4	5.2		57
23	23.4	1.5	71	45
Checks	23.4	5.2		57
24	9.8	0.7	81	28
Checks	8.1	3.0		46
36	16.3	0.6	84	23
Checks	18.5	4.2		56
37	15.8	0.5	86	27
Checks	18.5	4.2		56
38	9.0	1.3	61	25
Checks	8.1	3.0		46
42	21.1	0.1	98	30
Checks	23.4	5.2		57

Table 5. Block summaries of the efficacy of a single application of Foray 76B (30BIU/1.5L/ha) against the jack pine budworm (host trees without staminate flowers).

Block	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
6	2.3	0.1	89	5
Checks	2.2	0.9		17
7	2.4	0	100	7
Checks	2.2	0.9		17
9	5.5	0.2	87	10
Checks	8.1	2.2		30
14	8.8	1.5	37	23
Checks	8.1	2.2		30
15	5.0	0.8	43	25
Checks	8.1	2.2		30
16	3.9	0.4	75	4
Checks	2.2	0.9		17
17	7.7	0.5	76	6
Checks	8.1	2.2		30
20	2.6	0.2	82	5
Checks	2.2	0.9		17

cont'd.

Table 5. cont'd.

Block	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
21	8.9	0.4	83	11
Checks	8.1	2.2		30
22	11.1	0.3	90	7
Checks	13.0	3.9		32
23	6.7	1.2	33	22
Checks	8.1	2.2		30
24	1.7	0.9	0	16
Checks	2.2	0.9		17
36	4.1	0.3	82	14
Checks	2.2	0.9		17
37	3.9	0.1	94	6
Checks	2.2	0.9		17
38	4.4	0.2	89	9
Checks	2.2	0.9		17
42	5.3	0.2	86	12
Checks	8.1	2.2		30

Table 6. Efficacy of a single application of Foray 76B (30BIU/1.5l /ha) against jack pine budworm on jack pine with staminate flowers present.

	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
Spray[1]	2.4	0.6	75	25
Checks	2.2	2.2		31
Spray	7.7	0.6	71	21
Checks	8.1	3.0		46
Spray	12.7	0.5	88	19
Checks	13.2	4.0		54
Spray	17.7	0.9	78	31
Checks	18.5	4.2		56
Spray	23.0	0.8	84	19
Checks	23.4	5.2		57
Spray	54.0	0.8	90	26
Checks	42.2	6.6		68

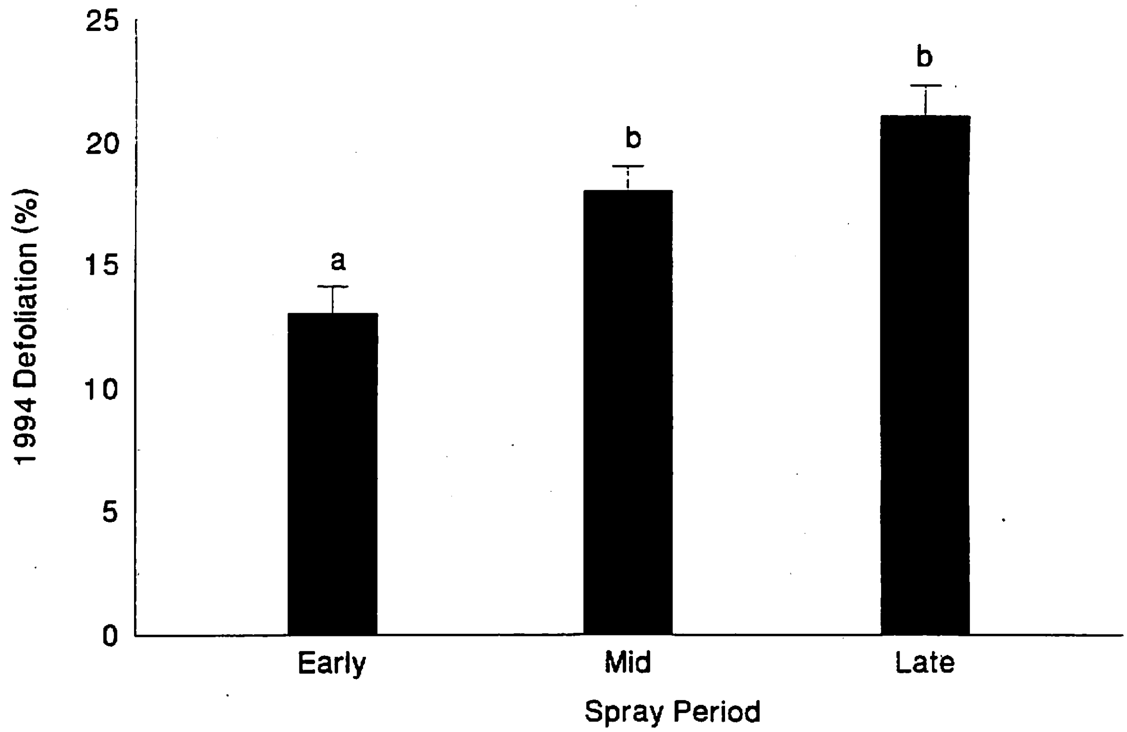
[1] Summary of all spray blocks.

Table 7. Efficacy of a single application of Foray 76B (30BIU/1.5L/ha) against jack pine budworm on jack pine without staminate flowers present.

	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
Spray[1]	2.0	0.3	63	10
Checks	2.2	0.9		17
Spray	7.5	0.5	75	15
Checks	8.1	2.2		30
Spray	12.6	1.0	74	19
Checks	13.0	3.9		32
Spray	17.9	0.6	89	13
Checks	18.1	5.6		40
Spray	22.5	1.6	77	26
Checks	22.4	6.9		66
Spray	34.5	1.3	68	16
Checks	38.0	4.4		51

[1]Summary of all spray blocks.

Figure 2. Mean and standard error of percent jack pine budworm defoliation in spray blocks treated June 9-21 (early), June 22-24 (mid), and June 25-27 (late) with a single application of Foray 76B (30BIU/1.5L/ha).



THE EFFICACY OF SINGLE AND DOUBLE APPLICATIONS OF RH5992®

ON JACK PINE BUDWORM IN ONTARIO[1]

by

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The Efficacy of Single and Double Applications of RH5992 ®
on Jack Pine Budworm in Ontario

Introduction

The jack pine budworm, *Choristoneura pinus pinus* Free., is the most destructive pest of jack pine in northern Ontario. Infestations typically last only a few years, but high populations are capable of completely defoliating mature trees in a single year. Top mortality and whole tree mortality may result from these outbreaks.

There are currently only two insecticides registered for use against the jack pine budworm in Canada; fenitrothion, and *Bacillus thuringiensis* (B.t.). However, since 1985, B.t. has been the only material used in aerial spraying programs in Ontario. B.t. Has been shown to be very effective against the jack pine budworm, but the development of environmentally benign alternative control products should be encouraged.

In field tests conducted in 1993, a new insect growth regulator, RH5992, was shown to be effective against the spruce budworm. The spruce budworm and jack pine budworm are very similar taxonomically, and laboratory tests indicated that RH5992 should be effective in controlling the latter.

In 1992 and 1993, several areas in the Central Region of northern Ontario were infested with the jack pine budworm. In 1993, moderate-to-severe defoliation caused by the budworm was mapped over an area of some 282,000 ha in this region. An operational control program was planned to protect approximately 20,000 ha of high value jack pine stands in Sudbury District in 1994. This was a co-operative project involving the Ontario Ministry of Natural Resources, E.B. Eddy Forest Products Ltd. and the Canadian Forest Service, Ontario Region. The occurrence of the outbreak, and the expectation of an operational control program, provided an opportunity to field test the efficacy of RH5992 on another major forest pest.

Methods

Study Area: The spray trials were conducted in jack pine stands located in Moses and Hart townships in the Central Region of northern Ontario. In 1992, jack pine budworm caused light levels of defoliation on jack pine in both townships. The following year, moderate levels of defoliation were recorded in Moses Township and light defoliation was observed in Hart Township. Foliage samples were collected from both areas during the winter of 1994 for assessment of overwintering second instar (L_2) populations. This survey indicated that budworm populations would be sufficient to result in moderate (25-75%) levels of defoliation in both locations in 1994.

In Hart Township (Block 1), a 50 ha block was treated in jack pine stands ranging in age from 50-70 years. There was a small black spruce component (20-30%) in each of the three stands composing this block. A total of 55ha was treated in the Moses Township (Block 2) spray block. This block was located in a 240 ha stand of pure jack pine that was approximately 65 years old. At the request of the Ontario Ministry of Environment, a 120 m buffer was left unsprayed along Alces Creek which formed the eastern boundary of this stand.

Treatments: A single treatment of RH5992 (70g/2L/ha) was applied in Block 1 on the morning of June 23. Wind speed was less than 5 kph, temperature was 12-14°C and the relative humidity (RH) was 90-99%. Jack pine budworm larvae were predominantly fifth instar with some thirds, fourths and sixths. The host development index was 4.0.

Block 2 received two applications of RH5992, the first on June 22 and the second five days later on June 27. Both were morning applications. On June 22, the winds were light (<5kph), the temperature was 10°C, and the RH was 99%. The larval index was 4.7 indicating a predominance of fourth and fifth instar and the host index was 3.4. Conditions during the second application on June 27 were very similar. Winds were less than 5kph, temperatures were 11-12°C, and the RH was 99%. Most larvae were in the fifth or sixth instar and the host index was 3.6.

All treatments were applied with a Cessna 188 Ag-truck aircraft equipped with four Micronair AU4000 rotary atomizers. On-block navigation was supported by a Differential Global Positioning System and spray parameters (flow rate, air temperature, relative humidity etc.) were monitored with an on-board data logging system.

Assessment: In early June, ten assessment plots were established in each spray block. The plots were distributed throughout the block and transected the block perpendicular to the anticipated flight path. Ten dominant or codominant jack pine were selected in each plot for prespray and postspray sampling.

The prespray samples were collected on June 20 and the postspray samples on July 21 and 22. For each of the prespray and postspray samples, a single mid-crown branch (60cm) was removed from each of the sample trees. The branches were cut into smaller sections and placed in individual paper bags. All samples were kept at 4°C until they could be examined in the laboratory where all jack pine budworm were removed and counted. All branches were examined twice to ensure that the larval counts were accurate. During the postspray survey, which occurred when larval feeding was essentially complete, the sample branches were rated for defoliation before they were clipped and bagged for transport to the laboratory. A total of 100 trees were sampled in each spray block. The data collected from these trees were compared to samples collected from unsprayed check plots (n = 470 trees) to assess spray efficacy.

In the laboratory, the number of shoots, male flowers, and jack pine budworm were determined for each branch. During the postspray survey, all larvae, and pupae removed from each sample branch were reared at room temperature to determine the final number of adult moths emerging from each sample.

Spray Deposit: Rhodamine dye (0.01%) was added to each tank mix to help monitor spray deposit for each spray session. Prior to treatment, Kromecote cards (three per plot) were affixed to the tops of one meter long stakes placed in canopy openings in five plots transecting each spray block. The cards were retrieved one hour after the completion of each spray session and returned to the laboratory for examination. Each card was viewed under a microscope and the number of spray droplets recorded for an area of five square centimetres per card.

Data Analysis: Prespray surveys revealed a high degree of variability in jack pine budworm larval populations within, and between plots. Previous experience had shown that the presence of staminate flowers on the host trees had a significant influence on jack pine budworm larval densities. When larval populations on trees with staminate flowers were compared (t-test) to those on trees without flowers, we found that populations were significantly higher on trees with flowers ($p < .01$). Therefore, spray efficacy was assessed with this factor in mind. Plot averages of prespray larval populations and defoliation are presented, but a more accurate assessment of the efficacy of RH5992 is presented when data from trees with, and without staminate flowers were analyzed separately.

Results

Insect and Host Development: Spring temperatures in the study area were generally much cooler than normal in April, May and early June. Consequently, jack pine budworm emergence and larval development were delayed by approximately one week. Insect and host development curves for Moses and Hart townships show very little difference in development rates between the two locations (Figure 1). A period of warm humid weather, that began on June 15 and lasted until June 26, seemed to stimulate development. Daily maximum temperatures during this period were in the high 20's or low 30's with minimum temperatures in the high teens. The operational spray program began on June 19 and the first RH5992 experimental block was treated on June 22.

Spray Deposit: There was considerable within and between plot variability in spray deposition on Kromecote cards in both spray blocks (Table 1). In Block 2, the average number of droplets per cm^2 was 25.4 (SD = 17.8) on the first application and 22.3 (SD = 9.6) on the second application. No deposit was detected in Plot 1 for the first application. This plot was directly adjacent to the 120 m buffer zone along the eastern boundary of the block and apparently was not sprayed on June 22. Deposit was high (Avg. = 19.6 droplets/cm^2) in this plot on the second spray date. Deposit in Block 1 was considerably lower than in Block 2 with an average of 8.1 droplets /cm^2 (SD = 5.1). Overall, spray deposit on the Kromecote cards was very high in most plots.

Field Efficacy: Tables 2 and 3 show plot averages of prespray larval populations and 1994 defoliation levels in each of the ten assessment plots in the two spray blocks. Minimum and maximum values have also been included to demonstrate the considerable variability that was observed within and between plots. For example, in Block 1, prespray larval densities varied from 2-97 per branch in plot 10, and defoliation levels varied form 10 - 90% in the same plot (Table 2).

In Block 1, the overall average prespray population was 13.7 larvae per branch, with a low of 5.4 in plot 6 and a high of 26.9 in plot 1 (Table 2). The average defoliation rate for the block was 26%. Defoliation was highest in plot 1 (43.5%) and lowest in plot 3 (10.5%).

Prespray larval populations averaged 14.3 per branch in Block 2. The highest population density occurred in plot 9 (Avg.=27.9 larvae per branch) and the lowest in Plot 1 (Avg.=6.1 larvae per branch) (Table 3). Defoliation levels were significantly lower in Block 2 compared to Block 1. The average defoliation rate for this block was 4% with a high of 8% in plot 5 and a low of 1% in plots 6 and 10. Several plots had average defoliation levels of less than 5%.

In tables 4-7, host trees with and without staminate flowers were analyzed separately in each block. The data were also grouped into six classes of increasing prespray larval density (0-5, 6-10, 11-15, 16-20, 21-25, and >25 prespray larvae per branch) and compared to similar unsprayed check plots.

Prespray populations on trees with flowers averaged 28.5 and 18.7 larvae per branch in Block 1 and Block 2 respectively. On trees without flowers, populations were significantly lower with an average of 7.1 larvae per branch in Block 1 and 12.1 in Block 2. Defoliation rates were also influenced by the presence or absence of flowers. In Block 1, the average defoliation rate on trees with flowers was 49% compared to 15% on trees without flowers. In Block 2, the difference between trees was less with an average defoliation rate of 4% on trees with flowers and 3% on trees without.

Results of a single application of RH5992 in Block 1 are presented in Table 4 for trees with staminate flowers and in Table 5 for trees without flowers. In both instances, estimates of population reduction attributable to the treatment were quite high (63-100%). However, this did not always translate into high levels of foliage protection. In trees with staminate flowers, defoliation levels on treated trees were often higher, or almost the same as, defoliation rates observed on unsprayed check trees at all population densities. Foliage protection was substantially better on trees without staminate flowers.

Estimates of population reduction attributable to a double application of RH5992 in Block 2 were consistently 100% (Tables 6 and 7). This significant reduction in jack pine budworm populations resulted in very low defoliation levels in this block. On both trees with, and without staminate flowers, observed defoliation rates were generally less than 10%.

Discussion

There is little doubt that a double application of RH5992 was effective in reducing jack pine budworm populations and protecting foliage. A total of 18 larvae and pupae were removed from the 100 postspray branch samples collected in Block 1. Only seven budworm were successful in completing development and producing adult moths.[1] Spray deposition in this block, based on an examination of Kromecote cards, was exceptionally good and, although plot 1 was missed on the first application, good deposit on the second application resulted in excellent foliage protection.

The results are not so unequivocal in Block 1 which received a single application of RH5992. Prespray budworm populations were similar to those in Block 2 and the two blocks were treated only one day apart. Larval and host development curves for the two areas were almost identical, so it is unlikely that there were significant differences in defoliation levels at the time of treatment. The only major difference seems to be in the levels of spray deposition measured in the two blocks. Records from the five plots assessed in each block, show that spray deposition was greater in Block 2 than in Block 1. Despite the lower deposition rates observed

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[1] These adults do not appear in tables 5 and 6 because on the effect of rounding averages.

in Block 1, however, droplet densities of 7-12 drops per cm^2 would generally be considered quite acceptable. In fact, when spray deposition is compared to foliage protection in the corresponding plots, the level of foliage protection is generally very good in plots 2, 3, 5 and 6 where deposition was high. In plot 1, where deposition was low, foliage protection was poor. Unfortunately, spray deposit was not assessed in plots 4, 7, 8, 9, and 10. However, when the locations of these plots within the spray block was considered, plots 4, 8, 9 and 10 were close to spray block edges and each had relatively poor results in terms of foliage protection. Plot 7 was located well within the block and foliage protection was very good. It would appear, therefore, that in Block 1 in plots 2,3,5, and 6 where deposition was measured and was relatively high, and in plot 7 located well inside the spray block, that a single application of RH5992 was effective in protecting foliage. In Plot 1 spray deposit was relatively low and results were poor. In the remaining plots deposition is unknown but is suspected to have been poor because of their proximity to the spray block boundaries.

A comparison of tables 4 and 5 also shows that foliage protection was substantially greater on trees without staminate flowers than on trees with staminate flowers. There is no obvious reason from the data that was collected why this should be so. One possible explanation is that when trees produce reproductive structures, such as staminate flowers, some of the resources that would normally be allocated to shoot development are redirected to flower production. Consequently, vegetative shoots tend to be smaller in years when the tree is producing flowers. Therefore, any feeding on these smaller shoots would result in a relatively higher defoliation rate. Another possible explanation is that larvae on trees with staminate flowers tend to spend as much time as possible feeding within the flower. Exposure of the larvae to insecticides may be somewhat reduced in this environment compared to those larvae feeding on vegetative shoots. It is possible that when the larvae finally did emerge from feeding in the staminate flowers that there was insufficient material remaining on the foliage to effectively control populations and protect foliage. This is an unlikely explanation in this block because the treatment occurred after the flowers had shed their pollen and the larvae had left the flowers to continue feeding on the vegetative shoots.

The timing of previous operational spraying programs against the jack pine budworm coincided with the movement of larvae from staminate flowers to vegetative shoots. This is generally about the time that the vegetative shoots were elongating and had broken through the fascicle to provide an adequate deposit surface. Results of the 1994 operational spraying program indicate that acceptable levels of foliage protection are achievable when treatments are applied somewhat earlier than in the past. Therefore, we would recommend that experimental field tests be conducted to evaluate the effectiveness of "early" treatments to reduce defoliation by the jack pine budworm.

Table 1. Summary of spray deposit in two blocks ι eated with single and double applications of RH5992® (70g/2.0*L*/ha) in Ontario, 1994.

		1st Application		2nd Application	
Block	Plot	Droplets per cm^2	SD	Droplets per cm^2	SD
Moses	1	0	0	19.6	4.6
"	2	18.5	7.9	20.5	3.2
"	3	32.2	8.7	35.1	6.8
"	4	35.5	10.6	18.0	3.6
"	5	40.8	16.5	18.4	13.3
Hart					
"	1	1.9	1.4		
"	2	7.1	3.0		
"	3	10.1	3.0		
"	5	8.9	3.3		
"	6	12.5	6.4		

Table 2. Plot summaries of prespray jack pine budworm larval densities and defoliation in jack pine stands aerially treated with a single application of RH5992® (70g/2.*0L*/ha) in Ontario, 1994.

Plot	Prespray Larvae per Branch			Defoliation (%)		
	Avg.	Min.	Max.	Avg.	Min.	Max.
1	26.9	6	77	43.5	5	85
2	11.5	0	63	19.0	5	70
3	6.2	2	17	10.5	5	25
4	21.0	0	63	40.5	5	90
5	8.7	0	26	11.5	5	30
6	5.4	0	12	19.0	5	70
7	10.2	0	43	12.0	5	25
8	13.1	2	52	29.0	5	90
9	10.6	2	30	39.0	15	55
10	23.6	2	97	32.0	10	90

Table 3. Plot summaries of prespray jack pine budworm larval densities and defoliation in stands aerially treated with two applications of RH5992® (70g/2.*0L*/ha) in Ontario, 1994.

	Prespray Larvae per Branch			Defoliation (%)		
Plot	Avg.	Min.	Max.	Avg.	Min.	Max.
1	6.1	1	27	1.5	0	5
2	11.7	0	29	1.7	0	5
3	7.2	2	14	3.3	0	5
4	17.8	2	95	2.4	0	5
5	11.8	2	25	8.4	2	20
6	11.0	0	42	1.4	0	2
7	11.0	0	29	7.7	2	25
8	20.2	3	65	4.7	2	10
9	27.9	3	88	3.6	0	5
10	18.7	0	71	1.3	0	5

Table 4. Efficacy of a single application of RH5992® (70g/2.0*L*/ha) on jack pine <u>with</u> staminate flowers present.

	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
Spray	3.6	0	100	37
Checks	2.2	2.2		31
Spray	7.7	1.0	64	45
Checks	8.1	3.0		30
Spray	11.5	1.0	71	40
Checks	13.2	4.0		54
Spray	18.2	0.2	95	38
Checks	18.5	4.2		56
Spray	21.0	1.0	79	30
Checks	23.4	5.2		57
Spray	51.4	1.0	87	62
Checks	42.2	6.6		68

Table 5. Efficacy of a single application of RH5992® (70g/2.0*L*/ha) on jack pine <u>without</u> staminate flowers present.

	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment(%)	1994 Defoliation (%)
Spray	2.5	0	100	10
Checks	2.2	0.9		17
Spray	7.5	0.1	95	17
Checks	8.1	2.2		30
Spray	11.7	1.3	63	21
Checks	13.0	3.9		32
Spray	18.0	0	100	31
Checks	18.1	5.6		40
Spray	24.0	0	100	12
Checks	22.4	6.9		66
Spray	26.0	0	100	15
Checks	38.0	4.4		51

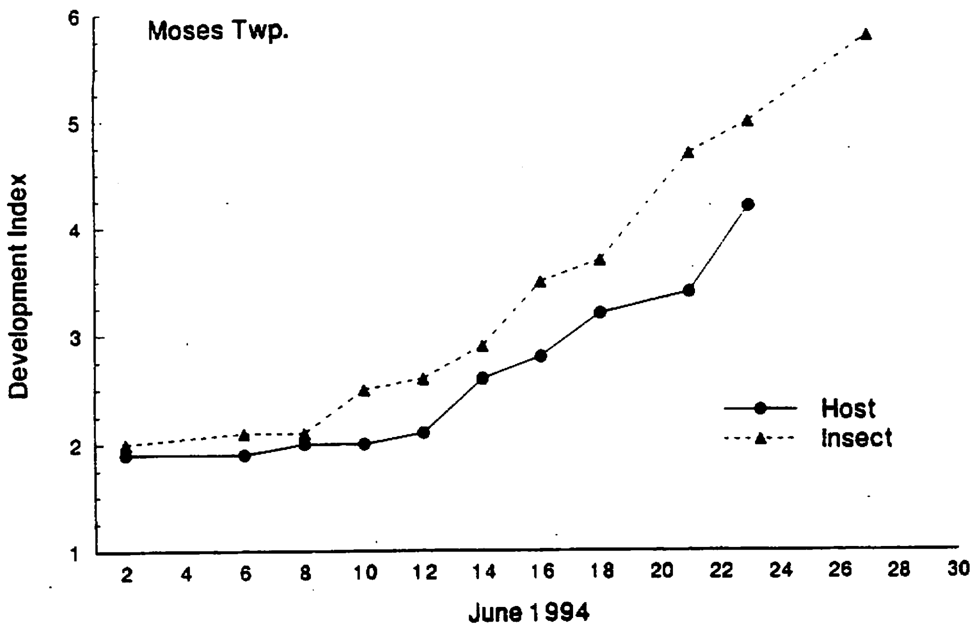
Table 6. Efficacy of a double application of RH5992® (70g/2.0*L*/ha) on trees with staminate flowers present.

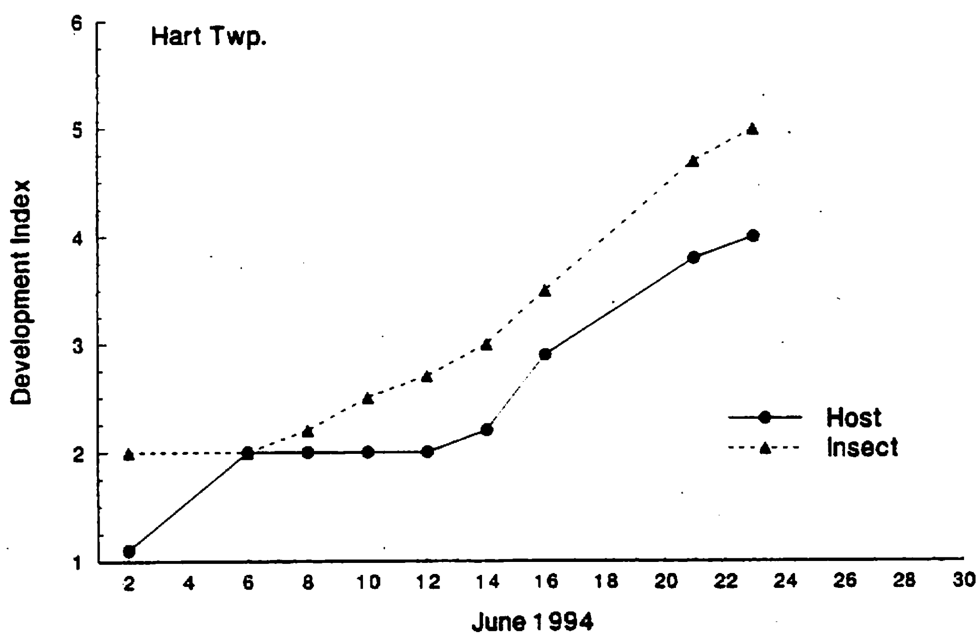
	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
Spray	3.0	0	100	2
Checks	2.2	2.2		31
Spray	8.7	0	100	2
Checks	8.1	3.0		46
Spray	12.3	0	100	5
Checks	13.2	4.0		54
Spray	17.0	0	100	7
Checks	18.5	4.2		56
Spray	25.0	0	100	20
Checks	23.4	5.2		57
Spray	60.8	0	100	6
Checks	42.2	6.6		68

Table 7. Efficacy of a double application of RH5992® (70g/2.0*L*/ha) on jack pine <u>without</u> staminate flowers present.

	Prespray larvae per 60 cm branch	Emerged adults per 60 cm branch	Population reduction due to treatment (%)	1994 Defoliation (%)
Spray	2.6	0	100	2
Checks	2.2	0.9		17
Spray	7.5	0	100	5
Checks	8.1	2.2		30
Spray	13.7	0	100	6
Checks	13.0	3.9		32
Spray	16.7	0	100	3
Checks	18.1	5.6		40
Spray	23.5	0	100	3
Checks	22.4	6.9		66
Spray	47.2	0	100	2
Checks	38.0	4.4		51

Figure 1. Jack pine budworm and jack pine development in Hart and Moses townships.





Report to the Twenty Second Annual Forest Pest Control Forum

1994 Joint E.B. EDDY-OMNR Jack Pine Budworm Foliage Protection Program in Ontario

Taylor Scarr and Joe Churcher
Ontario Ministry of Natural Resources

An aerial spray program to protect jack pine foliage from defoliation by jack pine budworm was conducted in 1994 through a joint effort by the Ontario Ministry of Natural Resources and E.B. Eddy Forest Products. Details on the timing and results of the program are contained elsewhere in these proceedings (Meating et. al...).

A total of 21,499 ha were sprayed with a single application of FORAY 76B (*Bacillus thuringiensis*) (manufactured by Novo Nordisk Bioindustrials Inc.) at rate of 30 BIU/ha (1.4 l/ha) All the spraying was accomplished by Supermarine Aviation Inc. using a single Dromader M-18 aircraft equipped with rotary atomizers. A Cessna 172F served as the pointer aircraft. All of the stands protected from defoliation were part of the Lower Spanish Forest.

This program and partnership were unique in several ways. First, it marked the first time that an aerial spray program was paid for in part by a Forest Management Agreement holder to protect foliage of trees on Crown land. E.B. Eddy Forest Products paid the cost of the aerial application and provided the Project Supervisor and accommodations.

The OMNR provided the B.t., navigators, and block security, as well as conducting the public consultation. E.B. Eddy was part of the regional planning committee from the beginning of the planning process, along with the Ontario Ministry of Environment and Energy. Phil Bunce represented E.B. Eddy in planning and conducting the spray program. Harri Liljalehto was the coordinator for the OMNR. The Project Supervisor for E.B. Eddy was Bob Dennis, with Klaus Ehrhardt responsible for the OMNR operational aspects of the program.

The L2 (overwintering) sampling, spray timing, and efficacy assessment were performed by the Forest Insect and Disease Survey Unit of the Canadian Forest Service through a Collaborative Research Agreement with the OMNR.

Stands selected for protection were chosen based on the following criteria:

- > 40 years old
- < 120 years old
- > $48 m^3$/ha of softwood volume
- > 40% jack pine by basal area
- stands not scheduled for harvesting within the next 3 years and
- stands scheduled for harvesting within the next ten years
- stands forecasted to receive moderate-to-severe defoliation in 1994

The budworm population forecasting was based on intensive L2 sampling. This allowed for the unique practice of protecting stands from defoliation in the first year of defoliation, rather than after at least one year of defoliation. This strategy was based on experience from the 1980s jack pine budworm outbreak, in which severe defoliation in the first year was a significant determinant of subsequent impact of the outbreak.

The project was also unique in that a regional economic impact model was used to conduct a cost-benefit analysis of the spray program. This analysis included cost of the spraying, value of the timber being protected, and impacts on local, regional, and provincial economies. Results of the analysis are currently being prepared for publication.

The public consultation process involved notices in newspapers announcing the proposed spray program, district open houses, presentations to District Advisory Committees, media interviews, letters to people on district mailing lists for timber management planning public consultation, and letters to all landowners within 1 km of a spray block.

Public response was light, and mostly supportive. There were three letters expressing concern about the spray program, one of which requested an individual environmental assessment of the spraying. This request was not granted by the Minister of Environment and Energy. Most of the concern centred on alleged effects of B.t. on non-target insectivores.

The program was unique for Ontario in that the B.t was transported to the site in Hoyer containers which were shipped from Holland, trucked from Toronto, and left on site, with a new full container arriving as needed. No drums or mixing and pumping sites were needed.

The program began June 19, and was completed by June 27. There were no incidents. This was the first time that FORAY 76B was used operationally in Ontario, and no difficulties were encountered.

This partnership marked a change in responsibilities in forest pest management in Ontario. Under a New Business Relationship between the forest industry and the OMNR, forest protection programs for areas under Forest Management Agreements will become the responsibility of the forest company holding the FMA.

Funding for the programs will come from a trust fund called the Forestry Futures Trust Fund. The Futures Fund will be administered by a MNR-industry board of directors. Money for the fund comes from a portion of the area charges that each company previously paid directly to the Crown. Instead of all of the area charges going to general revenues for the province, a portion will go to the Futures Fund with the remainder continuing to be sent to the province.

Planning is currently under way for 1995 for managing the jack pine budworm outbreak.

SOMMAIRE DU RELEVÉ DES INSECTES ET DES MALADIES DES ARBRES AU QUÉBEC EN 1994

PAR
CLÉMENT BORDELEAU[1]
DENIS LACHANCE[2]

Rapport préparé pour le Colloque annuel sur la lutte contre les ravageurs forestiers, Ottawa, du 15 au 17 novembre 1994

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1. Ministère des Ressources naturelles, Direction de la conservation des forêts, Québec (Québec)

2. Ressources naturelles Canada, Centre de foresterie des Laurentides, Sainte-Foy (Québec)

INTRODUCTION

Un sommaire des principaux ravageurs détectés dans les forêts du Québec en 1994 est présenté dans ce rapport.

Les faits saillants ont été :

- la progression des populations de la tordeuse des bourgeons de l'épinette dans la région de l'Outaouais;

- la détection de plusieurs petits foyers d'infestations de l'arpenteuse de la pruche sur l'Île d'Anticosti;

- le maintien des populations de la tordeuse du pin gris dans quelques secteurs de la région de l'Outaouais ainsi que la détection d'un nouveau foyer à l'Île-aux-Allumettes;

- la régression du diprion de Swaine dans le foyer épidémique localisé dans la région du Saguenay—Lac-Saint-Jean;

- la régression des infestations de la livrée des forêts et de la tordeuse du tremble;

- le maintien des populations de la spongieuse à un niveau endémique dans toute la province;

- la hausse des populations de l'arpenteuse de Bruce dans plusieurs régions du Québec;

- le déclin des populations de la légionnaire noire dans les aires reboisées de la région de la Côte-Nord;

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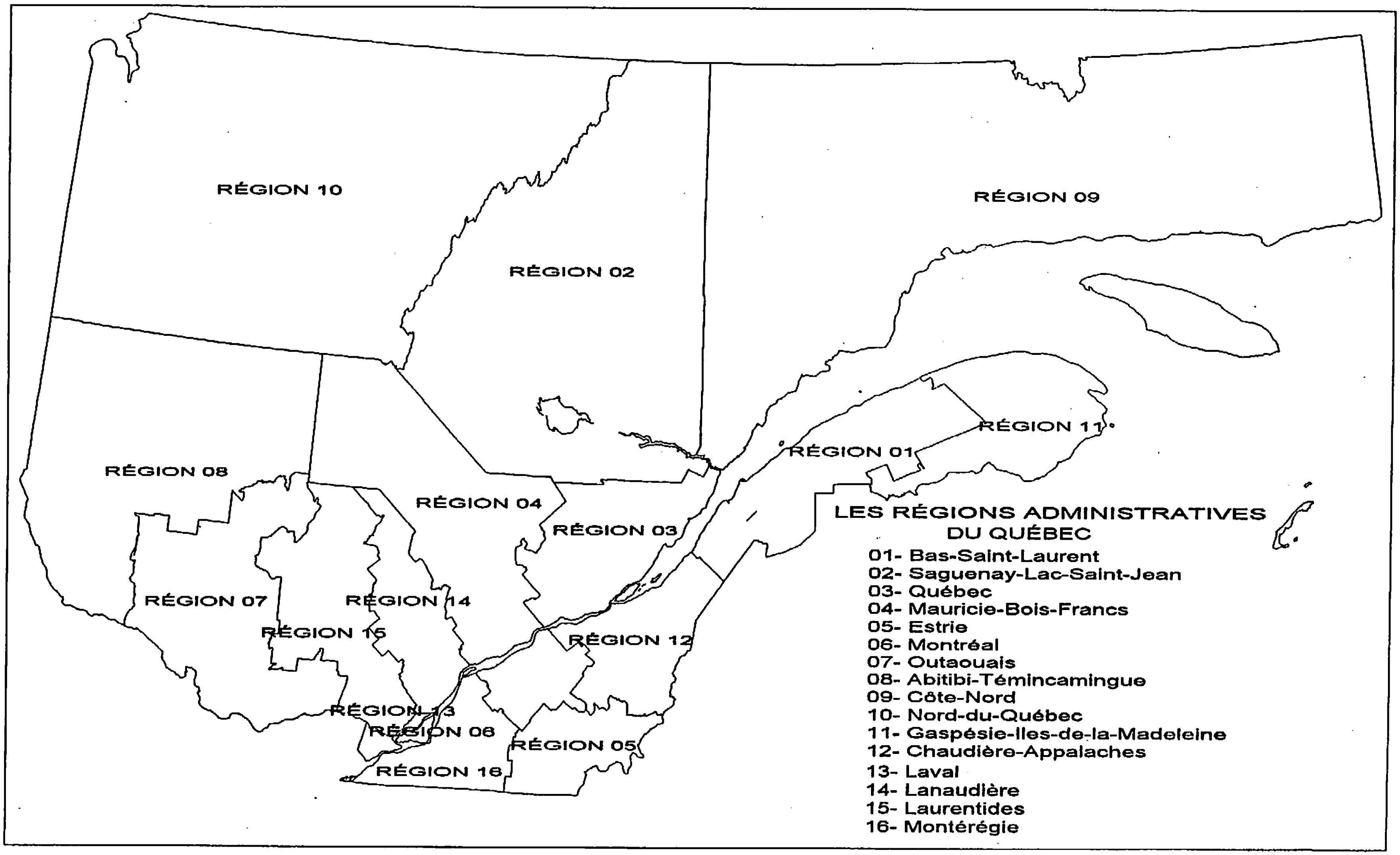
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LES RÉGIONS ADMINISTRATIVES
DU QUÉBEC
01- Bas-Saint-Laurent
02- Saguenay-Lac-Saint-Jean
03- Québec
04- Mauricie-Bois-Francs
05- Estrie
06- Montréal
07- Outaouais
08- Abitibi-Témincamingue
09- Côte-Nord
10- Nord-du-Québec
11- Gaspésie-Iles-de-la-Madeleine
12- Chaudière-Appalaches
13- Laval
14- Lanaudière
15- Laurentides
16- Montérégie

Carte 1

TORDEUSE DES BOURGEONS DE L'ÉPINETTE
Choristoneura fumiferana (Clem.)

INFESTATION

En 1994, les dégâts causés par la tordeuse des bourgeons de l'épinette ont été détectés sur près de 3 000 hectares localisés dans les forêts privées de la région de l'Outaouais. Les superficies défoliées couvrent six fois plus d'étendue qu'en 1993 et elles sont circonscrites à l'intérieur d'un périmètre délimité par les localités de Gatineau, Fort-Coulonge et North Low (Carte 2). Les niveaux de populations de l'insecte sont demeurés faibles dans les autres régions de la province, et les dégâts n'y ont pas été perceptibles.

Tableau 1 - Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette au Québec en 1994

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Élevé	
Outaouais	936 (103)*	1 148 (172)	828 (202)	2 912 (477)

* ( ) = Superficies affectées en 1993

PRÉVISIONS

L'inventaire des larves en hibernation (L2) a été conduit dans quelque 300 stations d'observation réparties dans toute la province. Les résultats partiels indiquent que les populations de tordeuses continuent de s'accroître dans la zone infestée en 1994 dans la région de l'Outaouais. Les dégâts devraient être particulièrement élevés le long de la rivière Gatineau en 1995. Aucune expansion majeure de l'infestation n'a cependant été décelée jusqu'à maintenant. L'insecte a également été relevé plus fréquemment au centre de la province, mais les dégâts demeureront imperceptibles l'an prochain. Dans les autres régions, les populations demeurent faibles.

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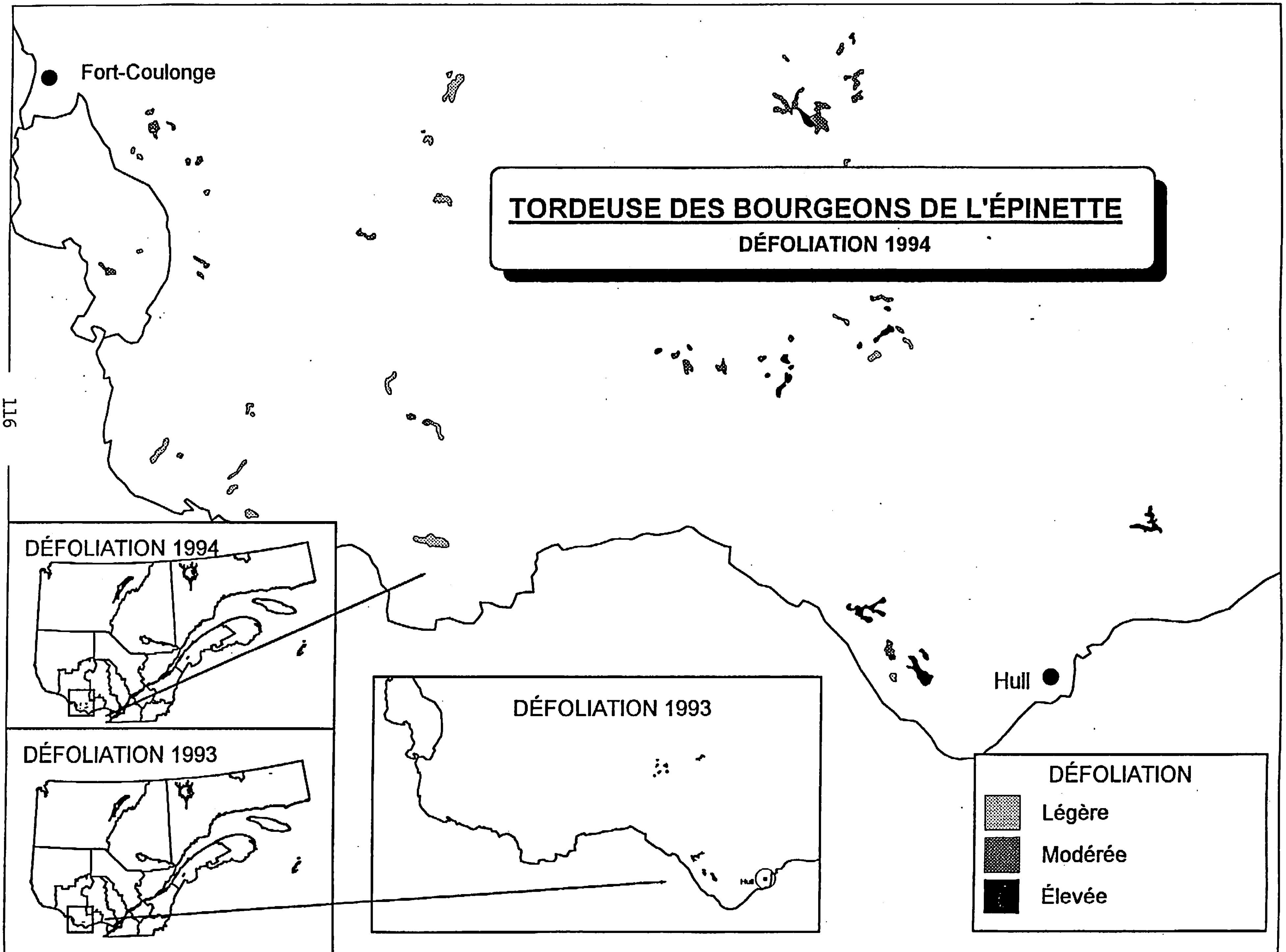
Fort-Coulonge
TORDEUSE DES BOURGEONS DE L'ÉPINETTE
DÉFOLIATION 1994
DÉFOLIATION 1994
DÉFOLIATION 1993
DÉFOLIATION 1993
Hull
DÉFOLIATION
Légère
Modérée
Élevée

Carte 2

ARPENTEUSE DE LA PRUCHE
Lambdina fiscellaria fiscellaria (Guen.)

INFESTATION

Des infestations locales de l'arpenteuse de la pruche ont été relevées dans plusieurs petits foyers localisés au sud-ouest de l'Île d'Anticosti (région de la Côte-Nord) (Carte 3). Les superficies affectées totalisent 975 hectares dont 358 ont été défoliés modérément ou sévèrement. La dispersion de ces foyers montre une hausse des populations plus généralisée que celle observée sur l'Île au cours des années antérieures (secteur de la rivière Jupiter en 1991, secteur de Rivière-à-la-Loutre en 1993). En l'absence des conditions abiotiques qui ont freiné ces dernières infestations, un risque éminent d'épidémies est à craindre dans les vieilles sapinières de l'ouest de l'Île d'Anticosti. Les populations se sont maintenues à un niveau endémique dans les autres régions de la province.

Tableau 2 - Superficies (ha) affectées par l'arpenteuse de la pruche au Québec en 1994

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Élevé	
Côte-Nord	617 (93)*	234 (320)	124 (59)	975 (472)

* ( ) = Superficies affectées en 1993

PRÉVISIONS

Un inventaire des oeufs a été réalisé à l'automne afin de suivre l'évolution de l'arpenteuse dans l'est de la province. Les résultats de cet inventaire ne sont pas encore disponibles.

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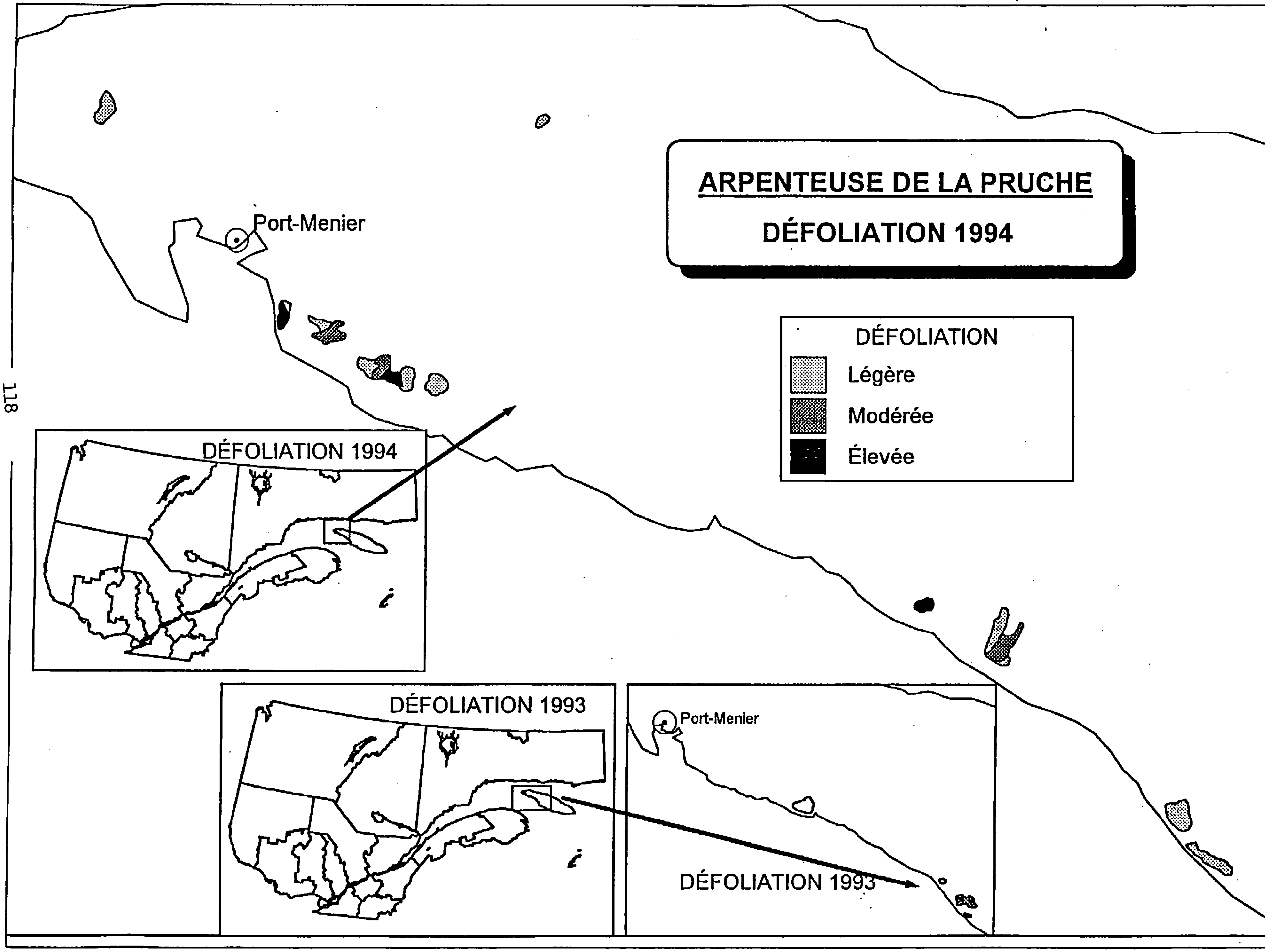

ARPENTEUSE DE LA PRUCHE
DÉFOLIATION 1994
DÉFOLIATION
Légère
Modérée
Élevée
Port-Menier
DÉFOLIATION 1994
DÉFOLIATION 1993
Port-Menier
DÉFOLIATION 1993

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Carte 3

TORDEUSE DU PIN GRIS
Choristoneura pinus pinus Free.

INFESTATION

Des défoliations locales ont été causées par la tordeuse du pin gris dans la région de l'Outaouais (Carte 4). Les superficies affectées totalisent 634 hectares dont 341 ont été défoliés modérément. Les dégâts ont continué de s'atténuer dans le foyer principal repéré en 1992 à l'Île-du-Grand-Calumet. Ils se sont cependant maintenus à un niveau modéré dans la partie nord de ce foyer ainsi que dans quelques secteurs situés à l'est de Fort-Coulonge. Une nouvelle infestation a également été détectée sur l'Île-aux-Allumettes.

Tableau 3 - Superficies (ha) affectées par la tordeuse du pin gris au Québec en 1994

Région administrative	Niveau de défoliation			Total
	Léger	Modéré	Élevé	
Outaouais	293 (362)*	341 (171)	0 (73)	634 (606)

* ( ) = Superficies affectées en 1993

PRÉVISIONS

Un relevé des larves en hibernation (L2) a été réalisé dans les aires infestées en 1994. Des résultats partiels indiquent que les foyers les plus anciens continueront de régresser l'an prochain. Des dégâts légers y sont prévus.

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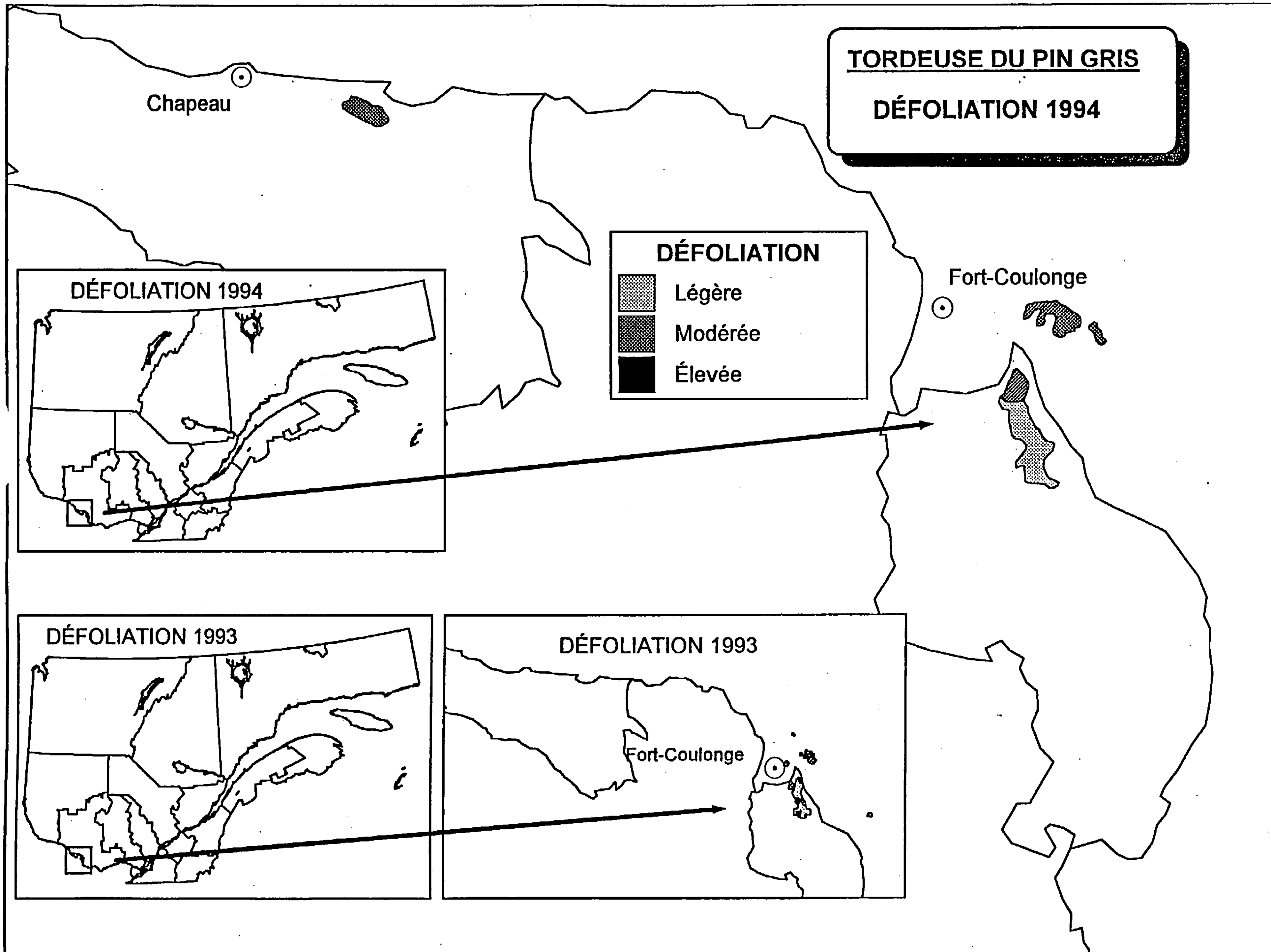
TORDEUSE DU PIN GRIS
DÉFOLIATION 1994
Chapeau
Fort-Coulonge
DÉFOLIATION
Légère
Modérée
Élevée
DÉFOLIATION 1994
DÉFOLIATION 1993
DÉFOLIATION 1993
Fort-Coulonge

Carte 4

DIPRION DE SWAINE
Neodiprion swainei Midd.

INFESTATION

Les populations du diprion de Swaine se sont maintenues généralement à un niveau faible dans l'ensemble des forêts de pin gris de la province. Les dégâts se sont avérés peu importants dans les foyers relevés depuis quelques années dans la région de la Mauricie-Bois-Francs, alors qu'une régression de l'insecte a été observée dans le foyer épidémique localisé à Pointe-Racine dans la région du Saguenay–Lac-Saint-Jean. Des dégâts modérés à élevés y ont toutefois été relevés sur 440 hectares, comparativement à 877 hectares en 1993. La mortalité des arbres continue de s'accentuer dans ce secteur.

SPONGIEUSE
Lymantria dispar (L.)

INFESTATION

La régression des populations de la spongieuse observée en 1993 s'est poursuivie en 1994. Aucune défoliation apparente causée par cet insecte n'a été relevée au Québec cette année.

LIVRÉE DES FORÊTS
Malacosoma disstria Hbn.

TORDEUSE DU TREMBLE
Choristoneura conflictana (Wlk.)

INFESTATION

Les populations de ces deux principaux défoliateurs du peuplier faux-tremble ont connu une régression marquée en 1994. Les superficies infestées par la livrée des forêts et la tordeuse du tremble dans la province ont en effet diminué respectivement de 50 % et 62 % par rapport à 1993. Les dégâts causés par la livrée n'ont été relevés que sur quelque 22 500 hectares locali-

...

sés principalement dans le secteur de La Tuque dans la région de la Mauricie–Bois-Francs, alors que la tordeuse du tremble a affecté quelque 650 hectares dans la région de Lanaudière et quelque 6 200 hectares dans la région de la Gaspésie–Îles-de-la-Madeleine. Les dégâts causés par ces deux insectes ont été de plus majoritairement de niveau léger. Le déclin de ces épidémies devrait se poursuivre en 1995.

ARPENTEUSE DE BRUCE
Operophtera bruceata (Hulst)

INFESTATION

En hausse depuis 1991, les populations de l'arpenteuse de Bruce ont continué d'augmenter en 1994. Ce défoliateur a été détecté sur l'érable à sucre et sur le peuplier faux-tremble dans presque toutes les régions du Québec. Des défoliations légères à modérées ont été relevées dans les régions de Chaudière-Appalaches, de l'Estrie et des Laurentides. Quelques foyers légers ont également été signalés dans les régions de la Montérégie et de l'Outaouais.

LÉGIONNAIRE NOIRE
Actebia fennica (Tausch.)

INFESTATION

Ce ravageur a causé, en 1993, des dégâts modérés dans des secteurs récemment ravagés par des feux de forêts et nouvellement reboisés dans la région de la Côte-Nord. En 1994, les populations de l'insecte sont complètement disparues.

FOREST INSECT AND DISEASE CONDITIONS IN QUÉBEC 1994

BY
CLÉMENT BORDELEAU[1]
DENIS LACHANCE[2]

Report prepared for the Annual Pest Control Forum, Ottawa, November 15-17, 1994

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1. Ministère des Ressources naturelles, Direction de la conservation des forêts, Québec (Québec)

2. Natural Resources Canada, Centre de foresterie des Laurentides, Sainte-Foy

INTRODUCTION

This report contains a summary description of the main insects and diseases identified in Québec's forests in 1994.

Highlights

- the increase in spruce budworm populations in the Outaouais region;
- the discovery of a number of small hemlock looper infestations on Anticosti Island;
- the persistence of jack pine budworm populations in some sectors of the Outaouais region and the discovery of a new infestation on aux Allumettes Island;
- the decrease of the Swaine jack pine sawfly populations in the Saguenay–Lac-Saint-Jean epidemic centre;
- decreases in forest tent caterpillar and large aspen tortrix infestations;
- the maintenance of gypsy moth populations at an endemic level throughout the province;
- the increase in bruce spanworm populations in several regions of Québec;
- the decrease in black army cutworm populations in the reforested areas of the Côte-Nord region.

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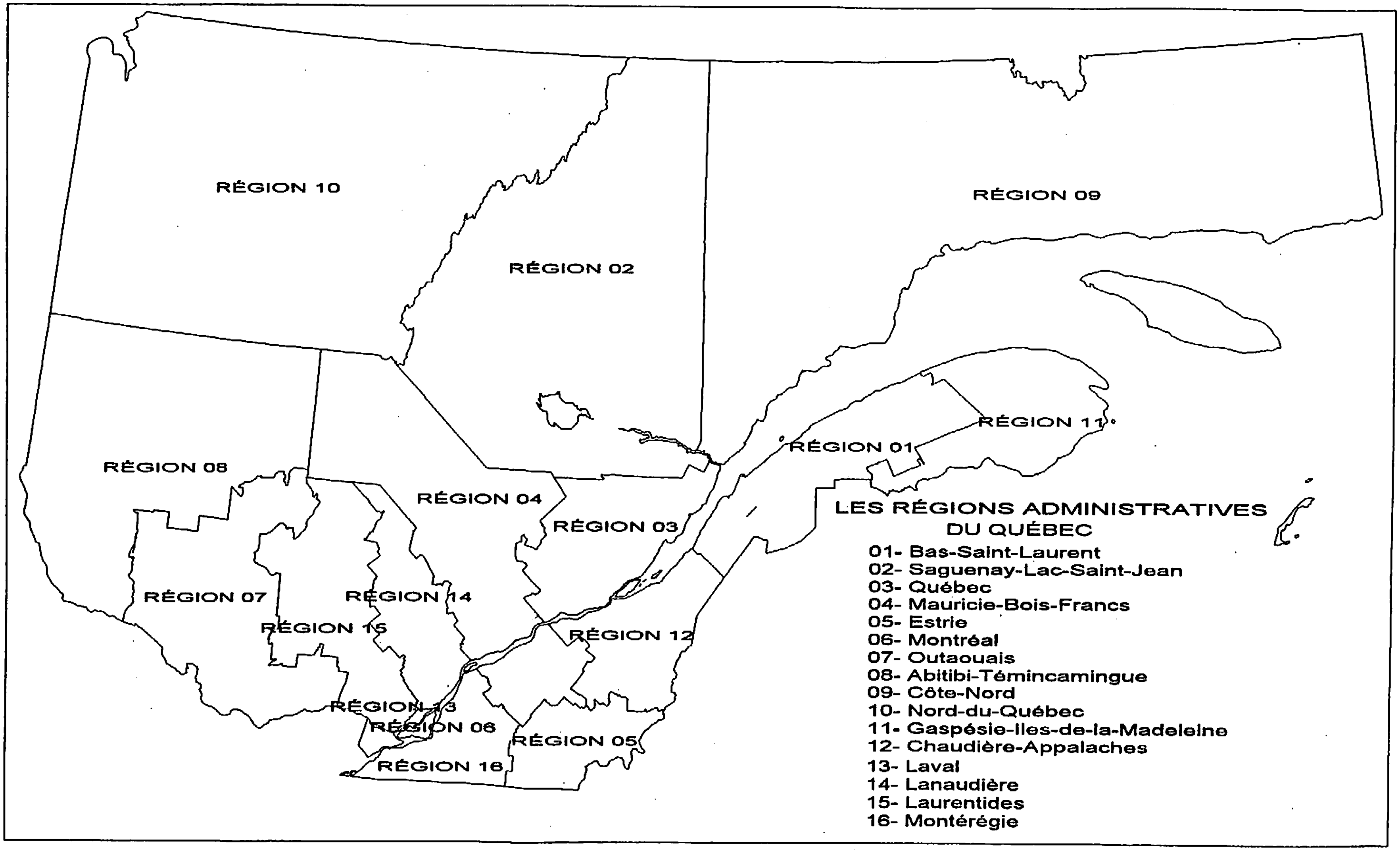
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08- Abitibi-Témincamingue
09- Côte-Nord
10- Nord-du-Québec
11- Gaspésie-Iles-de-la-Madeleine
12- Chaudière-Appalaches
13- Laval
14- Lanaudière
15- Laurentides
16- Montérégie

Figure 1

SPRUCE BUDWORM
Choristoneura fumiferana (Clem.)

OUTBREAK STATUS

In 1994, spruce budworm damage was discovered in nearly 3,000 hectares of private forest in the Outaouais region (Figure 2). Defoliation covers an area six times larger than in 1993 and is contained within the Gatineau-Fort-Coulonge-North Low triangle. Spruce budworm population levels have remained low elsewhere in the province, and no observable damage has been reported.

Tableau 1 - Areas (ha) of spruce budworm infestation in Québec in 1994

Administrative region	Level of defoliation			Total
	Light	Moderate	Severe	
Outaouais	936 (103)*	1 148 (172)	828 (202)	2 912 (477)

* ( ) = Areas affected in 1993

FORECAST

An inventory of hibernating larvae (L2) has been carried out in some 300 observation sites distributed throughout the province. Partial results show that in 1994 spruce budworm populations have continued to increase in the infested zone of the Outaouais region. In 1995, damage should be particularly severe along the Gatineau River. However, no major expansion of the infestation has been observed yet. The presence of the insect has also been more frequent in the center of the province, but damage should still be imperceptible next year. Populations remain low in the other parts of Québec.

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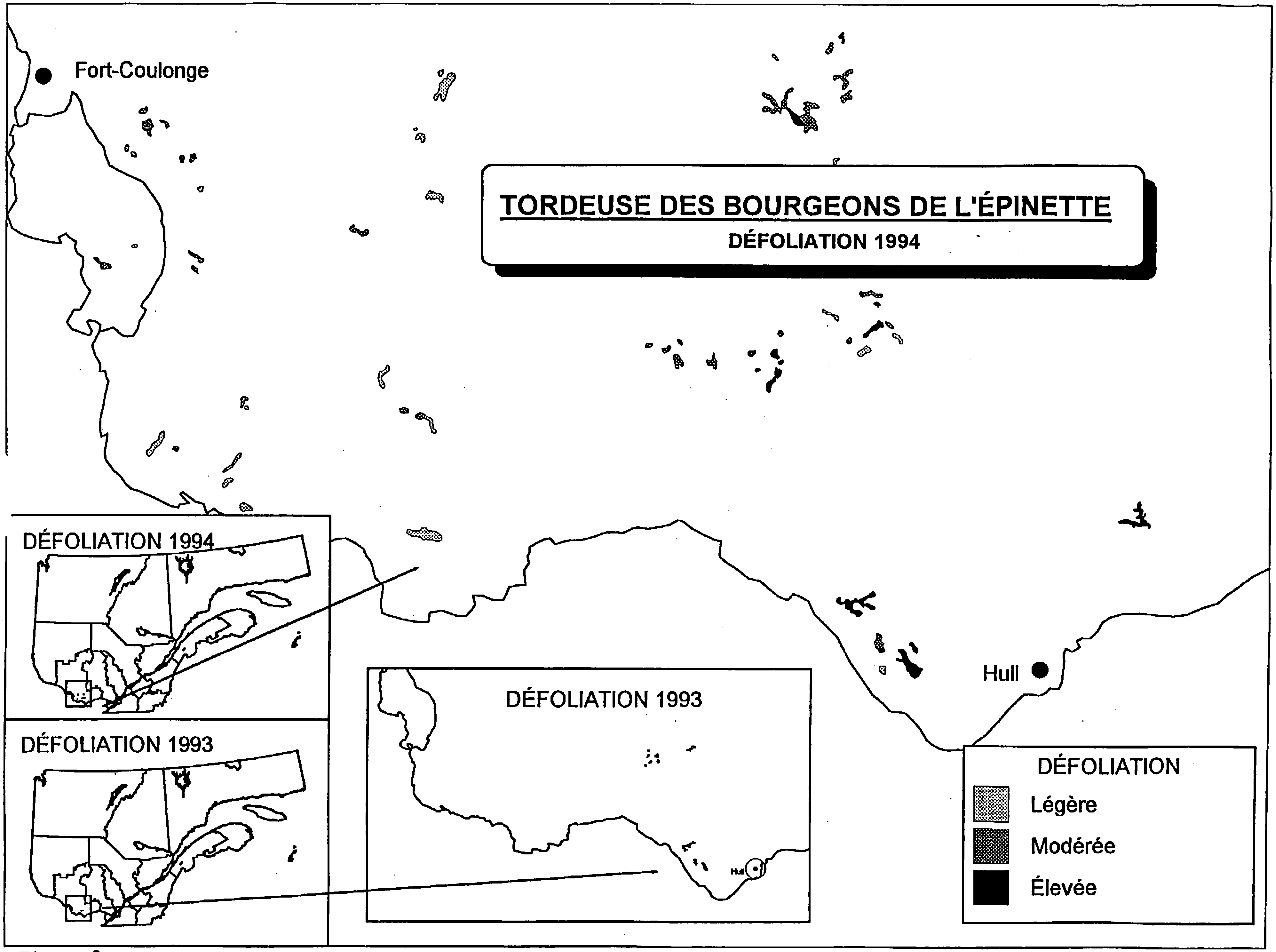
Fort-Coulonge
TORDEUSE DES BOURGEONS DE L'ÉPINETTE
DÉFOLIATION 1994
DÉFOLIATION 1994
DÉFOLIATION 1993
DÉFOLIATION 1993
Hull
DÉFOLIATION
Légère
Modérée
Élevée

Figure 2

HEMLOCK LOOPER
Lambdina fiscellaria fiscellaria (Guen.)

OUTBREAK STATUS

A number of small local infestations of hemlock looper were reported in the south-western part of Anticosti Island (Côte-Nord region) (Figure 3). Some 975 hectares are affected, 358 of which have moderate or severe levels of defoliation. The distribution of these infestations reflects a more generalized increase of population on the Island than in previous years (Jupiter River sector in 1991, Rivière-à-la-Loutre sector in 1993). In the absence of the abiotic conditions that checked these latter infestations, there is a clear risk of epidemic in the mature fir forests to the west of the Island. Populations have remained at an endemic level elsewhere in the province.

Tableau 2 - Areas (ha) of hemlock looper infestation in Québec in 1994

Administrative region	Level of defoliation			Total
	Light	Moderate	Severe	
Côte-Nord	617 (93)*	234 (320)	124 (59)	975 (472)

* ( ) = Areas affected in 1993

FORECAST

Eggs were inventoried in the fall to track developments in hemlock looper populations in Eastern Québec. The results of this survey are not yet available.

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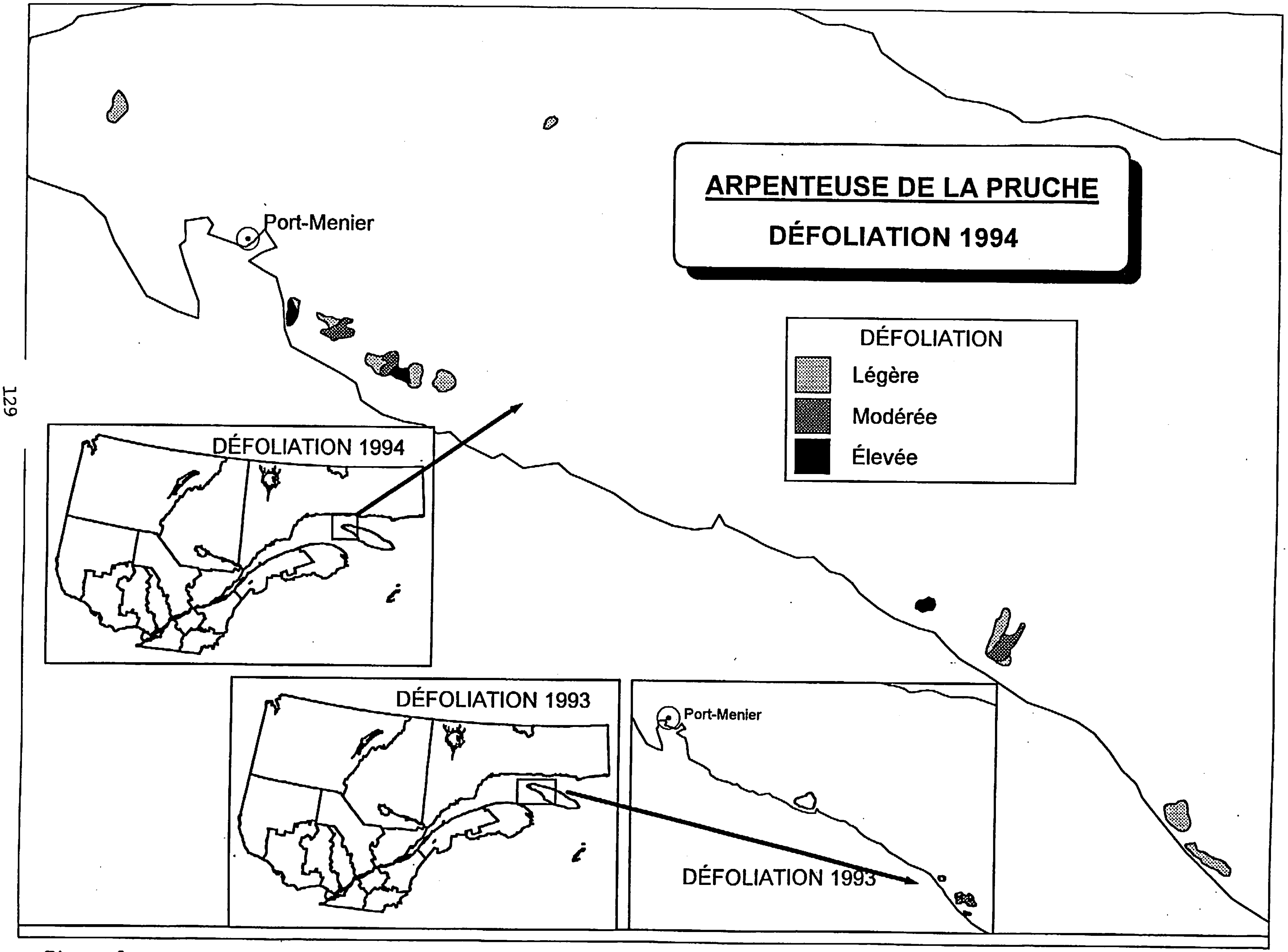
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DÉFOLIATION
Légère
Modérée
Élevée
Port-Menier
DÉFOLIATION 1994
DÉFOLIATION 1993
Port-Menier
DÉFOLIATION 1993

Figure 3

JACK PINE BUDWORM
Choristoneura pinus pinus Free.

OUTBREAK STATUS

Local defoliation caused by the jack pine budworm was found in the Outaouais region (Figure 4). Defoliation levels were moderate on 341 of the 634 hectares affected. Damage was less serious in the main centre of infestation discovered in 1992 on Grand Calumet Island, but remains moderate in the northern part of the infested area and in some sectors to the east of Fort-Coulonge. A new infestation was also discovered on aux Allumettes Island.

Tableau 3 - Areas (ha) of jack pine budworm infestation in Québec in 1994

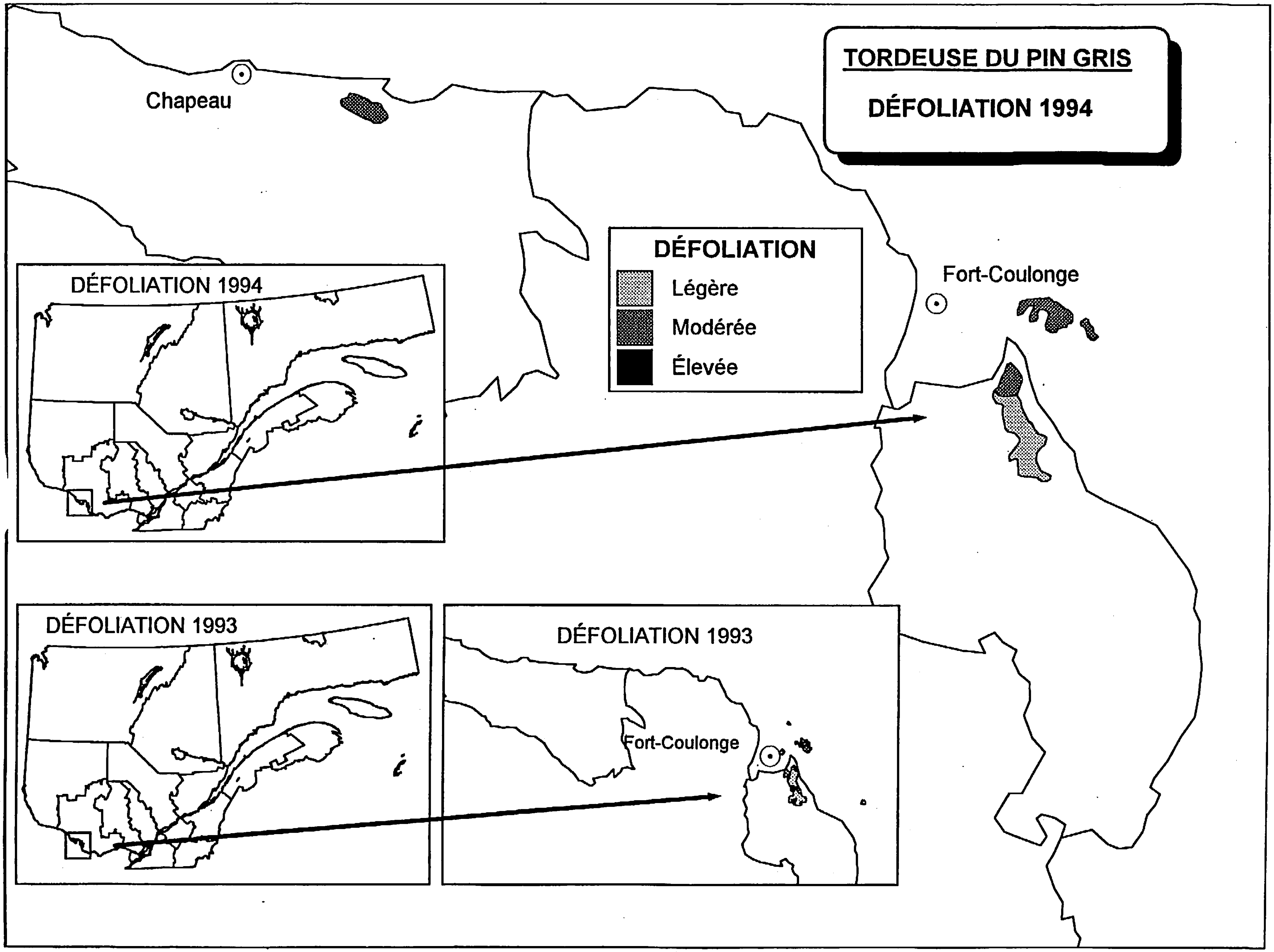
Administrative region	Level of defoliation			Total
	Light	Moderate	Severe	
Outaouais	293 (362)*	341 (171)	0 (73)	634 (606)

* ( ) = Areas affected in 1993

FORECAST

In 1994, an inventory of hibernating larvae was taken in the infested areas. Partial results suggest that the oldest infestations will continue to decrease next year, and only light damage is forecast for these areas.

...



TORDEUSE DU PIN GRIS
DÉFOLIATION 1994
Chapeau
Fort-Coulonge
DÉFOLIATION
Légère
Modérée
Élevée
DÉFOLIATION 1994
DÉFOLIATION 1993
DÉFOLIATION 1993
Fort-Coulonge

Figure 4

SWAINE JACK PINE SAWFLY
Neodiprion swainei Midd.

OUTBREAK STATUS

Swaine jack pine sawfly populations remained at a generally low level in the province's jack pine forests. Little damage was reported on infestation sites identified in recent years in the Mauricie-Bois-Francs region. Population levels have declined in the Pointe-Racine epidemic centre in the Saguenay-Lac-Saint-Jean region where moderate to severe damage was discovered over an area of only 440 hectares, compared with 877 hectares in 1993. However, tree death continues to increase in the sector.

GYPSY MOTH
Lymantria dispar (L.)

OUTBREAK STATUS

The decline in gypsy moth populations observed in 1993 continued in 1994, and no defoliation caused by the insect was reported anywhere in the province.

FOREST TENT CATERPILLAR
Malacosoma disstria Hbn.

LARGE ASPEN TORTRIX
Choristoneura conflictana (Wlk.)

OUTBREAK STATUS

Populations of these two major trembling aspen defoliators declined significantly in 1994. Areas infested by the forest tent caterpillar and the large aspen tortrix were reduced by 50% and 62% respectively compared with 1993 figures. Damage caused by the forest tent caterpillar was found on 22,500 hectares, mainly in the La Tuque sector of the Mauricie-Bois-Francs region,

...

while the large aspen tortrix damaged 650 hectares in the Lanaudière region and 6,200 hectares in the Gaspésie–Îles-de-la-Madeleine region. In both cases damage levels were mainly light. The decline of these epidemics is expected to continue in 1995.

BRUCE SPANWORM
Operophtera bruceata (Hulst)

OUTBREAK STATUS

The increase in bruce spanworm populations, which began in 1991, continued in 1994. The insect was found in sugar maples and trembling aspens in almost every region of Québec. Light to moderate defoliation levels were observed in the Chaudière-Appalaches, Estrie and Laurentides regions, and some small infestation sites were reported in the Montérégie and Outaouais regions.

BLACK ARMY CUTWORM
Actebia fennica (Tausch.)

OUTBREAK STATUS

In 1993, the black army cutworm caused moderate damage in the fire-damaged areas of the Côte-Nord region that had recently been reforestated. In 1994, the populations of this insect completely disappeared.

TECHNICAL NOTE No. 297

ISSN 0820-807

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES IN MID-JUNE 1994

This report is the first in a series this summer in which we will highlight forest pest conditions of significance in the Maritimes. This report covers the period up to mid-June, 1994. Subsequent reports will update the stories as they develop. More detailed information is available on request.

A cool wet spring during the month of May delayed tree and insect phenologies by an estimated two weeks. The Maritime region's weather monitoring stations recorded precipitation in amounts of 20 to 100% in excess of normal. Although frost was recorded at some of these stations up to and including the first full week in June, damage assessed so far has been no more than at light levels and limited to balsam fir in all three provinces.

Forest tent caterpillar, for the third year, has defoliated trembling aspen in New Brunswick. Severe defoliation appears restricted to the 1993 outbreak areas in southeastern York, northeastern Charlotte, Sunbury, Queens and Kent counties, N.B. Light defoliation, found at Sussex, Kings Co. and Upper Ridge, Westmorland Co., are new locations east of the current outbreak, suggesting a possible outbreak in subsequent years. Red oak, white birch, wire birch, apple, willow and alder have fallen prey to the so-called "army worms" in areas where trembling aspen was stripped of foliage. Forest tent caterpillar defoliation has been found for the first time since 1986 in Nova Scotia. Trace and light defoliation was reported in Annapolis, Lunenburg and Queens counties with severe defoliation in a few scattered hardwoods in Bridgetown, Annapolis Co., N.S. There have been no reports of damage in Prince Edward Island.

Eastern tent caterpillar is more common than in 1993 in southern New Brunswick, Antigonish and Guysborough counties and areas in western Nova Scotia, and the northeastern coast of Prince Co., P.E.I. Cherry, wild apple, and "flowering crabs" in urban settings are mainly affected, often with severe defoliation.

NURSERIES ☐

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SILVICULTURE ☐

UTILIZATION ☐

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TREE IMPROVEMENT ☐

INSECTS AND DISEASES ■

Canadian Forest Service-Maritimes Region

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Sirococcus shoot blight has been found causing shoot and branch mortality of tamarack at locations in York and Charlotte counties, N.B. Infection has varied from single trees to several trees per stand at all damage levels. This is only the second occasion of known shoot blight damage to tamarack recorded in the Maritimes. The first find in 1983 established tamarack as a new host record for *Sirococcus conigenus* (D&C) Cannon & Minter in Nova Scotia and Prince Edward Island.

Gypsy moth larvae in Nova Scotia are approximately 2.5 cm in length and are causing trace and light defoliation, together with Bruce spanworm and winter moth populations, on elm in Annapolis Royal, Annapolis Co. Gypsy moth larvae are also defoliating red oak at trace and light levels at Brooklyn, Queens Co., N.S. Spring egg mass surveys have added Barss Corner, Lunenburg Co. and Indian Fields, Shelburne Co. as new locations for gypsy moth in Nova Scotia. There are no new reports of damage or egg mass finds for New Brunswick and Prince Edward Island.

Aspen leafroller damage on trembling aspen appears to be more widespread in Madawaska, Victoria, Carleton, York, and Gloucester counties, N.B. than in 1993. Severe damage, from as many as six species, was found near St. Leonard, Madawaska Co., Grand Falls, Victoria Co. and Salmon River area, Victoria Co. Trace and light damage from leafrolling has been found throughout Nova Scotia and Prince Edward Island but patches of severe leafrolling were observed at North Alton, Kings Co., St. Croix, Hants Co. and Granton, Pictou Co., N.S.

Balsam shootboring sawfly populations, which have been very low in recent years, are on the increase in 1994. Shoot damage ranges from trace to severe levels in Nova Scotia and trace to light in New Brunswick and Prince Edward Island.

Other forest pests of note: **satin moth** has severely defoliated silver poplar in many areas in central and southeastern New Brunswick; **birch casebearer** caused moderate browning of white birch at a couple of locations in northeast New Brunswick and at Prince Edward Island National Park; **larch casebearer** populations continue to decline but small pockets of severe damage have been found in York and Charlotte counties, N.B.

J.E. Hurley and A.W. MacKay
Forest Insect and Disease Survey
June 17, 1994

NOTE TECHNIQUE

N° 297

ISSN 0820-807

LES PRINCIPAUX RAVAGEURS FORESTIERS DANS LES MARITIMES À LA MI-JUIN 1994

Ce rapport est le premier d'une série qui sera publiée cet été sur les principaux ravageurs forestiers dans les Maritimes. Il décrit les conditions observées jusqu'à la mi-juin 1994. Les rapports qui suivront renfermeront une mise à jour sur l'évolution de la situation. De plus amples informations peuvent être obtenues sur demande.

Le printemps a été frais et humide en mai, ce qui a retardé la phénologie des arbres et des insectes d'environ deux semaines. Les stations de surveillance des conditions météorologiques de la région des Maritimes ont enregistré des précipitations de 20 % à 100 % supérieures à la normale. Des périodes de gel ont été signalées jusqu'à la fin de la première semaine de juin à certaines de ces stations, mais les dommages observés jusqu'à maintenant sont légers tout au plus et sont limités au sapin baumier dans les trois provinces.

La **livrée des forêts** a défolié pour une troisième année le peuplier faux-tremble au Nouveau-Brunswick. Une défoliation grave semble limitée aux secteurs du sud-est du comté de York et du nord-est du comté de Charlotte, de même qu'aux comtés de Sunbury, Queens et Kent (Nouveau-Brunswick), où une infestation a eu lieu en 1993. Une défoliation légère a été observée à Sussex, comté de Kings, et à Upper Ridge, comté de Westmorland; il s'agit là de deux nouveaux endroits à l'est de la zone d'infestation actuelle, ce qui porte à croire qu'il y aura peut-être une infestation dans les années à venir. Le chêne rouge, le bouleau à papier, le bouleau gris, le pommier, le saule et l'aulne ont été attaqués par ce qu'il est convenu d'appeler des «vers légionnaires» dans les secteurs où le peuplier faux-tremble a été défolié complètement. Pour la première fois depuis 1986, la livrée des forêts a causé des dommages en Nouvelle-Écosse. On a signalé une défoliation minime et légère dans les comtés d'Annapolis, de Lunenburg et de Queens, de même qu'une défoliation grave de quelques feuillus dispersés à Bridgetown, comté d'Annapolis (Nouvelle-Écosse). Aucun dommage n'a été signalé sur l'Île-du-Prince-Édouard.

La **livrée d'Amérique** est plus répandue qu'en 1993 dans le sud du Nouveau-Brunswick, dans les comtés d'Antigonish et de Guysborough et dans des secteurs de l'ouest de la Nouvelle-Écosse, de même que sur la côte nord-est du comté de Prince, à l'Île-du-Prince-Édouard. Le cerisier, le pommier odorant et le «pommetier ornemental» croissant en milieu urbain sont les principales espèces touchées, la défoliation étant souvent grave.

PÉPINIÈRES ☐

PLANTATIONS ☐

SYLVICULTURE ☐

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AMÉLIORATION SYLVICOLE ☐

INSECTES ET MALADIES ■

Service canadien des forêts — Région des Maritimes
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La **brûlure des pousses Sirococcus** a causé la mort des pousses et des branches du mélèze dans les comtés de York et de Charlotte (Nouveau-Brunswick). L'infection variait, allant d'arbres individuels à plusieurs arbres par peuplement, et tous les niveaux de dommages ont été observés. C'est seulement la deuxième fois que l'on signale des dommages causés par cette brûlure au mélèze dans les Maritimes. La première observation, en 1983, a permis de déterminer que cette essence constituait un nouvel hôte de *Sirococcus conigenus* (D&C) Cannon & Minter en Nouvelle-Écosse et à l'Île-du-Prince-Édouard.

Les larves de la **spongieuse** mesurent environ 2,5 cm de longueur en Nouvelle-Écosse et causent, en association avec les populations d'arpenteuses de Bruce et d'arpenteuses tardives, une défoliation minime et légère de l'orme d'Annapolis Royal, comté d'Annapolis. Les larves de la spongieuse sont également à l'origine d'une défoliation minime et légère du chêne rouge à Brooklyn, comté de Queens (Nouvelle-Écosse). Les dénombrements de masses d'œufs effectués au printemps ont révélé que la spongieuse était maintenant présente à Brass Corner, comté de Lunenburg, et à Indian Fields, comté de Shelburn. Quant au Nouveau-Brunswick et à l'Île-du-Prince-Édouard, on n'a signalé aucun nouveau dommage ni masses d'œufs.

Les dommages causés par les **enrouleuses du tremble** semblent plus répandus qu'en 1993 sur le peuplier faux-tremble des comtés de Madawaska, Victoria, Carleton, York et Gloucester (Nouveau-Brunswick). Des dommages graves mettant en cause jusqu'à six espèces d'enrouleuses ont été observés près de Saint-Léonard, comté de Madawaska, à Grand-Sault, comté de Victoria, et dans le secteur de Salmon River, comté de Victoria. Des dommages minimes et légers ont été observés partout en Nouvelle-Écosse et à l'Île-du-Prince-Édouard, tandis que des dommages graves ont été signalés sur des bouquets d'arbres à North Alton, comté de Kings, à St. Croix, comté de Hants, et à Granton, comté de Pictou (Nouvelle-Écosse).

Les populations de **perce-pousses du sapin**, qui étaient peu nombreuses ces dernières années, sont à la hausse en 1994. Les dommages aux pousses vont de minimes à graves en Nouvelle-Écosse et de minimes à légers au Nouveau-Brunswick et sur l'Île-du-Prince-Édouard.

Autres ravageurs forestiers dignes de mention : le **papillon satiné** a gravement défolié le peuplier argenté dans de nombreux secteurs du centre et du sud-est du Nouveau-Brunswick; le **porte-case du bouleau** a causé un brunissement modéré du bouleau blanc à deux endroits dans le nord-est du Nouveau-Brunswick et dans le parc national de l'Île-du-Prince-Édouard; les populations de **porte-case du mélèze** continuent de diminuer, mais des dommages graves ont été observés sur de petites parcelles des comtés de York et de Charlotte (Nouveau-Brunswick).

J.E. Hurley et A.W. MacKay
Relevé des insectes et des maladies des arbres
le 17 juin 1994

TECHNICAL NOTE No. 299

ISSN 0820-807

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES AT THE END OF JUNE 1994

Forest pest conditions in the Maritimes, as they appear at the end of June 1994, are summarized here in our second report of the year.

Forest tent caterpillar has defoliated trembling aspen over a total of 392,000 ha in York, Sunbury, Charlotte, Queens, Kings, Kent, and Westmorland counties N.B. (Fig. 1). This is a two-fold increase in the area defoliated in 1993. Of the total area of defoliation, 284,000 ha was severe and 108,000 ha was moderate. Although the limits of the outbreak have changed only slightly from 1993 (defoliation was found for the first time in Kings County this year), the overall intensity of defoliation has increased to a level where a greater number of tree species, such as red oak, white birch, and wire birch, have been defoliated. Media and public attention has increased dramatically as larvae stripped foliage from a wide array of urban trees and shrubs. A number of callers have complained about annoying swarms of red-eyed flies. These flies are the pupal parasite (*Sarcophaga aldrichi* Parker) of the forest tent caterpillar. In addition to the counties reported above, trace and light defoliation has been found in Shelburne, Yarmouth, and Halifax counties, N.S. There have been no reports of defoliation from Prince Edward Island.

Spruce budworm defoliation in New Brunswick has been steadily declining in recent years. However, pest managers are keeping a close eye on population increases on white spruce, particularly in plantations. Moderate and severe defoliation by a mixed population of spruce budworm and **spruce budmoth** has been found in plantations in the Skin Gulch area of Victoria Co., New Brunswick. In Prince Edward Island, defoliation of white spruce appears to have declined from last year. However, light and moderate defoliation is still evident and confined mainly to southern Kings and Queens counties. Aerial surveys in all three provinces are expected to be underway within the next 2 weeks.

Sirococcus shoot blight infection of tamarack has been found across much of southern New Brunswick. Red flagging on infected branch tips, found at all damage levels, appears to affect only mature and semi-mature trees – those trees of cone-bearing age. Rarely more than a few trees are infected in a stand. In New Brunswick, flagging is often associated with infected, aborted female cones and the shoot beyond these dead cones. Although similar symptoms have been found on tamarack at several Nova Scotia locations and at a few locations in Prince Edward Island, the only confirmation of Sirococcus infection was at Forest Glen, Yarmouth Co. where trace to moderate damage was found.

NURSERIES

PLANTATIONS ☐

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ECONOMICS ☐

TREE IMPROVEMENT ☐

INSECTS AND DISEASES ■

Canadian Forest Service - Maritimes Region

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Fall cankerworm has been reported at increased population levels at a few locations in the Maritimes. Moderate and severe defoliation has been found on a number of hardwoods at urban and forest sites in Gloucester, Restigouche, and Sunbury counties, New Brunswick and Cape Breton Co., Nova Scotia. Manitoba maple has been hardest hit in all counties in Prince Edward Island.

More reports of moderate and severe defoliation of silver poplar by **satin moth** appear to indicate increased populations that are more widespread over the region than in 1993. Defoliated trees have now been found in nearly all New Brunswick counties; Kings, Queens, Antigonish, Guysborough, and Inverness counties, Nova Scotia; and throughout Prince Edward Island.

Gypsy moth daily observation pheromone traps should now have been placed by cooperators. The Gypsy Moth Coordinating Committee requests regular monitoring of these traps to determine whether storm fronts have blown in male moths from infested areas to the west and south of us. By verifying that blow-ins have or have not occurred we can evaluate all other traps used for delimitation and detection of gypsy moth in the Maritimes. There have been no reports of new gypsy moth finds in the Maritimes.

Other forest insect and disease conditions of note were as follows:
yellowheaded spruce sawfly moderately defoliated spruce at two locations in Queens County, and has severely defoliated blue spruce at locations in Carleton, York, and Sunbury counties, N.B.; **leaf and twig blight of aspen** is very common on trembling aspen in northern and southeastern areas of New Brunswick; **poplar serpentine leafminer** has mined foliage of trembling aspen at all levels of damage across northern New Brunswick; **oak leafroller and oak leaf shredder** have damaged red oak foliage at all levels of defoliation at several locations in Queens and Annapolis counties, N.S.; elm leafminer has browned mainly exotic elms in towns and villages of Queens, Kings, Annapolis, and Shelburne counties, N.S. and several locations across P.E.I.; **cherry blight** caused light and moderate damage to cherry throughout P.E.I.

J. E. Hurley
Forest Insect and Disease Survey
July 6, 1994

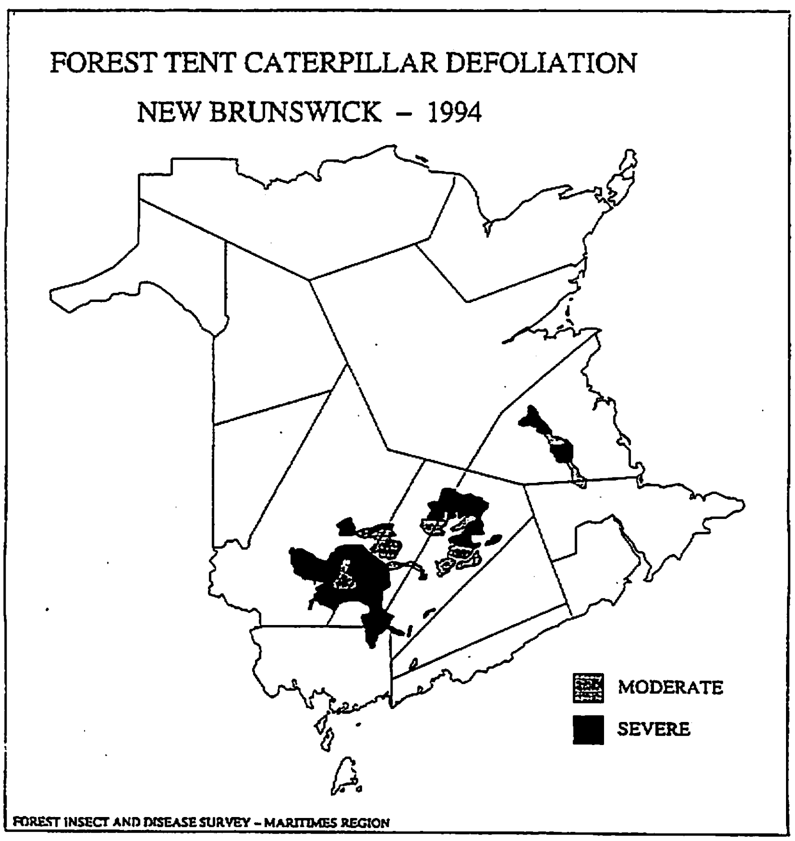

Fig. 1

NOTE TECHNIQUE

N° 299

ISSN 0820-807

LES PRINCIPAUX RAVAGEURS FORESTIERS DANS LES MARITIMES À LA FIN JUIN 1994

Les conditions observées à la fin de juin 1994 dans les Maritimes au sujet des ravageurs forestiers sont résumées dans cette note qui constitue notre deuxième rapport de l'année.

La **livrée des forêts** a défolié des peupliers faux-trembles sur une superficie totale de 392 000 ha dans les comtés de York, Sunbury, Charlotte, Queens, Kings, Kent et Westmorland au Nouveau-Brunswick (figure 1). Cela représente le double de la superficie défoliée en 1993. Sur l'ensemble de la superficie défoliée, 284 000 ha ont subi une grave défoliation et 108 000 ha une défoliation modérée. Même si les limites de la flambée n'ont que peu changé par rapport à 1993 (la défoliation a été observée pour la première fois dans le comté de Kings cette année), l'intensité globale de la défoliation a atteint un niveau tel qu'un plus grand nombre d'essences (comme le chêne rouge, le bouleau blanc et le bouleau gris) ont été touchées. Le phénomène a beaucoup retenu l'attention des médias et du public, car tandis que les larves rongeaient le feuillage d'un vaste éventail d'arbres et d'arbrisseaux urbains. Un certain nombre d'appelants se sont plaints d'essaims de mouches à oeil rouge. Ces mouches sont les nymphes de la livrée des forêts (*Sarcophaga aldrichi* Parker). Outre les comtés dont il est question ci-dessus, on a pu observer une défoliation infime et légère dans les comtés de Shelburne, Yarmouth et Halifax (Nouvelle-Écosse). Il n'y a pas eu un seul rapport de défoliation en provenance de l'Île-du-Prince-Édouard.

La défoliation provoquée par la **tordeuse des bourgeons de l'épinette** au Nouveau-Brunswick a régulièrement baissé ces dernières années. Toutefois, les responsables de la lutte contre les ravageurs observent de très près les hausses de population sur l'épinette blanche, particulièrement dans les plantations. Une défoliation modérée et grave provoquée par une population mixte de tordeuses des bourgeons et de **tordeuses des pousses de l'épinette** a été observée dans les plantations de la région de Skin Gulch dans le comté de Victoria (Nouveau-Brunswick). À l'Île-du-Prince-Édouard, la défoliation de l'épinette blanche semble avoir régressé par rapport à l'an dernier. Toutefois, une défoliation légère et modérée est toujours manifeste et est essentiellement confinée à la partie sud des comtés de Kings et Queens. Des relevés aériens des trois provinces devraient être entrepris au cours des deux prochaines semaines.

PÉPINIÈRES ☐

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INSECTES ET MALADIES ■

Service canadien des forêts — Région des Maritimes
C.P. 4000 Fredericton (N.-B.) E3B 5P7 - C.P. 667, Truro (N.-É.) B2N 5E5
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La **brûlure des pousses du mélèze laricin attribuable au «Sirococcus»** a été observée dans une bonne partie du sud du Nouveau-Brunswick. Le dépérissement des extrémités des branches contaminées, observé à tous les niveaux de dégâts, semble n'affecter que les arbres mûrs et semi-mûrs (ceux qui sont en âge de porter des cônes). Il est rare que plus de quelques arbres soient contaminés dans un peuplement. Au Nouveau-Brunswick, le dépérissement d'un arbre a souvent un rapport avec les cônes femelles avortés d'arbres contaminés et avec la pousse au-delà de ces cônes morts. Même si des symptômes de même nature ont été observés sur des mélèzes dans plusieurs endroits de la Nouvelle-Écosse et de l'Île-du-Prince-Édouard, la seule confirmation d'une infection par le Sirococcus a été faite à Forest Glen dans le comté de Yarmouth où des dégâts minimes à modérés ont été observés.

L'**arpenteuse d'automne** a été signalée en plus grands nombres dans quelques endroits des Maritimes. La défoliation modérée et grave d'un certain nombre d'arbres feuillus a été observée dans les villes et les stations forestières des comtés de Gloucester, Restigouche et Sunbury (Nouveau-Brunswick) et dans le comté de Cape Breton (Nouvelle-Écosse). C'est l'érable négondo qui a été le plus durement touché dans tous les comtés de l'Île-du-Prince-Édouard.

Un plus grand nombre de rapports de défoliation modérée et grave du peuplier blanc argenté par le **papillon satiné** semble indicatif d'une augmentation des populations de cet insecte dans la région par rapport à 1993. Des arbres défoliés ont maintenant été observés dans presque tous les comtés du Nouveau-Brunswick, dans les comtés de Kings, Queens, Antigonish, Guysborough, Inverness en Nouvelle-Écosse et dans toute l'Île-du-Prince-Édouard.

Les collaborateurs devraient avoir mis en place des pièges à phéromones qui permettent d'observer quotidiennement la spongieuse. Le comité de coordination de la spongieuse demande la surveillance régulière de ces pièges pour savoir si des creux barométriques ont amené avec eux des spongieuses mâles en provenance des régions infestées situées à l'ouest et au sud des Maritimes. En vérifiant qu'une infestation s'est ou non produite, nous pouvons évaluer tous les autres pièges qui servent à délimiter et à détecter la présence de spongieuses dans les Maritimes. Il n'y a pas eu de rapports de nouvelles observations de spongieuses dans les Maritimes.

Autres ravageurs forestiers dignes de mention :
La **tenthrède à tête jaune de l'épinette** a modérément défolié des épinettes dans deux endroits du comté de Queens et a gravement défolié des épinettes bleues dans plusieurs endroits des comtés de Carleton, York et Sunbury (N.-B.); la **brûlure des feuilles et des rameaux du faux-tremble** est très courante sur le peuplier faux-tremble dans le nord et le sud-est du Nouveau-Brunswick; la **mineuse des feuilles du tremble** a provoqué tous les niveaux de dégâts sur le feuillage de peupliers faux-trembles dans le nord du Nouveau-Brunswick; l'**enrouleuse et la tordeuse du chêne** ont endommagé le feuillage des chênes rouges à tous les niveaux de défoliation dans plusieurs endroits des comtés de Queens et d'Annapolis (N.-É.); la **mineuse de l'orme** a entraîné la brunissure d'ormes essentiellement exotiques dans les villes et les villages des comtés de Queens, Kings, Annapolis et Shelburne (N.-É.) et dans plusieurs endroits de l'Île-du-Prince-Édouard; la **brûlure du cerisier** a provoqué des dégâts légers et modérés aux cerisiers de toute l'Île-du-Prince-Édouard.

J. E. Hurley
Relevé des insectes et des maladies des arbres
6 juillet 1994

DÉFOLIATION PROVOQUÉE PAR LA LIVRÉE DES FORÊTS AU NOUVEAU-BRUNSWICK - 1994

MODÉRÉ
GRAVE

RELEVÉ DES INSECTES ET DES MALADIES DES ARBRES - RÉGION DES MARITIMES

Figure 1

TECHNICAL NOTE No. 302

ISSN 0820-807

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES AT THE END OF JULY 1994

Forest pest conditions in the Maritimes, as they appear at the end of July 1994, are summarized here in our third report of the year.

A **smog** alert issued by Environment Canada late on July 20th lasted for approximately 3 days. A stagnant air mass, originating from the northeastern United States, settled over Charlotte, Kings, and Saint John counties in southern New Brunswick creating conditions favorable for significant concentrations of ground level ozone. Coincidently, the Forest Insect and Disease Survey placed ozone monitors at 29 locations throughout the Maritimes Region, the day before the alert, to determine their feasibility as monitoring tools in forest stands. Although it is unclear at this time what visible effects on forests trees may be apparent, these devices are being tested to record and monitor ozone events ultimately.

Spruce budworm aerial surveys are now complete for all three Maritime provinces, with detectable defoliation found only in Prince Edward Island. Defoliation occurred over an area of approximately 38,600 ha, with 2500 ha moderately defoliated (33,800 ha of severe and moderate defoliation reported in 1993) and 36,100 ha of light defoliation, all mainly on white spruce in southern Queens and Kings counties (Figure 1). Although the area of defoliation dropped slightly from 1993 (43,000 ha) the most significant change was the decrease in overall intensity of defoliation.

Gypsy moth pheromone traps have been deployed for detection purposes throughout the Maritimes. A few cooperators from the Fredericton area, York County and St. Andrews, Charlotte County, New Brunswick report that no male moths have been caught in the daily monitoring traps during the month of July. The lack of blown-in males in our region's pheromone trap monitoring system will allow a more meaningful interpretation of catch results. Hopefully, for the second year in a row, no such blow-in events will occur anywhere in the Maritimes. Ground surveys by the New Brunswick Department of Natural Resources & Energy have found life stages, other than male moths, at three new locations: Fredericton Junction, Sunbury County; Oak Point Provincial Park, Kings County; and Bouctouche, Kent County.

NURSERIES

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INSECTS AND DISEASES ■

Canadian Forest Service - Maritimes Region

P.O. Box 4000, Fredericton, N.B. E3B 5P7 - P.O. Box 667, Truro, N.S. B2N 5E5

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Birch leafminer damage, the cumulative browning effect caused by three insect species on white birch and wire birch, is causing moderate and severe browning in many areas of Albert, Westmorland, and Kings counties, New Brunswick. The most severe damage was found at Kelly's Beach, Kouchibouguac National Park, Kent County.

Spruce beetle killed white spruce in several Nova Scotia mainland counties but is most widespread and of higher incidence in northern Antigonish, Kings, and Hants counties.

Stillwell's Syndrome is more common in eastern mainland Nova Scotia and Cape Breton than in 1993. Red crowns of balsam fir were also a common sight during aerial and ground surveys in Prince Edward Island.

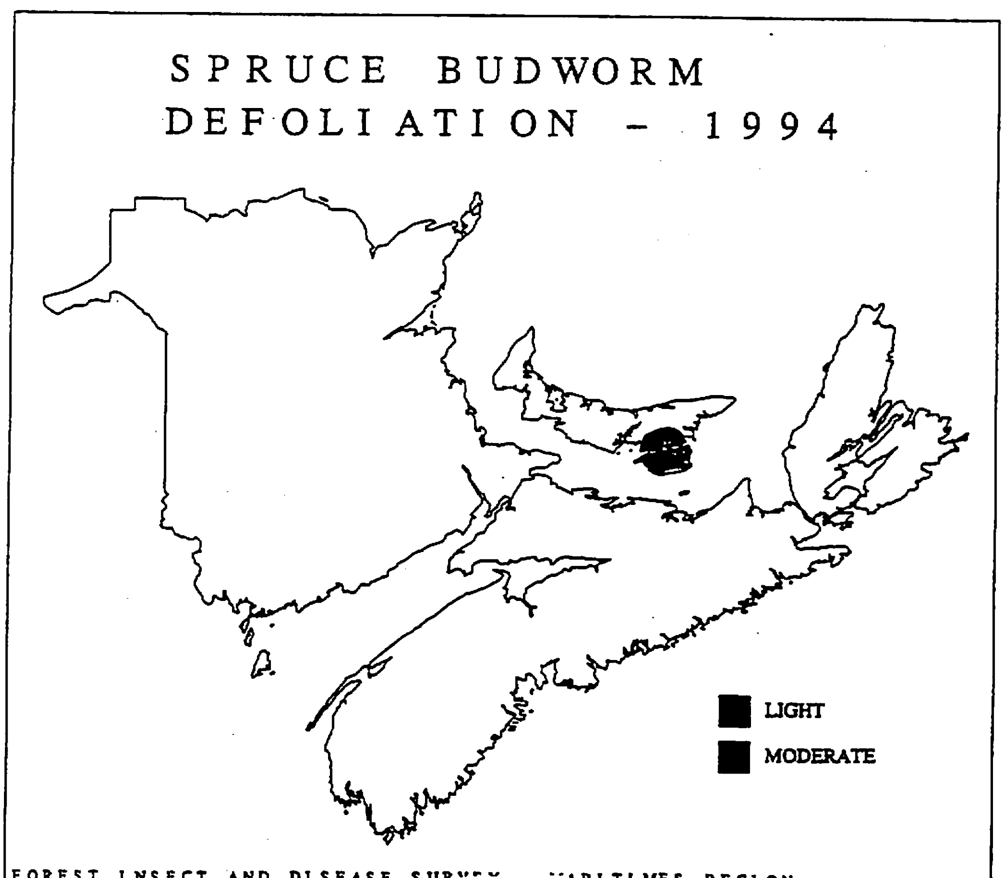
Fall webworm larvae have spun nests, easily visible along roadsides, on several deciduous species at several locations in central and southern New Brunswick, in three counties in southwestern Nova Scotia and most notably in the Brookfield-Hilden area, Colchester County.

Elm leaf beetle has, for the seventh year, caused moderate and severe browning on white elm in the city of Fredericton, York County, New Brunswick. The cumulative effect of several years of leaf skeletonizing has resulted in the death of about 40 downtown trees and has weakened many more.

Other forest insect and disease conditions of note were as follows: **alder flea beetle** has browned alder at all levels of damage across much of central and southern New Brunswick, western Nova Scotia, and across Prince Edward Island; **eastern blackheaded budworm** has caused trace and light defoliation to balsam fir in western Restigouche County, N.B.; **spiny elm caterpillar** has stripped willow and trembling aspen foliage, at all damage levels, throughout Madawaska, Restigouche, Kings, and Westmorland counties, N.B.; **needle rusts of balsam fir** are readily found across New Brunswick but damage levels are highest in northern areas (52% of needles on all balsam fir at Blacklands Brook, Restigouche Co.); **white pine weevil** is very common in parts of central and southern New Brunswick and western Nova Scotia with incidence as high as one-third of trees; **uglynest caterpillar** has been found in New Brunswick and Nova Scotia, most noteworthy near Upper Musquodoboit, Halifax County where several hundred nests were found; **imported willow leaf beetle**, a new pest record for Nova Scotia, has moderately and severely browned willow at several locations in southwestern Nova Scotia.

J. E. Hurley
Forest Insect and Disease Survey
August 5, 1994

Figure 1



NOTE TECHNIQUE

N° 302

ISSN 0820-807

LE POINT SUR LES RAVAGEURS DES FORÊTS DANS LES MARITIMES À LA FIN JUILLET 1994

Les dégâts provoqués par les ravageurs des forêts dans les Maritimes, à la fin de juillet 1994, sont résumés ici dans notre troisième rapport de l'année.

Une alerte au **smog** émise par Environnement Canada le 20 juillet en fin de journée a duré près de trois jours. Une masse d'air stagnant provenant du nord-est des États-Unis s'est immobilisée à la verticale des comtés de Charlotte, de Kings et de Saint John dans le sud du Nouveau-Brunswick, provoquant des conditions propices à de fortes concentrations d'ozone au niveau du sol. En marge de ce phénomène, les responsables du Relevé des insectes et des maladies des forêts ont installé des appareils de mesure de l'ozone dans 29 endroits des Maritimes la veille de l'alerte afin de déterminer s'ils constituaient de bons instruments de surveillance des peuplements forestiers. Même s'il est difficile de savoir pour l'instant quels effets visibles sont apparents sur les arbres forestiers, ces appareils continuent d'être testés pour enregistrer et surveiller les événements relatifs à l'ozone.

Les relevés aériens de la **tordeuse des bourgeons de l'épinette** sont désormais terminés dans les trois Provinces maritimes, et on n'a constaté une défoliation détectable qu'à l'Île-du-Prince-Édouard. Cette défoliation a affecté une superficie d'environ 38 600 ha, 2 500 ha étant modérément défoliés (33 800 ha de défoliation grave et modérée signalés en 1993) et 36 100 ha légèrement défoliés, principalement des épinettes blanches dans les comtés de Queens et de Kings dans le sud de la province (figure 1). Même si la superficie défoliée a légèrement baissé par rapport à 1993 (43 000 ha), le changement le plus notoire a été la baisse de l'intensité globale de la défoliation.

Des pièges à phérormone de la **spongieuse** ont été déployés à des fins de détection dans toutes les Maritimes. Quelques collaborateurs de la région de Fredericton, dans le comté d'York et de St. Andrews, dans le comté de Charlotte (Nouveau-Brunswick) nous ont appris qu'aucune spongieuse de sexe masculin n'avait été prise dans les pièges de surveillance quotidienne au mois de juillet. L'absence de mâles dans le système de surveillance que constituent les pièges à phérormone de la région permettra d'interpréter les résultats des prises de manière plus utile. On peut espérer que pour la deuxième année d'affilée, aucun front météorologique n'amènera des spongieuses dans les Maritimes. Les relevés au sol réalisés par le ministère des Ressources naturelles et de l'Énergie du Nouveau-Brunswick ont révélé des stades de développement autres que des spongieuses de sexe masculin dans trois nouveaux endroits : à Fredericton Junction, dans le comté de Sunbury; dans le parc provincial d'Oak Point, dans le comté de Kings; et à Bouctouche, dans le comté de Kent.

PÉPINIÈRES

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Service canadien des forêts — Région des Maritimes

C.P. 4000 Fredericton (N.-B.) E3B 5P7 - C.P. 667, Truro (N.-É.) B2N 5E5 - C.P. 190, Charlottetown (Î.-P.-É.) C1A 7K2

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Les dégâts causés par la **petite mineuse du bouleau** et l'effet de brunissure cumulé provoqué par trois espèces d'insectes sur le bouleau blanc et le bouleau gris se traduisent par une brunissure modérée et grave dans de nombreuses régions des comtés d'Albert, de Westmorland et de Kings (Nouveau-Brunswick). Les dégâts les plus sérieux ont été constatés à Kelly's Beach, dans le parc national Kouchibouguac, dans le comté de Kent.

Le **dendroctone de l'épinette** a tué des épinettes blanches dans plusieurs comtés de la Nouvelle-Écosse, mais il est surtout répandu et son incidence est particulièrement élevée dans les comtés d'Antigonish, de Kings et de Hants situés dans le nord.

Le **syndrome de Stillwell** était plus courant dans l'est de la Nouvelle-Écosse et au Cap-Breton qu'en 1993. Les relevés aériens et au sol réalisés à l'Île-du-Prince-Édouard ont révélé un certain nombre de cimes rouges sur des sapins baumiers.

Les larves de la **chenille à tente estivale** ont tissé des nids, qui sont faciles à voir depuis la route, sur plusieurs essences de feuillus dans plusieurs endroits du sud et du centre du Nouveau-Brunswick, dans trois comtés du sud-ouest de la Nouvelle-Écosse et particulièrement dans la région de Brookfield-Hilden, dans le comté de Colchester.

La **galéruque de l'orme** a pour la septième année d'affilée provoqué la brunissure modérée et grave d'ormes blancs dans la ville de Fredericton, dans le comté de York (Nouveau-Brunswick). L'effet cumulé de plusieurs années de squelettisation des feuilles a provoqué la mort d'environ 40 arbres du centre-ville et en a affaibli quantité d'autres.

Parmi les autres insectes et maladies des forêts dignes de mention, signalons : l'**altise de l'aulne** a entraîné la brunissure d'aulnes à tous les niveaux de dégâts dans une bonne partie du centre et du sud du Nouveau-Brunswick, dans l'ouest de la Nouvelle-Écosse et dans toute l'Île-du-Prince-Édouard; la **tordeuse à tête noire de l'épinette** a entraîné la défoliation infime et légère de sapins baumiers dans l'ouest du comté de Restigouche (N.-B.); la **chenille épineuse de l'orme** a dégarni le feuillage de saules et de peupliers faux-trembles à tous les niveaux de dégâts, dans les comtés de Madawaska, Restigouche, Kings et Westmorland (N.-B.); la **rouille des aiguilles du sapin baumier** affecte toutes les régions du Nouveau-Brunswick, mais les dégâts sont particulièrement élevés dans les régions septentrionales (52 % des aiguilles de tous les sapins baumiers au ruisseau Blackland, comté de Restigouche); le **charançon du pin blanc** est très courant dans certaines parties du centre et du sud du Nouveau-Brunswick et dans l'ouest de la Nouvelle-Écosse où il affecte jusqu'au tiers des arbres; la **tordeuse du cerisier** a été observée au Nouveau-Brunswick et en Nouvelle-Écosse, particulièrement près de Upper Musquodoboit, comté de Halifax, où plusieurs centaines de nids ont pu être observés; la **galéruque du saule importée**, nouveau ravageur découvert en Nouvelle-Écosse, a entraîné la brunissure modérée et grave de saules dans plusieurs endroits du sud-ouest de la Nouvelle-Écosse.

J.E. Hurley
Relevé des insectes et des maladies des forêts
5 août 1994

Figure 1

DÉFOLIATION CAUSÉE PAR
LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE — 1994

LÉGÈRE
MODÉRÉE

RELEVÉ DES INSECTES ET DES MALADIES DES FORÊTS - RÉGION DES MARITIMES

TECHNICAL NOTE No. 303

ISSN 0820-807

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES TO MID-SEPTEMBER 1994

This report, our fourth and final one for 1994, summarizes noteworthy forest pest conditions that have occurred since the end of July in the Maritimes.

Variable oak leaf caterpillar defoliation of beech has been found at locations in New Brunswick and Nova Scotia. Defoliation ranged from light to severe, with much of the damage on understorey trees and the lower canopy; in several locations, however, stands were completely defoliated. Most defoliation, involving an area of approximately 11,000 ha (7400 ha of which was severely defoliated), was in Charlotte and central and southern York counties, New Brunswick. Larvae were found in most western Nova Scotia counties, with the most significant defoliation at locations in Digby, Lunenburg, and Queens counties, as well as Antigonish County, N.S.

Gypsy moth continues to make inroads in the Maritimes. A total of 150 egg masses was found within a 200-m area in Kejimkujik National Park, Queens County, N.S. No visible defoliation was apparent. Egg masses were also found at several other Nova Scotia locations, all in areas where they have been found in previous years: Annapolis Royal, Bridgetown, and Upper Clements, Annapolis County; Hantsport, Hants County; Kentville, Kings County; Bridgewater, Lunenburg County; Brooklyn and Liverpool, Queens County. Several life stages were found near Central Cambridge, Queens County, N.B. There are no reports for Prince Edward Island. Gypsy moth pheromone traps should have been collected by now. The Gypsy Moth Coordinating Committee encourages prompt reporting and exchange of information to facilitate inter-agency fall egg mass surveys.

Browning of white birch was very visible along New Brunswick's Fundy coastline at levels not observed since 1988. Over an area of approximately 438,000 ha, white birch stands were affected at all levels of damage, with about 93,000 ha of severe browning just west of the City of Saint John, St. John County and the eastern half of coastal Charlotte County, including portions of Grand Manan and Campobello Islands.

Larch sawfly defoliation was more common and widespread in western Nova Scotia than in 1993, but was most noticeable in Lunenburg County, where severe defoliation occurred in numerous stands.

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Canadian Forest Service - Maritimes Region

P.O. Box 4000, Fredericton, N.B. E3B 5P7 - P.O. Box 667, Truro, N.S. B2N 5E5

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Spider mites caused moderate and severe browning of needles on young, open-growing larch in plantations and hedgerows, and along roadsides throughout Nova Scotia and Prince Edward Island.

Early fall coloration, especially on white birch and red maple, is prevalent throughout the Maritimes and is probably the effect of **drought**, caused by the hot, dry weather conditions we enjoyed this summer.

Other forest insects and diseases of note are as follows: **flat leaftiers** caused moderate and severe damage in most red oak stands in Annapolis, Halifax, Lunenburg, and Queens counties, N.S.; **birch sawfly**, common on white birch and alder throughout New Brunswick, completely defoliated young white birch at three locations in Restigouche and Northumberland counties, N.B.; **aspen webworms** caused trace, light, and moderate damage in areas of New Brunswick where forest tent caterpillar defoliation occurred earlier this year; **eastern larch beetle** caused increased larch mortality in Northumberland, Queens, and St. John counties, N.B., Digby County, N.S., and Prince County, P.E.I.; **flea weevils on willow** caused moderate and severe leaf browning throughout Nova Scotia and Prince Edward Island; **yellowheaded spruce sawfly** caused moderate and severe defoliation in numerous black spruce plantations in southeastern New Brunwick and Prince Edward Island; **greenstriped mapleworm** moderately and severely defoliated red maple near Allardville, Gloucester County, N.B.; **birch skeletonizer** affected patches of white birch at moderate and severe levels of browning throughout P.E.I.

Notice: Copies of the national report, "Forest Insect and Disease Conditions in Canada, 1991", are available on request. Please request in writing or by phone (506)452-3561 or fax (506)452-3078.

A.W. MacKay and J.E. Hurley
Forest Insect and Disease Survey
September 20, 1994

NOTE TECHNIQUE

N° 303

ISSN 0820-807

LE POINT SUR LES RAVAGEURS DES FORÊTS DANS LES MARITIMES À LA MI-SEPTEMBRE 1994

Ce rapport, qui est le quatrième et dernier de l'année 1994, fait le point sur les insectes et les maladies des arbres observés dans les Maritimes depuis la fin du mois de juillet.

On a observé un degré variable de défoliation du hêtre par la **livrée du chêne** au Nouveau-Brunswick et en Nouvelle-Écosse. Les dégâts constatés allaient de légers à graves, la plupart touchant les arbres du sous-étage et du couvert inférieur; dans plusieurs endroits toutefois, les peuplements étaient complètement défoliés. La plus forte défoliation touchant une superficie d'environ 11 000 ha (dont 7 400 ha étaient gravement défoliés) a été observée dans le comté de Charlotte et dans le centre et le sud du comté de York (Nouveau-Brunswick). Des larves ont été observées dans la plupart des comtés de l'ouest de la Nouvelle-Écosse, la défoliation la plus significative étant survenue dans les comtés de Digby, Lunenburg et Queens ainsi que dans le comté d'Antigonish (N.-É.).

La **spongieuse** continue de faire des incursions dans les Maritimes. Au total, 150 masses d'oeufs ont été observées dans un secteur de 200 m^2 dans le parc national Kejimkujik, comté de Queens (N.-É.). Il n'y avait pas de défoliation visible. Des masses d'oeufs ont également été observées dans plusieurs autres endroits de la Nouvelle-Écosse, partout là où on en avait observé les années précédentes : Annapolis Royal, Bridgetown et Upper Clements, comté d'Annapolis; Hansport, comté de Hants; Kentville, comté de Kings; Bridgewater, comté de Lunenburg; Brooklyn et Liverpool, comté de Queens. Plusieurs cycles biologiques ont été observés près de Central Cambridge, comté de Queens (N.-B.). Il n'y a pas eu d'observations à l'Île-du-Prince-Édouard. On a sans doute aujourd'hui ramassé le butin des pièges à phérormone de la spongieuse. Le Comité de coordination de la spongieuse préconise la transmission rapide de rapports et d'informations pour faciliter les enquêtes interorganismes sur les masses d'oeufs observées à l'automne.

Le **brunissement du bouleau blanc** était éminemment visible le long du littoral de Fundy au Nouveau-Brunswick à des concentrations qui n'avaient pas été vues depuis 1988. Sur une superficie d'environ 438 000 ha, les peuplements de bouleaux blancs avaient subi tous les niveaux de dégâts, environ 93 000 ha ayant subi un brunissement grave juste à l'ouest de la ville de Saint John, dans le comté de Saint-Jean et dans la moitié est de la région côtière du comté de Charlotte, notamment certaines parties des îles de Grand Manan et Campobello.

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- INSECTES ET MALADIES ■

Service canadien des forêts — Région des Maritimes

C.P. 4000 Fredericton (N.-B.) E3B 5P7 - C.P. 667, Truro (N.-É.) B2N 5E5

Also available in English upon request

La défoliation due à la **tenthrède du mélèze** était plus marquée dans l'ouest de la Nouvelle-Écosse qu'en 1993, mais était particulièrement visible dans le comté de Lunenburg, où de nombreux peuplements ont fait l'objet d'une grave défoliation.

Le **tétranyque à deux points** a provoqué le brunissement modéré et grave des aiguilles de jeunes mélèzes poussant à découvert dans des plantations et des haies et le long des routes à travers toute la Nouvelle-Écosse et l'Île-du-Prince-Édouard.

L'**apparition précoce des couleurs d'automne**, surtout sur les bouleaux blancs et les érables rouges, a pu être observée dans toutes les Maritimes et est sans doute imputable à la **sécheresse** résultant de l'été chaud et sec que nous avons connu cette année.

Parmi les autres insectes et maladies qu'il y a lieu de mentionner : l'**oécophore des feuillus** a causé des dégâts modérés et graves dans la plupart des peuplements de chênes rouges des comtés d'Annapolis, Halifax, Lunenburg et Queens (N.-É.); la **tenthrède du bouleau**, courante sur les bouleaux blancs et les aulnes de tout le Nouveau-Brunswick, a complètement défolié de jeunes bouleaux blancs dans trois endroits des comtés de Restigouche et de Northumberland (N.-B.); la **pyrale-tisseuse du peuplier** a provoqué des dégâts infimes, légers et modérés dans plusieurs secteurs du Nouveau-Brunswick touchés par la défoliation de la livrée des forêts au début de cette année; le **dendroctone du mélèze** a entraîné la mortalité accrue des mélèzes dans les comtés de Northumberland, Queens et Saint-Jean (N.-B.), dans le comté de Digby (N.-É.) et le comté de Prince (Î.-P.-É.); l'**orchestre du saule** a entraîné le brunissement modéré et grave des feuilles dans toute la Nouvelle-Écosse et l'Île-du-Prince-Édouard; la **tenthrède à tête jaune de l'épinette** a provoqué la défoliation modérée et grave de nombreuses plantations d'épinettes noires dans le sud-est du Nouveau-Brunswick et à l'Île-du-Prince-Édouard; l'**anisote de l'érable** a entraîné la défoliation modérée et grave d'érables rouges, près d'Allardville, comté de Gloucester (N.-B.); la **squeletteuse du bouleau** a provoqué des dégâts modérés et graves dans plusieurs foyers de bouleaux blancs à travers toute l'Î.-P.-É.

Nota : Vous pouvez vous procurer des exemplaires du rapport national «Insectes et maladies des arbres au Canada 1991». Il vous suffit d'en faire la demande par écrit ou au téléphone (506) 452-3561 ou télécopieur (506) 452-3078.

A.W. MacKay et J.E. Hurley
Relevé des insectes et des maladies des arbres
20 septembre 1994

SPRUCE BUDWORM AND HEMLOCK LOOPER IN NEW BRUNSWICK IN 1994

(Prepared * for Annual Forest Pest Control Forum, Ottawa, Nov. 14-17, 1994)

SPRUCE BUDWORM

Status

Spruce budworm has been a major pest of softwood forests of New Brunswick resulting in major aerial forest protection programs. Since 1952, control programs have been an annual occurrence with the sole exception of 1959 when there was optimism that the outbreak had or was going to collapse and hence no spraying was done. With the generally low population outlook from the fall 1993 forecast, the decision was made not to conduct any spraying on Crown land in 1994. J. D. Irving Limited, however, conducted a small (22 300 ha) program on their freehold limits. That program consisted of single applications of Bt (Foray 76B; Futura XIV-HP) to 79% of the area and single applications of Fenitrothion to 21% of the area. Figure 1 illustrates the size of protection programs conducted by Forest Protection Limited in New Brunswick from 1952 to 1994.

For the second consecutive year, the aerial survey of defoliation did not detect any areas of budworm feeding large enough to map. Figure 2 illustrates the historic trend of moderate and severe defoliation in New Brunswick from 1949 to 1994.

Forecast

The L2 survey conducted in the fall of 1994 identified areas totalling 284 000 ha (compared to 213 000 ha in 1993 - Figure 3) in which populations of spruce budworm were detected (Figure 4). Of this total, most of area (i.e. 278 000 ha) had low populations which are expected to cause non-detectable to light defoliation in 1995. One small area of 6 000 ha in northwestern New Brunswick close to the Quebec border had detectable moderate to high populations which are expected to cause moderate to severe defoliation in 1995. No major control programs are expected for 1995.

HEMLOCK LOOPER

Status

No damage due to hemlock looper was predicted to occur in New Brunswick in 1994 and none was detected by the aerial survey of defoliation.

Forecast

A fall 1994 egg survey was conducted at 300 locations where periodic damage had been detected in the past five years. All counts indicate low populations and hence no hemlock looper damage or control program is anticipated for 1995.

* N. Carter
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Fredericton, N.B., E3B 5H1

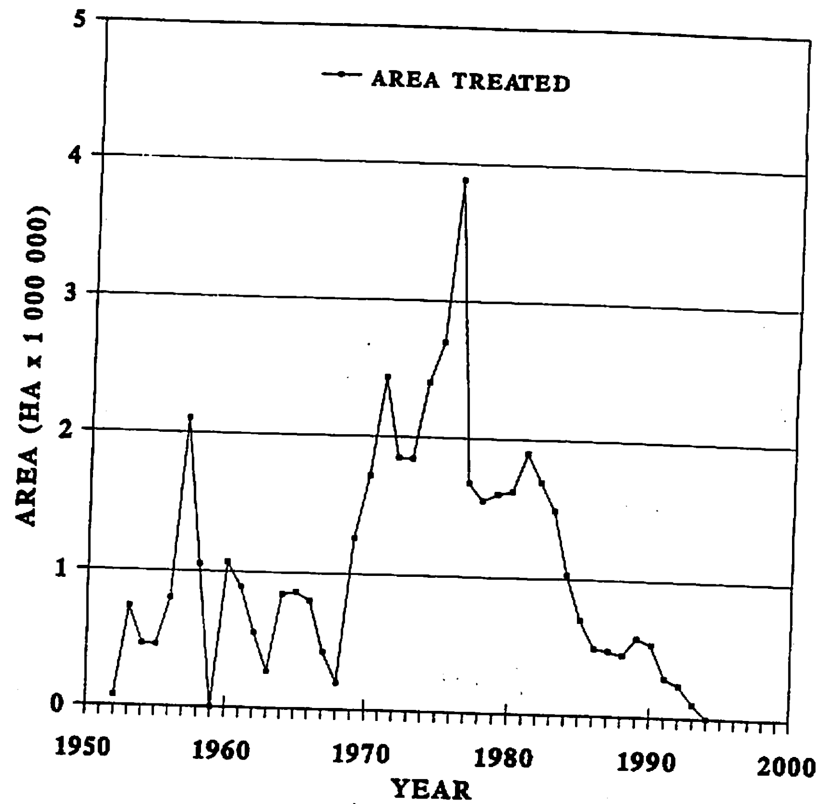

Figure 1. Size of protection programs against spruce budworm conducted by Forest Protection Ltd. from 1952 to 1994.

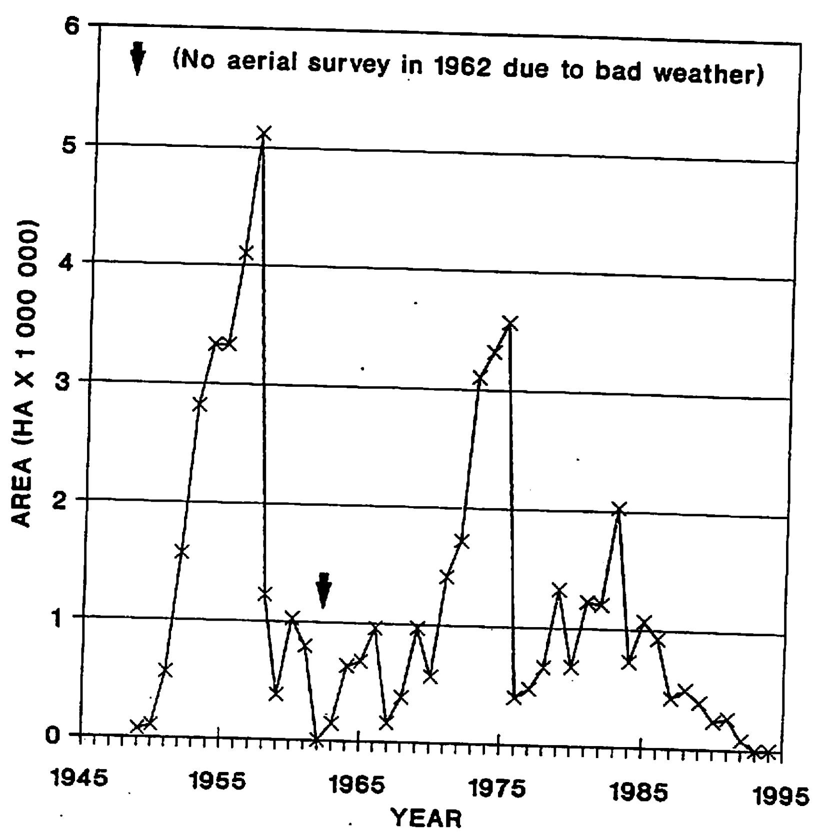

Figure 2. Historic trend of Moderate to Severe defoliation caused by spruce budworm in New Brunswick from 1949 to 1994.

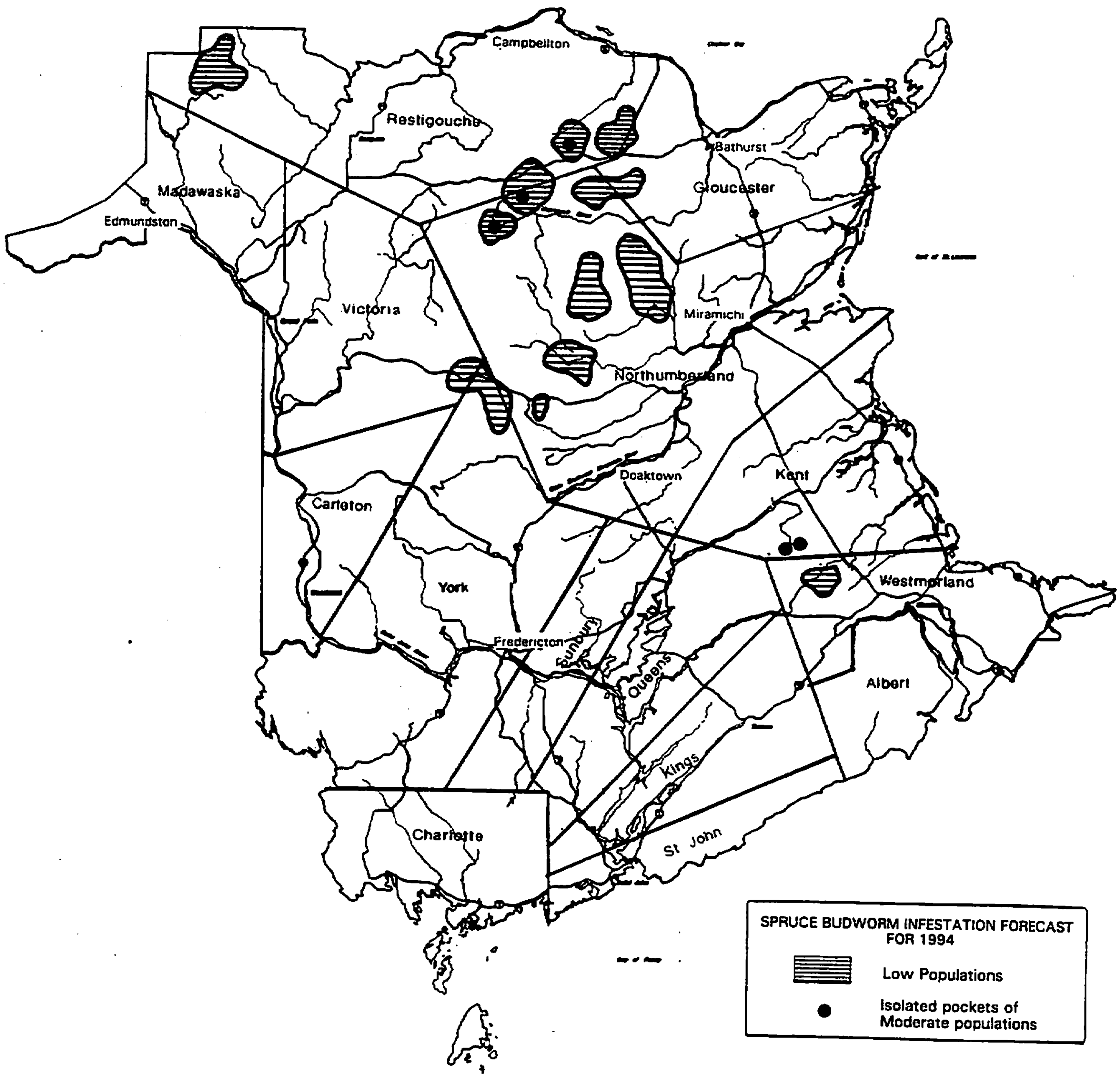

Figure 3. Spruce budworm infestation forecast for 1994 in New Brunswick.

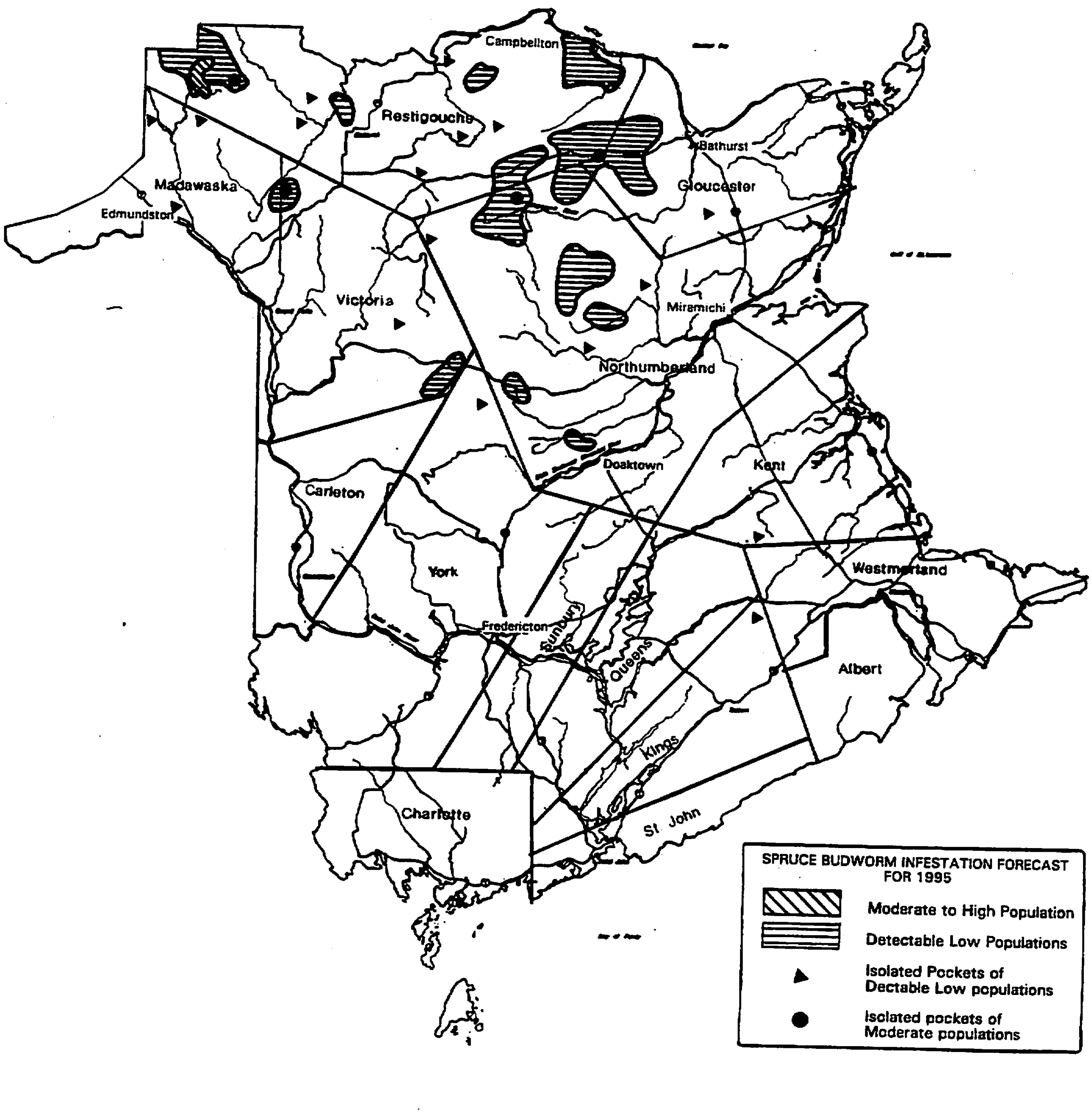

Figure 4. Spruce budworm infestation forecast for 1995 in New Brunswick.

GYPSY MOTH IN NEW BRUNSWICK IN 1994

(Prepared* for Annual Forest Pest Control Forum, Ottawa, Nov. 14-17, 1994)

BACKGROUND

Gypsy Moth (GM) was first detected in new Brunswick in 1936 and was reported to be eradicated by intensive actions over a 4-year period. It was, however, re-detected about 40 years later in 1981. During the 11-year period from 1981-1992, routine monitoring annually detected GM life stages, other than male moths, at locations in southwestern New Brunswick close to the Maine border, and at locations in Fredericton. Some locations had consistent annual finds while others have been inconsistent from year to year. Despite this history of presence, only once was visible defoliation caused by severe feeding. This was confined to 4 ha of second growth poplar in the vicinity of Moores Mills about 20-km north of St. Stephen in 1987. Very aggressive actions in 1987 and 1988 were successful in eradication at this location.

The saga of GM in New Brunswick since 1981 has been one of frustration on behalf of the New Brunswick Department of Natural Resources and Energy (DNRE) resulting from the lack of a federal national policy on GM and the lack of commitment by Agriculture and Agri-Food Canada (AAFC) to initiate an aggressive eradication and/or slow-the-spread program in the 1980s. Failure to do so was viewed by DNRE as being tantamount to abrogation of responsibility by AAFC. Although some very limited actions were taken, there was a failing to implement a 3-to-5 year plan to determine whether eradication or containment were indeed possible. It now appears that GM populations are also present in certain local areas not previously known to be positive for GM.

In the summer of 1993, it was brought to DNRE's attention by FIDS (CFS-MR) that positive finds of GM larvae east of Fredericton at Robertson Point on Grand Lake were confirmed. This represented a major change in the known distribution of GM in New Brunswick. DNRE mounted a fall egg mass survey ultimately looking for GM life stages at 551 locations. To our chagrin a total of 20 spots were found to be positive east of Fredericton, in addition to 24 locations in the southwest generally known to be positive (Figure 1). On the bright side was the fact that the positive locations were primarily in and around a few more specific locations (eg. Grand Lake, Washademoak Lake) as opposed to being generally and widely distributed everywhere. Based on this information, DNRE held internal discussions which subsequently led to consultation with AAFC officials early in 1994. What follows is the outcome of these discussions.

COOPERATIVE 1994 GM PROGRAM

The consensus of the consultation included the following:

- Eradication of GM from new locations in south-central New Brunswick could not be accomplished in a single year; a minimum three-year period, even five years, would be required with annual reviews to monitor progress.

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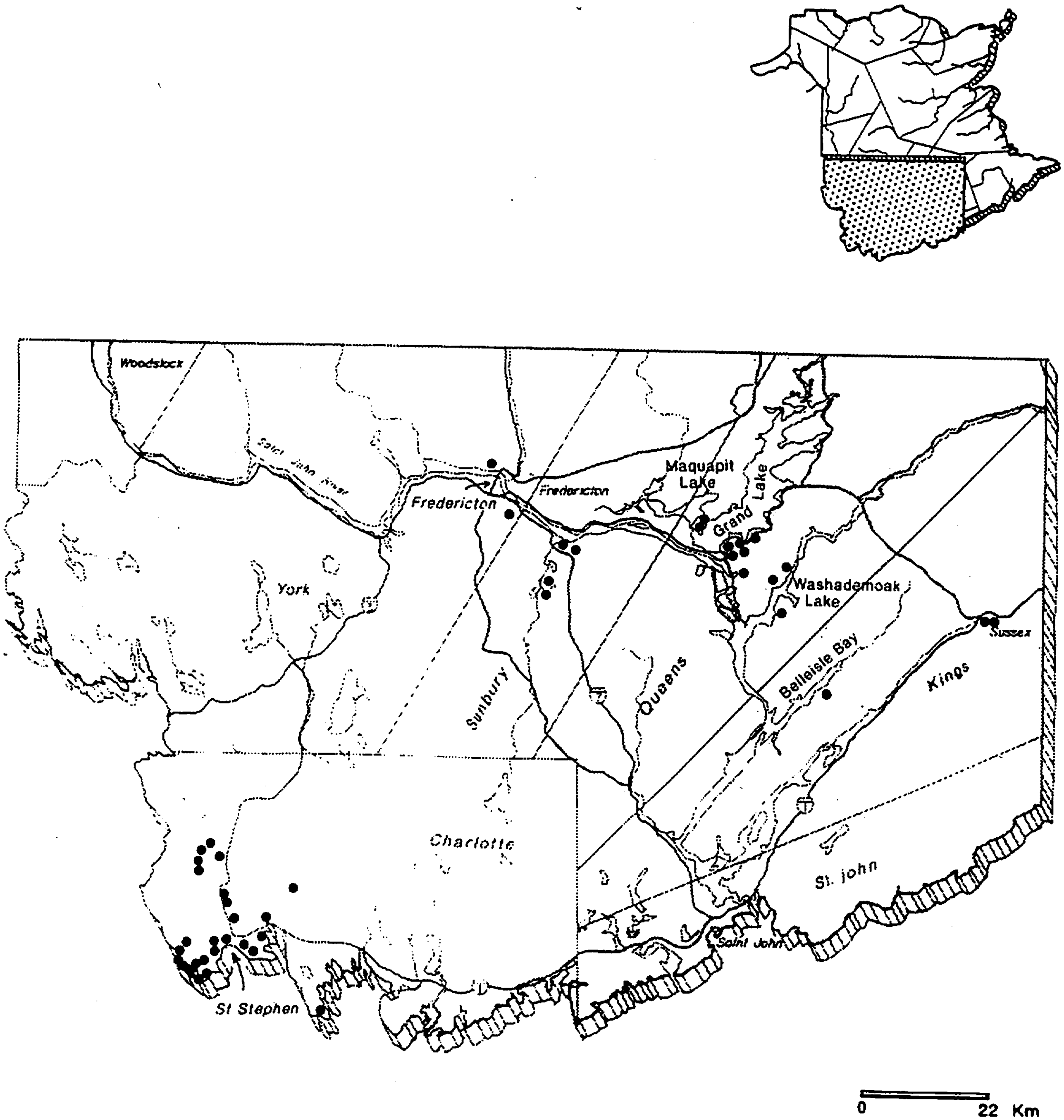


Figure 1. Approximate locations (•) where gypsy moth life stages (other than male moths) were found in New Brunswick in 1993 (Note: 507 negative locations not shown).

- Aerial applications of Bacillus thuringiensis var. kurstaki (Btk) was one of the safest and most cost-effective eradication treatments readily available for GM. Despite this it was recognized that because of bureaucratic procedures there was insufficient time to prepare and mount an aerial or ground control program for 1994.

- In place of aerial treatments, other actions be conducted to attempt to suppress or eradicate, and limit the spread of GM populations from known areas.

- That additional surveys be conducted to detect areas with GM populations for direct actions in 1994 where possible, or for follow-up action in 1995.

Although DNRE had outlined three options (i.e. $1.6 million - Most Aggressive; $1.0 million - Moderately Aggressive; $0.8 million - Least Aggressive), AAFC were not in position to participate at these levels. Consequently, at AAFC request, DNRE outlined minimal actions with an estimated cost of $150 000 to which AAFC agreed to contribute $75 000 if DNRE would do likewise. DNRE agreed, but without prejudice. The result was a program with two main objectives as follows:

1. Selected actions (other than aerial treatments) be conducted to eliminate or reduce GM populations and minimize the spread of this insect from previously detected locations; and,

2. Surveys be conducted to determine the distribution of GM: i) throughout the Province, and ii) within previously detected areas within the Province.

To accomplish these objectives, the following actions (i.e. condensed description) were done:

Spring '94 Egg Mass Search and Destroy:

From April 5 to May 10, egg mass search and destroy work was done at 14 locations east of Fredericton, and at 9 locations west of Fredericton. Overall, a total of 572 egg masses were collected, consisting of 414 from east of Fredericton, and 158 from west of Fredericton. All work was completed prior to the dates of first egg hatch.

Summer '94 Life Stage Survey:

A Province-wide survey for GM life stages other than male moths was conducted (excluding known positive zone in southwestern N.B.) from May 13 to July 8, and August 2 to 12. This survey was conducted primarily in high risk areas (i.e. recreational and cottage areas, parks and campgrounds) and other sites with favored host species. Searching was generally set at 30 minutes/2-person-crew/location for the purpose of detection rather than delimitation. All landowners were contacted either in person or by letter prior to or at the time of searching, and given search results prior to leaving the site.

A total of 594 locations were sampled of which 572 were negative and 22 were new positive sites (Figure 2). With few notable exceptions the survey indicated that GM was not generally widespread throughout the Province, but appeared to be primarily limited (outside the known positive southwestern area) to areas around Grand Lake, Washademoak Lake, and Belleisle Bay.

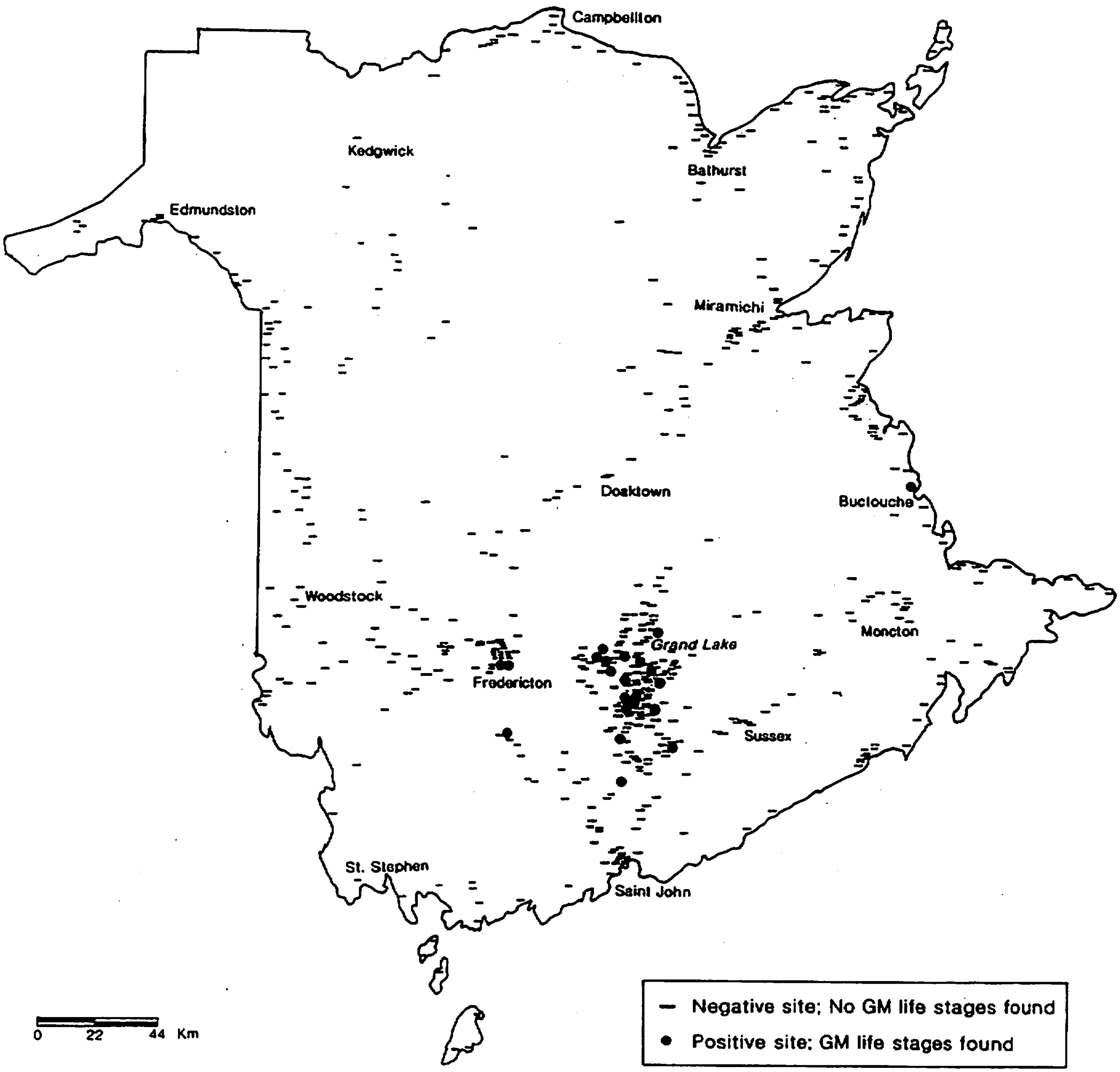


Figure 2. Locations sampled during the Summer '94 life stage survey.

Intensive Pheromone Trapping:

Intensive pheromone trapping was conducted at all sites found to be positive in the Fall of 1993 and at most positive sites found in the Summer '94 life stage survey. Traps were usually placed at a density of 25/ha using a transect method where possible to place them at regular spacing. Over the period July 12-21, a total of 1937 delta traps baited with lures were placed at 41 locations east of Fredericton, and 910 were placed at 21 locations west of Fredericton. Traps were placed prior to male moth emergence. A total of 158 traps were replaced after it was observed that male moths sometimes flew into traps and out again. Inspection revealed that due to the traps only having two sticky internal surfaces, the presence of 10-15 moths and dislodged wing scales limited trap catching efficiency.

Over the period Sept. 12-19, 98% of the traps east of Fredericton were collected (i.e. 1 887 traps). Of these, 211 traps were found on the ground, having apparently worn off the wire hanger. West of Fredericton, 99% of the traps were collected (i.e. 902 traps); including 60 found on the ground. Overall 25 847 male moths were caught, i.e. 18 293 east of Fredericton (avg. = 9.7/trap), and 7 554 west of Fredericton (avg. = 8.4/trap). In future, non-saturating traps would be more beneficial for efforts to reduce mating by maximizing the catch of males emerging before females.

Fall '94 Egg Mass Search and Destroy:

All locations positive in the Fall of 1993 or found to be positive during the Summer '94 life stage survey were examined from Sept. 19 to Oct. 26 in the Fall '94 egg mass search and destroy work. A total of 43 locations were searched east of Fredericton resulting in the finding of 8 231 new egg masses. West of Fredericton, a total of 331 new egg masses were found at 21 locations. The number of new egg masses ranged from 1 to a high of 2 236.

Overall, the occurrence of new egg masses (n.e.m.) east of Fredericton was 4.5 times greater than that found west of Fredericton on a person-hour (p-h) basis (i.e. 12.45 n.e.m./p-h cf. 2.83 n.e.m./p-h). This might, however, also reflect the greater time spent searching east of Fredericton (i.e. 661 p-h cf. 116 p-h). Five locations west of Fredericton and 14 locations east of Fredericton had >10 n.e.m./p-h searching.

Of note was the fact that east of Fredericton 7 of the original 42 positive locations were subsequently negative in the Fall of 1994; as were 5 of the original 22 positive locations west of Fredericton.

Fall '94 Egg Mass Forecast Survey:

The Fall '94 survey was conducted from Oct. 27 to Dec. 2 prior to significant snowfall. Overall, 688 locations were examined (30 minutes/2-person-crew/location). Positive GM life stages were found at 30 of the 452 locations east of Fredericton, and 22 of the 236 locations west of Fredericton. Because of the close proximity of many of these "locations" to previously detected sites, it was decided to determine the area of these zones (Figure 3). To do this a 1-km radius circle representing ca. 300 ha was drawn around each positive location on 1:50000 topographic maps. Where circles overlapped, hand contouring was done. As a result, east of Fredericton a total area of ca. 6 500 ha and 8 spot locations were identified. In contrast, west of Fredericton an area of ca. 24 000 ha and 8 spot locations were identified.

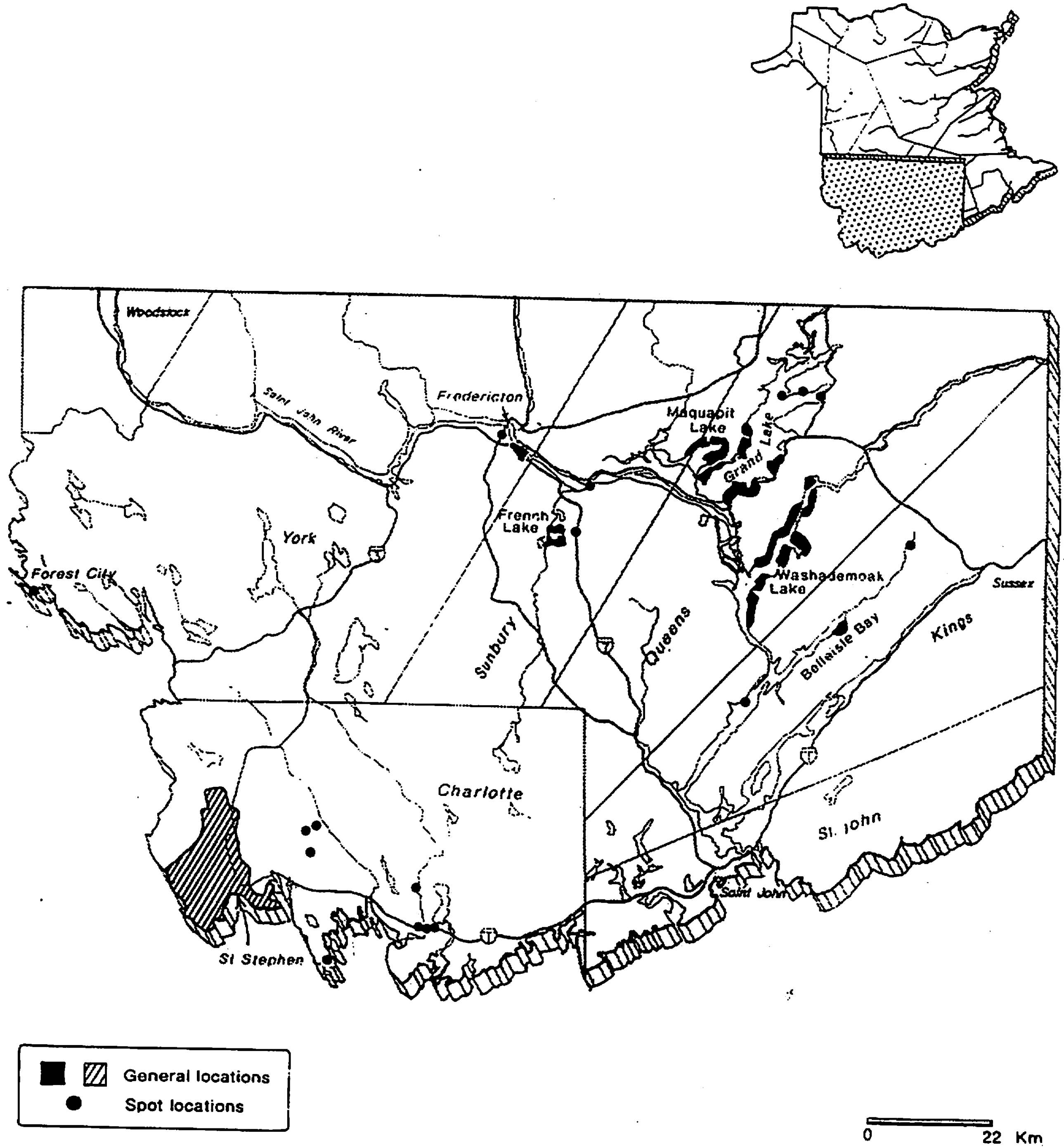


Figure 3. Areas and locations within which positive life stages of gypsy moth were detected in New Brunswick in the Fall of 1994.

Low-key Public Relations:

Given the nature of the insect and its known relationship to movement by people, the important role of public relations and education was recognized. Consequently, it was decided to provide information in a low-key manner, i.e. the program was not advertized nor portrayed as a control program, but as a series of basic actions using innocuous methods. Of interest was the fact that one of the areas which yielded some of the highest finds, had an active local environmental group called the Washademoak Environmentalists. Some of the principals of this group proved to be very helpful in "spreading the word" and enlisting homeowner help in the form of "what you can do about GM on your property". They facilitated liaison in a manner very helpful to the 1994 project around Washademoak Lake.

Essentially the public relations was divided into three categories, viz. 1) information and feedback from landowners where surveys and/or suppression actions were done; ii) information and feedback from special interest groups; and iii) information and feedback from the general public. Without going into detail, communications consisted of such things as: two general press releases - leading to one TV and several radio interviews; attendance at "open houses" (i.e. as part of other functions, <u>not</u> specifically held for GM); letters and pamphlets to landowners and interest groups (eg. Christmas tree growers, Maple Sugar Producers, National parks, several cities); as well as direct contact with people.

Despite conducting work at about 1 300 locations in 1994, only one complaint was received from one campground operator during the Summer '94 life stage survey. All other enquiries were for additional information. Also, despite conducting actions at 70 locations, only one complaint regarding intensive pheromone trapping was received from a cottage owner. Once provided additional information, the same individual took the lead in informing the local cottage association, subsequently leading to a positive find of GM.

IMPACT OF ACTIONS IN 1994 AND OUTLOOK FOR 1995

Actions taken at 43 locations east of Fredericton, and 21 locations west of Fredericton resulted in the removal and destruction of: 12 613 late instar larvae and pupae; 10 484 new egg masses; 158 female moths; and the trapping of 26 569 male moths. Despite all the actions taken, the situation for 1995 appears to have worsened. The number of positive locations west of Fredericton increased from 24 in the fall of 1993 to 38 in the fall of 1994. East of Fredericton, the 20 locations in the fall of 1993 increased more than three-fold to 66 in the fall of 1994.

These results suggest that GM populations in southwestern New Brunswick continue to persist at low levels predominantly within the same general area previously identified. East of Fredericton, in south-central New Brunswick, new locations were detected in and around high risk areas (i.e. sites with human activity and favored host trees) indicating GM to be more widespread within these areas than previously thought. It is within and from these areas that the risk of spread and future establishment of GM is highest. Unchecked, the potential exists for current pockets of GM populations to expand and coalesce over much larger areas and hence pose a greater threat to the urban environment and ultimately the general forests of New Brunswick.

Status of Some Forest Pests in Nova Scotia

Entomological Services
Nova Scotia Dept. of Natural Resources

Nov. 1994

Entomological Services is a section within the Nova Scotia Department of Natural Resources. It is responsible for monitoring and assessing insect population as well as disease occurrence in the forest. Some of the surveys are still ongoing and the analysis of data has just started. Full reports will be published this winter, through the Department. This report is a brief summary of information collected to date.

General Overview:

The spring warmed up fast and remained dry. These conditions set the tone for Nova Scotia weather throughout the summer and fall, warmer than normal and little precipitation. Insect numbers, generally were greater than last year especially with the Lepidoptera. Large numbers of forest tent, hemlock loopers, maple spanworm moths, rosey maple moths and satin moths were collected from the Department's province wide light trap system.

Spruce Budworm:

The Department along with Natural Resources Canada (FIDS) did an aerial survey to determine the extent of defoliation caused by SBW. No defoliation was found in 1994. The annual L-2 survey was conducted by NSDNR staff, with 173 sample points being taken (Map 1). The amount of area in the province where some level of budworm occurred was 56 000 ha (Map 2). This is a decline of 34% from the are infested last year. Graph #1 shows the total area in the province with some level of SBW infestation from 1971 to 1994. All the 1994 area of 56 000 ha was in the low population category. Pheromone traps were used for 2 purposes this year. First as a replacement for certain L-2 points in southern N.S. Twenty eight L-2 sampling points that had zero SBW population for the past 3 years were replaced with pheromone taps. If the catch was zero then an L-2 was not taken. This was a cost saving attempt.

The second use of the pheromone traps was a line of traps that ran from Chetticamp in Cape Breton through to Northport, Cumberland County (Map 3). Some catch occurred in Inverness County, but no SBW L-2 were found. This could have been a blow-in from P.E.I. Positive trap catches in Antigonish and Pictou were most likely the result of local moth activity (Table 1).

Hemlock Looper:

There was a general increase in the Hemlock looper population for 1994. The province wide light trap system had a 530% increase of captured adults.

NSDNR along with Natural Resources Canada (FIDS) set out a number of pheromone traps. FIDS did the general trapping for the mainland, 20 traps and Cape Breton, 4 traps. NSDNR did more extensive trapping in Cape Breton with 31 traps (Map 4).

High pheromone trap catches resulted in NSDNR undertaking a more intensive egg survey. First results show very high counts of healthy fertile hemlock looper eggs in a number of locations (Map 5). At present a delineation survey is underway to determine how much area could suffer defoliation. A possible treatment program using Btk for the highlands could occur in 1995.

Spruce Beetle:

Continue to be a problem in 1994. A more extensive aerial survey was undertaken during the late summer. Areas where significant Beetle infestation was found are shown in Map 6. It will not be until next month before we finish mapping these areas in detail.

Forest Tent:

Nova Scotia Dept. Natural Resources Light Trap Survey found that the catches for adults in 1994 were 145% higher than 1993. The areas where this insect seems to be building are as follows: Pictou, northern Colchester, Cumberland and North Mountain in the Valley.

Rosey Maple Moth and Maple Spanworm:

The Rosey Maple Moth has started to decline province wide but is still increasing in Chignecto and Liscomb game sanctuaries. The Maple Spanworm population increased over 500% from the 1993 numbers. No defoliation reported.

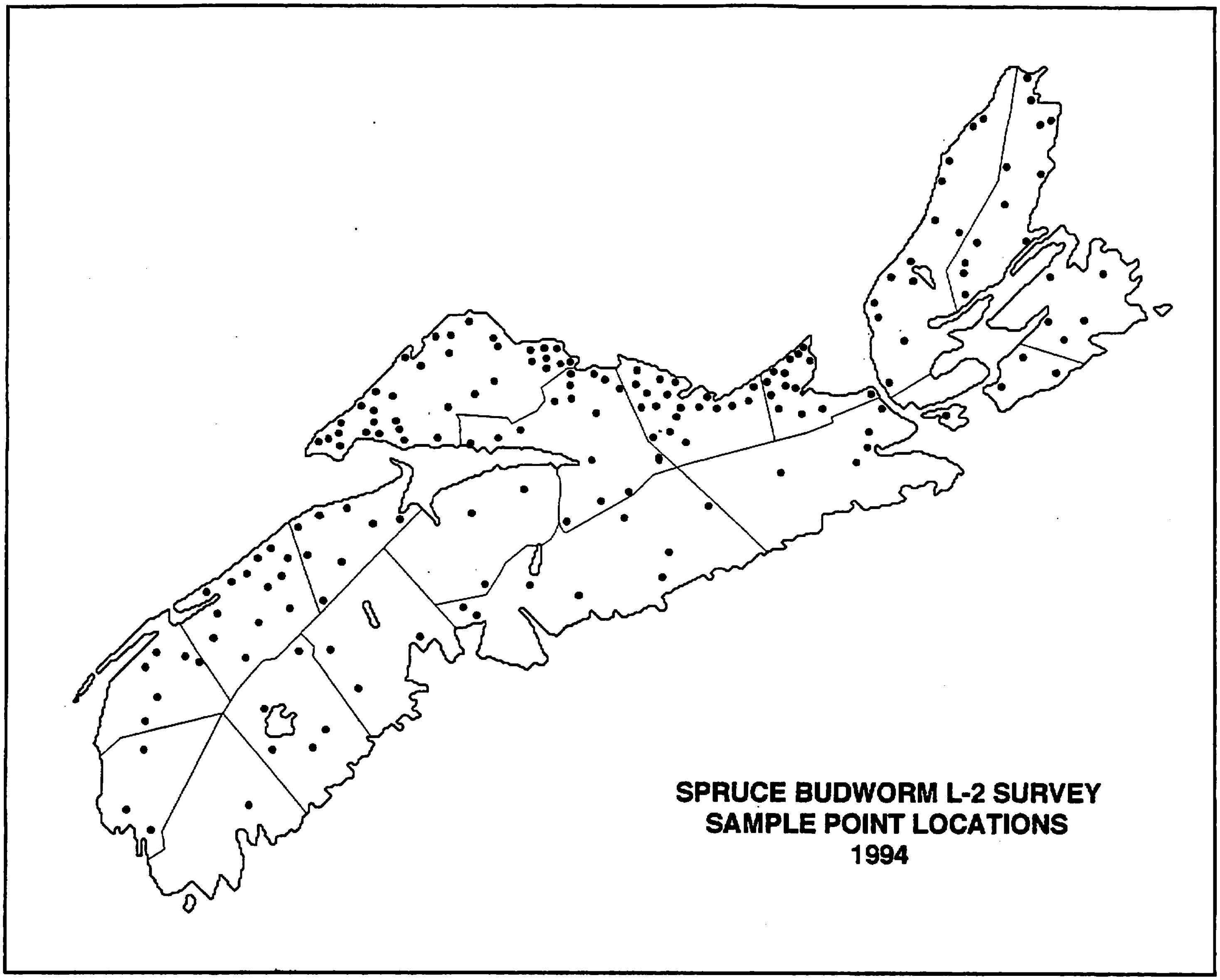
Eastern Dwarf Mistletoe:

A survey was done to determine where Eastern Dwarf Mistletoe (EDM) occurs in the province (Map 7). Black spruce, a preferred host of EDM, has become an important reforestation species in N.S. with over 20 000 ha planted in plantations. This parasite has the potential to infect some of these older black spruce plantations (15-20 years) especially ones planted next to an infected site. This winter, analysis of survey data will determine if a management plan is necessary.

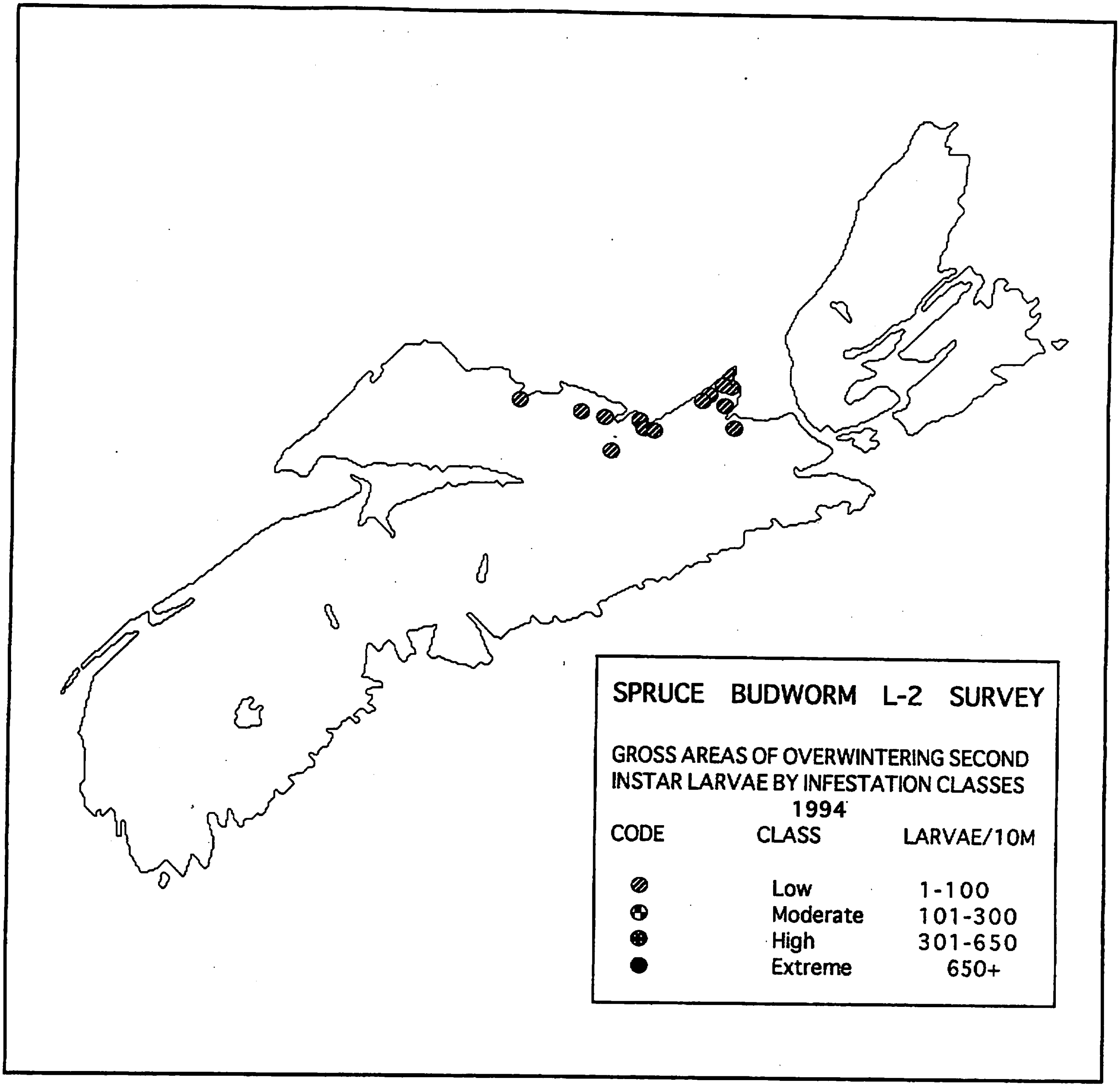
Sirococcus Shoot Blight in Red Pine:

NSDNR is still planning to start a province wide survey this year. There was very little spore release in the spring and correspondingly few symptoms occurred during the summer on trees in the infected areas.

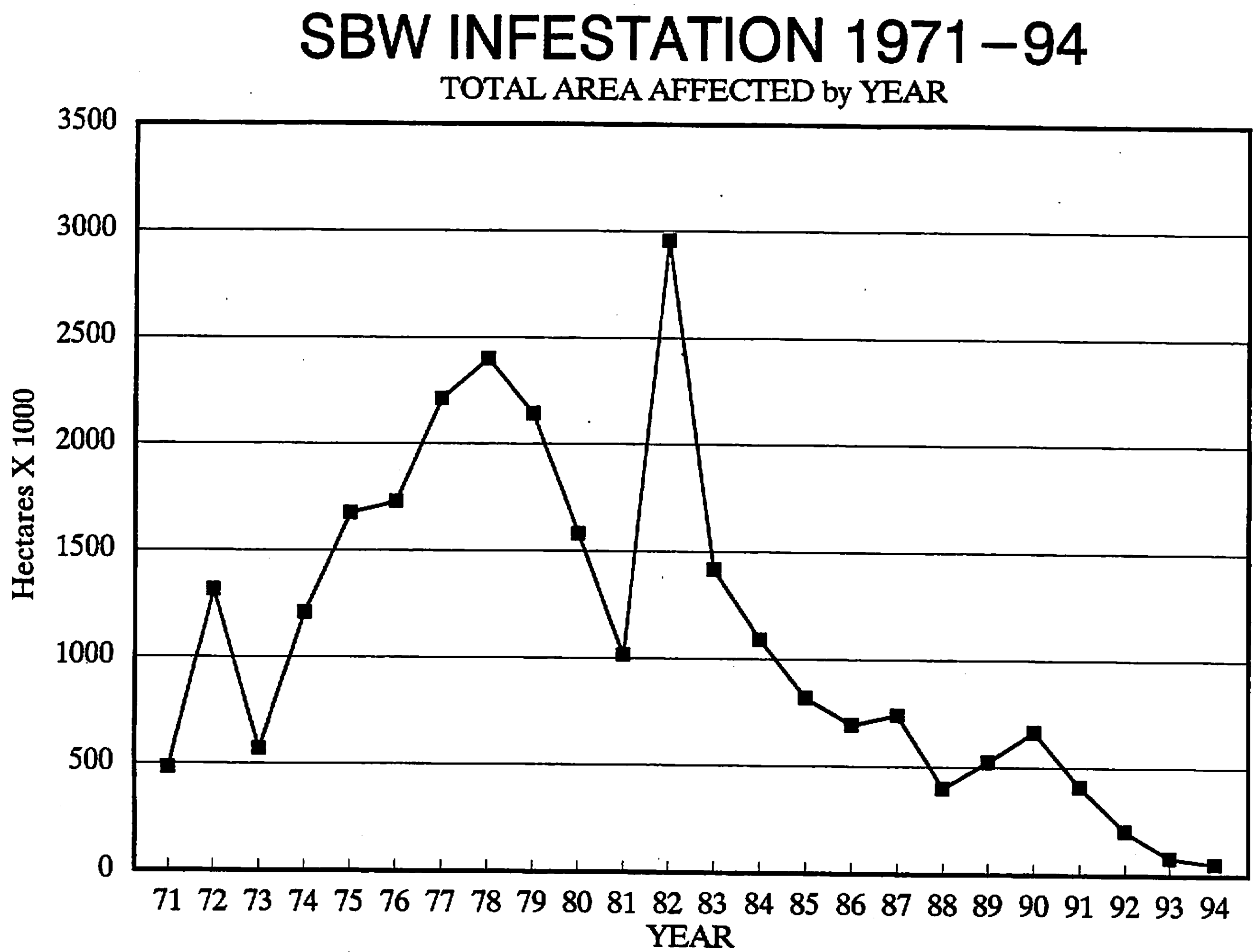
A program was undertaken late in 1993 and early 1994 to remove infested trees. This occurred mainly in the Garden of Eden Barren, and Trafalgar burn regions. Over 235 ha were removed and chipped. This was done in hopes of slowing the spread of this disease (Map 8 & 9).



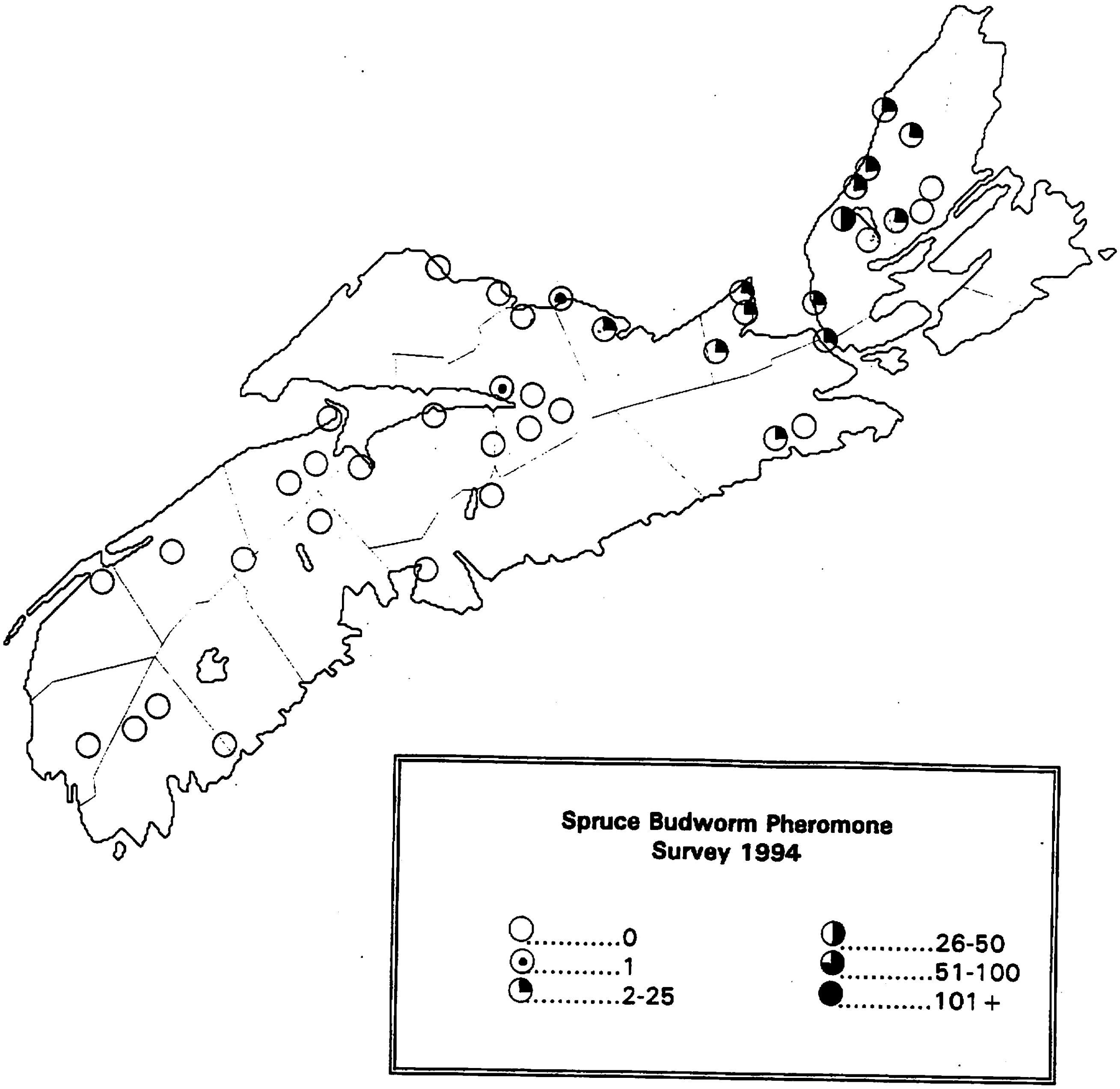
Map 1


SPRUCE BUDWORM L-2 SURVEY
GROSS AREAS OF OVERWINTERING SECOND INSTAR LARVAE BY INFESTATION CLASSES
1994
CODE
CLASS
LARVAE/10M
Low
1-100
Moderate
101-300
High
301-650
Extreme
650+

Map 2


SBW INFESTATION 1971–94
TOTAL AREA AFFECTED by YEAR
Hectares X 1000
3500
3000
2500
2000
1500
1000
500
0
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
YEAR

Graph 1



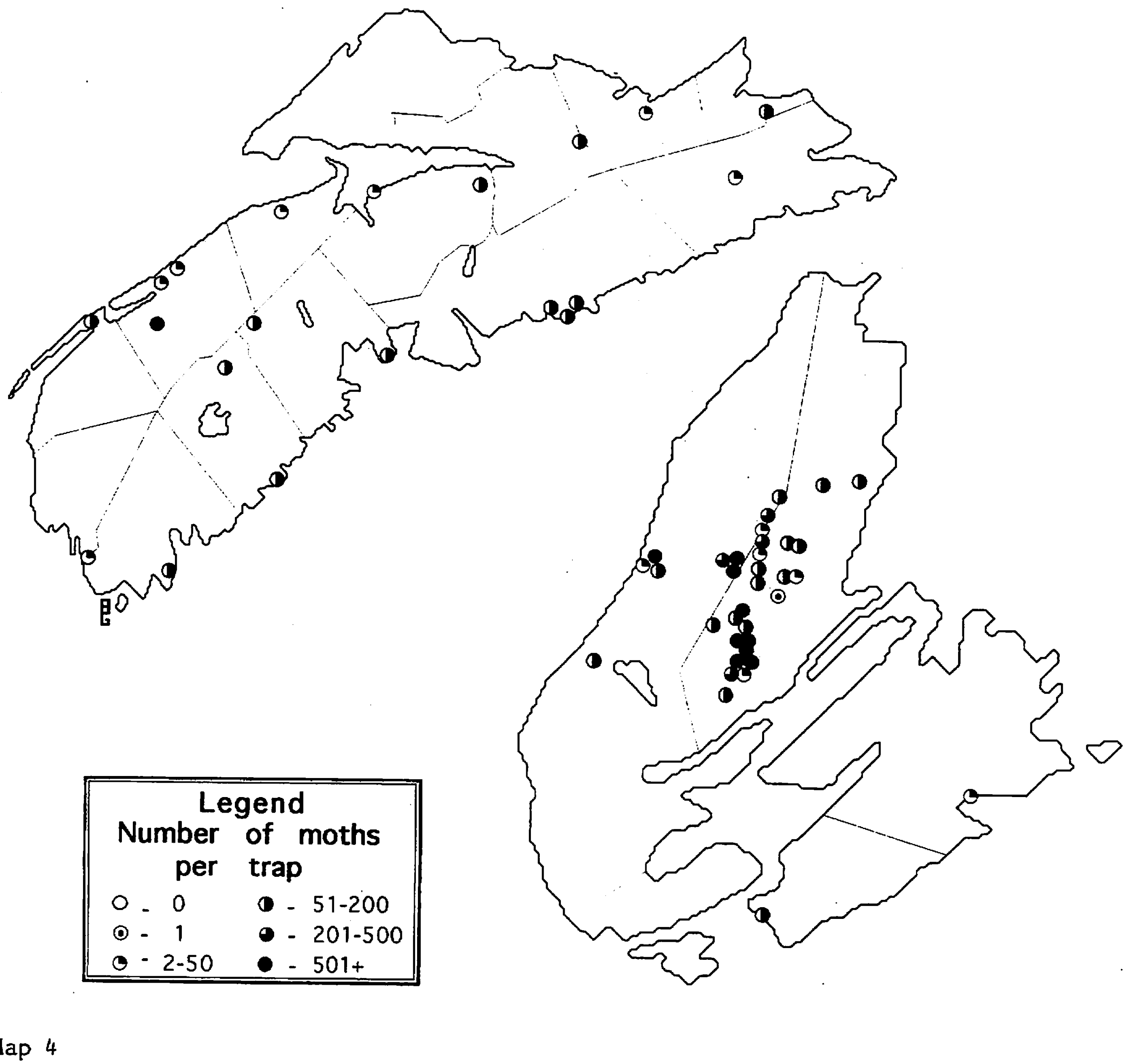
Map 3

COUNTY	LOCATION	# MOTHS
Annapolis	Corey Rd.	0
	Crisp Rd.	0
	Douglas Rd.	0
	Halfway Rd.	0
	Hampton	0
	Lake LaRose	0
Colchester	Stewiacke	0
	Upper Stewiacke	0
	Valley	0
	Insectary, Belmont	1
	Tatamagouche Park	0
Digby	Lansdowne	0
Guysborough	Country Harbour	0
	Goldenville	3
Halifax	Indian Hill	0
	Oldham	0
	MacLeod Lake	0
Hants	Admiral Rock	0
	Cape Tenny	0
	Upper Falmouth	0
Kings	Aylesford Lake	0
	Forest Hill	0
	Scots Bay	0
Lunenburg	Lake Darling	0
Queens	Wilkings Siding	0
Shelburne	Upper Clyde River	0
	Upper Ohio	0
Yarmouth	Kegeshook Lake	0
Antigonish	Beaver Mtn. Park	3
	Cribbons Point Rd.	8
	Georgeville	22
Cumberland	Northport	0
	Wallace Bay	0
Inverness	Big Intervale	4
	Black River	31
	Centennial	6
	Chimney Corner	11
	Dunvegan	10
	Marble Hill	7
	Port Hastings	14
	St.Joseph Du Moine	2
	W.S.Ainslie Glen	0
Pictou	Lyons Brook	16
	River John	1
Victoria	Big Barren	0
	Crowdis Airstrip	0
	Upper Middle River	3

Table 1: Spruce Budworm Pheromone Trap Results (1994)

HEMLOCK LOOPER PHEROMONE SURVEY

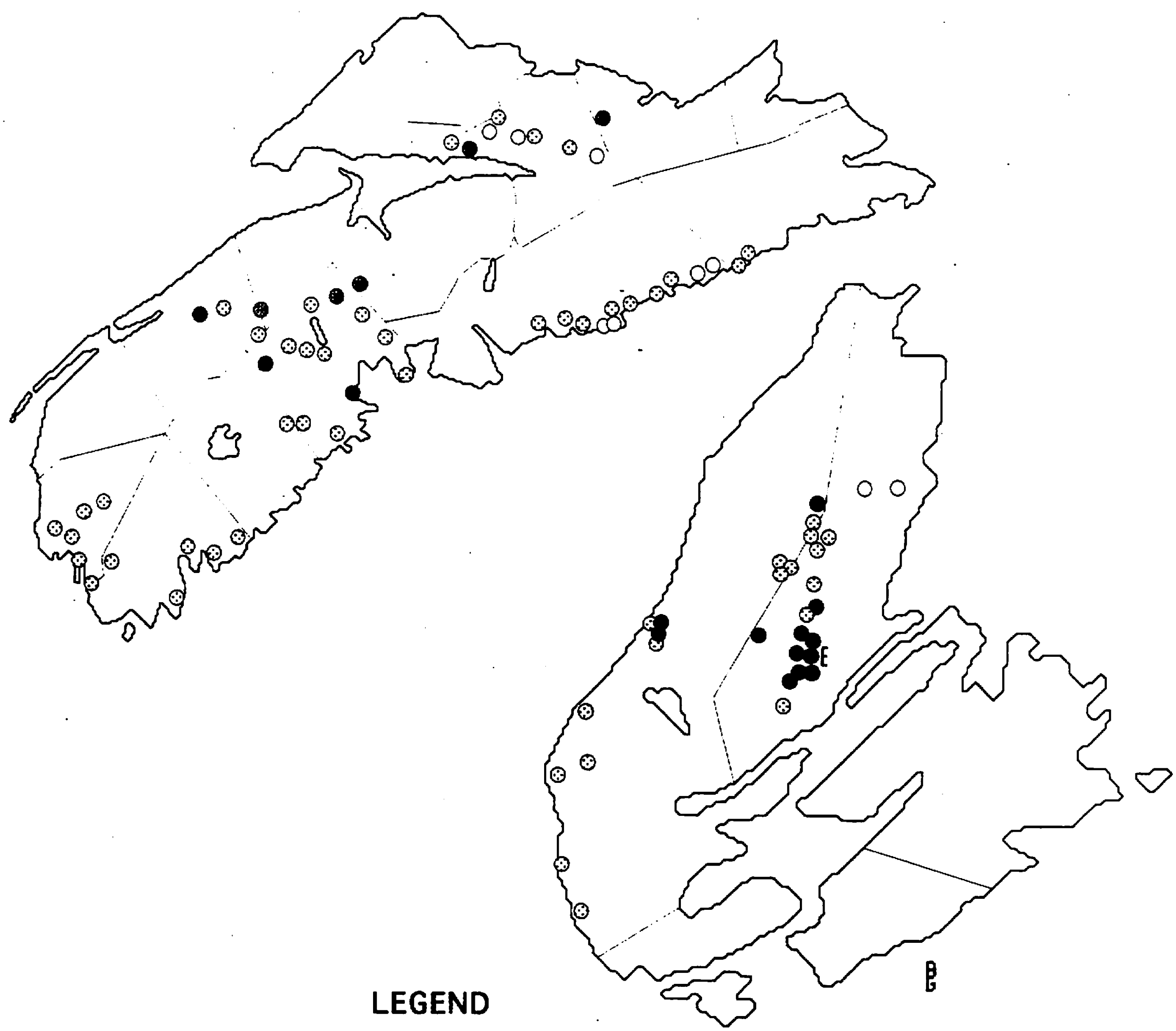
1994



Map 4

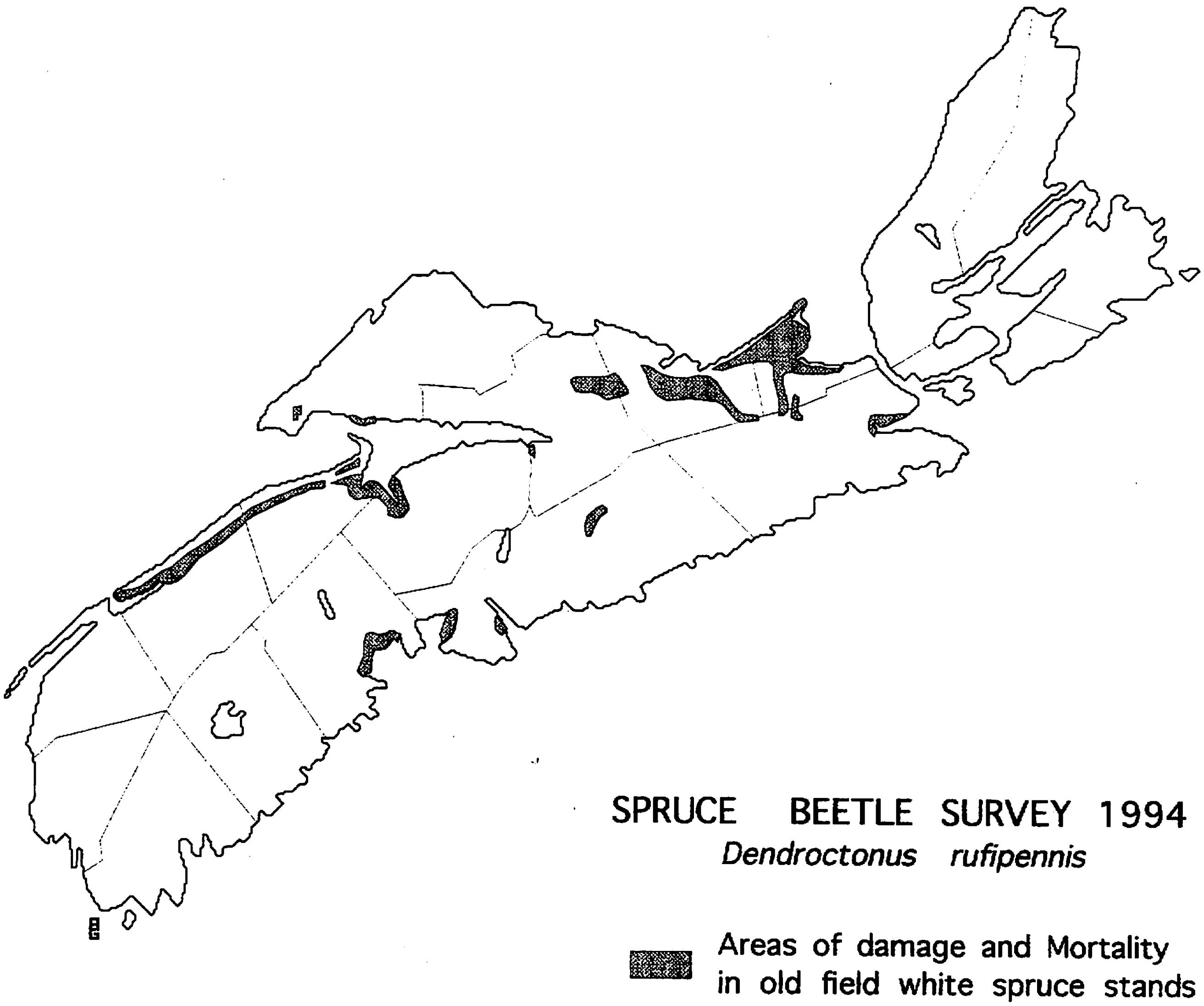
HEMLOCK LOOPER EGG SURVEY

1994

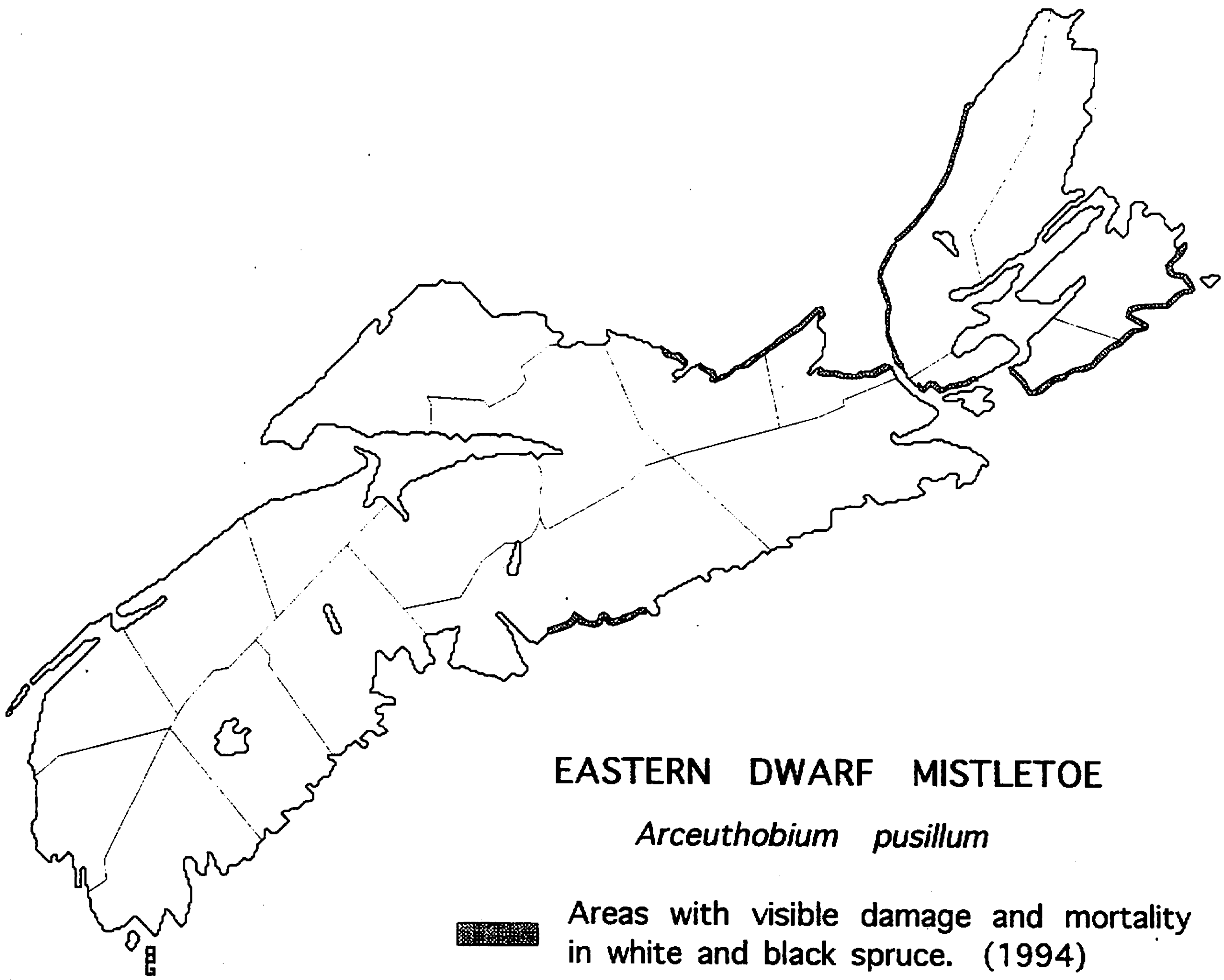


LEGEND

Fertile eggs per 100 cm branch	Symbol	Category
0	○	Zero
1-4	◍	Low
5-9	●	Moderate
10-19	●	High
20+	●E	Extreme


SPRUCE BEETLE SURVEY 1994
Dendroctonus rufipennis
Areas of damage and Mortality
in old field white spruce stands

Map 6

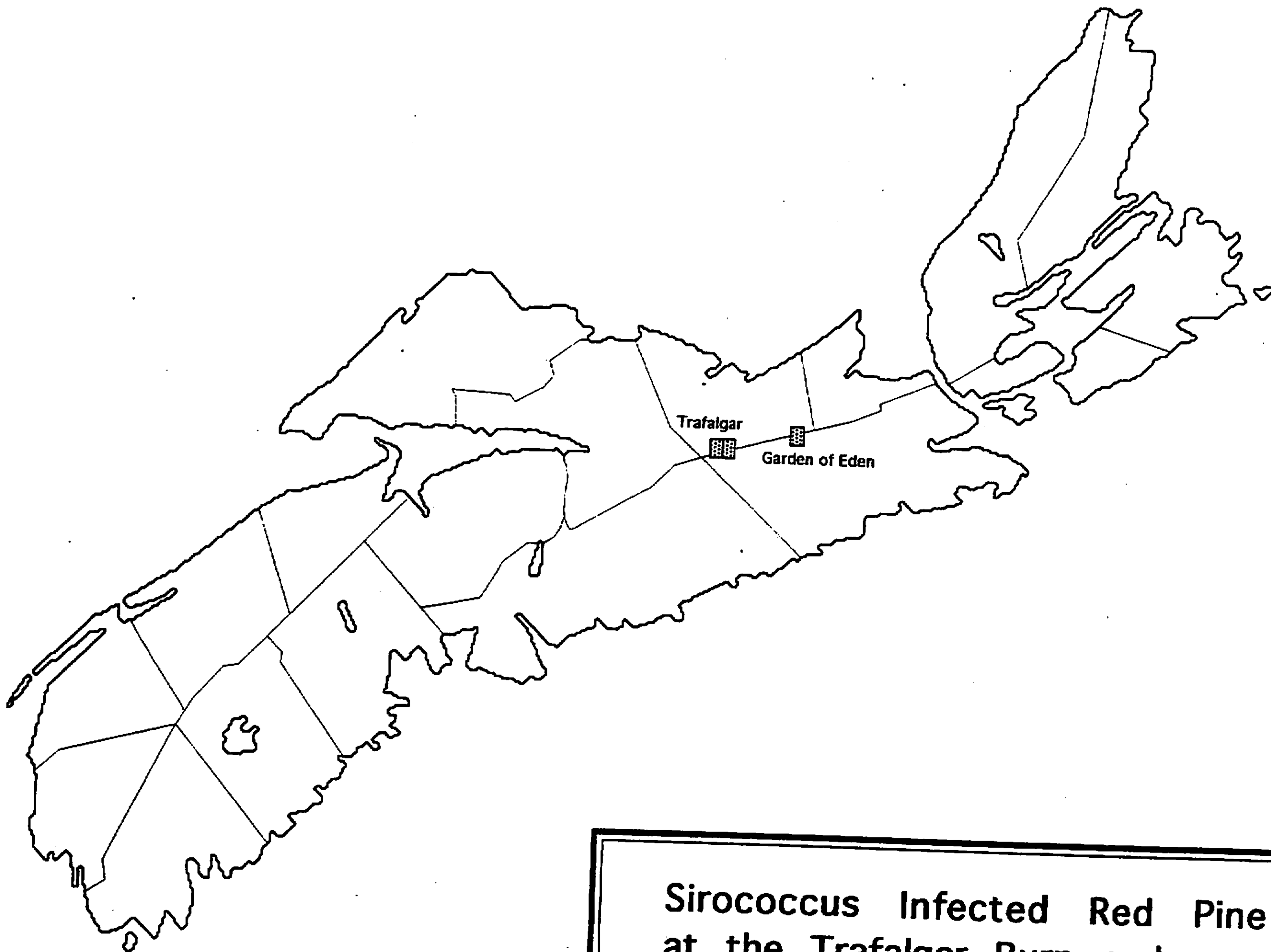


EASTERN DWARF MISTLETOE

Arceuthobium pusillum

▇ Areas with visible damage and mortality in white and black spruce. (1994)

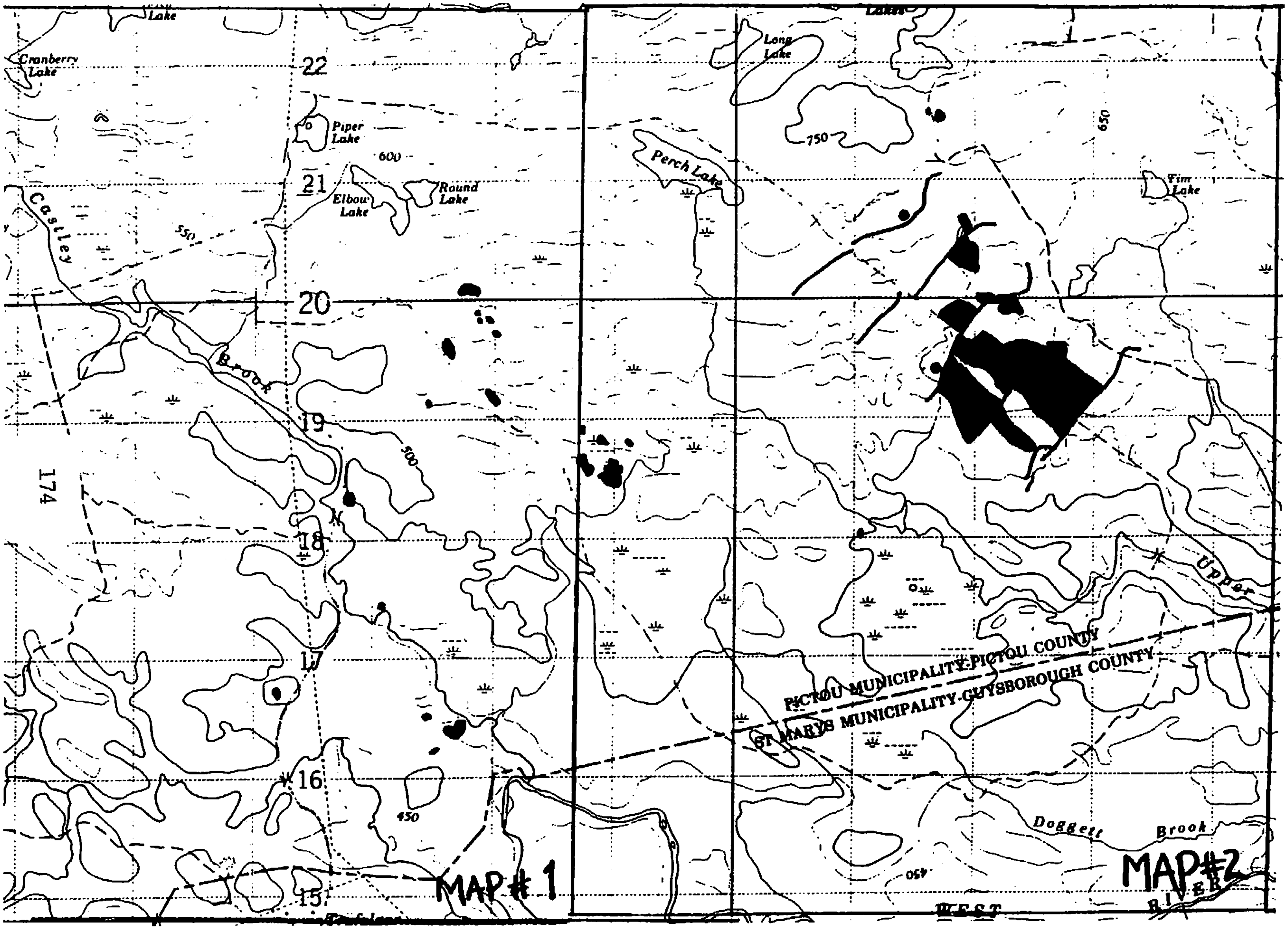
Map 7



Sirococcus Infected Red Pine at the Trafalgar Burn and Garden of Eden Barren.

(Outbreak, summer/93- Cut, winter/94)

Map 8



Map 9

Sirococcus Infected Red Pine Plantations at Trafalgar Burn

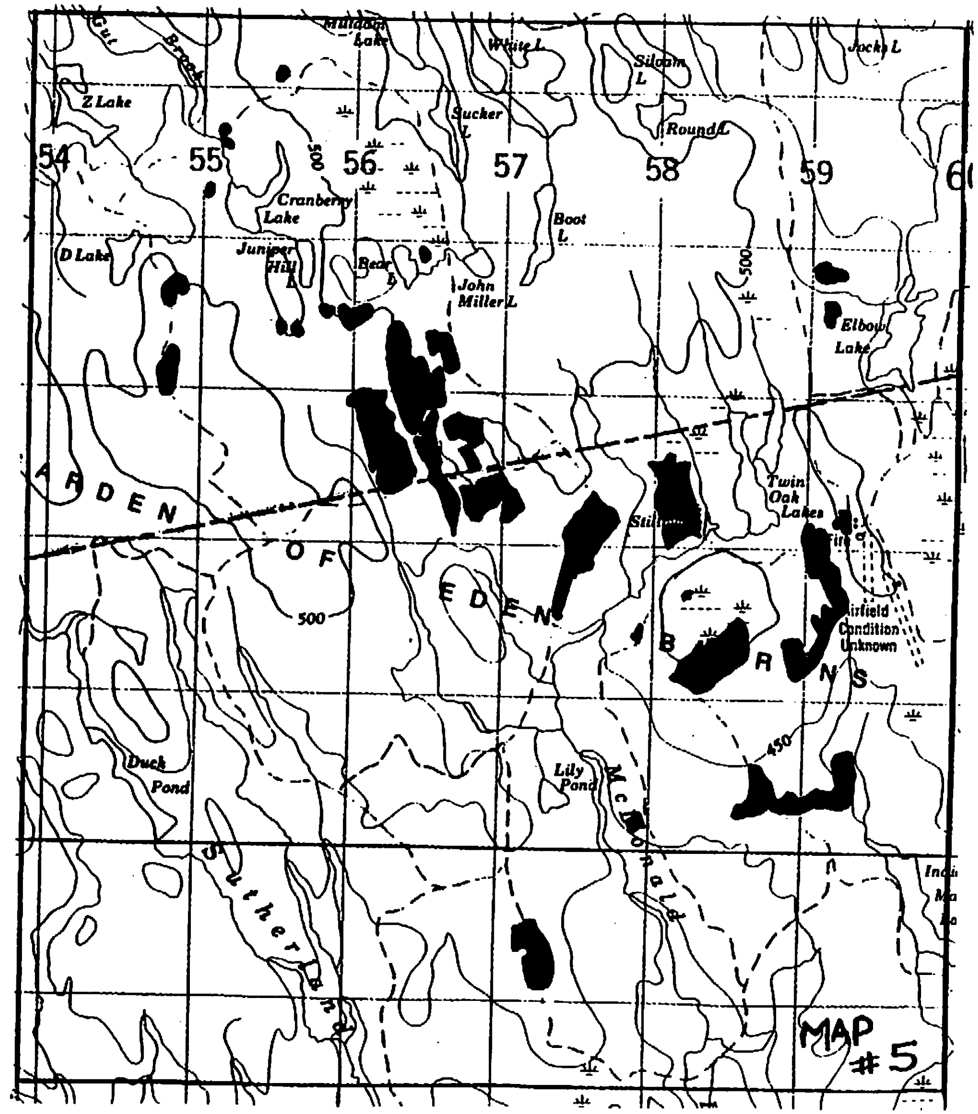
(115 ha unmerchantable)

SCALE 1: 50 000

Sirococcus Infected Red Pine Plantations at Garden of Eden Barrens

(100 ha, 80 ha merchantable & 20ha unmerchantable) SCALE 1: 50 000

Map 10



Finagle's Laws of Information

1. **The information you have is not what you want.**
2. **The information you want is not what you need.**
3. **The information you need is not what you can obtain.**
4. **The information you can obtain costs more than you want to pay!**

FOREST INSECT AND DISEASE CONDITIONS IN NEWFOUNDLAND AND LABRADOR IN 1994

REPORT TO THE 22ND ANNUAL FOREST PEST CONTROL FORUM
OTTAWA, NOVEMBER 14-17, 1994.

by

J. Hudak, K.E. Pardy, G.C. Carew, L. Oldford,
D.S. O'Brien, D.M. Stone, and W.J. Sutton.

EASTERN HEMLOCK LOOPER (EHL)

Larval Development and Defoliation - Weather throughout insular Newfoundland and eastern Labrador was unseasonably cool and wet during the first part of spring. Eastern Newfoundland and most of central Newfoundland turned warmer than the long-term average after mid-June and continued to remain warm. Precipitation was unusually low in eastern and central Newfoundland stressing trees on shallow soils. Weather in western Newfoundland remained cool in early summer, and plant and insect development lagged behind that of the remainder of the Island. However, weather improved dramatically in late June and insect development progressed rapidly during the remainder of the summer.

Moderate and severe defoliation were forecast to occur in several areas in central Newfoundland, but in western Newfoundland egg densities had been relatively low in samples collected in the fall of 1993. However high numbers of moths were caught in pheromone traps in the fall and these areas in western Newfoundland were closely monitored for larval populations this year. High larval numbers and severe defoliation were recorded in several areas in western Newfoundland including, near Hinds Lake, Lomond, Bonne Bay Little Pond, Goose Arm brook, and the South Brook Valley between Pasadena and North Harbour of Grand Lake. In central Newfoundland high larval numbers and severe defoliation occurred in many scattered locations from Victoria Lake in the south to the Exploits River in the north. In eastern areas of the Island, looper populations remained at outbreak levels in several areas, and these occurred from Clarenville to the Bonavista Peninsula and near Lake St. John. Larval development and survival were good in most of the infestations and resulted in severe defoliation. Generally the looper infestations continued to increase in distribution and severity. The total area of defoliation was about 14 000 ha including 11 000 ha in the moderate and severe category (Table 1, Fig. 1).

Biological Mortality Factors - Hemlock looper larvae were collected from eastern, central and western Newfoundland to determine natural mortality factors. Less than 1% of the larvae were parasitized. Disease organisms were present in all areas in various degrees of incidence and were tentatively identified as bacteria, yeast-like organisms and fungi;

Table 1. Areas (ha) of defoliation* caused by the hemlock looper in Newfoundland in 1994.

Unit	Light	Moderate	Severe	Total
1	0	0	18	18
2	0	20	799	819
7	18	72	0	90
9	0	0	19	19
10	246	55	24	325
11	43	16	60	119
12	640	847	1 600	3 087
13	511	359	3 056	3 926
14	61	208	293	562
15	924	2 785	437	4 146
16	272	327	280	879
GMNP	12	79	0	91
Total	2 727	4 768	6 586	14 081

*Light = 6% - 25%
Moderate = 26% - 75%
Severe = 76% - 100%

including *Entomophaga aulicae* and *Erynia radicans*. Contract research with Memorial University on the mass fermentation of *E. aulicae* has been successful in producing hyphal bodies capable of forming conidia on completely defined medium. Patenting this medium is in the process. The ultimate goal of this work is to initiate epizootics using artificially produced spores at the beginning of impending outbreaks to minimize forest damage. Initial results of work on the use of exotic parasitoids for improved biological control of the EHL is detailed in a poster.

Pheromone Trapping - A pheromone trap grid was established for the third year in the summer of 1994 using 50 permanent sample locations throughout the Island. Traps at numerous locations in western and central Newfoundland became saturated signifying a much increased population level in 1994. Details of this work will be reported to the Pheromone Trapping Working Group.

Control Program - The Newfoundland Forest Service, Department of Natural Resources conducted an operational control program against the EHL. The biological insecticide , *Bacillus thuringiensis* (B.t.) was applied to about 11 000 ha of balsam fir forest. Results of this program will be reported separately.

Damage Assessment - The EHL was the major cause of forest depletion in Newfoundland and Labrador from 1988 to 1992. Although the infestation was declining, moderate and severe defoliation occurred annually. The total volume of stand mortality in these defoliated areas during the 5-year period was 3 299 000 m^3. Approximately 353 00 m^3 was salvaged. In addition to the tree mortality, an estimated 343 200 m^3 were lost as a result of reduced growth.

Eastern Hemlock Looper Decision Support System (EHLDSS) - A project initiated in 1988 has developed a decision support system to facilitate integrated management of EHL populations across insular Newfoundland. Individual models were developed to predict probabilities of defoliation, timber mortality and decay, risk of impending outbreaks and larval phenology. Models and data were embedded in a geographic information system (ARC/INFO®) and linked to a menu-driven, graphical user interface FOKIS (Forest Knowledge Information Systems). The EHLDSS generates predictions of probabilities of initial and continued defoliation, timber mortality and decay based on forest stand characteristics and past and present EHL population levels. To support management decisions, each prediction run can be modified based on stand eligibility for control tactics, expected efficacious of various control measures, and acceptable mortality and decay volume resolution. Future versions of EHLDSS will include links to timber supply projection models and incorporate economic analyses and indicators.

Forecast for 1995 - Overwintering eggs were sampled at 1 100 locations in late October to forecast larval population levels and subsequent defoliation for 1995. The processing of the samples is in progress and numerous locations have very high egg numbers, over 100/branch sample, signifying severe defoliation for 1995. A comprehensive forecast will be prepared when all samples have been processed.

EASTERN SPRUCE BUDWORM (ESBW)

Larval Development and Defoliation - Populations of this important forest pest were at endemic levels throughout the Island and no areas of defoliation were detected in 1994. The infestation near Codroy Pond has collapsed. Pheromone traps at 12 locations in western Newfoundland were checked in July for possible moth invasion from the Maritime provinces. Traps at five locations were without moths, four traps had 1 moth, and three traps had 2, 4, and 12 moths respectively. These moths were caught before local emergence had commenced, and such low numbers indicate that moth invasion was relatively light in 1994.

Damage Assessment - Several small infestations were recorded from 1988 to 1991 in western Newfoundland, but have not caused tree mortality. However, volume loss from reduced growth was estimated at 2 800 m^3.

Spruce Budworm Decision Support System - Quantification of the impact of the spruce budworm continued to derive predictive equations relating stem-wood growth reduction to defoliation intensity, stand and site parameters. This work is a contribution towards a decision support system for the spruce budworm jointly developed for eastern Canada under the Green Plan.

BALSAM WOOLLY ADELGID (BWA)

Recent severe damage by this adelgid was common in many areas, particularly in thinned stands in western Newfoundland, and has caused major concerns for forest managers. Increased survey and research efforts, including an innovative remote sensing technology, are being used to develop a hazard rating system as an integral part of a comprehensive decision support system for the improved management of this important forest pest. A separate report details this initiative.

BLACKHEADED BUDWORM (BHBW)

Population levels of this budworm have decreased in recent years but a small infestation near Hawkes Bay on the Northern Peninsula has caused severe defoliation in 1994 in about 300 ha of overmature balsam fir stands. The infestation has lasted for five years, and caused 30 000 m^3 of tree mortality and 3 000 m^3 of growth reduction. Some tree mortality is expected in these stands.

The blackheaded budworm characteristically defoliates trees by causing damage to the current year needles; mostly in the upper portion of the crowns. An investigation to determine the potential of remote sensing to forecast the susceptibility (likelihood of defoliation) and vulnerability (likelihood of volume loss or mortality) of balsam fir stands to blackheaded budworm damage has been successful. Optimal logistic models were derived that integrate selected spectral measurements and forest inventory data to produce classification accuracies of 81%, 67% and 78% for susceptibility, pre-, and post-outbreak vulnerability respectively. A more detailed report is presented in a poster.

BALSAM FIR SAWFLY (BFS)

Moderate and severe defoliation was forecast to occur near Bottom Brook in western Newfoundland. High numbers of larvae and severe defoliation were recorded near Bottom Brook and Trout Brook. However part of the 1993 infestations collapsed and the total area of defoliation was about 1 200 ha. About 10% tree mortality has occurred in young stands along the Caribou Lake Road from past infestations.

European Pine Sawfly (EPS)

Pines were severely defoliated in many communities along Conception Bay of the Avalon Peninsula from Portugal Cove to north of Harbour Grace. In addition, new infestations were detected in 1994 on ornamental pines in Gander, Grand Falls and Corner Brook. These new infestations are significant range extensions from known areas of occurrence on the Avalon Peninsula, and were probably caused by human transport of infested pines. These new infestations represent a direct threat to native red pine stands. A cooperative effort was initiated in the early spring of this year to improve the detection and enhance the application of quarantine measures to prevent further spread of this important pine defoliator.

Pine False Webwor (PFW)

Defoliation by this false webworm, a sawfly, continued for a second year in and near St. John's however most trees were only lightly defoliated. The adult is a striking insect with metallic blue body and bright orange head. The insect was not collected in Newfoundland before 1990, and probably was accidentally introduced into the St. John's area. The pine false webworm is potentially a more serious defoliator of pines, including red pine, than the European pine sawfly, because the false webworm will also feed on new-growth needles after the old foliage is consumed. In the St. John's area Austrian pine seems to be the preferred host, followed by mugho pine, Scots pine and jack pine in decreasing order. The distribution of this false webworm will be closely monitored and this insect, together with the European pine sawfly, will be treated as serious threats to native red pine stands.

Black Army Cutworm (BAC)

A prescribed burn in 1993 at the experimental area near Glide Lake was closely monitored for adult and larval populations of the BAC. Trap catches of adults were low in fall of 1993, and larval numbers were also generally low in 1994, causing light defoliation of herbaceous vegetation. Monitoring of the burn will continue. Four other recent prescribed burns were monitored: 1) near Flat Bay Brook, burnt in 1992 and planted in 1993, trace of defoliation on hardwoods; 2) at Diamond Pond (Camp 180 Road), burnt in 1993, light feeding on herbs; 3) near St. Fintans, burnt in 1993 and planted in 1994, severe defoliation of scattered patches of pin cherry; 4) near South Branch, burnt in 1992 and planted in 1993, no discernable defoliation occurred. Results of experiments indicate that the use of Steinernematid nematodes for the control of BAC is promising, and are detailed in a poster.

Armillaria Root Rot (ARR)

About 10% dead or chlorotic black spruce occurred in a 10 year-old plantation in the Great Rattling Brook area, and about 20% of the black spruce in a plantation near Springdale were infected with this fungus. Most of the affected trees had distinctly deformed roots caused by improper planting. Along the Caribou road in western Newfoundland, about 10% of the trees damaged by the balsam fir sawfly were also infected with the ARR fungus.

Research on ARR forms an integral part of the Root Rot Network under the Green Plan and includes early detection of damage using remote sensing techniques, the identification of Armillaria species using molecular techniques, and the development of a hazard rating system and management guidelines to minimize damage. Initial results indicate that *A. ostoyae* contains a homologous gene for the production of cyclosporine used in organ transplants to minimize rejection reactions. This appears to be the first report of a cyclosporine synthetase homologous gene in an organism other than *Trichoderma polysporum*.

White Pine Blister Rust (WPBR)

Stem and branch infections by this rust continued to spread to young and old white pine in the Little Grand Lake road area in western Newfoundland. The disease was also recorded near Howley and Sheffield Lake in central Newfoundland, and along the road to the village of Terra Nova, and near Gambo Pond in eastern Newfoundland.

Research on this disease forms an integral part of the Stem Cankers of Forest Trees Network under the Green Plan, and concentrates on the biological and silvicultural control of WPBR. The goal is the development of management practices to minimize damage and promote the re-establishment of white pine stands in eastern Canada.

Scleroderris Canker (SC)

The European strain of *Gremmeniella abietina*, causing scleroderris canker, continued to infect Austrian pine at different areas in St. John's and near Portugal Cove on the Avalon Peninsula. The possible spread of the disease from the Avalon Peninsula to the highly susceptible red pine stands in central and western Newfoundland is a major concern of forest managers.

Experimental results on the susceptibility of various conifers to this disease provided guidelines for a cooperative effort to enhance the application of quarantine measures to prevent further spread. Additional research to improve the management of the disease is in progress, and forms part of the Stem Cankers of Forest Trees Network under the Green Plan.

REPORT TO THE 22nd ANNUAL FOREST PEST CONTROL FORUM,
Ottawa, 14-17 November, 1994

THE BALSAM WOOLLY ADELGID IN NEWFOUNDLAND IN 1994

by

Bowers, W.W and J. Luther

CANADIAN FOREST SERVICE, NEWFOUNDLAND & LABRADOR REGION
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Management of young balsam fir stands and Christmas tree plantations in eastern Canada is complicated by BWA. Damage is particularly prevalent in central and western Newfoundland where the insect has infested nearly 200 000 ha of balsam fir, the majority of which is less than 40 years old. Major silvicultural activities designed to reduce a serious wood supply deficit are threatened, making the sustainable supply of balsam fir questionable. Presently, foresters do not have enough information concerning BWA biology and its impact to make informed decisions. There is no effective control for BWA and a hazard-rating system developed in the 1970s has not been tested or placed into operational use. Indeed, it is questionable if existing hazard-rating maps that were derived from unmanaged stands can be applied to young managed stands. There is urgent need to develop a reliable pest management strategy for BWA.

Development and implementation of a decision support system for BWA remains an important research priority and a joint-venture initiative is underway to provide forest managers with a reliable tool for making more informed decisions. Progressively, the project has emphasized BWA biology, bionomics, and impact. Knowledge gained from these and earlier studies form the building blocks for hazard- and risk-rating systems under development through application of remote sensing technologies. The primary objective is to:

- *develop and deliver to forest managers a decision support system that will minimize losses caused by BWA.*

Four hypotheses were addressed under the above objective:

1. Site, stand and tree characteristics are significantly correlated with adelgid damage.
2. Populations of BWA and subsequent damage increase following thinning of balsam fir.
3. Stand conditions can be remotely sensed and characterized using spectral, spatial and digital terrain data sets.
4. Integration of knowledge will allow development of predictive models that will facilitate decision-making.

Important milestones achieved in 1994 include the following:

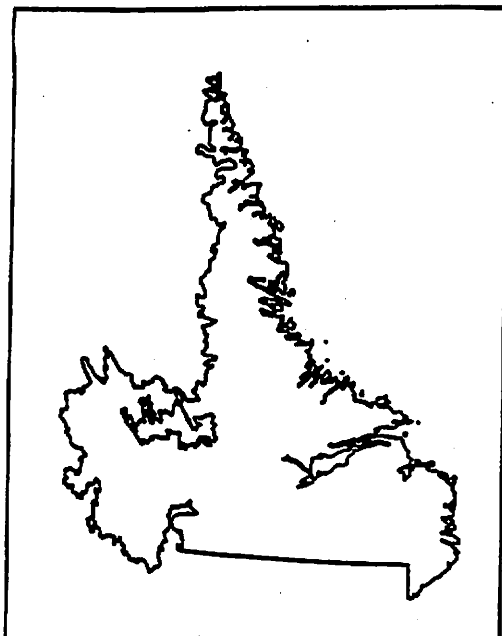
(i) The incidence of balsam woolly adelgid damage in managed and unmanaged fir stands within WNMF and MD 14 was mapped (ARCINFO/GIS).
(ii) Relationship between BWA and stand density was investigated using mensurational measurements and damage assessments from the Windsor Lake watershed.
(iii) BWA incidence data and selected inventory data were obtained from the provincial forest inventory database (permanent sample plots in MD 14 and 15 and from thinned spacing trials near Gallants).
(iv) Damage was assessed on a stand and individual tree basis in 1993 using SPOT and CASI data, respectively, for selected sites. This work was extended by Luther and Bowers in 1994 to include the following:

- satellite imagery was used to select study areas in managed and unmanaged bF stands including one site in the Western Newfoundland Model Forest (WNMF).
- ground-based spectral measurements were acquired in managed and unmanaged stands and foliage samples were taken to measure variations in foliar chemistry through detailed laboratory analysis.
- airborne CASI data were acquired from helicopter for spatial analysis of foliar chemistry, stand structure and growth characteristics, and damage assessment - precise geo-correction of CASI data is currently underway using GPS. This research encompassed 6 study areas using CASI at 1m and 2m resolution in spectral and spatial modes.
- Acquired digital contour data and stereo SPOT imagery for generation of digital elevation model; processing of the satellite imagery for the DEM is in progress to derive site conditions (elevation, slope and aspect) for input into HRS.

(v) Overwintering nymphs was collected from 5 sites throughout Newfoundland for resolution of the genetic structure of BWA (J. Bérubé and W. Bowers).
(vi) Sampling of foliage for nutritional and allelochemic compounds was completed successfully. Analysis of foliage is in progress at University Laval -Dr. Eric Bauce.

Results from above will be used to promote development of a Decision Support System (DSS) for BWA. A prototype hazard rating system (HRS) for MD 14 was given priority in 1994. Meetings held with with M. Power, T. Gillies (PNFI) to utilize FOKIS as a BAA-DSS interface.

Transferred information to province and industry through workshops and publications and participated in Canada/US adelgid working groups.



Natural Resources Canada
Canadian Forest Service
Forest Insect and Disease Survey
Hemlock Looper Defoliation
1994

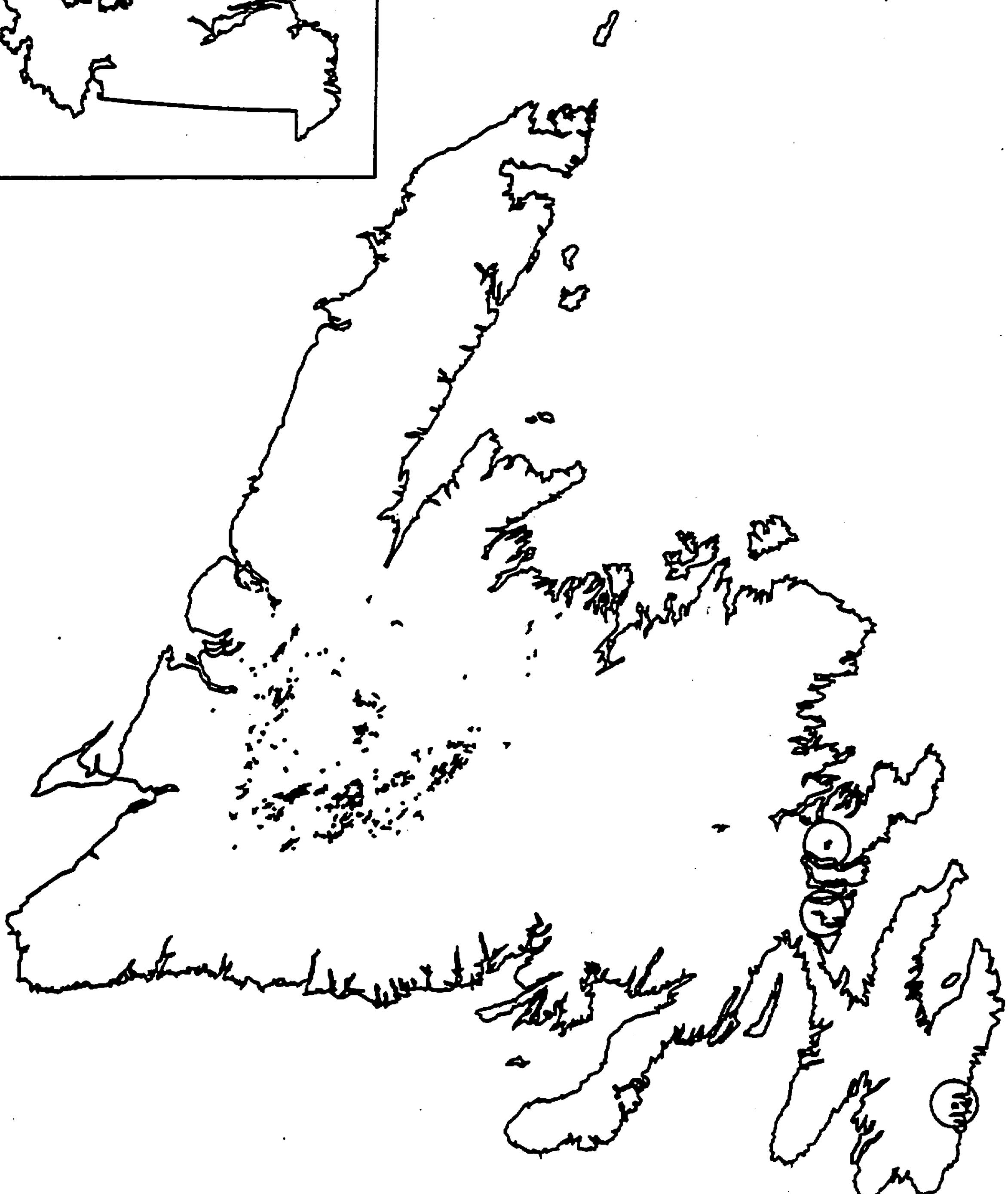


FIGURE 1.

INSECT AND DISEASE CONDITIONS IN THE UNITED STATES - 1994

Prepared for the
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Ottawa, Canada

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SPRUCE BUDWORM

LAKE STATES

In Minnesota spruce budworm defoliation (Appendix A) on the Superior National Forest was 545,122 acres. On State lands there was an additional 43,000 acres defoliated; up from 156,000 acres in 1993.

Defoliation on white spruce plantations continues on the Grand Portage Indian Reservation (Appendix A). Most of the white spruce plantations on the Reservation have now experienced four years of defoliation and are exhibiting symptoms of poor vigor and top dieback. Significant tree mortality will continue to occur in some stands if the infestation continues. Although a spray project was planned for spring 1994, it was canceled due to inclement weather. Because of continued defoliation this area is proposed for treatment in 1995.

Only scattered defoliation was reported in Wisconsin and Michigan. However, on the Chippewa National Forest approximately 2,980 acres were defoliated in 1993 while in 1994 it increased to 3,509 acres. Most of the plantations are 20+ years or older. On Isle Royale 6,843 acres of defoliation were reported.

NEW ENGLAND

For the second year in a row no spruce budworm defoliation was reported for Maine, New Hampshire, or Vermont.

WESTERN SPRUCE BUDWORM

REGION 1 (NORTHERN REGION)

Western spruce budworm caused defoliation in the Douglas-fir and true fir stands of the Northern Region during 1993 dropped to its lowest level since regionwide recordkeeping began in 1948 (Appendix B). This decline continued in 1994 even though weather conditions were near normal. Aerial detection surveys conducted during 1994 recorded only 787 hectares (ha) of visible defoliation compared to over 400,000 ha in 1992, and 18,194 ha in 1993. Pheromone baited traps used to monitor the adult flight were also down in 1993. No moths were caught over large areas where budworm populations have been moderate to high for many years. Regionwide zero to low trap counts continued in 1994. In one of the Region's most chronic areas just east of Missoula trap counts were 807 in 1992, 122 in 1993, and 155 in 1994 from 24 traps at the Lubrecht Experimental Forest. Even though trap counts increased by 33 moths populations are not expected to change much in 1995.

Table 1.--Budworm infested areas (ha) in Region 1.

Forest/Area	1991	1992	1993	1994	Trend 92/93
	- - - - - - - - - -	- - - - -	ha - - - -	- - - - -	- - - - - -
Nez Perce	4,940	19,410	295	0	-295
Beaverhead	10,823	16,166	702	0	-702
Bitterroot	111,814	3,467	441	0	-441
Custer	3,556	0	0	0	0
Deerlodge	144,221	114,243	3,378	787	-2,591
Flathead IR	22	27	0	0	0
Gallatin	12,528	2,560	2,351	0	-2,351
Helena	134,252	168,158	9,046	0	-9,046
L & C	85,065	59,062	476	0	-476
Lolo	768,264	11,693	1,035	0	-1,035
Garnets	67,159	5,792	470	0	-470
Total	651,206	400,578	18,194	787	-17,407

No budworm control projects were conducted in Region 1 in 1994. The budworm population outlook for 1995 throughout northern Idaho and western Montana is not expected to fully recover soon. With visible defoliation at 787 ha this year defoliation is not expected to be over 10,000 ha in 1995. If the weather patterns remain near normal, it could take several years before defoliation reaches the 600,000 ha level recorded in recent years.

REGION 2 (ROCKY MOUNTAIN)

Western spruce budworm continues to be a problem in many portions of Colorado. Although there are no large outbreaks at present, many stands have lingering populations. The majority of these stands are overstocked, multi-story stands composed of the shade tolerant species which are the favored hosts.

REGION 3 (SOUTHWESTERN)

Western spruce budworm defoliation in the Southwest increased from 27,650 hectares in 1993 to 153,360 hectares in 1994. In New Mexico, western spruce budworm defoliation was detected on the Carson (104,860 hectares) and Santa Fe (10,620 hectares) National Forests and the Jemez (1,100 hectares), Santa Clara (990 hectares), Picuris (470 hectares), and Taos (6,100 hectares) Pueblo Indian Reservations. On State and Private lands in northern New Mexico, western spruce budworm occurred on 29,220 hectares.

REGION 4 (INTERMOUNTAIN)

No spruce budworm defoliation reported for the second year in a row.

REGION 5 (PACIFIC SOUTHWEST)

Modoc budworm populations are at endemic levels on the Modoc National Forest. Light defoliation was found on west-facing slopes north of Lakeview, Oregon, Fremont National Forest (R-6).

No spray projects were conducted in 1994.

REGION 6 (PACIFIC NORTHWEST)

As of October approximately one-fourth of the Washington State data has been digitized and one-hundred percent of Oregon has been digitized. Data reported here will reflect this status.

Washington

Western spruce budworm (WSB) and Hemlock looper (HL) reported acreages are based on gross ocular estimates of aerial survey sketchmap polygons. These are:

WSB 42,000 acres
HL 24,000 acres

WSB activity is expected to continue in three small localized areas. No larval sampling is expected in 1995. Elsewhere, WSB and HL activity is expected to decline.

Oregon

Current WSB caused defoliation was detected on 37,500 acres. Acreages affected are expected to be similar for 1995.

REGION 10 (ALASKA)

Spruce budworm populations exploded in 1994 throughout interior Alaska (Appendix C). Heavily defoliated white spruce was aerially detected on 232,477 acres this year. Two budworm species were responsible for this defoliation; Choristoneura fumiferana and C. orae. Visible defoliation in 1993, however, accounted for only 32,481 acres. This apparent increase is mainly due to the large occurrence in 4th and 5th instar larvae of the 2-year budworm, C. orae. Heavy feeding by these mature instars increased the intensity of defoliation observed this year. This was also apparent in 1992 when more than 180,000 acres of defoliated white spruce were detected. Defoliation levels are expected to decline in 1985 as early instars of C. orae will be more common. Feeding damage from these instars is significantly less than that of the latter instars.

Approximately 500 acres of light defoliation was noted on mature Sitka spruce along the Chilkat River, northwest of Haines, in southeast Alaska.

There were no budworm suppression projects in Alaska this year.

Black-headed budworm, Acleris gloverana, populations were similar to levels noted last year. Approximately 193,000 acres of defoliated western hemlock and Sitka spruce were observed this year compared to 260,000 acres a year ago. Mortality and/or top-kill due to consecutive years of defoliation were noted on more than 10,000 acres of hemlock and spruce. Black-headed budworm populations are expected to remain static or increase slightly in 1995.

JACK PINE BUDWORM

LAKE STATES

Jack pine budworm defoliation was reported on 6,728 acres on the southern half of the Huron-Manistee National Forest, 14,852 acres on the Hiawatha National Forest, and 20,000 acres on the northern half of the Chequamegan National Forest. Other areas, such as the Ottawa National Forest, had less than 1,400 acres of light to scattered defoliation.

GYPSY MOTH STATUS--"NORTH AMERICAN"

NORTHEASTERN AREA

In 1994, the North American gypsy moth defoliated 406,529 acres of forested land within the 14 generally infested States. This was a decrease from the 1,195,200 acres defoliated in 1993 and a further decrease from the 2,309,000 acres defoliated in 1992.

Gypsy moth suppression and eradication projects in the Northeastern area in 1994 totaled 576,869 acres, with 534,633 acres treated by eight cooperating States, 35,775 acres treated by National Forests, and 6,461 acres on other Federal lands. The 1994 total is slightly higher than the 533,884 acres treated in 1993. In addition to the gypsy moth, 57,150 acres of elm spanworm infested forest land was treated in 1994 on the Allegheny National Forest in Pennsylvania and the Seneca Indian Nation in New York.

Outlook for 1995 indicates that nine States anticipate the need to treat gypsy moth populations on 535,000 acres and four National Forests plan treatment of 22,200 acres. In addition, the Allegheny National Forest plans to treat 30,000 acres of forest tent caterpillar infested areas in 1995.

Table 2.--Gypsy moth defoliation in 1994 by State--all Ownerships (includes State Cooperative, National Forest, other Federal, and AIPM).

State	Acres Defoliated
CT	0
DE	60,728
MA	60,000
MD	93,141
ME	2,000
MI	97,287
NH	7,020
NJ	17,846
NY	480
OH	100
PA	17,957
RI	300
VA	452,475
VT	0
WV	49,670
Total	859,004

REGION 1 (NORTHERN)

Through cooperative agreements between Idaho, Montana, North Dakota and the Forest Service pheromone baited gypsy moth traps are deployed throughout the Region. Trap placement is concentrated in areas of high-use recreation, along major travel routes, and most urban areas. With a few traps yet to be collected two moths were caught in Coeur d' Alene, Idaho, and one at Mammoth in Yellowstone National Park. No followup action is planned in 1995.

REGION 4 (INTERMOUNTAIN)

Only one moth was detected in 1994. This eradication project has been one of few successful large scale projects. In 1995 trapping will be maintained to ensure no recurrence.

REGION 5 (PACIFIC SOUTHWEST)

Table 3.--Summary of 1994 gypsy moth finds in California through August 15, 1994.

County	<-- Adults Trapped --> Detection	Quarantine	Date Last Adult	Properties - Egg Masses/Pupal Cases
Alameda	1	0	07/06/94	0
Los Angeles	1	0	08/09/94	0
Napa	1	0	07/19/94	0
Nevada	1	0	08/02/94	0
Orange	1	0	07/19/94	0
Sacramento	1	0	07/20/94	0
Santa Clara	2	0	08/15/94	0
Shasta	1	0	07/21/94	0
Sonoma	1	0	08/15/94	0
Total[1]	10	0		0

[1] Total gypsy moth finds through August 15, 1994, is two in southern California and eight in northern California.

Trend is now for more reports in northern California than southern California. This may be connected to a decline in the defense industry in southern California (less immigration and transport of household goods from the Northeast and Atlantic Coast into southern California).

REGION 6 (PACIFIC NORTHWEST)

Gypsy moth eradication projects were conducted by Oregon Department of Agriculture in Multnomah and Clackamas counties. Two ground applications of B.t. were used on 8.25 acres (7 acres in Clackamas County and a 1.25 acre site in Multnomah County) and three aerial applications were made on 270 acres in Carver (Clackamas County).

REGION 8 (SOUTHERN REGION)

In 1994, the North American gypsy moth defoliated 452,475 acres of forest land in the southeastern United States. This is a decrease from 589,100 acres in 1993 and further decrease from the all time high of 743,000 acres in 1992. The heaviest defoliation occurred along the expanding front as it moved down the Appalachian Mountains in northern Virginia.

The Commonwealth of Virginia aerially treated approximately 114,000 acres of forest land to suppress gypsy moth populations within the generally infested area. All treatments were effective in meeting the goal of foliage protection. Egg mass surveys in these treatment areas are not complete enough to evaluate the success of population reduction.

Estimates of gypsy moth mortality have not been made. All reported values would be highly subjective and without basis. Research has shown that those trees killed tend to be of lower quality than those that survive. On average, stands can expect to lose between 20 to 30 percent of their basal area after an outbreak.

In 1994, Tennessee treated approximately 8,000 acres for eradication in the northeastern corner of the State. In north central Arkansas 26,000 acres were successfully treated. However, trapping efforts in both these States have identified an additional reproducing population outside the 1994 treatment block, indicating that there will be additional areas treated in 1995.

A Slow-the-Spread Gypsy Moth Pilot Project was initiated in 1993. The goal of the Project is to determine the feasibility of using integrated pest management strategies to slow the spread of the gypsy moth over a large geographical area. The 1994 Project area included seven million acres in four States (North Carolina, Virginia, West Virginia, and Michigan). As part of the intervention strategies related to the project treatments were applied to 34,471 acres; 3.5 percent with Dimilin, 82 percent with B.t.k., 13 percent with mating disruption, and 1.5 percent with Gypchek.

GYPSY MOTH STATUS--"ASIAN"

NORTHEASTERN AREA

On August 3, 1994, Asian gypsy moths (AGM) were detected on Long Island, New York. Upon further investigation approximately 100 miles of forested urban area were determined to be infested. Most of the finds have been in the Oyster Bay area. In addition, Asian gypsy moths identified through DNA analysis have been found in the following States: California, Connecticut, Delaware, Massachusetts, Maryland, Maine, Michigan, North Carolina, New Jersey, New York, Ohio, Rhode Island, South Carolina, Virginia, and West Virginia.

REGION 6 (PACIFIC NORTHWEST)

Two eradication projects totaling 18 acres were conducted by Washington Department of Agriculture using a ground application of *Bacillus thuringiensis* (*B.t.*). A 1994 gypsy moth survey resulted in a trap catch of 173 individuals. Of those typed so far, seven have been identified as the Asian strain. Eradication projects at Oakbrook (Pierce County) and Anacortes Port (Skagit County) are planned for 1995.

REGION 8 (SOUTHERN)

On July 4, 1993, a ship carrying munitions from Germany docked at Sunny Point Military Ocean Terminal near Wilmington, North Carolina. Moths were seen flying from the ship on July 6 and were identified as gypsy moths. Various life stages (eggs, larvae, pupae, and adults) were found on many of the containers on deck as well as in some cargo holds. Major concerns developed when the females were observed flying--a characteristic of the Asian gypsy moth. Subsequently, several moths were identified as either hybrids or Asian strain.

An extensive eradication program is planned over the next few years with APHIS being the lead Federal agency. A cooperative eradication project was carried out in 1994 between APHIS and the North Carolina Department of Agriculture treating 141,000 acres with B.t.k. and 3,000 acres with Gypchek. Results of post-treatment monitoring are being analyzed. A few scattered male moths were trapped within the 1994 treatment area. There were some trap catches adjacent to the treatment area. It is anticipated that the 1995 proposed eradication project will involve significantly less acres than 1994.

WEED PREVENTION AND HERBICIDE USE

NORTHEASTERN AREA

Biological control is being used on leafy spurge and purple loosestrife on both Federal and State and Private lands. A new pest (Mile-a-minute weed) is spreading rapidly in Pennsylvania, Maryland, and West Virginia. A prolific seeder--and the fact that birds eat the seeds--is probably the cause of rapid spread. This weed could soon replace Kudzu as an important weed pest in the eastern United States.

REGION 1 (NORTHERN)

The Northern Region has continued an aggressive program of chemical and biological control of exotic noxious weed species. Target species include the knapweeds (spotted, diffuse, and Russian), yellow starthistle, leafy spurge, common crupina, rush skeletonweed, Canada thistle, houndstongue, and others. Approximately 10,000 acres are treated annually with herbicides. Herbicides used include Tordon (picloram), 2,4-D, and Transline (clopyralid). Herbicides are generally applied with ground equipment; however, aerial application is being considered for treatment of winter range in steep country.

The Forest Service is cooperating with the State of Montana in search and treat programs to prevent the establishment of new invaders. The species of primary concern are common crupina, yellow starthistle, and rush skeletonweed.

In conjunction with their Canadian and European counterparts, American researchers are making progress in the search for biological controls of introduced weed species. To date Forest Service personnel have tested a variety of biological control agents including several Apthona species on leafy spurge, the root-boring species Agapeta zoegana, and Cyphocleonus achates on spotted knapweed, Aplocera plagiata on goatweed, and Ceutorhynchus litura on Canada thistle.

REGION 4 (INTERMOUNTAIN)

The Intermountain Region's program against noxious weed species includes biological control and herbicide treatments. The targeted species treated are musk thistle, leafy spurge, Dyer's woad, knapweeds, yellow toadflax, crupina, and many others. Approximately 14,000 acres are treated annually with herbicides. Herbicides used included Tordon (picloram), 2 4-D, Dicamba, Glyphosate (Round-up), and Transline (Clopyralid). Treatments were applied primarily using ground equipment, although some were applied aerially.

REGION 6 (PACIFIC NORTHWEST)

Table 4.--Noxious weed acres by method of treatment in Region 6 in 1994.

						Total by State	
Chem	Manual[1]	Mechan[2]	Biol	Fire	Total	OR	WA
434	11,938	520	983	31	13,906	12,984	922

[1]Hand held tools or pulled
[2]Drive machine, mow, etc.

REGION 8 (SOUTHERN)

In 1994, the Region 8 herbicide program on Federal lands showed little change from 1993 levels, with approximately 65,000 acres treated. Selective treatments (backpack foliar, cut surface/injection, and streamline) accounted for the bulk of the activity. Little broadcast treatment was done. Three active ingredients accounted for the bulk of herbicide used; triclopyr, at an average rate of 1.0 lb. AI/ac, was the product most used, applied to approximately 50,000 acres; hexazinone, at an average rate of 1.25 lbs. AI/ac, was applied to approximately 8,000 acres; and glyphosate, at an average rate of 0.8 lb. AI/ac, was applied to approximately 6,000 acres. Herbicides were used for site preparation (approximately 30,000 ac); conifer release (approximately 30,000 ac); wildlife habitat improvement (approximately 5,500 ac); right-of-way maintenance (approximately 2,500 ac); and general weed control and hardwood release (approximately 1,500 ac).

FIRE

The past summer and fall was one of the worst fire seasons in the United States in the last 50 years. By September an area larger than the State of Connecticut had burned and expenditures by then had exceeded $780 million dollars. The final figures for 1994 will be one of the highest in fire history. Many or possibly most fires occurred in old bark beetle outbreak areas. This is true especially in the northwestern States. Acres burned as of November 4 were near the four million mark or an area the size of the States of Connecticut and Delaware.

REGION 1 (NORTHERN)

Table 5.--Wildfire starts and area burned from all causes on Forest lands in Region 1.

Year	1991	1992	1993	1994
Starts	1329	1429	383	2740
Acres	38,181	56,568	372	147,904

Table 6.--Total precipitation for June, July, and August 1994 in the Missoula, Montana, area.

Year	1991	1992	1993	1994
	- - - - - - - - -	inches	- - - - - - - - - -	
Three Month Total	3.81	2.91	4.79	2.68

REGION 4 (INTERMOUNTAIN)

The Intermountain Region continues to experience a severe drought. Portions of the Region have received below normal precipitation for eight consecutive years. A clear correlation between forest pest activity and precipitation is apparent. However, the more notable effect of extended drought in 1994 was the 3,907 fires that burned 1,081,859 acres of forest and rangeland in the Intermountain Region. Southern Idaho experienced its worst fire season on record, with nearly 650,000 acres burned. Many of the areas where fires were active were areas of current and past forest pest activity, most notably spruce beetle and Douglas-fir beetle.

Damage from extreme cold temperatures and drying winds affected approximately 2,500 acres of lodgepole pine on the Targhee National Forest in Idaho.

REGION 6 (PACIFIC NORTHWEST)

Washington

Fires were reported on 285,737 acres of forested land in Washington. The largest fires occurred in north central Washington (Tyee and Hatchery complexes).

Oregon

Fires were reported on 255,486 acres of forested land in Oregon (35% on National Forest System lands).

BARK BEETLES

NORTHEASTERN AREA

The common European pine shoot beetle was discovered in July of 1992 in the vicinity of Cleveland, Ohio. By December 1992 it had been found in 43 counties in six States: Illinois, Indiana, Michigan, Ohio, New York, and Pennsylvania. Delimiting surveys have brought the total number of infested counties in these States to a total of 116 as of November 1994.

REGION 1 (INTERMOUNTAIN)

Bark beetles continue to be a problem--especially mountain pine beetle. Last year a 33,000 acre fire burned over a beetle infested stand in Glacier Park. As of September a fire had burned 3,000 acres in West Glacier and was still burning.

REGION 2 (ROCKY MOUNTAIN)

There were no significant bark beetle outbreaks in Colorado in 1994. However, a sampling of stands which were hazard rated for bark beetles revealed that many stands are at risk of mortality due to bark beetles. This is a problem that is a high priority for future work by Forest Health Management.

REGION 3 (SOUTHWESTERN)

Arizona Zone

Mortality continues to increase in the true fir component of Big Ridge on the Kaibab National Forest. Approximately 1,850 acres were detected for 1994. This mortality is caused by a complex of <u>Annosus</u> root disease, <u>Scolytus</u> beetles, and western balsam bark beetles.

Roundheaded pine beetle continues to cause mortality on the Safford Ranger District, Coronado National Forest. In 1994, the number of new attacks appears to have decreased. Approximately 2,400 acres of mortality was detected this year.

New Mexico Zone

Tree mortality caused by the roundheaded pine beetle, often in conjunction with the western pine beetle and Mexican pine beetle, decreased from 13,830 hectares in 1993 to 9,580 hectares 1994. As in 1993, most of the tree mortality detected occurred in the Sacramento Mountains on the Lincoln National Forest (4,430 hectares) and Mescalero Apache Indian Reservation (5,150 hectares).

REGION 4 (INTERMOUNTAIN)

Following are estimates of the number of trees killed and acres infested by bark beetles in Region 4 during 1994. No visible defoliation was detected during aerial or ground surveys in 1994. Region 4 is in the process of digitizing aerial pest detection survey flight maps and the numbers in Table 8 are rough estimates of pest activity and will likely change when map processing is completed.

Table 8.--Bark beetle infestation in Region 4 in 1994 by acres and number of trees killed.

Pest	Trees Killed	Acres Infested
Mountain pine beetle	17,100	19,500
Douglas-fir beetle	94,200	78,000
Ips/Western Pine Beetle	3,100	2,900
Spruce Beetle	44,400	31,000
Fir Engraver Beetle	223,700	139,100
Western Balsam Bark Beetle	202,000	191,400
Jeffrey Pine Beetle	18,400	14,300
Total	602,900	476,200

General Overview of Pest Conditions during 1994 in Region 4

Mountain pine beetle activity remained static in lodgepole, ponderosa, and whitebark pine. The largest outbreak is located in the Sawtooth National Recreation Area in southern Idaho. Smaller outbreaks were located on the Caribou, Uinta, Manti-LaSal, and Dixie National Forests.

Douglas-fir beetle activity remained relatively static regionwide with most mortality located in southern Idaho and northern Utah. Areas with extensive mortality are located on the Boise, Caribou, and Wasatch-Cache National Forests. Western pine beetle activity, located primarily on the Boise and Payette National Forests in southern Idaho, continued to decrease due to host depletion and parasite/predator activity. Spruce beetle activity decreased on the Payette National Forest in southern Idaho and increased on the Manti-LaSal National Forest in central Utah. Small outbreaks are located on the Wasatch-Cache National Forest in northern Utah.

The most extensive tree killer in the Region continued to be the fir engraver beetle with most activity located on the Toiyabe National Forest in Nevada. Smaller outbreaks are located on the Boise and Payette National Forests in southern Idaho, and on the Wasatch-Cache and Dixie National Forests in Utah. Killing of subalpine fir by a complex of bark beetle pests, primarily western balsam bark beetle, and numerous disease pathogens decreased regionwide. Jeffrey pine beetle activity increased significantly on the Toiyabe National Forest with most mortality located in the Tahoe Basin.

REGION 5 (PACIFIC SOUTHWEST)

Table 9.--Bark beetle caused mortality within the National Forest lands, California, in 1993.[1]

Locale	Pine[2]		True Fir	
	Acres of Mortality	MMBF	Acres of Mortality	MMBF
Northern California	84,800	278.1	96,510[3]	290.5
Cascade/No. Sierra	34,300	172.1	179,950	181.6
Central/So. Sierra	163,600	305.5	111,950	171.1
Southern California	62,800	64.2	16,590	11.7
Total	345,500	819.9	405,000	654.9

1 Mortality is seldom from bark beetles alone as other factors (e.g. drought) and agents (e.g. root diseases) predispose trees to successful attack.
2 Includes ponderosa, Jeffrey, sugar, and lodgepole pines.
3 Includes Douglas-fir in the total.

REGION 6 (PACIFIC NORTHWEST)

Washington

Estimates of bark beetle activity are based on a sample of four U.S. Geological Survey quadrants in eastern Washington. Data for 1994 in these four quadrants was compared to 1993 data to obtain trend information. The average percent increase/decrease for each insect was applied to 1993 estimates for the entire State. The following are the 1994 estimates:

INSECT SPECIES	NO. OF TREES KILLED
Douglas-fir beetle	5,500
Fir Engraver	14,500
Mountain pine beetle	137,000
Western pine beetle	750,000

Decreases (from 1993 data) in total tree mortality were indicated in the sample areas for trees affected by Douglas-fir beetle, fir engraver, and mountain pine beetle. A four fold increase in tree mortality caused by western pine beetle was reported within the sample area. Increases in tree mortality caused by western pine beetle offset, in part, the decreases in mountain pine beetle associated tree mortality. Changes in reporting of damaging agents when aerially observed symptoms are the same (such as mountain pine beetle and western pine beetle in ponderosa pine) are based on information from field crews.

Oregon

The following is a summary of bark beetle activity:

INSECT SPECIES	NO. OF TREES KILLED
Douglas-fir beetle	52,200
Western pine beetle	27,500
Mountain pine beetle	164,900
Fir engraver	220,300

REGION 8 (SOUTHERN)

In 1994, overall southern pine beetle (SPB) activity declined throughout the South. It was interesting that the most intense activity reported was from Gainesville, Florida, an area that historically never experienced SPB problems previously. Last year, the highest beetle populations were located in Virginia and Texas and both areas experienced dramatic declines in the number of SPB spots detected during 1994.

After a mild, very wet summer, SPB populations seem to show a building trend (at least on National Forest land) in central and southwestern Mississippi and Alabama and the lower Piedmont area of Georgia. Several infestations in Georgia and Alabama have threatened colonies of the red-cockaded woodpecker, a Federally listed endangered species.

During 1993 SPB activity was especially high within the wildernesses located on the National Forests in Texas. Spruce budworm spots killed between 25 to 75 percent of the available host type within four of the five wildernesses. Several spots within wilderness spread to adjacent private land causing some impact. However, in 1994 the SPB activity in these areas has decreased dramatically. Only minor activity remains within the center of the Turkey Hill Wilderness.

Cooperative suppression projects were funded for the States of Alabama, Florida, North Carolina, South Carolina, Texas, Louisiana, and Virginia. Federal suppression projects were funded on the National Forests in Alabama, North Carolina, Mississippi, Texas, Kisatchie NF, Sumter NF, Jefferson NF, George Washington NF, and Oconee NF. Other Federal lands that have funded projects are the Big Thicket National Preserve, Natchez Trace Parkway, Noxubee Wildlife Refuge, and Fort Benning.

REGION 10

Spruce bark beetle (Dendroctonus rufipennis) populations declined slightly in 1994. Aerial detection in 1994 showed 645,000 acres of on-going infestations compared to 720,000 acres in 1993. Ground observations in 1994, however, indicate a heavy and successful spruce beetle flight in areas previously only lightly attacked. This increased activity will not become readily apparent until next summer as spruce normally take one year after attack to turn red. The majority of the spruce beetle infestations occur in south-central Alaska's Kenai Peninsula and the Copper River drainages.

OTHER PESTS

FOREST TENT CATERPILLAR

Northeastern Area

Extensive areas of defoliation have been reported from New York. As yet acreage figures are not available.

Region 8 (Southern)

Defoliation by the forest tent caterpillar in the Atchafalaya Basin, south of Baton Rouge, Louisiana, increased slightly in 1994. There were 225,000 acres affected as opposed to 185,000 in 1993. Of that total, 175,000 acres experienced greater than 50 percent defoliation. Growth impact begins to occur at defoliation levels of 50 percent or greater.

CYPRESS APHID, CINARA CUPRESSI (BUCKTON)

From October 24 to November 5, 1994, Yvonne Abraham of IIBC, Dan Kucera, U.S. Department of Agriculture, Forest Service, and Jose Chabolla of Sanidad Forestal made a collecting trip in and around Mexico City. Even though Mexican officials said we were too late ample specimens were found in native Mexican cypress stands (Cupressus lindleyi). Mummified aphids were shipped to IIBC in London on November 6. By November 7 over 20 parasites had emerged. Specimens have been shipped to taxonomists for identification. Since the aphid feeds on the bark similar to the aphid in Kenya the chances are great that this is the same aphid.

FRUITTREE LEAFROLLER

Region 8 (Southern)

In Louisiana, the fruittree leafroller, Archips argyrospyila, caused defoliation of approximately 115,000 acres of bald cypress. This has resulted in growth loss on 65,000 of those acres. The Parishes where defoliation occurred in 1994 were St. Martin, Assumption, Lafourche, St. James, St. John the Baptist, and St. Charles.

HEMLOCK WOOLLY ADELGID

Northeastern Area

Extensive areas of dead hemlock are visible in Connecticut, especially along the coast. Often the only visible green trees are in cities where they have been treated.

Region 8 (Southern)

In 1994, the hemlock woolly adelgid (Adelges tsugae) continued to increase its distribution and has infested eastern hemlock (Tsuga canandensis) along the eastern seaboard from Virginia to New Hampshire. Many areas are experiencing a great deal of hemlock mortality due to the adelgid infestations. Depending on environmental conditions hemlock mortality will occur from two to seven years after infestation. The adelgid is currently increasing its distribution twenty miles per year and the entire range of eastern hemlock will be infested in less than 20 years. To date, no natural resistance has been observed and without control measures all eastern hemlocks will be eliminated soon after infestation.

The Shenandoah National Park in Virginia and Delaware Watergap National Park are involved in suppression efforts in some recreation areas. The George Washington and the Jefferson National Forest had suppression projects for adelgid control in 1994 as well. These suppression projects would occur in high use recreation areas that have a major hemlock component.

DOUGLAS-FIR TUSSOCK MOTH

Region 5 (Pacific Southwest)

Douglas-fir tussock moth trap data will not be available until late November or early December.

Region 6 (Pacific Northwest)

Douglas-fir tussock moth activity was detected on 26,500 acres. A decrease in reported acres is expected for 1995.

PANDORA MOTH

Region 6 (Pacific Northwest)

Approximately 369,000 acres were reported affected by Pandora moth in central Oregon. The outbreak is expected to continue in 1996.

DISEASES

DOGWOOD ANTHRACNOSE

Region 8 (Southern)

Dogwood anthracnose, first discovered in the southeastern United States in the late 1980's, has spread to seven southern States and affected trees in 221 counties. The acres affected have increased from 0.5 million acres in 1988 to 10 million acres in 1994. In a series of permanent plots, the percentage of severely affected or dead trees has increased from 4 to 36 percent during the same time period. Control techniques are not available for forest trees, but hazard rating techniques are available. For high value trees, the hazard rating system also works, as well as a number of control techniques, such as mulching, fertilization, pruning, proper watering, and the use of pesticides. A decision key with the ten essential steps to maintaining a healthy dogwood has been completed. The University of Tennessee and the Forest Service are cooperating to identify possible sources of resistance. The geographic distribution and severity of the disease is projected to increase in the South during 1995.

BUTTERNUT CANKER

Region 8 (Southern)

Butternut is being killed throughout it's range in North America by a fungus of unknown origin (Sirococcus clavigignenti-juglandacearam). The fungus causes multiple cankers that eventually girdle and kill the infected trees. The disease has been in Region 8 for at least 40 years and is estimated to have killed 80 percent of the resource.

Butternut canker has been confirmed in Virginia, North Carolina, Georgia, and Tennessee, and infected trees are suspected in Arkansas, Alabama, South Carolina, and Mississippi. Trees exhibiting resistance have been found in North Carolina and are being propagated by grafting and nut collection, in cooperation with Region 8 and the NCFES. The USDA Forest Service has placed a moratorium on the harvesting of healthy butternuts, and guidelines are being developed to manage butternut on National Forest lands.

FUSIFORM RUST

Region 8 (Southern)

This disease has been epidemic in many areas of the South since the 1930's. Only Tennessee and Kentucky are free of significant rust occurrence (due to the small quantity of host trees and environmental conditions). An estimated 17 million acres (4.6 million acres slash, 12.1 million acres loblolly) are affected (10 percent or more trees infected). This amounts to 31 percent of the host acres (38 percent of slash acreage, 29 percent of loblolly acreage). Economic losses due to fusiform rust have been roughly estimated to be over 47 million dollars a year southwide.

Forest managers are applying several strategies which may ultimately reduce rust incidence and severity southwide. These include: careful matching of species to site, using geographic and genetic sources of rust resistance, adjustments in planting density, reduction of local oak populations, and mid-rotation thinnings. Fusiform rust will continue to be a major problem in the South for many years but a gradual decline should occur over time.

OAK DECLINE

Region 8 (Southern)

Instances of oak decline and mortality in the Southeastern United States have been reported since the mid-1800's and have included nearly all of the States in the Southern Region. The first Regional surveys of incidence, distribution, damage, and progress over time were initiated in the mid-1980's after several years of drought resulted in severe and widespread symptoms. These surveys and other research have shown that oak decline results from the interactions of physiologically mature trees growing under stress (caused by prolonged drought, insect defoliation, and/or frost) and opportunistic root disease fungi and insects that exploit weakened trees. Species in the red oak group are more severely affected than the white oak group with black and scarlet oaks most prone to mortality. Oak decline results in slower radial growth, tree mortality, reduced acorn yield and quality, reduced oak regeneration potential, and long-term changes in tree species composition. An estimated 3.9 million acres of upland hardwood forest type are affected in the Region (Kentucky excluded). Surveys in 1986-87 of selected National Forest Ranger Districts showed that over one-half of the hardwood forest type on the Lee Ranger District, George Washington National Forest, was affected. This compared with about one-third on the Wayah Ranger District, Nantahala National Forest, and one-fourth on the Buffalo Ranger District, Ozark National Forest.

While long-term monitoring is in the early stages, it appears that oak decline is increasing when compared with historical levels. Decline and mortality has dramatically worsened in areas where insect defoliation has been recurrent, as with the gypsy moth in northern Virginia. Oak forests are becoming more uniformly older with a concomitant increase in decline vulnerability with management trends on public lands moving towards less timber harvest. Where harvests are planned, partial cutting methods are increasingly prescribed. This introduces another source of stress on residual trees. The survivability of decline-vulnerable oaks under these conditions is not good.

OAK WILT

Region 8 (Southern)

Oak Wilt, caused by the fungus Ceratocystis fagacearum (Bretz) Hunt, invades the vascular system of oak trees causing them to wilt and die. Although all oak species are susceptible, red oak species are much more so and die more quickly than white oak species. The disease spreads tree-to-tree primarily through root connections. Oak wilt was first described in the United States in the early 1940's in Wisconsin and has since spread or been discovered in 19 states.

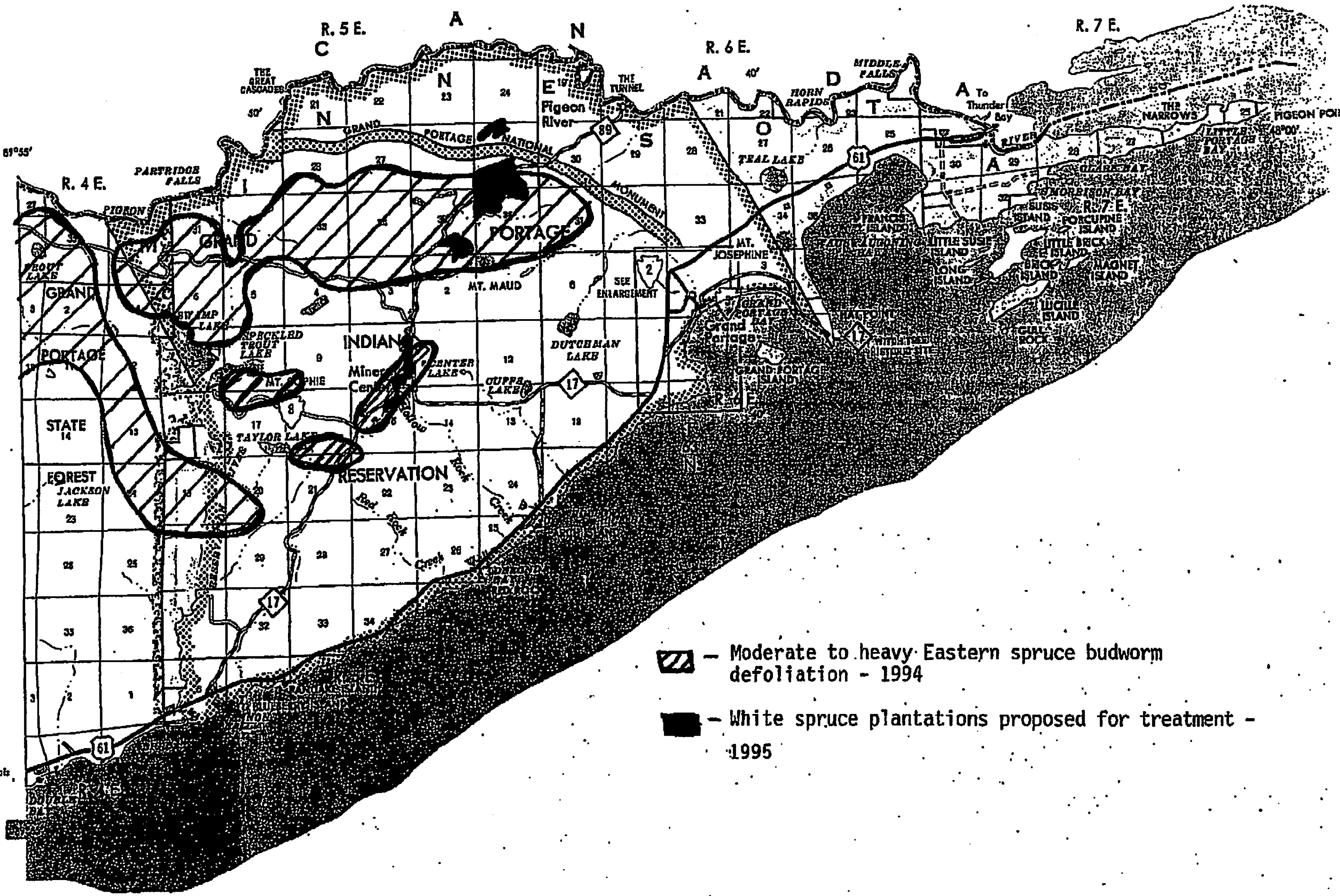
In the Southern Region, oak wilt is currently causing severe problems only in central Texas where it has been epidemic for over thirty years. A few infection centers are detected in the Appalachian Mountains each year but most are old infection centers and damage is limited to a few newly symptomatic trees. Control efforts are justified only in the case of landscape and ornamental trees. In central Texas, 46 counties are known to contain oak wilt. Some have thousands of acres of dead and dying trees. Live and red oaks in the Region have little commercial value but are highly prized for shade, aesthetics, wildlife, and watershed values. Both rural and urban trees are affected. Control treatments successfully implemented in central Texas include trenching to sever root connections and fungicide injections to prevent tree mortality of individual, high-value trees. Since 1988, a cooperatively funded suppression program has treated nearly 400 infection centers with over 120 miles of barrier trenches and injected over 2,016 trees with an approved fungicide. Oak wilt in the central Texas area will likely continue to increase over the next several years; east of Texas the disease should remain almost static as it has for a number of years.

YELLOW-CEDAR DECLINE

Region 10 (Alaska)

Decline and mortality of Alaska yellow-cedar (Chamaecyparis nootkatensis) continues to be one of the most spectacular forest problems in southeast Alaska. More than 500,000 acres of decline have occurred since the 1880s. Studies suggest that cedar decline is naturally occurring and is caused by some abiotic environmental stress.

Appendix A.--Moderate to heavy Eastern spruce budworm defoliation in 1994, and white spruce plantations proposed for treatment in 1995 in Minnesota.



FOREST SERVICE

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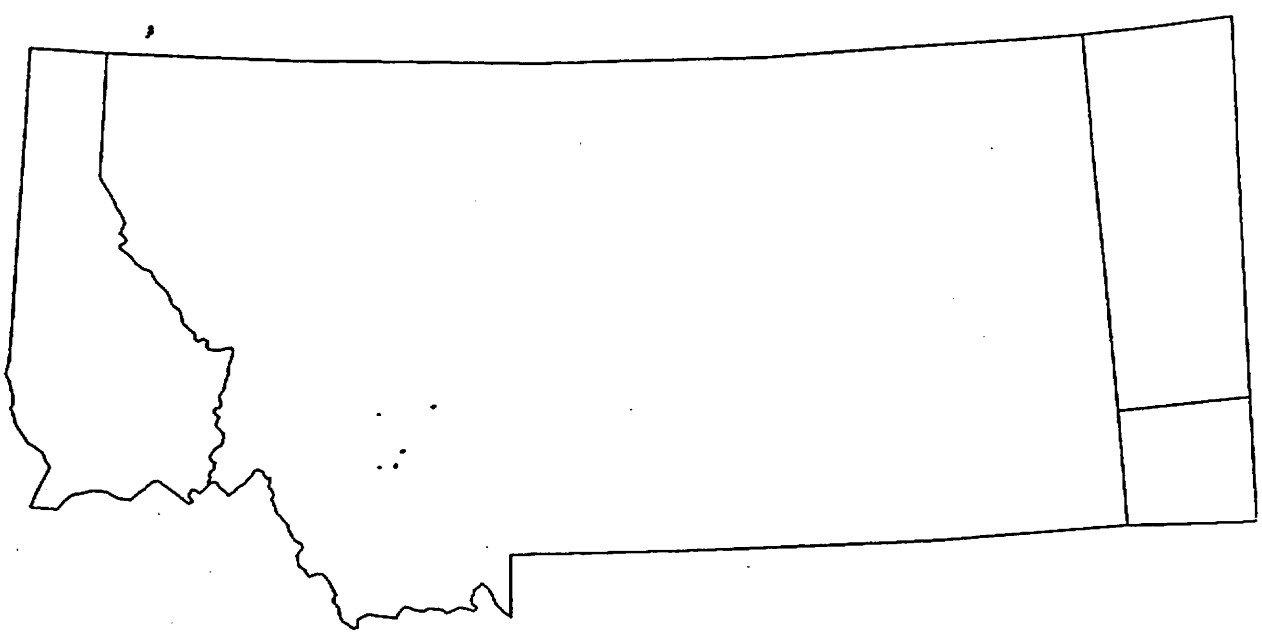
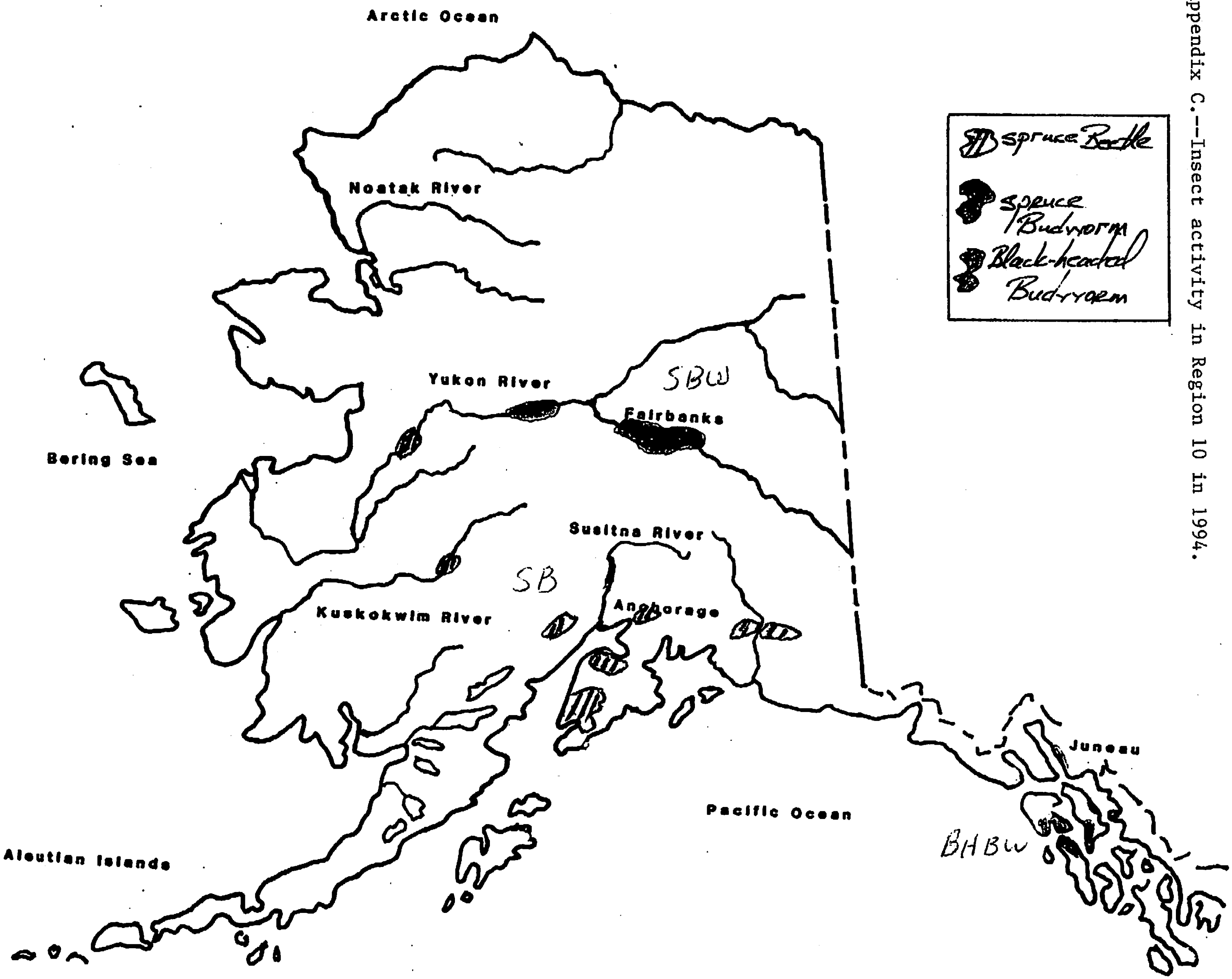
Appendix B.--Western spruce budworm defoliation in Region 1 in 1994.



FRIDAY OCT. 14,1994 09:07 AM ZONE 12 R01F00D00
PRODUCT OF USFS JELLY SYSTEM - AERIAL BUGS
REGION ONE SCALE 1:6847430
SBW 94

1994 Alaska (R-10) Insect Activity



Appendix C.--Insect activity in Region 10 in 1994.

Pine Shoot Beetle Infestations
by State, County, and Province

November 7, 1994

*** 1993 New Counties** **= 1994 New Counties**

Illinois--10

Kane	Will	*Kankakee	*Iriquois
*DuPage	*Cook	=McHenry	*Livingston
=Lake	=Kendall		

Indiana--31

Lake	Porter	Pulaski	St. Joseph
Newton	LaPorte	Fulton	Elkhart
Noble	Jasper	Starke	Marshall
Kosciusko	LaGrange	Steuben	Allen
Wells	Whitley	*Huntington	*Miami
*White	*Tippecanoe	*Benton	*DeKalb
*Grant	*Delaware	=Cass	=Blackford
=Wabash	=Adams	=Jay	

Michigan--37

Berrien	Cass	St. Joseph	Monroe
*Branch	*Hillsdale	*Lenawee	*Wayne
*Washtenaw	*Jackson	*Calhoun	*Kalamazoo
*Van Buren	*Barry	*Eaton	*Ingham
*Livingston	*Oakland	*Macomb	*Genesee
*Shiawasee	*Clinton	*Ionia	*Montcalm
*Gratiot	*Saginaw	*Isabella	*Midland
*Tuscola	*Allegan	=Lapeer	=St. Clair
=Sanilac	=Huron	=Kent	=Clare
=Bay			

Ohio--18

Huron	Richland	Ashland	Lorain
Cuyahoga	Medina	Wayne	Summit
Portage	Geauga	Lake	Astabula
Trumbull	Mahoning	*Erie	*Knox
=Stark	=Delaware		

Pennsylvania--10

Erie	Crawford	Lawrence	=Beaver
=Allegheny	=Butler	=Venango	=Warren
=Mercer	=Clarion		

New York--12

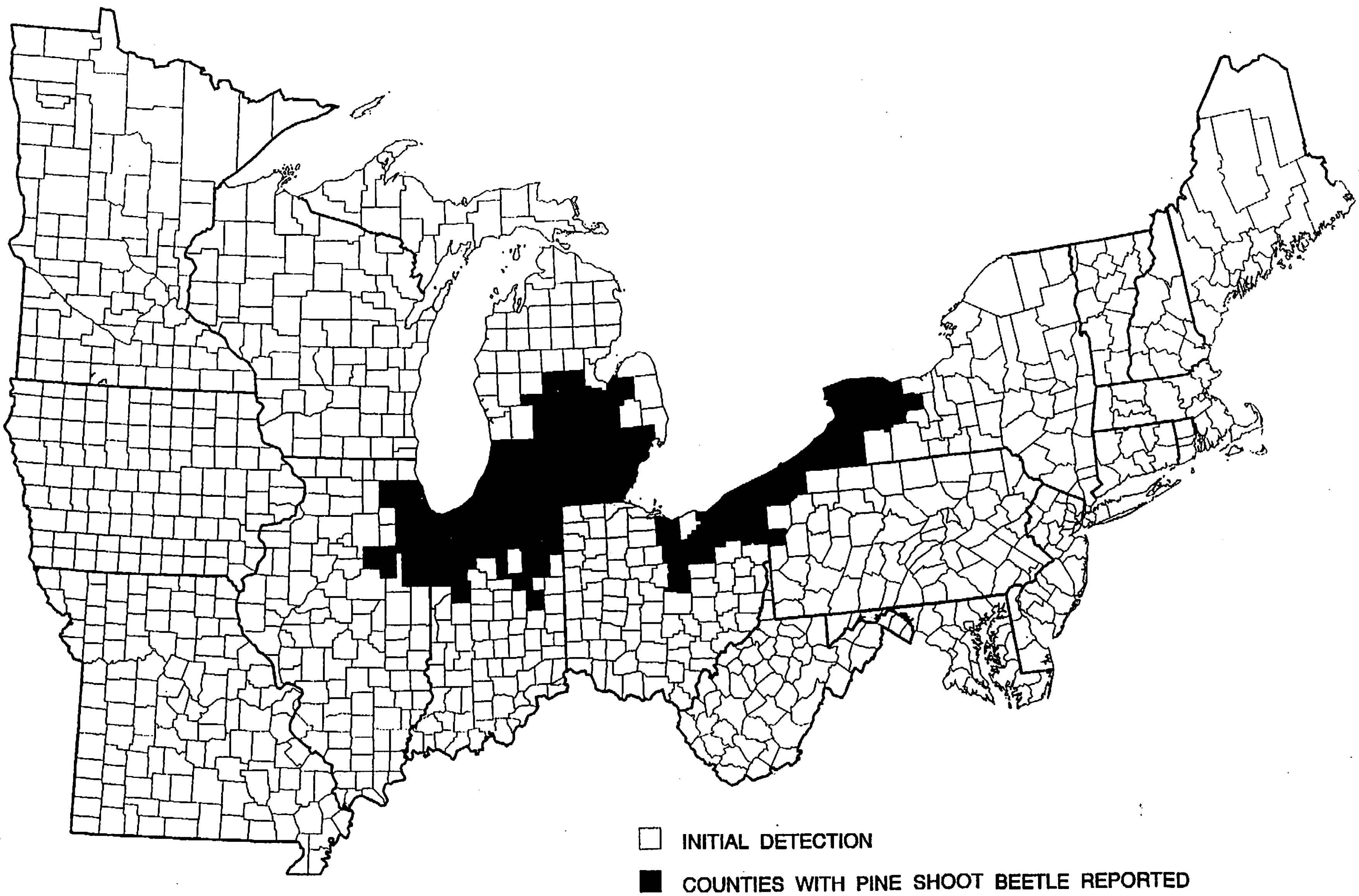
Niagara	Erie	*Chautauqua	*Wyoming
*Cattaraugus	*Genesee	*Orleans	*Monroe
*Livingston	*Ontario	=Oswego	=Allegany

Canada--10

Ontario

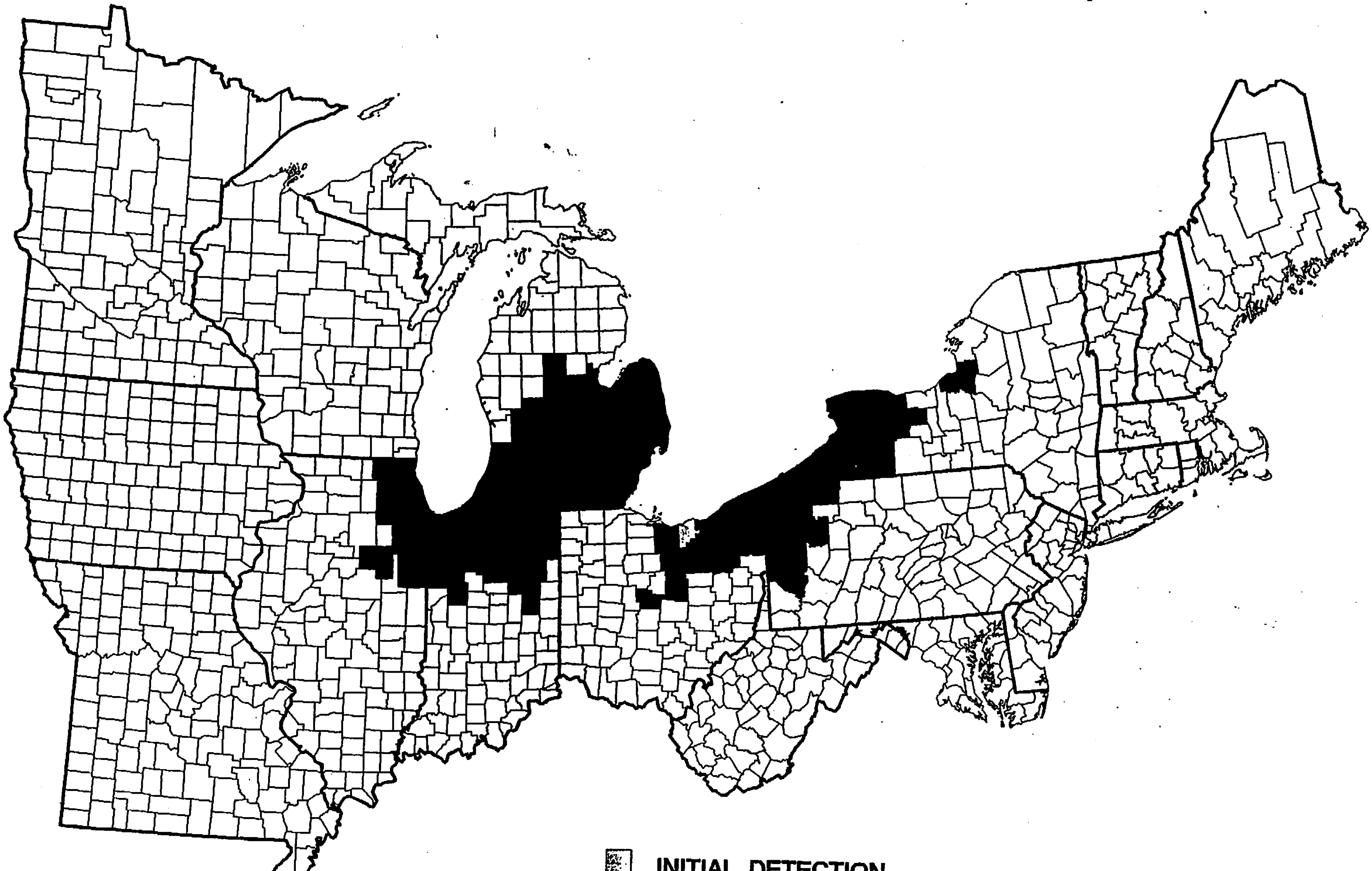
*Haldimand-Norfolk	*Hamilton-Wentworth		*Halton
*Niagara	*Waterloo		*Wellington
*Peel	=Dufferin	=Brant	=Oxford

Pine Shoot Beetle Distribution - 1993



Produced by: USDA Forest Service, Northeastern Area, Forest Health Protection GIS Group

Pine Shoot Beetle Distribution - 1994



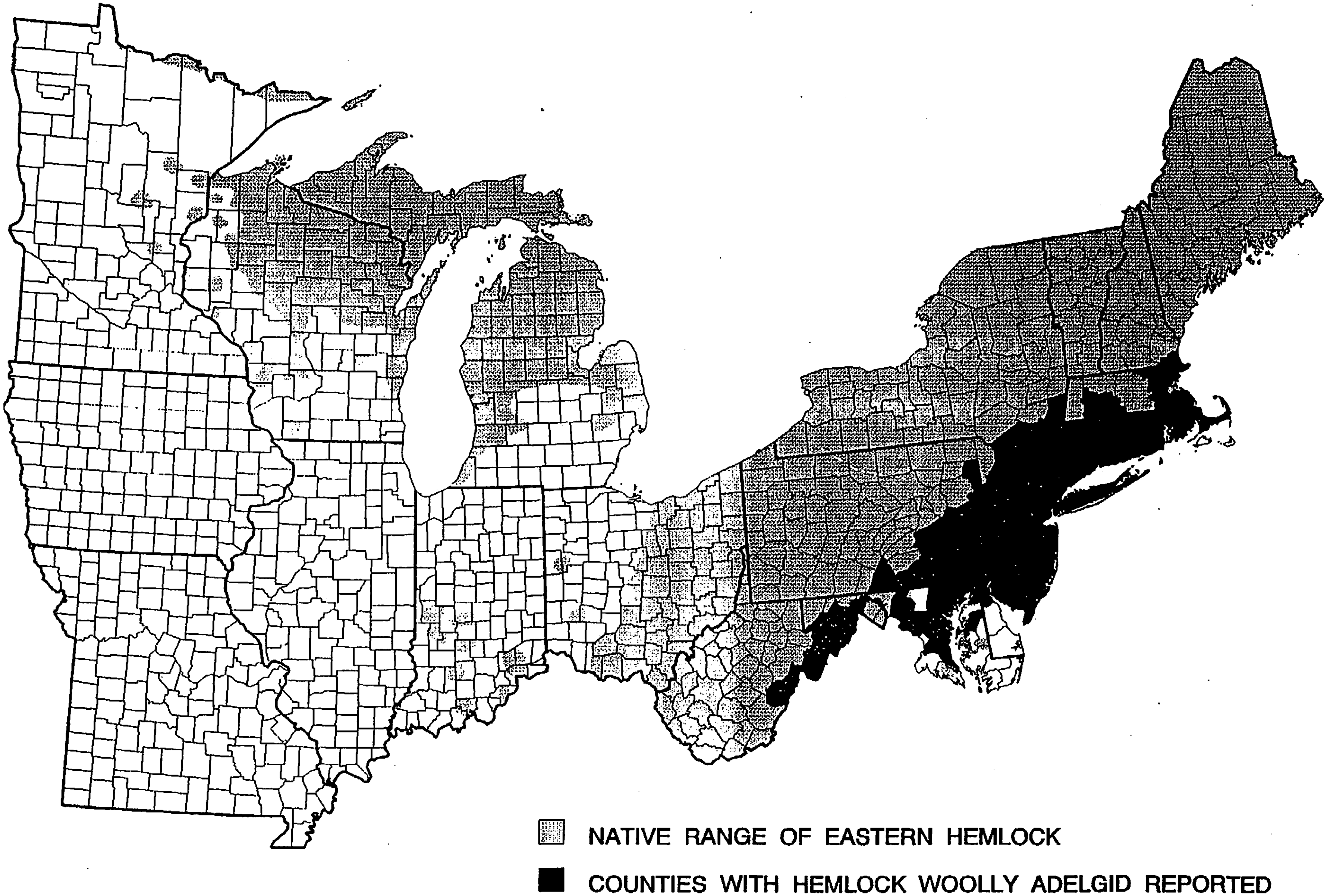
INITIAL DETECTION

COUNTIES WITH PINE SHOOT BEETLE REPORTED

Produced by: USDA Forest Service, Northeastern Area, Forest Health Protection GIS Team

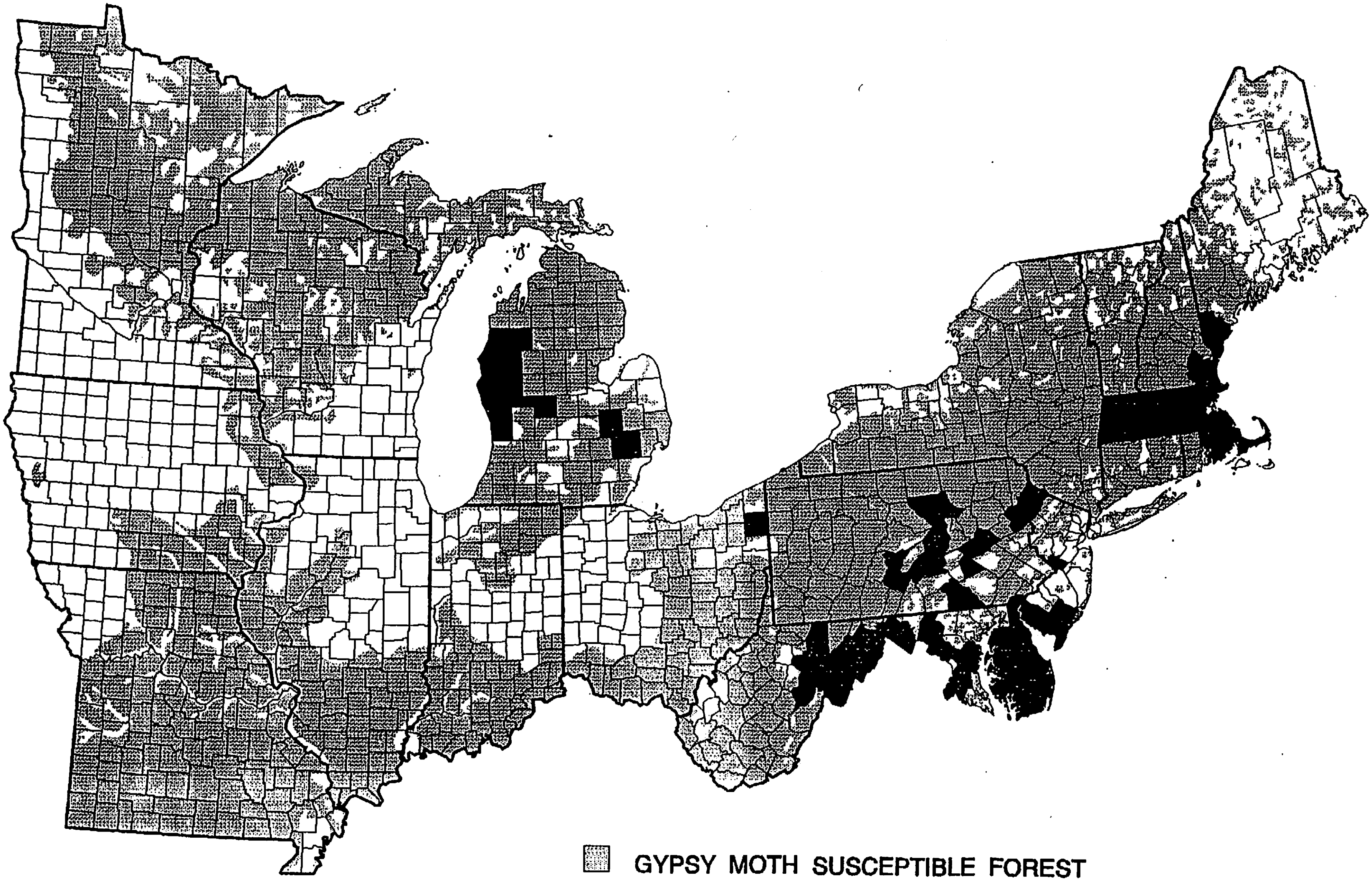
3/95

Hemlock Woolly Adelgid Distribution - 1994



oduced by: USDA Forest Service, Northeastern Area, Forest Health Protection GIS Team 3/95

Gypsy Moth Defoliation - 1994



GYPSY MOTH SUSCEPTIBLE FOREST

COUNTIES WITH GYPSY MOTH DEFOLIATION

'roduced by: USDA Forest Service, Northeastern Area, Forest Health Protection GIS Team

3/95

HERBICIDE USAGE IN ONTARIO - 1994

Joe Churcher and Dan Kott
Ontario Ministry of Natural Resources

Approximately 80,000 hectares of Crown forests were sprayed with herbicides in Ontario in 1994. Pesticide usage reports were still being compiled at the time of the twenty-second annual Forest Pest Control Forum (November 15-17), so the following figures are not final. They do, however, provide a good estimate of the amount and type of herbicide used, and the purpose.

Glyphosate (Vision) was by far the most common product used (74,313 hectares). Other herbicides were 2,4-D (4,400 ha), Velpar (495 ha), Pronone (445 ha), Release (100 ha) and Garlon (86 ha) (Table 1).

Herbicides were primarily used for tending of existing immature stands (69,676 ha), with only 10,163 hectares being site prepared using chemical means (Table 1).

Similarly, the vast majority of herbicides was applied from the air (76,597 ha), with the remaining 3,242 ha applied using ground application equipment (Table 2).

As is normal, the companies holding Forest Management Agreements (FMA's) conducted most of the herbicide program, treating a total of 65,082 ha. Forest management units managed by the Ministry of Natural Resources received 14,757 ha of herbicide treatments (Table 2).

TABLE 1: **PROVINCIAL HERBICIDES USED 1994/95**

Reporting date to: November 9, 1994

PESTICIDE	TENDING (ha)	SITE PREP. (ha)	TOTAL
1) Vision	65,451	8,862	74,313
2) 2,4-D	3,345	1,055	4,400
3) Velpar	298	197	495
4) Pronone	445	0	445
5) Release	51	49	100
6) Garlon	86	0	86
Total (hectares)	69,676	10,163	79,839

TABLE 2: **PROVINCIAL HERBICIDE USAGE 1994/95**

Reporting date to: November 9, 1994

	AERIAL	**GROUND**	**TOTAL**
FMA	63,548	1,534	65,082
CROWN	13,049	1,708	14,757
TOTAL	76,597	3,242	79,839

Herbicide Spray Programs in New Brunswick - 1994

(Prepared for Annual Forest Pest Control Forum in Ottawa, Nov. 14-17, 1994)

Agency	Area (ha)	Vision Rates (L/ha)	Type of Application
DNRE	9 662* (Crown)	3.7 to 4.9 (95% @ 4.2)	Helicopter
	109 (Crown)	4.2	Ground
	59 (C.F.S.)	4.2	Helicopter
Sub-total	9 830		
J. D. Irving	9 982	3 to 5	Fixed wing and helicopter
Fraser Inc.	3 048	4	Helicopter
N.B.I.P.	1 184	4.5 to 4.8	Fixed Wing
Sub-Total	14 214		
Grand Total	24 044		

* 87% plantations
13% natural release

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Experimental and Semi-Operational Applications of RH5992 against Spruce Budworm in 1994: Preliminary Results

A Report to the Annual Forest Pest Control Forum
Ottawa Ont., Nov 15-17, 1994

B.L. Cadogan[1], A. Retnakaran[2] R.Scharbach[1], A Robinson[1], & W. Tomkins[2]

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[1] Project 6100 - Pesticide Applications
[2] Project 1300 - Biotechnology of Insects

Experimental and Semi-operational Applications of RH5992 Against Spruce Budworm in 1994: Preliminary Results

B.L. Cadogan, A. Retnakaran, R.Scharbach, A.Robinson & W.Tomkins

Abstract. A field study conducted in NW Ontario investigated the efficacy of RH5992 (Mimic 2F) against spruce budworm Choristoneura fumiferana (Clem). The material was applied aerially at 70g (AI) in either 1 L or 2 L/ha and as single or double applications. The results show that a double application of 70g (AI) in 2 L/ha was the most efficacious application strategy and that it was effective on both balsam fir (Abies balsamea) and white spruce (Picea glauca). Experimental and semi operational sprays were equally effective in suppressing Sbw populations but the experimental application was the better of the two spray techniques in protecting foliage.

Experimental and Semi-operational Applications of RH5992
Against Spruce Budworm in 1994: Preliminary Results

B.L. Cadogan, A. Retnakaran, R.Scharbach, A.Robinson & W.Tomkins

Introduction

Mimic 2F (tebufenozide [RH5992]) (Rohm & Haas Inc., Springhouse, PA) is a new 24% (240g [AI]/L) flowable insecticide. It's active ingredient is a non steroidal molt accelerating compound that belongs to a novel class of insect growth regulators (IGRs), which mimic the action of the steroidal hormone 20-hydroxyecdysone in Lepidoptera (Wing 1988). When an insect ingests RH5992, it forces a developmentally premature molt that causes the insect to stop feeding and ultimately die.

Laboratory studies showed that RH5992 was toxic to spruce budworm Choristoneura fumiferana (Clem.)(Sbw) and field studies conducted from 1991 to 1993 showed that aerial applications of the product at 70g (AI)/ha were the most effective and as a consequence, the recommended strategies (Cadogan et al. 1992, 1993).

This report summarizes the results of a field study that was conducted in 1994 to: i) investigate the efficacy of the product applied at 70g(AI)/ha in two spray volumes as single and double applications; ii) determine which of the four strategies was most efficacious against Sbw; and, iii) compare an experimental and a semi-operational application.

Materials and Methods

The study was conducted in a mature spruce (Picea)-fir (Abies) forest about 20 km north of the town of Longlac in NW Ontario (Fig 1).

Four small (50- to 70- ha) blocks, one for each treatment, were selected for the experimental sprays and one large block (approx 300 ha) was chosen for the semi-operational treatment (Fig 1, Table 1). Five plots, each with 12 balsam fir trees as sample trees, were selected in each treatment block. Eight 5-10 ha plots, each with 12 balsam fir (Abies balsemea) as sample trees were chosen as untreated checks. In addition, 6-10 white spruce (Picea glauca) were chosen as sample trees in each plot in the following: one experimental block, the semi-operational block & check plots (Table 2).

The Mimic was mixed with water and a tracer dye (Rhodamine WT, 1% w/v; A.S. Patterson, Willowdale Ont.) was added to the tank-mix to facilitate deposit analysis. Two Agtrucks (C.F.S.-F.P.M.I. and Forest Protection Ltd. (FPL) N.B.), fitted with identical equipment (4- AU4000 rotary atomizers (Micronair Ltd, Bembridge UK), a differential global positioning system (Diff GPS Ag. Nav. System, PicoDas, Richmond Hill, Ont.) and a data logger (Cr10, Campbell Scientific, Edmonton, Alt) applied the sprays. Each experimental block was sprayed with one aircraft but the two aircraft operating as a team sprayed the 300 ha semi-operational block. When spraying, the aircraft flew at 176 km/h approximately 20m above the forest canopy using flight lines that were 40m apart. The experimental blocks were sprayed only on mornings to take advantage of high ()70%) relative humidity. However, the applications to the semi-operational block followed operational guidelines that tend not to discriminate against evening sprays; thus one semi-operational spray was applied in the morning and one in the evening.

We consider that the sprays were applied at least five days after the date that we judged to be optimum, due to the unavailability of the aircrafts. Thus when the first sprays were applied the balsam fir shoots had flushed and flared and there was clear evidence of defoliation.

Details of the application strategies are presented in Table 1.

Results

The RH5992 tank mixes for both the experimental and semi-operational sprays, with one exception, produced fairly coarse sprays with VMDs between 97 and 127 μm (Table 1). The second semi-operational spray recorded a very fine spray spectrum (VMD = 31 μm) but we suspect this was due to the evening spray when low relative humidity (≈62% in contrast to the ≥ 90% for the morning sprays) would have caused in-flight evaporation of the aqueous droplets. Both the spray spectra and the mean numbers of droplets per cm^2 probably reflected the relatively slow atomizer RPMs that we used (≈ 4200 to 5500 rpm).

Nevertheless, RH5992 reduced Sbw populations, with one exception, to remarkably low levels (Tables 1 and 2).

On Balsam Fir

A double application of RH5992 appears to be more effective in suppressing Sbw populations than a single application (Table 1). This observation confirms our findings in 1993. Two litres per hectare also appears to be more efficacious than 1 L/ha. In general, the strategy that used a single application at 70g (AI) in 1 L/ha was ineffective in controlling Sbw (Table 1). However, preliminary observations of the GPS data suggest that this block might not have been sprayed as thoroughly as the other blocks.

Defoliation of balsam fir in all of the blocks, although considerably less than that in the check plots, was higher than anticipated (Table 1). The block treated with a single application at 70g (AI) in 1 L/ha was the most heavily defoliated. This was primarily due to having been sprayed too late and with high pre-spray populations. Thus considerable damage (which cannot be accurately assessed because of soft shoots) was done prior to the sprays. In addition, RH5992 has to be ingested to be effective and works slowly, implying that some loss of foliage is obligatory.

We had hypothesised that the experimental treatment would be more efficacious than the semi-operational. However, we did not find any difference in Sbw population reduction between the experimental double application at 70g (AI) in 2 L/ha and the semi-operational treatment at the same dose (Table1). More defoliation was observed in the semi-operational block (Table 1) but this was probably because some of the sample trees in the semi-operational block were shaded by hardwood trees and consequently, not fully exposed to the sprays.

On White Spruce

Controlling Sbw on white spruce (Picea glauca) has always been difficult. The sporadic bud-flushing that extends over long periods, and the tendency of white spruce shoots to retain their budcaps and shelter the larval microhabitat from sprays tend to make Sbw larvae on spruce less vulnerable than those on balsam fir.

However, in this study, RH5992 sprayed twice at 70g (AI)/ha suppressed Sbw on white spruce as effective as on balsam fir (Table 2). With respect to Sbw population reduction, we found no difference between the semi-operational and experimental strategies.

The defoliation of white spruce in both spray blocks (Table 2) was considerably less than in the check plots, which were almost totally defoliated by the large sbw population. Nevertheless, defoliation in the semi-operational block was about 2 times that in the experimental block.

Conclusions

These preliminary data suggest that: i) RH5992 sprayed twice at 70g (AI) in either 1 or 2 L/ha controlled spruce budworm most effectively on balsam fir; ii) a strategy using a double application of RH5992 at 70g (AI) in 2 L/ha appears to be the most effective strategy, and is efficacious on both balsam and white spruce; and, iii) there was no significant difference in Sbw population reductions between the experimental and semi-operational treatments. However, as expected, the experimental treatments were less defoliated than the semi-operational block.

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Fig 1. 1994 RH5992 study site showing (1-5) treatment and check (c) areas, as well as the location of the meteorlogical equipment (M). Longlac 1994.

Table 1. Spray deposit, spruce budworm population reduction and defoliation of balsam fir after experimental and semi-operational treatments with RH992. Longlac 1994.

Block	Treatment[a]	Application [b]			Deposit [c]		Sbw/45cm branch ($\bar{x}$±SD)		% Corrected	%
	Strategy	No.	Date	Time	Drop/cm² ($\bar{x}$±SD)	VMD (µm)	Prespray	Postspray	Population Reduction[d]	Defoliaion ($\bar{x}$±SD)
1	70 + 1 x 2	1E	14/6	06:42	0.3 ± 0.3	99				
		2E	19/6	06:00	0.6 ± 0.4	119	26.0 ± 12.2	1.3 ± 1.7	88	40 ± 22
2	70 + 2 x 2	1E	14/6	05:55	1.9 ± 1.2	117				
		2E	19/6	05:42	0.9 ± 0.6	110	27.6 ± 16.2	0.4 ± 0.8	97	49 ± 21
3	70 + 2 x 1	1E	14/6	06:30	1.2 ± 0.7	127	14.5 ± 10.6	1.3 ± 1.4	80	32 ± 21
4	70 + 1 x 1	1E	14/6	06:14	1.8 ± 1.1	97	21.8 ± 15.2	7.4 ± 7.3	14	63 ± 29
5*	70 + 2 x 2	1S	14/6	07.53	1.3 ± 0.6	108 (95)*				
		2S	18/6	21.22	0.5 ± 0.1	31	29.2 ± 19.1	0.4 ± 0.8	97	63 ± 19
Checks	None	-----	None	-----	-----	None	30.7 ± 16.2	10.2 ± 6.9	-----	92 ± 5

[a] g(AI) in L of tank mix x no. of applications
[b] **E** denotes an experimental spray; **S** denotes a semi-operational treatment
[c] On Kromekote cards at midcrown
[d] Using Abbott's formula (Abbott 1925)
*These two VMDs were generated with the two tank mixes from the different aircraft implying that the mixes were probably different.
At time of writing, statistical analyses were incomplete

Table 2 Spruce budworm population reductions & defoliation of white spruce after experimental & semi-operational treatments with RH5992. Longlac 1994.

Block	Treatment Strategy[a]	Application[b]			Deposit[c]	Sbw/45cm branch (x̄±SD)		% Corrected	% Defoliation
		No.	Date	Time		Prespray	Postspray	Population	(x̄±SD)
2	70 + 2 x 2	1E	14/6	05:55		54.9 ± 35.4	0.5 ± 0.9	97	29 ± 15
		2E	19/6	05:42					
5	70 + 2 x 2	1S	14/6	07:53		38.3 ± 20.6	0.3 ± 0.5	95	48 ± 18
		2S	18/6	21:22					
Check	None	-----	None	-----		61.1 ± 33.0	8.7 ± 6.3	-----	85 ± 5

[a] g(AI) in L of tank mix x number of applications
[b] **E** denotes experimental and **S** denotes semi-operational treatments
[c] See table 1 for deposit data
[d] Using Abbott's formula (Abbott 1925)
At time of writing statistical analyses were incomplete

"PROTECTION AGAINST DEFOLIATION BY THE SPRUCE BUDWORM FOR TWO YEARS - EVIDENCE FOR LETHAL EFFECT OF RH-5992 ON 2ND INSTARS"

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The non-steroidal ecdysteroid agonist, **RH-5992 (Mimic)**, induces a precocious, incomplete molt in spruce budworm larvae that results in the mortality of the insect. Within 12 hrs after ingestion, the larva **stops feeding** and within 48 hrs the **head capsule slips** exposing an untanned cuticle that is very thin and poorly formed. When applied at the rate of **70g in 2 L per ha** twice, it provides excellent population control and near perfect foliage protection. The 1993 spray trials were extremely successful and provided conclusive data on the control potential of this hormone analog. Since the plots were only 50 ha in size, we expected the moths from the adjacent areas to fly in and repopulate the plots. Contrary to our expectation there were hardly any larvae in the 1993 treated plots in the spring of 1994. Our first thought was that this material was a strong ovipositional deterrent and as a result the moths did not lay eggs in the sprayed plots. However, when we did a lab assay, it became clear that the moths could not discriminate between the treated and untreated arenas. This meant that the first instars that emerged from the eggs were some how affected. Laboratory and greenhouse studies have indicated that the first instars indeed get the material but the effect is manifested as soon as they molt into the second instars. These seconds show head capsule slippage and die in that state. This stage appears to be extremely sensitive to RH-5992. We are in the process of determining how the non-feeding firt instars get the ma

The significance of this finding is truly awesome. Application at bud break when the spruce budworm is predominantly in the fourth instar stage results in controlling the insect population that year and also provides foliage protection. Since the half life of this compound, especially in old needles is 54 days, it lasts well into august when the moths fly in and lay the eggs that will result in repopulating the area during the next year. However, the RH-5992 in the foliage is some how taken in by the crawling first instars which results in affecting almost all the second instars. This obviously results in the protection of the trees during the subsequent year as well. This means that one needs to spray only once every two years! Therefore one not only gets an economic saving but also an environmental advantage. This is the first reported case of such an effect.

Research in Natural Products Entomology in 1993

Blair Helson, John McFarlane and Dave Comba
Forest Pest Management Institute
Canadian Forest Service

Report to the 21st Annual Forest Pest Control Forum

Development of Natural Products for Management of Forest Insect Pests

Funded in part by Green Plan IFPM Funds

A standard, synthetic-diet incorporation bioassay with spruce budworm larvae for long-term continuous feeding exposure has been established for the primary screening of natural products. Screening of **toosendanin**, a Chinese botanical received from M. Isman, UBC and **F005** from the paw paw tree provided by J.T. Arnason, U. of Ottawa, in comparison with azadirachtin from the neem tree and fenitrothion is currently in progress. A representative **flavonoid** compound has also been tested using this technique in collaboration D.B. Lyons, CFS, Ont. and M Abou-Zaid, FPMI.

In 1993, primary emphasis was placed on evaluating **Azatin-EC**, a commercial formulation from the neem tree containing 3% azadirachtin for its potential in forest insect pest management. Tests with larvae of spruce budworm, eastern hemlock looper and gypsy moth on sprayed foliage were continued and experiments were initiated to assess its contact toxicity to these species. The toxicological characteristics of Azatin to spruce budworm larvae are under investigation including its residual activity outdoors, its effects on reducing feeding, the sensitivity of different instars and its simulated efficacy on potted trees infested with larvae. Its spectrum of activity is being examined on other forest pests including white pine weevil adults, and larvae of forest tent caterpillar, black army cutworm, white marked tussock moth, European spruce sawfly and pine false webworm(with D.B. Lyons). A second formulation of neem being considered by Phero Tech for commercial development was received from M. Isman and is being compared with Azatin in spruce budworm bioassays.

Two pilot field trials were carried out with Azatin in 1993. In collaboration with D. B. Lyons, a row of 30 red pine infested with pine false webworm were sprayed with 50g AI/ha by mistblower. In collaboration with P. deGroot, FPMI, a novel strategy was tested using Azatin for white pine weevil management. The strategy was to treat white pine leaders after eggs were laid and many had hatched to expose young larvae directly through the possible systemic action of neem. Ninety infested white pine leaders were treated with 50 g AI/ha on 24 June. Both trials gave encouraging results and expanded trials are planned for 1994.

Evaluation of the spectrum of activity of **depitched tall oil**, a natural by-product of the Canadian softwood kraft pulp industry, to forest pests is continuing with larvae of spruce budworm, black army cutworm, eastern hemlock looper, forest tent caterpillar, European spruce sawfly, mountain ash sawfly, pine false webworm and adults of white pine weevil.

XDE-105, a naturally derived product provided by Dow Elanco has been tested on spruce budworm larvae to determine its toxicity by contact and ingestion. A report for Dow Elanco was prepared and sent with recommendations on further development. Dow Elanco have not yet decided if they want to pursue development of this product for forestry.

<u>The mechanism for the resistance of red maple to forest tent caterpillar larvae</u>

Funded through Special S & T Opportunities Fund

Feeding Ecology. In 1993, the standard, no-choice leaf-disk assay developed last year was used to evaluate the feeding preferences of fourth instar FTC larvae on the seven species of local maples: red, sugar, silver, striped, mountain, Manitoba and Norway (3 varieties) maple. The feeding preferences of gypsy moth and white marked tussock moth for red, sugar and silver maples were also examined in comparison with FTC larvae. Choice tests with red and sugar maple leaf disks were conducted to determine if brief extractions of intact disks with various solvents affected feeding response.

Chemical Ecology. Large quantities of red and sugar maple leaves were again collected in 1993 for extractions from the field site near Sault Ste Marie used last year. Red maple extract and appropriate fractions were prepared by M. Abou-Zaid Natural Products Chemist FPMI for evaluating their effects on FTC larvae. Isolation and identification of compounds from red maple continued. Elucidation of the secondary chemistry of sugar maple was initiated.

Choice feeding assays with aspen leaf disks and 1-day old fourth instar larvae were conducted to test the extracts, fractions and selected pure compounds for feeding deterrency. Different years of RM extract, 3 major fractions, 2 simple phenolic compounds identified from red maple which do not exist in sugar maple at three different concentrations and 2 representative flavonoid compounds have been examined to date this year.

We have also developed a synthetic diet incorporation technique to investigate the effects of red and sugar maple extract on the growth, development and survival of FTC larvae. Different concentrations and both years of red maple extract have been tested for such effects on second instar larvae. Three major fractions, the two phenolic compounds and the two flavonoid compounds have also been incorporated in diet. Experiments are in progress to determine the relative effects of red and sugar maple extracts in diet on first instar larvae of FTC, GM and WMTM larvae

A graduate student was recruited this year to investigate the mechanism of action of active constituents of red maple on FTC larvae at the University of Ottawa under the supervision of Professor J.T. Arnason.

To summarize our findings to date, red maple extract, the phenolic and flavonoid fraction and the 2 phenolic compounds possess feeding deterrent and growth reducing effects.

Research in Natural Products Entomology in 1994

Blair Helson, John McFarlane and Dave Comba
Forest Pest Management Institute
Canadian Forest Service

Report to the 22nd Annual Forest Pest Control Forum

Development of Natural Products for Management of Forest Insect Pests

Supported in part by Green Plan IFPM Funds

In 1994, we focused on the development of neem extracts as a selective alternative for specific forest pests which do not currently have biological control agents (Bt, viruses) available for their control including white pine weevil, sawflies and seed and cone insects. We concentrated on evaluating a new formulation of neem from Phero Tech Inc., Delta, B. C. and compared it with Azatin which we have tested previously. The toxicological properties of these formulations to spruce budworm larvae were investigated further including residual activity and simulated efficacy on potted trees infested with larvae under natural weathering conditions outdoors. Neem's spectrum of activity on several other forest pests (forest tent caterpillar, black army cutworm, white marked tussock moth, European spruce sawfly and pine false webworm(with D.B. Lyons)) was verified. All species were susceptible, particularly the sawflies. Consequently, 5 additional species of sawflies were field collected and tested. All appear to be highly susceptible to neem. The potential natural synergist, dillapiol was received from J. Arnason, U. of Ottawa and tests on the introduced pine sawfly have been initiated to determine if it synergizes neem. Bioassays with neem in combination with Bt. or Mimic on spruce budworm have also been initiated.

In 1994, field trials were carried out with Azatin and/or PheroTech neem against pine false webworm, white pine weevil and introduced pine sawfly. In collaboration with D. B. Lyons, CFS, Ontario, rows of plantation red pine infested with pine false webworm were sprayed with the 2 formulations at 50 and 200g AI/ha by mistblower. Good protection was achieved with all treatments. For instance, the Phero Tech neem formulation at 50g/ha reduced larval populations 87% and provided 85% protection to 1-year old, red pine foliage

In collaboration with P. de Groot, FPMI, jackpine leaders were treated with 50 g AI/ha PheroTech neem by compressed air sprayer for white pine weevil management. The treatments were applied at 5 different times during the season. The best leader protection was obtained with the later treatments after eggs were laid supporting the idea that neem acts through local systemic action on larvae within the leader (see separate report by B. Zylstra). Azatin was also applied on one of the later treatment dates. Leader protection was 75% with Azatin compared to 82 % with the Phero Tech neem treatment on the same date. Treated and untreated leaders were also dissected at 2-week intervals throughout the season to observe potential effects on growth, development and survival of larvae. Large numbers of white pine weevil were collected this summer for laboratory studies to identify the mechanism of action of neem on white pine weevil.

Additional funding from the Pest Management Alternatives/ Minor Use Green Plan program provided the opportunity to conduct a field trial in September with Phero Tech neem on introduced pine sawfly on natural white pine in collaboration with D. B. Lyons. Forty trees, 2 to 4m. in height on an island in Georgian Bay were treated individually by mistblower at 50gAI/ha during the second generation in an effort to protect the remaining new foliage. Many larvae were late instars at the time of treatment. Larval populations were reduced 62%, 14 days after treatment and 73% foliage protection was achieved. A laboratory colony of this multivoltine species was established and studies have been initiated to determine the toxicological properties of neem on introduced pine sawfly.

Other natural products received from participants in the Natural Products Research Network were extensively screened in diet incorporation tests on spruce budworm and gypsy moth larvae this year. The products were Stopfeed from *Aglaia odorata,* a tree from SE Asia, ITK(±BHA synergist) from the pepper (Piperaceae) family, F-005 from the paw paw tree, toosendanin from chinaberry, Annonide-A from *Annona spp.* 2 red maple phenolic compounds and tall oil in comparison with neem extracts and traditional insecticides as standards. Stopfeed in particular, toosendanin and ITK show promising activity. Topical and conifer needle ingestion tests with these 3 extracts on spruce budworm have been initiated.

<u>The mechanism for the resistance of red maple to forest tent caterpillar larvae</u>

Supported by Special S & T Opportunities Fund

Feeding Ecology. In 1994, the growth and survival of forest tent caterpillar and gypsy moth larvae on whole leaves of seven species of maples were compared from hatch to pupation. Another experiment examined the performance of fourth instar FTC larvae on these tree spp. White marked tussock moth were also reared on red, sugar and silver maple leaves. These experiments were conducted to determine if differences in short-term feeding preferences among maple spp are reflected in differences in growth & survival. The effects of leaf age on feeding preferences of FTC for red and sugar maple was reexamined using standard, <24h old 4th instar larvae. Results of these experiments have not been analysed yet

Chemical Ecology. Large quantities of red and sugar maple leaves were collected by M. Abou-Zaid at monthly intervals in 1994 from a field site near Sault Ste Marie established 2 years ago. These leaves were extracted and fractions containing phenolics and flavonoids, terpenoids or indole alkaloids were prepared for biochemical workup and bioassays with FTC larvae. Isolation and identification of compounds from red maple continued. Fifteen compounds have been isolated and identified by M. Abou-Zaid to date. Elucidation of the secondary chemistry of sugar maple is continuing In addition, fresh plant material of *Acer spicatum* Lam. (mountain maple), *Acer saccharinum* L. (silver maple), *Acer pensylvanicum* L. (striped maple) and *Acer negundo* L. (manitoba maple) was collected near Sault Ste Marie and extracts prepared to correlate biochemically based antifeedant and growth inhibitory effects with relative feeding preferences.

A major effort this year has been directed at identifying the red maple compounds responsible for feeding deterrency to FTC larvae. Choice feeding assays with <24h old fourth instar larvae on aspen leaf disks were developed to use very small quantities of compounds for testing. This technique has been used to test different concentrations and mixtures of the two known, deterrent phenolic compounds from red maple. Four additional compounds have been tested for deterrency in comparison with one of the deterrent phenolics as a standard. These compounds were not deterrent. Five major fractions of red maple extract are currently being compared with the corresponding fractions from sugar maple at different concentrations to detect differences in feeding activity among fractions and tree spp. We have not pursued feeding stimulants in sugar maple because sugar maple extracts on leaf disks of a host tree spp, trembling aspen, did not increase feeding. In fact we now have evidence that sugar maple extracts have negative effects on the growth of forest tent caterpillar larvae and we are currently investigating this phenomenon.

Rob Nicol, a MSc student at the University of Ottawa is investigating the mechanism of action of active constituents of red maple on the growth, development and survival of FTC larvae under the supervision of Professor J.T. Arnason. To date, Rob has conducted life cycle diet incorporation assays with red maple extract at different concentrations and nutritional indices tests with fourth instar larvae on red and sugar maple extract in synthetic diet in comparison with red maple, sugar maple and trembling aspen leaf disks. He has also examined the effects of 4 compounds from red maple.

AERIAL SPRAY TRIALS WITH DISPARVIRUS IN CARRIER 244 AND WITH FORAY 48B ON GYPSY MOTH IN 1994

A report to the 22nd Annual Forest Pest Control Forum
(Ottawa, Ontario, 14-17 November, 1994)

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ABSTRACT

Aerial spray trials were conducted with Disparvirus (nuclear polyhedrosis virus) and Foray 48B *(Bacillus thuringiensis)* in Pinery Provincial Park near Grand Bend, Ontario. Test plots, with predominantly black oak trees, were 10 ha in area. Gypsy moth larvae were in their first instar when spraying commenced on May 27th and were at the peak of the second instar when Foray 48B was applied on June 9th. Oak leaves were about 22% expanded at the start of the operation and 50% expanded when it finished. The virus was formulated in Novo Nordisk Carrier 244. Dosage was a double application of 5×10^{11} polyhedral inclusion bodies (PIB)/ha (total 10^{12} PIB/ha) with the applications 6 days apart. Two volumes were tested, 5.0 L/ha and 2.5 L/ha. The Foray was applied as a single application of 50 BIU in 4.0 L/ha. Each treatment was replicated on 5 plots.

A detailed assessment involved pupal counts under burlap traps, defoliation estimates, microscopic diagnosis of levels of nuclear polyhedrosis virus infection pre-spray, counts of male moths in pheromone traps and pre- and post-spray egg mass counts. Pupal counts and defoliation in treated plots were statistically significantly lower ($p<.05$) compared to untreated check plots. Egg mass counts were adjusted to reflect overwinter mortality; post-spray egg mass counts in all treated plots were below the threshold level of 1,250/ha and only 1 of 5 check plots was below this figure. Population reductions due to treatment (Abbott's formula), using an average of the check plots was 76±8% for the Disparvirus treatment at 5.0 L/ha, 80±4% for Disparvirus at 2.5 L/ha and 96±1% for the Foray 48B treatment.

INTRODUCTION

Trials with gypsy moth nuclear polyhedrosis virus (NPV) have been conducted every year since 1988 in Ontario using either Disparvirus produced by the Forest Pest Management Institute or Gypchek supplied by the USDA Forest Service. In 1992 and 1993, trials were conducted in collaboration with American Cyanamid Co. with a view to registering a wettable powder formulation applied at 5×10^{10} PIB/ha with the addition of an adjuvant, 1% Blankophor BBH. Results were encouraging, but the company decided not to continue the development of a gypsy moth viral insecticide product.

Entotech, a subsidiary of Novo Nordisk Bioindustrials Inc, developed a carrier for Gypchek in 1992 that was called 109-5. This was improved in 1993 and renamed Carrier 244. It was tested in Michigan in 1993 by USDA Forest Service scientists, but was not tested in Ontario. Trials were conducted in 1994 with Disparvirus in Carrier 244 to produce efficacy data using this carrier to tank mix with Disparvirus. If satisfactory results are obtained, Carrier 244 will be incorporated as part of the Disparvirus label.

MATERIALS AND METHODS

Plots

Plots were located in Pinery Provincial Park, near Grand Bend, Ontario. The Pinery has a total area of about 2,400 ha. Plots treated with Disparvirus were 210 x 480 m giving an area of 10 ha. A block 5 km x 210 m, giving an area of 105 ha was treated with Foray 48B *(Bacillus thuringiensis)* and five 10 ha plots were measured out within this strip. There was a buffer zone of at least 200 m between the plots. All plots contained more than 90% oak; mainly black oak, *Quercus velutina*, is found in this area, although white oak, *Q. alba*, is also present, as well as hybrids. A description of the 20 plots is given in Table 1, with the number of stems per ha, diameter at breast height (DBH) and pre-spray gypsy moth egg mass (EM) density.

Treatments

Two NPV treatments were replicated on five 10 ha plots and a further five 10 ha plots were monitored as untreated check plots. The Foray 48B, *Bacillus thuringiensis*, (Novo Nordisk Bioindustrials Inc.) treatment was applied on a 105 ha block in which five 10 ha plots were selected and marked out. Treatments are listed in Table 2. The virus applications used 90% Carrier 244 (Novo Nordisk Bioindustrials Inc.) with the technical virus powder suspended in 10% water and added to Carrier 244. The first virus treatment was a double application, 6 days apart, of $5x10^{11}$ PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 5.0 L/ha The second virus treatment was the same as the first, but the emitted volume was 2.5 L/ha. The *B.t.* treatment used Foray 48B with a single application of 50 BIU in 4.0 L/ha. Erio acid red at 0.2% was added to all tank mixes to allow deposit quantification. To identify the plots from the air, the centre lines were marked using white, helium-filled balloons. Seven swaths, 30 m wide, were used to treat each plot and the 105 ha block sprayed with *B.t.*

Aerial applications

Aircraft type: Cessna Agtruck

Rate: $5x10^{11}$ PIB/ha NPV (x2) with Disparvirus technical powder containing $1.4x10^{10}$ PIB/g or 50 BIU/ha (x1) *Bacillus thuringiensis*

Tracer dye: 0.2% Erio acid red

Emitted volume: 5.0 L/ha or 2.5 L/ha NPV or 4.0 L/ha *B.t.* (Note: The first application at 5.0 L/ha on May 27th was applied at 2.5 L/ha with plots sprayed twice because, due to low temperatures and high viscosity of Carrier 244, the desired flow rate could not be achieved)

Number of applications: Double NPV treatments and a single *B.t.* treatment

Days between applications: 6 between double NPV treatments

Date and time: NPV treatments between May 27 and June 3; 5.0L/ha at 08:15-09:40 on May 27 and the second application on June 02 at 20:45-21:25; 2.5 L/ha at 07:00-08:00 on May 28 and the second application on June 03 at 06:10-07:05. The

B.t. treatment was on June 09 at 06:25-06:55.

Number of plots treated: 15 total with 5 replicates in virus treatments 1 and 2, and 5 in *B.t.* treatment (Table 2)

Table 1. Description of plots used for 1994 field trials

Treatment	Plot	No. of stems/ha	DBH (cm) of sample trees (±SE)	Average no. of pre- spray EM/ha (±SE)
Virus 1	1	580	30.2 ± 1.8	24,510 ± 3,286
	2	385	34.1 ± 1.5	14,735 ± 6,903
	3	495	28.5 ± 1.2	21,120 ± 4,306
	4	555	29.4 ± 1.8	31,590 ± 2,873
	5	405	31.9 ± 2.3	19,325 ± 2,578
Virus 2	1	460	29.1 ± 1.4	15,890 ± 2,867
	2	435	28.1 ± 1.2	3,560 ± 691
	3	535	30.6 ± 1.5	15,650 ± 1,690
	4	490	34.9 ± 1.8	11,637 ± 2,701
	5	520	29.9 ± 1.6	11,175 ± 1,521
B.t.	1	555	23.4 ± 1.2	1,440 ± 204
	2	500	30.3 ± 1.4	1,925 ± 342
	3	550	24.0 ± 1.1	8,330 ± 1,171
	4	475	26.3 ± 1.4	25,490 ± 2,111
	5	505	20.8 ± 2.6	12,135 ± 1,051
Check	1	505	30.4 ± 1.2	3,460 ± 682
	2	435	27.3 ± 1.3	8,980 ± 1,320
	3	445	22.2 ± 1.1	7,130 ± 758
	4	445	30.5 ± 1.4	5,630 ± 771
	5	406	29.7 ± 2.3	18,165 ± 1,930

Table 2. Aerial spray treatments in 1994

Treatment number	Material	Dosage PIB/ha or BIU/ha	Number of applications	Days apart	Volume application rate (L/ha)
Virus 1	Disparvirus in Carrier 244	5×10^{11} PIB/ha	2	6	5.0
Virus 2	Disparvirus in Carrier 244	5×10^{11} PIB/ha	2	6	2.5
B.t.	Foray 48B	50 BIU/ha	1	-	4.0

Total area: 205 ha; 100 ha with NPV and 105 ha with *B.t.*

Spray equipment: 4 Micronair® AU 4000 rotary atomizers using a 55° blade angle

Speed of rotation: 5,600-6,200 r.p.m. for NPV and 5,400 to 6,200 r.p.m. for *B.t.*

Flow rate: 45 L/min @ 5.0 L/ha and 22.5 @ 2.5 L/ha for NPV and 36.0 L/min for *B.t.*

Swath width: 30 m

Flying speed: 176 km/h

Height above canopy: 10-15 m

Meteorological measurements

(a) Spray weather

Two 12 m towers were erected, tower 1 in Virus plot 2-4 and tower 2 in Virus plot 1-1 (Figure 1). At both towers, temperatures were measured at 2.4 m and 10.7 m, relative humidity at 7.6 m and wind speed and direction at 12.0 m. A rain gauge was located at each tower. Tower 1 was about 2.5 km from the shoreline while tower 2 was about 500 m from the lake. Instruments were sampled at 1 second intervals and 5 min averages were logged using a CSI CR10 data logger. In addition to the data from the towers, a tethersonde was flown at a central location for plots treated that day. On spray mornings, readings of temperature, relative humidity, wind speed and wind direction were recorded at 2 m intervals to a height of 50 m every 15 min from daybreak until spraying was completed. A summary of the meteorological conditions on the four mornings and one evening when spray applications were conducted is given in Table 3. Generally, canopy average temperature ranged from 3 to 11°C during spray runs with humidities above 60%. Winds at canopy top were relatively light for all sprays except the evening application of Virus 1 when winds were gusting to 5.5 km/h. For all sprays, winds were higher at plots closer to the lakeshore than those further inland. All sprays were carried out in stable to neutral conditions.

Average wind speeds and direction on the towers at 12 m and the tethersonde at emitted spray height are given in table 4. On May 27, the boundary layer at 05:30 was characterized with a low inversion to 20 m and isothermal conditions above. By 08:15, when spraying commenced, the low inversion had eroded away due to surface heating leaving a layer tending to neutral stability. Wind speeds peaked at around 25 m (aircraft height) at 6 km/h. A comparison between the tower and tethersonde winds indicates a strong shear between the top of the canopy and the aircraft. On May 28, stability above the canopy was slightly stable to neutral with humidity constant at 60% throughout the 50 m layer. Winds at aircraft height increased during the spray application to values approaching 12 km/h. An increase in wind speed at the top of the canopy was also noted. During the evening spray on June 2, conditions were neutral to slightly stable in winds that gusted above 16 km/h at aircraft height. Winds below aircraft height diminished significantly to values of 2 - 5 km/h at the top of the canopy. Relative humidities were near 70%. The early morning spray of June 3 commenced with a strong stable layer to 20 m and isothermal above. Winds were light (<1 km/h) and relative humidities were near 100%. The surface based inversion prevailed throughout the spray period. The *B.t.* spray on the morning of June 9th took place in a stable layer with a capping inversion between 20 and 30 m. Winds at aircraft height were consistently <5 km/h.

(b) Post-spray weather

A summary of the number of hours the air temperature was above 15°C, rainfall during the spray period and rainfall for 5 days after the applications are all given in Table 5. A threshold temperature of 15°C was chosen as the temperature above which gypsy moth larvae actively feed; this requires experimental confirmation. Number of hours above 15° at the lakeshore were fewer than at the more inland location. Generally, rain collected at the inland plot was less than closer to the lake possibly due to spatial inhomogeneity of rainfall or due to a denser canopy and hence sheltering of the rain gauge. Post-spray temperatures over the subsequent 5 days following the second virus application and the *B.t.* application were relatively warm, leading to a significant number of days having temperatures exceeding 15°C. Accumulated hours with temperatures exceeding 15°C at the top and bottom of the canopy were only marginally different. Post-spray rain was minimal with no rain within 24 hr on 4 of the 5 spray days and a light drizzle (1.8 mm, maximum rate 0.5 mm/5 min) occurring 11 hr after the first application of Virus 2.

Table 3. Meteorological conditions during spray applications

	Tower 1 (inland)			Tower 2 (near lake)			
Date/ (Time)	Air temp °C	% RH	Wind speed km/h	Air temp °C	% RH	Wind speed km/h	Stability
May 27 (0815-0940)	5-7	93-62	0.4-3.6	6-7	82-73	1.9-5.2	Stable-neutral
28 (0700-0800)	8-9	73-60	0.4-1.4	8-10	68-56	1.5-3.4	Stable
June 02 (2045-2125)	11	66-70	2.3-1.3	11	70	5.5-2.3	Stable-neutral
03 (0610-0705)	3-4	98	0.0	3-4	96	0.3-1.4	Stable
09 (0625-0655)	3	97	0.0	3-4	95	0.4-1.5	Stable

Table 4. Average tower and tethersonde wind speed and direction during spray applications

	Tower 1 (inland)		Tower 2 (near lake)		Tethersonde	
Date	km/h	°Mag	km/h	°Mag	km/h	°Mag
May 27 a.m.	1.9	358	3.5	014	6.1	004
28 a.m.	1.1	239	2.3	218	8.4	220
June 02 p.m.	1.6	005	3.7	033	11.5	012
03 a.m.	0.0	-	1.0	353	1.5	280
09 a.m.	0.0	-	1.0	168	3.0	145

Table 5. Summary of temperature and rainfall during the spray period and for 5 days after the last spray application

	Tower 1 (inland)					Tower 2 (near lake)				
	Temp > 15°C			Rain		Temp > 15°C			Rain	
	10.7m	2.4m	Total Time	Total Rain	Max Rate	10.7m	2.4m	Total Time	Total Rain	Max Rate
Date	hr	hr	hr	mm	mm/5min	hr	hr	hr	mm	mm/5min
May 27*	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28*	9.2	9.6	0.3	1.0	0.1	6.6	7.8	0.4	1.8	0.5
29	15.8	15.6	0.0	0.0	0.0	16.1	15.7	0.0	0.0	0.0
30	20.4	16.8	0.0	0.0	0.0	20.7	16.8	0.0	0.0	0.0
31	24.0	24.0	0.1	0.1	0.3	22.7	22.1	0.3	4.8	2.8
June 01	1.5	1.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
02*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
03*	9.7	10.0	0.0	0.0	0.0	7.3	7.9	0.0	0.0	0.0
04	13.8	13.8	0.0	0.0	0.0	14.7	13.8	0.0	0.0	0.0
05	15.4	15.3	0.0	0.0	0.0	16.0	15.2	0.0	0.0	0.0
06	18.3	18.4	1.0	5.8	1.3	17.8	18.3	1.0	7.1	1.3
07	5.8	6.1	0.0	0.0	0.0	5.1	5.8	0.0	0.0	0.0
08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	134.0	131.0	1.4	6.9		127.1	123.4	1.7	13.7	
June 09*	No data available[1]					5.9	6.8	0.0	0.0	0.0
10						14.9	12.8	0.0	0.0	0.0
11						24.0	16.5	0.6	19.8	5.1
12						23.7	19.1	0.0	0.0	0.0
13						23.9	19.1	2.2	10.2	1.0
14						14.7	14.8	0.0	0.0	0.0
TOTAL						107.1	89.3	2.8	30.0	

* Spray days
[1] Tower struck by lightening June 9

Host and insect pest development

(a) Insect development

Insect development was determined by examining 100 larvae collected on the morning of the spray application. On May 27 and 28, all larvae were in their first instar. On June 2, 70% were first instar and 30% second instar and on June 3, 70% were first, 28% second and 2% third instar. On June 9, at the time of the *B.t.* application, 40% were first instar, 48% second instar and 12% third instar.

(b) Host tree phenology

At each plot, 20 leaves on black oak trees were measured at 2 to 3 days prior to the first two spray applications and on the last three spray days. The same leaves were measured again when fully expanded. Leaves were 17% expanded on May 24, 22% on May 25, 41% on June 2, and 50% on June 3 and June 9. Pre-spray defoliation was limited to shot-holes in the foliage and was <5%.

Deposit sampling and assessment

Spray deposits on oak leaves and artificial foliage at two heights in the forest canopy were sampled as well as Kromokote cards and stainless steel plates on the ground. Samples were taken at four sites in each of the virus-treated plots (20 sites per virus application) and at 20 sites in 4 of the plots treated with *B.t.* At each sampling site a halyard was placed in a deciduous tree and used to mount natural and artificial foliage samplers at heights of 7 - 9 m and 10 - 12 m, corresponding to mid- and upper-crown levels. Artificial foliage, comprised Kromekote card and polyethylene leaves with a silhouette area of 43 cm^2 per leaf suspended on fine wire supports and oriented close to horizontal. Oak branch tips, 10 to 15 cm in length, were mounted at the same heights. At each sampling site a 10x10 cm Kromekote card and two 20x20 cm stainless steel plates were placed on the ground.

Droplet densities (stains/cm^2) on oak foliage were measured within 48 h of sample collection by examining upper and lower surfaces of the leaves under UV light, with 5 to 10 leaves assessed from each sample; five 1 cm^2 areas were scanned on upper and lower surfaces; stains were not measured, due to uneven spreading. Stain densities were recorded on "Kromekote artificial foliage" and on ground cards, and stains were sized and corrected for spread factor. Spray deposits on polyethylene artificial leaves and stainless steel ground plates were quantified by fluorometry and compared to samples of the tank mixes to determine the amount of tank mix deposited.

Egg mass counts

Twenty 0.01 ha (10 m x 10 m) sub-plots containing at least three oak trees were established in each treated and untreated check plot. All egg masses on all the tree trunks and branches were counted and egg masses from ten 1 m^2 areas on the ground were also counted. Binoculars were used to count egg masses higher in the trees. Number of egg masses on the ground was multiplied by 10 and added to the number counted above ground. This figure in turn was multiplied by 100 to convert it to number of egg masses per hectare. There was considerable overwinter mortality of egg masses in Pinery Provincial Park in the winter of 1993/94. A survey was conducted to determine the percentage of egg masses that had not hatched below the snow line at 60 cm and above the snow line between 60 cm and 1.8 m with 10 egg masses collected above and below the snow line in each plot. Pre-spray egg mass counts were adjusted for overwinter mortality in subsequent calculations to determine the effectiveness of the applications. Pre-spray egg mass counts were made in April and May and post-spray counts in late October when ground vegetation had died down.

Incidence of virus infection

Fifty larvae were collected before the spray applications between May 24 and June 6 from all the treated and check plots (total 1,000 larvae) to determine the incidence of naturally occurring NPV. These larvae were smeared on microscope slides, stained with buffalo black and examined for the presence of polyhedral inclusion bodies.

Pupae in burlap traps

Strips of burlap 45 cm wide were folded double, making the trap 22.5 cm wide, and nailed to the trunks of 3 oak trees in each of the 20 egg mass survey sub-plots in all the treated plots and the untreated check plots. When pupation reached 90%, insects were counted with pre-pupae and healthy larvae scored as pupae. The circumference of each tree was measured and the count per burlap trap converted to number of pupae per metre of burlap.

Defoliation estimates

Five 45 cm oak branch tips were collected at mid-crown using pole pruners from each of the 20 egg mass survey sites in each plot. All the leaves on the tips were examined. Totally eaten leaves, recognised by the remaining petiole, were scored as 100% defoliated. Intact leaves were removed and scored as 0% defoliated. Partially eaten leaves were removed individually and the amount of foliage eaten was estimated. An overall defoliation figure for each branch tip was then calculated. This procedure takes 10 to 15 min to estimate defoliation on each branch tip and is used as a training procedure. Once familiar with different levels of defoliation, three observers made a visual assessment of each branch, estimating defoliation in 5% increments, and reaching a consensus. The mean for each sub-plot was calculated followed by the overall figure for the 100 branch samples from each treated plot and each check plot.

Pheromone traps

Three Multipher® gypsy moth traps were placed in each of the 20 plots on July 4-5. Traps were baited with 500 µg (+)-Disparlure lures, which were chemically modified to reduce catch and avoid trap saturation. Traps containing the lure and dichlorovos strips to kill male moths were hung 1.5 m from the ground and 0.2 m from the tree trunk. Traps were visited on August 3 and an interim moth count obtained; they were removed at the end of the flight period, August 15-16, and the male moth catch counted.

RESULTS

Spray deposits

A summary of measured spray drop densities from the virus and *B.t.* treatments is presented in Table 6. Data from sampling sites with no observable spray deposit were excluded from the analysis. These were observed on the upwind side of virus-treated plots and the proportion of sites at which no deposits were observed were 10, 13 and 6% for natural foliage, artificial foliage and ground cards respectively. Moderately good deposits were obtained in the virus sprays with average drop densities (/cm^2) ranging between 0.9 and 2, and 0.8 and 3 on the top leaf surfaces at the upper- and mid-crown levels, respectively. Artificial foliage showed somewhat higher deposits, ranging from 5 to 8 and 5 to 7 on the upper surfaces at upper- and mid-crown, respectively. The closer proximity and sheltering of the natural leaves and their variable orientation probably accounted for the difference observed between natural and artificial leaves. Average deposit densities on ground cards were similar to those on artificial foliage and ranged from 4 to 8. Canopy penetration was good as indicated by similar deposit levels at the two canopy levels and on the ground. Deposits were predominantly on the upper surfaces. Drop densities obtained in the 5.0 and 2.5 L/ha applications were generally similar. Drop sizes are given in Table 7. The average VMD and NMD on artificial foliage was 167µm and 66µm and was similar to values of 181µm and

88µm from ground cards. The volume of spray deposited averaged 20% at mid-crown on artificial foliage and 20% on ground plates (Table 7).

Drop densities from the *B.t.* application were variable and 25% of sites were found to have no observable deposit on the natural foliage, artificial foliage or ground cards. Deposits were much higher in plots 1 and 2 (*B.t.*A) than in plots 3 and 5 (*B.t.*B) and they were analysed separately (Table 6). In plots 1 and 2, average number of droplets was very high on the upper surfaces of real and artificial foliage at upper- and mid-crown with 30 and 31/cm² and 17 and 16/cm², respectively, with 12/cm² on ground cards. Densities were considerably lower on the undersides of leaves. Drop densities in plots 3 and 5 were similar to those recorded from the virus applications with 3 and 4 drops/cm² at upper- and mid-crown on real foliage, 4 and 5 on artificial foliage and 6 on ground cards. Droplet sizes were 99 and 55 µm for the VMD and NMD on artificial foliage and 146 and 72 µm on ground samplers (Table 7).

Table 6 Drop densities (average ± SD) on oak leaves, artificial foliage and ground cards

Treatment (Application)		Drop densities (/cm²)				
		Oak leaves		Artificial foliage		Ground cards
		Upper[1]	Mid[1]	Upper	Mid	
Virus 1 (1)	T[2]	2 ± 5	3 ± 5	7 ± 8	6 ± 4	6 ± 4
	B[2]	1 ± 3	1 ± 3	0.2 ± 1	0.04 ± 0.2	
Virus 1 (2)	T	1 ± 2	0.8 ± 2	6 ± 5	5 ± 6	4 ± 2
	B	0.2 ± 0.7	0.3 ± 1	0.06 ± 0.2	0.08 ± 0.3	
Virus 2 (1)	T	0.9 ± 2	0.8 ± 2	5 ± 4	5 ± 4	5 ± 3
	B	0.2 ± 0.5	0.4 ± 0.9	0.04 ± 0.3	0.04 ± 0.3	
Virus 2 (2)	T	1 ± 2	1 ± 2	8 ± 6	7 ± 6	8 ± 5
	B	0.2 ± 0.5	0.1 ± 1	0.06 ± 0.3	0.01 ± 0.1	
B.t. A[3]	T	31 ± 16	30 ± 20	17 ± 13	16 ± 13	12 ± 5
	B	2 ± 7	3 ± 9	0 ± 0	0 ± 0	
B.t. B[3]	T	3 ± 3	4 ± 3	4 ± 3	5 ± 4	6 ± 4
	B	0.3 ± 1	1 ± 2	0.0 ± 0.0	0.0 ± 0.0	

[1] Canopy level
[2] T and B denote data from the top and bottom of foliar surfaces
[3] A and B denote data from *B.t.* plots 1 and 2 and plots 3 and 5, respectively

Incidence of virus infection

A total of 1,000 larvae, collected prior to the spray applications, was microscopically diagnosed for virus infection. Plots ranged from 0 to 10% of larvae infected with an average level of 3.9% infection (Table 8a).

Table 7. Deposited drop sizes and percent deposited on artificial foliage and ground samplers

Treatment (Application)	Artificial foliage (Mid)			Ground samplers		
	VMD (µm)	NMD (µm)	% Volume deposited	VMD (µm)	NMD (µm)	% Volume deposited
Virus 1 (1)	196	72	18 ± 14	200	76	10 ± 8
(2)	171	49	8 ± 6	153	59	8 ± 4
Virus 2 (1)	194	75	28 ± 48	227	128	20 ± 12
(2)	106	66	24 ± 28	142	88	32 ± 36
B.t. (Average A&B)	99	55	–[1]	146	72	–[1]

[1] Data not available

Pupal counts

The numbers of pupae per metre of burlap are given in Table 8b. The mean number of pupae/m was similar in the three treatments, 5.9, 6.4 and 4.6 for the two virus treatments and the *B.t.* treatment and statistically significantly different ($p<.05$; Mann-Whitney rank-sum test) from the untreated check plots at 43.0.

Defoliation estimates

Defoliation estimates are shown in Table 8b. Defoliation was light in all the treated plots with averages of 18.6% and 19.0% in the two virus treatments and 20.0% in the *B.t.* treatment. The range was considerable in the check plots, from 22.0 to 73.7% with a mean of 47.1%. which was statistically significantly greater ($p<.05$; Mann-Whitney rank-sum test) from the treatments.

Pheromone trap catches

Male moth catches are shown in Table 8a. Average moth catches per trap were lower in all the treated plots than the check plots, but the ranges were large. The mean for the 5.0 L/ha and 2.5 L/ha virus treatments were 117.5 and 179.5, the mean for the *B.t.* treatment was 113.1 and the mean for the check plots was 273.9.

Egg mass counts

Pre-spray egg mass counts from the 15 treated and 5 untreated check plots are given in Table 1 and the counts corrected for over-winter mortality are given in Table 8b. These uncorrected counts ranged from 1,440 to 31,590/ha and the adjusted counts from 1,224 to 13,728/ha. Post-spray egg mass counts were made in late October (Table 8b). There were significant reductions between pre-spray counts and post-spray counts in all three treatments compared to the check ($p<.05$; Mann-Whitney rank-sum test). The mean post-spray egg mass counts ranged from 105 to 970/ha in the two virus treatments with a mean of 447 for the 5.0 L/ha treatment and a mean of 375 for the 2.5 L/ha treatment compared with a mean of 81 in the *B.t.* treatment. The mean of the check plots was 1,598.

Results of two calculations giving population reduction due to treatment (Abbott's

Table 8a. Assessment of treatments on gypsy moth in 1994

Treatment	Plot	% Virus infection May 24 - June 6 (n=50)	Average male moth catch/ pheromone trap (n=3)
Virus 1	1	8	41.7
	2	8	76.7
	3	4	91.0
	4	6	65.3
	5	6	312.7
	Mean	6.4	117.5
Virus 2	1	2	161.3
	2	4	102.0
	3	2	104.3
	4	0	303.0
	5	10	225.0
	Mean	3.6	179.1
B.t.	1	0	46.0
	2	2	90.0
	3	6	73.0
	4	0	86.0
	5	0	270.3
	Mean	1.6	113.1
Check	1	4	180.7
	2	0	191.0
	3	0	456.0
	4	8	257.3
	5	8	284.7
	Mean	4.0	273.9

formula) and designated %PR 1 and %PR 2 are shown in Table 8b. There was a major population crash in check plot 5 which had the highest pre-spray egg-mass count; this plot was considered atypical and was not used in calculations of population reduction due to treatment. In the statistical analysis of these data, pre-spray and post-spray egg mass counts on individual 0.01 ha sub-plots were paired and this figure was used to calculate the percent population change. Hence, this figure differs from that obtained using the plot means shown in Table 8b. Using %PR 1, each treated plot was matched to the check plot with the closest mean pre-spray egg mass count provided that a 2 SE interval about the mean overlapped the mean of the treated plot under consideration. One plot, *B.t.* plot 4, could not be matched with any of the 5 check plots, so the calculation of %PR 1 for the *B.t.* treatment was made using only 4 of the 5 plots. The mean population reductions due to treatment using %PR 1 were 79%, 83% and 93% for virus treatments at 5.0 L/ha, 2.5 L/ha and for *B.t.*, respectively. %PR 2 used the average of check plots 1 to 4, since a regression equation was not significant.

Table 8b. Assessment of treatments on gypsy moth in 1994

Treatment	Plot	Pupae/m (± SE)	% Defoliation (± SE)	Adjusted Pre-spray (± SE)	Post-spray (± SE)	% Change (± SE)	%PR1 (nearest check)	%PR2
Virus 1	1	3.2 ± 1.43	5.4 ± 1.19	11030 ± 1516	970 ± 310	-87.8 ± 3.7	64(2)	48
	2	3.3 ± 0.99	24.9 ± 2.36	7368 ± 792	105 ± 41	-98.8 ± 0.4	94(2)	94
	3	7.7 ± 3.08	21.8 ± 2.74	13728 ± 2870	595 ± 122	-92.3 ± 2.0	82(2)	68
	4	11.8 ± 3.12	21.8 ± 1.94	4739 ± 442	415 ± 82	-91.7 ± 1.4	63(3)	78
	5	3.4 ± 0.72	19.1 ± 1.64	7730 ± 1058	150 ± 61	-98.2 ± 0.7	92(2)	92
	Mean	5.9 ± 1.70	18.6 ± 3.42	8919 ± 1563	447 ± 158	-93.8 ± 2.1	79 ± 7	76 ± 8
Virus 2	1	7.0 ± 1.53	17.5 ± 1.69	11918 ± 2205	640 ± 177	-92.8 ± 1.6	78(2)	66
	2	9.0 ± 1.63	18.6 ± 1.66	2848 ± 567	310 ± 76	-86.9 ± 3.2	90(1)	83
	3	4.5 ± 0.53	19.6 ± 1.80	10173 ± 1127	295 ± 49	-96.5 ± 0.7	88(2)	84
	4	9.1 ± 2.75	19.6 ± 1.53	6726 ± 2258	355 ± 76	-89.2 ± 3.2	78(2)	81
	5	2.5 ± 0.36	19.8 ± 1.51	5588 ± 780	275 ± 55	-94.0 ± 1.3	79(3)	85
	Mean	6.4 ± 1.28	19.0 ± 0.43	7450 ± 1621	375 ± 68	-91.9 ± 1.7	83 ± 3	80 ± 4
B.t.	1	5.4 ± 1.12	22.7 ± 1.96	1224 ± 178	80 ± 24	-94.8 ± 1.3	94(4)	96
	2	2.7 ± 1.03	17.5 ± 2.62	1251 ± 228	30 ± 18	-98.1 ± 1.1	98(4)	98
	3	6.4 ± 0.75	28.1 ± 1.83	4582 ± 661	105 ± 29	-94.6 ± 1.9	90(3)	94
	4	1.3 ± 0.33	6.5 ± 0.72	12746 ± 1082	35 ± 15	-99.7 ± 0.1	--	98
	5	7.3 ± 1.36	25.2 ± 2.66	7281 ± 647	155 ± 39	-97.5 ± 0.7	91(2)	92
	Mean	4.6 ± 1.13	20.0 ± 3.80	5417 ± 2154	81 ± 23	-96.9 ± 1.0	93 ± 2+	96 ± 1
Check	1	42.5 ± 3.60	49.8 ± 3.59	2249 ± 454	2515 ± 289**	123.6 ± 51.5	--	--
	2	84.4 ± 7.29	73.7 ± 1.86	7184 ± 1078	1745 ± 134	-47.8 ± 22.3	--	--
	3	33.1 ± 2.93	45.1 ± 2.89	5704 ± 622	1355 ± 100	-69.8 ± 4.5	--	--
	4	38.6 ± 3.85	44.9 ± 2.17	1778 ± 232	1811 ± 135**	48.6 ± 26.5++	--	--
	5*	16.2 ± 2.42	22.0 ± 1.52	10899 ± 1187	560 ± 95	-93.5 ± 1.3	--	--
	Mean	43.0 ± 11.28	47.1 ± 8.23	5563 ± 1680	1598 ± 320	-7.8 ± 40.76	--	--

Footnotes are on following page

Footnotes for Table 8b

* omitted from the calculations of %PR1 and %PR2.

** **NOT** significantly different in egg masses/ha between pre-spray and post-spray (p>.10). (paired Wilcoxon)

++ **NOT** significantly different from zero (p>.05). (Wilcoxon)

+ mean and standard error based on 1 less plot (1 *B.t.* plot had no matching check plot)

% change = mean of [(Post-spray - Pre-spray)/Pre-spray]*100 among the 20 sample trees in each plot.

%PR1 = 100*(1-(Treated post-spray*Check pre-spray)/(Treated pre-spray*Check post-spray)), where Check pre-spray and Check post-spray come from the check plot with the nearest mean. (Note: one PR1 is missing since the treated pre-spray plot ± 2 SE was not in the range of any pre-spray check plot ± 2 SE).

%PR2 = 100*(1-(Treated post-spray/Check post-spray)) where Check post-spray is the overall average of the post-spray check values (average=1857, n=4) since the estimated regression equation was not significant.

When this method of analysis was used, there were slight variations from %PR 1, with population reductions due to treatment of 76% and 80% for virus treatments at 5.0 L/ha and 2.5 L/ha, respectively, and 96% for the *B.t.* treatment. Virus treatment 1 and virus treatment 2 were both significantly different from the *B.t.* treatment in %PR 2 (p<.05; Kruskat-Wallis one-way of variance nonparametric test).

DISCUSSION

It was a cool spring and treatments were applied later than in previous years. Lake Huron had a cooling effect on Pinery Provincial Park and this was evident in the difference in cumulative temperature readings from towers 1 and 2 which were 2.5 and 0.5 km, respectively, from the lake shore.

Both NPV treatments and the *B.t.* treatment had a significant impact on the gypsy moth population, both in terms of population reduction and foliage protection. The overwintering egg mass mortality, which ranged from 15 to 85%, was a major factor in reducing the very high egg mass densities found in some plots. Adjusted egg mass densities were used in the calculations to determine population reduction due to treatment. If successful treatments are evaluated on the basis of keeping defoliation below 40% and post-spray egg mass densities below 1,250/ha, all the treated plots fell well below these figures. In 4 of the 5 check plots, defoliation exceeded 40% and post-spray egg mass counts ranged from 1,355 to 2,515/ha. The population collapsed in check plot 5. This plot was eliminated from calculations of population reduction due to the treatments. There was naturally occurring NPV throughout the area which is normal in any established gypsy moth outbreak. Pre-spray incidence of NPV infection ranged from 0 to 10% (n=50).

The 5.0 L/ha application was complicated by the fact that on the first application, plots had to be sprayed twice at 2.5 L/ha because a flow rate of 5.0 L/ha could not be achieved due to low temperatures and increased viscosity of Carrier 244. This is a problem that must be addressed before operational use of Carrier 244 is contemplated. An emitted volume of 5.0 L/ha has been used experimentally in Ontario for several years. Attempts to use lower volumes using different tank mixes have proved to be less effective. It is encouraging to note that results with 2.5 L/ha using Carrier 244 were as good as those at 5.0 L/ha. Carrier 244 costs about $2.50 U.S./L, so a reduction in volume rate provides a considerable cost saving, and increases the efficiency of spray aircraft in large scale operations.

Results from the *B.t.* application were outstanding with post-spray egg mass densities ranging from 30 to 155/ha. It was intended to apply the *B.t.* in two applications of 30 BIU/ha, 3 to 7 days apart. However, the aircraft was urgently required elsewhere and the *B.t.* was applied at the maximum permitted label dosage in a single application. Obviously, single applications are preferable to double applications if adequate control can be achieved and in this situation the single application worked well. Single applications can result in poor control when egg hatch is extended over a long period, such as in mountainous terrain. The situation in Pinery Park was flat terrain, but temperatures were cooler closer to the lake shore. All the *B.t.* treated plots were about the same distance from the lake.

Detailed measurements using a tethersonde provide meteorology relevant to the layer through which the spray cloud moves. As can be seen with the 1994 data, winds and meteorology above the forest canopy are not adequately represented by tower measurements made to the top of the canopy. Spray deposit assessments indicated that coverage and penetration were good for both virus applications and the *B.t.* application. The two virus applications, employing volume rates of 5.0 and 2.5 L/ha, resulted in similar droplet densities which adds evidence for recommending the lower volume. Spray drops were found largely on upper leaf surfaces, as noted in the 1993 trials. This combined with the fact that early instar gypsy moth larvae feed mainly on the undersides of leaves suggests that the targeting of these sprays may be improved by obtaining greater deposits on the undersides of leaves. This could probably be achieved using smaller droplets applied under turbulent conditions. These trials have proved that tank mixing Disparvirus with Carrier 244 is a viable pest management option provided problems concerning the viscosity of Carrier 244 at low temperatures are rectified.

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STUDIES ON THE ENVIRONMENTAL CHEMISTRY OF FORESTRY INSECTICIDES

[Project No. FP-72 - Environmental and Ecological Chemistry]

[Study No. FP-72/02 - Environmental Chemistry, Insect Management Products]

Report to the 22nd Annual Forest Pest Control Forum

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ABSTRACT

Major studies undertaken by the Environmental Chemistry (Insecticides) Group, either independently or cooperatively, are summarized briefly. The key areas encompassing the chemical and environmental behaviour of: (I) tebufenozide (MIMIC® or RH-5992); (II) *Bacillus thuringiensis* (*kurstaki*)[*B.t.*(*k*)]; (III) azadirachtin (AZ-A); and (IV) the analytical methods necessary for the studies in I to III are highlighted. Rain-washing of foliar deposits of Dimilin® WP-25 formulated in four different carrier liquids is also outlined.

RESUME

Les études majeures entreprises par le groupe de Chimie de l'Environnement (Insecticides), indépendamment ou en coopération, sont résumées brièvement. Les domaines principaux comprenant le comportement chimique et environnemental de: (I) tebufenozide (MIMIC® ou RH-5992); (II) *Bacillus thuringiensis* (*kurstaki*)[*B.t.*(*k*)] et (III) azadirachtin (AZ-A); ainsi que (IV) les méthodes analytiques nécessaires pour les études de (I) à (III) sont passés en revue. Le lessivage par la pluie des dépôts foliaires de quatre formules liquides différentes de Dimilin® WP-25 est aussi rapporté.

INTRODUCTION

The Environmental Chemistry (Insecticides) Study has two primary objectives: (1) to study the distribution, persistence, toxicity and fate of forestry insecticides in different components of the forest environment; and (2) to develop adequate analytical capabilities to identify and quantify trace levels of the residue moieties present in various forestry matrices. In addition, cooperative interactions with the scientists here and elsewhere, form a viable approach to solve some of the challenging problems facing pest control methods in forestry and thereby yielding rewarding results. This report summarizes some of the achievements made in the research activities conducted during 1993/94.

I CHEMICAL STUDIES ON TEBUFENOZIDE - ANALYSIS AND ENVIRONMENTAL FATE

(1) Analysis of MIMIC® (RH-5992, Tebufenozide) in Formulated Products by Gas Chromatographic and Liquid Chromatographic Methods: A Comparative Study

Thirteen formulated products (formulation concentrates and spray mixes) containing MIMIC®, also known as RH-5992 or tebufenozide [N'-*t*-butyl-N'-(3,5-dimethylbenzoyl)-N-(4-ethylbenzoyl) hydrazine], were analyzed, after solvent dissolution by agitation, using direct gas chromatography (GC) and reverse phase high performance liquid chromatography (HPLC). The responses of the analyte to three GC detectors (flame ionization detector, FID; nitrogen-phosphorus detector, NPD; and electron capture detector, ECD) using three fused silica capillary columns of varying internal diameters were compared. The mini-bore (0.25 mm I.D.) DB-5 [(5 % phenyl)-methylpolysiloxane] column, attached to the ECD was better suited to quantify the analyte in formulated products than the mega-bore DB-1 (dimethylpolysiloxane) and DB-17 [(50 % phenyl)-methylpolysiloxane] columns linked to the FID, NPD or ECD. Analysis by GC-FID and a reverse phase HPLC method using an RP-8 column (10 μm particle size) with a mobile phase consisting of acetonitrile-dioxane-water and a diode-array UV detector set at 236 nm also gave values similar to the GC-ECD method. However, due to the rapidity and sensitivity of sample analysis, GC-ECD is the technique of choice for the quantification of MIMIC in formulated products.

(2) **Simultaneous Determination of Tebufenozide and Five of Its Intact Metabolites from Forestry Matrices by High-Performance Liquid Chromatography**

A simple, rapid and reliable high-performance liquid chromatographic (HPLC) method for the determination of tebufenozide insecticide and five of its intact metabolites in spruce foliage, litter, forest soil, sediment and natural water is described. The fortified litter, soil and sediment samples were extracted with acidic methanol in the presence of Celite® and the aqueous phase was partitioned with dichloromethane (DCM) after removing the alcohol. The residues in the DCM phase, after evaporation to dryness, were dissolved in hexane and cleaned by Florisil® column. The treatment of spruce foliage was similar except that the acidic methanol was also partitioned with hexane prior to DCM extraction. Natural water was extracted with DCM and the residues were taken in methanol for HPLC analysis without any column cleanup. The chromatographic system consisted of an ODS Hypersil (5 μm) 250 x 4 mm column linked to a UV detector set at 236 nm. The mobile phase consisted of methanol-water with 0.005 M PIC A as an ion-pairing agent. Mean recoveries of the analytes, depending on their structure, ranged from 65.7 to 103.9 % with standard deviations ranging from 1.7 to 10.6 %. Limits of detection for the solid matrices ranged from 0.01 to 0.03 μg/g and for water it was 1.5 μg/L. The method was applied successfully to the analysis of field samples sprayed with tebufenozide and demonstrated its suitability.

(3) **Degradation Kinetics of Tebufenozide in Model Aquatic Systems Under Controlled Laboratory Conditions**

The hydrolysis of the insecticide tebufenozide was studied in the dark at 20 to 40°C in buffered (pH 4 to 10) distilled water, and at 20°C in unbuffered, sterilized and unsterilized stream water. Tebufenozide was very stable in acidic and neutral buffers at 20°C and the corresponding pseudo-first-order rate constants (k_{obsd}) and half-lives ($T_{1/2}$) were 5.946×10^{-4} and 13.10×10^{-4} d^{-1}, and 1166 and 529 d, respectively. The hydrolytic degradation was dependent on pH and temperature. At pH 10 and at 20, 30 and 40°C, the k_{obsd} (10^{-4} d^{-1}) and $T_{1/2}$ (d) values were 34.22, 66.72 and 130.0; and 203, 104 and 53.3, respectively. The energy of activation (E_a) values for the hydrolysis of tebufenozide at pH 4, 7 and 10, calculated from the Arrhenius plots, were 83.50, 66.71 and 50.87 kJ/mol, respectively. Tebufenozide was stable in sterilized stream water in the dark ($T_{1/2}$ = 734 d) but it degraded fairly rapidly in unsterilized stream water ($T_{1/2}$

= 181 d). Sunlight photodegradation of the chemical was slower ($T_{1/2}$ = 83.0 h) than the photolysis by ultraviolet radiations ($T_{1/2}$ values at 254 and 365 nm were 9.92 and 27.6 h, respectively); nevertheless, it was still appreciable during the summer months at 46°31' N latitude. The differences in degradation rates between the unsterilized and sterilized stream water and the degradation of the chemical in the sterile, distilled water in sunlight, suggests that microbial processes and photolysis are the two main degradative routes for tebufenozide in natural aquatic systems:

(4) **Photostability and Rainfastness of Tebufenozide Deposits on Fir Foliage**

Two formulation concentrates of the insecticide, tebufenozide, [Mimic®, also known as RH-5992, N'-*t*-butyl-N'-(3,5-dimethylbenzoyl)-N-(4-ethylbenzoyl) hydrazine], an aqueous flowable (2F) and an emulsion-suspension (ES), were diluted with water and sprayed onto balsam fir branch tips at 140 to 150 g of active ingredient (AI) in 4.0 to 5.0 L/ha. Simulated rainfall was applied onto treated branch tips after different ageing periods of deposits. Foliar washoff of RH-5992 was assessed after application of different amounts of rain. A direct relationship existed between the amount of rainfall and AI washoff. The larger the rain droplet size, the greater the washoff. Longer rain-free periods made the deposits more resistant to rain. Regardless of the amount of rainfall, rain droplet size and ageing period, foliar deposits of the 2F mixture were washed off more than those of the ES mixture.

Another set of branch tips was exposed to simulated sunlight at two different radiation-free periods, and the emission-intensity spectra were measured. The amount of AI disappeared from foliage after exposure to radiation was measured. A direct relationship existed between radiation intensity and AI disappearance from foliage. The longer the duration of exposure, the greater the disappearance. Unlike the rain-washing, the ageing of foliar deposits had little influence on photo-induced disappearance of the AI. Regardless of the amount and intensity of radiation, and radiation-free period, AI deposits of the ES mixture disappeared more than those of the 2F mixture.

(5) **Foliar Persistence and Residual Toxicity of Tebufenozide to Spruce Budworm Larvae**

A field study was conducted, using ground application, to investigate persistence of tebufenozide in white spruce foliage after application of an aqueous flowable formulation, RH-

5992 2F, at three dosage rates, 35, 70 and 140 g of the active ingredient (AI), in 2.0 L/ha. Droplet size spectra of the sprays were determined on Kromekote® cards and AI deposit was assessed on glass plates. Foliage was collected at different intervals of time up to 64 d after treatment and tebufenozide residues were measured by high-performance liquid chromatography. Simultaneously, foliage was also fed to laboratory-reared 4th and 6th instar spruce budworm larvae. Tebufenozide residues in foliage declined gradually with time according to first-order kinetics. The average rate constant and half-life of disappearance (DT_{50}) were 0.0340 and 20.45 d, respectively. Corresponding to the residues, larval mortality declined gradually, but was still appreciable (49 to 70 %) when fed with foliage collected 64 d after treatment. The amount of foliage consumed by the larvae decreased when tebufenozide residue levels increased. The LD_{50} values for both the instars were similar and averaged to *ca* 25 ng/insect, but the LD_{90} values were significantly lower for the 4th instar than for the 6th instar, at 63.6 and 96.1 ng/insect, respectively. At a foliar concentration of 1.0 μg tebufenozide per g foliage (fresh wt.), the larvae should consume about 65 to 100 mg of foliage in 10 d to cause mortality in about 90 % of the population of the spruce budworm.

II DROPLET SIZE SPECTRA QUANTIFICATION OF δ-ENDOTOXIN BY ELISA AND DEPOSIT ASSESSMENT OF *BACILLUS THURINGIENSIS* VAR. *KURSTAKI* SPRAY APPLICATIONS

(1) Influence of Droplet Sizes on the Persistence of *Bacillus thuringiensis* on Oak Foliage Under Laboratory Conditions

The effect of droplet sizes of deposits on foliage on persistence of *Bacillus thuringiensis* var. *kurstaki* (*B.t.*(*k*)) applied as an aqueous flowable formulation was investigated under greenhouse conditions. Uniform droplets, 42 to 250 μm in diameter, of a *B.t.*(*k*) formulation, Foray 48B, were applied onto foliage of oak seedlings. Leaves were clipped at different intervals of time after treatment, the toxic protein was extracted, and the extracts were bioassayed using 4 instar gypsy moth larvae. The mean half-lives of *B.t.*(*k*) inactivation (DT_{50}) in foliage were about 26 h for the largest droplets (250 μm), and about 12 h for the smallest droplets (42 μm). The DT_{50}'s for the 42 and 73 μm droplets were significantly lower than for the 103 and 132 μm droplets, which in turn were lower than for the 160 to 250 μm range. An upper limit in the 130 to 160 μm range was indicated, beyond which the rate of inactivation was independent of droplet sizes applied. The slower rate of inactivation of *B.t.*(*k*) when present in large droplets as opposed to that in small droplets, could be attributed to the area of exposure to sunlight. The amount of *B.t.*(*k*) in one 250 μm droplet is equivalent to that in 210 droplets each of 42 μm. The probability of exposure to sunlight is much greater for deposits made up of several 42 μm droplets than for those of a single 250 μm droplet. Thus, the effect of droplet sizes of deposits on sunlight-mediated inactivation of *B.t.*(*k*) on oak foliage was indicated.

(2) Droplet Size Spectra and Deposits of Aerially Sprayed *Bacillus thuringiensis* Formulations Under Field Conditions

Two commercial formulations of *Bacillus thuringiensis* var. *kurstaki* (*B.t.*(*k*)), Foray® 48B and Thuricide® 48LV, were applied aerially over nine spray blocks in a hardwood forest in West Virginia in 1991. Droplet spectra and spray mass deposits were determined using water-sensitive paper strips (WSPS), glass micro-fibre filters (GMFFs), glass plates and castor oil. Mass deposits of *B.t.*(*k*) were also assessed on natural foliage by two bioassay methods, i.e., feeding of homogenized foliage containing a starch-sucrose solution and force-feeding bioassay of foliar extracts containing re-dissolved protein precipitate. Deposits on canopy foliage and ground samplers were also assessed by total protein assay and enzyme-linked immunosorbent assay (ELISA). Droplet spectra on the WSPS were different from those on castor oil. Droplets on horizontal ground WSPS were larger than those on vertical ground WSPS. WSPS placed at canopy level collected more droplets than those at ground level. The total protein deposits (ng/cm^2) were consistently higher on all blocks than the delta-endotoxin protein deposits. Spray mass recovery on the ground samplers were low, and ranged from 2.9 to 8.0 % of the applied rates.

(3) Enzyme-Linked Immunosorbent Assay (ELISA) for the Quantification of *Bacillus thuringiensis* var. *kurstaki* Delta-Endotoxin in Commercial Formulations

The widespread use of microbial pesticides for forest insect control necessitates determination of the delta-endotoxin protein levels in commercial formulations to optimize their use-patterns in the field. As the analyte is biochemical and/or biological in nature, classical analytical procedures are often not applicable for this purpose, and new types of analytical methods need to be developed. A sandwich type enzyme-linked immunosorbent assay (ELISA) was developed to detect and quantify *Bacillus thuringiensis* var. *kurstaki* (*B.t.*(*k*)) delta-endotoxin in nine commercial formulations that are being used for forest insect control in North America. Formulation ingredients (formulants) interfered with the toxin response in three of the nine formulations, and the total protein needed to be separated from formulants for ELISA. Total protein levels were consistently higher (about 40 to 60 %), in all formulations than the delta-endotoxin content because of the presence of inactive proteins. Results of three types of force-feeding bioassays [using spruce budworm, *Choristoneura fumiferana* (Clemens.)] viz., with diluted formulations, formulation extracts, and redissolved protein precipitates, showed that the formulants contributed to bioactivity and had to be removed to assess toxicity of the *B.t.*(*k*) protein alone. The delta-endotoxin content of formulations correlated better with the LD_{50}'s (ng of total protein/larva required for 50 % mortality) of the redissolved protein precipitates of formulations than with those of the diluted formulations and formulation extracts. As more microbial pesticides are being introduced for forest insect control, it is crucial that analytical methods are in place for quality control of commercial formulations, both from the standpoint of improved efficacy and environmental safety.

(4) Spray Deposit Assessment of *Bacillus thuringiensis* on Foliage

Bacillus thuringiensis var. *kurstaki* (*B.t.*(*k*)) is being used widely for forest insect control, and it is important to determine how much of the sprayed material reaches the canopy foliage following aerial application. Before we embark on *B.t.*(*k*) deposit assessment, we should know what components of a commercial formulation can and do contribute to insect toxicity. The overall toxicity of a *B.t.*(*k*) formulation arises from: (a) total delta-endotoxin proteins consisting of several delta-endotoxin fractions, some toxic to target insects and others to nontarget insects; (b) spores present in the *B.t.*(*k*) preparation; and (c) formulation ingredients which could contribute to insect toxicity, either directly or indirectly by synergism with the protein fractions present. An understanding of this complexity is important, especially because *B.t.*(*k*) is not as potent as some synthetic chemicals (eg. permethrin), and is not as persistent in the environment as some synthetic chemicals. Therefore, field effectiveness of *B.t.*(*k*) depends on which one of the three factors predominate under field conditions, because some degree of field persistence is necessary for efficient control of insects throughout the critical period of insect development.

Basically, four types of methods have been developed for spray deposit assessment of *B.t.*(*k*):

(i) **ELISA Method**

The method involves the use of Enzyme-Linked Immunosorbent Assay (ELISA) to determine the total delta-endotoxin proteins in foliar deposits. The experimental procedure involves rigorous techniques for: (i) sampling of field foliage after spray application; (ii) storage of the collected samples; (iii) wash-off of the protein deposit (active plus inactive) using an alkaline buffer (pH 11 to 12, depending on the formulation sprayed); (iv) precipitation of the protein at pH 4.5 to remove formulation ingredients; (v) redissolving the protein precipitate in the alkaline buffer (pH 12), and conducting the ELISA against a positive control, a delta-endotoxin standard. This procedure is time-consuming and involves intricate techniques that are suitable for an experimental spray trial, and not for large-scale operational spray programs.

The advantage of this ELISA method is that it provides information on the "total delta-endotoxin deposits" obtained on foliage, i.e., the toxic fraction of the *B.t.*(*k*) proteins deposited. This information is extremely useful for researchers who are interested in toxicity assessment to nontarget insects, i.e., nontarget Lepidoptera, Coleoptera and Diptera.

There are three major disadvantages of this method: (1) it does not provide information on the total spray mass (or spray volume) deposited after field application of a commercial formulation. This parameter is important to know because other ingredients present in a spray formulation (including the *B.t.*(*k*) spores) could be toxic to target insects (nontarget insects may or may not be affected). Therefore, the ELISA method does not provide information on the total deposits, i.e., on the total toxicity of a formulation; (2) this method requires a minimum of about two weeds to obtain the necessary information on the adequacy of deposits on foliage, which is too long to make a recommendation to an operator to respray the blocks or not; (3) we have not yet found an alternative antibody, except that of Bruce Hammock, that is suitable for field samples of foliage, nor for a commercial *B.t.*(*k*) formulation. Further investigations are necessary to explore the use of alternative antibody samples of other researchers for *B.t.*(*k*) deposit assessment. Some companies have introduced sample kits for rapid assessment of delta-endotoxins, but these kits have yet to be validated by detailed research studies, to determine whether or not they meet the requirement as per the claim. At present, only very few publications are available in the literature, and these studies have to be evaluated scientifically whether or not the methodologies reported are applicable to our needs for *B.t.*(*k*) deposit assessment.

(ii) Total Protein Assay by the Modified Bicinchoninic Acid Method

The second method involves determination of the "total *B.t.*(*k*) protein" deposited on foliage. The word "total" does not represent "absolute total", but it simply refers to the total protein under the experimental conditions used (eg., depending on the pH of the buffer for solubilization, the time duration for extraction, and the influence of other ingredients on solubilization of the protein fractions).

Details of field foliage collection, storage, wash-off of protein deposits and protein solubilization, precipitation and redissolution, are the same as those used in the ELISA method. However, the protein content of the deposits were quantified using a modified bicinchonininc acid method, using the commercially available bicinchoninic acid kit after slightly modifying the ingredients of the kit to make it applicable to the *B.t.*(*k*) proteins (the commercial kit is mainly prepared for serum proteins of humans, animals, etc., and needed to be optimized to increase quantification efficiency of *B.t.*(*k*) proteins present in the commercial formulations).

The advantage of this method is its speed (and hence the low cost compared to the ELISA method), and about 7 to 10 samples can be quantified within 36 h after sample collection. This method may be applicable to large-scale operational SBW control programs, if enough samples were collected for realistic deposit assessment, and if several technicians could work simultaneously to obtain the results within 36 h. Another advantage of this method is that it provides an estimate of the total spray deposit, because it includes the active and inactive protein fractions.

The disadvantages of this method are: (1) it ignores the toxicity due to spores, and due to formulation ingredients (if any); and (2) it does not provide information on the total delta-endotoxin proteins, which is valuable to the environmental researchers.

(iii) The Bioassay Methods

Several bioassay methods, such as direct foliar feeding, force-feeding of foliar extracts, etc., can be used, but reliable mortality data could be available only 7 to 10 d after sample collection. The advantage of the bioassay method is that it is simple and easy to do (and hence the low cost). However, the time period is too long to make any realistic recommendation to the spray operators to respray the blocks or not. Furthermore, the high variability in mortality data, depending on the susceptibility and instar stage of the insects, introduces inaccuracies in the results. Another disadvantage of the bioassay method is the lack of information on the factors contributing to toxicity to target and nontarget insects (i.e., the lack of specificity of toxic action).

Nonetheless, other sublethal toxic effects (eg., body-weight depression, biochemical abnormalities, etc.) can be explored as the parameters to quantify field spray deposits, although in our experience the minimum period required for the onset of these parameters in the insects is at least 48 h after *B.t.*(*k*) ingestion. In my opinion, reliable data can be obtained only after about 72 h. This period again may be too long to make a recommendation to the spray operators to respray the blocks or not.

(iv) **A New Method for the Quantification of Total Spray Mass Deposit**

The principle of this method is to combine the total protein assay method (see above) with other quantification methods to determine the total spray mass deposited, regardless of the toxic components. This new method has been developed and is now used successfully to determine total spray mass deposit of the Foray 76B formulation after aerial application in the Longlac trials in 1994.

The advantage of this method is that it provides the sum total of deposits from all fractions, the total protein fractions plus the formulation ingredient fractions. Consequently, this is the only method that has the capability to provide the total spray mass deposit accurately after aerial application of a commercial formulation.

The disadvantages of this method are (1) it takes about two weeks to obtain the relevant information; and (2) it requires sophisticated techniques for fractional extraction, precipitation and redissolution procedures, which require constant monitoring of the work in progress by the supervisor to minimize errors, in the analytical procedures. This method is now being written for a journal publication.

Further research studies are being conducted to minimize the time period required to obtain results. However, these steps take time, manpower and funding without which the research studies could not be conducted. One important point is worth mentioning: the ingredients in commercial formulations keep changing constantly, so do the procedures for preparing the fermentation product. Therefore, field deposit assessment methods developed for one formulation may not be applicable for another. It may be necessary to constantly conduct research to develop new methods every year for quantification of field deposit assessment.

Apart from these four types of methods that have been proven to be useful for *B.t.*(*k*) deposit assessment under field conditions, a HPLC method has been reported in literature for quantification of *B.t.*(*k*) proteins, but the method has not yet been proven to be useful for field deposit assessment under forestry spray application conditions. The HPLC quantification of the total delta-endotoxins is somewhat similar to the ELISA method listed above, and not in any way better. A major disadvantage of the HPLC method is that it requires pure *B.t.*(*k*) protein standards to identify and quantify the peaks, thus introducing complexities in the analytical procedures. The method would be not only time-consuming, but also too expensive to apply to large-scale operational spray trials. Moreover, the method does not provide information on the toxicity due to spores, or formulation ingredients.

III PERSISTENCE AND FATE OF AZADIRACHTIN IN ENVIRONMENTAL MATRICES

(1) Uptake, Translocation, Persistence and Fate of Azadirachtin in Aspen Plants (*Populus tremuloides* Michx.) and its Effect on Pestiferous Two-Spotted Spider Mite (*Tetranychus urticae* Koch)

A commercial neem formulation containing azadirachtin-A (AZ-A) was applied to the soil around the root system of potted aspen plants (*Populus tremuloides* Michx.) (grown in a greenhouse). The uptake, translocation, persistence and dissipation of AZ-A in the plants were studied. The effect of foliar residues of AZ-A on the population of two-spotted spider mites (*Tetranychus urticae* Koch) was also evaluated. The compound was taken up by the root system within 3 h and translocated in the stem and foliage within 3 d, confirming that the chemical is systemic. The peak concentrations (μg/g, fresh weight) of AZ-A occurred at 10 d post-treatment, and were distributed in roots, stem and foliage in the ratio of 8.1 : 1.0 : 2.3, respectively. The rate of dissipation of AZ-A from the matrices was rapid, and the residual concentrations on the last day of sampling (50 d post-treatment) in roots, stem and foliage were in the ratio 2.7 : 1.0 : 1.2, respectively. Control of mites by AZ-A residues in foliage was statistically significant, and the bioactivity declined within 30 d. The final residue level of AZ-A in the soil after 50 d was about 25 % of the initial value, with a half-life of dissipation of about 26 d.

(2) **Kinetics of Azadirachtin Hydrolysis in Model Aquatic Systems by High-Performance Liquid Chromatography**

The hydrolysis of azadirachtin-A isomer (AZ-A) was studied at 20°C in the dark in buffered distilled water at pH 4, 7 and 10, and in unbuffered sterilized and unsterilized pond water. Individual solutions were fortified in triplicate with pure AZ-A and formulated AZ-A separately. Hydrolysis of AZ-A in pond water was studied by using pure AZ-A only. At pH 10, AZ-A fortified either in pure form or as formulation, was hydrolysed rapidly and the DT_{50} was only about 2 h. At pH 4, the DT_{50} values for the pure and formulated AZ-A were 19.2 and 38.3 d, respectively, indicating that the chemical is relatively stable in acidic medium. The stability was diminished at pH 7 and the corresponding DT_{50} values were 12.9 and 30.5 d. The data show that the hydrolysis of AZ-A is greatly influenced by pH in the order pH 10 >>> pH 7 > pH 4. The differences in DT_{50} values between pure AZ-A and formulated AZ-A, at pH 4 and 7, suggest that hydrolysis is considerably retarded by the surfactants in the formulation. The average pH and DT_{50} values for the sterilized and unsterilized pond water were 8.08 ± 0.49 and 7.36 ± 0.28, and 6.91 d and 11.94 d, respectively. The faster degradation of pure AZ-A in sterilized water, compared to the unsterilized water, was likely due to chemical hydrolysis. Microbial action in the degradation of AZ-A in the unsterilized pond water appeared to be minimal.

(3) **Influence of Droplet Sizes on the Persistence of Azadirachtin (Isomer A) on Oak Foliage Under Laboratory Microcosm**

Uniform droplets, 95 to 450 μm in diameter, of an azadirachtin formulation, Margosan-O®, containing a tracer dye, were applied onto foliage of oak seedlings. Leaves were clipped at different intervals of time after treatment, azadirachtin was extracted, and the extracts were analyzed by high-performance liquid chromatography. The DT_{50} of azadirachtin loss from foliage was about 19 h regardless of the droplet sizes applied. This behaviour could be attributed to the nonaqueous formulation of Margosan-O, which is a clear solution. The droplets of Margosan-O, regardless of their initial sizes, would penetrate into foliar cuticle and be spread over a large area, enhancing exposure to sunlight. Thus, the droplet sizes applied could not contribute to differences in sunlight-induced loss of the chemical.

IV ANALYTICAL METHODS DEVELOPMENT/ENVIRONMENTAL BEHAVIOUR OF INSECTICIDES

(1) Supercritical Fluid Extraction of Pesticides from Forestry Matrices

A simple and inexpensive home-made supercritical fluid extraction (SFE) apparatus was used in the off-line SFE of aminocarb and fenitrothion residues from conifer foliage and forest soil. Using conventional solvents of different polarity and solvent strength as supercritical fluids (hexane, ethyl acetate, methanol and acetonitrile), extractions of fenitrothion and aminocarb residues from forest soil and conifer foliage were conducted under different experimental conditions. Analysis of the extracts was done by capillary gas chromatography (GC) after necessary partition and column cleanup steps. Experiments were carried out to study the effects of pressure, temperature, flow rate, sample size, analyte concentration and matrix type on extraction efficiencies. These variables had considerable influence on the recovery of the analytes from the two matrices. The recovery data are presented and compared with the results obtained from Sorvall® extraction. Most often, Sorvall extraction was superior to SFE and the recoveries were > 90 % with limited interference in the chromatograms. Suitability and limitations of SFE as the sample preparation method for forestry matrices in residue analysis, using conventional solvents as supercritical fluids, became apparent because of low recoveries in certain cases and excessive interference in the analysis due to co-extractive impurities.

(2) A Gas-Liquid Chromatographic Method to Determine Size Spectra of Droplets of an Aerially Applied Nonvolatile Spray Mix Deposited on Kromekote® Cards

A nonvolatile oil-based spray mix of a low vapour-pressure insecticide, aminocarb, containing an oil-soluble red dye was applied at a dosage rate of 70 g of the active ingredient (AI) in 1.5 L/ha, using a fixed wing aircraft equipped with four Micronair® AU3000 atomizers, over a 1000 m x 500 m spray block selected in Bathurst, New Brunswick, Canada. Spray was applied twice, each at an interval of 5-d, to provide a total dosage rate of 140 g AI in 3.0 L/ha. Spray mass recovery was assessed on glass plates and droplets were collected on Kromekote® cards, both at ground level. The stain sizes were grouped into different categories. The areas containing the stains were excised, and the aminocarb present was quantified by gas-liquid chromatography (GLC). The mass of aminocarb per droplet in each stain size category was evaluated. From the mass, the spherical droplet diameter ('d'), number and volume median diameters ($D_{N.5}$ and $D_{V.5}$, respectively), a new parameter [mass (of aminocarb) median diameter] ($D_{M.5}$), and the droplet size spectra were calculated. The $D_{M.5}$ for the 1st application was 56 µm, which was identical to the $D_{V.5}$, whereas the $D_{N.5}$ was smaller at 45 µm. The corresponding values for the 2nd application were: $D_{M.5} = D_{V.5} = 63$ µm, but the $D_{N.5}$ was 53 µm. Because the spray mix was nonvolatile, all the droplet size spectra parameters were identical, both at spray release height and at ground level.

The present study provided, for the first time in literature, a novel method to determine directly the spherical diameters of the droplets deposited on artificial samplers, without having to go through the tedious procedures of spread factor measurements under laboratory conditions. In fact, the present study made it possible to calculate spread factors under field conditions, by using the stain diameters measured, and the spherical diameters calculated from the aminocarb concentration levels.

(3) Fluorometric Determination of Aminocarb and Mexacarbate and Some of Their Metabolites by Liquid Chromatography: Influence of Structural Factors on Fluorescence Intensity

A direct and sensitive high performance liquid chromatographic method with fluorescence detection is reported to identify aminocarb and mexacarbate and some of their metabolites. The observed detection limits were compared by linking the liquid chromatograph to a variable wavelength UV detector. The separation system consisted of an RP-8 OS (10 µm) 20 cm x 4.6 mm I.D. column and acetonitrile-phosphate (pH 7.2) buffer. The excitation and emission wavelengths of the fluorescence detector were set at 200 and 370 nm, respectively. The UV detector was set at 242 and 200 nm for aminocarb and mexacarbate, respectively. The sensitivity in fluorescence detection was not superior to UV method because of the influence of substituents on the aryl ring on fluorescence intensity. Both methods were found to be adequate for the determination of most of the analytes from natural water at nanogram levels after necessary extraction and cleanup procedures.

(4) **Effect of Temperature, Adjuvants, Water Hardness, pH, Storage Period, etc. on the Stability of Pesticide Formulations**

Pesticide formulation concentrates should maintain their physicochemical stability from the time of preparation until field application. Literature information on pesticide stability is lacking at present, especially after field storage under the conditions of the operational spray programs for forest pest control. The present study provides information on the influence of water hardness, pH, formulation ingredients, carrier media, storage periods and temperature fluctuations, on phase separation, pesticide hydrolysis, degradation and metabolism, in some simple formulation concentrates prepared in the laboratory, and in some complex formulation concentrates obtained from pesticide companies.

The investigation indicated that the greater the hardness of water, the greater the stability of the active ingredients. Formulants increased the storage stability of pesticides. Polymeric formulants of larger molecular mass provided greater stability to pesticides than the surfactants of smaller molecular size. The longer the storage period, the lesser the stability of pesticides. Highly water-soluble pesticides degraded to a much greater extent than the sparingly soluble ones. Degradation occurred much more in aqueous media than in non-aqueous media, and the type of metabolites formed differed in the two media. Commercial formulation concentrates made up of several ingredients provided metabolites different from those found in the simple formulations prepared in the laboratory. Pesticide degradation occurred to a much greater extent after storage of the commercial formulation concentrates under outdoor conditions at extreme fluctuating temperatures, than after storage in the laboratory at a constant temperature.

(5) **Rain-washing of Foliar Deposits of Dimilin® WP-25 Formulations**

Dimilin® WP-25, a wettable powder formulation of diflubenzuron (DFB) [1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl) urea], was formulated in four different carrier liquids, *viz.* water; a light petroleum paraffinic oil, ID 585; a heavy paraffinic oil, Sunspray® 7N; and a 1:2 mixture of a light petroleum aromatic solvent (Cyclosol® 63) and canola oil. This provided four end-use mixtures, Dim-W, Dim-585, Dim-7N and Dim-Cy-C, respectively, each containing 28 g of DFB per litre. Balsam fir branch tips clipped from greenhouse-grown seedlings, and sugar maple branch tips clipped from field-grown young trees, were exposed to uniform-sized droplets (ranging in diameters from 135 to 190 μm) of the four end-use mixtures which were atomized using a monodispersed droplet generator. Droplets were collected on the fir and maple branch tips and the initial residue per g fresh weight of foliage was determined by high-performance liquid chromatography (HPLC). The branch tips were exposed to cumulative rainfall of 3, 6 and 10 mm at an intensity of 5 mm/h and at time intervals of 1, 12, 36 and 72 h after DFB treatment, to test the influence of 'ageing' of foliar residues on rainfastness. Foliar samples were collected for residue determination just before the onset of rainfall, and at 0.5 h post-rain. DFB was quantified by the HPLC method.

In the case of fir foliage, the Dim-W formulation was the most susceptible to rain-washing and the rainfastness did not increase with the ageing period of foliar deposits. In contrast, the three oil-based mixtures showed greater rainfastness depending upon the carrier liquid and the ageing period. Rainfastness decreased in the order of Dim-Cy-C > Dim-7N > Dim-585 > Dim-W. In contrast, the data on maple foliage indicated that the ageing of deposits increased the rainfastness of all the 4 end-use mixtures. Dim-585 was the most susceptible to rain washing, and rainfastness decreased in the order of Dim-W > Dim-Cy-C > Dim-7N > Dim-585.

Preliminary results of the efficacy and timing of Azadirachtin, an extract of neem, against white pine weevil in young jack pine plantations

Report to the Twenty-Second Annual Pest Control Forum.

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INTRODUCTION

This research is a continuation of field trials to develop cost-effective, yet environmentally safe methods of preventing white pine weevil, *Pissodes strobi,* damage to young jack pine plantations, especially high value stands such as family and stand tests. Current weevil management practices include clipping and burning the infected leaders whenever manpower and money are available. Insecticide treatments of methoxychlor at 1.1 Kg/ha and permethrin at 140 g/ha have shown to be effective in preventing leader mortality when applied early by back pack sprayers or mist blower applications (de Groot and Helson 1993). Permethrin is yet to be registered for WPW use, while Methoxychlor is becoming difficult to procure.

The natural product, Neem, derived from the seeds of the neem tree, has been shown to be effective against such enclosed feeders as the birch leaf miner and the elm bark beetle, when applied as a trunk injection (Marion et al., 1990) and (Harrell and Pierce, 1994). We decided to try a Neem derivative, Azadirachtin, (Phero Tech, Inc., 7572 Progress Way, Delta, B.C.) as a topical spray on jack pine to determine if this product would prevent white pine weevil feeding, and hence, subsequent leader mortality.

The analysis of all field collected data is not yet complete. Head capsule measurements to determine instar, and effect of weather on the development of the weevil larvae remain to be determined. This report presents the efficacy data of a Azadirachtin formulation applied by a back pack sprayer directly to the leaders to control white pine weevil damage in young jack pine trees.

METHODS

Experimental site and layout

The trials were conducted in a large jack pine plantation in Cuthbertson Township, Ontario, in the Sault Ste. Marie District, located at about 46° 46' latitude and 84° 29' longitude. The area had been harvested in 1985, site prepared using a prescribed burn in 1987, and planted with jack pine container stock in 1989. Present stocking was almost full at about 2500 stems per hectare. The site was bounded on the south and west sides by the Garden River, but no spray plots were established within 300 meters of the river.

Three blocks, designated A, B and C, were established each containing six plots of 50 sample trees. Each plot was randomly assigned a treatment timing and was separated from the others by at least 100 meters to avoid contamination from other treatments. All trees were selected, tagged and numbered in the fall of 1993, as WPW activity commences as soon as the snow melts from the site. Tree heights averaged 2.4 meters although height varied considerably across the plantation. Mean heights and diameters of 50 trees were taken in each block and recorded in Table 1. White pine weevil damage last season (1993) averaged 18, 20 and 19% in blocks A, B and C, respectively and similar levels were expected for 1994.

Table 1. Host tree characteristics for white pine weevil control study with Azardirachtin in Cuthbertson Township, Ontario, 1994

Replication	Height (m)	Diameter (cm)
Block A	2.48 ± 0.07	2.47 ± 0.15
Block B	2.14 ± 0.06	1.75 ± 0.12
Block C	2.55 ± 0.08	2.53 ± 0.16

Spray Application

Spray applications were carried out with a Solo® back pack sprayer calibrated to deliver 600 ml per minute of spray formulation. Spray was applied to each tree at the rate of 20 ml per leader, by spraying opposite sides of the leader with 10 ml of material to ensure total coverage. Applications were usually carried out between 9:30 and 11:00 am on the day of treatment. Treatments were always made in the same order, starting at rep A, then B and C. Actual time to treat a 50-tree plot ranged from 10 to 15 minutes, depending on the terrain.

The spray formulation for each treatment consisted of Azadirachtin 20g (a.i.)/liter (5% v/v) and water (95%). A total formulation of 4 liters was mixed for each treatment, which included 1 liter to fill the lines, pump and tank.

The timing of the various treatments were scheduled according to the following plan:

Treatment 1	at first sign of adult emergence
Treatment 2	at first sign of oviposition
Treatment 3	7 days after first oviposition
Treatment 4	14 days after first oviposition, larvae expected.
Treatment 5	21 days after first oviposition, larvae expected.

Twenty leaders were clipped each week from April 28 to July 20, 1994 and dissected to determine the number of punctures, eggs and the number of larvae. A total of 100 punctures per leader was examined for weevil development and these data were used to determine timing of each spray application (Table 2).

Treatments 4 and 5 were not applied according to the initial schedule. After the third treatment, the development sample indicated that no larvae were present. Thus the next treatment was delayed until larvae were present, which was 21 days after the 3rd treatment. Treatment 5 was carried out 7 days after the 4th, at which time 58% of the eggs had hatched.

Statistical Analysis

Treatment means were compared by a Chi square test with $\alpha = 0.05$, (BMDP 1992). Percent leader protection was determined by Abbotts formula (Abbott 1925).

Results

All treatments resulted in fewer damaged leaders in the treatment plots than did the untreated control plots (Table 2). The first treatment, although showing some protection, was not significantly different from the untreated control. Treatments 4 and 5, carried out when 34 and 58 percent of the eggs had hatched, respectively, showed the most leader protection at 82 and 71 percent, respectively. This data clearly shows that very good leader protection can be acheived using this product, especially when timed to treat young larvae.

Table 2 Number of leaders damaged and percent leader protection after spraying jack pine leaders with Azadirachtin for control of white pine weevil, Cuthbertson Twp, Ontario, 1994

Treatment Number	Treatment Date	WPW Development	Leaders Damaged [1] (n=150)	Percent Leaders Protected [2]
1	May 9	First Adults	17 b	39
2	May 18	First Eggs	11 a	61
3	May 25	100 % eggs	12 a	57
4	June 15	34% larvae	5 a	82
5	June 22	58% larvae	8 a	71
6	Untreated		28 b	

1. Numbers within a column followed by different letters are significantly different from the untreated control, (α=0.05), Chi square , (BMDP 1992).
2. Values were derived by subtracting the treatment means from the untreated, and dividing by the untreated mean to arrive at the percentage (Abbott, 1925).

Future Research

Future research will include lab toxicology studies to determine the optimum dose response relationship and to determine, if possible, the mode of action of azadirachtin against the white pine weevil larvae. This will include the establishment of a lab population on jack pine foliage as well as on artificial diet so that young larvae will be available for treatment. These data will be used to compare 3 applications rates and two timings in field trials in 1995.

References

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UPDATE OF INTEGRATED PEST MANAGEMENT RESEARCH MARITIMES REGION

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Prepared for the Twenty-Second Annual Forest Pest Control Forum

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OVERVIEW

Integrated forest pest management (IFPM) is the optimization of pest control in an ecological and economically sound manner. It involves the coordinated use of multiple tactics to keep damage below economically injurious levels with minimal *effects* on non-target organisms, including humans and other vertebrates, beneficial insects, and plants.

The current IFPM project at the Canadian Forestry Service-Maritimes Region develops and implements environmentally safe and effective biological agents and integrated pest management techniques to minimize the use of traditional chemical pesticides by:

- The development of effective methods of controlling specific forest insect pests using various micro-organisms such as entomopathogenic nematodes and bacteria.
- The development of effective pest control methods by isolating, identifying and synthesizing natural products, such as pheromones and antifeedants for use against insects, and phytotoxic compounds of plant or fungal origin which have potential for controlling competing vegetation.
- The study of specific insect pests: their life cycles, the improvement of sampling methods, and quantification of impact of damage in a forest management context leading to the development of specific integrated pest management strategies.

KEY ACTIVITIES - Networks

- Spray Efficacy Research Group (SERG)
- Insect-Parasite Nematodes Working Group (IPN)
- Biological Control of Competing Vegetation Research (BICOVER)
- IPM in Seed Orchards Network
- Pheromone Research Group

FUNDING AND SUPPORT AND COOPERATORS

- NSERG	
- Forest Industry	Forest Protection Limited J.D. Irving Limited N.B. Department of Natural Resources and Energy
- Biological Pesticide Industry	Abbott Laboratories Novo BioKontrol Rhom & Haas

- Natural Resources - Canada (CFS-Maritimes)
- N.B. Research and Productivity Council
- Forest Pest Management Institute
- External Affairs
- City of Fredericton (N.B.)
- Fundy Model Forest

IFPM TEAM AT CFS-M

Study Areas	Leaders
Research on and leadership in the development of entomopathogenic nematodes for control of forest insect pests.	G. Thurston
Development and testing of microbial agents, pheromones, insect growth regulators and new application systems for the control of forest insect pests.	E.G. Kettela (Project leader, IFPM Team)
Research and development of disease and insect control in tree nurseries, greenhouses and plantations.	L. Lanteigne
Determination of the impact of insect behaviour on the efficacy of microbials such at *B.t.* and the determination of dose transfer mechanisms pertinent to improving efficacy.	P.C. Nigam
Biological control of forest pests with emphasis on the use of *Trichogramma minutum* for control of the spruce budmoth.	D.P. Ostaff
Identification, isolation and/or synthesis of naturally occurring substances of plant or fungal origin that may be developed for use in pest control systems.	G.M. Strunz
Research on natural mortality factors affecting seed and cone insects and development of methods of damage prediction and pest control in seed orchards.	J.D. Sweeney
Development of an effective methodology for assaying spray deposits of microbial and insect growth regulators, assaying the potential of Dr. Strunz's output. Biological diversity	A.W. Thomas

HIGHLIGHTS OF 1994 INVESTIGATIONS:

- Evaluation of Quantity of Quality of *B.t.* Deposit on White Spruce

- Field Trials of Several Potential Control Agents Against the Elm Leaf Beetle
  - Nematodes
  - *Bacillus thuringiensis tenebrionis*
  - Parasite/predator complex

- Baseline Study of Lepidoptera Biodensity in a New Brunswick Fir Spruce Forest: Impact of Forest Practices

- Naturally Occurring Compounds and Their Efficacy Against Spruce Budworm

- Demonstration Trials with Pheromones for Management of the Spruce Budmoth (*Zeiraphera canadensis*) - 3 ha Treated

SPRAY EFFICACY RESEARCH GROUP

EVALUATION OF QUALITY AND QUANTITY OF B.T. SPRAY DEPOSIT ON WHITE SPRUCE

FUNDED BY:	- Forest Protection Limited	\$10,000
	- Novo Nordisk	\$17,000
and	- Cooperation Agreement on Forest Development	\$17,000
	TOTAL	**\$44,000**

Interim Report October 10, 1994

Submitted by: Mr. E.G. Kettela

Test site selection was carried during April and May, 1994, and adequate sites were identified on the Black Brook Limits of J.D. Irving Limited. Permission to enter on and treat plantations of white spruce was received in early June but final provincial permits to carry out spraying were not received from Environment N.B. until June 21, 1994. However because of the very late spring season we were able to conduct most aspects of the field program. Eight test sites of uniform stand composition and tree size were selected and treated (Table 1). Forest Protection Limited, for their part, provided a Cessna 188 spray aircraft and experienced ground personnel and pilot. The aircraft was fully instrumented to provide all necessary aircraft operating parameters.

Although not in the original plan, we were able to generate some information on efficacy. Fortuitously, most of the stands selected were infested with spruce budworm. Intensive sampling for larvae was incorporated into the work schedule.

RESULTS TO DATE

Data analysis is underway and a complete report is scheduled for February 1, 1995. To date my data analysis has shown the following:

1) Quality of Spray Deposit

White spruce - old needles (2 sites) - 100 drops	- Mean diameter drop stain - 62 μm
Balsam Fir - old needles	- 68 μm

(100 drops)

2) Spray deposit decreases downwind after 100 meters (Table 2)

3) Distribution in crown of White Spruce (Table 3)

- Highest deposit in upper 1/3 of crown
- Lowest deposit in lower 1/3 of crown

4) Spray deposit at Midcrown (Table 4)

- Higher on fir than on spruce
- But only one site examined as yet.

WORK TO BE COMPLETED

5) Insect sampling summaries for four sites are shown in Table 5.

- Analysis of Spacial distribution in six sites
- Complete comparisons of fir spruce deposit
- Complete analysis of new vs old foliage deposit on white spruce
- Anticipated completion date February 1

Interim.rep/10/94

TABLE 1: Spray Parameters for FORAY 76B Trials, 1994 in New Brunswick.

Site	Date	No. Passes	Height over trees-m	Flow rate/head L/min	Total flow rate L/min	Nominal BIU/ha	Wind	Temp	Rh
FORAY 1	June 22, pm	10	10	2	8	30	w2-4/kph	18°C	80%
FORAY 2	June 22, pm	15	10	2	8	45	w2-4/kph	18°C	80%
FORAY 3	June 23, am	10	30	2	8	30	3-5/kph	18°C	85%
FORAY 4	June 24, am	15	30	2	8	45	3-5/kph	22°C	70%
FORAY 5	June 24, am	10	10	2	8	30	w1-2/kph	16°C	85%
FORAY 6	June 24, am	15	10	2	8	45	w1-2/kph	16°C	81%
FORAY 7	June 24, am	10	30	2	8	30	3-4/kph	16°C	77%
FORAY 8	June 24, am	15	30	2	8	45	4-6/kph	17°C	70%

TABLE 2: Mean Spray Drops/Needle on White Spruce Mid Crown Branches.

Meters Downwind	Drops/needle *			
	Site 1 (30 BIU/ha)		Site 2 (45 BIU/ha)	
	Line 1 (thinned)	Line 2 (unthinned)	Line 1 (unthinned)	Line 2 (thinned)
50	0.54	0.64	0.71	0.56
100	0.71	0.59	0.74	0.40
150	0.11	0.25	0.29	0.27
200	0.06	0.07	0.11	0.12
250	0.06	0.05	0.18	0.17
300	0.06	0.04	0.17	0.19

* Mean spray deposit for 5 trees 400 needles/station downwind.

TABLE 3: Spray Drop Distribution Vertically on White Spruce Foliage for Treatment Sites 1 and 2 (unspaced) at the 50 meter Downwind Site.

	30 BIU/ha Site 1 (Line 2)	45 BIU/ha Site 2 (Line 1)
Upper Crown	1.18 ± 0.74	1.26 ± 0.62
Mid Crown	0.64 ± 0.33	0.71 ± 0.51
Bottom ⅓ of Crown	0.17 ± 0.21	0.15 ± 0.19

TABLE 4: Summary of Spray Deposit (Drops/needle) on Balsam Fir and White Spruce at the 50 meter Downwind Site for Site # 1, line 2 treated with FORAY 76B (5 trees each).

Tree Species	Spray Drops/needle (Mid Crown)
Balsam Fir	0.78 ± 0.62
White Spruce	0.64 ± 0.33

TABLE 5: Summary of Spruce Budworm and Zeiraphera Sampling at Four Locations in the Skin Gulch Area on White Spruce, all Treated With one Application of 30 BIU/ha in Early-Mid June.

Sites Treated					
		5	6	7	8
Early June	Zeiraphera/50 cm branch	4.3	3.1	3.7	1.2
	4/5th instar budworm/ 50 cm branch	7.8	26.4	21.7	6.9
Late June	6th instar budworm/ 50 cm branch	5.3	14.9	10.3	1.2
Mid July	budworm pupae/ 50 cm branch	1.1	6.3	3.7	0.5
% Survival - 1994		14.1	23.9	17.1	7.2
% Defoliation - 1994		10	42	37	7
Previous		Trace	<5	<5	Trace <-5

* No unsprayed control with similar populations available.

THE ELM LEAF BEETLE IN FREDERICTON

CFS-Maritimes Region scientists are assisting the City of Fredericton in finding a control against the elm leaf beetle, an insect which is seriously damaging the city's shade trees.

Fredericton has been waging a successful battle against Dutch elm disease for nearly forty years and managed to save 70% of its magnificent trees which gave it the distinction of being called the City of Stately Elms.

A serious, high level, unexpectedly sustained outbreak of the lem leaf beetle during the past seven years has put the already stressed century-old trees in jeopardy. Some sixty of these trees died and needed to be removed as a consequence in 1994.

Scientists in the Integrated Forest Pest Management project of CFS-Maritimes have been working with the city to find a biological, non-chemical solution to the problem. Experiments involving the efficacy of a beetle-specific formulation for the biological insecticide *B.t.t.*, the use of nematodes and a search for natural enemies (parasites and predators) have been carried out in 1994, following up on preliminary work done in 1993. Both the *B.t.* and the nematode treatments offer promise of success.

Plans are proceeding towards the registration of the *B.t.t.* in 1995 and the development of the nematode treatment towards commercial application. Some aspects of the nematode treatment also have public awareness and public participation implications.

1994 IPM WORK

CFS-Maritimes, as a corporate citizen of the City, has been closely involved since the 1940's with efforts to save the trees in Fredericton, to maintain the ambience of the urban forest and to use the experience gained here to provide guidance in the management of the urban forest throughout the Region.

1994 FIELD TRIALS

Three approaches were taken in the 1994 field trials:

1) Parasite/predator complex was investigated.
2) Nematodes (*Steinernema carpocapsae*) used for control.
3) *Bacillus thuringiensis tenebrionis* (*B.t.t.*) used for control.

To avoid the use of potentially hazardous chemicals to control this pest of Fredericton's elms, scientists at the Canadian Forest Service have been investigating the use of several biological control agents. Each of the pathogens being tested has been determined to be safe for use and no negative environmental effects are known. Of the

(*B.t.t.*) is being tested against leaf-feeding stages of the insect. This bacterium is effective only against leaf-feeding beetles and must be ingested before it is to have any effect. In experiments this year, *B.t.t.* afforded some protection to the leaves from feeding larvae but the level of protection did not appear to be as great as with chemicals. Further investigation, with more consistent application equipment, must be made. The timing of the spray application must also be worked out more carefully. The effectiveness of the bacterium was particularly striking on one tree that received uneven coverage with the spray; untreated areas were 100% defoliated whereas the sprayed areas were only defoliated by about 40%.

Tree bands and ground mulch applications with entomopathogenic ("insect-killing") nematodes proved to be very effective against the pupal stage of the insect. The large majority of insects recovered from these treatments had been killed by the nematodes. These treatments are only effective against the insect after it has completed its feeding and has descended the tree to pupate. While doing nothing to reduce the damage to the tree in the current year, it is hoped that reduction of the elm leaf beetle population will result and damage in subsequent years may be lessened.

LIFE CYCLE:

Adult elm leaf beetles spend the winter in sheltered dry places, such as attics and sheds, (Victorian style houses are preferred overwintering sites), and under bark scales at the bases of elm trees.

Spring emergence begins about the time that elm buds begin to swell, (mid-May) and the adults fly from buildings to nearby elms and feed by chewing holes in the unfolding leaves. The spring emergence period can be extended by adults which have overwintered in colder sites, causing overlap of the insect's stages, and causing a long period of foliage feeding.

Eggs are laid in mid to late June and hatching occurs about a week later when the larvae begin a two to three week feeding period. Larvae feed on the underside of leaves, and can cause leaves to dry out and turn brown.

Full grown larvae crawl down the tree and pupate in bark crevices or at the base of the tree, or in lawn grass as one would find in a city much as Fredericton.

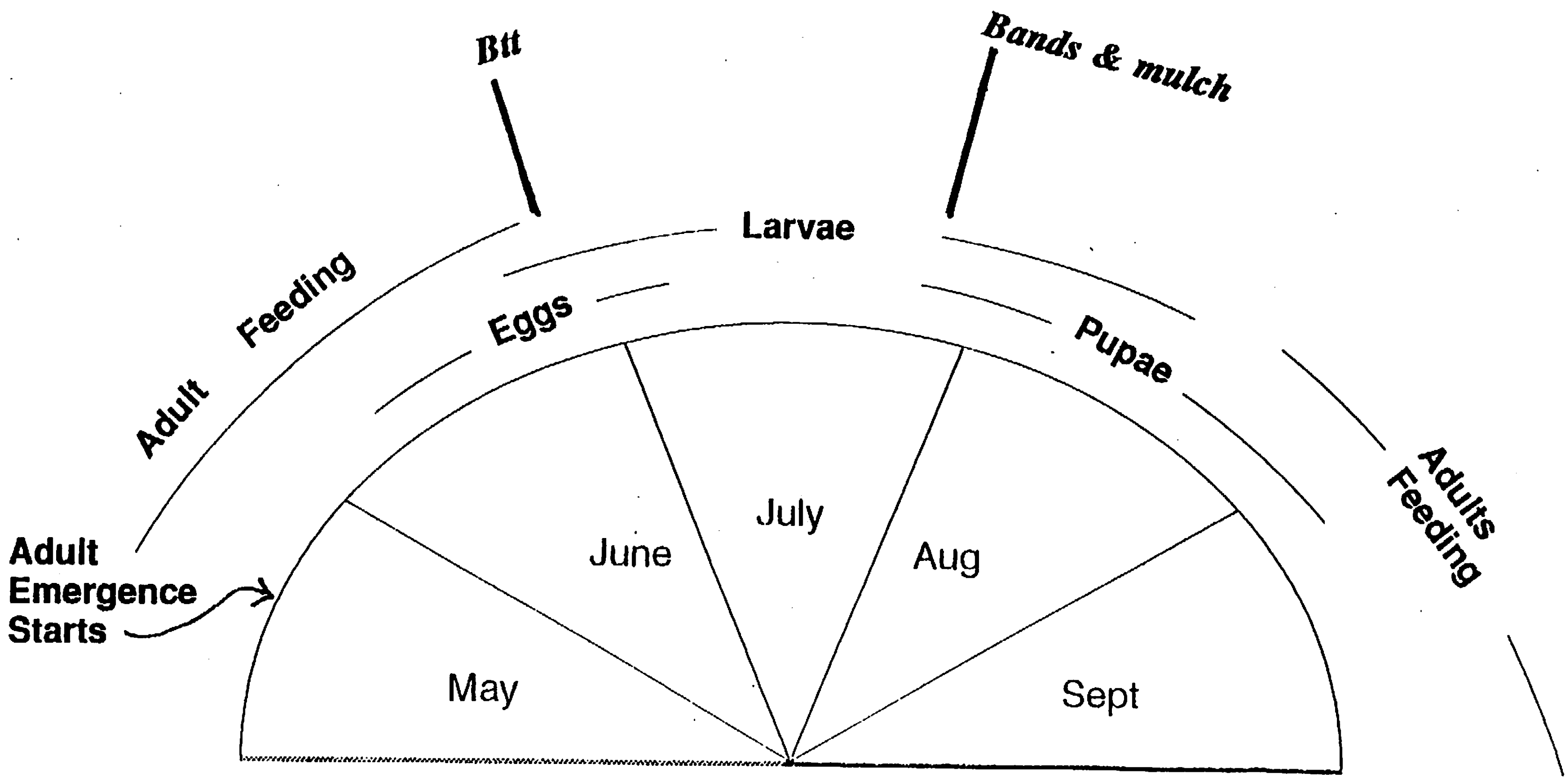
Following pupation (two weeks), adults mature and move to hibernation sites in late August to mid fall after a period of feeding on a second flush of elm leaves.

In the eastern U.S., this pest may have one or two generations and a partial third generation. In Fredericton, we found that there is one generation per year.

A native parasite, *Tetrastichus brevistigma Gahan* occasionally exerts a considerable degree of control in the Northeastern States. During damp weather the fungus, *Sporotrichum globuliferum*, is also occasionally effective in control.

Elm Leaf Beetle (Xanthogaleruca (=Pyrrhalta) lutea (Muller))

LIFE CYCLE



Adults overwinter
Old buildings, dry sheltered places, under bark, tree cracks & crevices

RESULTS:

1) <u>Parasites:</u> No parasites were found in the elm leaf beetle population. This allows for investigations to be initiated towards introduction of parasites.

2) <u>Nematodes:</u> Were found to provide excellent control ie. population reduction in the pupal stage.
   - Maintenance conditions required are well suited to beetles pupation conditions.
   - Potential for more extensive treatment
   - Potential for use against the white pine weevil, and debarking weevil

3) <u>*B.t.t.*</u>: Found to provide very encouraging results ie. population reduction in the larval stage.

ELM LEAF BEETLE -- Nematodes

Experiment:

- incorporate nematodes into "hydromulch" cellulose mulch
- apply tree bands and ground mulch
- recover live and dead insects
- dissect insects to determine cause of death

Data:

		% insects dead
Tree Bands		
	Nematode	90
	Control	15
Ground Mulch		
	Nematode	91
	Control	39

ELM LEAF BEETLE -- *Btt*

Experiment:

- pre-treatment defoliation assessment
- treat with *Btt*
- 2 week later - post-treatment defoliation assessment

Data:

	Further defoliation after treatment
Treated trees	11%
Untreated trees	41%

SEEDLING DEBARKING WEEVIL -- Nematodes

Experiment:

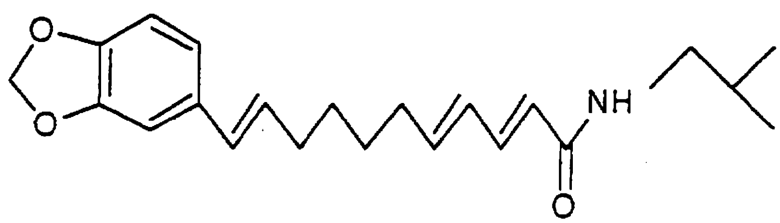
- treat seedlings with nematodes
- transplant to field
- assess seedling mortality

Data:

	Tree Mortality (%)
Treated areas	3 - 11
Untreated areas	27 - 47

Many insecticidal unsaturated isobutylamides have been isolated from *Compositae* and *Rutaceae*. Potent members of this class, such as pipercide, containing a methylenedioxyphenyl group have been isolated from black pepper (*Piper nigrum*) by Sumitomo scientists Miyakado et al.

Pipercide



[Miyakado et al .(Sumitomo) 1979]

We developed a short, efficient strategy for synthesis of pipercide and the related *P. nigrum* alkaloid, piperolein A, and some analogues, from simple, readily available precursors. It is noteworthy that this enabled us to prepare pipercide in an overall yield of 21% in just six steps, whereas previously reported syntheses required nine to eleven steps, and afforded far lower yields of the synthetic pipercide. We have been able, by this means to accumulate sufficient quantities of these *Piper* compounds for meaningful bioassays against insect pest spp. The assays will be conducted by Dr B. Helson at FPMI, and additional material sent as reference to Professor Durst (working on Arnason's *Piper* sp.).

A paper describing the pipercide/piperolein A syntheses was prepared and has just been published [G.M. Strunz and H. Finlay (1994) Tetrahedron, **50**, 11113-11122]. Several conference presentations relating to our research under the Green Plan NPIC Network were also given.

CONCERNS OF NEW BRUNSWICK DEPARTMENT OF NATURAL RESOURCES & ENERGY AND THE FOREST INDUSTRY REGARDING FOREST PROTECTION IN RELATION TO FUTURE PEST CONTROL OPTIONS

Forest protection against spruce budworm has been an annual commitment in new Brunswick moreso than in any other jurisdiction faced with serious outbreaks. For instance, in Ontario and Quebec combined, there are dead and dying softwood forests over areas equal to four times the size of all New Brunswick. While such losses might be acceptable to them, protection in New Brunswick is more critical to preserving our wood supply, providing industrial growth, and maintaining a high standard of living for our residents.

Over the years, many control options have been researched and proven impractical or ineffective. Meanwhile the insecticide Fenitrothion became the mainstay of the program through its proven track record, and it has become the standard against which other controls are measured. The effective protection it has given has also retained forests which now are being identified for other purposes, such as wildlife habitat management. Although research over the years has shown some environmental side effects, the same studies also revealed recovery or ecosystem resilience over varying periods indicating that it is not a threat to long-term sustainability or biodiversity. In this context Fenitrothion has been regarded as an environmentally acceptable insecticide.

The attached sheets outline the concerns of the New Brunswick Department of Natural Resources and Energy and the forest industry, and provides independent support why the registration of Fenitrothion should be retained.

Forestry, Forest Management and Forest Protection in New Brunswick

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General - principles of forest management and protection.

- Effective Forest Protection is the foundation of intensive forest management.
- The forests of New Brunswick are being intensively managed.
- Forest protection methods must be: available, affordable, effective, and environmentally acceptable.
- Fenitrothion has been available, affordable, effective and environmentally acceptable for 25 years.
- Both chemical and biological controls have roles to play in forest protection.

The Dilemma - why the concern in New Brunswick.

- De-registration of Fenitrothion jeopardizes long-term forest management.
- Available protection options are limited (B.t. or Fenitrothion).
- If Fenitrothion is de-registered, the only choice is B.t.
- B.t. has not been effective against high populations of spruce budworm.
- B.t. costs more, hence protection costs are higher.
- De-registration of Fenitrothion forces higher costs on Government and industry - **money which could go to health care, education, deficit control, reduced borrowing, etc..**

The Forest Industry - importance to New Brunswickers.

- Provides about 35 000 direct and indirect jobs (1 in 8 in Province).
- Generates over $250 million in wages and salaries.
- Regionally important: 10 pulp/paper mills, 100+ sawmills (30 single-industry communities depend on forestry).
- Provides almost 25% of all goods produced in Province.
- Accounts for more than 40% of total exports.
- Gross value of production exceeds $2 billion/year.
- Accounts for about 9% of the Gross Domestic Product.
- **Forestry is New Brunswick's single largest resource industry.**

The Resource - why New Brunswick forests are at risk.

- 83% of New Brunswick is productive forest land (i.e. 6 million ha).
- 73% of productive area has significant volume of softwood (390 million m^3).
- 80% of softwood volume is spruce and fir (**primary budworm hosts**).
- 50% of softwood volume is mature and overmature (**highest risk**).

The Spruce Budworm - why it is a threat to fir/spruce forests.

- Primary hosts are fir and spruce (especially mature/overmature forests).
- Causes: reduced vigor, root mortality, seed loss, growth loss, tree mortality.
- Trees die after 3-5 years of repeated severe attack.
- Weakened trees are subject to attack by secondary insects and disease.
- Natural component of forest ecosystem (periodic outbreaks back to 1700s).
- Natural agents do not act fast enough to control outbreaks before trees are killed.
- Causes vast mortality if left unchecked (eg. **millions of ha and millions of m^3**).

Supply and Demand - why effective protection is critical in New Brunswick.

- There is no surplus softwood in New Brunswick!
- Current industrial softwood demand is for 7.7 million m^3/year.
- Sources of supply are: Crown land (52%); Large Freehold (19%); Woodlots (21%).
- **THE BALANCE (8%) IS FROM IMPORTS.**
- Reduced supply jeopardizes New Brunswick's forest industry, hence socio-economic benefits.
- Removal of forests for non-fibre uses exacerbates the need for effective protection.

Long-Term Management Plan - major components in New Brunswick.

- Scheduled harvesting of mature forests (to promote younger vigorous forests).
- Silviculture (planting, spacing, and tending to offset projected supply deficits).
- Integrated management (Mature Coniferous Forests; Deer Wintering Areas, etc.).
- Active protection against fire, INSECTS and disease.

Protection Options - what is realistic in the forseeable future.

- Status of perceived applied control options:
  - Forest (host) management: a **long-term commitment** (50-100 years) **in progress.**
  - Parasites, predators, fungi, microsporidia, pheromones: **not viable.**
  - Genetic control and host asynchrony: **not viable.**
  - Viruses: **not yet viable** (being researched); future uncertain.
  - Insect growth regulator: **possibly** in near future **(not operationally proven).**
  - Bacteria (B.t.): operational but **costly**; results **unpredictable.**
  - Chemical: **fully operational** BUT choices limited to **one product only!** Other possible products are not registered, not being produced, or those registered might have more significant environmental concerns.

Doc.: fencon.nb

CRITICAL ASSESSMENT OF THE DISCUSSION DOCUMENT ON THE REGISTRATION STATUS OF FENITROTHION INSECTICIDE

AGRICULTURE CANADA
D93-01

Prepared for the Forest Pest Management Caucus
by the Centre for Toxicology
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June 28, 1993

PREFACE

The approach used in this review has been to objectively and critically assess the existing literature on fenitrothion and recent reviews on the subject with particular reference to the Discussion Document on the registration status of fenitrothion insecticide (Agriculture Canada, D93-01). In addition, the Fenitrothion Risk Assessment (Pauli *et al.*, 1993) and the Economic Benefits Assessment (Deloite and Touche, 1992) and reviews by L. McCarty (1993) and J.B. Sprague (1992 and 1993) were consulted.

1 EXECUTIVE SUMMARY

Having reviewed the Discussion Document on the Registration Status of Fenitrothion Insecticide and other pertinent literature, reviews and critiques we conclude that there is neither strong nor compelling evidence to conclude that the *current management options and use pattern of fenitrothion are causing unacceptable harm to human health and the environment.* We recommend that:

> **Provincial regulatory authorities be charged with the responsibility of implementing the mitigatory options as outlined in Option 3 of the Discussion Document. This should be done with as wide a range of pest management options as possible to better maintain a sustainable forest environment keyed to local conditions.** This decision is based on the following criteria:

1 *Bt* does not provide a reliable control option for high or extreme populations of the Spruce Budworm and may not normally provide the management objective of specified foliage protection under these conditions. Forests with these populations would typically be the forests of highest priority for treatment. Without documented environmental risk assessment of *Bt* use and particularly the non-treatment option, we believe fenitrothion should be available for control of these populations.

2 Three areas of environmental hazard have been identified. These are hazards to 1) pollinators and the indirect influence of this on plant reproduction; 2) effects of fenitrothion on aquatic organisms in small lentic bodies of water and acid bogs and; 3) effects on birds. In reviewing the data provided, we find that much of the concern arises from studies that do not represent the current operational spray programs nor adequately consider existing mitigatory restrictions and the natural resiliency of ecosystems. In addition, much of the concern appears to arise from "extremes cases" and rarely reflects mean and median responses observed in the field. Most significantly, we fail to see evidence of long-term population effects, although individual effects and transitory population reductions have been documented.

The following points relate to the specific issues.

- **Pollinators:** Much of the information in the Discussion Document is spurious and often does not relate to any of the existing control options under provincial regulations. We believe that restriction c) in Option 3 "No area would be treated with fenitrothion in consecutive years" would add safety factors that would mitigate against any population effects in pollinators as well as the resulting (but speculative) effects on plant reproduction. As stated in the Discussion Document, the implementation of buffer zones around blueberry fields has eliminated the problem of reduced berry production.

- **Aquatic organisms:** We concur with the Discussion Document that effects of the current use pattern of fenitrothion on lotic and large lentic systems would be minor and transitory. Most of the concern expressed in the Discussion Document[2] relates to small lentic ponds and acidic bogs. Two studies were cited as sources for most of the concern. We have reviewed the critique of Sprague[35] and the comments from McCarty[34] and agree with their analysis and assessment of the data. These sites have extreme environmental conditions and our understanding is that these humic bogs are relatively rare and characterized by trees which normally would normally not be treated for budworm control. We consider that current data do not demonstrate any indication of long-term population effects to aquatic organisms. In addition, we fail to see any scientific justification for increasing the buffer zones to 500 m from the currently enforced provincial buffer zones of 400 m. The 400-m zones are based on spray swath criteria and typically result in at least a 99%+ reduction of deposit to protected waters.

- **Birds:** We concur with the Discussion Document that there is scientific evidence which indicates behavioral effects in birds and that occasional bird deaths have occurred as a result of fenitrothion application. Under current use practices, we have not seen any demonstration of population effects to birds either by direct mortality or reduction in insect food sources. There are no studies to suggest that a single bird species has become rare or endangered in New Brunswick, despite over 20 years of fenitrothion use. Restrictions a) and, most importantly, c) of Option 3 would provide additional safety factors against any potential effect to birds.

3 Provinces have authority and responsibility to carry out forest protection including pest management. Options 1 and 2 remove all potential for fenitrothion use including removal of viable control options for extreme budworm populations. The suggestions in options 3 and 4 of the Discussion Document do not prevent individual provinces from eliminating fenitrothion use. We believe that risk/benefit assessment should recognize the diversity of forest compositions and the significance of the forestry economy in each province. We see no evidence to suggest long-term population effects resulting from fenitrothion use (as currently practised) and believe that local implementation of the suggestions in option 3 will increase the safety factors for organisms protected by Federal legislation e.g. fish and migratory birds. Taking the pest management suggestions as stated in option 3 in the Discussion Document into consideration, we believe the provinces should make the final determination on use of fenitrothion in the sustainable management of forest ecosystems.

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An Ecotoxicological Review of "Fenitrothion Risk Assessment" Pertaining to the Discussion Document: Registration Status of Fenitrothion Insecticide

Prepared by: L.S. McCarty, Ph.D.

May 19, 1993

Executive Summary

Contrary to the Discussion Document: Registration Status of Fenitrothion Insecticide, released by Agriculture Canada, the assessment presented herein, developed with available information using scientifically-defensible ecotoxicological principles, concludes that the large-scale spraying of fenitrothion for forest pest control, as currently practiced operationally, is environmentally acceptable.

The Executive Summary of the Fenitrothion Risk Assessment (FRA), which also appears in the Discussion Document, contains a very brief (6 line) impact assessment statement. Nowhere in either report is there a detailed discussion of weighing of the evidence or the scientific basis for the judgement presented. Furthermore, there was no evaluation of the environmental risk associated with alternatives, such as the use of other pesticides or the complete cessation of the forest pest control program. As a result of these and other deficiencies the FRA does not qualify as a complete and valid risk assessment.

Hazard identification concludes correctly that fenitrothion represents a potential hazard but risk analysis fails to demonstrate that exposure to fenitrothion causes ecologically significant adverse effects, either directly or indirectly, to non-target organisms, when used as currently regulated for forest pest control. The table presented below summarizes the information. These conclusions are consistent with those presented in the FRA and serve to illustrate that the judgement in the Impact Assessment statement in the Discussion Document is not supported by the opinions and conclusions presented in the detailed text of the FRA.

Summary of Fenitrothion Risk Assessment Based on Ecological Field Work at the Population Level

Organism	No Significant Adverse Effects	Possible Significant Adverse Effects	Definite Significant Adverse Effects	FRA Indicates More Research Needed
Soil microorganisms & soil/litter arthropods	X	-	-	No
Nontarget terrestrial arthropods	X	-	-	No
Pollinators & certain herbaceous plants	X	?	-	Yes
Terrestrial macrophytes	X	-	-	No
Algae & aquatic macrophytes	X	-	-	No
Aquatic invertebrates	X	-	-	Yes, very small (<5 ha) ponds
Fish	X	-	-	Yes, very small (<5 ha) ponds
Amphibians	X	-	-	Yes
Reptiles	no data	-	-	?
Birds	X	?	-	Yes
Mammals	X	-	-	No

Three contentious areas - possible effects on certain pollinators and herbaceous plants, impacts in very small ponds and acetylcholinesterase inhibition in birds - require some further discussion.

Much speculation and concern has been expressed about possible effects of fenitrothion spraying on certain insect pollinators and certain herbaceous forest plants. However, few data are available to evaluate this for the current spray application protocol. It does not appear to be a major concern, although appropriate research could provide further clarification.

The small bog ponds studied by Fairchild (1990) exhibited transient effects on the invertebrate populations present. No fish were present in these ponds. Some questions remain about the applicability of these results to small ponds in general as these types of ponds are uncommon in forests and the application was not an operational spray exposure. Also, it is unlikely that such ponds would ever be sprayed in an operational program as they were in a large bog area with few trees. Work by Ernst *et al.* (1991 and unpublished data) on other small ponds has been offered as support for serious effects on aquatic organism in small ponds in general. There are questions about how representative water samples, obtained from pond surface slicks immediately after an operational spray, would be of exposures received by resident fish and invertebrates. However, it is unnecessary to dwell on this deficiency as it is clear that the bioassay test results are invalid. The fish toxicity and severe Daphnia mortality obtained in these laboratory bioassays can readily be explained simply as a result of the dramatic osmotic shock suffered when they were abruptly placed in very soft water after having been reared in moderately hard water. This is a clear and fundamental error with respect to Environment Canada's own published standard bioassay protocols. Furthermore, the promotion by Environment Canada of such seriously flawed data as diagnostic of serious, site-specific environmental toxicity is very questionable.

The contention that a reduction of bird brain acetylcholinesterase (AChE) activity to about 50% of normal is diagnostic of imminent death has been shown to be not true. Birds can survive brain AChE inhibition as low as about 30% of normal. Inhibition to the order of 50-60% of normal is associated with transitory modifications in behaviour. There has been much speculation associated with the ecological implications of this now discredited opinion. The current understanding is more in line with observations of general good health for bird populations in the forests of New Brunswick. Immediately after operational forest spraying with fenitrothion under the present regulations minor, transient behaviourial changes have been noted in wild birds; however, no obviously stressed or dead birds have been found and long-term adverse effects have not been reported. The speculation about nutritional effects due to changes in the abundance of invertebrate prey are incongruent with the judgement in the FRA that, under the current protocol, no long-term effects have occurred in non-target invertebrate populations.

When the detailed text of the FRA is examined it appears that the conclusion that should be reached is opposite to that cited in the Discussion Document. In fact, it is my opinion that the weight of the evidence indicates that the large-scale spraying of fenitrothion for forest pest control, as currently practiced operationally, is environmentally acceptable.

The Regulatory Options presented in the Discussion Document were developed from the Impact Assessment. Since it has been shown that the conclusions made in that section are inappropriate and unsupportable, there is no solid scientific support to suggest that any substantial change to the current operational protocol is required. **Option 4, Continued Registration With No Change in Current Use-Patterns, clearly represents the logical regulatory option.**

Recommendations:

1. There should be strong objections to the flawed and incomplete Fenitrothion Risk Assessment document being considered a properly executed risk assessment for the use of fenitrothion for the control of some forest pests.

2. There should be strong objections to the scientifically-biased Impact Statement (Section 4.3 in the Discussion Document) being considered as a valid conclusion. The judgement made in this brief section is clearly inconsistent with the opinions and conclusions which appear in the detailed text of the Fenitrothion Risk Assessment document.

3. If a risk assessment is to be required for fenitrothion or any other forestry pesticide or practise, specific guidelines on the format, content, objectives, and assessment criteria should be determined prior to the initiation of the work. Also, a consensus on this should be obtained from the major stakeholders and an independent panel should review and judge the risk assessment and make recommendations to the appropriate government authorities.

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Comments on the Agriculture Canada report:

Discussion Document. Registration status of Fenitrothion insecticide

by

John B. Sprague

1993 • April • 21

This review focuses on the aquatic matters comprising part of section 4 of the Agriculture Canada Discussion Document, those being in my field of expertise.

General summary of opinion

A formal Risk Assessment should be compiled by technically competent scientists in an open-minded and balanced manner. Quantitative evaluations should be used, so far as possible, to arrive at reasoned opinions and decisions. It was therefore disappointing to read the Risk Assessment part of this Discussion Document. The document failed to include all the steps required for a proper risk assessment and risk/benefit analysis, and it did not always show the other desirable and necessary qualities mentioned above. The Risk Assessment part of this Discussion Document (i.e. section 4) should not have been released by the government in its present form.

The Fenitrothion Value Assessment in section 5 of the Discussion Document is not in my field of expertise and therefore I cannot judge it. However I get a strong impression in that section of a rigorous, objective, numerical analysis, a contrast to the generally loose narrative approach in the environmental toxicology of sections 4.2 - 4.3.

The environmental risk section of this Discussion Document has scientific inaccuracies and the overall methodology is inadequate. If indeed, this Discussion Document is a fair summary of the full document on risk assessment (not released at the time of writing this), then that full document is also inadequate and unacceptable for official use.

There are two major deficiencies evident in the environmental risk assessment of the Discussion Document.

(1) **Incorrect representation of ecological side-effects.** The erroneous presentation arises from uncritical acceptance of (a) statements, opinions and "concerns" which lack a basis of scientific evidence, (b) examples based on partial or extreme selections from a spectrum of data, and (c) unpublished material which already suffers from deficiencies (a) and (b). A professional risk assessment should attempt to make a thorough and searching examination of all the information available, then attempt to present a balanced and unbiased picture of that technical information, and what it means.

(2) **Failure to carry out a proper environmental assessment, because some of the necessary steps of risk assessment are missing, and a final procedure of comparing risks with values is not attempted.** The final step of risk assessment, usually called risk characterisation, is not presented as a discrete section to provide a quantitative description of the relation of hazard and exposure. There is complete failure to consider and include the ecological side-effects of alternative pesticides, alternatives to pesticide use, and the "do-nothing" option. In general, those alternatives should be considered for the risk of general damage to ecosystems. Consideration of alternative actions including the "do-nothing" option is an essential part of all valid environmental impact assessments and should also be part of an environmental risk assessment for pesticide use.

Finally, there is no attempt to carry out the last step of a total analysis, which should be a comparison of risks with "benefits" (or "values") for the various alternatives.

Deficiency number (1) means that the Discussion Document is scientifically inaccurate and can therefore be misleading to a reader. Deficiency number (2) means that the Discussion Document is of an inadequate professional and technical quality, and therefore is not suitable as a basis for official decisions. The Discussion Document should be withdrawn by the government, and the Environmental Risk Assessment should be redone in a proper scientific manner, and appropriate new options drawn up.

Recommendations

(1) The failings of the Discussion Document should be pointed out during the 90-day period in which comments are invited. The Environmental Risk section of the document appears to have a pronounced bias against fenitrothion. Technical comments were provided to the government a year ago, pointing out the incorrect presentation at that time, of some of the aquatic work. The technical comments appear to have been ignored in preparing the Risk Assessment. The serious misinterpretations should be pointed out again, and objection should be made to those statements which fail to give a balanced interpretation.

(2) There should be an outside review of the full background of data for the Environmental Risk Assessment, and the background document should be released by the government for that purpose. The review should involve an environmental toxicologist who is familiar with proper procedures for Environmental Risk Assessments. I regret that time is not available for me to do this. The part that I know about in detail is distorted in this Discussion Document, and I have described that distortion in the present report. One or more qualified person(s) should take the time to look up the original work in the other cases, and to provide objective interpretations.

Deficiency: Lack of quantitative confirmation

The section on Risk Assessment is sprinkled with undocumented speculation about what might happen. I did not count them, but the text contains many "may", "might", "suggest", and the raising of "concerns". No doubt many of the items are indeed possibilities, but on the other hand, these things *may not* happen.

It would not appear to be an unbiased approach to follow these conditional verbs with disconcerting but hypothetical statements about damage. For example, on page 15, paragraph 2: "Waterfowl raising broods in the treated areas may suffer from the removal of their invertebrate food source." However, the actual evidence from areas of operational spraying is that there is little or no detectable effect on benthic aquatic invertebrates (see last item of Appendix B of my report). The same inference is raised at the top of page 18 about the food of waterfowl in ponds, but there is no field documentation in the aquatic section about damage to populations of pond invertebrates from operational spraying.

Deficiency: Questionable sources of information

In the Environmental Risk Assessment, many of the pieces of information appear to be derived from unpublished sources. I am hampered in this judgment because the Discussion Document did not give any references or reference list. Nevertheless it appeared from the wording of the document that many sources of information, if given in a reference list, would be shown as a "personal communication".

For an important document such as this, dealing with registration status of an insecticide, there is a great benefit in relying on information that has been set forth in a formal report, or better still in a refereed publication. In those cases the reviewer can scrutinize in the full report, the methods used and the apparent quality, variability, and interpretation of the results. For the author of a full report, the simple act of writing leads towards a careful interpretation and conclusions that are supported by the findings. The author's reputation for scientific objectivity depends on the written interpretation, which therefore is usually a reasonable one.

My concern about the quality of information is based on the part I know about, the studies by Environment Canada in 1991 of some ponds in New Brunswick which were sprayed operationally. When I critiqued those studies (Sprague 1992), there had been no report written on the findings and as far as I know there still is no comprehensive report. Information on the studies was in the form of various letters or memos and data-sheets containing what might be parts or all of the measurements. Statements of methods did not seem to be available, and it was necessary to surmise that methods were similar to those in earlier work (Ernst et al. 1991). The only exception to these difficulties was for toxicity tests done at Dartmouth; they were fully documented and of high quality (Wade 1991), however the relevance of the toxicity findings was at question because there was no information on how the samples were originally obtained from the ponds. As described in the section immediately below, earlier statements by government workers about the 1991 studies, repeated in this Discussion Document, did not at all represent a correct interpretation of conditions that would have occurred in the ponds.

An Update on User Requested Minor Use Label Expansion (URMULE)

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The User Requested Minor Use Label Expansion Program (URMULE), following the recommendations of the Pesticide Registration Review (PRR), replaced the Minor Use of Pesticides Program (MUPP) which had been established in the late 1970's. Minor Uses of pesticides are defined as "those necessary uses of pesticides for which the anticipated sales volume is not sufficient to persuade the manufacturer to carry out the research required for registration" (Plant Industry Directorate 1993).

URMULE considers only products that are currently registered in Canada, the product registrant must be willing to add the new use to the product label, and there must be reasonable grounds to expect that the pesticide will be effective for the proposed use (Plant Industry Directorate 1993).

The present status of herbicide submissions under the URMULE Program are outlined in Table 1.

Table 1. The present status of forest herbicide submissions under the URMULE Program.

Trade Name	Common Name	Submission Number	Status
Amitrol-T	amitrol	94-550	pending sponsor
Dual 960E	metolachlor	93-516	pending label
Gesagard 80W	prometryn	92-517	withdrawn
Pursuit	imazethapyr	92-505	pending sponsor
Edge 50DF, 60DC, 5G	ethalfluralin	91-563	pending advisors
Agricultural Weed Killer No. 1	varasol	90-540	withdrawn

The present status of insecticide submissions under the URMULE Program are outlined in Table 2.

Table 2. The present status of forest insecticide submissions under the URMULE Program.

Trade Name	Common Name	Submission Number	Status
Foray - 48B	Bt	94-101	approved
Cygon - 480E	dimethoate	93-120	pending label
Virtuss	NPVs	91-114	withdrawn
Ambush	permethrin	89-118, 89-119, 89-120	pending advisors

Literature Cited

Plant Industry Directorate. 1993. User Requested Minor Use Label Expansion. Agriculture and Agri-Food Canada. Regulatory Directive Dir93-23. 6 p.

An Update on User Requested Minor Use Registration (URMUR) Program Pilot - Gallery

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The User Requested Minor Use Registration Program (URMUR) Pilot criteria were established in 1992 (Plant Industry Directorate 1994) in response to the *Recommendations for a revised Federal Pest Management Regulatory System* (Pesticide Registration Review Team 1990). When enacted, the legislation will provide for a URMUR which will enable user groups to apply for the registration of a pesticide that is registered for that particular use in the United States. An interdepartmental working group developed the criteria for a pilot URMUR program in December 1992, and in March 1993, Gallery 75DF (isoxaben) was chosen as the URMUR pilot for the forestry sector.

In order to be eligible for the URMUR program, the following criteria must be met:

1. active ingredient is registered in the U.S., but not in Canada
2. the registrant (in this case DowElanco) must be willing to participate in the program and supply information as requested,
3. identified sponsorship by a user group (in this case the Canadian Forest Nursery Weed Management Association - CFNWMA)
4. falls under the minor use definition,
5. identified need (lack of alternatives), high priority for the user group,
6. data base should be less than 5 years old,
7. no major health or environmental concerns identified,
8. proposed use and volume identified.

The Gallery URMUR Pilot is keeping within the defined schedule. The Environment review is complete and Health is to complete rulings and forward toxicology reviews to Environment by October 27, 1994. The Canadian Forest Service (CFS) provided a review of crop tolerance and efficacy data to Agriculture and Agri-Food Canada (AAFC) by:

1) reviewing crop tolerance / efficacy trials that were conducted in Canada in 1993,
2) summarizing proposed crop tolerance / efficacy trials for 1994,
3) reviewing crop tolerance / efficacy data as provided to me from U.S. trials by DowElanco, and
4) reviewing the published literature on crop tolerance / efficacy trials in forestry or horticultural landscape crops.

The CFS, with the assistance of the CFNWMA provided a list of crop and weed species to be included on the Gallery in July, 1994. It was decided that species with one season of data by September 1994 will be included on the label. A second report summarizing the 1994 crop tolerance / efficacy trials will be provided by the CFS to AAFC by November 25 1994.

A label has been drafted, changing the class designation from "Restricted" to "Commercial". The restriction is only for listed trees for eventual reforestation.

The URMUR Minor Use definition has been changed as follows:

- the previous obligation for growers to develop "boundaries" (ie area/volume) has been waived
- the area / volume question will be addressed on a "case by case" basis

No major concerns have been noted to date with the gallery pilot project, and a regulatory decision is expected before December 31 1994.

The Gallery Pilot project has been a learning experience for all involved, and from the Forest Pest Management Institute's (FPMI) perspective, there are a number of recommendations and conclusions for future URMUR projects:

1. It is important that the product be made available to the individuals conducting trials during the late winter, before the growing season. The product was sent out at a fairly late date in 1993, making it difficult to conduct the required trials.

2. Suggested crop and weed species for the Canadian label should be decided on prior to conducting trials. An avenue should be available to add crop and weed species to the label as efficacy / crop tolerance data becomes available.

3. Rates of application should be consistent across the country and also with those on the U.S. label, if appropriate.

4. If available, summaries of crop tolerance and efficacy from the U.S. should be provided early in the process by the registrant. This data may be relied on for crop tolerance / efficacy data for species which are common to Canada.

5. The criteria of URMUR should be changed to allow products that have been in the registration process for a number of years to be eligible under URMUR. The rationale for this suggestion is that if a program similar to URMUR had been in place, some of these products where the anticipated sales volume is only marginal might not have been channelled through the regular stream for pesticide submissions.

6. The URMUR Program is extremely important for forestry. Most pesticide use in forest tree nurseries fall under the definition of minor use.

Literature Cited

Pesticide Registration Review Team. 1990. Recommendations for a revised Federal Pest Management Regulatory System. Final Report. Ministry of Supplies and Services Canada. 71 p.

Plant Industry Directorate. 1994. Pilot project- User Requested Minor Use Registration Program. Agriculture and Agri-Food Canada. Note to CAPCO C94-01. 5 p.

The Advanced Forest Pest Management Training Program (AFPM)

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Forestry and resource management issues have become increasingly complex as we approach the 21'st century. Forests are no longer viewed simply just as a ready supply of timber, but as a complex resource that, in addition to contributing towards our monetary well-being, must also fulfil recreational, social, cultural, ecological and spiritual needs. If the goal of having forest ecosystems managed in a more holistic manner is to be realized, it is essential that opportunities be created to allow forest managers and other interested parties to acquire expert training that presents multi-disciplinary information in a collated and practical manner. This is especially true in the field of Forest Pest Management, which has historically been the domain of a handful of "experts" and rarely fully integrated into forest ecosystem management. A vital component of enhancing environmental protection within the discipline of forest pest management is ensuring that pesticide applicators, forest managers, and other interested parties have a clear understanding of the benefits and risks associated with forest pest management practises as well as expert training in the technology associated with applying them.

The Forest Pest Management Institute, has addressed the issue of expert training in the Forest Pest Management field by spearheading the Advanced Forest Pest Management Training Program (AFPM). The program has developed four advanced courses in Forest Pest Management: 1) the Advanced Forest Herbicides Course, 2) the Forest Insect Management Course, 3) the Integrated Forest Pest Management Course, and 4) the Integrated Pest Management Course For Forest Nurseries. Partners currently involved in the program include:

1) Canadian Forest Service, NRCan. - Forest Pest Management Institute; Ontario Region (Northern Ontario Development Agreement - Northern Forestry Program); Green Plan - Integrated Forest Pest Management Initiative
2) Ontario Ministry of Natural Resources
3) Ontario Training Adjustment Board - Ontario Skills Training Investments.

The courses are presented in ten day blocks by 30 instructors from across North America with international technical reputations and superior teaching skills. Education strategies such as lectures, group discussions, group projects, case studies, computer modelling sessions, field demonstrations and field trips are integrated in order to provide for different learning styles. Pre-arranged recreational opportunities are included in all courses. New ideas and approaches are developed from featured evening speakers addressing forest pest management from a variety of perspectives.

Each course is divided into main subject areas or modules. The modules are developed as intensive learning packages that bring together the best available technical information on the subject. A typical module features a teaching team of 3 to 6 instructors over a 1 to 3 day time period. The teaching teams ensure that their topics are not only well presented, but learned in an effective manner. Participants frequently add to the depth of the learning experience by bringing their expertise forward in discussion and lecture periods.

Each module is linked to the others so that lessons are integrated in an applied manner. By the end of the courses, participants view pest populations, treatment options, prevention options, social and environmental concerns, and other factors, as a dynamic array of considerations that need to be incorporated in a successful integrated pest management strategy.

Participants are evaluated by completing a course practicum. A land base is assigned to small groups who are charged with developing pest management strategies and prescriptions that are rationalised in terms of cost-effectiveness, environmental consequences and social acceptability. This exercise is completed over the ten day period of the course, and the result of each group's work is presented to a discriminating audience of instructors, other course participants and interested members of the public. Written records of these group practicums are expected to be of sufficient quality to eventually become published as case studies in Forest Pest Management Program Planning Guides, targeted at the hands on users in the forest pest management industry.

These courses are targeted towards mid-career professionals and will appeal to forest resource managers, pest management professionals, pesticide management regulators, pesticide applicators and others who have an interest in improving their knowledge of forest pest management. These courses are most appropriate for individuals with a professional responsibility in the area of forest vegetation management, forest resource management, forest pest management, forest tree nurseries, or natural resource management. The AFPM provides detailed expert level training in forest pest management that is not available elsewhere.

The Third Annual Advanced Forest Herbicides Course (AFHC) took place in Sault Ste Marie from September 24 to October 2, 1993. This year there were 23 participants in the course including representatives from both government and non-government organizations (Figure 1) from British Columbia, Manitoba, Saskatchewan, Ontario, Quebec, New Brunswick, Michigan, Wisconsin, and Maine. The AFHC was a resounding success again this year. Final course evaluation results found that the course was rated as excellent or very good by 100 per cent of the participants that responded to the course evaluation.

The First Integrated Forest Pest Management (IFPM) Course took place in Sault Ste Marie from October 14 to 23, 1993. Twenty two participants, including representatives from both government and non-government organizations from Alberta, Ontario, New Brunswick, and Idaho, as well as 4 international participants from Chile and 2 from Poland received 10 days of expert instruction from 30 instructors from across North America. The first IFPM Course was a unbridled success.

Final course evaluation results found that the course was rated as excellent or very good by 100 per cent of the participants that responded to the course evaluation.

The tentative schedule for upcoming AFPM courses is as follows:
1) The Integrated Forest Vegetation Management Course (formerly the Advanced Forest Herbicides Course) - Spring 1995, Prince George B.C.
2) The Forest Insect Management Course - Fall 1995, Sault Ste Marie
3) The Integrated Pest Management Course for Forest Nurseries - Fall 1995, Kemptville Ontario

In addition to these courses, the AFPM will be developing a short course in Forest Pest Management / Decision Support in cooperation with Petawawa National Forestry Institute to be delivered in December 1995.

FOREST PEST CONTROL FORUM
Colloque sur la répression des ravageurs forestiers

Conference Centre, Ottawa
Centre de conférences, Ottawa

January 5, 1995

Dr. Arthur Olson
Assistant Deputy Minister
Food Production and Inspection Branch
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Dear Dr. Olson,

At the Twenty-second Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 15-17, 1994, an issue regarding importation of beneficial insects was openly discussed during the Issues Debate Session and led to a resolution requesting action from your organization. Background on this issue and the resolution itself are as follows:

Background:

The Canadian Forest Service (CFS) biological control working group advised the Forest Pest Control Forum that there was a possibility of delays in the importation and use of new species of beneficial insects to be used primarily for laboratory and field studies directed to the feasibility and assessment of inoculative field releases (i.e. classical biological control).

This concern arose from the possibility that the environmental risk assessment and the administration of permits for importation of beneficial insects which are currently the responsibility of the Plant Protection Division may be turned over to the Plant Industry Directorate. The current system, involving Plant Protection Entomologists, is working well and has been in effect for many years.

The CFS biological control working group feels that the guidelines/regulations currently proposed by the Plant Industry Directorate are designed for inundative releases of beneficial organisms, but are not appropriate for, and would unnecessarily restrict, importation of beneficial insects for laboratory study and/or inoculative release.

The Working Group endorses the general agreement made at the Biological Control Regulation Workshop held by Agriculture Canada in January 1993, that the Plant Protection Division should continue to control the importation of beneficial insects to be used in laboratory studies and/or inoculative field releases.

Resolution:

WHEREAS, there was a Biological Control Regulation Workshop held by Agriculture Canada in January 1993 where there was **agreement** that applications for the importation of beneficial insects for inoculative release continue to be administered by the Plant Protection Division, and

WHEREAS, new regulations for commercial biological control agents are under development by the Plant Industry Directorate; and

THEREFORE, be it resolved the attendees at the Twenty-Second Annual Forest Pest Control Forum ask that Agriculture Canada provide confirmation to the Forum that this (January 1993) agreement still stands.

Issues at the Forum are openly debated, the wording of the resolution reflects the wishes and serious concerns of the majority (90% or greater) of the participants. As Chairpersons of the Steering Committee and Issues Debate Session of the Forum, we respectfully submit to you this resolution. We look forward to your reply which will be conveyed to all members who attended this years Forest Pest Control Forum.

Yours sincerely,

Ben Moody

Forest Pest Control Forum
Steering Committee Chairman
Dr. Ben Moody
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Forest Pest Control Forum
Issues Debate Chairman
Dr. Richard Westwood
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Agriculture Canada

Food Production and Inspection Branch | Direction générale, Production et inspection des aliments

FEB FEV 3 1995

Your file Votre référence

Our file Notre référence

Dr. Ben Moody
Forest Pest Control Forum
Steering Committee Chairman
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Dear Dr. Moody:

Re. Resolution from the Forest Pest Control Forum

Thank you for your letter of January 5, 1995 containing the Resolution and background information from the Forest Pest Control Forum concerning the importation of beneficial insects.

The *Plant Protection Act (PP Act)* came into force in 1990 with a mandate to protect all plant life in Canada, not just agricultural crops. New *Plant Protection Regulations,* expected to be enacted this year, contain a commitment to continue making decisions on importing invertebrates based on pest risk assessment using the North American Plant Protection Organization standards.

I have for some time shared your concern regarding over-regulation with respect to biocontrol. Several initiatives have been taken to address this question, beginning with a consultation with Entomological Society of Canada Members in Saskatoon and followed by a workshop sponsored by this Department, as referenced in your letter. These meetings brought together researchers and other experts in the field from both the public and private sectors, including representatives from the forestry community.

These discussions laid the foundation for a safety based tiered approach to regulation, based on familiarity with the biological organism and the proposed use, i.e., laboratory/inoculative vs inundative. The procedural details were worked out subsequently via an interdepartmental team with representation from Agriculture and Agri-Food Canada (Animal and Plant Health Directorate [APHD], Plant Industry Directorate, and Research Branch), Natural Resources Canada [NRCan], Health Canada and Environment Canada.

In summary, APHD will continue their traditional role and mandate under the *PP Act*, i.e., regulate import or domestic movement - for all situations (research, inoculative and inundative). Only inundative situations are given further consideration via the safety based tiered approach mentioned above.

This process, which has been developed from the outset with the cooperation and support of your Department should, I believe, meet the needs you describe. It is presently being tested and validated using current practical examples as models. If you see further opportunities for improvement or refinement it would probably be best to have them brought, via your NRCan representative (Ms. Sexsmith), to the attention of the interdepartmental team mentioned above.

Yours sincerely,

A.O. Olson
Assistant Deputy Minister

c.c. Dr. Richard Westwood
Dr. Y. Hardy

Posters

1. Forecasting balsam fir forest defoliation by insects using satellite remote sensing - J. Luther et al.

2. European parasitoids under evaluation for introduction to control the hemlock looper - R.J. West et al.

3. Establishment of Olesicampe geniculatae as an effective control of the mountain ash sawfly in Newfoundland - R.J. West et al.

4. Steinernematid control of black army cutworm - R.J. West et al.