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Report of the Twenty-third Annual Forest Pest Control Forum

Government Conference Centre
Ottawa, Ontario

November 21–23, 1995

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

Centre de conférences du Gouvernement
Ottawa (Ontario)

Du 21 au 23 novembre 1995

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Canadian Forest Service / 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)
May 1996 / mai 1996

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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
B. Kostyk, Sault Ste. Marie

Manitoba Department of Natural Resources
K. Knowles, Winnipeg

Alberta Land and Forest Service
H. Ono, Edmonton

N.B. Forest Protection Ltd.
P. Amirault

University of Toronto
Andrew Moody, Toronto

Environment Canada
Ian Nicholson, Pesticides Division, Ottawa

Novo Nordisk
Stephen A. Nicholson, Hartington, Ontario

Rohm and Haas
Al McFadden

Abbott Laboratories Ltd.
Richard Groen, Ontario

Canadian Wildlife Service
Bruce D. Pauli, Hull

Pest Management Regulatory Agency

Wendy Sexsmith, Ottawa

Agriculture Canada

D. Walter, Plant Health Division, Ottawa
Jean Hollebone, 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
Lesley Cree, Diagnostic Services Division, Ottawa

Canadian Forest Service, Natural Resources Canada

Allan Van Sickle, Victoria
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
Gaston Laflamme, Ste. Foy, Quebec
José Valero, Ste. Foy, Quebec
G.M. Howse, Sault Ste. Marie
J. Meating, Sault Ste. Marie
Mike Dumas, Sault Ste. Marie
Wayne Richards, 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
Art Retnakaran, Sault Ste. Marie
Larry Marshall, PNFI
Wade Bowers, Nfld. & Labrador Region
J. Hudak, St. John's, Nfld.
R. West, St. John's, Nfld.
Les Carlson, Ottawa
J. Peter Hall, Ottawa

P. Singh, Ottawa
Brian Haddon, Ottawa
Gordon Miller, Ottawa
B. Moody (Secretariat)

Other

Delio Tortosa, Sault Ste. Marie

NOTICE OF 1996 MEETING

The Twenty-fourth Annual Forest Pest Control Forum

will be held in

Sussex Room, 1st Floor

Government Conference Centre

2 Rideau Street, Ottawa, Ontario

November 19, 20, 21, 1996

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

AVIS DE LA RÉUNION DE 1996

Le vingt-quatrième 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 19 au 21 novembre 1996

(de 8 h 30 à 17 h 00)

Agenda

Twenty-third Annual Forest Pest Control Forum

Government of Canada Conference Centre

2 Rideau Street
Sussex Room, 1st Floor
Ottawa, Ontario

November 21, 22, 23, 1995
8:30 a.m. - 5:00 p.m.

Tuesday, November 21

Session I - Introduction

8:30 - 9:00 — 1.1 Introductory Address

1.2 Remarks and Introductions
- G. Miller/ B.H. Moody, Forum Secretariat

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

9:00 - 12:00 - 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 by CFS regions	Control Operations/Pest Management Summary	
2.1	Newfoundland - J. Hudak	H. Crummey	- Newfoundland
2.2	Maritimes - L. Magasi	N. Carter E. Georgeson L. Magasi	- New Brunswick - Nova Scotia - P.E.I.

10:00 - 10:30 - **BREAK** (Opportunity to view **POSTER SESSION**)

	Pest Conditions by CFS regions	Control Operations/Pest Management Summary	
2.3	Québec - D. Lachance		- Quebec
2.4	Ontario - G. Howse	J. Churcher	- Ontario
2.5	Prairies and Northwest Territories - J. Brandt	Keith Knowles	- Manitoba - Saskatchewan
		H. Ono	- Alberta
2.6	B.C. & Yukon - G. A. Van Sickle		- British Columbia
2.7	United States - D. Kucera		

2.8 Other
- Spruce Budworm Efficacy Trials and Status
- Gypsy Moth npv Trial and Status
- Yellowheaded Spruce Sawfly Status - N. Carter

12:00 - 1:00 - LUNCH

1:00 - 2:00 - Session II Continues

2.9 Use of GPS-GIS for Ttracking of Spray Aircraft - Results of Operational Trials - Delio Tortosa, Taylor Scarr, Bill May

2.10 Other

Disease Control and Use of Disease for Vegetation Management

2.11 Elucidation of Aantisporulation Mechanism(s) in *Ophiostoma ulmi* and it's Potential for the Control of Other Forest Pathogens
- Wayne Richards

2.12 Use of *Chondrostereum purpureum* and Other Wound Pathogens for the Control of Aaspen Regeneration - Mike Dumas

Vegetation Management Summaries (To be tabled)

1 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.

2 General Discussion

3:00 - 3:30 - BREAK

Session III **The New CFS "Network" Approach and A New way of Doing Business**

3 . 1 Forest Pest Management Methods Network: Business/ Research Strategies - E.Caldwell

3.2 Forest Health Network -

3.3 Other Pest Rrelated Networks

Session IV **Issues/Resolutions**

4:30 - Issues Debate, Chairperson - Keith Knowles for Richard Westwood

- Initiation of Discussion on Changing the Mandate/Fformat of the Forest Pest Control Forum

- 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.

Additional Notice: Rick West is proposing a get-together of **pheromone** working group members and other interested parties for an informal meeting.

Wednesday, November 22

Session V - **Research, Environmental Monitoring and Other Reports** - Errol Caldwell (Chairperson)

5.1 Determination of Optimum Drop Sizes of RH5992 (MIMIC 2F) Against Spruce Budworm Larvae for Stomach and Contact Toxicity - P.C. Nigam, S.E. Holmes

5.2 Contact and Residual Toxicity of MIMIC and Fenitrothion against Spruce Budworm Larvae - P.C. Nigam, B.V. Helson, J.W. McFarlane, S.E. Holmes, D.R. Comba

5.3 Experiment to Test the Efficacy of B.t., in Terms of Foliage Protection Against Very High Spruce Budworm Populations - Denise Moranville, SOPFIM

5.4 Monitoring Spruce Budworm Populations with Pheromone Traps: an Update - Chris Sanders, Barry Lyons

10:00 - 10:30 BREAK (and POSTER SESSION)

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

5.5 Something New/different in Integrated Forest Pest Management Rsearch !?! - Ed Kettela ?

5.6 Other

Session VI **Pest Management Regulatory Considerations** - (Pest Management Regulatory Agency PMRA)

6.1 Update on the PMRA and the Alternatives Office

6.2 User Requested Minor Use Registration Program (cancelled)

6.3 URMUR - Label Expansion -

6.4 Tebufenozide (Mimic)/CUSTA

6.5 Triclopyr (herbicide)

6.6 Other

12:00 - 1:00 LUNCH

6.7 Overview of Regulatory Requirements and Review Process for
- Pheromone
- Microbial
- Invertebrate Biological Pest Control Agents

6.8 Forest Insect Management Training Program
- C. Howard/I. Harvey

6.9 National Pesticide Data Base

6.10 Other

3:00 - 3:15 BREAK

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

7.1 Update on Forest Pest Management (Quarantine) Committee
- G. Miller/Jean Hollebone

7.2 Update on Quarantine Pests Issues - Marcel Dawson
- Gypsy Moth Policy
- Asian Gypsy Moth
- Tomicus sp. Pine Shoot Beetle
- Wood Products Import Regulations
- Dunnage

7.3 Other

4:30 - 5:30 **Issues Debate**

Decision on the Forest Pest Control Forum

Short Meeting on Quarantine Zone Standards - Marcel Dawson, AAFC

WORKSHOPS

Monday, November 20, Conference Centre, 2 Rideau Street

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

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

Thursday, November 23, Conference Centre, 2 Rideau Street

- Forest Pest Management Caucus
  - J.P. Martel
    9:00 - 11:00 a.m. - Room 202

- Forest Health Network Meeting
  - T. Sterner (Chairperson)
    8:30 a.m. - 5:00 p.m. - Sussex Room

- Forest Pathology Working Group Meeting
    9:00 - 11:00 a.m. - Committee Room
  - G. Laflamme (Chairperson)

- Discussion on Control of White Pine Blister Rust, Scleroderris Canker, and Annosus Root Rot; All Forum Participants are welcome.

- B.t. - Decision Making Group
  9:00 - 12:00 a.m. - Room 207
  - Dave Davies (Chairperson)

Friday, November 24, Conference Centre, 2 Rideau Street

- Forest Health Network Meeting (closed session)
  - T. Sterner (Chairperson)
  8:30 a.m. - 3:00 p.m. - Sussex 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 second time and attendees are encouraged to submit Posters)

Tuesday and Wednesday - November 21 & 22 (during extended Refreshment Break)

1. - 3. Three Posters from Newfoundland - R. West, A. Carroll and J. Bérubé

1. The Efficiency of Aerial Applications of Bacillus thuringiensis and MIMIC 240LV Against the Hemlock Looper - R.J. West, et al.

4. Low Cost GPS-GIS Tracking of Spray Aircraft - Bill May, Delio Tortosa, Taylor Scarr

5. Dose Transfer Mechanisms of B.t. in the Spruce Budworm Micro-habitat After Aerial Application - P.C. Nigam, S.E. Holmes, E. Kettela

INTERPRETATION SERVICES

Only for November 21 and 22, 1995 - 8:30 - noon and 1 P.M. - 5:30 P.M.

Programme

Vingt-troisième Forum annuel sur la répression des ravageurs forestiers

Centre de conférences du gouvernement du Canada

2, rue Rideau
Salle Sussex, 1er étage
Ottawa (Ontario)

21, 22 et 23 novembre 1995
8 h 30 - 17 h

Mardi 21 novembre

Première séance - Introduction

8 h 30 - 9 h 1.1 Mot d'ouverture

1.2 Remarques et présentations
- G. Miller/B.H. Moody, Secrétariat du Forum

Deuxième séance - **Résumés sur la situation des insectes et des maladies des arbres et les opérations de lutte**
- B.H. Moody/G. Miller (présidents de la séance)

9 h - 12 h - À tour de rôle, les chefs régionaux du RIMA résument les conditions relatives aux ravageurs importants, et les représentants des provinces présentent un aperçu des opérations de lutte. (Les présentations devraient être limitées à 15 minutes).

	Conditions relatives aux ravageurs par région du SCF	Résumé des opérations de lutte/gestion des ravageurs	
2.1	Terre-Neuve - J. Hudak	H. Crummey	- Terre-Neuve
2.2	Maritimes - L. Magasi	N. Carter	- Nouveau-Brunswick
		E. Georgeson	- Nouvelle-Écosse
		L. Magasi	- Î.-P.-É.

10 h - 10 h 30 - **PAUSE** (occasion de voir les **présentations par affiches**)

	Conditions relatives aux ravageurs par région du SCF	Résumé des opérations de lutte/gestion des ravageurs	
2.3	Québec - D. Lachance		- Québec
2.4	Ontario - G. Howse	J. Churcher	- Ontario
2.5	Prairies et Territoires du Nord-Ouest - J. Brandt	Keith Knowles H. Ono	- Manitoba - Saskatchewan - Alberta
2.6	C.-B. et Yukon - G. A. Van Sickle		- C.-B.
2.7	États-Unis - D. Kucera		

2.8 Autres

- Tordeuse des bourgeons de l'épinette - essais pour déterminer l'efficacité de méthodes et situation
- Spongieuse - essai du vpn et situation
- Le point sur la tenthrède à tête jaune de l'épinette
  - N. Carter

12 h - 13 h - DÉJEUNER

13 h - 14 h - Suite de la deuxième séance

2.9 Utilisation du GPS et de SIG pour la localisation d'aéronefs d'arrosage - résultats d'essais opérationnels
- Delio Tortosa, Taylor Scarr, Bill May

2.10 Autres

Contrôle des maladies et leur utilisation pour la gestion de la végétation

2.11 Élucidation des mécanismes bloquant la sporulation chez *Ophiostoma ulmi* et potentiel d'application contre d'autres pathogènes forestiers
- Wayne Richards

2.12 Utilisation de *Chondrostereum purpureum* et d'autres pathogènes des blessures pour contrôler la régénération des trembles
- Mike Dumas

Résumés sur la gestion de la végétation (devant être déposés)

1 Dépôt des résumés régionaux sur les problèmes de gestion de la végétation et les opérations de contrôle - représentants provinciaux et régionaux (Forêts Canada) pour la Colombie-Britannique, les Prairies, l'Ontario, le Québec, les Maritimes, Terre-Neuve et les États-Unis.

2 Discussion générale

15 h - 15 h 30 - PAUSE

Troisième séance - **La nouvelle approche des «réseaux» du SCF et une nouvelle façon de fonctionner**

3.1 Réseau des méthodes de lutte antiparasitaire : stratégies d'affaires/de recherche - E. Caldwell

3.2 Réseau de la santé des forêts -

3.3 Autres réseaux reliés aux ravageurs

Quatrième séance - **Préoccupations/résolutions**

16 h 30 - Discussions sur les préoccupations, président - Keith Knowles pour Richard Westwood

- Lancement de la discussion sur le changement du mandat et de la forme du Forum

- Discussions sur des points particuliers

REMARQUE : Les membres doivent veiller à ce que les préoccupations/recommandations à discuter soient bien documentées et soumises préalablement au secrétaire du Forum afin qu'elles puissent être examinées à la réunion du comité directeur la veille de l'ouverture du Forum.

Avis : Rick West propose une petite réunion informelle des membres du groupe de travail sur les **phéromones** et des autres personnes intéressées.

Mercredi 22 novembre

Cinquième séance - **Recherche, surveillance de l'environnement et autres rapports**
- Errol Caldwell (président)

5.1 Détermination de la taille optimale des gouttelettes de RH5992 (MIMIC 2F) contre les larves de la tordeuse des bourgeons de l'épinette pour la toxicité stomacale et la toxicité par contact - P.C. Nigam, S.E. Holmes

5.2 Toxicité par contact et résiduelle du MIMIC et du fénitrothion contre les larves de la tordeuse des bourgeons de l'épinette - P.C. Nigam, B.V. Helson, J.W. McFarlane, S.E. Holmes, D.R. Comba

5.3 Expérience visant à contrôler l'efficacité de B.t. pour la protection du feuillage contre de très fortes populations de la tordeuse de bourgeons de l'épinette - Denise Moranville, SOPFIM

5.4 Le point sur la surveillance des populations de la tordeuse des bourgeons de l'épinette à l'aide de pièges à phéromone - Chris Sanders, Barry Lyons

10 h - 10 h 30 - PAUSE (et PRÉSENTATIONS PAR AFFICHES)

Cinquième séance - **Recherche, surveillance de l'environnement et autres rapports** (suite)

5.5 Du nouveau dans les recherches sur la lutte antiparasitaire intégrée!?! - Ed Kettela?

5.6 Autres

Sixième séance - **Considérations relatives à la réglementation sur la lutte antiparasitaire** - (Agence de réglementation de la lutte antiparasitaire [ARLA])

6.1 Le point sur l'ARLA et le Bureau des nouvelles méthodes

6.2 Programme d'homologation des usages limités à la demande des utilisateurs (annulé)

6.3 PHULDU - Extension du profil d'emploi -

6.4 Tébufénozide (Mimic)/ACCEU

6.5 Triclopyr (herbicide)

6.6 Autres

12 h - 13 h - DÉJEUNER

6.7 Aperçu des exigences réglementaires et du processus d'examen pour :
- les phéromones
- les pesticides microbiens
- les agents biologiques invertébrés

6.8 Programme de formation en gestion des insectes forestiers
- C. Howard/I. Harvey

6.9 Base de données nationale sur les pesticides

6.10 Autres

15 h - 15 h 15 - PAUSE

Quatrième séance - Gestion des ravageurs exotiques des forêts ou préoccupations concernant la quarantaine

4.1 Le point sur le comité de la gestion des ravageurs forestiers (quarantaine)
- G. Miller/Jean Hollebone

4.4 Le point sur les questions de quarantaine - Marcel Dawson
- Politique sur la spongieuse
- Spongieuse asiatique
- Grand hylésine des pins (*Tomicus sp.*)
- Réglementation sur les importations des produits de bois
- Fardage

4.5 Autres

16 h 30 - ? **Discussions sur les préoccupations**

Décision au sujet du Forum

<u>Courte réunion sur les normes applicables aux zones de quarantaine - Marcel Dawson, AAC</u>

ATELIERS

Lundi 20 novembre, Centre de conférences, 2, rue Rideau

- Comité des techniques de protection des forêts
  - G. Howse (président)
    8 h 30 - 16 h 30 - Salle Sussex

- Comité directeur du Forum sur la répression des ravageurs forestiers
  - B.H. Moody/ Keith Knowles pour R. Westwood (présidents)
    16 h 30 - 18 h 30 - Salle Sussex

Jeudi 23 novembre, Centre de conférences, 2, rue Rideau

- Caucus sur la gestion des ravageurs forestiers
  - J.P. Martel
    9 h - 11 h - pièce 202

- Réunion du réseau de la santé des forêts
  - T. Sterner (président)
    8 h 30 - 17 h - Salle Sussex

- Réunion du groupe de travail sur la pathologie forestière
  - G. Laflamme (président)
    9 h - 11 h - Salle des comités

- Discussion sur la lutte contre la rouille vésiculeuse du pin blanc, le chancre scléroderrien et la maladie du rond; tous les participants au Forum sont les bienvenus.

- *B.t.* - Groupe décisionnel
  - Dave Davies (président)
    9 h - 12 h - pièce 207

Vendredi 24 novembre, Centre de conférences, 2, rue Rideau

- Réunion du réseau de la santé des forêts (séance fermée)
  - T. Sterner (président)
    8 h 30 - 15 h - Salle Sussex

REMARQUES 1) D'autres ateliers peuvent être organisés au besoin. Veuillez informer le secrétaire le cas échéant.

2) Le temps prévu pour chaque session peut varier.

PRÉSENTATIONS PAR AFFICHES - (Il y aura à nouveau cette année des présentations par affiches. Les participants sont encouragés à soumettre des affiches)

Les mardi et mercredi 21 et 22 novembre (durant les pauses prolongées)

1. - 3. Trois affiches de Terre-Neuve - R. West, A. Carroll et J. Bérubé

1. Efficacité des applications aériennes de *Bacillus thuringiensis* et de MIMIC 240LV contre l'arpenteuse de la pruche - R.J. West, *et al.*

4. Localisation à faible coût d'aéronefs d'arrosage à l'aide du GPS et de SIG - Bill May, Delio Tortosa, Taylor Scarr

5. Mécanismes de transfert des doses de *B.t.* dans le micro-habitat de la tordeuse des bourgeons de l'épinette après épandage aérien - P.C. Nigam, S.E. Holmes, E. Kettela

SERVICES D'INTERPRÉTATION

Seulement les 21 et 22 novembre, de 8 h 30 à midi et de 13 h à 17 h 30

Abstracts/Résumés

Forest Insect and Disease Conditions in Newfoundland and Labrador in 1995

(Insectes et maladies des arbres à Terre-Neuve et au Labrador en 1995)

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

Ce rapport décrit les conditions relatives aux insectes et aux maladies qui ont causé le plus de dommages aux forêts de Terre-Neuve et du Labrador en 1995, notamment l'arpenteuse de la pruche, le diprion du sapin, le puceron lanigère du sapin, le diprion du pin sylvestre et le chancre scléroderrien.

En général, les infestations de l'arpenteuse de la pruche se sont aggravées et ont continué leur progression. La superficie totale défoliée a été d'environ 58 400 ha, dont 22 800 ha où la défoliation a été modérée ou grave.

The Balsam Woolly Adelgid in Newfoundland in 1995

(Le puceron lanigère du sapin à Terre-Neuve en 1995)

W.W. Bowers

Dans l'Est du Canada, la gestion des jeunes peuplements de sapins baumiers et des plantations d'arbres de Noël est compliquée par la présence du puceron lanigère du sapin. Les dommages sont particulièrement importants dans le centre et l'ouest de Terre-Neuve où cet insecte a infesté près de 200 000 ha de sapins baumiers âgés en majorité de moins de 40 ans.

La mise au point d'un système d'aide aux décisions concernant ce puceron demeure une importante priorité sur le plan de la recherche. Des recherches conjointes sont effectuées en vue de fournir aux gestionnaires forestiers un outil fiable leur permettant de prendre des décisions mieux éclairées.

Status of Some Forest Pests in Nova Scotia

(Situation de quelques insectes et maladies en Nouvelle-Écosse)

Eric Georgeson

Ce rapport rend compte de la situation en 1995 de divers insectes et maladies, notamment la tordeuse des bourgeons de l'épinette, l'arpenteuse de la pruche, le dendroctone de l'épinette, la livrée des forêts, la spongieuse, le diprion du sapin et la brûlure des pousses à Sirococcus. Le groupe de la Gestion intégrée des ravageurs a effectué un relevé aérien pour déterminer l'étendue de la défoliation causée par la tordeuse des bourgeons de l'épinette. Aucune défoliation n'a été observée en 1995. Un réseau de piégeage comptant 60 pièges à phérormone a été établi à l'échelle de la province. Seulement trois papillons ont été capturés.

La population de l'arpenteuse de la pruche continue d'augmenter dans toute la province. Les captures d'arpenteuses adultes dans le réseau de piégeage (pièges lumineux) ont augmenté de 40 %. Un relevé aérien effectué le 28 août 1995 a permis de déceler une faible défoliation (10 à 30 %) sur 55 hectares et une défoliation modérée (31 à 60 %) sur 12 hectares dans la zone du ruisseau Macrae du mont Crowdis.

Spruce Budworm in New Brunswick in 1995
(La tordeuse des bourgeons de l'épinette au Nouveau-Brunswick en 1995)
N. Carter et L. Hartling

En 1993 et 1994, les relevés aériens de la défoliation causée par la tordeuse des bourgeons de l'épinette n'ont décelé aucune zone assez étendue pour être cartographiée. En 1995, le relevé a mis en évidence une défoliation modérée sur seulement 4 312 ha dans deux zones principales. Le relevé effectué à l'automne 1995 à 814 endroits dans la province n'a indiqué aucune population hivernante (L2) aux niveaux modérés ou élevés. En fait, seulement 11 foyers de niveau faible ont été observés. Par conséquent, il ne devrait pas y avoir de défoliation décelable au Nouveau-Brunswick en 1996 sauf, peut-être, à des endroits isolés où les populations hivernantes n'ont pu être observées à cause de l'intensité de l'échantillonnage. Aucune mesure de répression ne sera nécessaire en 1996.

Protection Spray Trials Against Spruce Budworm in New Brunswick in 1995
(Essais d'arrosage contre la tordeuse des bourgeons de l'épinette au Nouveau-Brunswick en 1995)
N. Carter, L. Hartling, R. Farquhar

En 1995, certains peuplements infestés par la tordeuse des bourgeons de l'épinette au Nouveau-Brunswick ont été traités par des épandages aériens d'insecticides afin de contrôler l'efficacité de ceux-ci quant à la protection du feuillage. Les insecticides choisis étaient deux marques homologuées de *Bacillus thuringiensis* var. *kurstaki* (Foray 76B et Dipel 64AF) et un insecticide chimique non homologué, le tébufénozide (MIMIC). Les essais visaient notamment à obtenir des données sur l'efficacité de ces produits lorsqu'ils sont utilisés à de faibles doses. Étant donné que le tébufénozide était en attente d'homologation, et que son coût est élevé, on était particulièrement intéressé à déterminer s'il était efficace à faibles doses. Forest Protection Limited a planifié et réalisé les arrosages. Au total, 5 732 ha ont été traités.

Par ailleurs, J.D. Irving Ltd. a traité 3 518 ha de ses propres terres au B.t., par comparaison à 22 267 ha en 1994.

Status of Gypsy Moth in New Brunswick in 1995
(Situation de la spongieuse au Nouveau-Brunswick en 1995)

Dan Lavigne et Nelson Carter

Au cours de l'automne 1995, le ministère des Ressources naturelles et de l'Énergie a de nouveau recherché les masses d'oeufs, concentrant ses efforts dans les parties sud-ouest et centre-sud de la province. Au total, 601 emplacements ont été visités, et des spongieuses (stades autres que celui du papillon mâle) ont été décelées à 137 endroits, dont 26 nouveaux foyers. Dans bien des cas, ces nouveaux foyers sont situés à quelque distance de zones où la présence de la spongieuse était connue. Les données ne permettent pas de déterminer si les populations continueront de croître pour atteindre un niveau épidémique dans la province.

Alternative Application Strategy For Gypsy Moth Virus
(Autre stratégie pour l'application du virus de la spongieuse)
N. Carter, D. Lavigne et J. Proude

Au cours des trois dernières années, la situation de la spongieuse au Nouveau-Brunswick a beaucoup changé. L'insecte a envahi de nouvelles régions, et ses populations y semblent en hausse. Comme c'est souvent le cas, les zones infestées se trouvent dans des lieux habités de façon permanente ou saisonnière (chalets) ou autour de tels lieux. En 1994, plusieurs propriétaires de chalets ont autorisé le ministère des Ressources naturelles et de l'Énergie à appliquer expérimentalement un programme de lutte intégrée pour réduire les populations de la spongieuse. Ce programme comporte des missions de recherche et de destruction des masses d'oeufs au printemps, l'installation d'un nombre limité de pièges en toile et un piégeage intensif à la phéromone. Malheureusement, ces mesures ont loin d'avoir donné les résultats escomptés, car les densités des masses d'oeufs étaient plus élevées à l'automne qu'au printemps. En 1995, le MRNE a proposé un essai de faible envergure du virus de la polyédrose nucléaire qui serait appliqué d'une façon inhabituelle. Plus précisément, il a proposé de l'appliquer directement sur les masses d'oeufs au printemps, au moment de l'éclosion des oeufs, en utilisant une pissette, la théorie étant que les larves émergentes s'infecteraient, se disperseraient sur leurs lieux d'alimentation, mourraient et contamineraient l'environnement ainsi qu'indirectement d'autres larves qui mourraient à leur tour à des stades de développement plus avancés, avec pour résultat qu'à l'automne les densités des masses d'oeufs seraient plus faibles.

Yellowheaded Spruce Sawfly in New Brunswick
(La tenthrède à tête jaune de l'épinette du Nouveau-Brunswick)
N. Carter, W. Patterson et G. Simpson

La tenthrède à tête jaune de l'épinette, *Pikonema alaskensis* (Rohwer), est un insecte nord-américain qui attaque les jeunes épinettes poussant à découvert de toutes espèces. Depuis 1991, sa présence est devenue plus évidente dans la partie sud-est du Nouveau-Brunswick.

Au cours de l'automne 1994, un relevé aérien (hélicoptère) a été effectué pour reconnaître les plantations endommagées sur les terres de la Couronne. Les dommages dans cinq plantations ont été jugés particulièrement préoccupants. Ces plantations ont ensuite fait l'objet de relevés intensifs sur le terrain au printemps pour déterminer si des mesures de protection devaient être prises en 1995.

Au total, les cinq plantations d'épinettes noires infestées couvraient 463 ha. Il a été estimé que 10 % à 21 % de la superficie de chacune de ces plantations étaient touchés.

Les études effectuées au cours de l'été 1995 ont fourni les premières données de base sur la biologie naturelle de cette tenthrède et les dommages qu'elle cause aux épinettes noires dans les plantations infestées du sud du Nouveau-Brunswick.

Spruce Budworm and Gypsy Moth in Ontario in 1995
(La tordeuse des bourgeons de l'épinette et la spongieuse en Ontario en 1995)

- Statut de l'infestation en 1995
- Prévisions pour 1996
- Opérations d'arrosage en 1995

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

En 1995, l'infestation de la tordeuse des bourgeons de l'épinette en Ontario a régressé pour la troisième année consécutive. De 4 266 656 ha en 1994, la superficie totale défoliée de façon modérée à grave est passée à 3 450 483 ha.

Dans le cas de la spongieuse, les populations en Ontario ont recommencé à croître en 1995 après avoir diminué les trois années précédentes. La superficie totale touchée par une défoliation modérée à grave a atteint 19 879 ha, par comparaison à 5 645 ha en 1994. La superficie défoliée devrait croître encore en 1996. Aucun arrosage aérien contre la spongieuse n'a été effectué par le MRNO en 1995.

Jack Pine Budworm in Ontario in 1995
(La tordeuse du pin gris en Ontario en 1995)
J.H. Meating, H.D. Lawrence, G.M. Howse, M.J. Applejohn et T. Scarr

Après cinq années d'augmentation, la superficie totale défoliée de façon modérée à grave par la tordeuse du pin gris a été réduite à 293 292 ha en 1995, alors qu'elle était de 419 344 ha en 1994.

En 1995, un programme d'arrosage opérationnel contre la tordeuse du pin gris a été réalisé sur 51 015 ha.

Northwest Region Status of Important Forest Pests in 1995
(Ravageurs et maladies d'importance dans la région du Nord-Ouest en 1995)
James Brandt (présentation faite par W.J. Volney)

Ce rapport fait le point sur les ravageurs et les maladies qui causent des dommages importants aux arbres dans la région du Nord-Ouest en 1995. L'information présentée a été fournie en majeure partie par les organismes responsables des forêts au Manitoba, en Saskatchewan et en Alberta ainsi que par le ministère des Ressources renouvelables des Territoires du Nord-Ouest.

Forest Pests in Manitoba in 1995
(Ravageurs et maladies des forêts au Manitoba en 1995)
A.R. Westwood, *et al.*

Ce rapport résume les conditions relatives aux ravageurs et aux maladies des arbres au Manitoba en 1995 et les activités en vue de leur répression. Il traite notamment des points suivants : tordeuse des bourgeons de l'épinette, tordeuse du pin gris, étude sur les pins gris résistant à la rouille-tumeur autonome, programme sur l'impact des ravageurs et des maladies dans les parcelles sylvicoles permanentes, autres maladies des forêts, maladie hollandaise de l'orme, relevé renouvelé des ravageurs et des maladies des forêts en 1995 et évaluations particulières.

Forest Insect and Disease Management Programs
Summary Report - 1995
(Programmes de lutte contre les insectes et les maladies des arbres forestiers
Rapport sommaire - 1995)
Alberta Land and Forest Service
H. Ono

Les infestations de la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clemens), dans la province ont augmenté en 1995, poursuivant la tendance observée en 1994. La zone de protection des forêts de l'Alberta comptait trois infestations couvrant une superficie estimée à 203 011 ha. Une formulation de B.t.k. à base d'eau (Foray 48B®) a été appliquée par voie aérienne sur 110 923 ha de peuplements modérément à gravement défoliés par la tordeuse dans la région boréale du Nord-Ouest.

Par ailleurs, les populations du dendroctone du pin ponderosa ont atteint leur plus bas niveau depuis quelques années. L'infestation du dendroctone de l'épinette s'est poursuivie, atteignant 23 771 ha d'épinettes blanches. Le rapport présente des données sur d'autres sources de dommages, notamment le faux-gui, le charançon du pin blanc, *Armillaria* et les lièvres. Il traite également des sources de dommages à la régénération, du programme de piégeage à la phéromone et des activités de prévention de la maladie hollandaise de l'orme en Alberta.

Status of Important Forest Pests and
Experimental Control Projects in Pacific & Yukon Region in 1995
(Le point sur les principaux ennemis des forêts et
les mesures de lutte expérimentales dans la région du Pacifique et du Yukon en 1995)
G.A. Van Sickle, B.E. Callan, T. Gray, P. Hall (BCFS)
L. Humble, I. Otvos et N. Humphreys

Les auteurs présentent la situation d'environ 25 sources de dommages économiquement importants dans la région du Pacifique et du Yukon en 1995, ainsi que des prévisions pour 1996. Ce résumé a été établi à partir des rapports d'observation sur le terrain de neuf surveillants du Relevé des insectes et des maladies des arbres, et aussi à partir des renseignements fournis par l'industrie forestière, des chercheurs et des organismes gouvernementaux. Les changements les plus notables en 1995 sont l'accroissement des populations du dendroctone du pin ponderosa, de la livrée des forêts, du papillon satiné, de l'arpenteuse verte de la pruche et du puceron lanigère du sapin, et une hausse marquée des cas de maladie des aiguilles du pin ainsi que de la mortalité attribuable à la sécheresse. Des populations du dendroctone de l'épinette, de la légionnaire noire, de la spongieuse, du perce-pousse européen du pin, de la tordeuse du tremble, des mineuses du bouleau et des scolytes de l'écorce de l'orme européen ont encore été décelées. Par ailleurs, des baisses des populations du dendroctone du douglas, du scolyte de l'écorce du sapin baumier, des tordeuses de l'épinette, de l'arpenteuse de la pruche de l'Ouest, de la chenille à houppes du douglas, de la tordeuse à tête noire de l'Ouest et du porte-case du mélèze ont été observées.

Les recherches et les essais de répression effectués comprennent : des essais de confusion à l'aide de phéromone pour lutter contre la tordeuse occidentale de l'épinette; la mise au point d'une phéromone pour l'arpenteuse occidentale du chêne; la répression biologique du dendroctone du pin ponderosa; des relevés et projets de répression des scolytes de l'écorce (12 millions de dollars); des essais de B.t.k. contre la tordeuse occidentale de l'épinette; l'étalonnage continu d'un système de piégeage à la phéromone pour l'arpenteuse de la pruche de l'Ouest.

Insect and Disease Conditions in the United States in 1995
(Conditions des insectes et des maladies aux États-Unis en 1995)
Dan Kucera

Ce rapport porte sur la situation aux États-Unis en 1995 des tordeuses de l'épinette, de la tordeuse du pin gris, des spongieuses, de la chenille à houppes du douglas, de la livrée des forêts, de la tordeuse du pommier, des scolytes de l'écorce, du puceron du cyprès, du puceron lanigère de la pruche, de l'anthracnose du cornouiller, du chancre du noyer cendré, de la rouille fusiforme, du déclin du chêne et d'autres insectes et maladies. Il traite également des activités de prévention de la végétation concurrente, de l'utilisation d'herbicide et des incendies.

An Overview of Research on Insect Pests and Tree Diseases at Canadian Forest Service, Sault Ste. Marie
(Aperçu de la recherche sur les insectes et les maladies des arbres par le Service canadien des forêts, à Sault Ste Marie)

Rapport présenté au 23^{e} Forum annuel sur la répression des ravageurs (tenu à Ottawa, en Ontario, du 21 au 23 novembre 1995)

préparé pour Erroll Caldwell

Spatial Analysis of Spruce Budworm Pheromone Trap Data
(Analyse spatiale des captures de la tordeuse des bourgeons de l'épinette dans les pièges à phéromone)
D.B. Lyons, C.J. Sanders, A.M. Liebhold, B.G. Pierce et P.S. Robertson

Chaque année depuis 1986, des pièges appâtés avec une phéromone sont installés par des organismes coopérants dans toute l'aire de la tordeuse des bourgeons de l'épinette en Amérique du Nord, et le nombre des papillons mâles capturés est déterminé. Ces données ponctuelles ne peuvent toutefois pas être utilisées pour analyser les tendances spatiales dans un système d'information géographique (SIG). Des logiciels permettant de produire à partir des données ponctuelles des cartes de contours pouvant être assimilées par un SIG ont été mis au point et intégrés à une interface utilisateur graphique (IUG) conviviale. En ouvrant le module de la base de données de l'IUG, l'utilisateur peut ajouter, réviser ou supprimer des données sur les captures. Dans le module géostatistique, pour chaque sous-ensemble de données (données d'une année pour une région), un modèle à variogramme est utilisé pour définir les relations spatiales entre les données ponctuelles, et une technique connue sous le nom de krigeage est appliquée pour interpoler entre les points. IDRISI®, un SIG à structure matricielle peu coûteux, entièrement fonctionnel, est employé pour afficher, manipuler et analyser les résultats du krigeage. Les cartes obtenues présentent des intervalles de contour indiquant les zones estimées d'équidensité des papillons. CorelDRAW!, un programme graphique structuré, vectoriel, est utilisé pour préparer des cartes de haute qualité présentant les résultats du piégeage.

Un modèle de régression logistique a aussi été mis au point pour prévoir la défoliation de la tordeuse. La première étape a consisté à produire, à l'aide du SIG, à partir des cartes de défoliation annuelles (1977 à 1993) fournies par l'unité du Relevé des insectes et des maladies des arbres, une carte de probabilité indiquant la fréquence (proportion) des années de défoliation. Cette carte, les cartes de défoliation annuelles et les cartes d'interpolation des données de piégeage à la phéromone (1986-1993) ont ensuite été combinées pour créer le modèle de régression logistique. Pour prévoir la défoliation d'une année, ce modèle utilise la carte de défoliation antérieure et les données sur les captures. La carte obtenue indique la probabilité de défoliation dans toute l'Ontario.

The Efficacy of Dipel 76AF on Jack Pine Budworm in Ontario: 1995 Trial

(Efficacité du Dipel 76AF contre la tordeuse du pin gris en Ontario : essai de 1995)

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

L'objectif de cette étude était de vérifier l'efficacité du Dipel 76AF contre la tordeuse du pin gris. Les deux emplacements d'essai, qui couvraient au total 137 ha, étaient situés dans des peuplements de pins gris âgés de 70 à 90 ans se trouvant au nord-ouest de Sudbury, en Ontario. Une seule application de Dipel 76AF s'est révélée extrêmement efficace pour la protection du feuillage et la réduction des populations de la tordeuse lorsque la densité de celle-ci était faible à modérée.

The Efficacy of MIMIC 240 LV on Jack Pine Budworm in Ontario: 1995 Trial

(Efficacité de MIMIC 240 LV contre la tordeuse du pin gris en Ontario : essai de 1995)

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

Les populations hivernantes de la tordeuse du pin gris ont été évaluées à un certain nombre d'endroits dans toute la zone actuellement infestée du nord de l'Ontario. Compte tenu des populations larvaires (L2), des conditions des peuplements et de la proximité des arrosages opérationnels, trois blocs totalisant 252 ha ont été choisis dans le township de Roberts dans la région du Centre. La défoliation de la tordeuse du pin gris avait été observée pour la première fois dans cette région en 1994, et il avait été prévu qu'elle serait modérée à grave en 1995.

Même si les populations larvaires avant l'arrosage étaient plus faibles que prévues, les résultats de l'essai indiquent qu'une seule application de MIMIC 240 LV réduit nettement la défoliation par rapport aux parcelles témoins non traitées, ce qui appuie les observations faites en 1994 lorsque les populations de la tordeuse avant l'arrosage étaient nettement plus élevées.

Effects of Additives in some Commercial Formulations of

Azadirachtin on the Phytophagous Spider Mite,
<u>Tetranychus</u> <u>Urticae</u> Koch
(Effets d'additifs contenus dans certaines formulations commerciales d'azadirachtine sur le tétranyque phytophage *Tetranychus urticae* Koch)
K.M. Sundaram

Une préparation d'azadirachtine-A Purece (AZ-A) et quatre formulations à base de neem (RH, MO, PT et AT) contenant l'isomère de l'insecticide ont été testées pour déterminer leur pouvoir répulsif, leur toxicité et leur pouvoir d'inhibition de l'oviposition sur le tétranyque à deux points (*Tetranychus urticae* Koch). Les tétranyques ont été placés sur des disques foliaires de tremble (*Populus tremuloides* Michx.) traités et non traités, et leur fécondité, leur niveau d'alimentation et leur mortalité ont été évalués. Les résultats indiquent que les effets de l'AZ-A varient selon le type de formulation et la concentration de l'AZ-A. Des réductions importantes de l'alimentation et de l'oviposition, corrélées avec les concentrations d'AZ-A, ont été enregistrées parallèlement à une augmentation importante du pouvoir répulsif. L'augmentation de la concentration des formulations entraînait une mortalité supérieure de *T. urticae* et des réductions du nombre total d'oeufs pondus, du pourcentage d'oeufs éclos et de la survie des tétranyques après émergence. Les effets inhibiteurs et biologiques diminuaient dans l'ordre suivant : AT›PT›MO›RH›AZ-A.

Vegetation Management Reports
(Rapports de gestion de la végétation)
Len Lanteigne

Rapport sur les recherches suivantes :

1. essais nationaux portant sur le champignon *Chondrostereum purpureum*;

2. recherche/transfert de technologie sur les mauvaises herbes dans les pépinières forestières;

3. impact de différentes options de gestion de la végétation sur la succession végétale, l'approvisionnement en bois et certaines caractéristiques de l'environnement dans la région de la Forêt acadienne (L. Lanteigne et D. Pitt, Service canadien des forêts; B. Brunsdon, J.D. Irving Ltd.; W. Bell, ministère des Ressources naturelles de l'Ontario).

Update on Exotic Forest Pests and Plant Quarantine Issues
(Le point sur les ennemis exotiques des forêts et les questions de quarantaine des plantes)
Marcel Dawson

L'auteur fait le point sur les questions et problèmes suivants en 1995 : politique sur la spongieuse, spongieuse asiatique, étude des marqueurs génétiques de la spongieuse, réglementation nationale sur la spongieuse, grand hylésine des pins, Comité de la lutte contre les ravageurs forestiers, maladie hollandaise de l'orme, chancre scléroderrien, importation de produits de bois non ouvrés de l'extérieur du continent et politiques sur le fardage.

SÉANCE DE PRÉSENTATION PAR AFFICHES

Efficacy of Aerial Applications of Bacillus thuringiensis and MIMIC 240LV against the Hemlock Looper

(Efficacité des épandages aériens de *Bacillus thuringiensis* et de MIMIC 240LV contre l'arpenteuse de la pruche)

Rick West

Résumé

Deux formulations aqueuses de *Bacillus thuringiensis* (B.t.), ABG6387 et ABG6414, et l'insecticide biochimique tébufénozide, MIMIC 240LV, ont été appliqués sur des peuplements de sapins baumiers ayant subi une éclaircie précommerciale et infestés par l'arpenteuse de la pruche. L'efficacité des arrosages a été évaluée du point de vue du dépôt des gouttelettes, de la réduction des populations et de la défoliation des feuillages de l'année et de l'année précédente.

Low Cost GPS-GIS Tracking of Spray Aircraft

(Technique peu coûteuse de suivi des aéronefs d'arrosage à l'aide du GPS et d'un SIG)

Bill May, Delio Tortosa, Taylor Scarr

Dose transfer mechanisms of B.t. in the spruce budworm micro-habitat after aerial application

(Mécanismes de transfert des doses de B.t. dans le micro-habitat de la tordeuse des bourgeons de l'épinette après épandage aérien)

P.C. Nigam, S.E. Holmes et E. Kettela

FOREST INSECT AND DISEASE CONDITIONS IN NEWFOUNDLAND AND LABRADOR IN 1995

REPORT TO THE 23RD ANNUAL FOREST PEST CONTROL FORUM
OTTAWA, NOVEMBER 21-23, 1995

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 - Temperatures were below average throughout the Island in late spring and early summer with less than normal precipitation. A late frost occurred in areas of western and central Newfoundland on June 29 and July 2. As the season progressed temperatures reached normal levels and precipitation remained low with the exception of heavy rains experienced throughout western Newfoundland on July 21 and 24. Generally insect development progressed normally during the remainder of the summer. In eastern Labrador weather conditions were generally normal with scattered periods of heavy rain and high temperatures.

Moderate and severe defoliation were forecast to occur on about 120 000 ha. The defoliation survey was completed for all areas of the Island and defoliation occurred in most of the forecasted areas, except in the central portion of the province from Redcross Lake to Diversion Lake, and in the Bay d'Espoir area. Severe defoliation forecast for several areas on the Bonavista Peninsula also did not materialize. A heavy late frost on June 29 may have been responsible for the collapse of populations in these areas.

Generally the looper infestations increased in distribution and severity (Fig. 1). Digitizing of defoliated areas is in progress and the results will be reported at a later date.

Biological Mortality Factors - Hemlock looper larvae were collected from central and western Newfoundland to determine natural mortality factors. Less than 5% of the larvae were parasitized mainly by tachinid species. Disease organisms were present in several areas in various degrees of incidence and were tentatively identified as bacteria, yeast-like organisms and fungi; including *Entomophaga aulicae*. 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 presently in progress. The ultimate goal of this work is to initiate epizootics using artificially produced spores at the beginning of impending outbreaks to minimize forest damage. Results of work on the use of four exotic parasitoids from Europe for improved biological control of the EHL were negative. These parasitoids did not develop well on EHL and are not suitable for release as control agents.

Pheromone Trapping - A pheromone trap grid was established for the fourth year in the summer of 1995 using 50 permanent sample locations throughout the Island. Traps at numerous locations became saturated signifying increased population levels. The mean numbers of mates per trap in western, central and eastern Newfoundland were 1187, 237 and 771 respectively. In comparison the 1994 catches were 801, 292 and 179 respectively.

Control Program - The Newfoundland Forest Service (NFS), Department of Natural Resources conducted an operational control program against the EHL. The biological insecticide, *Bacillus thuringiensis* (B.t.) was applied to about 48 000 ha of balsam fir forest. Results of this program will be reported separately.

The Canadian Forest Service (CFS) conducted an experimental program testing the efficacy of two aqueous formulations of B.t. and the growth regulator tebufenozide, MIMIC 240 LV. Both insecticides were effective in reducing larval numbers and preventing defoliation from low to moderate populations of EH. Additional testing in stands with high populations is warranted. Early application of MIMIC at the beginning of larval hatching should also be evaluated to determine if deposits persist long enough to kill late hatching larvae.

Damage Assessment - The EHL was the major cause of forest depletion in Newfoundland and Labrador from 1988 to 1995. The CFS cooperated with the NFS to assess the damage. The total volume of stand mortality in these defoliated areas during the 5-year period from 1988 to 1992 was 3 299 000 m^3. Approximately 353 000 m^3 was salvaged. In addition to tree mortality, an estimated 343 200 m^3 were lost as a result of reduced growth. Damage assessment is more recently defoliated stands in progress.

Eastern Hemlock Looper Decision Support System (EHLDSS) - A project initiated was in 1988 to develop 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, and improved analysis of spatial distribution of EHL.

Forecast for 1996 - Overwintering eggs were sampled at over 1 000 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 had very high egg numbers signifying severe defoliation for 1996. 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 1995. 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. All were without moths, except one near Barachois Park where only two moths were caught before local emergence had commenced. Such low numbers indicate that moth invasion was relatively light in 1995. Catches from local populations were also low in all areas with the highest number of 10 moths caught near Corner Brook.

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 involved derivation of 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 initiated 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 about 300 ha of overmature balsam fir stands. 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.

BALSAM FIR SAWFLY (BFS)

Moderate and severe defoliation was forecast to occur in 1995 near Bottom Brook in western Newfoundland. High numbers of larvae and severe defoliation were recorded near Bottom Brook and Trout Brook. About 10% tree mortality has occurred in young stands along the Caribou Lake Road from past infestations. An extensive area of severe defoliation was also reported near Burin.

YELLOWHEADED SPRUCE SAWFLY (YSS)

Defoliation reported by Abitibi-Price personnel in black spruce plantations near Sunday Pond, central Newfoundland was investigated and the causal agent identified as yellowheaded spruce sawfly. Damage was most severe in more exposed areas of open and less vigorous trees and near stand boundaries and roadsides. This insect has the potential to cause tree mortality in those areas. In the overall stand however, approximately 20% of the trees were affected and the infestation was confined to the upper crowns causing 10-30% defoliation. This insect also caused varying degrees of defoliation of ornamental spruce in eastern Newfoundland.

EUROPEAN PINE SAWFLY (EPS)

Pines were severely defoliated by the EPS 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 initiated in the early spring of last year to improve the detection and enhance the application of quarantine measures and domestic insecticides to prevent further spread of this important pine defoliator were well received and supported by the public.

PINE FALSE WEBWORM (PFW)

Defoliation by this false webworm, a sawfly, continued for a third 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 PFW is potentially a more serious defoliator of pines, including red pine, than the European pine sawfly, because the PFW 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.

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 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 continued, but no significant defoliation occurred in 1995.

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 Lake 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 biotechnology, and the development of a hazard rating system and management guidelines to minimize damage.

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 WPBR forms an integral part of the Stem Cankers of Forest Trees Network under the Green Plan, and concentrates on biological and silvicultural control. The goal is the development of management practices to minimize damage. A cooperative working group has been established by the Newfoundland Department of Natural Resources to promote the re-establishment of white pine as a commercial species.

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 the disease provided guidelines for a cooperative effort to enhance the application of quarantine measures to prevent further spread of this disease. 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.

ACID RAIN NATIONAL EARLY WARNING SYSTEM (ARNEWS)

All permanent ARNEWS plots were precisely located with GPS (Geographic Positioning System) and were inspected for pest conditions and sampled for soil and vegetation as part of the 5-year remeasurement program. Abundance and diversity of soil arthropods were monitored in three ARNEWS plots in western Newfoundland.

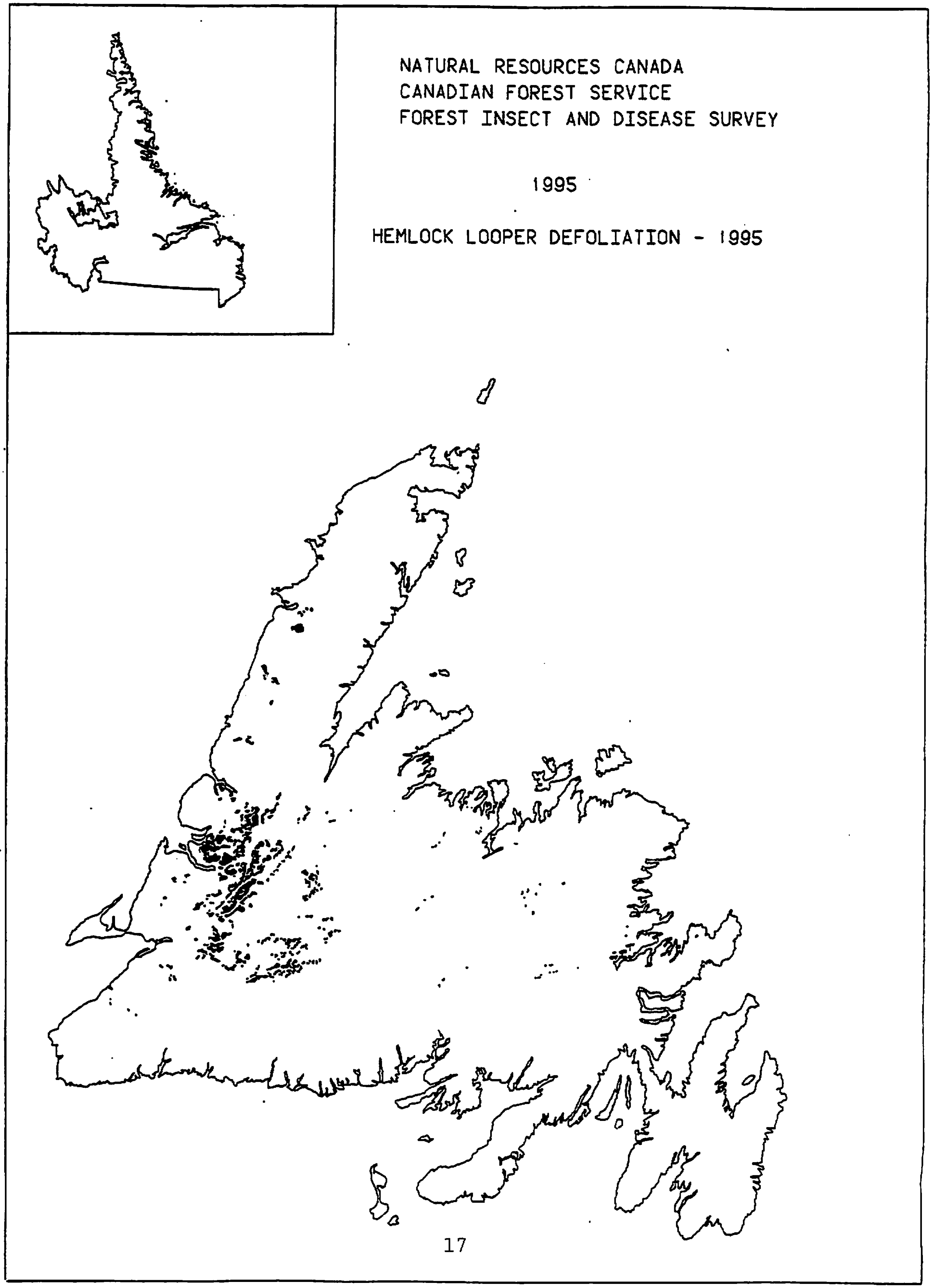

Figure 1. Areas of moderate and severe defoliation by the hemlock looper in Newfoundland in 1995.

REPORT TO THE 23rd ANNUAL FOREST PEST CONTROL FORUM,
Ottawa, 21-23 November, 1995

THE BALSAM WOOLLY ADELGID IN NEWFOUNDLAND IN 1995

by

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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 are being addressed to promote delivery of a DDS for BWA:

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 1995 include the following:

(i) Over 100 balsam fir sites in western Newfoundland were visited and balsam fir stands assessed for damage caused by BWA. Each site was spatially referenced using GPS; site and stand characteristics were recorded and linked to forest inventory data using (ARCINFO/GIS). Functional relationships between the incidence of balsam woolly adelgid damage and characteristics of managed and unmanaged fir stands/sites will be established.

(ii) Analysis of balsam fir foliage for nutritional and allelochemic compounds related to feeding by BWA was completed. A journal publication reporting these findings is in preparation.

(iii) Damage caused by BWA 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 and 1995 to include the following:

- satellite imagery was used to select study areas in managed and unmanaged balsam fir 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 in 1994 from helicopter for spatial analysis of foliar chemistry, stand structure and growth characteristics, and damage assessment. This research encompassed 6 study areas using CASI at 1m and 2m resolution in spectral and spatial modes. In 1995, precise geo-correction of CASI data was completed, using GPS.
- acquired digital contour data and stereo SPOT imagery in 1994 for generation of digital elevation model; processing of the satellite imagery for the DEM to derive site conditions (elevation, slope and aspect) for input into HRS was completed in 1995. A journal publication summarizing these results is in progress.

Results from above will complement studies on BWA bionomics and when linked to survey data (Forest Health Monitoring) will promote development of a Decision Support System (DSS) for BWA. A prototype hazard rating system (HRS) for MD 14 will hopefully have island-wide application.

AERIAL HEMLOCK LOOPER CONTROL PROGRAM IN NEWFOUNDLAND, 1995

(Prepared by H. Crummey, Insect & Disease Control Section, Newfoundland Forest Service)
(for Annual Forest Pest Control Forum Report - 1995)

Introduction

In 1995, the Newfoundland Forest Service (NFS) conducted a hemlock looper control program in central and western Newfoundland which was carried out under licence and within guidelines established by the provincial Department of Environment. This report outlines the main aspects of the program. The efficacy data collected during this program and presented here are strictly operational and, therefore, subject to the constraints and logistics of the various parameters of the program.

Hemlock looper population status and forecast for 1995:

The forest insect defoliation forecast for 1995 was generated by Natural Resources Canada - Canadian Forest Service (CFS)-Newfoundland and Labrador Region, based on a cooperative fall survey carried out jointly by CFS and the Department of Natural Resources - Newfoundland Forest Service (NFS), and with input from NFS. This forecast formed the basis for determining the need for a control program in 1995 and provided the outline to initiate identification of proposed treatment areas.

Proposed treatment:

Based on the forecast and the importance of the stands expected to be defoliated (mostly semi-mature, second growth and pre-commercial thinnings), the NFS on behalf of Abitibi-Price Inc. and Corner Brook Pulp & Paper proposed to treat up to approximately 60 000 ha of mainly balsam fir forest using two applications of *Bacillus thuringiensis* var. *kurstaki* (B.t.). The objective of the program was to prevent mortality on high priority areas by reducing the numbers of looper larvae and thereby limiting feeding pressure and hence defoliation. Those blocks (stands) which were of highest priority in terms of value and which had looper population levels requiring control action would be scheduled for treatment. The priority areas which initially had lower population levels would continue to be monitored until it was evident that control action was not necessary. It was understood that this would result in some delay in treating lower priority blocks, except those with very high population levels and/or previous defoliation. All original proposed blocks would be checked for population levels, but those with the highest priority were to receive the most emphasis.

Aircraft:

Spray operations were based out of the unpaved airstrip at Buchans in central Newfoundland and the airport at Deer Lake. Spray aircraft for the project consisted of three teams of single-engine aircraft consisting of two teams of four (4) single-engine Dromader M-18 planes on contract from Épandair Inc. and one team of two (2) single-engine Bull Thrush on contract from Agric Air, both contractors from Quebec. Each aircraft was equipped with Micronair spray atomizers. Navigation for spray missions was provided by helicopters and supervision was carried out using an Enstrom EN 48 helicopter and two fixed-wing aircraft.

Insecticide/treated areas:

Only biological insecticides (B.t.) were applied in 1995, consisting of two products - Dipel®264 and Foray®76B, applied at a rate of 30 BIU (Billion International Units) per hectare (ha) per application.

Spray blocks were located in central Newfoundland, extending from Victoria Lake eastward to Red Cross Lake with a block east of South Twin Lake and one near Diversion Lake, and in western Newfoundland from Little Grand Lake northeast to Adies Pond and westerly to Gros Morne National Park. A total of 47 893 ha were treated, consisting of thirty-four (34) blocks, including one (1) block and four (4) extensions treated after defoliation was noticed during the program (Table 1). Of the total area, 6 202 ha (approximately 13 %) received one application, 40 305 ha (approx. 84 %) received two applications, and 1 386 ha (approx. 3 %) received three applications. The proposed blocks receiving one application generally had lower population levels or were a lower priority, or as indicated, were treated with a single late application, after current defoliation became evident. A number of the proposed blocks were monitored for insect populations, but were not treated because of very low insect numbers. The proposed plan concerning priority areas and treatment schedules outlined above was followed during the program.

Spray operations:

Spray missions began in the evening of July 1 and ended the morning of July 28. Excellent spray weather was encountered early in the program, resulting in few delays. Minor weather delays were encountered throughout the program, particularly in the later half.

Program surveys:

Two methods of larval sampling were employed: - 1) tree beating, and 2) branch sampling.

1) tree beating is a relative method consisting of beating a set amount of foliage with poles, over a 2 x 3 meter sheet, and counting the resulting dislodged larvae. This method gives a rapid estimation of population levels. Along with larval numbers, additional information recorded included the instar(s) of sampled larvae, percent current tree defoliation, and shoot development class (Dorais & Kettela 1982). Trees, once sampled, were not subsequently resampled.

2) branch sampling consisted of clipping one mid-crown, 45-cm branch tip per tree using pole pruners. Samples were returned to a laboratory to determine larval numbers, larval instars, shoot development, and shoot defoliation (Fettes 1950). Trees were resampled.

The tree beating method was the one mainly used in 1995 to sample and assess hemlock looper larval populations . However, there are difficulties in that trees are not resampled, thus adding the existing inter-tree variability at one point in time with the unknown variability of new sample trees.

Table 1. Area (ha) treated, product used and number of applications for hemlock looper control, Newfoundland - 1995.

BLOCK NO.	LOCATION	PRODUCT [a]	AREA (HA) BY APPLICATION(S)			TOTAL
			x1	x2	x3	
102	Adies Pond	FO	-	-	1 386	1 386
102E [b]	Adies Pond Extension	FO	1 230	-	-	1 230
103	Bonne Bay Little Pd.	FO	-	2 222	-	2 222
105	Bonne Bay Big Pd.	FO	-	797	-	797
106	Grindstone Pond	FO	-	720	-	720
107	North Lake	FO	-	1 089	-	1 089
108	Mistaken Pond	FO	-	1 455	-	1 455
109	Goose Arm Pond	FO	-	355	-	355
113	Monkey Brook	FO	-	1 019	-	1 019
114	Hughes Lake	FO	225	238	-	463
115	Kettle Pond	FO	-	685	-	685
115E [b]	Kettle Pd. Extension	FO	405	-	-	405
116	Moose Pond	FO	-	541	-	541
117	Thirty-Ninth Brook	FO	-	711	-	711
118	Island Pond	FO	-	5 685	-	5 685
118E [b]	Island Pd. Extension	FO	475	-	-	475
119	South Brook	FO	-	659	-	659
120	Carp Creek	FO	-	738	-	738
121	BlackGulch Brook	FO	-	488	-	488
122	North Pond	FO	-	852	-	852
123	Litte Gran Lke	FO	-	3 387	-	3 387
126	Halfway Mountain	FO	107	-	-	107
128	Sadder Lake North	FO	502	-	-	502
130	Bottle Lake	DI	-	2 543	-	2 534
131	Puddle Pond	DI	517	-	-	517
132	Padille Pond	DI	-	2 674	-	2 674
133	Lloyd's Lake	DI	125	1 160	-	1 285
134E [b]	Lloyd's River Extension	FO	210	-	-	210
135	Tulk's Brook	DI	-	956	-	956
136	East Tulk's Pond	DI/FO	53	1 631	-	1 684
137	Costigan Lake	DI/FO	878	3 200	-	4 078
138	Valentine Lake	DI/FO	-	280	-	280
139	Victoria Dam West	DI	-	309	-	309
140	Victoria Dam East	DI	-	365	-	365
141	Red Cross Lake	DI	-	2 364	-	2 364
152	Diversion Lake	DI/FO	-	2 516	-	2 516
157 [b]	Victoria Lake Extra	FO	1 475	-	-	1 475
TOTAL			**6 202**	**40 305**	**1 386**	**47 893**
% of Total			**12.9**	**84.2**	**2.9**	

[a] DI = DiPel 264; FO = Foray 76B; All applied at 30 BIU per hectare per application.

[b] Extra areas identified after defoliation appeared

Additional information was generated from collected data on the larval index [1] of development and the shoot index [2] of development.

Development:

Sample locations (plots) were established within proposed spray blocks, as well as untreated areas when available. The information gathered consisted of insect population levels, tree shoot development classes and percent current defoliation. Data were used to verify the defoliation forecast, refine infestation areas, the necessity for treatment and to appropriately time insecticide application, as well as find suitable untreated areas.

Pre-spray:

Based on the development data and just prior to treatment, pre-spray sampling was carried out on all proposed spray blocks with sufficient looper population and at the appropriate stage of foliage (shoot) development. Data were recorded on larval population levels, larval index of development, shoot index of development (Dorais and Kettela 1982) and levels of defoliation of the current year foliage (tree estimate). Similarly, plots were established wherever possible in adjacent untreated areas based on suitable population levels and stand type to compare with the treated plots.

Post-spray:

This was the same as for pre-spray. These samples were continued throughout the program as logistics permitted. There were some delays in collecting data at the required time due to weather problems. Post-spray data where available were compared with the pre-spray data to determine the effectiveness of the program. Intermediate sampling of larvae was also used to assess whether additional treatment was warranted.

Deposit assessment:

Usually, droplet deposit is not determined during operational spray programs. In 1995, foliage samples were collected immediately after spray from a number of plots and blocks to assess mortality of field collected looper larvae from untreated areas fed on the contaminated foliage. Treated foliage represented only the Foray 76B products. Foliage was collected within 1 to 1.5 hours following spray application. Five mid-crown branches were sampled per location and separately returned to the lab where shoots were removed and placed in one ounce cups. Twenty-five (25) larvae for each spray plot or untreated check were placed individually in cups with sufficient foliage, and allowed to feed up to ten (10) days. Survival of the larvae was recorded.

Results:

Treatment

The dates of insecticide application and field sampling are provided in Table 2. As indicated, there were few significant delays experienced in applying insecticide during the first two weeks. Initially, scheduled blocks received their first treatment within a few days of the decision

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1 larval index = ((no. of 1st instar larvae*1)+...+(no. of 4th instar larvae*4))/no. of larvae. There are only 4 larval instars for hemlock looper in Newfoundland (Carroll 1956).

2 shoot index = ((no. of class 1*1)+...+(no. of class 5*5))/no. of shoot assessed (Dorais & Kettela 1982).

that larval and shoot development and larval numbers were appropriate, although some slight delay occurred as a result of treatment schedule logistics and priorities. As already indicated, some areas were not treated promptly due to the concern that all high priorities blocks were thoroughly assessed before elimination from treatment, and the decision to treat lower priorized areas. The only exceptions were where high looper numbers were encountered, defoliation was becoming very evident and/or the area had received previous defoliation.

Assessment of program

Tables 3 summarizes the data collected using the tree beating method.

Not all treated areas were assessed for efficacy due to logistics and the need to identify all significant areas within the forecast and priority locations that should be treated. In addition, some of the areas identified for treatment through observation of defoliation were also not sampled.

As frequently occurs, looper larval densities were quite variable, both within plots, between plots and between blocks. It is of importance to note that there was a significant increase in looper densities at several locations which hasn't been seen since the peak infestation years between 1985 - 1988. Population levels were in the low category in a number of plots, but were medium to high, and even extreme in several blocks. For treatment plots assessed, the mean number of larvae per beat ranged from 22.0 to 2125.0 (Table 3). For untreated plots, the number of larvae per beat ranged from 50.0 to 458.7.

Ideally, the timing of the first application of insecticide for hemlock looper is when shoot development is between classes 4 and 5, i.e. IDS of 4.0 to 5.0, and when larval development is between the first and second instars, i.e. IDL of 1.0 to 2.0. Treatment should be applied when the new needles are flared sufficiently to allow for spray droplet deposit and after larvae have hatched but before significant feeding damage (defoliation) occurs. Delays result in more pre-spray defoliation and therefore less foliage protection.

Shoot development in 1995 was at the appropriate stage, i.e. all shoots had an IDS of 5.0 when larval development had progressed to the desired stage for treatment. Generally, blocks scheduled for early treatment (highest priority) received their first application when larval development was appropriate. The second application was applied as soon as weather, scheduling and logistics permitted. Lower priority blocks were treated later as previously explained. Pre-spray defoliation ranged considerably depending on the population levels and the interval from hatch until treatment. Defoliation in most treated plots was confined to the current year foliage; very little older foliage appeared to be affected with some exceptions relating to post spray weather or where there was previous defoliation and/or high looper population.

The overall larval mortality in treated blocks was generally quite good, averaging over 90 % compared with an average of about 23 % for untreated areas.

The determination of success is also reflected in the amount of final defoliation compared with that recorded prior to treatment. Overall, there was only a slight increase in defoliation at final post-spray compared with pre-spray, except for blocks where there was delayed application and/or with high to extreme population levels, or where post-spray weather may have affected the B.t.(Blocks 120). In these cases defoliation increased. As usual, there were several anomolies noted in the results. Defoliation increased in untreated plots.

Table 2. Date of spray application and plot sampling for hemlock looper control program in NF, 1995.

BLOCK NO.	PLOT NO.	APPLICATION & DATE			SAMPLE DATE		
		1ST	2ND	3RD	PRE	POST	POST
102	1,3	JL 1 pm	JL 6 pm	Jl23a/25p	Jn28	JL12	AU 1
102E	-	JL23a/25	-	-	-	-	-
103	6,7	JL 7p/8p	JL12p/14	-	JL 6	-	JL26
105	1	JL 4 pm	JL10 pm	-	JN30	-	JL20
106	3	JL 4 pm	JL11 am	-	JN29	-	JL26
107	-	JL 6 am	JL12 am	-	-	-	-
108	5	JL 6 am	JL12 am	-	JL 4	-	JL29
109	2	JL 5 am	JL11 am	-	JL 4	JL 8	JL29
113	-	JL 6 am	JL11 pm	-	-	-	-
114	-	JL18 pm	JL28 pm	-	-	-	-
115	2	JL11 am	JL18 pm	-	JL 9	-	JL29
115E	-	JL18 pm	-	-	-	-	-
116	3	JL22 pm	JL28 pm	-	JL12	JL29	-
117	2	JL 2 am	JL 6 pm	-	JL 1	JL 7	JL13/AU3
118	1,2	JL 4p/5a	JL10p/11	-	JL 2	JL 9	JL18/AU3
118E	-	JL28 pm	-	-	-	-	-
119	1	JL11am	JL17 am	-	JN30	-	-
120	1	JL11 am	JL22 pm	-	JL 8	-	JL13
121	2	JL11 am	JL17 am	-	JL 8	-	-
122	4	JL 9 am	JL14 pm	-	JL 8	-	JL31
123	1,2	JL 5pm	JL13 am	-	JL 4	JL12	JL20/AU3
126	-	JL26 am	-	-	-	-	-
128	-	JL26 am	-	-	-	-	13-
130	1	JL 7a/11p	JL25 pm	-	JL 6	-	JL28
131	1	JL25 pm	-	-	JL20	-	-
132	1,2	JL11 pm	JL21p/22	-	JL 6	-	AU3
133	1,2	JL 6 am	JL22 pm	-	JL 5	JL12	JL31/AU3
134E	1	JL28 am	-	-	JL25	AU 3	-
135	-	JL15 am	JL25 pm	-	-	-	-
136	-	JL22 pm	Jl28 am	-	-	-	-
137	1,2	JL18a/21	JL26 am	-	JN30/JL	JL31	-
138	-	JL22 pm	Jl28 am	-	-	-	-
139	-	JL 8 pm	JL15 am	-	-	-	-
140	2	JL 8 pm	JL15 am	-	NJL 8	-	JL26/AU3
141	2	JL 5 pm	JL13 am	-	JN30	-	JL26
152	1	JL18 am	JL26 am	-	JL12	-	JL28
155	1	JL18 am	JL 28 am	-	JL 9	-	-
157	-	JL28 am	-	-	-	-	-

Table 3. Tree beating: mean larval densities, larval development, pre-spray current defoliation and final post-spray larval mortality and current defoliation from treated spray blocks and untreated areas, Newfoundland in 1995.

BLOCK	PLOT	PRE-SPRAY (means)			POST-SPRAY	
		l/BEAT [a]	IDL [b]	% DEF [c]	% MORT [d]	% DEF [c]
102	1,3	180.7	1.1	3.0	99.7	18.0
Check		370.2	1.0	2.0	9.1	39.0
103	6,7	73.8	1.3	5.0	96.7	7.5
Check		50.0	1.3	5.0	11.4	11.7
105	1	134.6	1.0	5.0	99.1	8.0
106	3	255.0	1.0	4.0	92.7	13.0
108	5	534.7	1.1	6.7	99.3	11.7
109	2	134.8	1.3	7.0	100.0	10.0
Check		143.4	1.0	5.0	6.1	18.0
115	2	115.0	2.1	5.0	68.1	21.7
Check		51.3	2.2	6.7	0.0	36.7
Check		167.0	1.5	20.0	2.6	86.7+28
116	3	359.0	2.2	23.3	81.3	33.3
Check		458.7	2.5	45.0	69.5	81.7+37
117	2	586.2	1.0	10.0	98.4	15.0
118	1,2	144.8	1.0	4.0	98.8	19.5+7
120	1	424.0	2.0	35.0	99.9	43.0+10
122	4	138.0	1.5	25.0	61.6	18.3+7
Check		129.7	1.5	6.9	0.0	52.7
123	1,2	238.5	1.0	5.0	95.0	10.0
130	1	266.0	1.1	5.0	98.9	5.0
132	1	149.3	1.2	5.0	98.0	5.0
132	2	2125.0	1.2	25.0	99.7	48.3+15
133	1	1257.0	1.1	8.3	99.8	73.3+17
133	2	390.0	1.1	5.0	95.1	5.0
Check		319.3	2.0	20.0	83.1	76.7
134E	1	304.7	2.7	75.0	84.2	71.7+23
137	1,2	22.0	1.0	1.0	51.4	5.0
140	2	317.0	1.7	13.3	86.2	73.3+22
141	2	107.4	1.0	3.0	89.6	6.0
152	1	783.3	1.8	31.7	84.3	75.0

a=no. Of larvae per sample; b= Index of larval development; c=% defoliation of current years growth (+ older needles); d=% larval mortality

Feeding trial

The feeding trials were designed to give a crude indication of insecticide deposit and effectiveness compared with unsprayed foliage, by feeding looper larvae on sprayed and unsprayed foliage. Table 4 indicates, that larvae were exposed to B.t. and that survival was less on sprayed foliage.

Aerial defoliation assessment:

The annual aerial survey to map defoliation, conducted by NFS with input from the CFS, was used to further assess defoliation in treated blocks. Generally, although the forecast was for moderate to severe defoliation, most of the treated blocks, particularly those with significant larval populations, had only scattered pockets of damage, the exception being where post-spray weather affected the product (Blocks 119, 120 & 121) and where there was previous defoliation. More defoliation was mapped outside of the spray blocks. There was more defoliation in the areas which received a late application of insecticide after damage became noticeable. Table 6 provides the percent of block area defoliated by category. In areas where population levels were categorized as higher and treatment was delayed or applied later , there was significantly more defoliation.

Conclusion:

The 1995 hemlock looper spray program was considered successful in limiting defoliation by reducing population levels, based on the limited data collected. The results reported were influenced by sampling restraints in terms of variability and timing due to weather as well as the normal parameters in operational programs. The aerial defoliation assessment corroborates the observations in the field. There were some exceptions which appeared to be partially explained by previous defoliation and/or delays in the application of insecticide in combination with higher population levels. Data indicated that both products were comparable in the observed results.

Table 4. Block, plot, number of larvae, B.t. product, percent mortality and larval index of development at set-up for 1995 hemlock looper feeding trials in Newfoundland.

BLOCK/PLOT	NO. OF LARVAE	BT PRODUCT	% MORTALITY	
1st application		Trial Days:	5	PLOT 10
109-1	25	FORAY 76B	100	100
109-2	25	FORAY 76B	60	100
109-3	25	FORAY 76B	16	100
109-4	25	FORAY 76B	20	92
109-5	25	FORAY 76B	80	100
117-1	25	FORAY 76B	36	100
117-2	25	FORAY 76B	92	100
117-3	25	FORAY 76B	40	100
117-4	25	FORAY 76B	48	100
117-5	25	FORAY 76B	40	100
2nd application				
109-1	25	FORAY 76B	24	100
109-2	25	FORAY 76B	72	100
109-3	25	FORAY 76B	76	100
109-4	25	FORAY 76B	44	100
109-5	25	FORAY 76B	20	96
117-1	25	FORAY 76B	72	100
117-2	25	FORAY 76B	84	100
117-3	25	FORAY 76B	32	84
117-4	25	FORAY 76B	100	100
117-5	25	FORAY 76B	88	100
CHECK-1	25		32	48
CHECK-2	25		56	72
CHECK-3	25		20	32
CHECK-4	25		48	52
CHECK-5	25		32	48
CHECK-6	25		28	40
CHECK-7	25		20	40
CHECK-8	25		16	32

* All larvae were field collected

Table 5. Aerial defoliation estimate for hemlock looper spray blocks in Newfoundland in 1995.

BLOCK #	LOCATION	TREATED SIZE (HA)	% OF BLOCK AREA BY DEFOL. CATEGORY			
			NONE	LIGHT	MOD.	SEVERE
102	Adies Pond	1 386	100	-	-	-
102E *	Adies Pond Extension	1 230	75	23	2	<1
103	Bonne Bay Little Pond	2 222	100	-	-	-
105	Bonne bay Big Pond	797	88	12	-	-
106	Grindstone Pond	720	73	27	-	-
107	North Lake	1 089	92	8	-	-
108	Mistaken Pond	1 455	68	31	<1	-
109	Goose Arm Pond	335	100	-	-	-
113	Monkey Brook	1 019	100	-	-	-
114	Hughes lake	463	98	2	-	11
115	Kettle Pond	685	35	65	-	-
115E *	Kettle Pd. Extension	405	26	61	13	-
116	Moose Pond	541	35	50	6	9
117	Thirty-Ninth Brook	711	99	-	-	1
118	Island Pond	5 685	95	2	1	2
118E *	Island Pd. Extension	475	54	-	-	46
119	South Brook	659	82	4	14	-
120	Carp Creek	738	45	27	28	-
121	Black Gulch Brook	488	44	-	52	4
122	North Pond	852	92	5	3	-
123	Little Grand Lake	3 387	94	6	-	-
126	Halfway Mountain	107	100	-	-	-
128	Saddler Lake North	502	100	-	-	-
130	Bottle Lake	2 534	98	1	-	<1
131	Puddle Pond	517	96	3	1	-
132	Padille Pond	2 674	99	-	<1	-
133	Lloyd's Lake	1 285	97	-	3	-
134E *	Lloyd's River Extension	210	82	15	3	-
135	Tulk's Brook	956	99	-	1	-
136	East Tulk's Pond	1 684	97	3	<1	-
137	Costigan Lake	4 078	99	1	-	-
138	Valentine Lake	280	79	-	7	14
139	Victoria Dam West	309	85	-	-	15
140	Victoria Dam East	365	94	-	-	6
141	Red Cross Lake	2 364	99	<1	<1	-
152	Diversion Lake	2 516	100	-	-	1
155	Seal Bay Brook	695	100	-	-	-
157	Victoria Lake	1 475	70	-	10	20
	TOTAL	47 893				

* = extra areas identified after defoliation appeared

STATUS OF SOME FOREST PESTS IN NOVA SCOTIA PREPARED FOR THE 23RD ANNUAL FOREST PEST CONTROL FORUM NOVEMBER 1995 OTTAWA

Eric Georgeson
Nova Scotia Department of Natural Resources
Integrated Pest Management Section
P.O. Box 130
SHUBENACADIE, NS
B0N 2H0

Please Note:

This is only a preliminary report since data is still being analyzed and assembled at the time of writing. For a more finished report please contact me at the following address sometime early in 1996.

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Provincial Entomologist
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Nova Scotia Department of Natural Resources
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23 Creighton Road
SHUBENACADIE, NS
B0N 2H0

Integrated Pest Management (IPM) is a section within the Forest Protection Subdivision of the Nova Scotia Department of Natural Resources. The responsibilities of this section are to identify, monitor, and assess insect populations and forest disease conditions in Nova Scotia (primarily forest pests). We also recommend management strategies and carry out forest insect and disease education projects and displays. There are various research projects and surveys that we are involved in with the Federal Government and private industry.

Integrated Pest Management plans, organizes and conducts the vegetation management spray operation on Crown Land and control of noxious weeds in Provincial Parks.

Integrated Pest Management has offices in Shubenacadie and a seasonal lab in Belmont. The lab is otherwise known as the Insectary or the Bughouse. Five permanent staff members and varying numbers of casual staff carry out the duties of the section.

General Overview:

A very mild winter and cool spring across the Province was followed by an average year as far as temperature went, although there was below average rainfall. The mild winter in particular resulted in a better than normal overwintering survival rate for various insects. The earlier defoliators such as Satin Moth and Spring Canker Worm caused wide spread defoliation and resulted in much public concern. An overwintering egg survival study on Gypsy Moth found that there was a survival rate of 84%. This was reflected in very high population counts later in the summer.

The drier than normal spring and summer resulted in less disease in the various insect populations. The one notable exception being a small pocket of gypsy moth that was infected by a "wilt" disease.

Spruce Budworm, *Choristoneura fumiferana* (Clem.):

IPM conducted an aerial survey to determine the extent of defoliation caused by spruce budworm. No defoliation was found in 1995. A Province wide pheromone trap system was set up with sixty (60) traps. Only three (3) moths were captured.

The annual L-2 survey was completed by Nova Scotia Department of Natural Resources staff with one hundred twenty seven (127) sample points being taken (Figure 1). The results of the L-2 wash survey was zero overwintering population in the sample points. We are at the low ebb of the spruce budworm life history. The graph in Figure 2 gives a snapshot of the rise and fall of the spruce budworm population in Nova Scotia.

Plans are now to reduce the number of L-2 points by 85% and replace this survey system with a pheromone trap grid system.

Hemlock Looper, *Lambdina f. fiscellaria* (Gn.):

The hemlock looper population continues to increase across the Province. There was a 400% increase in hemlock looper adults captured in the province wide light trap system. An aerial survey on August 28, 1995, found 55 hectares of low defoliation (10-30%) and 12 hectares of moderate defoliation (31-60%) in the MacRae Brook area of Crowdis Mountain (Figure 3).

Pheromone traps were placed province wide (Figure 4). The results of the traps collected to date indicate that a significant hemlock looper population build up occurred on Cape Breton Island, as well as Antigonish and Guysborough Counties on the mainland. Some pheromone trap catches on Cape Breton Island contained over 4,000 moths/trap.

The 1994 hemlock looper egg survey determined 4,570 hectares of softwood in Victoria and Inverness Counties in Cape Breton were at risk to being defoliated in 1995.

The 1995 province wide hemlock looper egg survey was undertaken based on the higher than expected adult counts in the pheromone survey. Initial results show very high counts of healthy fertile eggs in a number of locations (Figure 5).

At present we are trying to delineate how much area could suffer defoliation. A possible treatment program using Btk for the highlands could occur in 1996.

Spruce Beetle, *Dendroctonus rufipennis*:

The province wide survey that started in 1994 was completed this summer. Figure 6 shows the areas of heaviest attack. By means of aerial surveys we have mapped over 4,400 hectares of white and red spruce attacked by this insect, causing heavy mortality.

Forest Tent Caterpillar, *Malacosoma distria* (F.):

The expected defoliation caused by this insect did occur in Digby and Annapolis Counties (Figure 7). Light trap catches of the forest tent caterpillar dropped 78% Province wide. Only in Cumberland County were there any significant catches this summer.

Rosy Maple Moth, *Dryocampa r. rubicunda* (F.)
and
Maple Spanworm, *Ennomos magnaria* (Gn.):

The rosy maple moth population is building steadily in the Chignecto Game Sanctuary. Some defoliation has been noted. The maple spanworm population has dropped over 50% from 1994 numbers. No defoliation was noted for this insect.

<u>Gypsy Moth</u>, *Lymantria dispar* (L.):

Gypsy moth populations greatly increased in areas where populations are already established in western Nova Scotia (Figure 8). To keep track of populations the Nova Scotia Department of Natural Resources did a number of joint surveys with Agriculture and Agri-Food Canada. Detection surveys were done in the eastern region and delineation surveys were done in the western area. The results are still being processed and will not be ready until December. Nova Scotia Department of Natural Resources set up a permanent gypsy moth trap system using 25 multipher traps. The results are in Figure 9. We plan to double the number of traps by next year.

<u>Balsam Fir Sawfly</u>, *Neodipriom abietis* and <u>White Marked Tussock Moth</u>, *Orgyia leucostigma* (J.E. Smith):

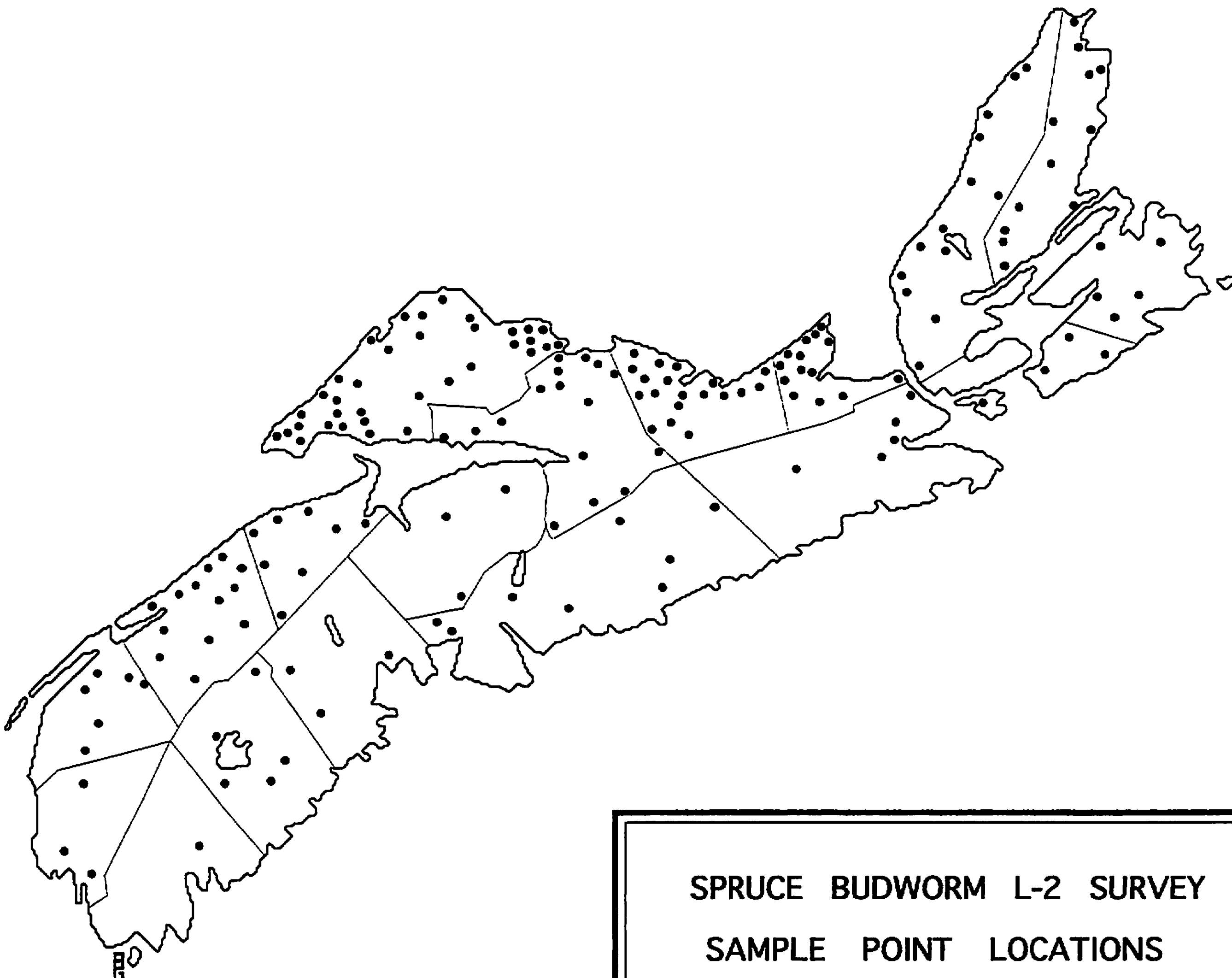
A high population level of balsam fir sawfly was found in the New Harbour area of Guysborough County (Figure 11). Approximately 250 hectares of damage was found mostly in 10 to 15 foot high pre-commercially thinned balsam fir (Figures 9 and 10). As many as six sawfly cocoons were found on each shoot. Samples taken back to the lab had a 51% successful hatch rate. We are expecting heavy defoliation in 1996.

There is also a general increase in the white marked tussock moth in Pictou, Antigonish, Colchester and Guysborough Counties. Only low defoliation in scattered areas is noted to date.

<u>Sirococcus Shoot Blight of Red Pine</u>, *Sirococcus conigenus*:

An aerial survey done in September found 169.3 hectares of red pine that should be removed at Trafalgar and the Garden of Eden barrens areas (Figure 10). It was noted that infected red pine plantations in the Atlantic and Bay of Fundy coastal areas continue to decline with many plantations exhibiting mortality.

PEST CONTROL FORUM 1995
LIST OF FIGURES



SPRUCE BUDWORM L-2 SURVEY
SAMPLE POINT LOCATIONS
1995

Figure 1

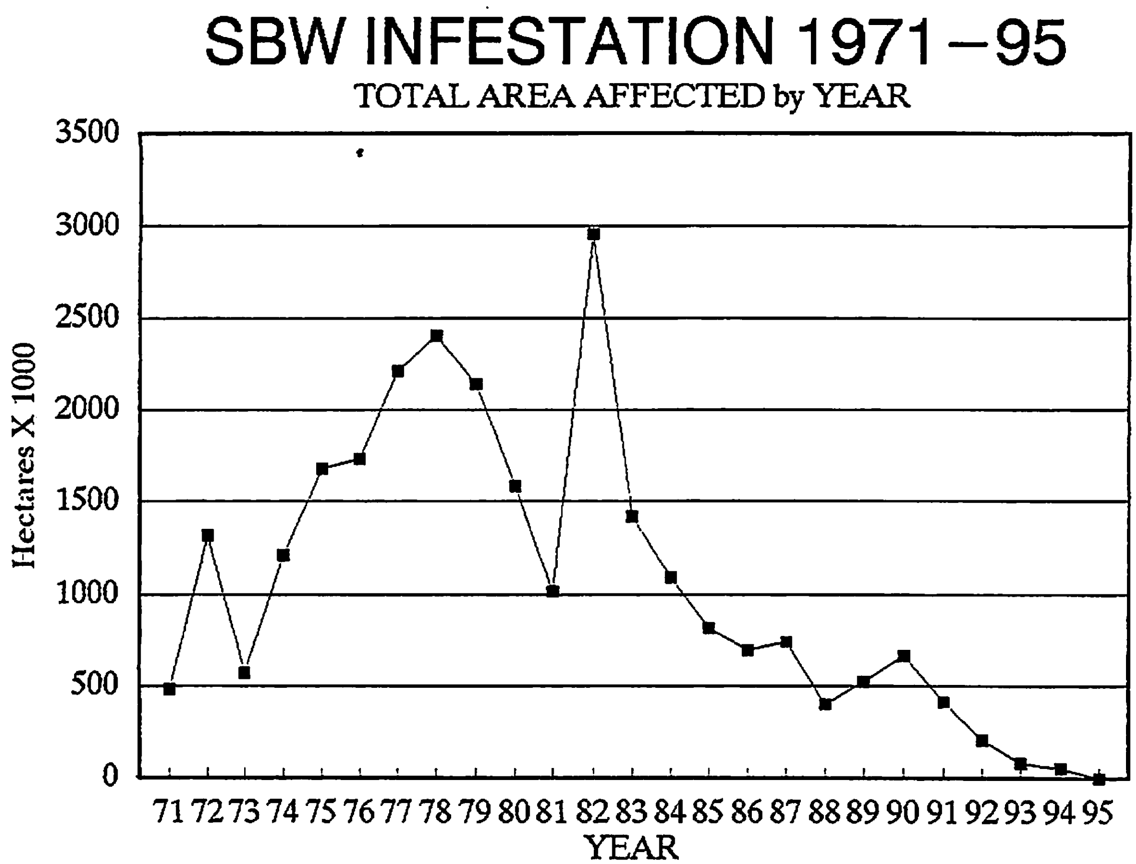

SBW INFESTATION 1971–95
TOTAL AREA AFFECTED by YEAR
Hectares X 1000
3500
3000
2500
2000
1500
1000
500
0
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95
YEAR

Figure 2

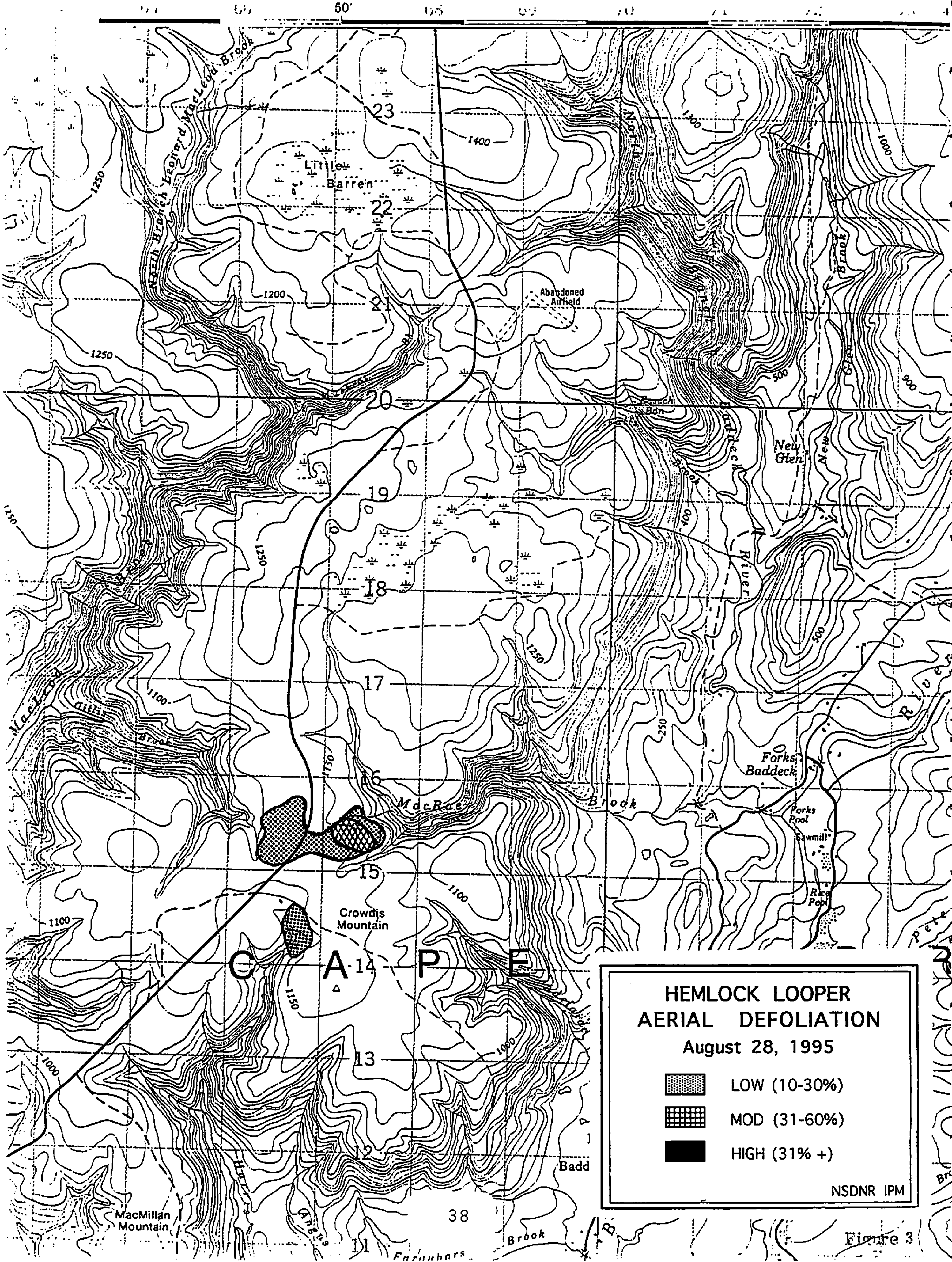
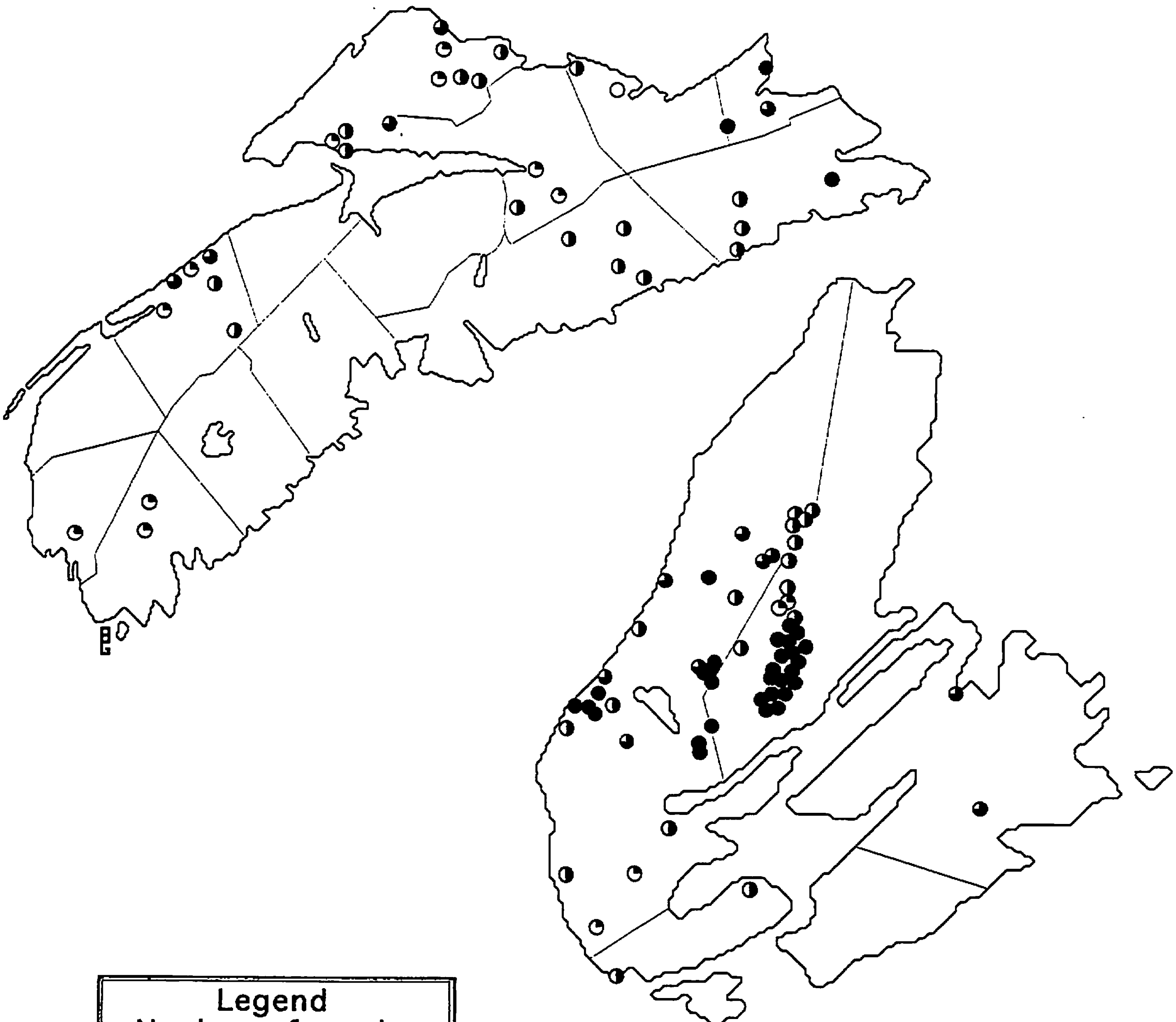

HEMLOCK LOOPER
AERIAL DEFOLIATION
August 28, 1995
LOW (10-30%)
MOD (31-60%)
HIGH (31% +)
NSDNR IPM
Little Barren
Abandoned Airfield
North Branch Leonard MacLeod Brook
MacRae Brook
Crowdis Mountain
MacMillan Mountain
New Glen
New Glen Brook
North Branch Baddeck River
Forks Baddeck
Forks Pool
Sawmill
Rice Pool
Gillis Brook
MacLeod Brook
C A P E
50'
23
22
21
20
19
18
17
16
15
14
13
12
11
1400
1300
1250
1200
1150
1100
1000
900
500
400
250

Figure 3

NOVA SCOTIA
HEMLOCK LOOPER PHEROMONE SURVEY
1995

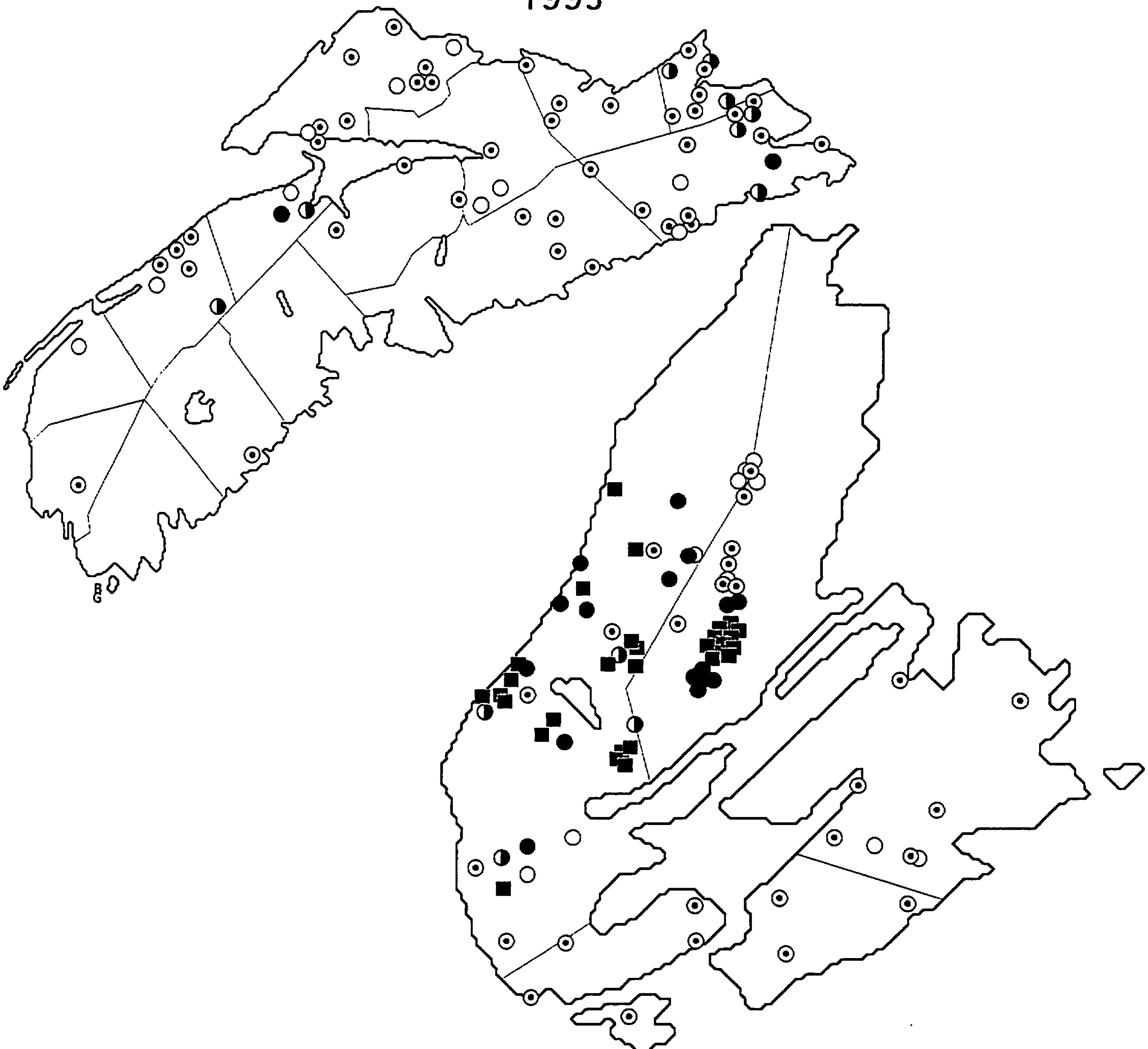


Legend
Number of moths per trap
○ - 0
◐ - 51-200
⊙ - 1
◕ - 201-500
◔ - 2-50
● - 501+
IPM NSDNR

Cape Breton Island (enlarged)

Figure 4

NOVA SCOTIA
HEMLOCK LOOPER EGG SURVEY
1995



LEGEND

Fertile eggs per 100 cm branch	Symbol	Category
0	○	Zero
1-4	⊙	Low
5-9	◑	Moderate
10-19	●	High
20+	■	Extreme

Integrated Pest Management NSDNR

Figure 5

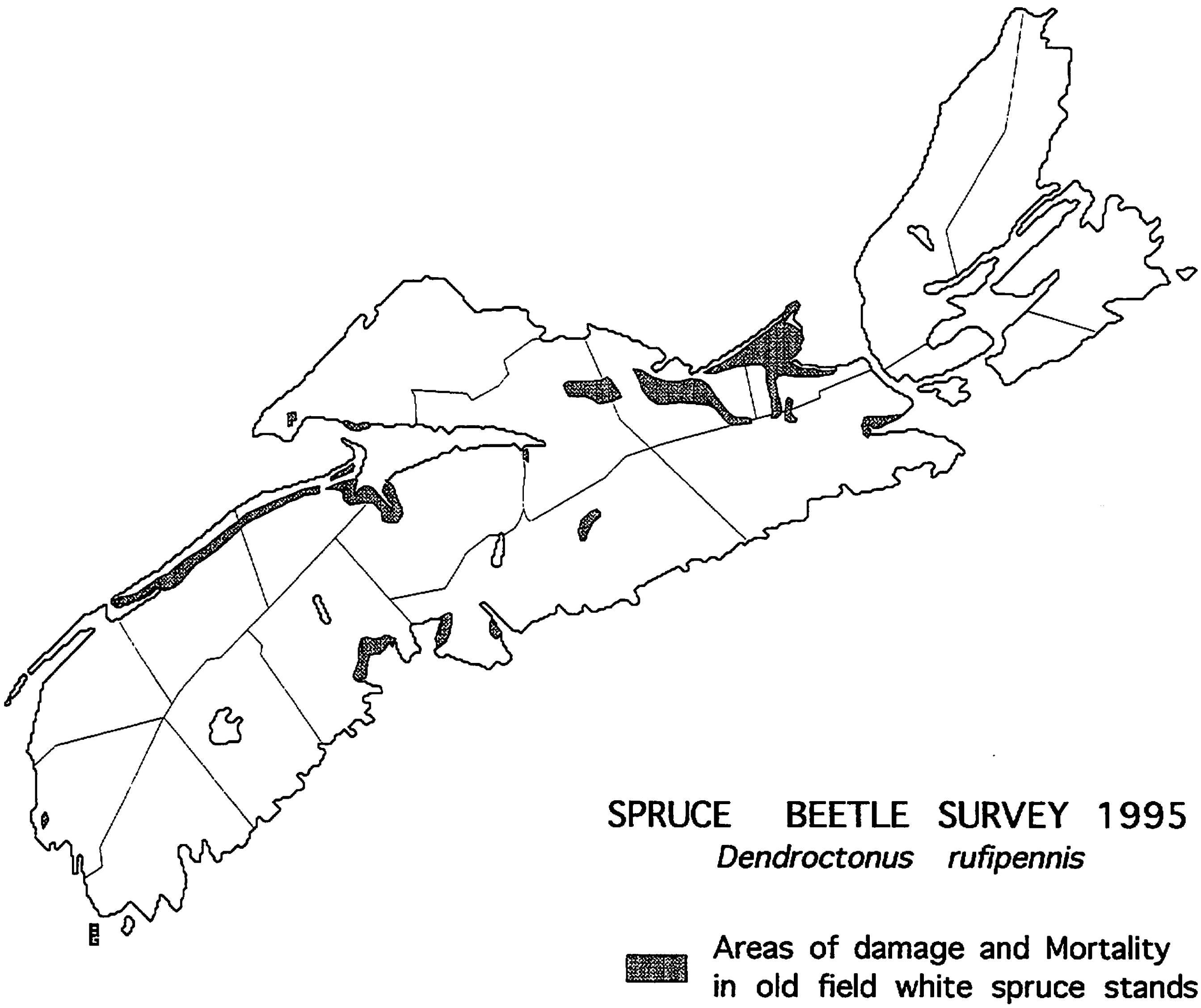

SPRUCE BEETLE SURVEY 1995
Dendroctonus rufipennis
Areas of damage and Mortality in old field white spruce stands

Figure 6

FOREST TENT DEFOLIATION 1995

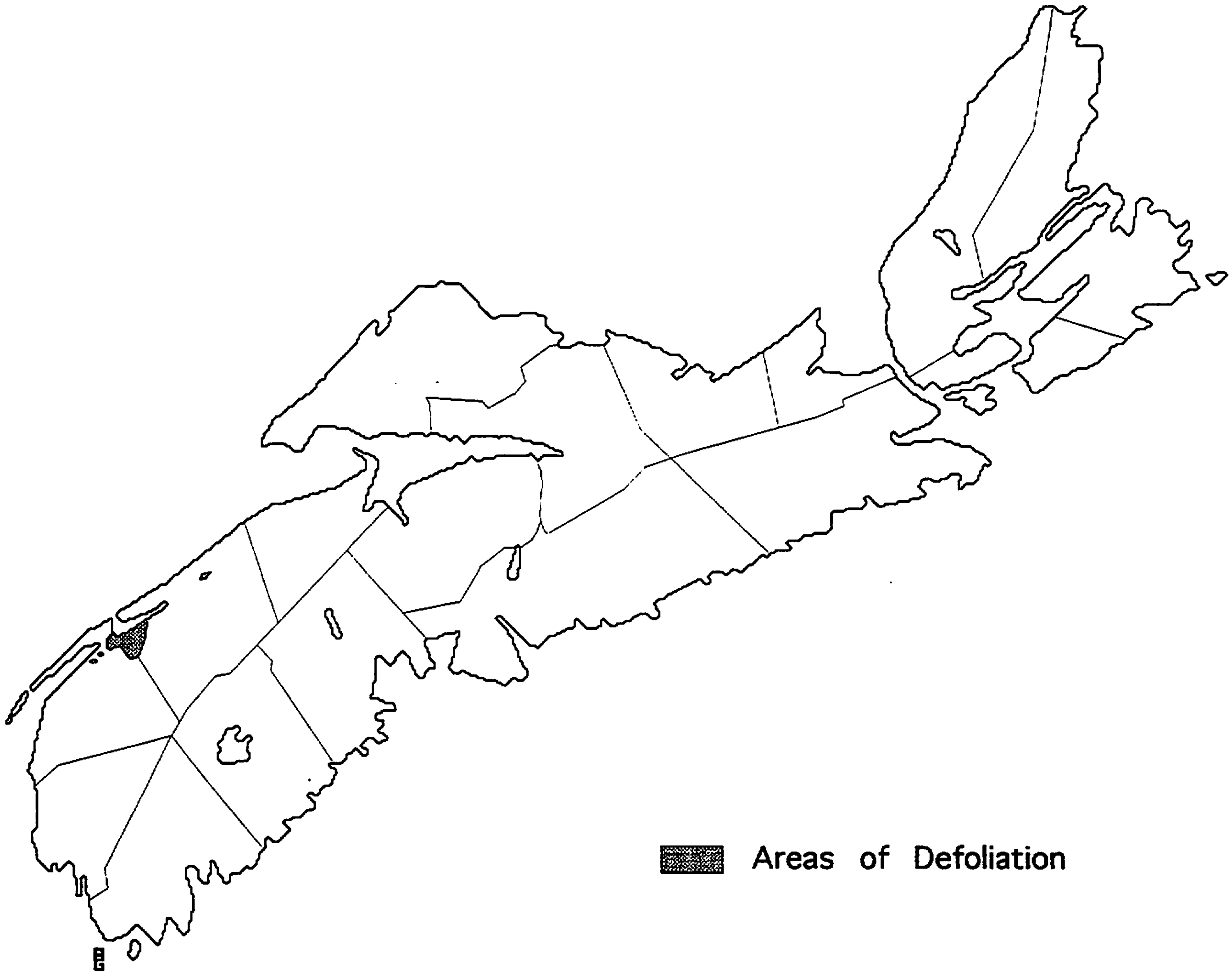


Figure 7

GYPSY MOTH POPULATION CONCENTRATIONS
NOVA SCOTIA 1995

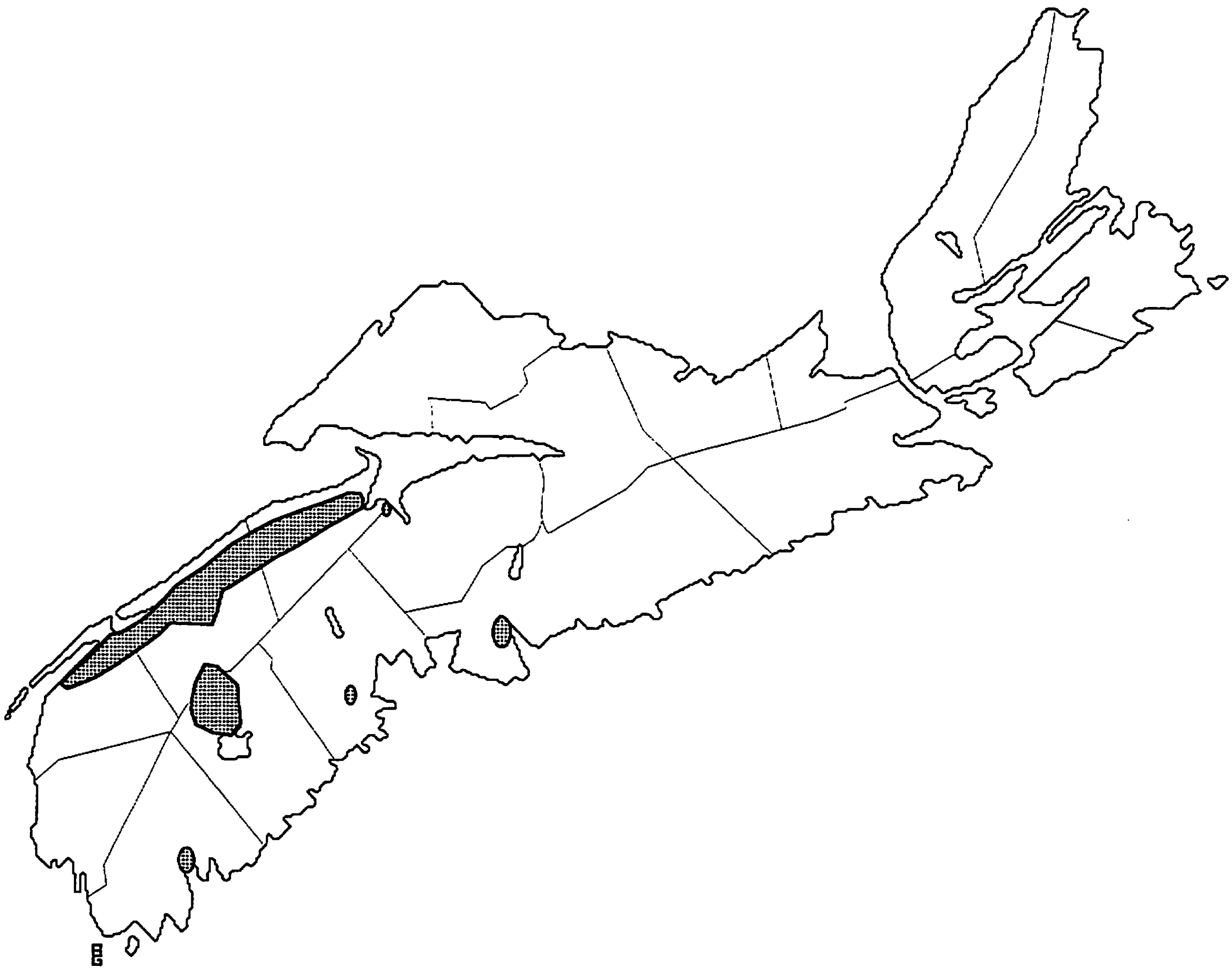


Figure 8

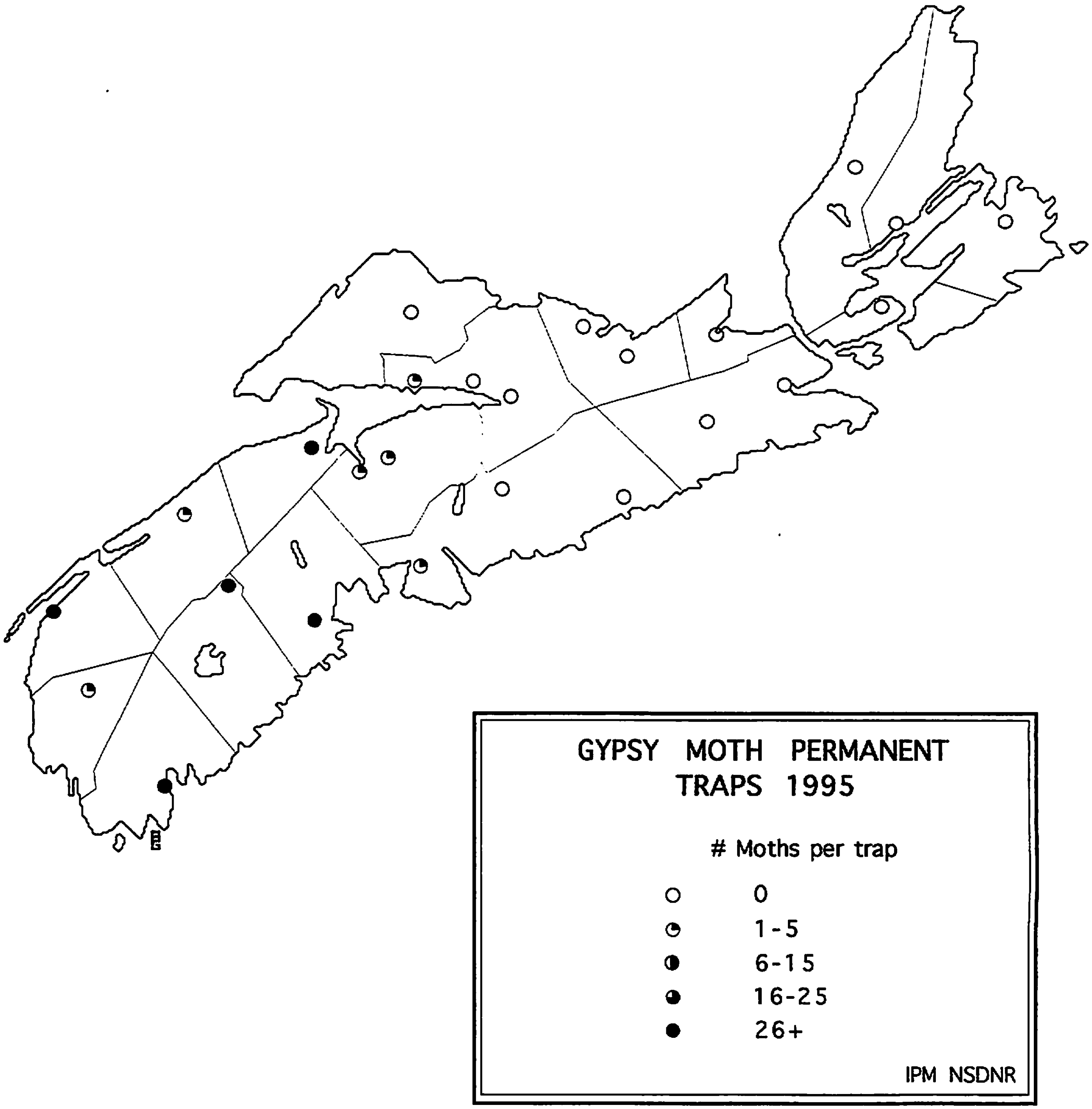

GYPSY MOTH PERMANENT TRAPS 1995
Moths per trap
0
1-5
6-15
16-25
26+
IPM NSDNR

Figure 9

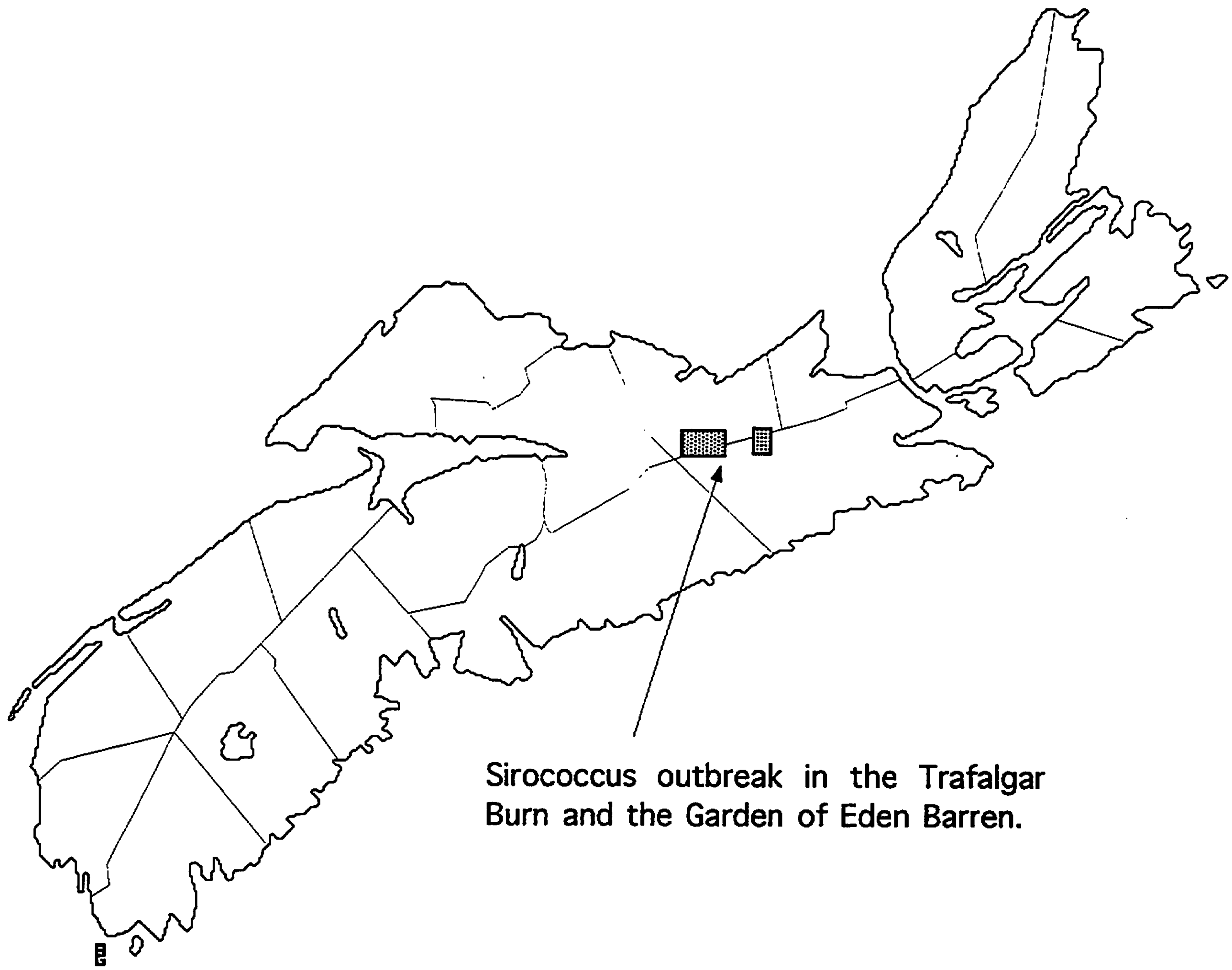

Sirococcus outbreak in the Trafalgar
Burn and the Garden of Eden Barren.

Figure 10

Balsum Fir Sawfly 1995

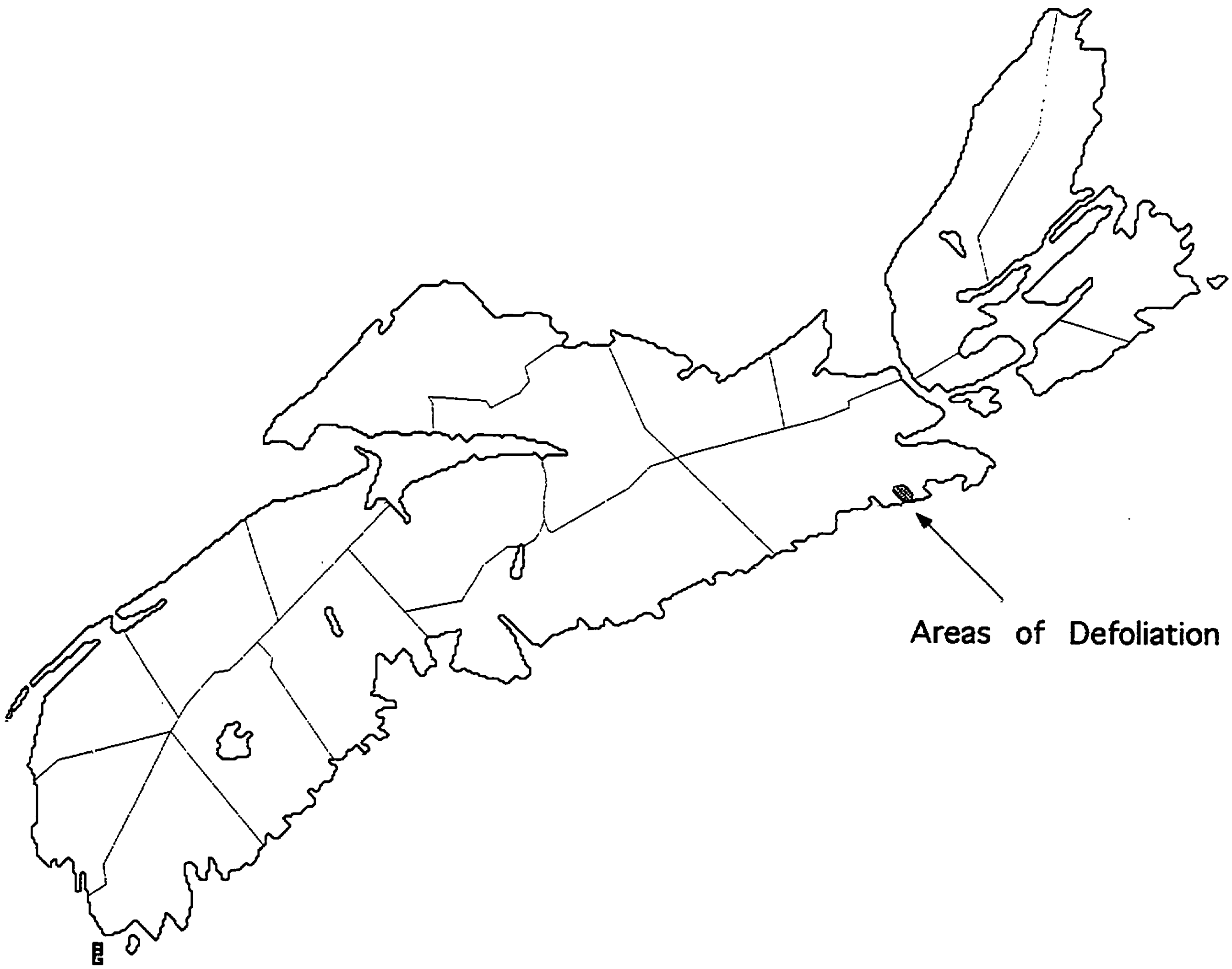
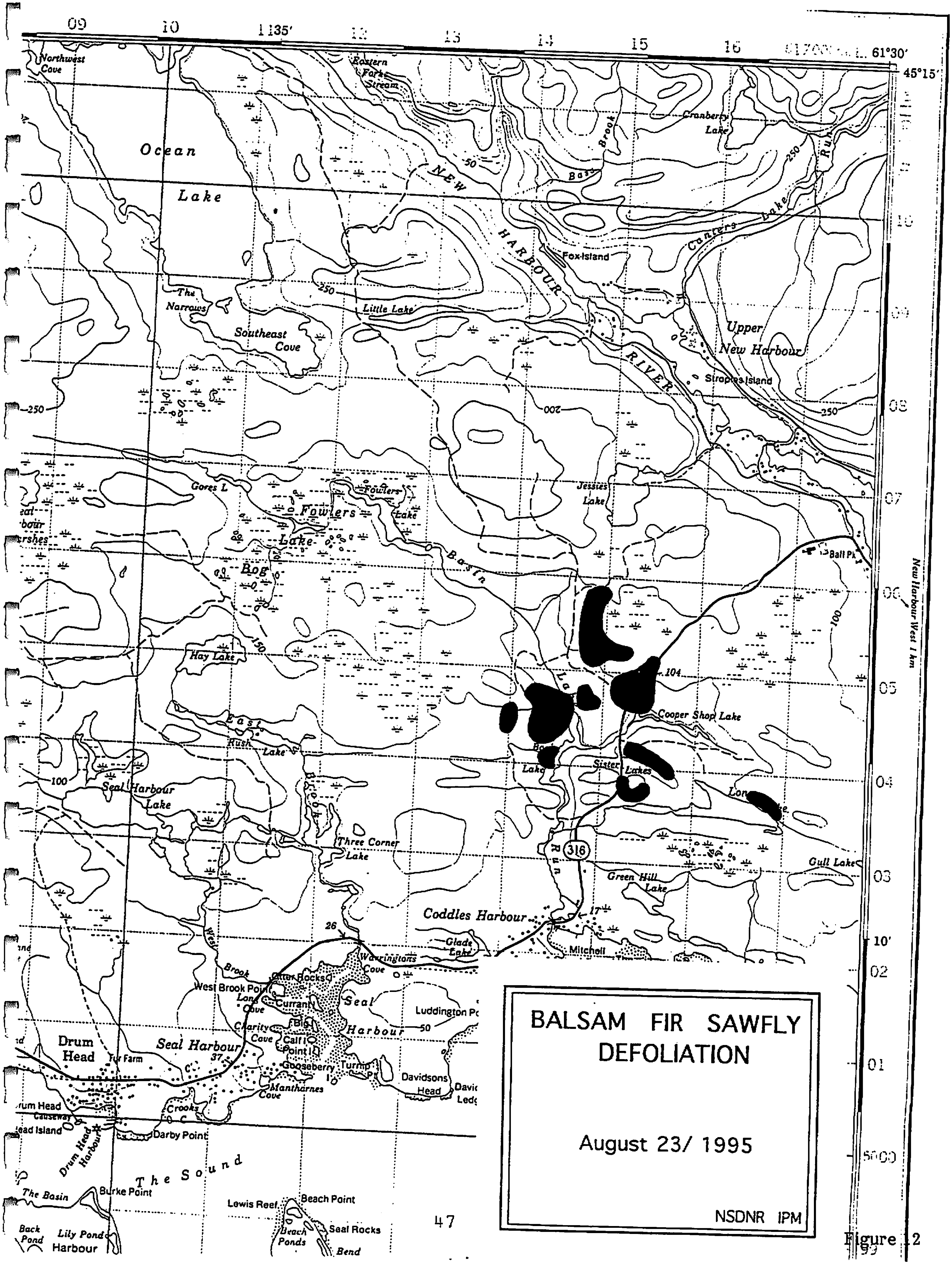


Figure 11



BALSAM FIR SAWFLY DEFOLIATION

August 23/ 1995

NSDNR IPM

Figure 12

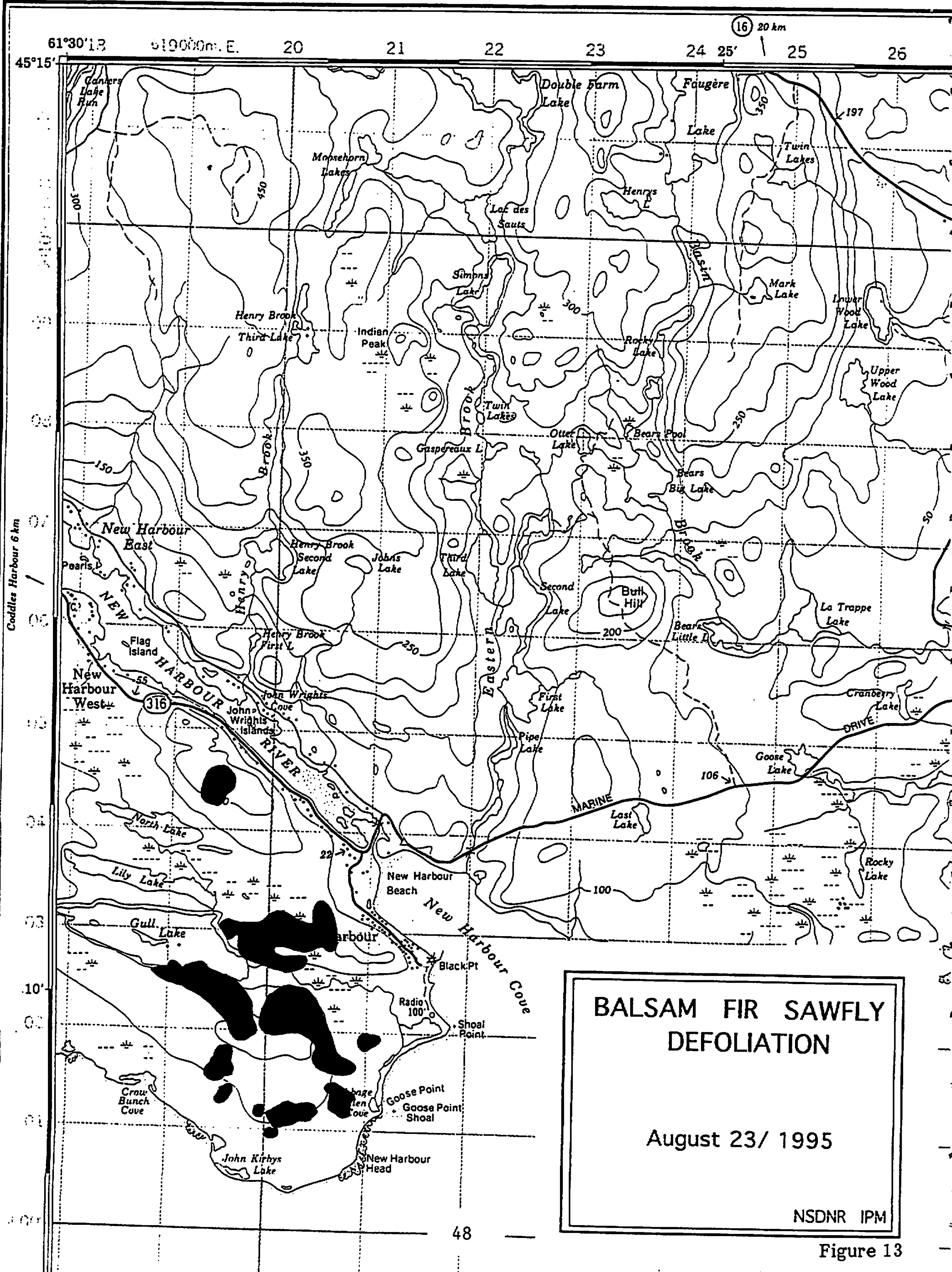

BALSAM FIR SAWFLY
DEFOLIATION
August 23/ 1995
NSDNR IPM
61°30'
45°15'
.10'
20
21
22
23
24
25'
25
26
20 km
Coddles Harbour 6 km
Double Farm Lake
Fougère Lake
Twin Lakes
Moosehorn Lakes
Henrys L
Lac des Sauts
Simmons Lake
Mark Lake
Lower Wood Lake
Henry Brook Third Lake
Indian Peak
Rocky Lake
Upper Wood Lake
Twin Lakes
Otter Lake
Bears Pool
Gaspereaux L
Bears Big Lake
New Harbour East
Pearls
Henry Brook Second Lake
Johns Lake
Third Lake
Second Lake
Bull Hill
La Trappe Lake
Flag Island
Henry Brook First L
Bears Little L
New Harbour West
John Wrights Cove
John Wrights Islands
First Lake
Cranberry Lake
Pipe Lake
Goose Lake
NEW HARBOUR RIVER
MARINE DRIVE
Last Lake
North Lake
Lily Lake
New Harbour Beach
Rocky Lake
Gull Lake
New Harbour Cove
Black Pt
Radio 100
Shoal Point
Goose Point
Goose Point Shoal
Crow Bunch Cove
John Kirbys Lake
New Harbour Head
Eastern Brook
Basin Brook
Henry Brook
316

Figure 13

STATUS OF GYPSY MOTH IN NEW BRUNSWICK IN 1995
(Prepared* for Annual Forest Pest Control Forum, Ottawa, Nov. 21-23, 1995)

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 commitment by Agriculture and Agri-Food Canada (AAFC) to initiate an aggressive eradication and/or slow-the-spread program in the 1980s and the lack of a federal national policy on GM (finally one was adopted in 1995). 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 local areas not previously known to be positive for GM.

1993

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 (of 272 examined) were found to be positive east of Fredericton, in addition to 24 locations (of 279 examined) 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.

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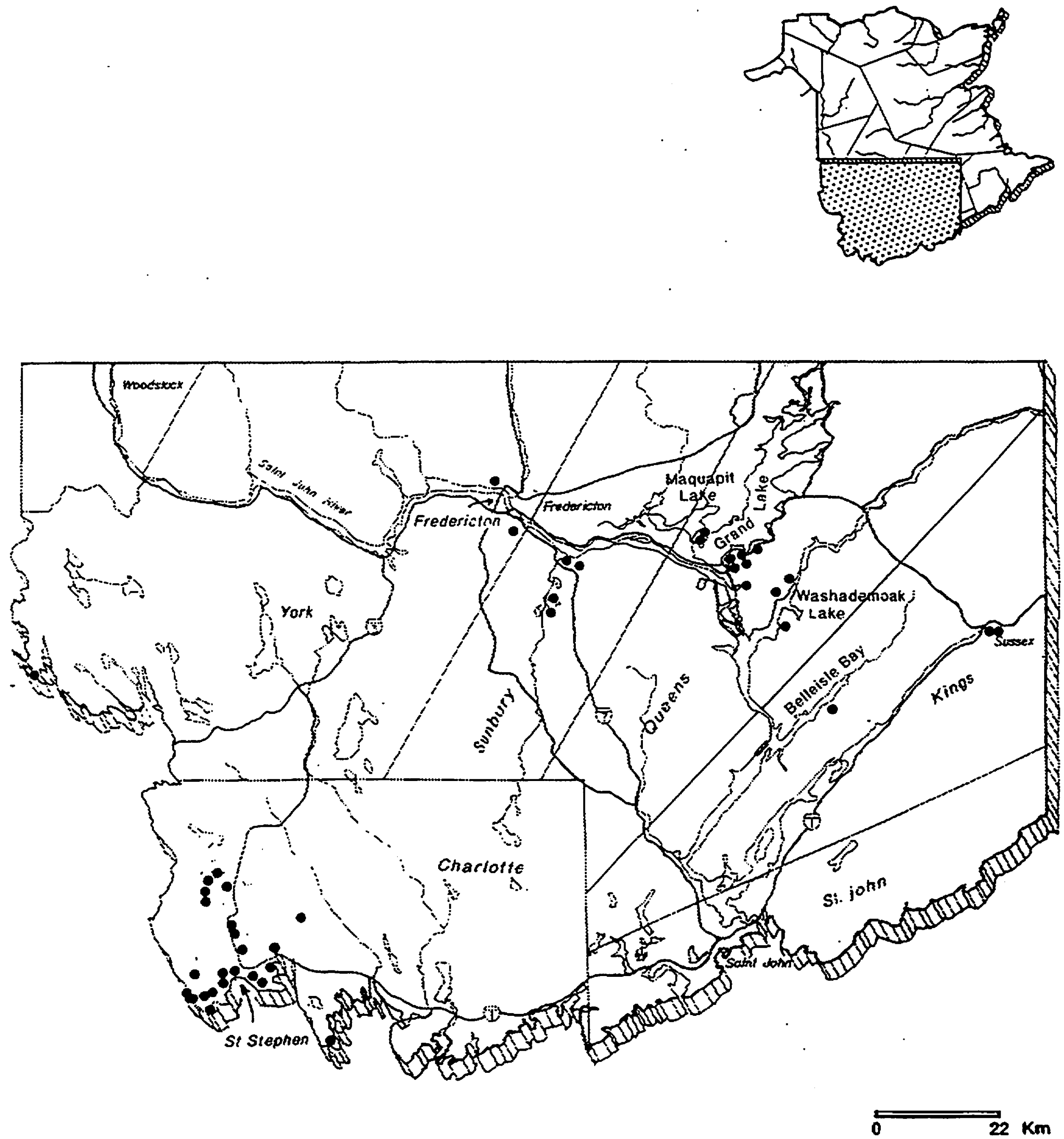

Figure 1. Approximate locations (●) where Gypsy Moth life stages (other than male moths) were found in New Brunswick in 1993 (Note: 507 negative locations not shown).

1994

In the summer of 1994, a Province-wide survey for GM life stages other than male moths was conducted (excluding the 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.

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.

In the Fall of 1994, a survey was conducted from Oct. 27 to Dec. 2 prior to significant snowfall. Overall, 687 locations were examined (30 minutes/2-person-crew/location). Positive GM life stages were found at 65 of the 451 locations east of Fredericton, and 38 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.

1995

In the fall of 1995, egg mass searches were again conducted by DNRE, concentrating on the southwestern and southcentral parts of the Province. Overall, a total of 601 sites were visited resulting in the detection of life stages (other than male moths) at 137 locations. Whereas the majority of these corresponded to previously known positive areas, 26 were new detections. In many cases, these new sites are located at some distance from the known areas/zones (Figure 4). Whether GM populations continue to grow and coalesce to ultimately cause an outbreak in the Province remains to be seen.

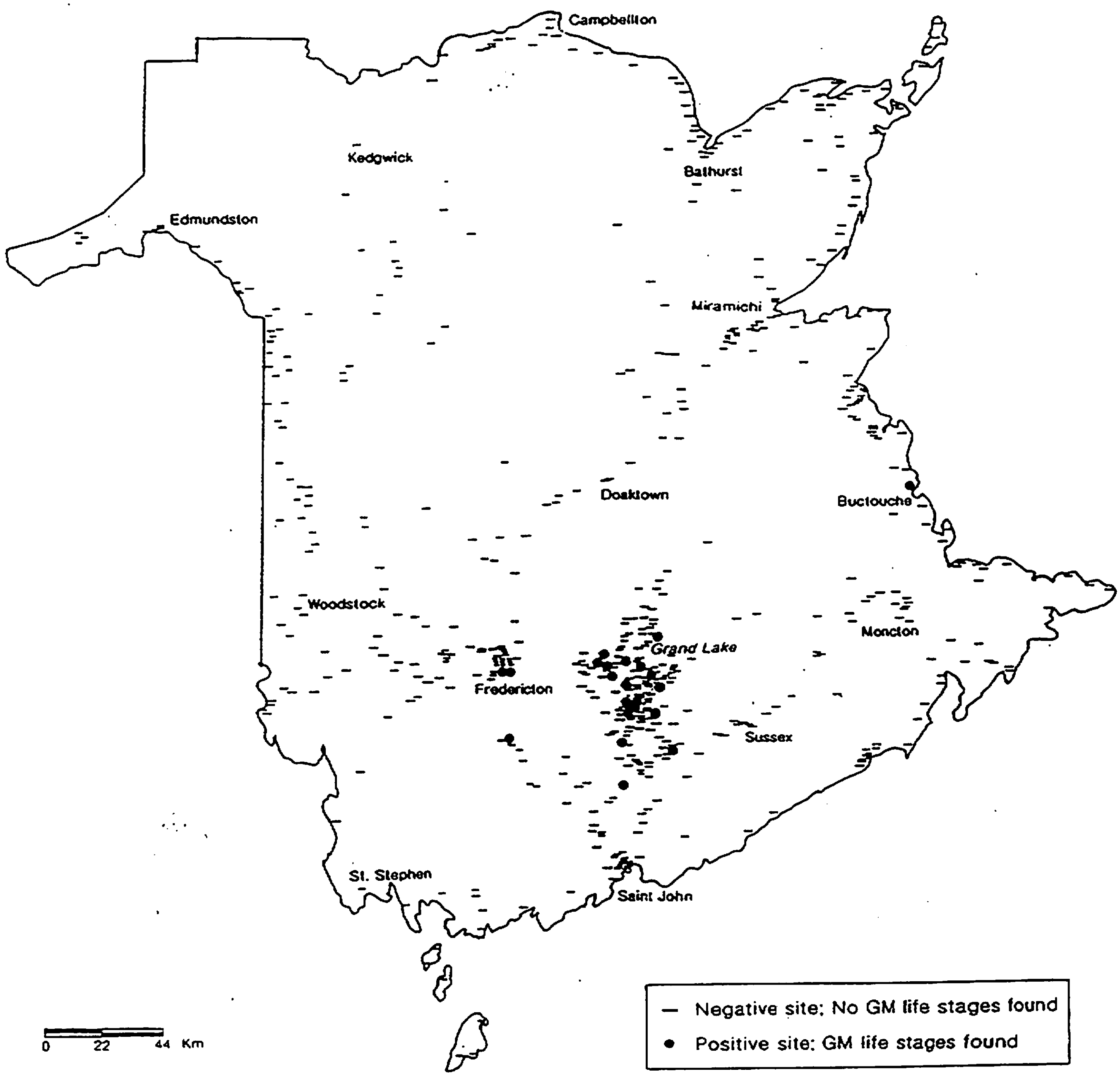

Figure 2. Locations sampled for Gypsy Moth life stages (other than male moths) during the Summer 1994 life stage survey.

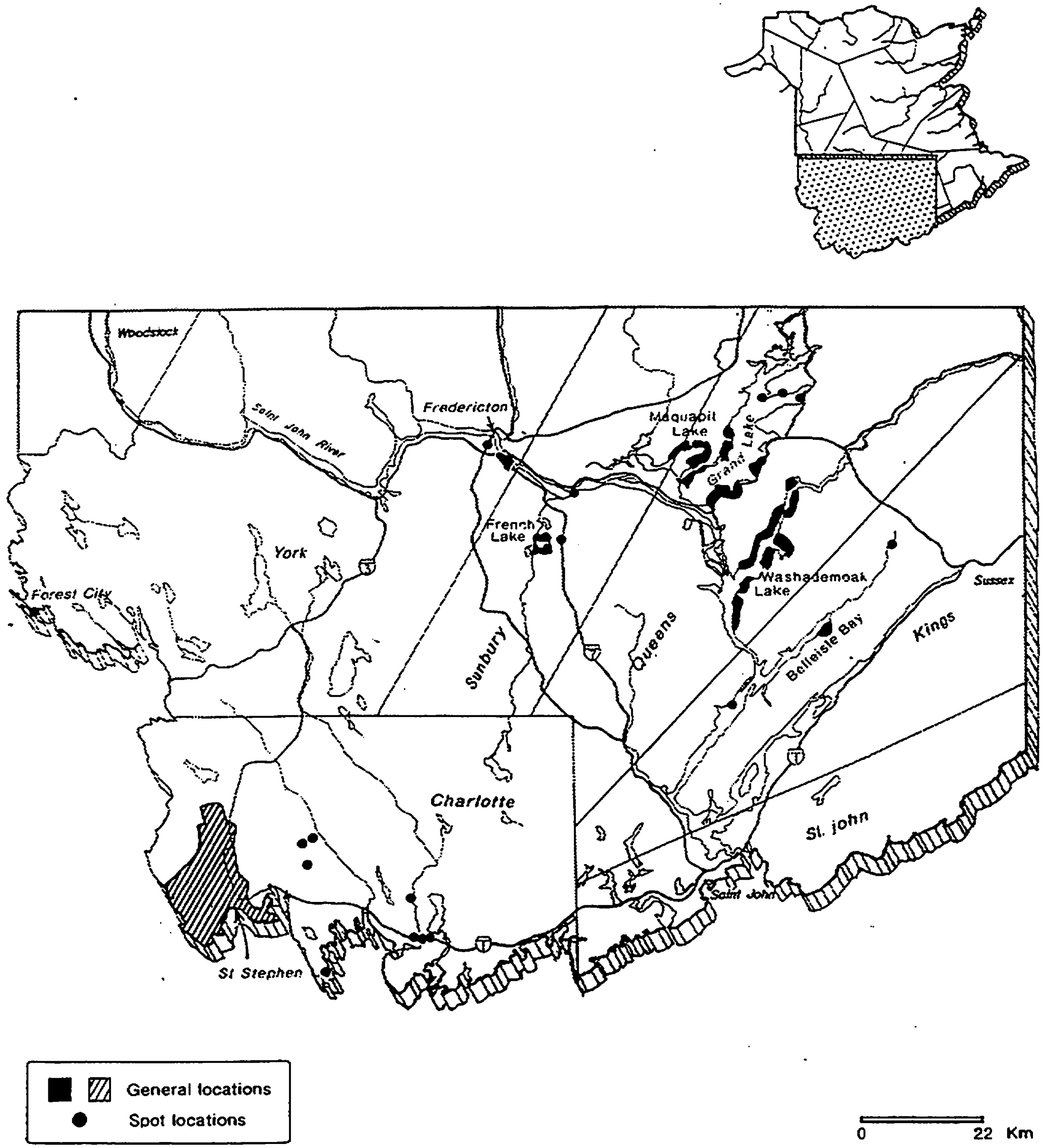

Figure 3. Areas and locations within which positive life stages of Gypsy Moth (other than male moths) were detected in New Brunswick in the Fall of 1994.

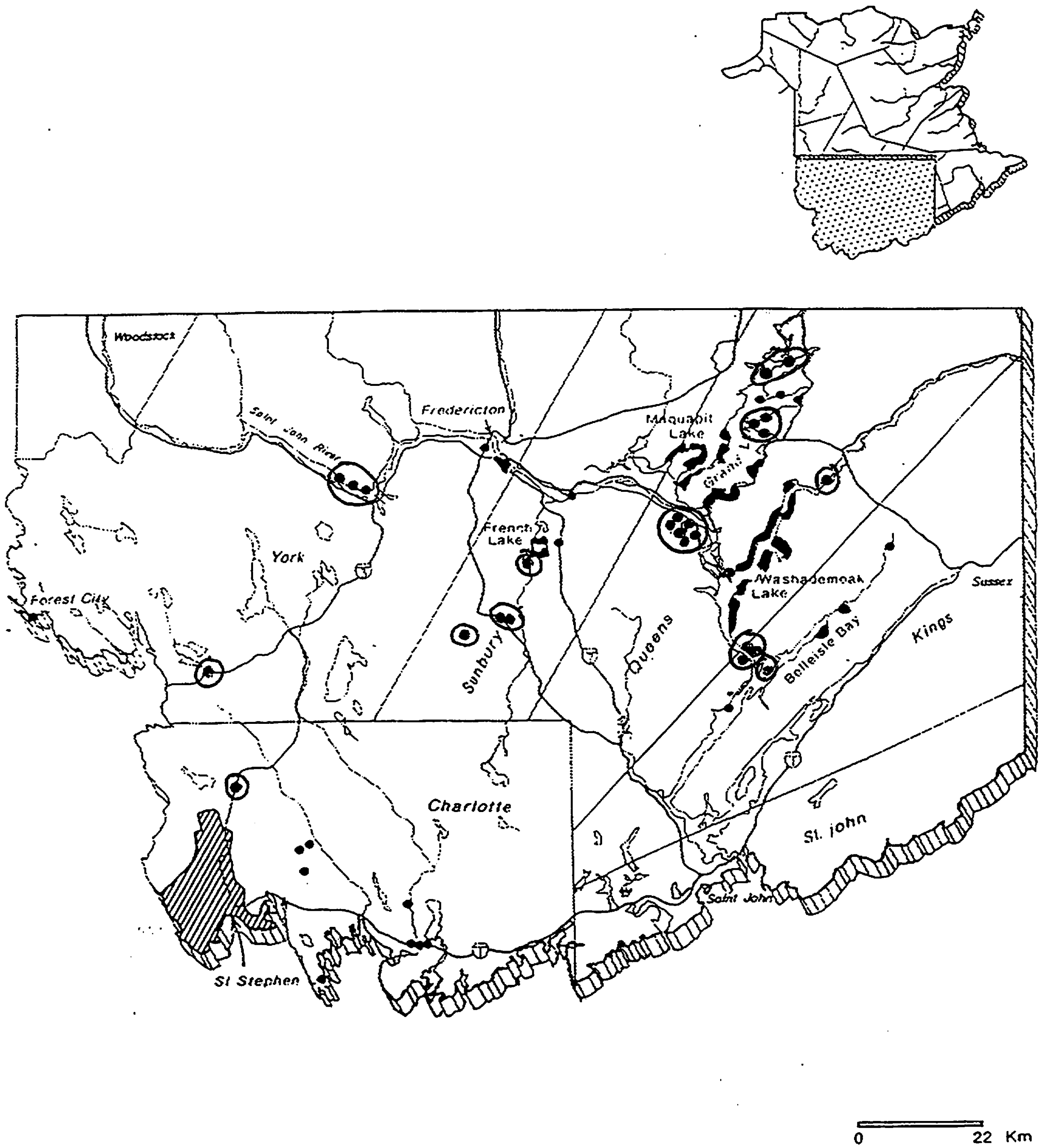

Figure 4. Approximate locations where Gypsy Moth life stages (other than male moths) were found in New Brunswick in 1995. (Note: negative locations not shown).

SPRUCE BUDWORM IN NEW BRUNSWICK IN 1995
(Prepared * for Annual Forest Pest Control Forum, Ottawa, Nov. 21-23, 1995)

Status

Spruce budworm has been the main pest of softwood forests in 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, no spraying was done on Crown land in 1994. Nonetheless, J. D. Irving Limited treated 22 300 ha on their freehold limits. In 1995, Forest Protection Limited treated 5732 ha in protection spray trials for the Department of Natural Resources and Energy; and J. D. Irving Ltd. treated 3518 ha of its own freehold land. Figure 1 illustrates the size of protection programs conducted by Forest Protection Limited in New Brunswick from 1952 to 1995.

In 1993 and 1994, the aerial survey of defoliation did not detect any areas of budworm feeding large enough to map. In 1995, the survey detected only 4312 ha of moderate defoliation located in two main areas (Figure 2). The larger area (4135 ha) occurred in the northwest close to the Quebec border. The smaller area (177 ha) was located in the north-central part of the Province. Figure 3 illustrates the historic trend of moderate and severe defoliation in New Brunswick from 1949 to 1995.

Forecast

The 1995 fall forecast conducted at 814 points around the Province did not detect any overwintering L2 populations in moderate or higher categories. In fact, only 11 detectable low points were encountered (Figure 4). Hence New Brunswick should be virtually free of detectable defoliation in 1996, unless there are isolated pockets which were not identified due to the sampling intensity used. No control action is required in 1996.

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Fredericton, N.B., E3B 5H1

Doc.: 95SBWfor.um

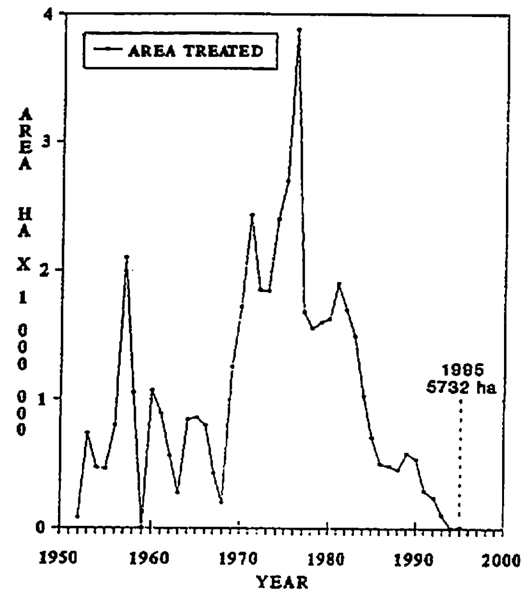

Figure 1. Size of protection programs against spruce budworm conducted by Forest Protection Ltd. from 1952 to 1995.

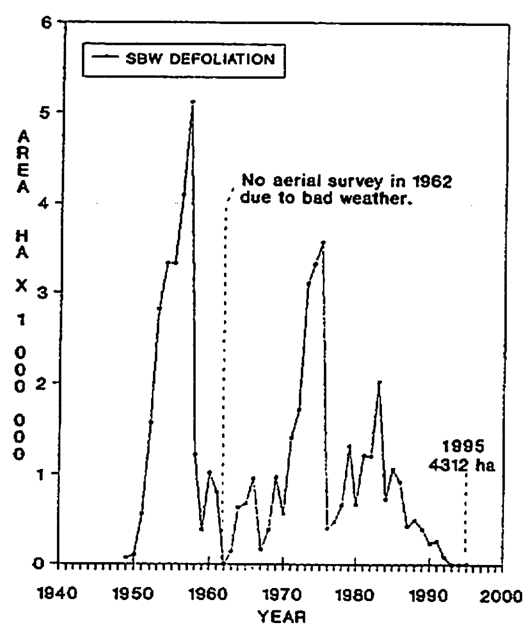

Figure 3. Historic trend of Moderate to Severe defoliation caused by spruce budworm in New Brunswick from 1949 to 1995.

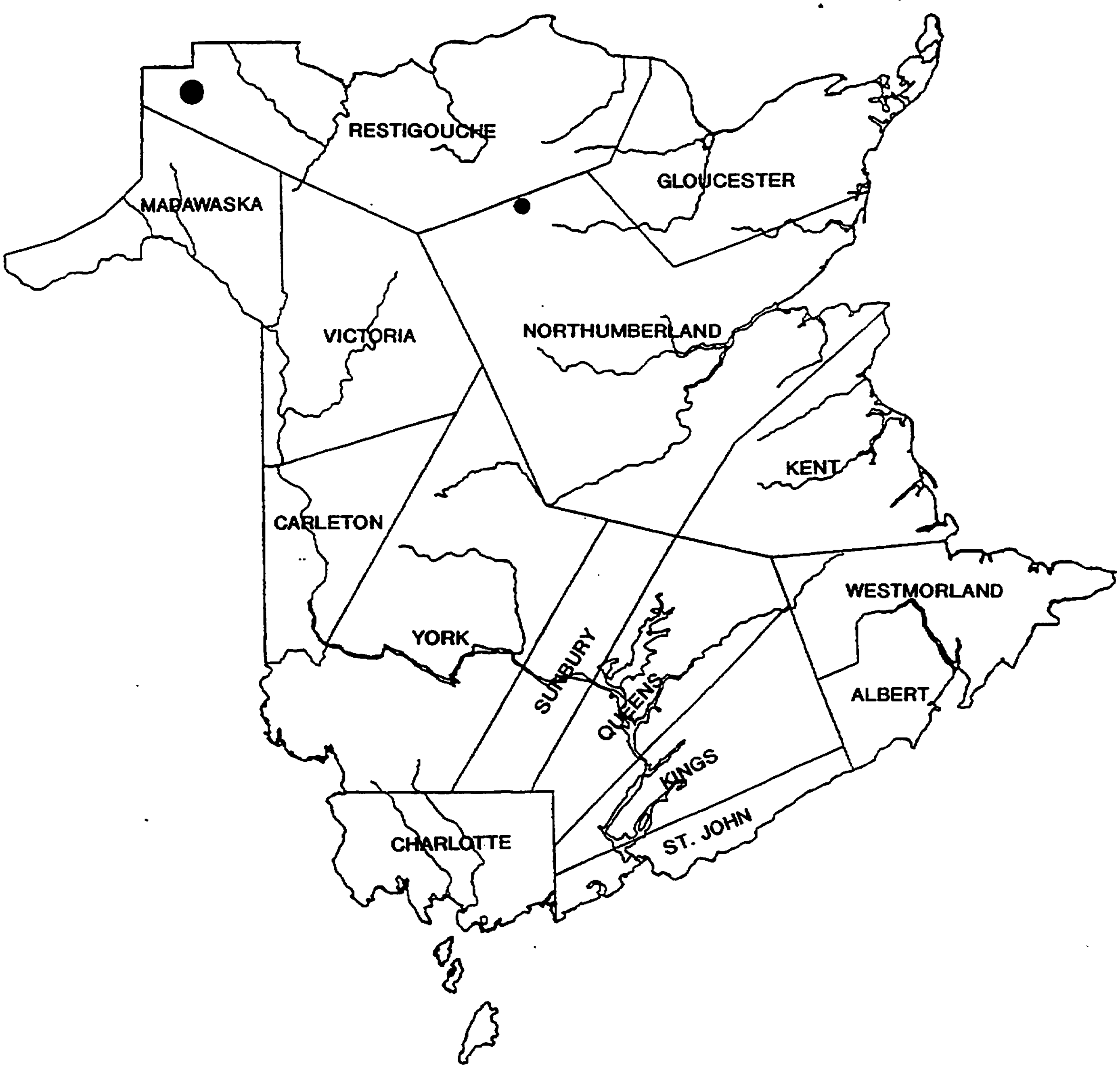

Figure 2. Area of moderate defoliation caused by spruce budworm in New Brunswick in 1995.

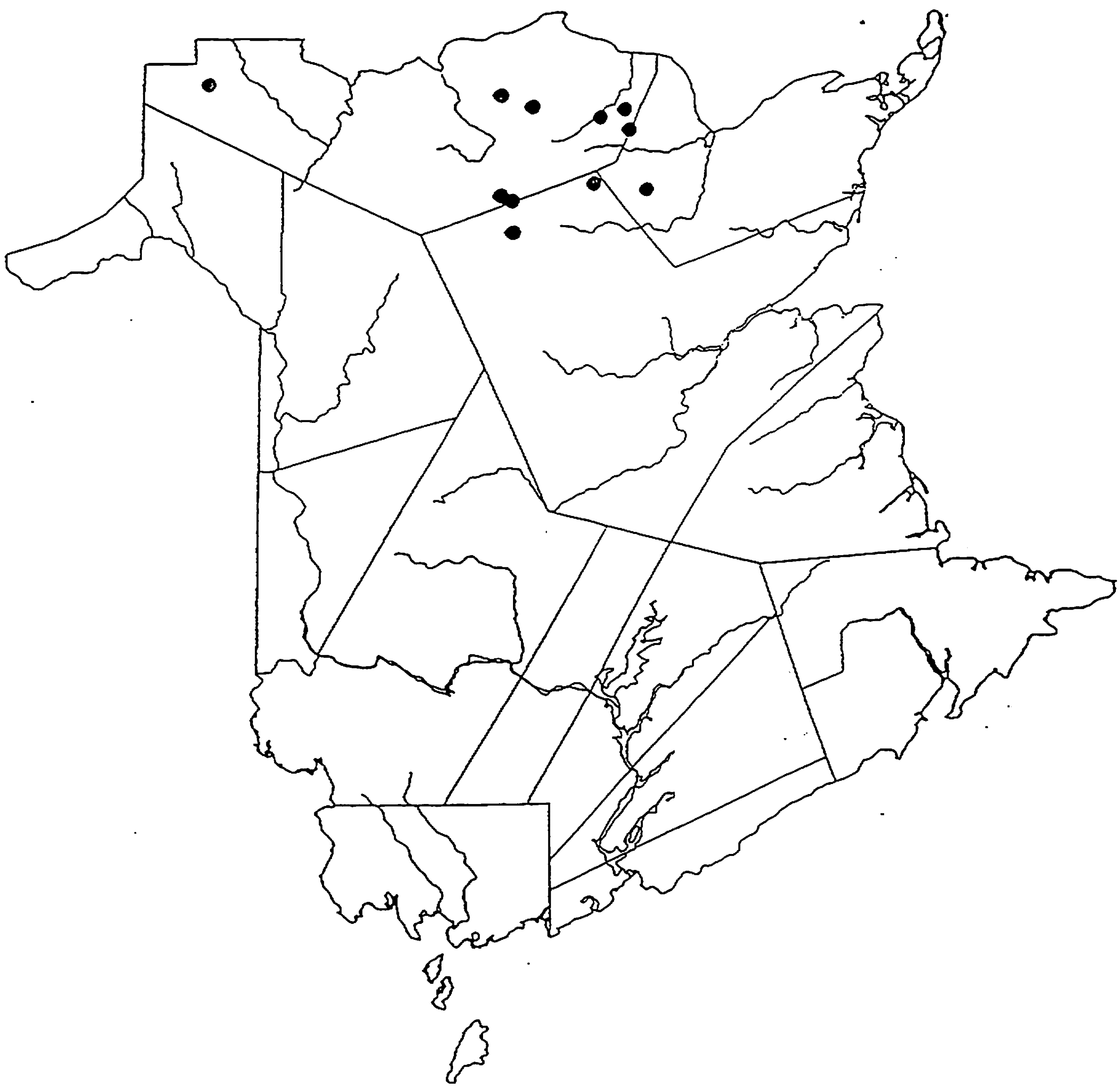

Figure 4. Isolated pockets of detectable low spruce budworm populations forecast to have non-detectable to light defoliation in New Brunswick in 1996.

PROTECTION SPRAY TRIALS AGAINST SPRUCE BUDWORM IN NEW BRUNSWICK IN 1995
(Prepared for Annual Forest Pest Control Forum, Ottawa, Nov. 21-23, 1995)

In 1995, selected spruce budworm infested forest stands in New Brunswick were aerially treated with insecticides to test their efficacy in foliage protection. The insecticides chosen were: two registered brands of Bacillus thuringiensis var. kurstaki, i.e. Foray 76B and Dipel 64AF; and the unregistered chemical insecticide Tebufenozide, brand name MIMIC. The specific objective of the trials was to gather efficacy data for these products applied at low dosage rates. Tebufenozide was of particular interest because of its pending registration; and, because of its high cost, the desire to determine whether a low application rate was efficacious.

TREATMENT INFORMATION

The total area treated was 5 732 ha (Table 1; Figure 1). Spray logistics were planned and implemented by Forest Protection Limited. Approximately 21.1% of the area received a double application of MIMIC at 35 g/0.5 L/ha. About 42.9% received a double application of Foray 76B @ 10 BIU/0.5 L/ha, and 36.0% received a double application of Dipel 64AF @ 15 BIU/1.2 L/ha.

In addition, J. D. Irving Ltd. treated 3 518 ha of its own freehold land with B.t. (Cook, J.D.I. Ltd. pers. comm.) compared to an area of 22 267 ha in 1994.

Table 1. Treatments applied by Forest Protection Limited for protection trials against spruce budworm in New Brunswick in 1995 (does not include J. D. Irving Ltd. program).

Treatment[a]	Hectares	Percent	Aircraft Type[b]
Two Applications - Biological			
10 BIU F76B/0.5 L/ha + 10 BIU F76B/0.5 L/ha	2 462	42.9	SSP
15 BIU D64AF/1.2 L/ha + 15 BIU D64AF/1.2 L/ha	2 060	36.0	SSP
SUB-TOTAL BIOLOGICAL ONLY:	4 522	78.9	
Two Applications - Chemical			
35 g Teb/0.5 L/ha + 35 g Teb/0.5 L/ha	1 210	21.1	SSP
SUB-TOTAL CHEMICAL ONLY:	1 210	21.1	
GRAND TOTAL:	5 732	100.0	

[a] Teb = Tebufenozide (MIMIC)
D64AF = Dipel 64AF
F76B = Foray 76B

[b] SSP = Small Spray Planes (i.e. 2 Cessna 188s with Micronair AU4000s)

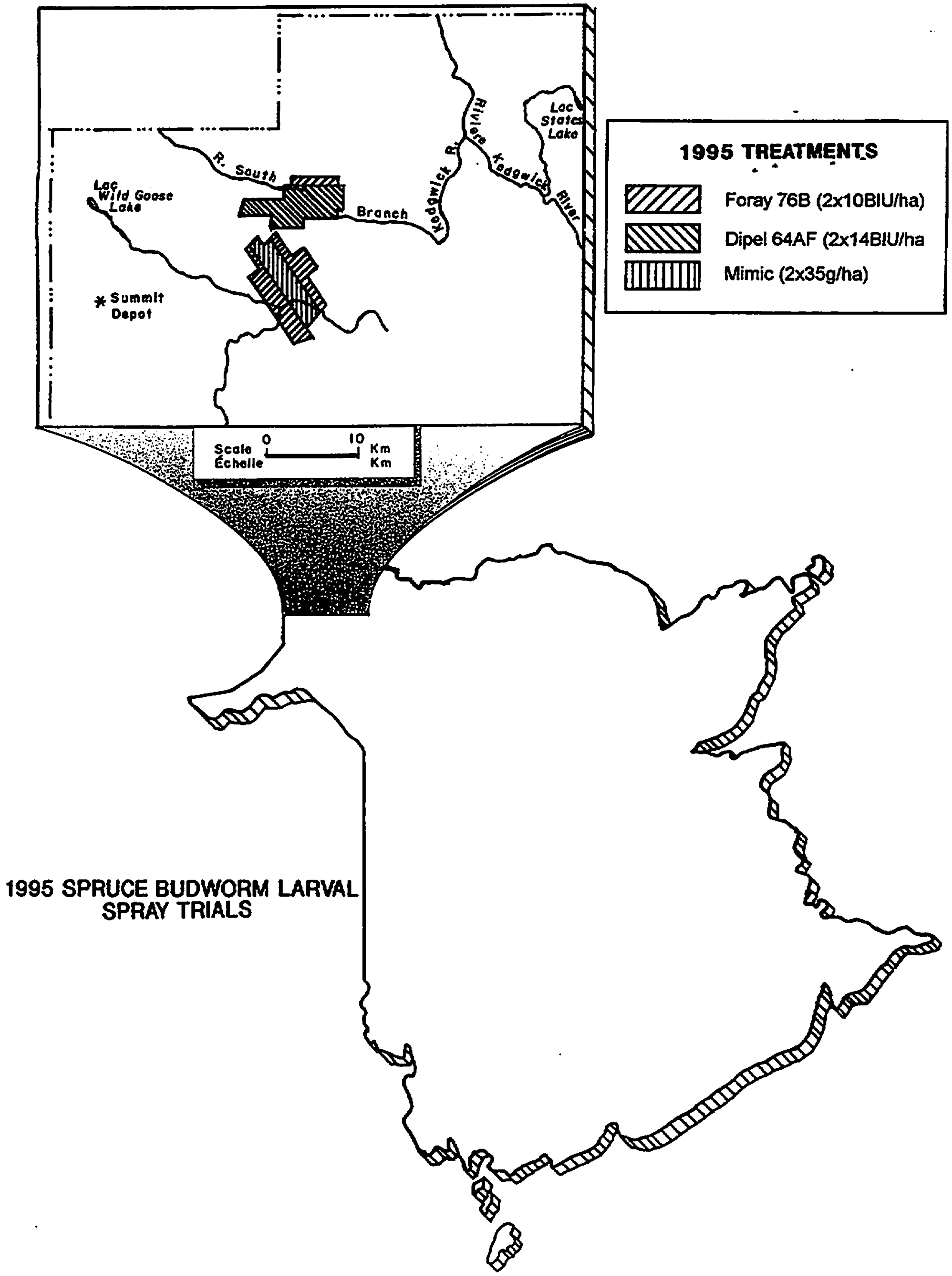

Figure 1. Areas treated by Forest Protection Limited for protection trials against spruce budworm in New Brunswick in 1995 (does not include J. D. Irving Ltd. program).

All insecticides applied by FPL were applied using 2 Cessna 188s, equipped with wind-driven Micronair AU4000 rotary atomizers. The "enhanced atomization technique" was utilized whereby the flowrate through each rotary atomizer was calibrated to approximately 2L/min/unit to produce finer spray droplets.

The MIMIC block (No. 4) and the Foray block (No. 5) were opened for treatment the morning of June 10. The Dipel block (No.2) opened slightly later on June 13.

Application of MIMIC and B.t. began the morning of June 13 and all first applications were completed by June 13 and June 16, respectively. All double applications were arbitrarily scheduled to have a minimum 5-day interval between applications. Applications terminated the morning of June 23.

Shoot elongation and larval development were favorable at the time areas were deemed ready for treatment. Delays due to adverse weather were minimal and post-spray weather did not appear to be a problem.

Because of the special interest in the new product MIMIC, it was decided to obtain spray deposit data after the first spray, 4 days later (prior to the second spray), and immediately after the second spray. This sampling effort was conducted by the Canadian Forest Service-Maritimes Region, and the chemical analyses were done by the New Brunswick Research and Productivity Council in Fredericton.

RESULTS

In 3 treatment blocks and 3 untreated areas, a total of 650 trees were assessed for pre-spray populations, final post-spray populations, and final percent current defoliation. Overall mean pre-spray populations of spruce budworm larvae in untreated plots were lower than those encountered annually between 1988 and 1992; and natural mortality was higher (Table 2). Populations and mortality were similar to 1993, and hence levels of defoliation were somewhat similar to that year.

Differences in pre-spray populations at the block level indicate <u>caution</u> in making comparisons, especially between the MIMIC data and the B.t. data, as well as between MIMIC and the check (untreated) data (Table 3).

To minimize population differences, the data were stratified into four pre-spray larvae/bud population classes (viz.: ≤0.1; >0.1≤0.2; >0.2≤ 0.3; >0.3) for analyses (Table 4). This revealed that most data fell in the low and moderate classes for which Foray 76B and Dipel 64AF both gave similar results with mean percent defoliation being less than in the untreated plots. Sample sizes were too small to draw any conclusions for B.t. in the two higher

Table 2. Changes in mean population levels, mean percent defoliation, and mean percent natural larval mortality in untreated check plots in New Brunswick from 1988 to 1993.

Year	n*	Pre-spray Larvae per 45-cm $\bar{X} \pm SE$	Pre-spray Larvae per bud $\bar{X} \pm SE$	% Natural Mortality $\bar{X} \pm SE$	% Current Defoliation $\bar{X} \pm SE$
1988	395	26.1±1.1	0.364±0.015	65.6±1.5	84.4±1.1
1989	413	14.1±0.6	0.185±0.009	70.5±1.6	48.1±1.7
1990	400	17.6±1.0	0.201±0.011	51.8±1.8	56.7±1.8
1991	400	20.4±0.8	0.262±0.010	65.7±1.5	72.2±1.5
1992	325	10.5±0.5	0.179±0.008	65.2±1.9	67.8±1.5
1993	195	5.8±0.5	0.075±0.005	94.2±1.3	19.4±1.3
1994	n/a	n/a	n/a	n/a	n/a
1995	200	4.4±0.3	0.060±0.003	96.0±1.0	23.0±1.0

* "n" Values may vary for % Natural Mortality.

Table 3. Mean larval densities, larval mortality, and current defoliation on balsam fir trees from treated and untreated transects within the forecast in northern New Brunswick in 1995.

Treatment/ Block No.	n	Pre-Spray Larvae per 45-cm	Pre-Spray Larvae per bud	% Mortality Observed	% Defol- iation Observed
Tebufenozide (MIMIC) - 2 x 35 g/ha					
Block 4	150	8.7	.120	96.0	51.0
Bacillus thuringiensis - (Foray 76B) - 2 x 10 BIU/ha					
Block 5	150	2.3	.033	89.0	16.0
Bacillus thuringiensis - (Dipel 64AF) - 2 x 15 BIU/ha					
Block 2	150	3.5	.049	98.0	11.1
Untreated					
C-1	50	2.4	.036	100.0	15.0
C-2	75	4.1	.063	99.0	23.0
C-3	75	6.1	.073	92.0	29.0
C-pooled	200	4.4	.060	96.0	23.0

population classes, **hence more data are required to confirm acceptable efficacy of Foray 76B and Dipel 64AF at these levels.**

Ironically, mean defoliation in the MIMIC plots exceeded the levels in the untreated plots at similar pre-spray larval densities. To explain this, it is postulated that there was a re-distribution of larvae caused by larvae dropping to the mid-crown from the upper-crown after pre-spray samples had been obtained. This could have happened if the insecticide deposit somehow disturbed the larvae and caused them to vacate their original feeding sites without causing immediate mortality. Hence more feeding damage would have occurred than expected.

Table 4. Summary of means and standard errors of various parameters for treatments stratified by pre-spray population classes.

Pre-spray Population Range (Larvae/Bud)	Treatment*	n	Larvae/ 45-cm $\bar{x}\pm SE$	Larvae/ Bud $\bar{x}\pm SE$	Total Larval Mortality $\bar{x}\pm SE$	% Defoliation $\bar{x}\pm SE$
≤0.1	Untreated (Pooled)	168	3.3±0.2	.044±.002	96.0±1.0	22.0±1.0
	2 x Teb. @ 35 g/ha	80	5.4±0.3	.062±.003	94.0±2.0	46.0±3.0
	2 x F76B @ 10 BIU/ha	141	2.1±0.2	.026±.002	89.0±3.0	16.0±1.0
	2 x D64AF @ 15 BIU/ha	131	2.2±0.2	.033±.003	99.0±1.0	10.0±1.0
>0.1≤0.2	Untreated (Pooled)	29	10.0±0.6	.139±.005	98.0±1.0	30.0±3.0
	2 x Teb. @ 35 g/ha	46	10.9±0.7	.141±.004	98.0±1.0	58.0±3.0
	2 x F76B @ 10 BIU/ha	9	5.8±1.2	.140±.009	92.0±7.0	17.0±3.0
	2 x D64AF @ 15 BIU/ha	16	11.4±1.1	.139±.008	98.0±1.0	16.0±3.0
>0.2≤0.3	Untreated (Pooled)	3	10.3±4.1	.220±.003	100.0±0.0	38.0±16.0
	2 x Teb. @ 35 g/ha	18	13.8±1.1	.238±.006	99.0±1.0	50.0±6.0
	2 x F76B @ 10 BIU/ha	-	-	-	-	-
	2 x D64AF @ 15 BIU/ha	2	16.5±8.5	.228±.006	100.0±0.0	39.0±20.0
>0.3	Untreated (Pooled)	-	-	-	-	-
	2 x Teb. @ 35 g/ha	6	20.8±2.8	.370±.035	100.0±0.0	59.0±6.0
	2 x F76B @ 10 BIU/ha	-	-	-	-	-
	2 x D64AF @ 15 BIU/ha	1	20.0±0.0	.417±.000	100.0±0.0	13.0±0.0
Pooled	Untreated	200	4.4±0.3	.060±.003	96.0±1.0	23.0±1.0
	2 x Teb. @ 35 g/ha	150	9.4±0.6	.124±.007	96.0±1.0	51.0±2.0
	2 x F76B @ 10 BIU/ha	150	2.8±0.4	.036±.003	89.0±2.0	16.0±1.0
	2 x D64AF @ 15 BIU/ha	150	4.1±0.5	.052±.005	98.0±1.0	11.0±1.0

*Treatments:
- Untreated - Unsprayed transects.
- 2 x Teb. @ 35 g/ha - Tebufenozide @ 2 x 35 g/ha.
- 2 x F76B @ 10 BIU/ha - Foray 76B @ 2 x 10 BIU/ha.
- 2 x D64AF @ 15 BIU/ha - Dipel 64AF @ 2 x 15 BIU/ha.

A total of 74 foliage deposit samples were collected within 12 hours after the first application of MIMIC. Analysis subsequently revealed a wide range of deposit from 142 to 2120 ppb, and an overall mean deposit of 615 ppb.

Another series of 25 samples taken 4-days later had an average of 472 ppb (range: 110-1228) in the foliage indicating a 23% loss of active ingredient over this period.

Another 45 samples were collected within 12 hours after the second treatment (i.e. 5 days post first treatment) and revealed a mean deposit of only 715 ppb (range: 101-4962). It appears, therefore, that there was not a good deposit from the second application as it was only about one-third of the first.

Analyses were done to examine whether there was a relationship between deposit and defoliation or insect mortality, but no relationships were found. Whether this was because of the "poorer" second deposit, or an overall inadequate deposit, or some other cause (related to the type of insecticide and its mode of action?) is unknown. **More testing is required to determine whether 2x35g/0.5L/ha is too low a dosage rate for MIMIC.**

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ALTERNATIVE APPLICATION STRATEGY FOR GYPSY MOTH VIRUS
(Prepared* for Annual Forest Pest Control Forum held Nov. 21-23, 1995 in Ottawa)

Introduction

In the past three years, the situation with Gypsy Moth (GM) in New Brunswick has changed significantly due to the expansion of populations to new areas and the apparent increase in population densities in these areas. As is often the case, the areas infested are in and around permanent habitation or recreational (eg. cottage) sites. These are locations in which control action, such as aerial application of insecticides, is controversial (to say the least). Nonetheless, in one particular area in south-central New Brunswick there exists an infested area in which the landowners take a special interest in their local circumstances. In 1994, several cottage owners permitted the Department of Natural Resources and Energy to try an integrated control program to reduce GM populations through spring egg mass search and destroy missions, limited burlap tree banding, and intensive pheromone trapping. Unfortunately, these actions proved less than successful as egg mass densities were greater in the fall than in the spring.

Through the dialogue that was established between DNRE, the landowners, and the local Washademoak Environmentalists, an agreement was reached to "try something different" in 1995. DNRE proposed a low-key trial using GM nucleopolyhedrosis virus (npv) which would be applied in an alternative manner. Specifically it was proposed to use hand-held "squirt bottles" to apply the npv directly to GM egg masses in the spring at the time of egg hatch. The theory was that the emerging larvae would become infected, disperse to feeding sites, die and contaminate the environment where un-infected GM larvae would subsequently become infected and die in later instars - hopefully resulting in lower fall egg mass densities.

If this technique gave positive results, it might be considered an alternative application strategy for using GM virus under certain circumstances in sensitive areas rather than aerial application or by ground equipment.

It was anticipated that the method would have a greater chance of affecting populations in circumstances of high egg mass densities where the probability of "cross-infection" would be positively density dependent (i.e. greater larval infection and subsequent fall egg mass reduction where spring egg mass densities were highest). For this trial, however, the range of egg mass densities was dictated by those existing on the sites chosen.

Because GM npv is not yet registered in Canada, a Research Permit was obtained from Agriculture and Agri-Food Canada.

Project Objectives:

1. To determine levels of infection of Gypsy Moth (GM) larvae as a result of the direct application of nucleopolyhedrosis virus (npv) to GM egg masses in the field.

2. To determine the overall impact of npv treatments on population densities.

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Lab Prodedures:

All rearings were conducted in controlled environmental chambers set at 25°C, 60% RH, and 16:8 L:D photoperiod. Environmental chambers and Bell diet were made available by Mr. E. Kettela of CFS-M (Natural Resources Canada). DNRE had done similar rearings previously (Carter and Kettela, 1993[a]).

The nucleopolyhedrosis virus was provided by Dr. J. Cunningham of the Forest Pest Management Institute (Natural Resources Canada) in Sault Ste-Marie, Ontario along with recommended formulation and application rate.

DNA-probes and interpretation were performed by Dr. C. Lucarotti and Mr. Benoit Morin of CFS-Maritimes (Natural Resources Canada), who also assisted in confirming some microscopic diagnoses, especially when other pathogens were encountered.

Selection of Treatment Sites

Based on survey results in the Fall of 1994, three sites in the Washademoak Lake area (south-central New Brunswick) with high GM egg mass densities were identified as candidate areas for the trials. Collections of larvae from one of these sites in 1994 yielded no symptoms of npv infection (Lavigne, 1995[b]). Subsequent to a consultative process with a local interest group, area residents and affected landowners, the three sites were accepted for treatment.

Verification of npv infectivity

Two small lab trials were conducted to demonstrate the viability of the npv and dose acquisition of virus by larvae emerging from treated egg masses. In the first trial, purified npv was applied to small diet plugs and placed in 1.5 ml eppendorf vials to which was added a single first instar GM larva. Of the 15 larvae thus treated 14 died and were confirmed heavily infected with npv.

The second trial was done by spraying the formulated npv on three egg masses in the lab with a hand-held spray bottle calibrated to deliver approximately 1 ml/pump (equivalent to about 5 x 10^7 PIB[c]/ml). The formulation (0.5 L) consisted of 0.65 g of the virus powder (GYPCHECK) dissolved in 375 ml of distilled water and 125 ml of molasses. Each egg mass was treated once with about 2 ml of formulation. Egg masses were allowed to hatch and a subset of emerged larvae (35/egg mass) reared individually on Bell diet until fourth instar or death. Percent viral infection and mortality for each subset after this single application was 60%, 63%, and 26% with a combined average of 50%.

General Health of Population Pre-treatment

The boundaries of all three treatment sites were determined and marked. The areas were: 2.5 ha (site A); 0.8 ha (site B); and 1.0 ha (site C). Within these boundaries intensive searching was done and all substrates with egg masses were flagged. From one site, egg masses were

[a] Carter, N. E. and Kettela, E. 1993. A preliminary study of the biology of gypsy moth in New Brunswick and initial examination of selected Integrated Pest Management techniques. Department of Natural Resources and Energy. Project 5.1-23-93 of the Canada-New Brunswick COOPERATION Agreement. 24 pp.

[b] Lavigne, D. 1995. Co-operative 1994 gypsy moth program in New Brunswick. New Brunswick Department of Natural Resources and Energy. 55 pp + Appendices.

[c] PIB = polyinclusion bodies; infective stage of virus.

collected from three height classes (0-61 cm; >61-121 cm; >121 cm) prior to egg hatch and incidental data (i.e. egg mass length and width) were collected to examine the general health of the population. Collected egg masses were returned to the lab and allowed to hatch to determine natural overwintering survival. Overall results compared to similar data for 1993 and 1994 are given in Table 1.

Table 1. Comparison of summary statistics for egg mass size, number of eggs/egg mass and egg hatch from 1993 to 1995.

Summary statistics for:	1993[a]	1994[b]	1995[b]
% egg masses with hatch	39.7%	42.7%	47.7%
% of eggs hatched from egg masses with hatch	16.8%	66.6%	83.4%
% of eggs hatched from all egg masses	7.8%	28.5%	31.8%
# eggs/egg mass	502	501	513
avg. egg mass length (cm)	3.4	3.0	3.4
avg. egg mass width (cm)	1.8	1.8	2.0
avg. egg mass area (sq. cm)	6.1	5.4	7.0

[a] Data from southwestern New Brunswick.
[b] Data from southcentral New Brunswick.

Background Levels of Virus

Prior to treatment, 20 egg masses were collected from each of the three sites, returned to the lab and allowed to hatch. Subsets of emerged larvae were taken and individually reared on Bell diet to death or larval instar ≥ 3 at which stage they were sacrificed. Dead or sacrificed larvae were examined microscopically to determine the presence of virus or other microbial agents. Genetic probing of a subset of larvae was also done to determine the presence of virus. Interestingly, none of the 486 specimens examined microscopically showed any positive signs of npv. On the other hand, genetic probing detected npv to be present at each site, viz. 2.9% at site 1; 5.7% at site 2; and 8.4% at site 3; for an overall average of 5.6%. These data suggest that despite its presence in the population the npv was not expressing its activity in these lab rearings.

Treatment of Egg Masses

To determine when treatments of virus should be started, egg hatch was monitored at all three sites. First hatch was noted on a variety of substrates on May 14th. Over the period May 16th to May 31st, five applications of virus were made to 1570 egg masses (Site 1 - 650; Site 2 - 670; Site 3 - 250). Applications were made every 3-4 days (Figure 1). Repeat applications were necessary due to protracted egg hatch (naturally occurs over a 2-3 week period) and anticipated degradation of the virus once exposed to the environment. For each application, 2 ml of virus formulation was directly applied, from a distance of about 15 cm, to each egg mass using a hand-held spray bottle. In some cases, emerged larvae that were still on the egg masses were also directly treated.

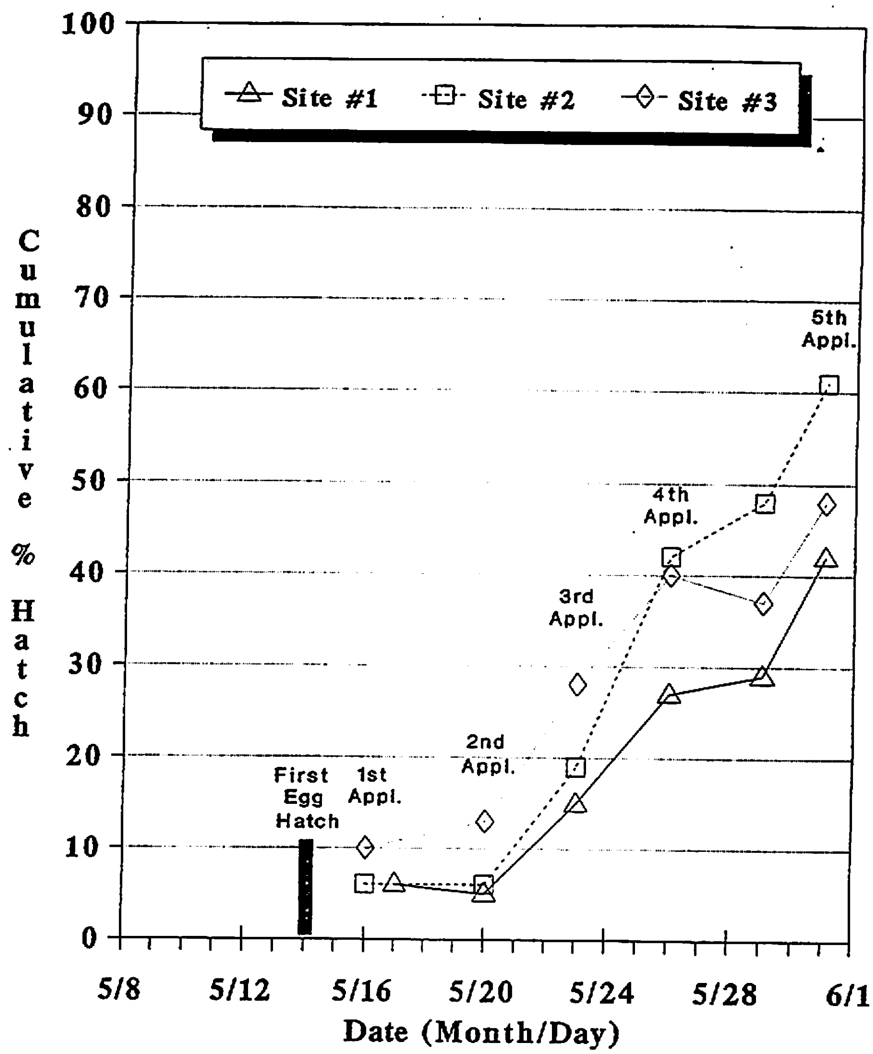

Figure 1. Timing of npv applications in relation to percent hatch of Gypsy Moth egg masses.

Post-treatment Infection of Larvae after Egg Hatch

Collections of hatched larvae from treated egg masses were made prior to each subsequent treatment, returned to the lab, and individually reared on Bell diet to determine % viral infection and subsequent mortality. From combined genetic probing and microscopic diagnoses, % incidence of virus after 1st application (for the three sites combined) was 21%; after 2nd application, 73%; after 3rd application, 69%; after 4th application, 73%; and after 5th application, 58% (Figure 2). These data suggest that two applications might have been sufficient to cause about 70% infection of emerging larvae though additional treatments improve the chances of success.

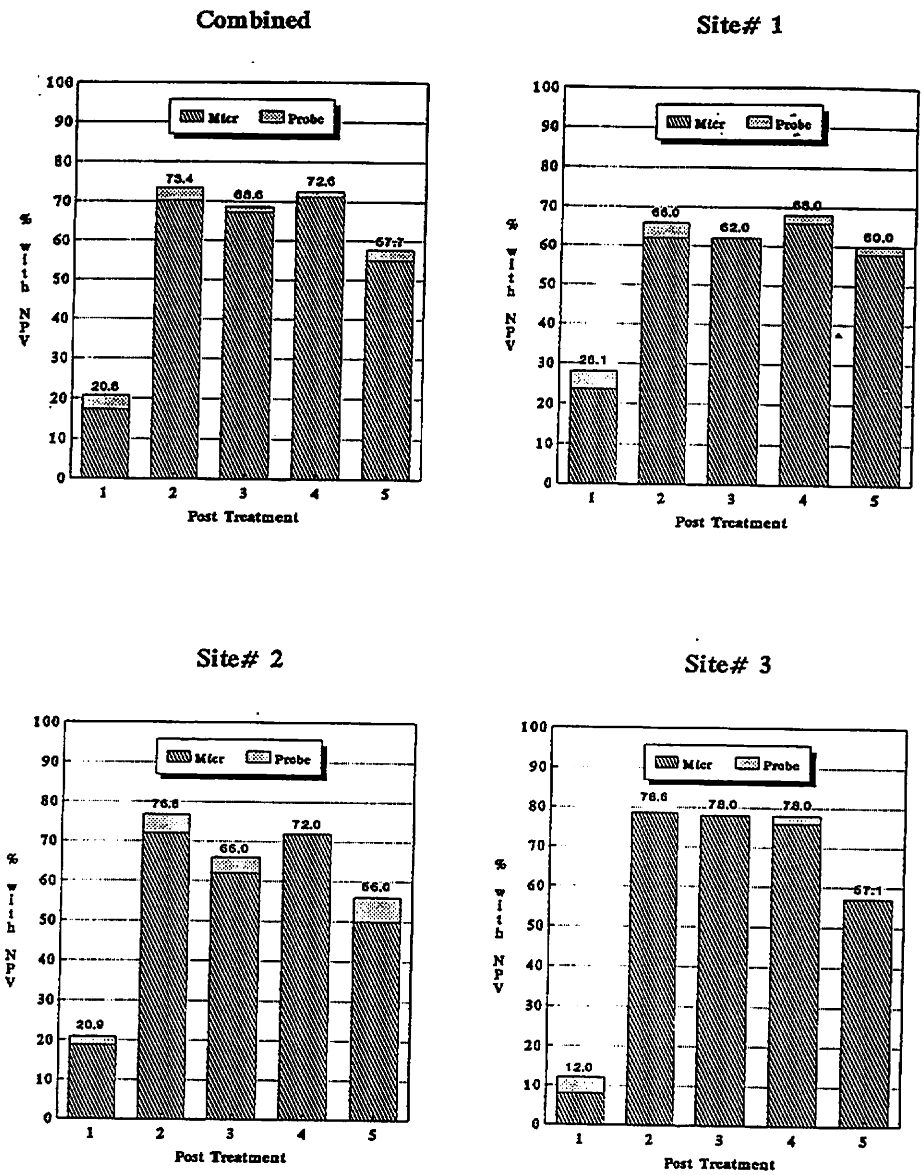

Figure 2. Rates of npv infection in Gypsy Moth larvae collected from egg masses.

Removal of Egg Masses from Treatment Sites

All emerged and unemerged egg masses were collected and removed from treated sites. This was done to confirm the pre-treatment egg mass densities as the base against which to compare fall egg mass densities for the purpose of examining whether population reductions had occurred. All flagging tape on marked substrates was removed.

Infection of Larvae Throughout the Summer

To determine virus infection within subsequent larval stages and possible transmission within the population, bi-weekly collections of larvae from randomly selected trees were conducted from

June 6th to July 21st. For each collection, 50 living larvae and up to 25 dead larvae per site were collected singly, and returned to the lab. Living larvae were reared individually on Bell diet until death or adult emergence. Cadavers were diagnosed for the presence of npv or other microbial agents through microscopic examination and genetic probing. Viral infection was confirmed by both means, and two of the three sites showed evidence of higher infection levels later in the summer in the larger instars confirming transmission of the npv within the population (Figure 3).

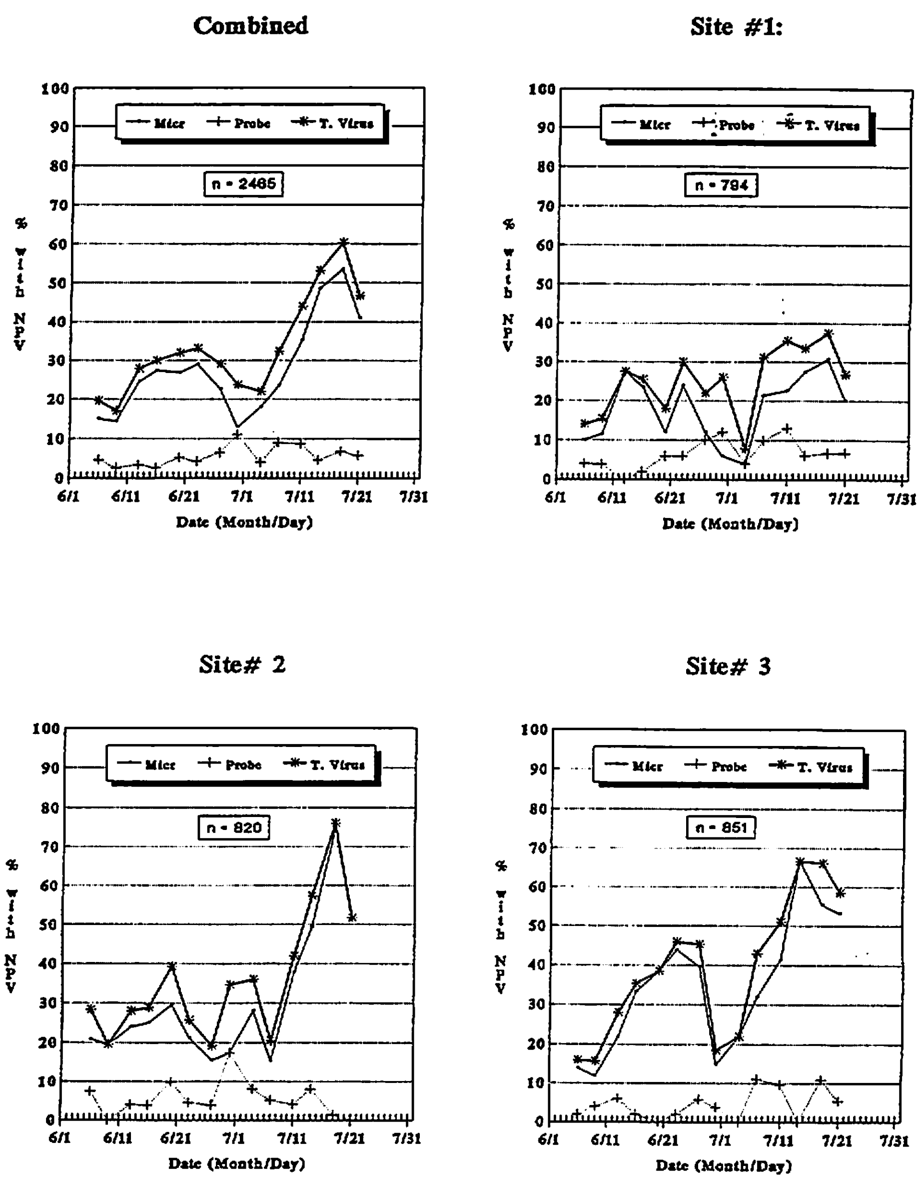

Figure 3. Rates of npv infection in Gypsy Moth larvae randomly colected from various substrates throughout the summer in areas where egg masses had been treated with npv.

Post-treatment Egg Mass Densities / General Health of Population

In the fall, each site was searched and the number of new egg masses determined for comparison to pre-treatment densities. Apparent population reductions were demonstrated in all three sites (Figure 4). In site 1, egg mass density was 17% lower; in site 2, it was 24% lower; and in site 3, it was 65% lower. The overall egg mass reduction for all sites combined was 52%. Interestingly, the greatest reduction occurred at site 3, the one with the highest egg mass density in the spring. Future trials at sites with much higher densities could prove the value of this alternative application technique.

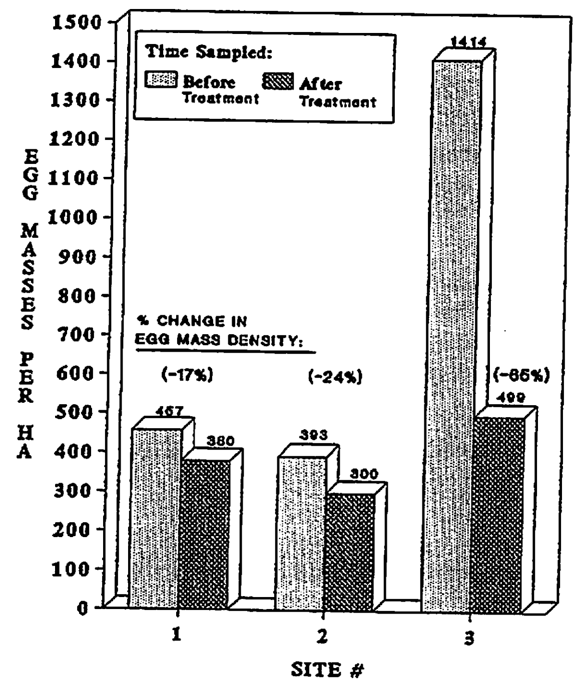

Figure 4. Apparent reductions in Gypsy Moth egg mass density from the spring (= pre-treatment) to the fall (= post-treatment) within the three treated sites.

On each site a small subset of egg masses were collected and placed in cold storage. The rest of the egg masses found were removed as part of DNRE's commitment to the landowners for their cooperation in permitting the trials on their property. In the spring of 1996, the collected egg masses will be used to determine any possible carryover effects such as: i) changes in egg mass size, ii) changes in the number of eggs per egg mass, iii) lower viability (hatching success), and iv) viral infection of newly emerging larvae. Such changes might indicate a shift in the general health of the population in the spring after treatment.

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YELLOWHEADED SPRUCE SAWFLY IN NEW BRUNSWICK
(Prepared for the Annual Forest Pest Control Forum held Nov. 21-23, 1995 in Ottawa)

The yellowheaded spruce sawfly (YHSS) (Pikonema alaskensis (Rohwer)) is a North American insect which attacks young, open-growing spruce trees of all species. Roadside and ornamental trees as well as plantations and natural regeneration in open areas are attacked. Plantations are usually not attacked until the third to fifth year after planting, and trees may be killed after three or four years of moderate to heavy defoliation[1].

Since 1991, the presence of YHSS has become more noticeable in the southeastern part of New Brunswick. Initially it was detected as occasional observations of young roadside trees, both natural and planted, showing typical sawfly defoliation of current and older needles. By 1994, the frequency of observation in plantations was greater and patches of damage had become detectable. Because of the great number of high-value spruce plantations throughout the area, the concern of the New Brunswick Department of Natural Resources and Energy increased.

In the fall of 1994, an aerial (helicopter) survey was done to look for damaged plantations on Crown land. This effort identified five main plantations of concern. These were subsequently targeted for intensive ground surveys in the spring to determine the need for protection in 1995.

In total, the five infested black spruce plantations covered 463 ha, within which it was estimated that the affected area ranged from 10% to 21% of the plantation (Table 1). Although some tree mortality was noted in the oldest plantation, damage in the other four plantations was mostly rated light-to-severe on scattered trees. Subjectively, the level of infection was "guesstimated" as generally only 10-20% of the trees being attacked. Consequently, it was decided to forego protection in 1995 and monitor the situation more closely during the year.

Table 1. Condition of five black spruce plantations infested with yellowheaded spruce sawfly in southeastern New Brunswick in the spring of 1995.

Plantation Designation	Year Planted	Tree Ht (m)	Total Area (ha)	Area (ha) (%) Affected	Damage Level
A	1984	3-5	100	19.3 (19)	L-S, Some Mortality
B	1987	2-3	98	13.8 (14)	L-M, scattered trees
D	1987	2-3	115	16.6 (14)	L-S, scattered trees
E	1989	1-2	75	7.2 (10)	L-M, scattered trees
F	1989	1-2	75	16.0 (21)	L-M, scattered trees
Total			**463**	**72.9 (15)**	

[1] USDA. 1985. Insects of eastern forests. USDA. For. Serv. Misc. Pub. 1426. pp. 404-406.

Once it became public that a protection program (possibly using Fenitrothion) to control the YHSS was being considered by DNRE, concerns were raised by the public and partners in the Fundy Model Forest (FMF) because of the controversy of this insecticide and the impending decision from the federal registration review in progress. Upon request from the General Manager of FMF, officials of DNRE, the New Brunswick Department of Environment, and J. D. Irving Ltd. attended a meeting to review the situation. This meeting focused on the need to begin looking for alternatives to Fenitrothion and led to the preparation of a research project spearheaded by Mr. E. Kettela of CFS-Maritimes. Elements of the project (to be reported elsewhere) were:

- Biological Studies of YHSS, led by Dr. Don Ostaff (CFS-M);
- Efficacy Trials of Neem and Nematodes Against YHSS, led by Dr. G. Thurston (CFS-M); and
- Pheromones of YHSS, led by Dr. P. Silk (NB Research and Productivity Council).

Funding for these projects was provided by FMF.

In addition to these research projects, DNRE initiated studies to gather biological and survey information throughout the spring, summer, and fall. Results of these efforts are presented here.

BIOLOGY OF YELLOWHEADED SPRUCE SAWFLY

Because of the paucity of information about local populations of YHSS, plots were established to gather baseline data that would be relevant to future monitoring, research, or control programs. A temperature data logger was set up in a Stephenson screen in one plantation (designated B) on March 31, 1995 and operated continuously until August 16, 1995. Temperature data were used to calculate cumulative degree days (DD) above 3°C, to which biological data could be related.

Spring Cocoon Collection

One of the first bits of information to be investigated was the overwinter survival and parasitism of the YHSS. To do this, several soil samples (0.5 m x 0.5 m) were obtained from plots in each of the five plantations (4 in A; 2 each in B, D, E, F). These samples were returned to the laboratory and individually sorted by hand and coarse-mesh sieves to obtain the cocoons in which the YHSS overwinter. Collected cocoons were placed in covered petri dishes and held at room temperature in the laboratory for emergence. Individual adult sawflies and parasites which emerged were periodically removed and put in 70% alcohol for later identification and tallying.

The data revealed several things (Table 2). First, is the apparent overall low survivorship of YHSS adults, being 5.6% for males and slightly greater at 7.9% for females, which despite being a fairly consistent trend throughout all plantations, is probably not a significant difference. Nonetheless, an equal or slightly higher proportion of females could indicate stable or rising populations. Second, is the apparent overall level of parasitism at 17.8%, which would be interesting to follow in succeeding years to see its relationship to YHSS population trends. Identification of parasites is yet to be done though 4 species of the Family Ichneumonidae are suspected.

Most cocoons (672 or 68.7%) failed to have any sawfly or parasites emerge. Dissections to determine the fate of these cocoons, if possible, are yet to be completed.

Table 2. Summary of data for YHSS and parasites emerging from cocoons collected in the spring of 1995 in 5 black spruce plantations in southeastern New Brunswick.

Plantation and Plot	Number of Cocoons	Number of adults		Number of Adult Parasites	% Emergence		
		YHSS♂	YHSS♀		YHSS♂	YHSS♀	Parasites
A-2	71	1	2	12	1.4	2.8	16.9
A-4	284	15	19	40	5.3	6.7	14.1
A-6	44	2	4	8	4.5	9.1	18.2
A-7	78	4	3	19	5.1	3.8	24.4
Total A	477	22	28	79	4.6	5.9	16.6
B-4	47	1	3	9	2.1	6.4	19.1
B-5	199	22	27	52	11.1	13.6	26.1
Total B	246	23	30	61	9.3	12.2	24.8
D-1	52	1	0	11	1.9	0.0	21.2
D-4	130	6	12	13	4.6	9.2	10.0
Total D	182	7	12	24	3.8	6.6	13.2
E-1	14	0	1	2	0.0	7.1	14.3
E-5	2	0	0	0	0.0	0.0	0.0
Total E	16	0	1	2	0.0	6.3	12.5
F-1	42	2	5	5	4.8	11.9	11.9
F-5	15	1	1	3	6.7	6.7	20.0
Total F	57	3	6	8	5.3	10.5	14.0
Gr. Total	**978**	**55**	**77**	**174**	**5.6**	**7.9**	**17.8**

Adult Emergence

a) Ground Emergence Traps

Mature larvae of YHSS overwinter in cocoons in the soil. As soil temperatures increase in the spring after the snow disappears, the insects pupate and transform to adult male or female sawflies which emerge from the cocoons and surrounding soil. To detect when emergence occurred and over what period, a number of fine-meshed emergence traps (0.7 m x 0.7 m) with collecting jars were set at surface level in each of the five selected plantations. The first adults were detected in plantation B on June 9, 1995, corresponding to 282 DD, calculated using temperature data collected from the site. By June 13, 1995 adult emergence was noted in all five areas. The last adult collected in plantation B occurred on June 27, 1995 though the occasional adult emerged as late as July 21 in plantation D. The rate and duration of adult emergence in each plantation is shown in Figure 1.

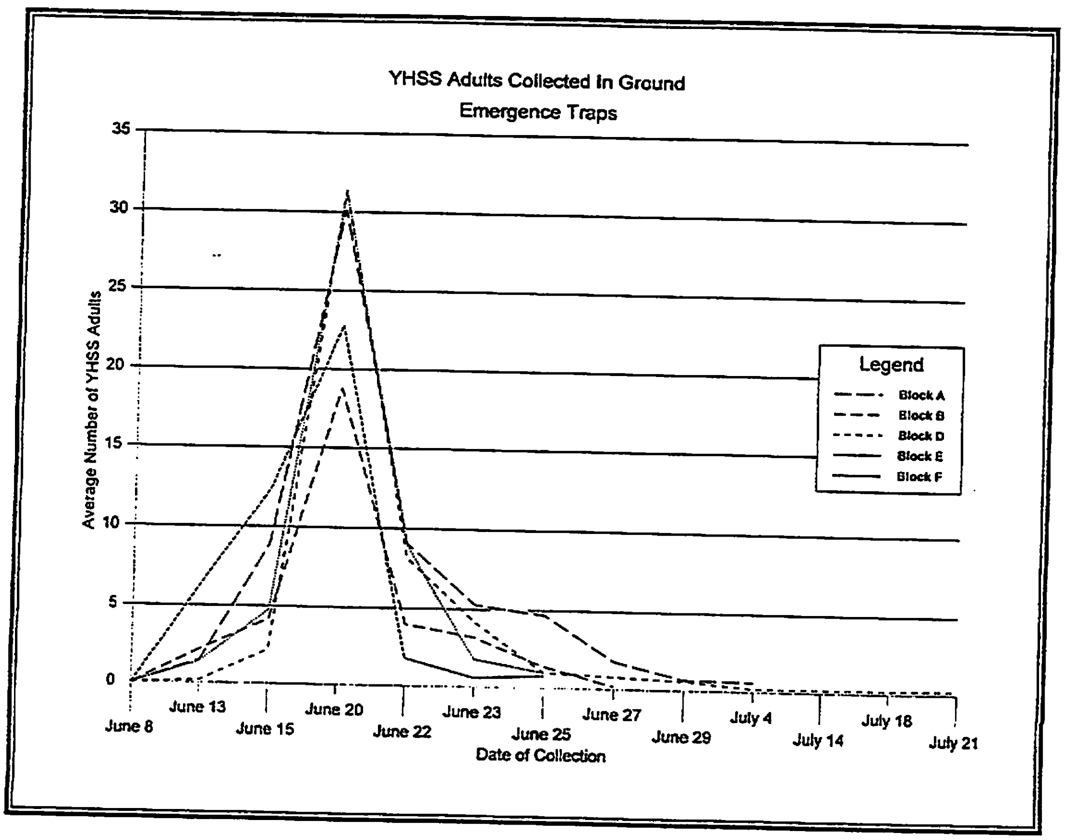

Figure 1. Emergence of adult yellowheaded spruce sawflies in 5 black spruce plantations in southeastern New Brunswick in 1995.

b) **Pheromone Traps**

Another method of monitoring the presence of adult YHSS is with sticky traps baited with pheromone which acts as an attractant to lure the males into the trap. The primary sex pheromone of female YHSS adults is (Z)-10-nonadecenal[1] with (Z)-5-tetradecenol as a secondary component.[2] Through the kindness of Dr. R. L. Bartelt[3] of the USDA a quantity of pheromone lures was made available. Individual lures were put in Delta sticky traps (three interior surfaces sticky) and placed out in plots in each of the five plantations (15 in A; 5 in each of B, D, E, F). In addition, non-baited traps (equal numbers) were placed out to validate that the pheromone was indeed attracting the adult males. The unbaited traps were operated continuously (June 6 - July 11), whereas the baited traps were replaced mid-way through the period (June 21) in case the pheromone had lost its effectiveness.

Results of the trapping confirm that over the period sampled, catches of male YHSS adults in baited traps were approximately 18 times greater (824 cf. 46) than in unbaited traps (Table 3). Interestingly, some females were also found in the traps, and ironically somewhat similar numbers occurred in unbaited as well as baited traps. It is presumed, therefore, that these are only incidental catches in the traps. The usefulness of various trap designs and other parameters for tracking YHSS emergence and population monitoring warrant further investigation.

Table 3. Summary of catches of male (and female) yellowheaded spruce sawfly adults in baited and unbaited traps in 5 black spruce plantations in southeastern New Brunswick in 1995.

Site	Baited						Unbaited*	
	June 6-June 21		June 21-July 11		Total		June 6-July 11	
A	232	(3)**	447	(16)	679	(19)	38	(7)
B	14	(2)	45	(2)	59	(4)	0	(0)
D	3	(0)	14	(1)	17	(1)	3	(5)
E	33	(0)	8	(0)	41	(0)	3	(2)
F	13	(1)	15	(1)	28	(2)	2	(4)
Totals	**295**	**(6)**	**529**	**(20)**	**824**	**(26)**	**46**	**(18)**

* Unbaited traps were not replaced during the period.
** Numbers in brackets are female YHSS adults which presumably represent incidental catches.

1 Bartelt, R. J. and R. L. Jones. 1984. J. Chem. Ecol. 9:1333-1341.
2 Bartelt, R. J., Jones, R. L., and T. P. Krick. 1984. J. Chem. Ecol. 9:1343-1352.
3 Dr. R. J. Bartelt. Research Entomologist. USDA, Bioactive Constituents Unit, Agricultural Research Service. 1815 North University Street, Peoria, Illinois, 61604.

Host Tree Phenology

To determine the association between YHSS egg deposition and host phenology, the flushing of planted black spruce trees was monitored. A 45-cm branch tip from each of five trees in a plot was randomly sampled on each visit. All vegetative buds on the right-hand side of each branch were classed for degree of flushing (5 classes) and a Shoot Index[1] was calculated. The first eggs were noted in plantation B on June 19, 1995 when the Shoot Index was about 3.4 (Figure 2). Egg deposition continued over the next 1-2 weeks as host shoots continued to flair and expand.

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[1] Shoot Index = Σ (no. class 1 x 1) + (no. class 2 x 2) ... + (no. class 5 x 5)) ÷ total no. buds.

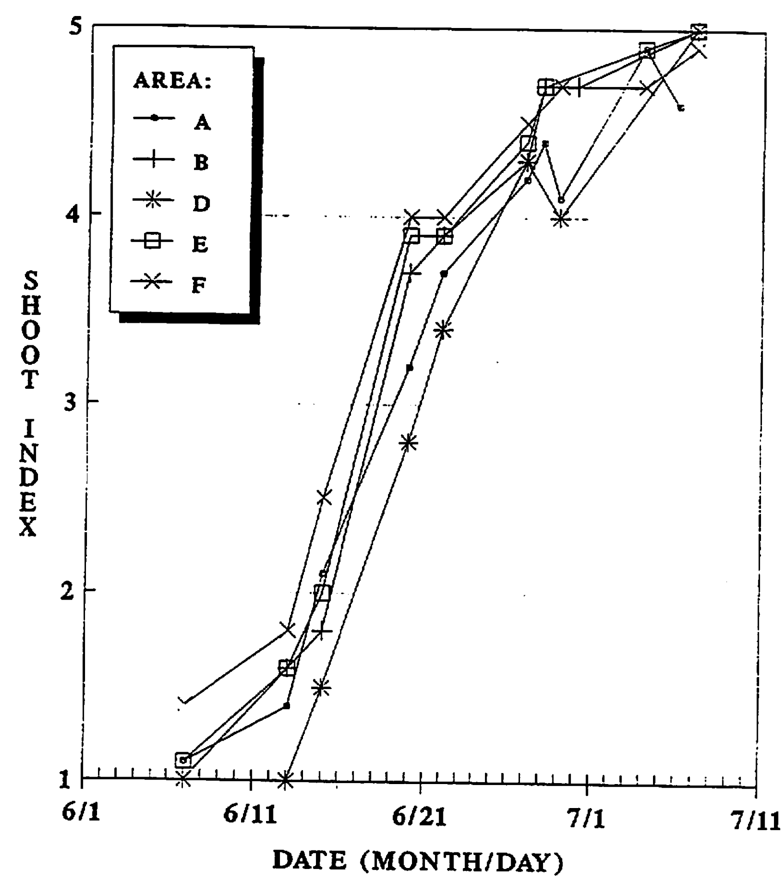

Figure 2. Flushing rates of black spruce (expressed as Shoot Index) in 5 plantations sampled in southeastern New Brunswick in 1995.

Egg Stage of YHSS

Adult YHSS females deposit their eggs singly and generally at the base of new needles during bud flush. The eggs are partially inserted into the needles, and can be seen with the naked eye (with training), though magnification and bud dissection is required for making accurate counts. The first eggs were seen in plantation B on June 19, 1995 (DD = 411), and first egg hatch was detected in the same plantation on June 23, 1995 (DD = 463). On June 27, 1995 (DD = 519) it was estimated there were 50% eggs and 50% larvae present.

Egg Parasitism

Egg parasitism of YHSS is rare and therefore survivorship of eggs is very high, though two species of parasites are known[1]. These are Tetrastichus sp. and Trichogramma minutum. The latter species is of interest because it can be mass reared and a good deal is known about ground and aerial dispersal systems. Consequently it might have potential for use in future population control programs.

Through fortuitous circumstances a technician, of the Forest Pest management Section of DNRE, observed and collected approximately 30 parasitized eggs from planted ornamental black spruce trees on the grounds of the Hugh John Flemming Forestry Centre (in Fredericton) in early June. These were brought to the laboratory where 10 Trichogramma adults emerged. These were split into small groups (1-3) and put into several cups with ten shoots having YHSS eggs (collected from the Fundy area) on them. Approximately 40 eggs became parasitized and yielded more Trichogramma adults. These were sent to Dr. Sandy Smith at the University of Toronto for species confirmation and possible colony establishment (which did not succeed).

In all the field observations of eggs in the Fundy area no egg parasitism was detected, though no detailed survey was conducted.

Larval Development of YHSS

Monitoring larval development began on June 28, 1995. Approximately every 2-4 days, random branches were collected in each of the five plantations and various numbers of larvae were collected by hand and put in 70% alcohol. Each collection was later examined using a graduated microscope to measure head capsule widths to assign larval instars and document larval development (Figure 3). According to the literature, there are five larval instars for males and six for females. A Larval Index[2] was calculated for each sample date and results indicate a common trend in larval development and the type of variability that occurs between locations. Using a computer model called BioSIM[3] to estimate cumulative degree days for each plantation (other than B), the larval indices were plotted (Figure 4). This type of information can be used

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[1] Houseweart and Kulman, 1976. Env. Ent. 5(5): 859-867.

[2] Larval Index = (Σ (L1x1) + (L2x2) ... + (L6x6)) $\div$ no. larvae in collection.

[3] Régnière, J. et. al. 1995. Nat. Res. Can., Can. For. Serv., Ste. Foy, Que. Inf. Rep. LAU-X-116.

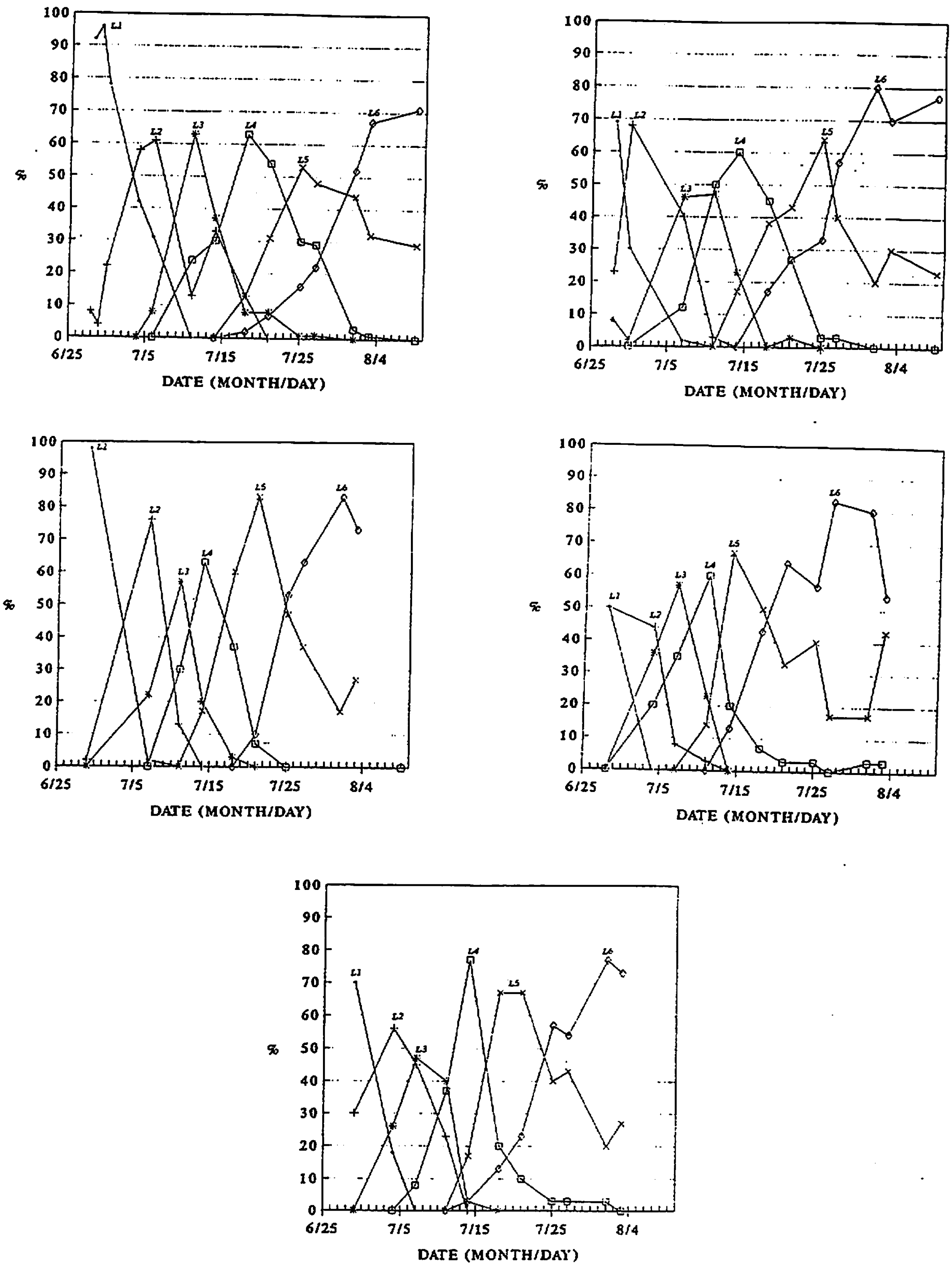

Figure 3. Larval development of yellowheaded spruce sawfly in 5 black spruce plantations in southeastern New Brunswick in 1995.

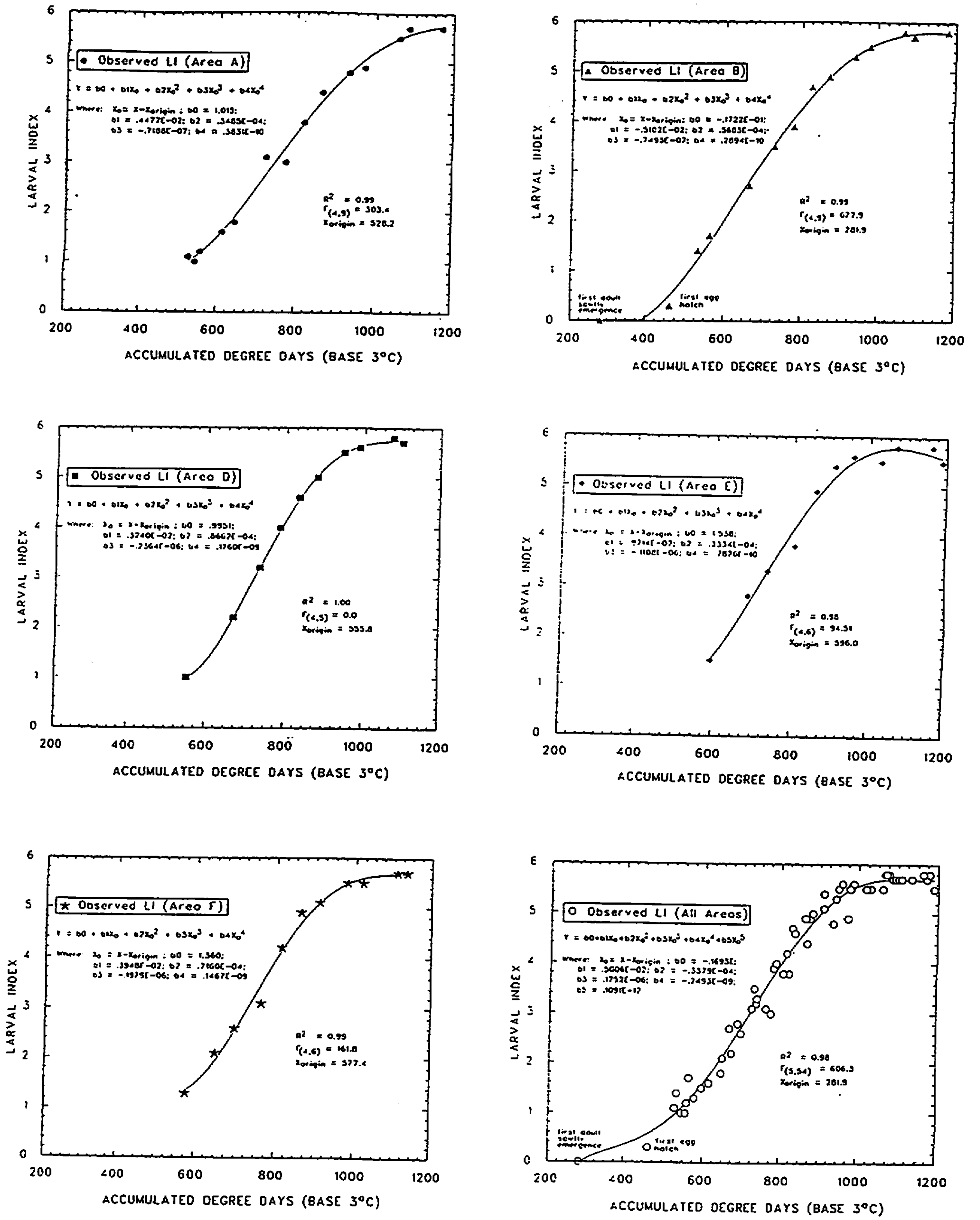

Figure 4. Index of larval development of yellowheaded spruce sawfly in relation to degree day accumulations (base 3 • C) in 5 black spruce plantations in southeastern New Brunswick in 1995.

in planning and conducting control programs. No effort was made to monitor the dropping of larvae to the ground or their establishment in cocoons. Nonetheless, by August 10, 1995 (DD = 1199) very few larvae were found on the sampled trees indicating feeding was virtually complete for the year.

DAMAGE CAUSED BY YELLOWHEADED SPRUCE SAWFLY

Spring Tree Mortality Study

The plantation with the most evidence of persistent YHSS attack was the oldest one (plantation A, 11-yr.-old) in which the trees were 3-5 m tall. Damage was most severe across an irregular band approximately 300-m wide running the length of the plantation adjacent to its easterly edge. To measure the degree of damage in this zone, two transects were run the length of the area, trees marked every 5 m, and each tree assigned to one of five damage classes described as follows:

Class A - tree dead; or < 10% green foliage on bottom of tree.
Class B - top half or more dead; new shoots present on bottom half of tree only.
Class C - top half or more dead; bottom portion > 10% green.
Class D - whole tree living; previous defoliation noticeable but new shoots flushing.
Class E - green tree; relatively little defoliation; new shoots present.

The survey was done well after bud flush had begun and before 1995 defoliation had occurred to avoid making subjective estimates of dead trees/tops. At the time of assessment (June 26/27, 1995), the Larval Index was 1.1 and the Shoot Index was 4.2. Results indicate that approximately 24% of the trees were classed dead in each transect (Table 4) with 13-18% classed as having dead tops. Each tree was marked for follow-up assessment in 1996 to determine how much change occurred due to YHSS attack in 1995.

Table 4. Summary of black spruce tree condition in two transects in plantation A assessed after shoot flushing was well advanced in the early summer of 1995.

Damage Class*	Number (%) of trees in each Class	
	Transect 1	Transect 2
A	15 (24.2)	18 (24.0)
B	5 (8.1)	3 (4.0)
C	6 (9.7)	7 (9.3)
D	31 (50.0)	33 (44.0)
E	5 (8.1)	14 (18.6)
Totals	62 (100.0)	75 (100.0)

* see text for description

Current Defoliation

To investigate the feeding damage caused by YHSS larvae, a number of circular 5-m plots were established in each plantation and all the trees within the plots marked. From each tree a branch (with larvae present) was selected at random and marked. Ten shoots were selected, marked, and all the larvae counted on them in situ. This was done at a time when the shoots were fairly-well opened and the larvae were predominantly first and second instars. The exact number of larvae might, therefore, be somewhat imprecise due to limitations in seeing the small first instars with the naked eye and their gregarious (clustered) feeding habit. Feeding damage on current-year needles was non-detectable at this time. Because YHSS larvae also feed on older-years' needles, a defoliation rating was assigned to the whole branch. In addition, a damage rating was assigned to the whole tree. These ratings were the baseline against which feeding damage was compared in the fall.

To examine whether there was a relationship between spring larval counts and final defoliation of current-year needles, the data were grouped in classes of 0.2 larvae/shoot and correlated with mean defoliation in each class (Figure 5). Analyses were done for plantation A alone because it was oldest and had the tallest trees. Plantations B and D were pooled because they were intermediate in age and height. Likewise, plantations E and F were pooled because they were youngest and smallest. Also, all data were pooled and analyzed. Overall these analyses demonstrate that there was a reasonable relationship between larval densities and defoliation of current-year needles of black spruce according to the methods employed in this study. In particular, it appears that larval densities sometimes as low as only 0.1 larva/shoot can cause 50% defoliation of current-year needles on young black spruce trees in plantations. Since this is a first attempt at investigating this relationship, further studies could refine and/or replace this method and relationship.

Branch Defoliation

The impact of YHSS feeding was also evidenced by an increase in the proportion of branches rated in higher defoliation categories in the fall compared to their ratings in the spring prior to feeding (Figure 6). In the fall, the proportion of branches rated in the > 50% defoliation classes in plantation A was 47% compared to 24% in the spring. In plantations B and D, the proportion similarly increased to 42% from 22%. Likewise, in plantations E and F the proportion increased to 32% from 6%.

Whole Tree Defoliation

Overall tree condition also declined as a result of YHSS feeding (Figure 7). For instance, in plantation A the proportion of trees rated > 50% defoliated was 41% in the fall compared to 25% in the spring. In plantations B and D, the proportion increased to 18% from 7%. And likewise, in plantations E and F, the proportion increased to 7% from 2%.

Figure 8 illustrates the results for all branch and whole tree defoliation ratings for all plantations combined.

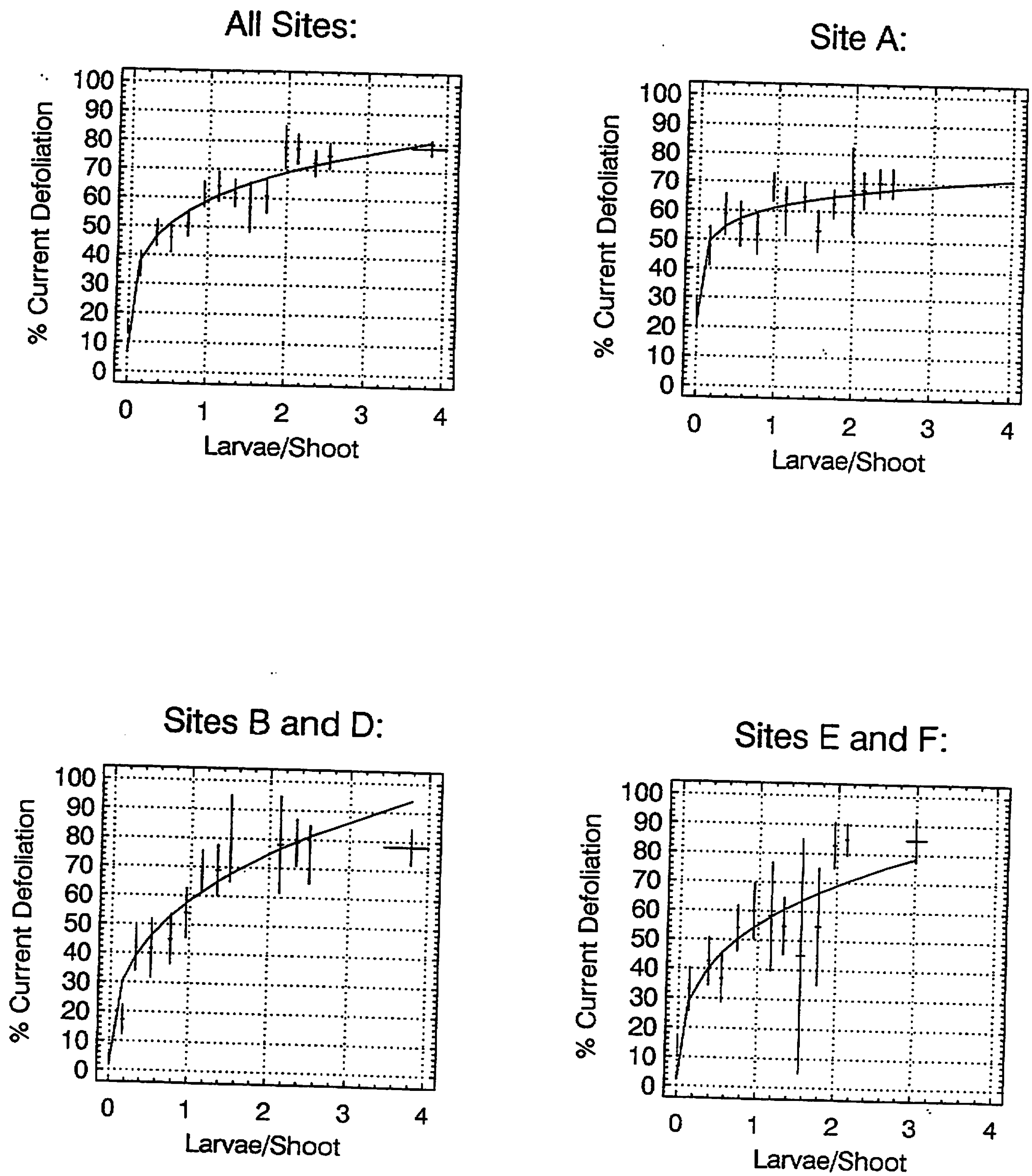

Figure 5. Relationships between the mean number of YHSS larvae/shoot in the spring and fall estimates of mean defoliation of current-year foliage of black spruce in the plantations sampled in southeastern New Brunswick in 1995.

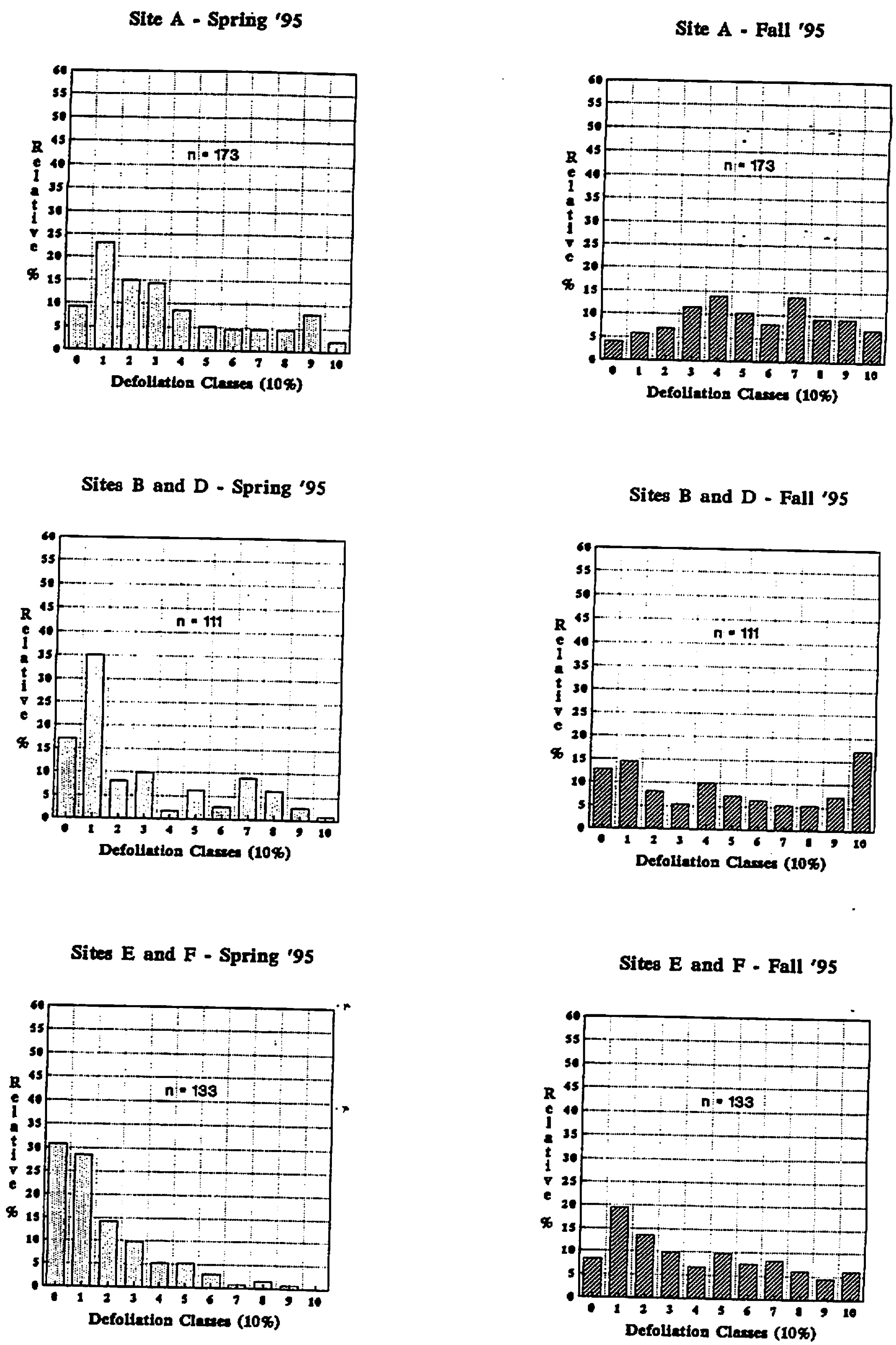

Figure 6. Changes in branch defoliation ratings between spring and fall as a result of YHSS feeding on black spruce in selected plantations sampled in southeastern New Brunswick in 1995.

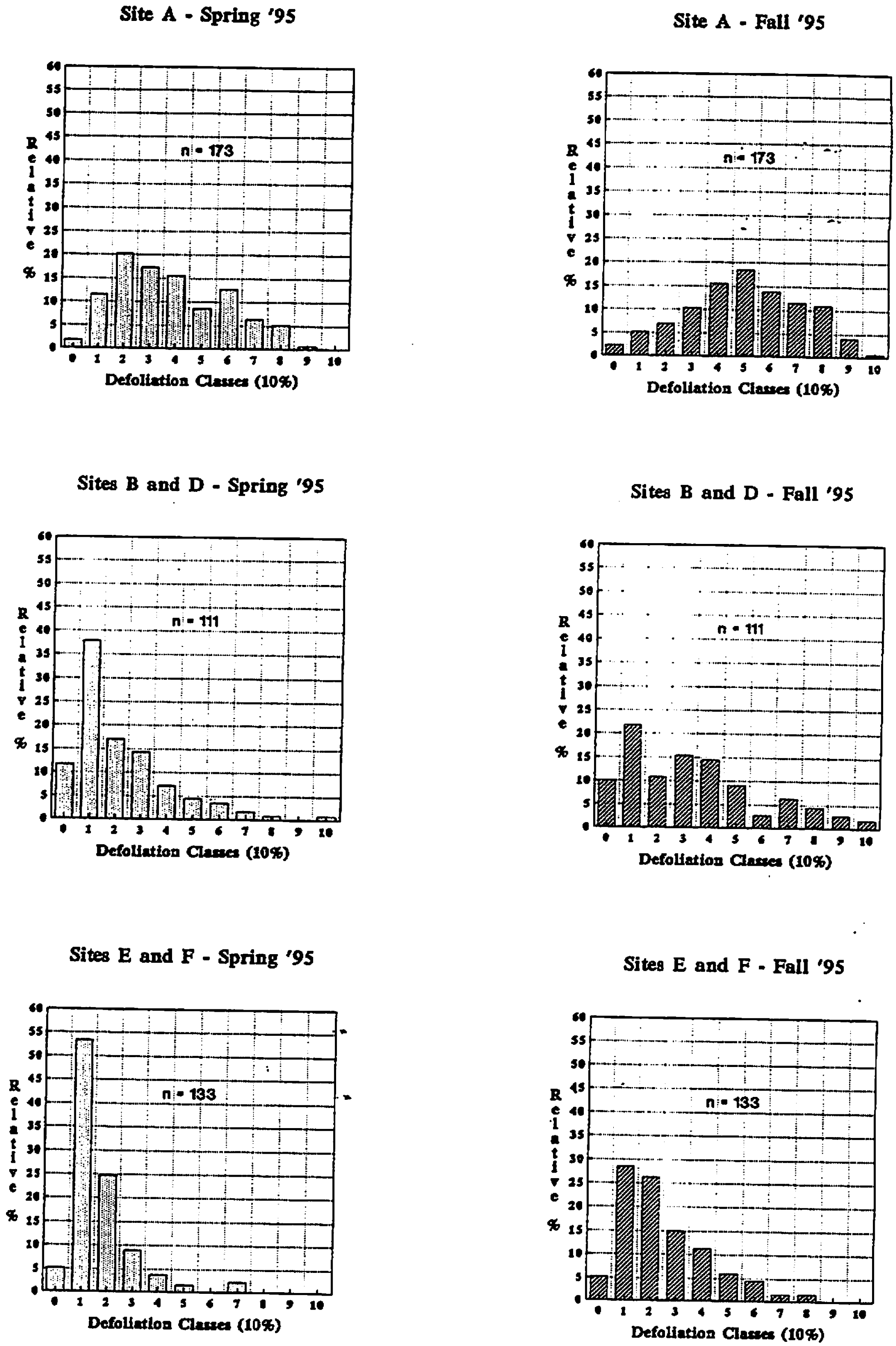

Figure 7. Changes in whole tree defoliation ratings between spring and fall as a result of YHSS feeding on black spruce in selected plantations sampled in southeastern New Brunswick in 1995.

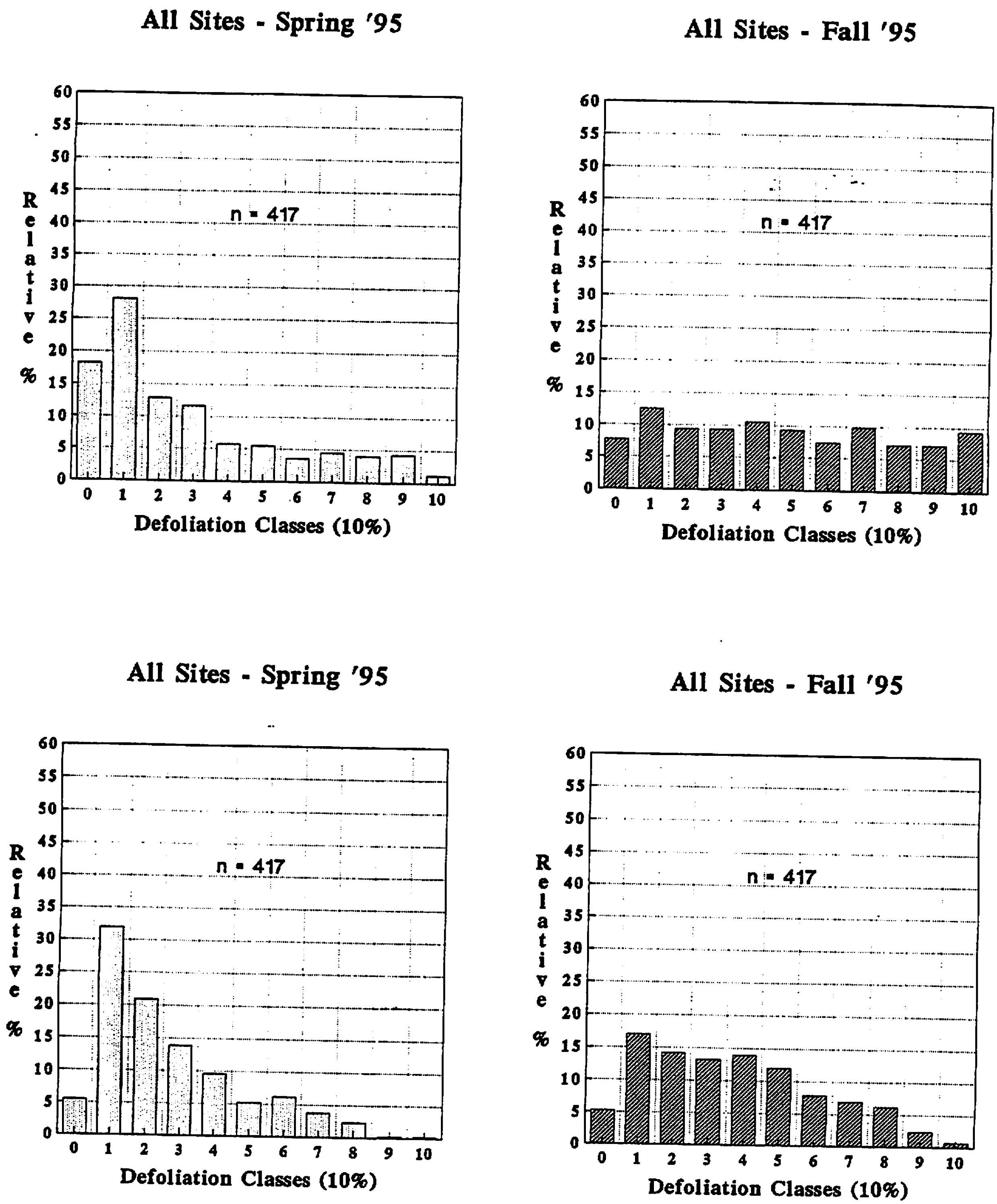

Figure 8. Changes in branch and whole tree defoliation ratings for all black spruce plantations pooled, as a result of YHSS feeding in 1995.

FALL SURVEY

To determine whether the extent of YHSS attack had become more noticeable in other plantations on Crown land, aerial (helicopter) and ground surveys were done in the fall. In the 5 original plantations, defoliation intensified within the previously identified zones, and in all but plantation B, the affected zone was larger. More surprising was the finding that the number of plantations showing signs of attack increased by 26 (Table 5) from 5 in the spring, and the geographic distribution was greater. Information from J. D. Irving Ltd. (Brunsdon, pers. comm.) indicated another -- plantations were infested on their freehold land also (some known from prior years).

The level of attack varied, with 4 new plantations on Crown land having distinct patches or zones of defoliation (though none was as intense as A) and the level of infection was "guesstimated" to range from 30% to 50% of the trees. In the remaining plantations, attack was generally limited to scattered trees having the potential to increase in intensity if attack continues in the future. Two other observations were made. First, although most attacked plantations were black spruce, several red spruce plantations were now attacked. Second, plantations established only two years ago were being attacked. Finally, the total area of the affected plantations was 719 ha, more than doubling the area of the original plantations, bringing the total affected area on Crown land to 1182 ha.

Table 5. Plantations detected as being newly infested by yellowheaded spruce sawfly on Crown land, based on surveys in southeastern New Brunswick in the fall of 1995.

Plantation Number	Year(s) Planted	Tree Species*	Area	Plantation Number	Year(s) Planted	Tree Species*	Area
1	1989	bS	30	14	1991	bS	15
2	1990	bS	36	15	1991	bS	21
3	1979	bS	24	16	1993	bS	10
4	1989	bS	28	17	1992	bS	17
5	1993	bS	26	18	1992	bS	14
6	1990	bS	33	19	1992	rS	15
7	1988	bS	17	20	1993	bS	7
8	1990	bS	112	21	1993	bS	2
9	1990	bS	27	22	1993	rS	14
10	1988-89	bS	48	23	1993	bS	14
11	1989-90	bS	22	24	1990	bS	59
12	1991	bS	11	25	1989	bS	10
13	1991	bS	18	26	1989	bS	89
				Total Area			**719**

* bS = black spruce; rS = red spruce.

CONCLUSION

Investigations undertaken in the summer of 1995 provide the first baseline data on the natural biology of the YHSS and its feeding damage on infested black spruce trees in plantations in southern New Brunswick. **These data stand to be refined over time pending further study.** Meanwhile, they provide a reasonable set of data on which control and/or research programs can be planned. For instance, information on the emergence of adults in the spring provides a basis for examining a pheromone mating disruption strategy to control YHSS populations. Likewise, data on the time of egg deposition and hatch provide the basis for examining population disruption using the egg parasite Trichogramma minutum. Additionally, the larval development data provide a framework for timing research or operational control programs using pesticide to prevent defoliation or reduce populations. Finally, preliminary methods of measuring feeding damage have been demonstrated for possible use in assessing insecticide foliage protection efficacy.

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Doc.: YHSSNBfo.rum

SOMMAIRE DU RELEVÉ DES INSECTES ET DES MALADIES DES ARBRES AU QUÉBEC EN 1995

PAR

CLÉMENT BORDELEAU[1]

DENIS LACHANCE[2]

Rapport préparé pour le Colloque annuel sur la lutte contre les ravageurs forestiers, Ottawa, du 21 au 23 novembre 1995

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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 1995 est présenté dans ce rapport.

Les faits saillants ont été :

- la poursuite de la progression des populations de la tordeuse des bourgeons de l'épinette dans la région de l'Outaouais et la découverte d'un nouveau foyer d'infestation dans la région de la Mauricie—Bois-Francs;

- la présence de plusieurs foyers d'infestations locales de l'arpenteuse de la pruche dans les sapinières du sud-ouest de l'Île d'Anticosti;

- le maintien des populations de la tordeuse du pin gris dans les foyers localisés dans la région de l'Outaouais;

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

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

- l'augmentation spectaculaire des populations du porte-case du bouleau dans plusieurs régions du Québec;

- les défoliations importantes causées localement par la tenthrède à tête jaune de l'épinette dans l'est du Québec.

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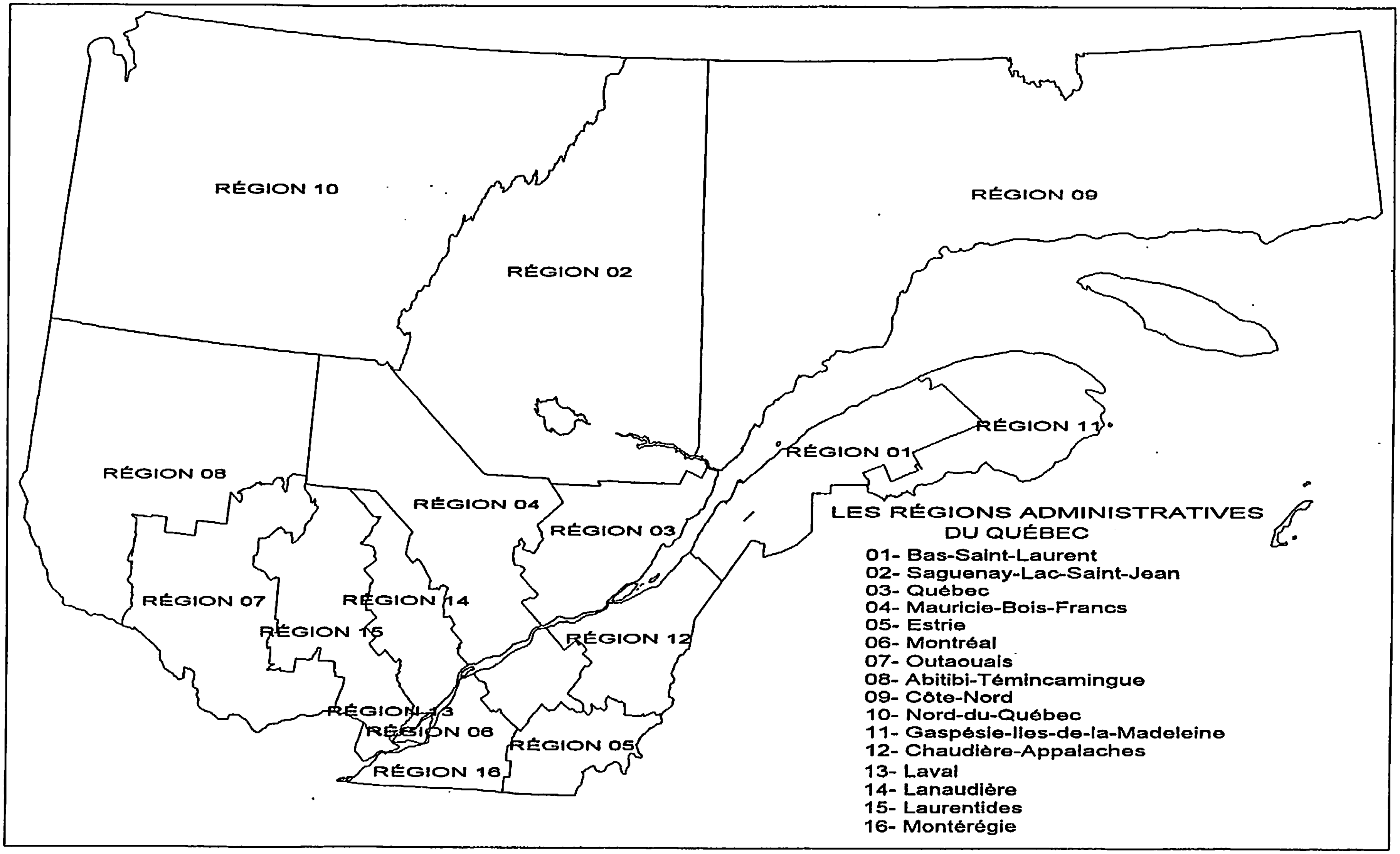
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RÉGION 16
LES RÉGIONS ADMINISTRATIVES
DU QUÉBEC
01- Bas-Saint-Laurent
02- Saguenay-Lac-Saint-Jean
03- Québec
04- Mauricie-Bois-Francs
05- Estrie
06- Montréal
07- Outaouais
08- Abitibi-Témincamingue
09- Côte-Nord
10- Nord-du-Québec
11- Gaspésie-Iles-de-la-Madeleine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

Carte 1

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

INFESTATION

Les dégâts causés par la **tordeuse des bourgeons de l'épinette** ont continué de s'accroître et de s'intensifier dans la région de l'Outaouais. Dans l'ensemble, les populations demeurent confinées presque aux mêmes endroits que l'an dernier, soit dans le périmètre délimité par les localités de Fort-Coulonge, Kazabazua et Gatineau (Carte 2). Les superficies affectées ont toutefois augmenté et l'intensité des attaques a été beaucoup plus importante. Les défoliations se sont avérées modérées ou graves sur au-delà de 4 300 hectares localisés principalement dans le bassin de la rivière Gatineau, entre Wakefield et North Low. Un nouveau foyer totalisant 84 hectares a également été détecté dans la région de la Mauricie—Bois-Francs : des plantations d'épinettes blanches âgées de 30 à 60 ans et comprises à l'intérieur des limites du Sanctuaire de Drummondville ont été gravement défoliées. La superficie totale infestée en 1995 couvre 4 703 hectares, comparativement à 2 912 hectares en 1994.

Tableau 1 - Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette au Québec en 1995

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Élevé	
Outaouais	309 (936)*	653 (1 148)	3 657 (828)	4 619 (2 912)
Mauricie—Bois-Francs	11 (0)	29 (0)	44 (0)	84 (0)
Grand total	320 (936)	682 (1 148)	3 701 (828)	4 703 (2 912)

* ( ) = Superficies affectées en 1994

PRÉVISIONS

L'inventaire des larves en hibernation (L2) a été réalisé dans quelque 300 sites distribués dans toute la province. Les résultats montrent que la situation en 1996 sera relativement semblable à celle de cette année; les dégâts demeureront circonscrits dans le même périmètre qu'en 1995, soit dans la région de l'Outaouais et dans le sanctuaire de Drummondville. Les populations demeureront faibles dans les autres régions du Québec et les dégâts ne devraient pas y être perceptibles.

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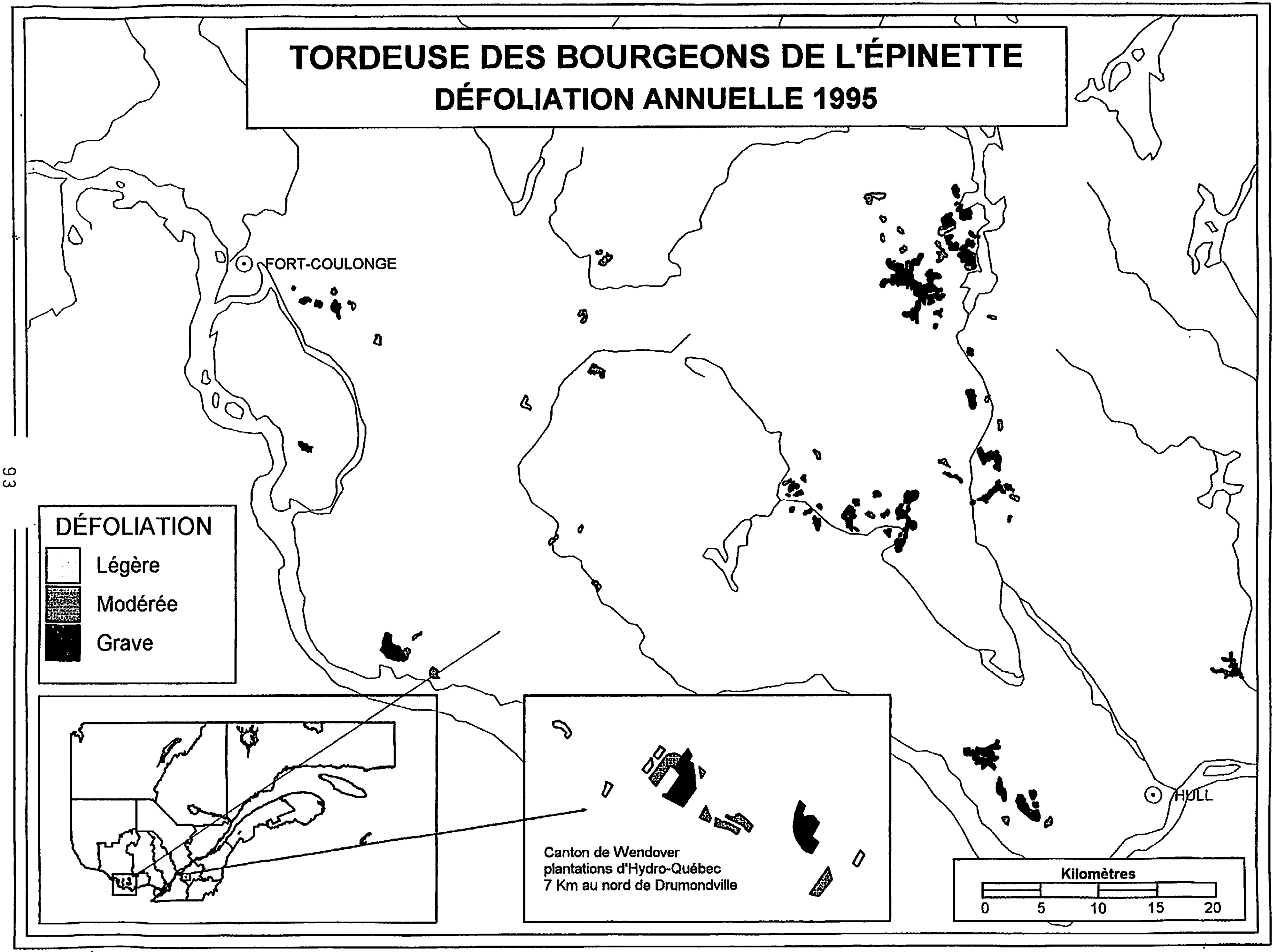

TORDEUSE DES BOURGEONS DE L'ÉPINETTE
DÉFOLIATION ANNUELLE 1995
FORT-COULONGE
HULL
DÉFOLIATION
Légère
Modérée
Grave
Canton de Wendover
plantations d'Hydro-Québec
7 Km au nord de Drumondville
Kilomètres
0 5 10 15 20

Carte 2

ARPENTEUSE DE LA PRUCHE
Lambdina fiscellaria fiscellaria (Guen.)

INFESTATION

Des infestations locales d'**arpenteuses de la pruche** ont encore été signalées cette année à l'Île d'Anticosti. Les dégâts ont été relevés, comme l'année dernière, au sud-ouest de l'Île (Carte 3). L'infestation est fragmentée en de nombreux petits foyers localisés entre la rivière-aux-Cailloux et Baie-Sainte-Claire. Les superficies défoliées ont quelque peu diminué, passant de 975 hectares en 1994 à 672 hectares en 1995, mais les défoliations ont été généralement plus graves. Un foyer isolé a également été détecté au sud de la région de l'Abitibi-Témiscamingue : des dégâts graves ont été relevés dans un peuplement localisé sur une île du réservoir Kipawa. Une hausse des populations de l'insecte a finalement été observée dans quelques secteurs situés à l'est de la péninsule gaspésienne, sans toutefois causer des dégâts notables sur le sapin.

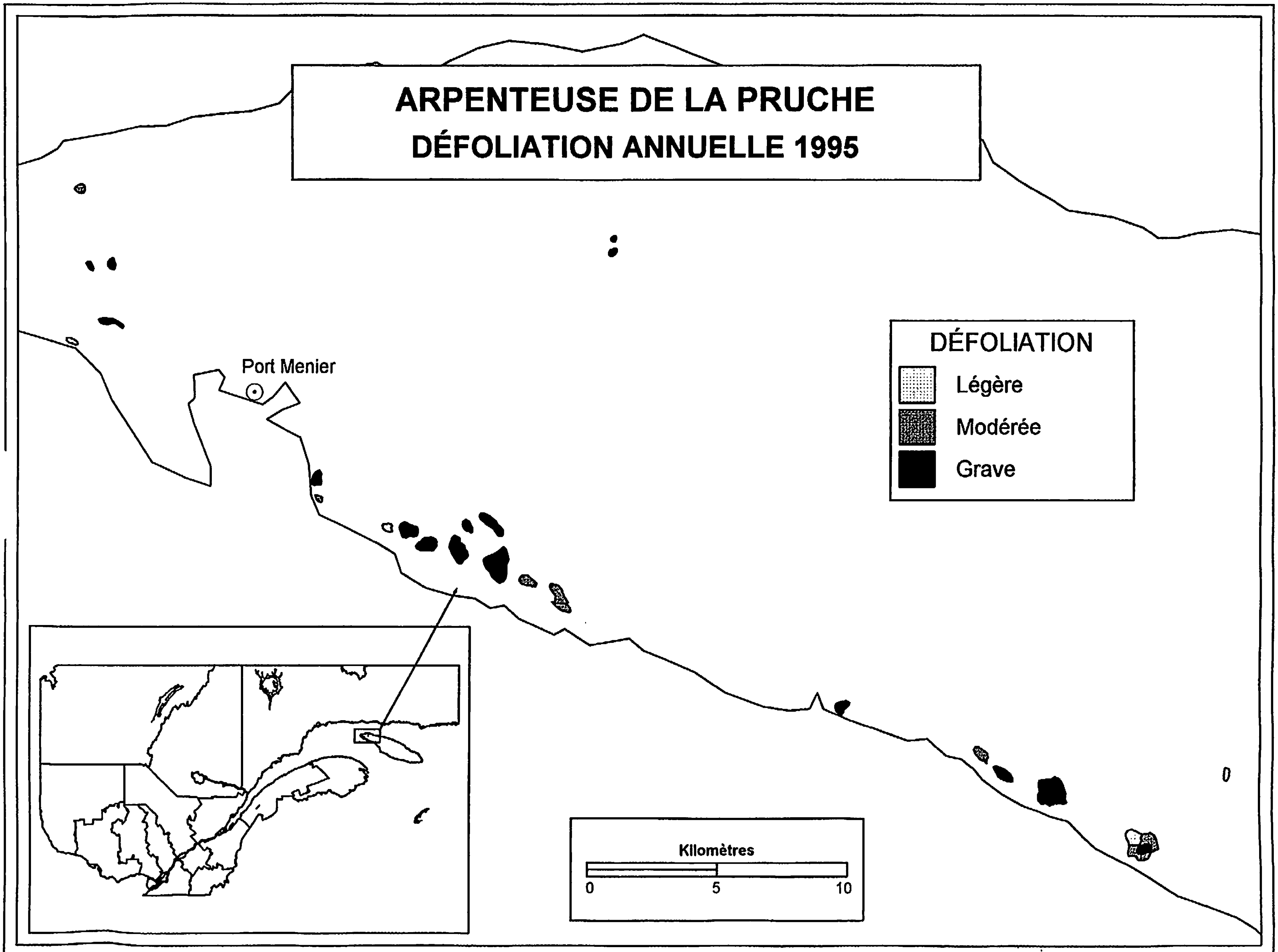
Tableau 2 - Superficies (ha) affectées par l'arpenteuse de la pruche au Québec en 1995

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Élevé	
Côte-Nord	55 (617)*	160 (234)	457 (124)	672 (975)

* ( ) = Superficies affectées en 1994

PRÉVISIONS

Un relevé des oeufs a été effectué à l'automne dans les régions de l'est du Québec. Il a été dirigé dans les stations du réseau de pièges à phéromone où la capture moyenne de papillons par piège était supérieure à 1 000 ainsi que dans les stations du réseau de parcelles permanentes localisées sur l'Île d'Anticosti. Les résultats de ces relevés ne sont pas encore disponibles.


ARPENTEUSE DE LA PRUCHE
DÉFOLIATION ANNUELLE 1995
Port Menier
DÉFOLIATION
Légère
Modérée
Grave
Kilomètres
0
5
10

Carte 3

TORDEUSE DU PIN GRIS
Choristoneura pinus pinus Free.

INFESTATION

Les défoliations causées par la **tordeuse du pin gris** dans la région de l'Outaouais se sont révélées cette année plus intenses que prévu. Les superficies atteintes ont doublé, passant de 634 hectares en 1994 à 1 250 hectares en 1995, alors que les dégâts se situent principalement à des niveaux modérés et graves. Les infestations se sont maintenues dans les foyers localisés sur l'Île-du-Grand-Calumet, le long de la Route 148 à l'est de Fort-Coulonge ainsi que près de Chapeau sur l'Île-aux-Allumettes (Carte 4). De nouveaux petits îlots de défoliation légère à modérée ont également été détectés près de Vinton, Fort-Coulonge et sur l'Île-aux-Allumettes, alors qu'un foyer plus important de défoliation grave était relevé de chaque côté de la Route 301 près de Kazabazua. Dans la région de l'Abitibi-Témiscamingue, des défoliations légères ont été détectées dans deux plantations localisées près du réservoir Decelles ainsi que dans le verger à graines Duverny situé au nord de Landrienne.

Tableau 3 - Superficies (ha) affectées par la tordeuse du pin gris au Québec en 1995

Région administrative	Niveau de défoliation			Total
	Léger	Modéré	Élevé	
Outaouais	57 (293)*	650 (341)	543 (0)	1 250 (634)

* ( ) = Superficies affectées en 1994

PRÉVISIONS

Un relevé des larves en hibernation (L2) a été réalisé dans les aires infestées en 1995. Les défoliations seront encore importantes dans les foyers situés sur l'Île-du-Grand-Calumet et à Kazabazua.

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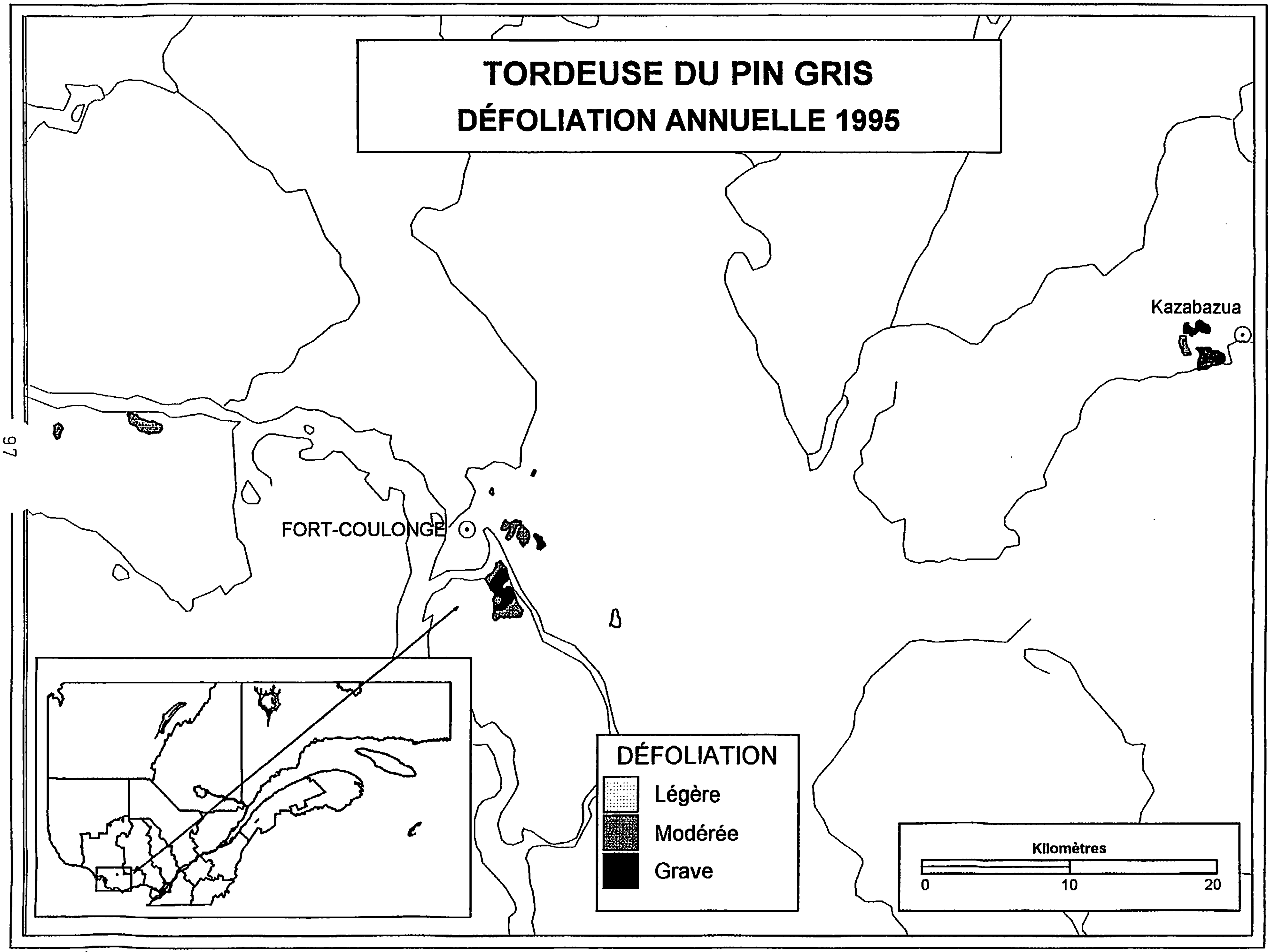


TORDEUSE DU PIN GRIS
DÉFOLIATION ANNUELLE 1995
Kazabazua
FORT-COULONGE
DÉFOLIATION
Légère
Modérée
Grave
Kilomètres
0
10
20

97

Carte 4

SPONGIEUSE
Lymantria dispar (L.)

INFESTATION

Pour une troisième année consécutive, aucune défoliation apparente pouvant être attribuée à la spongieuse n'a été rapportée dans son aire de distribution au Québec.

LIVRÉE DES FORÊTS
Malacosoma disstria Hbn.

TORDEUSE DU TREMBLE
Choristoneura conflictana (Wlk.)

INFESTATION

Le déclin important des populations des deux principaux défoliateurs du peuplier faux-tremble, la **livrée des forêts** et la **tordeuse du tremble**, observé l'an dernier, s'est poursuivi cette année d'une manière encore plus marquée. Un total d'environ 4 700 hectares demeurent affectés par la livrée des forêts alors qu'en 1994, cette superficie totalisait 22 500 hectares. C'est dans le secteur de La Tuque, dans la région de la Mauricie—Bois-Francs, que la diminution est la plus spectaculaire; la zone infestée est passée de 22 000 hectares en 1994 à 3 700 hectares en 1995, et seulement 150 hectares ont été défoliés à un niveau modéré cette année. Dans cette même région, un petit foyer totalisant 1 100 hectares demeure encore actif près de Saint-Joachim-de-Courval où 89 hectares de forêts ont été défoliés sévèrement. Quant à la tordeuse du tremble, ses populations ont aussi diminué considérablement au point où seulement quelques îlots de défoliations de niveau trace ont été observés dans les foyers déja rapportés l'an dernier, soit dans les secteurs de Saint-Donat-de-Montcalm, Saint-Michel-des-Saints (région de Lanaudière) et des rivières York et Saint-Jean (région de la Gaspésie—Îles-de-la-Madeleine). Cependant, le foyer d'infestation des lacs Corbett (région de l'Outaouais) rapporté l'an dernier s'est intensifié cette année avec un total de 1 200 hectares de défoliation dont 33 de niveau modéré.

ARPENTEUSE DE BRUCE
Operophtera bruceata (Hulst)

INFESTATION

Les populations de l'**arpenteuse de Bruce**, ce défoliateur important de l'érable à sucre, continuent leur progression dans plusieurs régions du Québec. Quelques érablières sont défoliées à des niveaux modérés et légers à plusieurs endroits, principalement dans la plaine sud du Saint-Laurent. Les régions où les défoliations sont les plus importantes sont : Chaudière-Appalaches, Estrie, Laurentides et Outaouais. Jusqu'ici les populations de cette arpenteuse semblent se disperser dans plusieurs érablières de ces régions sans toutefois se concentrer dans un secteur donné.

PORTE-CASE DU BOULEAU
Coleophora serratella (L.)

INFESTATION

Une augmentation spectaculaire des populations du porte-case du bouleau a été remarquée cette année sur le bouleau à papier dans plusieurs régions du Québec. Les peuplements les plus touchés se situent au nord des régions de Lanaudière et de la Mauricie—Bois-Francs, au Saguenay—Lac-Saint-Jean, sur la Côte-Nord et également dans les régions du Bas-Saint-Laurent et de la Gaspésie—Îles-de-la-Madeleine. Dans l'ensemble, les défoliations se situent à des niveaux variant de modérés à élevés.

NOCTUELLE DÉCOLORÉE
Enargia decolor (Wlk.)

INFESTATION

Pour une deuxième année consécutive, la **noctuelle décolorée** a causé des défoliations importantes et souvent spectaculaires sur le peuplier faux-tremble dans trois régions du Québec. Au Saguenay—Lac-Saint-Jean, cette noctuelle est encore très active dans les foyers déjà connus, soit au sud du lac Kénogami et au sud de Roberval. De nouveaux foyers de défoliation de niveaux modéré à élevé ont été signalés au nord-ouest de La Tuque, dans la région de la Mauricie—Bois-Francs. La région de l'Abitibi-Témiscamingue a également connu des dégâts importants de cet insecte, principalement dans plusieurs secteurs situés au sud de Rouyn; les défoliations étaient importantes le long des Routes 101 et 391 jusqu'à la ville de Témiscaming ainsi que dans la zone située entre les lacs des Quinze et Simard.

...

PLANTATIONS

CHANCRE SCLÉRODERRIEN
Gremmeniella abietina (Lagerberg) Morelet

Dans les aires reboisées, le taux d'infection de la maladie du **chancre scléroderrien** a augmenté considérablement dans certaines plantations et tests de descendance de pins. La mortalité de pins rouges d'une quarantaine de pieds de hauteur a même été observée dans quelques plantations affectées par la race européenne de la maladie (région des Laurentides).

TENTHRÈDE À TÊTE JAUNE DE L'ÉPINETTE
Pikonema alaskensis (Roch.)

La **tenthrède à tête jaune de l'épinette** a causé localement des défoliations importantes dans des plantations d'épinettes noires et d'épinettes blanches des régions de Québec, de Chaudière-Appalaches et du Bas-Saint-Laurent. Les principaux secteurs infestés ont été relevés sur la Côte de Beaupré (U.G. des Laurentides), dans le Fief Hubert (U.G. de Portneuf), dans un corridor s'étendant de Saint-Paul-de-Montminy à Saint-Luc (U.G. de la Beauce et des Appalaches) ainsi que dans les cantons Lagrange et Casault (U.G. du Bas Saint-Laurent).

SPRUCE BUDWORM AND GYPSY MOTH IN ONTARIO, 1995

- Outbreak Status 1995
- Forecasts 1996
- Spraying Operations 1995

by

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

1. Report prepared for the 23rd Annual Forest Pest Control Forum, Ottawa, November 21-23, 1995.

2. Natural Resources Canada, Canadian Forest Service, 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 1995:

In 1995, the spruce budworm outbreak in Ontario declined for the third consecutive year. Total area of moderate to severe defoliation was 3 450 483 ha compared to 4 266 656 ha in 1994 (Figure 1, Table 1). Increases in the area infested in the Sioux Lookout, Dryden, and Hearst districts were more than offset by large declines in the Fort Frances, Nipigon, Red Lake, and Thunder Bay districts, and by smaller declines in the Wawa and Kenora districts.

In northwestern Ontario, infestations increased in area and intensity east and northeast of Lac Seul in the Sioux Lookout District. As well, they extended into the Sturgeon Lake area of the eastern Dryden District. There was a lessening in the intensity of the infestation in the Red Lake District, with damage classed as moderate rather than severe, and some reduction was noted in the infestation in the Trout Lake-Ball Township area. There was also a reduction in the area affected between Umfreville Lake and Wade in the Kenora District, but elsewhere infestations remained largely the same as last year. There was a marked budworm decline in the eastern part of the Fort Frances District, where populations collapsed in the area east of Namakan Lake, in the central part of Quetico Provincial Park, and in the Marmion Lake area. Infestations remained heavy in the western part of the Fort Frances District and along the Highway 11 corridor between Calm Lake and French Lake. A new pocket of defoliation was mapped along the American border north of Knife Lake and west of Saganaga Lake. Infestations declined markedly in the eastern and southern parts of the Thunder Bay District, but an irregularly shaped area of moderate to severe defoliation persisted in the central part of the district from the northwest coast of Lake Superior near the city of Thunder Bay north to the Cheeseman and Mooseland lakes area. In the Nipigon District infestations on the west side of Lake Nipigon collapsed; only one small area persisted on the northeast side of the lake between Mount St. John and Inspiration Lake. Many pockets of infestation, which occurred in 1994 in the eastern Nipigon District between Lake Nipigon and the Selwyn Lake-Stevens area, collapsed in 1995. Only a few scattered patches of defoliation persisted north and south of Manitouwadge. On the eastern edge of the outbreak, infestations expanded somewhat in the southwestern corner of the Hearst District, but subsided slightly in the northwest corner of the Wawa District.

In northeastern Ontario there was a slight increase in the area affected by the small infestation on the Sudbury-North Bay district boundary in the vicinity of the village of Warren. A small, new infestation was found on the Whitefish Lake Indian Reserve and several small pockets recurred on Manitoulin Island in the Sudbury District. One large pocket of new infestation and several small patches were mapped in the Ramsey Lake area between

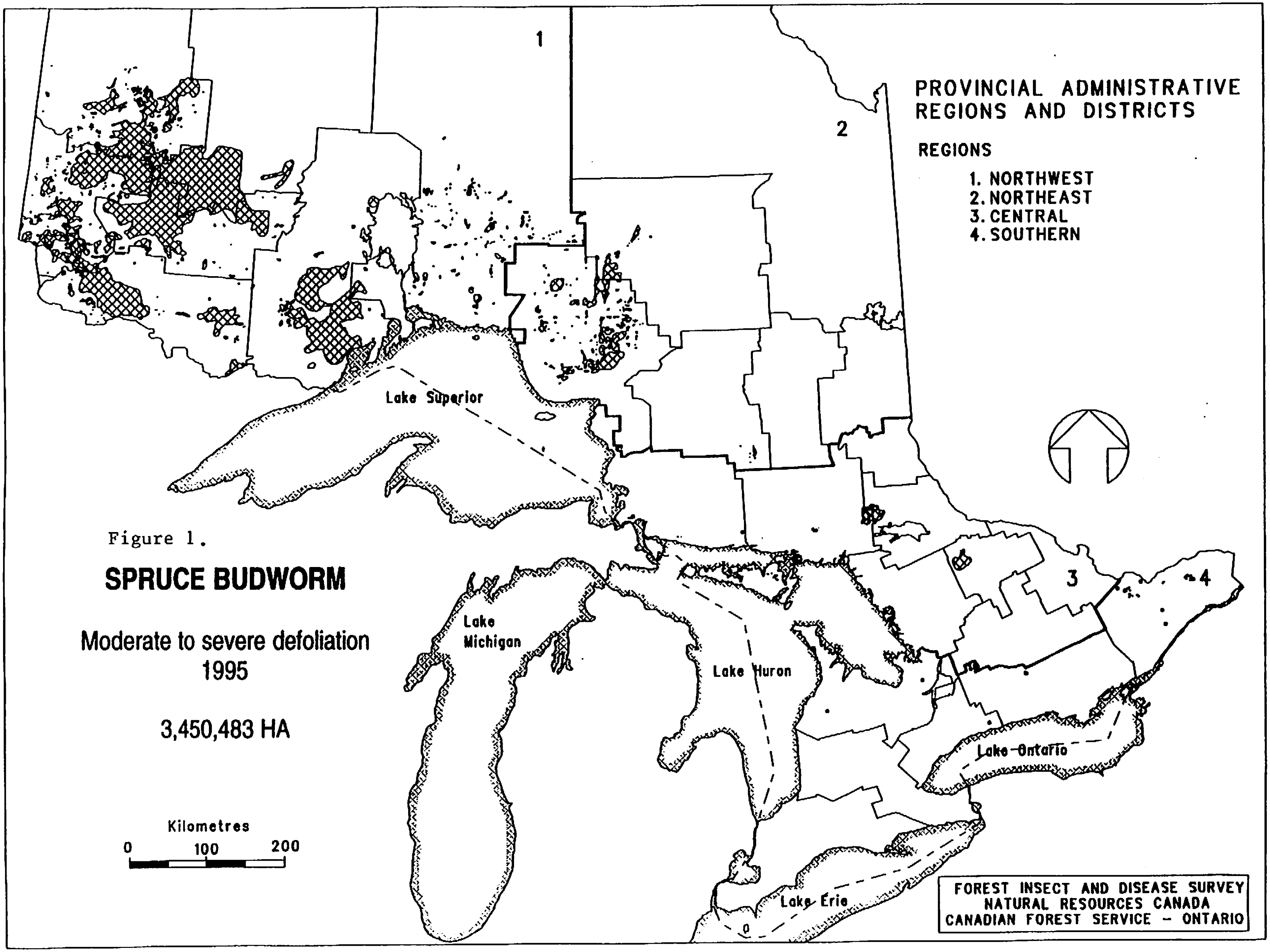


Figure 1.

SPRUCE BUDWORM

Moderate to severe defoliation
1995

3,450,483 HA

Hall and McPhail townships, Chapleau District. In the Sault Ste. Marie District, several small pockets of defoliation were discovered in the McCarthy Lake area, southeast of Elliot Lake and north of Thessalon in Kirkwood Township. The infestation in the city of Sault Ste. Marie and environs enlarged somewhat in 1995.

In southern Ontario new infestations were mapped south and east of Arnprior. Existing infestations increased in size and intensity in Gloucester Township and in the Larose Forest area of Clarence and Cambridge townships in the Kemptville District. Small, new infestations were mapped north of Havelock in the Tweed District and a new infestation was discovered in the Coboconk area of the Bancroft District. Small pockets of infestation persisted in a number of widely separated white spruce (*Picea glauca* [Moench] Voss) plantations in the Midhurst and Maple districts.

In 1995, the gross area of spruce budworm-associated tree mortality in Ontario increased by only 127,088 ha to a total of 7 910 424 ha (Figure 2). The largest increases occurred in the districts of Thunder Bay, Nipigon, Hearst and Dryden.

Forecasts 1996:

The results of egg-mass surveys (Table 2) indicate an overall decrease in egg-mass densities averaging 38. It is expected that the extent and severity of defoliation will be less in 1996 than 1995.

Spraying Operations 1995:

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

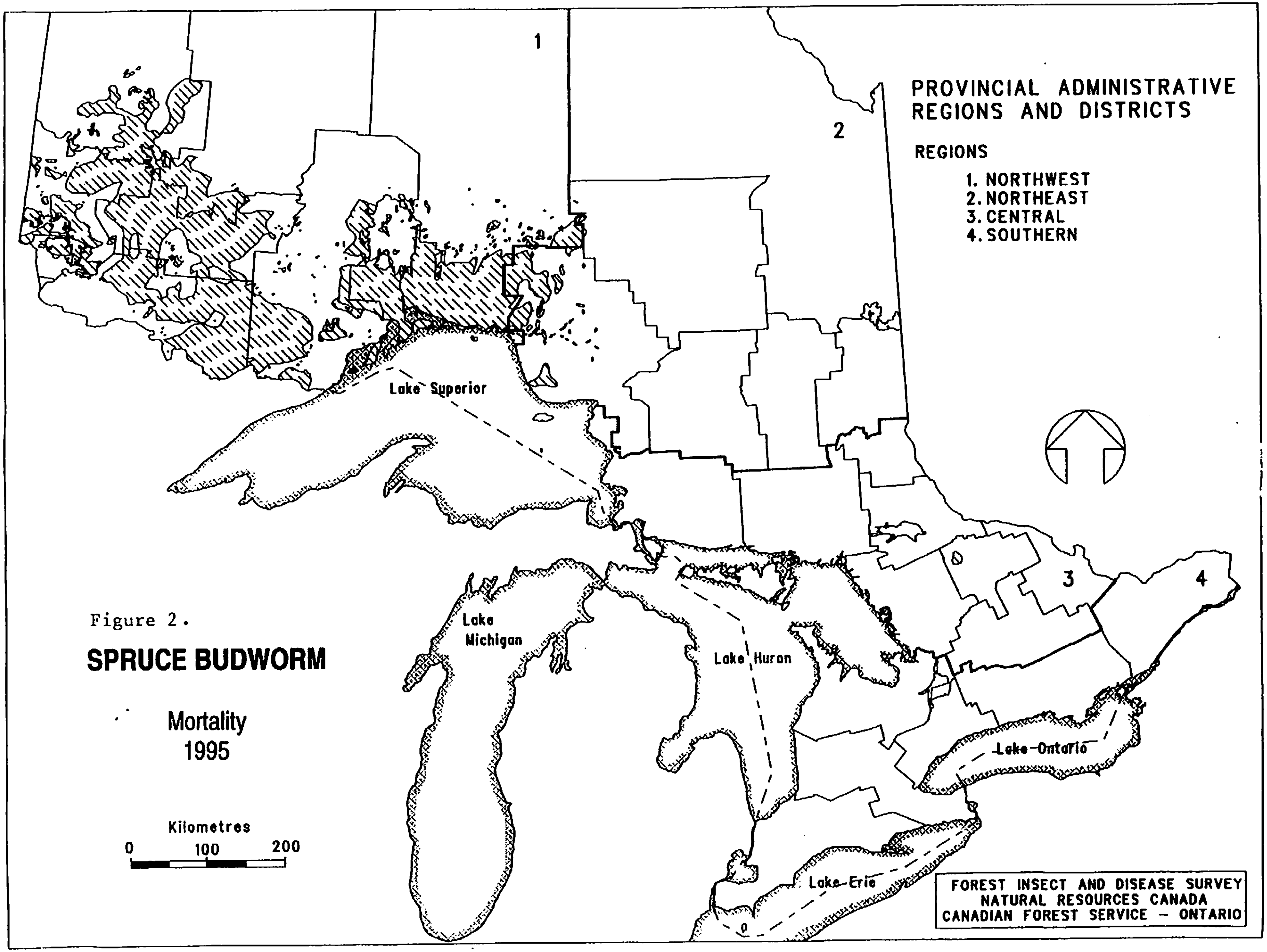


Figure 2.

SPRUCE BUDWORM

Mortality
1995

Table 1. Gross area of moderate to severe defoliation caused by the eastern spruce budworm in Ontario, 1992-1995.

Region / District	Area (ha) 1992	1993	1994	1995
Central				
Algonquin Park	26 900	20 405	57 405	33 672
North Bay	1 545	10 468	27 995	28 269
Sault Ste. Marie	965	4 639	915	2 713
Sudbury	1 365	9 150	22 640	26 371
Bancroft	0	0	0	1 828
	30 775	**44 662**	**108 955**	**92 883**
Northeast				
Chapleau	0	0	0	2 695
Cochrane	11 205	11 647	0	0
Hearst	458 578	268 208	42 245	53 413
Wawa	1 621 297	1 370 822	241 340	221 446
	2 091 080	**1 650 677**	**283 590**	**277 554**
Northwest				
Dryden	853 616	997 273	507 450	601 490
Fort Frances	424 784	422 244	506 878	373 401
Kenora	867 632	850 187	571 555	513 141
Nipigon	2 399 493	2 583,644	355 699	95 569
Red Lake	805 912	638 964	559 847	392 031
Sioux Lookout	533 554	556 122	367 437	576 055
Thunder Bay	1 588 892	1 247 302	1 004 558	521 802
	7 473 883	**7 295 736**	**3 873 424**	**3 073 489**
Southern				
Cambridge	0	0	20	0
Kemptville	10	85	570	5 638
Maple	2	0	0	7
Midhurst	12	17	97	97
Tweed	0	0	0	815
	24	**102**	**687**	**6 557**
TOTAL	**9 595 762**	**8 991 177**	**4 266 656**	**3 450 483**

Table 2. Comparison of spruce budworm egg-mass densities in the regions of Ontario between 1994 and 1995.

Region	No. of locations: Sampled in 1995	Common to 1994 and 1995	Average egg-mass density per 9.29 m^2 of branch: 1994	1995	Change (%)
Northwest	165	143	214	131	-39
Northeast	101	96	44	24	-45
Central	78	71	16	13	-16
Southern	12	11	471	318	-32
Total	**356**	**321**	**128**	**79**	**-38**

Gypsy Moth

<u>Outbreak Status 1995</u>:

Gypsy moth populations in Ontario began rebounding in 1995 after three successive years of decline. The total area of moderate to severe defoliation increased to 19 879 ha from the 5 645 ha recorded in 1994 (Table 3). The most widespread defoliation occurred in the Sudbury District in numerous pockets clustered around the city of Sudbury from the Whitefish Lake Indian Reserve to the Falconbridge-Capreol townships area (Fig. 3). Most of the defoliation was noted on white birch (*Betula papyrifera* Marsh) and trembling aspen (*Populus tremuloides* Michx.). To a lesser extent red oak (*Quercus rubra* L.) growing on exposed, rocky ridges was also infested. Single small pockets of defoliation were mapped on the north side of Finn Bay in the Killarney Provincial Park and along Highway 17 near the town of Webwood in the Sudbury District. The insect was found for the first time in infestation proportions in the Sault Ste. Marie District. Here, nine small pockets of moderate to severe defoliation were mapped in the vicinity of Lake Duborne and Granary Lake north of the town of Blind River. These infestations occurred mostly on scattered red oak and to a lesser extent on white pine and white birch growing on rocky hill tops.

New, heavy infestations were mapped in the Parry Sound District. In total, 2 413 ha of red oak and trembling aspen were severely defoliated between the Naiscoot River and the southern part of the Magnetawan Indian Reserve. In the Aylmer District, small infestations that occurred in Moore and Mosa townships in 1994 collapsed in 1995. Similarly, the small pockets of infestation that occurred in the Pinery Provincial Park last year declined to light intensity. New infestations, totaling 208 ha, were aerially mapped midway between the towns of Harrow and Kingsville in adjoining areas of Colchester South and Gosfield South townships. Much of this defoliation was in mature hardwood stands having a high oak content.

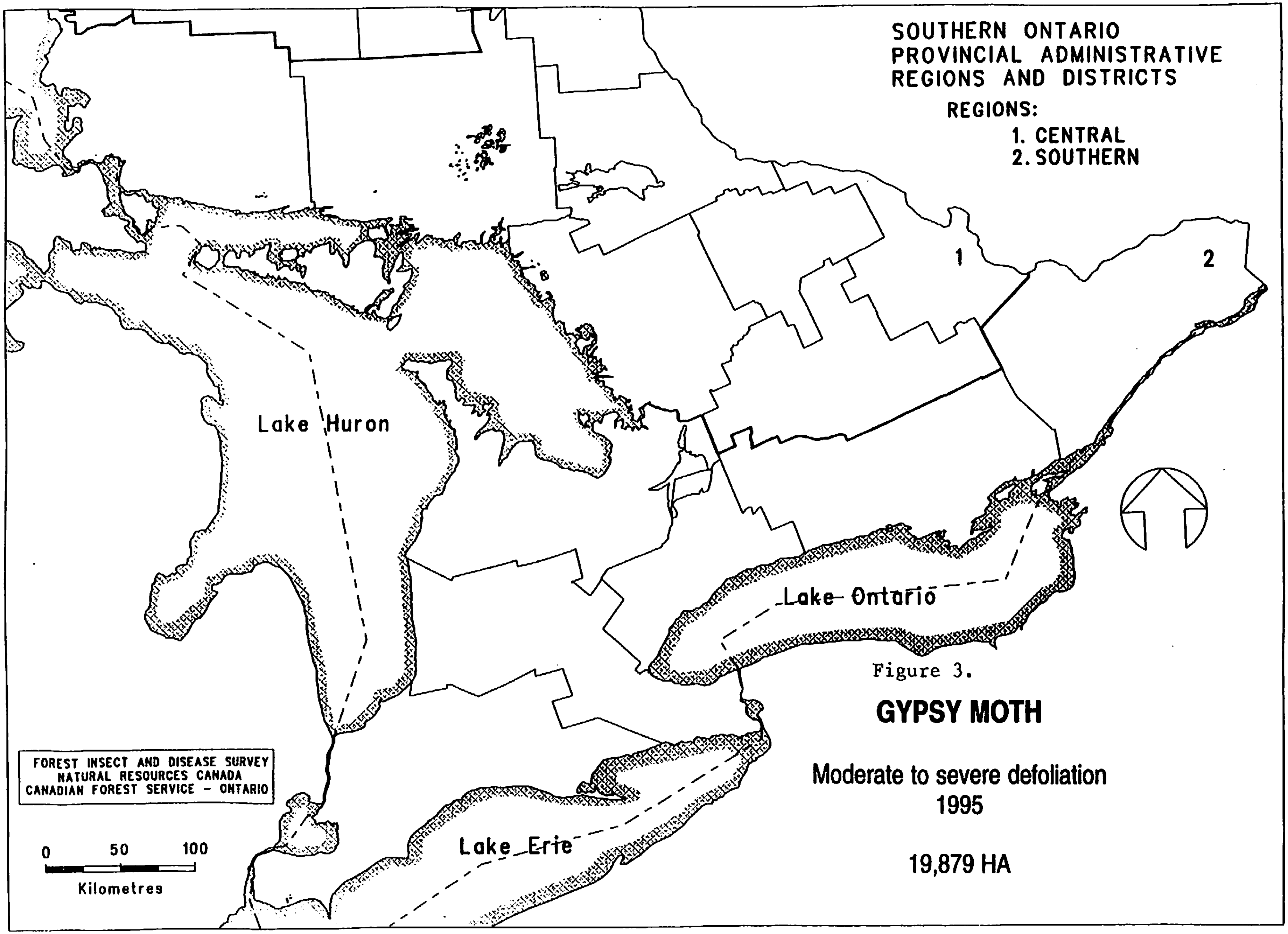


Figure 3.

GYPSY MOTH

Moderate to severe defoliation
1995

19,879 HA

Table 5. Gross area of moderate to severe defoliation by the gypsy moth in Ontario, 1993-1995.

Region District	Area (ha) 1992	 1993	 1994	 1995
Central				
Algonquin Park	591	0	0	0
Bancroft	13 205	0	0	0
Parry Sound	1 513	0	0	2 413
Pembroke	2 301	0	0	0
Sudbury	3 502	6 645	5 543	17 033
Sault Ste. Marie	0	0	0	225
	21 112	**6 645**	**5 543**	**19 671**
Southern				
Aylmer	123	2 357	102	208
Cambridge	225	0	0	0
Maple	3 986	304	0	0
Midhurst	1 036	349	0	0
Tweed	7 978	129	0	0
	13 348	3 139	102	208
TOTAL	**34 460**	**9 784**	**5 645**	**19 879**

Forecasts for 1996:

Predictions for 1996 are based on historical trends and speculation since gypsy moth egg-mass surveys were not conducted in Ontario in 1995. The historical trend shows that gypsy moth populations reached their lowest level in the past 15 years in 1994 and are increasing. The area of defoliation is expected to increase further in 1996 compared to 1995.

Spraying Operations 1995:

There were no aerial spraying operations against gypsy moth conducted by OMNR in 1995.

JACK PINE BUDWORM IN ONTARIO, 1995[1]

-Outbreak Status 1995

-Forecasts 1996

-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 23rd Annual Forest Pest Control Forum,
Ottawa, November 21-23, 1995.

[2]Natural Resources Canada, Canadian Forest Service–Sault Ste. Marie, Ontario.

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

OUTBREAK STATUS 1994

After five years of increase, the total area of moderate to severe defoliation caused by the jack pine budworm declined in 1995 to 293,292 ha, down from the 419,344 ha reported in 1994 (Table 1; Figure 1). As in 1994, most of the infestation occurred in the Central Region, although several small areas of damage, totalling 4,332 ha, were observed in Timmins and Chapleau districts in the Northeast Region. Most of the decline in 1995 occurred in Sudbury District where the infestation was reduced from 277,129 ha to 116,031 ha. This was offset somewhat by increases in the infestations in Algonquin Park, North Bay, Parry Sound, Pembroke, and Sault Ste. Marie districts. Along with the reduced size of the infestation, defoliation levels within many stands were also generally lower than in previous years. The production of staminate flowers on host trees also decreased from 1994 in many stands throughout the infestation and may have contributed to the overall reduction in budworm populations. No defoliation was detected in the Northwest Region in 1995.

FORECASTS 1995

Jack pine budworm egg mass samples were collected from 176 locations throughout Ontario in 1995. These locations form a plot network that was established in 1992 and 1993 with funding from the Northern Ontario Development Agreement. This network is intended to support longterm impact and population monitoring studies that will form the basis for jack pine budworm management prescriptions in Ontario. Stands were selected using age and site class criteria and are located throughout the Central, Northeast, and Northwest regions.

Overall, there was a 70% decrease in jack pine budworm egg mass numbers in 1995 (Table 2). Reductions were recorded in each of the three regions and in 9 of the 10 districts surveyed. In areas currently infested with budworm in the Central and Northeast regions, egg mass numbers declined by 74% and 40 % respectively. Forecasts for most sample locations in the Central region call for little or no defoliation in 1996. Based on the substantial reductions in larval populations observed in some areas and the low egg mass numbers, it would appear that the infestation throughout much of this region is collapsing. The situation in the Northeast Region is less certain and follow-up L2 surveys are currently underway. No egg mass samples were collected from the Parry Sound and Pembroke areas this year. However, recent L2 surveys in Parry Sound District indicate that moderate to severe levels of defolliation can be expected throughout much of the currently infested area again in 1996.

In the Northwest Region, the 1994 egg mass survey indicated that a slight increase in budworm populations was expected in 1995 with the possibility of a few small patches of defoliation. However, there was no evidence of a population increase in this region and the 1995 egg mass survey produced a total of only 4 egg masses at 88 locations. It is unlikely that there will be any defoliation in the Northwest Region in 1996.

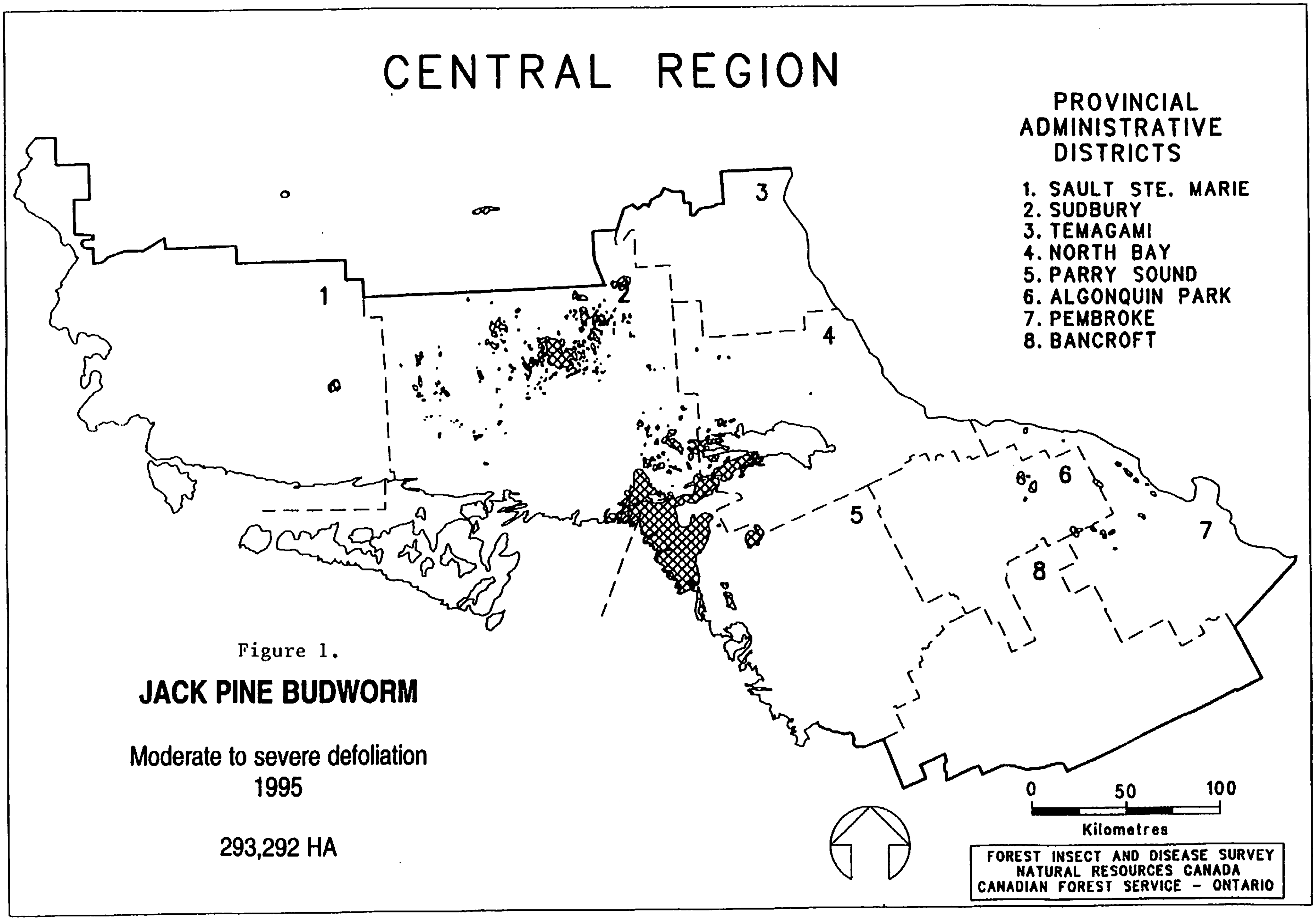


Figure 1.

JACK PINE BUDWORM

Moderate to severe defoliation
1995

293,292 HA

Table 1. Gross area of moderate to severe defoliation caused by the jack pine budworm in Ontario, 1992-1995.

Region District	Area (ha)			
	1992	1993	1994	1995
Northwest				
Red Lake	693	0	0	0
	693	**0**	**0**	**0**
Central				
Algonquin Park	495	380	1,590	6,312
Bancroft	30	0	0	0
North Bay	16,379	19,035	25,052	27,289
Parry Sound	77,551	91,645	106,898	129,272
Pembroke	2,704	4,202	3,875	7,077
Sault Ste. Marie	0	1,095	1,240	2,962
Sudbury	60,349	165,840	277,129	116,031
Temagami	0	50	110	17
	157,478	**282,247**	**415,894**	**288,960**
Northeast				
Timmins	0	0	3,450	3,076
Chapleau	0	0	0	1,256
	0	**0**	**3,450**	**4,332**
TOTAL	**158,704**	**282,247**	**419,344**	**293,292**

SPRAYING OPERATIONS

In 1995, the Ontario Ministry of Natural Resources (OMNR) carried out an operational spray program against the jack pine budworm over some 51,015 ha in the Upper and Lower Spanish management units and in the Sudbury and Espanola crown management units. This was a co-operative program involving OMNR, the Canadian Forest Service–Sault Ste. Marie (CFS), and E.B. Eddy Forest Products Ltd. The objective of the program was to protect selected high value jack pine stands from defoliation, volume loss, and mortality. Stands eligible for the protection program had to meet the following criteria: >40% jack pine, >48m^3/ha softwood component, >40 years old, and not scheduled for harvest within the next 3 years. Also, all eligible stands had a moderate to severe defoliation forecast for 1995 based on egg mass and/or L2 samples.

Four M18 Dromaders, each equiped with 6 Micronair rotary atomizers were used to treat each block with a single application of Foray 76B (Novo Nordisk) at a rate of 30BIU/1.5L/ha. The aircraft operated out of two airstrips, the Sudbury Regional Airport and a strip in Durban Township south of E.B. Eddy Camp 12. A total of 22 spray sessions were required to complete the program which ran from June 17–25.

Table 2. Comparison of jack pine budworm egg mass densities in Ontario in 1994 and 1995.

Region District	No. Locations	Total egg masses 1994	Total egg masses 1995	Change (%)
Central				
North bay	2	10	18	+80
Sault Ste. Marie	18	38	5	-87
Sudbury	44	258	58	-78
Total	64	306	81	-74
Northeast				
Chapleau	15	1	0	-100
Timmins	9	36	22	-39
Total	24	37	22	-40
Northwest				
Dryden	17	1	1	0
Fort Frances	16	3	1	-67
Kenora	13	1	0	-100
Red Lake	24	7	2	-71
Sioux Lookout	18	4	0	-100
Total	88	16	4	-75
TOTAL	**176**	**359**	**107**	**-70**

Timing: Weather data was gathered daily from the Sudbury weather office from April 1 to July 31 to monitor degree day accummulations in the spray area. In late May, monitoring plots were established at 6 locations throughout the operational spray area to track insect and host development (Figure 2). Plots were sampled every two days until completion of the program. Host shoot and larval development was assessed and a development index calculated for each location on each sample date.

Abnormally cool temperatures were common throughout northeastern Ontario in April and May 1995, delaying jack pine budworm emergence until early June. Spray operations were targeted to begin when the larval index was 3.5 and the host index was 4.0. However, above normal temperatures (25–35°C) from June 16-26 resulted in rapid larval development. All operational blocks were opened on June 17 when larval development indices ranged from 3.4–4.1 and host development indices were 3.0–3.4 (Figure 2).

Assessment: A total of 18 operational blocks were assessed. This represented approximately 30% of the total area treated. Some 150 assessment plots (10 trees per plot) were established in spray blocks and another 45 plots were monitored in untreated check areas. A single mid-crown branch (60cm) was collected from each tree and examined in the laboratory for both prespray and postspray samples. Prespray samples were collected in June, approximately 3-5 days before treatment and postspray samples were collected in July when 75% or more of the budworm were in the pupal stage and feeding was complete. Each postspray branch was rated for budworm defoliation.

Data Analysis: Earlier studies have shown that the presence of staminate flowers on jack pine has a significant influence on jack pine budworm population densities within and between trees in a stand. In 1995, approximately 16% of the sample trees produced staminate flowers. Analysis of variance showed that prespray budworm populations were significantly higher ($F = 248.68$; $p < .001$) on trees with flowers (average = 23.0 larvae/branch) than on trees without flowers (average = 4.2 larvae /branch). Therefore, estimates of the efficacy of the 1995 spray program are reported separately for trees with and without staminate flowers.

Early Spray Trial: In the past, control operations against the jack pine budworm on jack pine were started when the host needles had broken through the needle fascicle and had begun to flare. At this stage the foliage provided a good deposit surface and generally coincided with the presence of 3rd and 4th instar budworm. This timing regime has resulted in effective foliage protection in previous programs, but evidence suggested that equally acceptable levels of protection could be achieved by starting somewhat earlier in the host development curve. If this were true, then the operational programs could begin earlier and thus improve foliage protection efforts. In 1995, three blocks were treated prior to the start of the operational spray program to test the efficacy of an early spray regime. Block L24 was treated on June 12, five days before the start of the operational program. The other two blocks, S12N and S12S, were treated on the 14th, and 15th of June respectively.

Experimental Trials: Two experimental trials were conducted by the Canadian Forest Service to test the efficacy of single applications of Dipel 76AF (Abbott Laboratories) and MIMIC 240LV (Rohm & Haas Canada Ltd.). Results of these trials are reported under separate cover.

RESULTS

The objective of the 1995 operational spray program against the jack pine budworm was to protect trees from defoliation. Results for each spray block assessed in 1995 are presented in

Tables 3 and 4. Overall, the average defoliation rate on all trees in the spray blocks was 4.3% (SD ± 9.5%) compared to 33.1% (SD ± 33.4%) in the untreated check plots. Defoliation rates on trees with staminate flowers were higher than on trees without staminate flowers (Table 5). Significant differences in defoliation rates were also seen when trees with similar prespray larval populations were compared (Figure 3). There is little doubt that the 1995 operational spray program was effective in reducing defoliation.

Table 3. Jack pine budworm: prespray larvae, adults, and defoliation rates on trees with staminate flowers treated aerially with a single application of Foray 76B (30BIU/1.5L/ha).

Block No.	Prespray larvae/branch (60cm)	Adults per branch (60cm)	Defoliation (%)
L4	5.4	0	4.2
L5	9.7	.385	12.6
L8	10.8	.333	10.0
L9	10.0	0	0
L11	8.0	0	2.3
L12	11.5	0	7.5
L21	15.3	0	0
L22	12.8	0	1.6
L25	12.0	0	0
L26	23.7	0	6.6
E1	45.0	0	5.0
E2	8.0	0	0
E4	12.0	0	0
E6	62.8	0	3.8
E7	5.5	.091	4.2
E10	7.0	0	2.0
E17	81.3	.182	13.2
U2	28.1	.611	21.8

Differences in jack pine budworm survival (prespray larva to adult) in spray and check plots were also significant (ANOVA; $F = 261.21$, $p < .001$). Overall, there was an average of .093 (SD ± .465) adults/branch in spray plots compared to 2.043 (SD ± 3.548) in the checks, nearly a 22 fold difference. These differences were consistent on trees with and without flowers (Table 5) and demonstrate that a single application of Foray 76B was also very effective in reducing jack pine budworm populations.

Table 4. Jack pine budworm prespray larvae, adults, and defoliation on trees without staminate flowers treated aerially with a single application of Foray 76B (30BIU/1.5L/ha)

Block	Prespray larvae/branch (60cm)	Adults per branch (60cm)	Defoliation (%)
L4	1.4	0	2.3
L5	2.6	.108	5.0
L7	1.2	0	2.6
L8	3.5	.148	7.1
L9	6.3	.138	4.6
L10	2.0	0	1.0
L11	1.3	0	3.6
L12	4.7	0	4.1
L21	1.4	0	1.0
L22	2.6	.022	2.6
L25	4.5	.044	1.0
L26	7.8	.025	1.4
E1	3.5	0	2.4
E2	1.8	0	1.0
E4	1.5	.105	1.0
E6	2.8	.024	3.3
E7	3.2	.011	3.0
E10	4.0	0	1.0
E17	6.2	0	8.3
U2	14.1	.421	8.8

Table 5. Jack pine budworm prespray larvae, postspray adults, and defoliation rates on jack pine treated aerially with a single application of Foray 76B (30BIU/1.5L/ha) (± SD).

Treatment	Average prespray larvae per branch	Average adults per branch	Average defoliation (%)
Spray (flowers)	22.9 ± 30.2	.211 ± .715	10.5 ± 18.1
Checks (flowers)	30.9 ± 19.3	4.185 ± 4.692	62.8 ± 32.4
Spray (no flowers)	6.8 ± 9.7	.070 ± .391	3.1 ± 5.7
Checks (no flowers)	6.8 ± 9.7	1.028 ± 2.230	19.1 ± 23.0

Early Spray Trial: Results of the early spray trial are presented in Table 6 and Figure 4. Overall, foliage protection levels were comparable to those observed in blocks treated later in the program. Prespray budworm populations were relatively low in L24, however, in untreated check plots, defoliation rates averaged 15%–16% compared to 1%–2% found in this spray block. Defoliation rates in S12S were unexpectedly high on trees with flowers, but this number is significantly affected by two individual trees that had defoliation levels of 70% and 80%. When these trees were excluded from the analysis, the average defoliation rate on trees with flowers decreased to 10.4%, a figure more typical of defoliation rates observed in other spray blocks. It would appear, therefore, that acceptable levels of foliage protection can be achieved with an earlier timing regime. This should significantly increase the operational window for future programs.

Table 6. Jack pine budworm: prespray larval populations and defoliation in plots treated aerially with an early application of Foray 76B (30BIU/1.5L/ha)

Block	Date Sprayed	Host Index	Larval Index	Prespray larvae/br		Defoliation (%)	
				+	-	+	-
L24	06/12	2.0	2.7	0	3.9	2	1
S12N	06/14	3.1	3.5	19.0	3.9	0	1
S12S	06/15	3.2	3.9	18.7	2.5	29	3

+ Staminate flowers present; - staminate flowers absent

In blocks treated after the start of the operational spray program, there was a gradual increase in defoliation rates over time (Figure 4). However, even on June 25th, the last day of the operation, observed defoliation levels in the spray blocks were substantially lower than those found in the untreated checks.

Figure 2. Jack pine budworm: insect and host development indices, 1995.

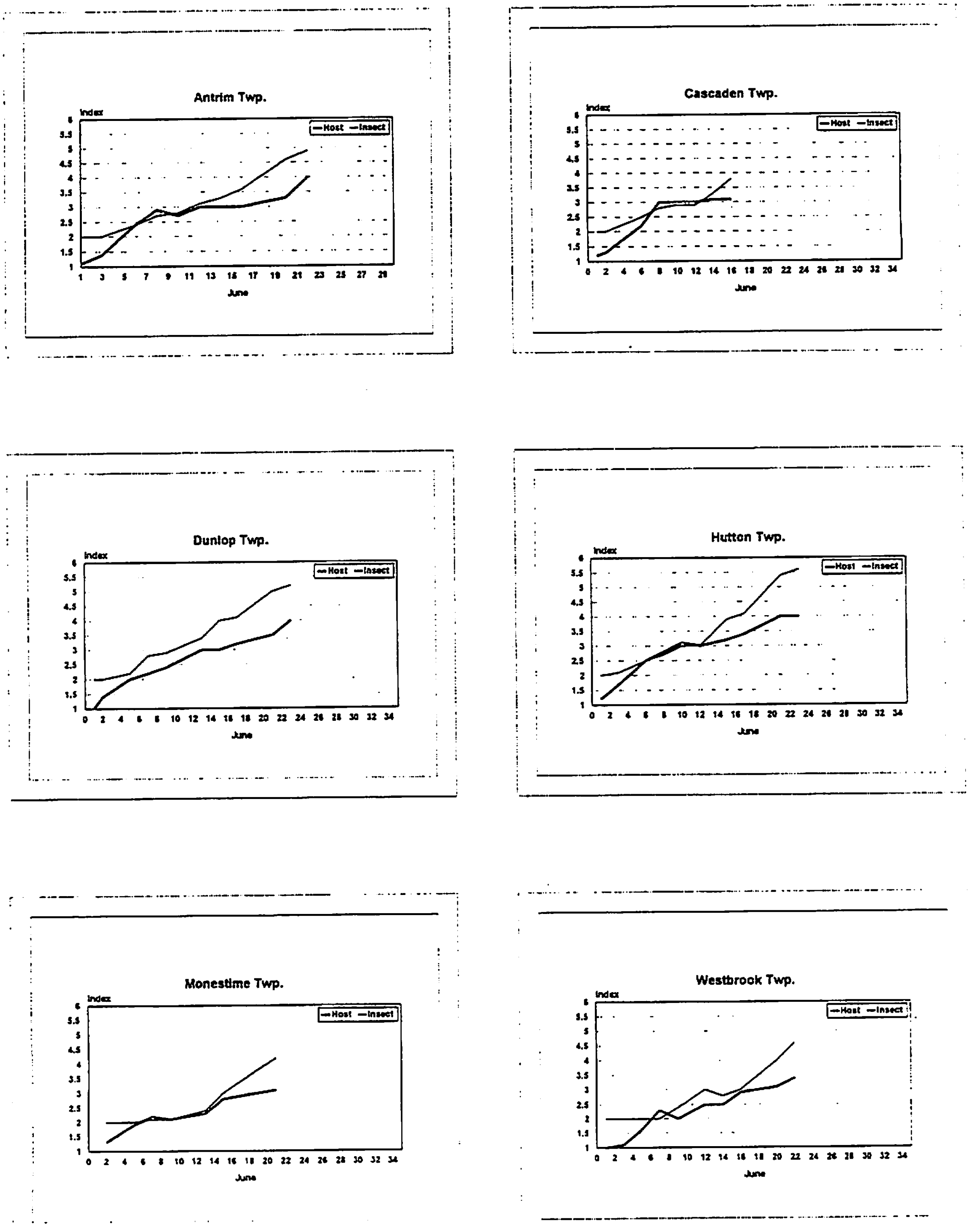


Figure 3. Defoliation in spray and check plots at increasing jack pine budworm populations.

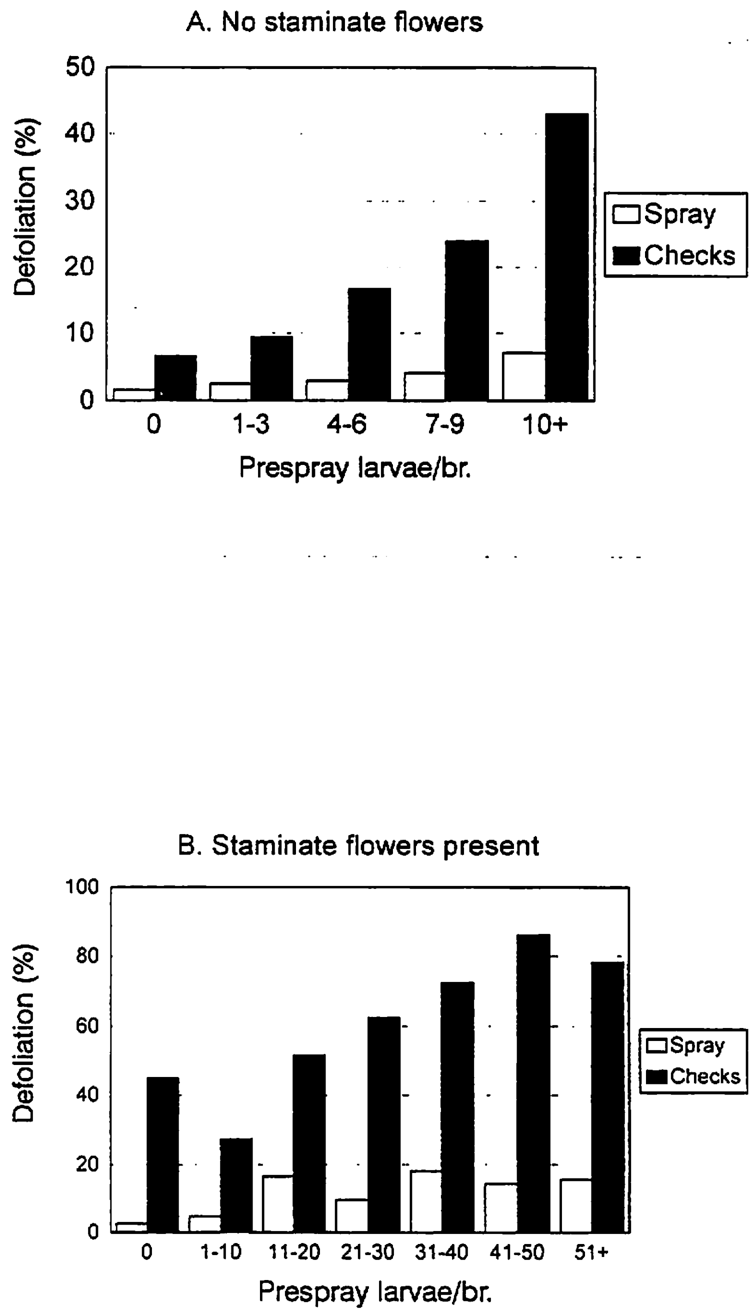
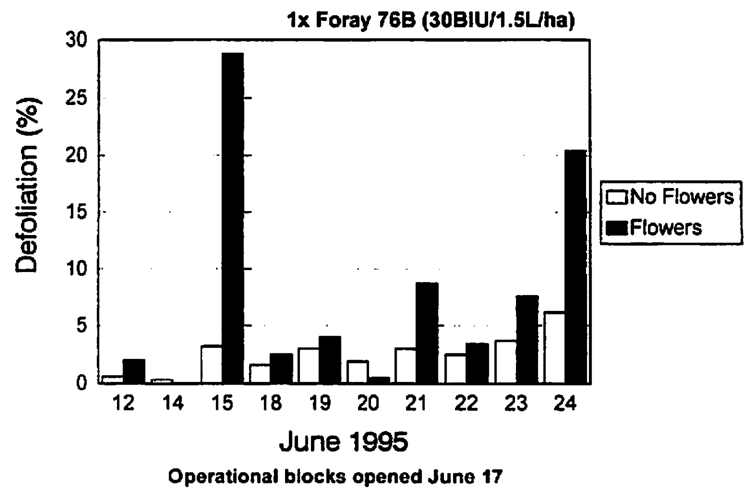


Figure 4. Jack pine budworm: average defoliation on each spray date



Forest Insect and Disease Notes

Northwest Region

A-031

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Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

Canada

UPDATE OF MAJOR FOREST PESTS IN 1995

by
James P. Brandt

The following article provides a brief overview of the status of major forest pests in Alberta, Saskatchewan, Manitoba, and the Northwest Territories. For more detailed information refer to the report titled *Forest insect and disease conditions in west-central Canada in 1995 and predictions for 1996*. Copies of the report are available at the Northern Forestry Centre.

Spruce budworm

Spruce budworm (*Choristoneura fumiferana* [Clem.]) infestations continued in the Northwest Boreal and Northeast Boreal regions in Alberta in 1995. The total area of defoliation in these two regions was 203 741 ha, of which 83% (168 479 ha) was rated as severe and 17% (35 262 ha) was rated as moderate. Other small infestations were observed along the Red Deer River in Red Deer and along the North Saskatchewan River in Edmonton.

Spruce budworm infestations in the Northwest Boreal Region increased in area while the severity of defoliation remained about the same. The area of defoliation mapped during aerial surveys of infested white spruce forests was 173 266 ha. Most areas of defoliation noted in 1994 were still present in 1995. New infestations were observed along the South Shekilie River, in the Cameron Hills west of the hamlets of Steen River and Indian Cabins, along the James and Dizzy creeks, west of Zama Lake along the Hay River, south of Mount Watt near Highway 58, east of the Rainbow Lake townsite, east of John D'Or Prairie Indian Reserve, and near Dunvegan.

In the Northeast Boreal Region, the area and severity of defoliation increased slightly. The area of moderate and severe defoliation was 17 621 and 12 854 ha, respectively. The area of moderate defoliation included 695 ha of defoliation in Wood Buffalo National Park. Infested stands near the Athabasca and House rivers occurred in most of the same areas recorded in 1994. New infestations were observed along the Deadman and Loon creeks, and along the Algar River.

Aerial applications of the bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki* (*Btk*; Foray 48B formulation), were applied operationally to 110 923 ha of white spruce forests in the Northwest Boreal Region to protect spruce foliage and suppress budworm populations. To test the efficacy of these insecticides, an additional 665 ha were treated with Foray 76B and 1033 ha were treated with Dipel 48AF.

In Saskatchewan, the total area of defoliated white spruce–balsam fir forests was 98 910 ha. Spruce budworm infestations in the Prince Albert Region covered 65 079 ha. All defoliation was rated as moderate-to-severe. North of Big River defoliation occurred in five areas: east of Delaronde Lake, south and east of Smoothstone Lake, between Doré and Smoothstone lakes, and near Sled Lake. The infestation near Tibiska and Crean lakes in Prince Albert National Park increased in size in 1995 and included areas outside the park south of Leadley Lake and east of Montreal Lake. The two major infestations near Red Earth and Hudson Bay increased in area. Several new infestations were detected during surveys in 1995. One infestation consisted of several patches along the Sipanok Channel, the Saskatchewan River east of Tobin Lake, the Torch River, and northwest of Potato Lake. The second occurred in several areas southwest of Prince Albert in and adjacent to the Nisbet Provincial Forest.

In the La Ronge Region, infestations covered 33 085 ha. These infestations included large areas of spruce forest between Wapawekka Lake, Lac la Ronge, Pinehouse Lake, and north of the Churchill River. New infestations were observed between Cumberland and Namew lakes. A previous spruce budworm outbreak occurred in this area near Namew Lake along the Saskatchewan-Manitoba border between 1951 and 1970. In the Meadow Lake Region, two small infestations were noted southeast of the town of Green Lake and along the Beaver River north of Green Lake.

Aerial applications of *Btk* (Foray 48AF) were applied by Saskatchewan Environment and Resource Management over 8550 ha of spruce budworm-infested stands to suppress budworm populations and reduce the risk of timber losses. There were two main spray blocks: one near Wapawekka Lake south of Lac la Ronge (1800 ha) and the other between Doré and Smoothstone lakes (6750 ha). Each spray block received two applications.

Spruce budworm infestations in Manitoba occurred in five administrative sections: Aspen Parkland, Interlake, Lake Winnipeg East, Mountain, and Pineland. A total of 55 592 ha of white spruce and spruce-balsam fir forests were infested, of which 40 125 ha were classed as moderate and 15 467 ha were classed as severe. Infestations were found in the same general areas as those reported in 1994, but the area of defoliation increased by 15% in 1995. In the Aspen Parkland Section, a spruce budworm infestation, which has been present for several years, continued in the Spruce Woods Provincial Forest. An aerial survey was not conducted over this infestation.

In the Interlake Section, spruce budworm infestations covered 11 562 ha, of which 9419 ha were rated as moderate and 2143 ha were rated as severe. Infestations in Management Unit 40 continued on Moose and Deer islands, near Ebb & Flow and Moose lakes, and south of Washow Bay. In Management Unit 41, infestations were observed near Lake St. George and Jackhead Lake.

In the Lake Winnipeg East Section, moderate spruce budworm defoliation occurred on 28 249 ha and severe defoliation occurred on 8733 ha. In Management Unit 30, infestations persisted near Dorothy, Nutimik, Big Whiteshell, Little Whiteshell, Crowduck, Lone Island, West Hawk, and Falcon lakes. Infestations in Management Unit 31 continued in 1995 in the following areas: near the Hollow Water and Manigotagan villages, near Wanipigow Lake, in the Long and Quesnel lakes area, in the Garner and Gem lakes area, near the Sandy, Black, and O'Hanly rivers, east of the Winnipeg River near the Maskwa River, north and east of Lac du Bonnet, and in the Oiseau and Bernic lakes area. In Management Unit 35, infestations also continued on the east side of Lake Winnipeg across from Deer Island and near Loon Bay.

In the Mountain Section, budworm defoliation covered 1816 ha and occurred in the same area near Davey, Cutbank, Little Island, Snake, Noses, and Drugstore lakes reported in 1994. Spruce budworm outbreaks in the Pineland Section occurred in three areas (5232 ha). Two of these occurred in Management Unit 23 on the south side of Lac du Bonnet and on several islands in the lake, and east of the Pinawa Channel. The third area was in Management Unit 20 south of East Braintree.

For the first time in several years, an operational spray program was conducted by Manitoba Natural Resources. *Bacillus thuringiensis* var. *kurstaki* (*Btk*; Dipel 48AF) was applied once over 450 ha and twice over 14 773 ha. The treated areas included those near Falcon, Dorothy, Garner, and Beresford lakes, Maskwa and Sandy rivers, Loon Straits, and Duck Mountain. Manitoba Natural Resources also continued an experimental trial using Mimic® 240 LV over 1260 ha near Garner Lake in Management Unit 31; this is the second year of the trial. The trial involved one or two applications of the insecticide at a rate of 70 g active ingredient per hectare. Spray trials were also conducted by the Canadian Forest Service in cooperation with Manitoba Natural Resources using various *Btk* products and Mimic®.

In the Northwest Territories, populations of spruce budworm dropped significantly in 1995. While the insect was still widespread throughout white spruce forests, the area of moderate-to-severe defoliation was much less — 36 822 ha in 1995 compared to 370 270 ha in 1994. Sporadic infestations were present along the Slave River from Great Slave Lake to the Alberta-Northwest Territories border, along the Taltson River, along the Martin River and on the slopes of the Martin Hills, along the Mackenzie River from its confluence with the Redknife River north to its confluence with the Dahadinni River, along the Willowlake River, and along the North Nahanni River near its confluence with the Mackenzie River. One new area of defoliation was observed along the upper Kotaneelee River near the Yukon-Northwest Territories border.

Forest tent caterpillar

In Alberta, the number of areas where moderate-to-severe forest tent caterpillar (*Malacosoma disstria* Hbn.) defoliation occurred increased in 1995. Many areas in the Northwest Boreal Region near Peace River, Guy, Nampa, Grimshaw, and Fairview were defoliated in 1995, as they were in 1994. The same was true for areas in the Northeast Boreal and Parkland regions near Cooking Lake and the southern portion of Elk Island National Park. New areas of defoliation were detected near Moose and Muriel lakes in the Northeast Boreal Region; and southwest of Grande Prairie, west of the village of Bad Heart, along the Peace River near its confluence with the Ksituan River, near Dixonville and Hawk Hills, near the Twin Lakes, west of Wadlin Lake, and along Highway 58 east of the Chinchaga River in the Northwest Boreal Region. In the Northwest Boreal Region there was 17 553 ha of moderate defoliation and 146 202 ha of severe defoliation. In the Northeast Boreal Region there was 15 490 ha of moderate-to-severe defoliation and 6286 ha of severe defoliation, while in the Parkland Region, moderate-to-severe defoliation occurred over 36 486 ha.

In Saskatchewan, the forest tent caterpillar infestation noted near Battleford in the Saskatoon Region in 1994 increased in area this season. Ninety-five percent of the 91 049 ha of defoliation near Battleford was rated moderate-to-severe; the remainder was rated as light. The infestation in the Battleford area now extends from Sweet Grass Indian Reserve northwest of Battleford to just west of Struan including areas east of Winniford Lake, Mosquito and Red Pheasant Indian reserves, and the Eagle Hills Escarpment. Two areas were also noted east of North Battleford along Highway 40 and one area along the North Saskatchewan River near Sonningdale. In the Meadow Lake Region, additional areas of forest tent caterpillar defoliation were observed south of Glaslyn along Highway 4 and between Brightsand and Turtle lakes.

In Manitoba, little forest tent caterpillar defoliation occurred in 1995. Only 163 ha of moderate defoliation was mapped in the province: 32 ha in the Duck Mountain Provincial Forest in the Mountain Section, and 131 ha in Whiteshell Provincial Park in the Lake Winnipeg East Section.

A large outbreak of forest tent caterpillar was detected for the first time in the Northwest Territories. Several areas of defoliation were observed along the Liard River from south of Fort Liard to north of the Flett Rapids, along the Petitot River near its confluence with the Liard River, and southwest of Lake Bovie. Of the 32 459 ha of forest tent caterpillar defoliation in the Fort Liard area, there was 2864 ha of light defoliation, 7379 ha of light-to-moderate defoliation, 5841 ha of moderate defoliation, and 16 375 ha of moderate-to-severe defoliation.

Other aspen defoliators

Two other insects caused significant aspen defoliation in the Northwest Region: large aspen tortrix (*Choristoneura conflictana* [Wlk.]) and aspen leafroller (*Pseudexentera oregonana* [Wlsm.]). In Alberta, large aspen tortrix caused 67 075 ha of defoliation in Wood Buffalo National Park, east of the Slave River, in several small isolated patches west of Edmonton and near Sundre, south of Wolf Lake, and between Tucker, Marie, and Cold lakes. There was 8365 ha of light-to-moderate defoliation, 42 401 ha of moderate defoliation, 14 247 ha of moderate-to-severe defoliation, and 2062 ha of severe defoliation.

Aspen leafroller caused patchy defoliation in many of the same locations in Alberta noted in 1994 along river valleys and adjacent aspen forests, but defoliation was less severe in 1995. Exceptions were two large areas with light-to-moderate defoliation: along the Smoky River northeast of Grande Cache in the Northwest Boreal (24 730 ha) and Northern East Slopes (22 248 ha) regions, and near Gregoire Lake south of Fort McMurray (19 939 ha) in the Northeast Boreal Region.

In Saskatchewan, populations of large aspen tortrix continued to decline from the peak in 1993; only 9947 ha of defoliation occurred in 1995. Large aspen tortrix defoliation was observed in five small patches in the Prince Albert Region along the north slopes of the Pasquia Hills and north and northeast of Smoky Burn. Other tortrix infestations were observed east of Green Lake and in two small patches north of Meadow Lake Provincial Park in the Meadow Lake Region. Aspen leafroller defoliation was observed in small patches north and northwest of Hudson Bay (698 ha) and in or near Greenwater Lake Provincial Park (1107 ha) in the Prince Albert Region.

No defoliation caused by large aspen tortrix or aspen leafroller was observed in Manitoba or in the Northwest Territories.

Bark beetles

Mountain pine beetle (*Dendroctonus ponderosae* Hopk.) infestations remained low in Alberta in 1995. Beetles were detected at several locations by means of pheromone-baited trap trees. No mountain pine beetle-killed trees were detected when an aerial survey was conducted in the Southern East Slopes Region. The flight, which occurred in August, included surveys of the Oldman, Castle, West Castle, Crowsnest, and Carbondale river valleys, and the Allison, Lynx, Racehorse, and Dutch creek valleys. In the Northern East Slopes Region, no mountain pine beetle-killed trees were observed during aerial surveys of the Jackpine, Muddywater, South Sulphur, and Wildhay river valleys, and the Pauline, Hardscrabble, Rock, and Sheep creek valleys in the Willmore Wilderness Provincial Park.

Aerial surveys over Banff and Jasper national parks detected no recently killed trees. Areas aerially surveyed in Jasper National Park included the Smoky, Miette, Snaring, Athabasca, Whirlpool, Middle Whirlpool, Chaba, Astoria, and Sunwapta river valleys. Areas aerially surveyed in Banff National Park included areas near the Kicking Horse Pass, the North Saskatchewan, Alexandra, Howse, Spray, Mistaya, and Bow river valleys, and the Healy, Brewster, Redearth, Pharaoh, and Bryant creek valleys.

Spruce beetle (*D. rufipennis* [Kby.]) infestations in the Northwest Boreal Region in Alberta were mapped for the first time in several years. Several patches of scattered spruce beetle-killed white spruce trees were mapped in an area bounded by Nina Lake to the east, Keg River to the north, 30 km west of the sixth meridian to the west, and the Hotchkiss River to the south. Two other isolated patches were observed: one was southwest of Bison Lake east of the Peace River, the second patch was on the Halverson Ridge southeast of the Chinchaga River. The total area of these patches of scattered dead spruce was 23 771 ha.

The infestation of Douglas-fir beetle (*D. pseudotsugae* Hopk.), which was initially reported in 1991 in Jasper National Park, continued to expand in 1995. While the number of areas containing killed Douglas-fir trees remained unchanged at about 63 areas scattered in the Athabasca River valley north and south of the Jasper townsite, the number of dead trees has increased since 1994. Most areas had less than 50 attacked trees that had been killed since the infestation began.

Lodgepole pine dwarf mistletoe

In 1995, surveys were conducted in Alberta and Saskatchewan to map severe infestations of lodgepole pine dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.). These surveys were a continuation of those initiated in 1994. Areas not previously mapped in Alberta included areas along the North Saskatchewan River near the Amelia, Bruderheim, Sniatyn, Smoky Lake, and Lindbergh townsites; near North Buck Lake northeast of Boyle; northwest of Algar Lake; and north of Lake Athabasca. All infestations occurred in jack pine forests. The total area of previously unmapped infestations in Alberta was 63 888 ha, bringing the total area of jack pine forest infested by dwarf mistletoe to 176 013 ha. The area of lodgepole pine forests infested in Alberta was up slightly to 54 528 ha; one area (199 ha) was mapped late in 1994 near the Livingstone River.

In Saskatchewan, an additional 12 723 ha of dwarf mistletoe-infested jack pine forests were mapped late in 1994 and in 1995. The new areas were located along the Saskatchewan River northeast of Squaw Rapids, southeast of Canoe Lake, northwest of the Torch River townsite, near Durocher Lake, north of Matheson Lake in Meadow Lake Provincial Park, and south of Hunters Lake in Prince Albert National Park. The total area of jack pine forests severely infected by dwarf mistletoe was 136 705 ha, which included the 123 982 ha reported in 1994.

Dutch elm disease

Surveys to detect the incidence of Dutch elm disease (DED)(*Ophiostoma ulmi* [Buis.] Nannf.) in Alberta were continued in 1995 by Alberta Agriculture and the municipalities of Brooks, Medicine Hat, Lethbridge, Red Deer, St. Albert, Strathcona County No. 20, Calgary, and Edmonton. The smaller European elm bark beetle (*Scolytus multistriatus* [Marsh.]) was intercepted in traps in Calgary for the second consecutive year and in Edmonton (3 beetles in 3 traps) for the first time in 1995. The DED pathogen was not cultured from any of the captured bark beetle specimens.

In Saskatchewan, the distribution of DED was similar to its occurrence in 1994. The main areas of infestation included the Carrot, Saskatchewan, Red Deer, Souris and Qu'Appelle river valleys, and the Wascana and Brokenshell creek valleys.

The range of DED in Manitoba extended northward to the Red Deer River in the western portion of the province in 1995. Riparian forests with a high incidence of DED included those adjacent to the Red, Assiniboine, Boyne, and Souris rivers. Urban centers with a high incidence of the disease included Brandon, Dauphin, Morden, Portage la Prairie, Selkirk, Steinbach, Winkler, and Winnipeg. Both the smaller European elm bark beetle and the native elm bark beetle (*Hylurgopinus rufipes* [Eichh.]) occur in Manitoba, but only the native elm bark beetle plays a major role in the spread of the disease. The smaller European elm bark beetle is most prevalent in Winnipeg.

This note, if cited, should be referred to as a personal communication with the author(s).

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FOREST PESTS IN MANITOBA - 1995

PREPARED FOR THE 23rd ANNUAL FOREST PEST CONTROL FORUM NOVEMBER 21-23, 1995

OTTAWA

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Spruce Budworm

The spruce budworm, *Choristoneura fumiferana,* infestation in Manitoba increased in size in 1995 to approximately 55,124 ha. Approximately 53,308 ha of spruce/fir forests were moderate to severely defoliated in the Pine Falls Paper Co. Forest Management License (FML) area, Nopiming, Whiteshell and Hecla Island Provincial Parks, Grindstone Peninsula and Moose Creek Provincial Forest. The infestation in the Duck Mountain Provincial Forest decreased from 5,946 ha in 1994 to 1,816 ha in 1995, largely as a consequence of an aerial insecticide application.

Based on defoliation predictions derived from the 1994 egg mass surveys an operational budworm suppression program was implemented in the Pine Falls Paper Co. Forest Management License Area, Whiteshell Provincial Park and Duck Mountain Provincial Forest in 1995.

The bacterial insecticide, *Bacillus thuringiensis* (*Bt*) was aerially applied to 15,223 ha. The *Bt* operational spray project was carried out at six locations. The treatment areas were Falcon Lake (275 ha) and Dorothy Lake (400 ha) in Whiteshell Provincial Park, Beresford Lake (50 ha) Maskwa River (4,956 ha), Sandy River (4,908 ha) and Loon Straits (1,494 ha) in the Pine Falls Paper Co. Forest Management License (FML) area and in Duck Mountain Provincial Forest (3,140 ha). With the exception of 400 ha at Dorothy Lake, which received a single application, a double application was made for a total spray area of 29,996 ha.

The Falcon Lake, Dorothy Lake and Maskwa River spray blocks were opened on June 1, 1995. The Sandy River block was opened June 3, 1995 and the Loon Straits block on June 5, 1995. The Duck Mountain spray block was not opened until June 12, 1995. Spray block openings coincided with white spruce shoot development index 3.5 (Auger's Class) and peak 4th instar spruce budworm larval development.

Dipel 48 AF was applied by three Air Tractor 401 AT fixed wing aircraft each equipped with eight AU 5000 Micronair rotary atomizers. A single application consisted of a dosage of 30.4 Biological International Units (BIU) per ha in a volume of 2.4 litres per ha.
Aircraft swath width was 70 meters.

In cooperation with the Forest Pest Management Institute of the Canadian Forest Service, Sault Ste. Marie and Rohm and Haas Canada Ltd., an experimental aerial spray project with Mimic® (RH-5992, tebufenazide) flowable was carried out at Garner Lake in the Pine Falls Paper Co. FML area. An area of approximately 1,260 ha at Garner Lake was treated with Mimic. This area received a single application at 70 grams active ingredient (a.i.) per ha. The product was applied with water providing an application volume of 2.0 litres per ha (290 ml Mimic and 1,710 ml water). The product was applied by a Cessna 188 Ag-Truck fixed-wing aircraft at a swath width of 45 m using four AU 4000 rotary atomizers. The insecticide applications were carried out June 4 to 6 1995.

Pre and post spray larval surveys were carried out to determine application timing and spray efficacy. Average pre spray budworm larval numbers per 45 cm branch sample ranged from 12 at Duck Mountain to 25 at Sandy River in the Pine Falls Paper Co. FML area. Each plot consisted of five dominant or codominant white spruce or balsam fir trees. Sampling consisted of the removal of two 45 cm branch tips at mid-crown per tree to assess larval mortality, defoliation and egg mass densities.

Generally the 1995 spray project proved very efficacious. The population reduction in the treated areas ranged from 62% at Falcon Lake (Whiteshell Provincial Park) to 96% at Loon Straits (Table 1). Population reduction in the untreated blocks was: Whiteshell Provincial Park - 51%, Pine Falls FML - 64% and Duck Mountain Provincial Forest - 60%. Statistical analysis (t-test and ANOVA) indicated a significant difference ($p \leq 0.05$) in budworm mortality between treated and control blocks in Whiteshell Provincial Park and the Pine Falls Paper FML.

Table 1: Spruce budworm 1995 control program - reduction in larval numbers

Location	Treatment	Larvae/45 cm Branch Pre Spray	Larvae/45 cm Branch Post Spray	Reduction
Whiteshell	*Bt* 2X[1]	18.8	7.1	62%
Whiteshell	Untreated	21.9	10.6	51% *
Pine Falls FML				
Maskwa River	*Bt* 2X[1]	12.8	3.4	73%
Sandy River	*Bt* 2X[1]	6.6	0.9	86%
Loon Straights	*Bt* 2X[1]	14.3	0.6	96%
Beresford Lake	*Bt* 1X[2]	35.3	7.5	79%
Garner Lake	Mimic 1X[3]	14.6	3.5	76%
Pine Falls	Untreated	32.5	10.8	64% *
Duck Mountain	*Bt* 2X[1]	10.2	3.2	69%
Duck Mountain	Untreated	11.9	4.7	60%

1. Two applications of *Bt* (Dipel 48AF) at 30.4 BIU/ha in a volume of 2.4 l/ha.
2. One application of *Bt* (Dipel 48AF) at 30.4 BIU/ha in a volume of 2.4 l/ha.
3. One applications of Mimic at 70 grams a.i. per ha in a volume of 2.0 l/ha.

* Percentages are significantly different at $p \leq 0.05$.

Generally light defoliation occurred in the spray areas while moderate defoliation occurred in the untreated blocks (Table 2). Statistical analysis (t-test and ANOVA) indicated a significant difference ($p \leq 0.05$) in defoliation between treated and control blocks and the Pine Falls Paper FML.

Egg mass surveys to predict 1996 defoliation on a province-wide basis indicated that generally light defoliation is predicted for Duck Mountain Provincial Forest, light to moderate defoliation for Whiteshell and Nopiming Provincial Parks and moderate defoliation for the Namew Lake area of northwestern Manitoba. Within the Pine Falls Paper Co. FML area, light defoliation is expected at Sandy River, Garner Lake and Loon Straits, moderate defoliation north of the Winnipeg River (Lac du Bonnet) and severe in the Maskwa River area.

Table 2: Spruce Budworm - 1995 defoliation and predictions for 1996.

Location	Treatment	Defoliation	Egg Masses /10 m^2 Foliage	1996 Defoliation Prediction
Whiteshell	*Bt* 2X[1]	13%	1	Light
Whiteshell	Untreated	36%	36	Light-moderate
Pine Falls FML				
Maskwa River	*Bt* 2X[1]	12%	374	Severe
Sandy River	*Bt* 2X[1]	7%	0	Light
Loon Straights	*Bt* 2X[1]	16%	22	Light
Beresford Lake	*Bt* 1X[2]	54%	32	Light-moderate
Garner Lake	Mimic 1X[3]	15%	10	Light
Pine Falls	Untreated	62%*	35	Light-moderate
Duck Mountain	*Bt* 2X[1]	30%	4	Light
Duck Mountain	Untreated	31%	27	Light

1. Two applications of *Bt* (Dipel 48AF) at 30.4 BIU/ha in a volume of 2.4 l/ha.
2. One applications of *Bt* (Dipel 48AF) at 30.4 BIU/ha in a volume of 2.4 l/ha.
3. One applications of Mimic at 70 grams a.i. per ha in a volume of 2.0 l/ha.

* Percentages are significantly different at $p \leq 0.05$.

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.

Preliminary analysis indicates the Pherocon trap to be more effective in attracting adult male moths during endemic population levels. In 1995, the total number of male moths marginally increased across the province (Table 3).

Table 3: Total male jack pine budworm moths caught in the two trap types.

TRAP TYPE	YEAR										
	1985	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95
Pherocon 1C	2060	419	229	323	391	179	73	160	241	187	195
Multipher					59	47	34	106	33	39	40

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 4).

Table 4: Estimated levels of jack pine male flowering averaged over the 12 trap locations.

	1986	1987	1988	1989	1990	1991	1992	199 3	1994	1995
% staminate buds	4	9	15	72	26	37	61	47	77	52

Since 1986, there has been no defoliation or egg masses found on the branches collected at 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.

Permanent Silvicultural Plot Pest Impact Program

Since 1986, the Silviculture Section of the Manitoba Forestry Branch has established Regeneration Performance Assessment (RPA) 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 Landscape Management began a survey regime in 1990, within the Silvicultural RPA 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 1995, a third pest assessment was conducted on the 1986 permanent silvicultural RPA plots. These included 25 plantations or 212 plots with white spruce, black spruce, and jack pine. Data from this sampling program is being entered into the recently developed MNR, Forest Landscape Management Pest Survey System. Preliminary analysis of the third assessment for the 1986 plantations was completed. Over 2,500 seedlings were examined. Eighty-eight percent of these seedlings were healthy, and only 5 percent mortality occurred by average age of 9 years. Of the seedlings assessed, approximately 60 percent had some type of damage present. The number of trees with crown damage decreased as trees matured, whereas the stem and terminal areas of the trees had increased levels of damage at later inspection periods. The crown area had reduced amounts of deer browse as trees matured. Stem damage and deformity was mainly caused by small mammal browse, the northern pitch and twig moth and competition. The major causes of injury to the terminal was the northern pitch and twig moth, *Petrova albicpaitana*, clipping by large mammals and some weevils. Many other pests were present, but in low numbers.

Tip Dieback

The impact of the tip dieback condition in red pine, (*Pinus resinosa*); thought to be caused by *Rhizosphaera kalkhoffi*, is being monitored in 11, 26 and 39 year old plantations. The level of infection has remained consistent in the 26 and 39 year old plantations since the time of plot initiation. In the 39 year old plantation in Sandilands Provincial Forest, infection levels have remained in the 41% to 48% range over a six year period. Infection rates in the 26 year old plantation in Belair Provincial Forest remain at approximately 25% over a three year period. In the 11 year old plantation in Agassiz Provincial Forest the infection rate has decreased from 66% to 53% between 1994 and 1995. Despite very low mortality, there is substantial impact on growth and tree form. Chronically infected trees have experienced height losses of approximately 35% in the 26 and 39 year old plantations and 45 % in the 11 year old plantation. Diameter at breast height growth loss on chronically infected trees is approximately 19% in the 26 and 39 year old plantations and 13% in the 11 year old plantation.

Aspen Decay Survey

In recent years trembling aspen has gained in importance as a commercial species in Manitoba. There has been a perception that the aspen resource suffers substantial volume loss due to heart rot caused by *Phellinus tremulla*, a common wood decay fungus. Cull factors for aspen, originally developed for the saw log industry, range from 20% to 40% in Manitoba. With aspen utilization for other products increasing (e.g. oriented strand board, particle board and paper board), Manitoba has instituted a detailed damage appraisal survey to determine if present cull factors are appropriate when aspen is used for manufacturing board products. The survey will eventually include all Forest Management Units (FMU's) in Manitoba where aspen has the potential to be commercially important. The survey has being carried out in two FMU's in southeastern Manitoba and one FMU in western Manitoba.

Forest stand types of cutting class 3 (immature, > 3 metres in height), cutting class 4 (mature, rotation age) and 5 (overmature) in which aspen is a major component have been included in the survey. Individual forest stands of the appropriate stand types were randomly selected and each plot consisted of nine sample trees. Sample trees were felled and sectioned into one metre bolts. Stem decay tracings made in the field and then digitized into a computerized format and assessed for volume loss. The approximate volume lost to advanced decay in the southeastern FMU's in Manitoba was as follows:

a) cutting class 3 - 2%
b) cutting class 4 - 4%
c) cutting class 5 - 7%

Based on these results, recommendations have been made to lower cull factors in aspen being used for the manufacture of products other than lumber.

Digitizing and calculations for the FMU in western Manitoba is underway. The aspen decay project will continue to asses the impact of decay diseases on the quality and volume of the province's aspen resource.

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. 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 1995. 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 now extends from the Manitoba-Ontario border into Saskatchewan and northward to the Red Deer River.

During the 1995 provincial survey (June - September 1995), 8,119 elms were marked for removal. The total consisted of 6,658 American elm, *Ulmus americana*; and 1,461 Siberean elm, *Ulmus pumila*. Of this total, 375 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 addition, 83 elm firewood piles were located and marked for removal. In the City of Winnipeg, 8,461 were slated for removal, 2,843 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 over 1994. Although there was an increase in marked elms versus 1994 (1,547 trees), this included the survey and marking of elm trees (1,145) in a new area near Portage la Prairie, Manitoba. There was also an increased of 3676 marked trees in Winnipeg, of these approximately 3226 were Siberean elm in river bank areas killed by flooding during the last several years.

From April 1, 1994 to March 31, 1995 the Provincial DED Sanitation crews removed 8,194 diseased and hazard elms; the City of Winnipeg removed approximately 3,548 in 1994 and the City of Brandon removed 45.

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 1979. 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.

1995 Integrated Forest Renewal and Pest Survey

After a number of years of field testing and analysis Manitoba has now begun to integrate forest health information into existing silviculture forest surveys to develop a comprehensive forest health and condition survey. Damage codes and a pictorial guide were designed to help silvicultural forest regeneration survey staff identify high priority pests of young forest stands while carrying out surveys. The amalgamation of these forest health codes with the silvicultural survey objectives is being carried out to make Province wide surveys more efficient. It is anticipated that incorporation of health and damage codes into the regeneration survey will identify stands requiring an intensive forest health assessment. Also, by identifying pests early in stand development, we should prevent or minimize losses by modifying operational forest practices.

The survey was designed utilizing information collected over an eight year period. The high priority regenerating forest pests were determined from Renewed Forest Pest Survey (RFPS) data collected in 300 stands covering 8,500 ha throughout Manitoba as well as the assessment data of 615 Regeneration Performance Assessment plots. Further analysis is needed as the original RFPS survey was developed to detect pest problems in stands older than ten years of age, and initially may not be completely applicable to regeneration surveys (age 3 to 7). Forest Health codes for use by regeneration staff have been limited to stands aged five to seven. The method of data collection has proven simple to learn, efficient for surveyors to collect, and will lead to the identifion of stands requiring a return forest health assessment. The main objective is to ensure that trees with unacceptable pest problems are not considered as satisfactory stocking in a plot.

The data collected by the new survey will be analysed and verified in the field to determine the applicability to stands of young ages and whether it is correctly identifying stands requiring follow up. Once the survey functions correctly, a Forest Health Severity Index will be designed and implemented as a means to categorize stand information and problem stands requiring action. Forest health data will be entered on GIS to provide a baseline. The immediate goal is to provide the Regional Offices with summarized Forest health data as part of the regular regeneration survey. Long term goals include determining whether problems are repetitive; e.g. linked to certain geographic locations, stand type, or forestry practice. The data will also be used to direct research needs e.g. ways to reduce impact on volume losses. The long term goal is to identify and prevent inherited problems from the preceding stand which may affect new stands (pre-harvest prescriptions), and to recommend modification in reforestation and stand tending activities to minimize pest impact. A similar procedure is being implemented in the newly developed Free to Grow Surveys.

Below is a list of the high priority renewed forest pests which warrent consideration in Manitoba:

Diseases: Dwarf Mistletoe *(Arceuthobium americanum, A. pusilum)*, Stem Canker *(Sphaeropsis pinea, Ceratocystis minor)*, Armillaria Root Disease *(Armillaria ostayae)*, Tip Dieback *(Rhizosphaera kalkoffii)*, Western Gall Rust *(Endocronartium harknessii)*.

Insects: Terminal Weevils *(Pissodes strobi, Pissodes terminalus)*, Root Collar Weevils *(Hylobius warreni, H. radicis)*.

Abiotic/Animal: Planting Problems; Browse; Weather - flood, drought, hail, frost.

Pest Specific Assessments

During 1995 intensive follow up forest health assessments were conducted in a 1982 black and white spruce plantation at Half-way Lake, Manitoba (northwest part of the province) which was identified by the Renewed Forest Pest Survey as having high levels of white pine weevil *(Pissodes terminalis)* damage. The stand had been herbicided in 1985 and several swaths had been missed by the aerial applicator leaving areas of planted trees with aspen cover. It was observed that weevil incidence appeared much higher in the open growing areas. Tree species, height and weevil attack were recorded along cruise lines spaced 20 meters apart in sprayed and unsprayed areas. The herbicided areas (open growing spruce) had a much higher incidence of weevil attack (13.3% of the sample trees) compared to 1.6% of the sample trees growing in a mixedwood situation (canopy cover). Average height of black spruce was 1.4 m in open areas compared to 1.7 m under aspen cover. Trees < 0.5 m in height were omitted from the height calculation to eliminate younger naturally regenerated trees.

In 1994 a pre-harvest assessment conducted in an overmature, site 2 jack pine stand in the Sandilands Provincial Forest, Manitoba showed the percentage area infected by Armillaria root rot (Armillaria sp.) to be 74.5%. In 1995 infection centers were mapped along cruise lines which were spaced 50 meters apart and digitized using the GIS. This map has been utilized to aid in the planning of post harvest activities and for long term monitoring of the affects of Armillaria on the regenerating stand. The areas experiencing heavy infestation and wind throw due to butt rot were prioritized for harvesting to avoid further losses. There are several stands, in a similar state of decline, which are identified in harvesting plans. At Regional staff's request, a research study in a large Armillaria infection center to compare different site preparation techniques was established. Comparisons between the performance of natural regeneration versus planted stock will be conducted on stumped and non-stumped plots. All removed stumps were checked for Armillaria infection. Aspen trap stakes were placed at 10 meter intervals on the non-stumped plot to determine the level of Armillaria present. Samples from these trap logs will be cultured to identify the specie(s) of Armillaria.

Vegetation Management

Table 5: 1995 Herbicide application summary in Manitoba.

USER	Purpose	Method	Product	Rate l/ha	Area treated (ha.)
MNR Forestry	Site prep.	Ground - Brackie	Vision	2.7	235
MNR Forestry	Release	Aerial - Fixed wing	Vision	2.5 - 6.0	1170
Repap Manitoba	Release	Aerial - fixed wing	Vision	5.0	211
Pine Falls Paper Inc.	Site Prep.	Ground - Brackie	Vision	2.5	583
Total					2,199

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FOREST INSECT AND DISEASE MANAGEMENT PROGRAMS

SUMMARY REPORT - 1995

Alberta Land and Forest Service

Mature Stand Pests

Eastern Spruce Budworm

The eastern spruce budworm, *Choristoneura fumiferana* (Clemens), infestations in the province increased during this year, following the trend observed in 1994. Three infestations were covering an estimated 203 011 ha within the Forest Protection Area in Alberta.

A water-based B.t.k. formulation (Foray 48B^R^) was aerially sprayed over 110 923 ha of moderately to severely budworm-defoliated stands in the Northwest Boreal Region in Alberta. In a field trial to test other Btk formulations, Foray 76B^R^ was sprayed twice, back to back, over 665 ha; Dipel 48AF^R^ was sprayed twice, with a five-day interval between sprayings, over 445 ha. The aerial sprays were carried out between the peak occurrences of fifth and sixth instar larvae (June 3-10). The main objective of this spraying was to reduce the budworm population to a level that would consequently keep future defoliation nil-light, i.e., below 35%. The technical details of aerial spraying are given in Appendix I.

Overall, the sprayed plots (N= 14)had an average of 80% budworm mortality compared to the unsprayed check plot that had 51% budworm mortality. The average postspray budworm mortality between the plots sprayed once and the plots sprayed twice was similar. Foray 76B and Dipel 48AF reduced the budworm populations by 75.0% and 85.6% respectively, in the experimental blocks. The cost of operational spraying, excluding labor cost, was $13.24 per ha per application.

Multipher-I^R^ pheromone traps were placed, two traps per site, at 92 sites that are not currently defoliated but having a high risk of budworm infestation. The data from these traps showed budworm populations capable of severe defoliation - more than two thousand moths per trap - at two trap sites and budworm populations capable of moderate defoliation, i.e., 500-2000 moths per trap, at 11 sites. All these sites with high trap catches are close to the currently defoliated areas (Figure 1).

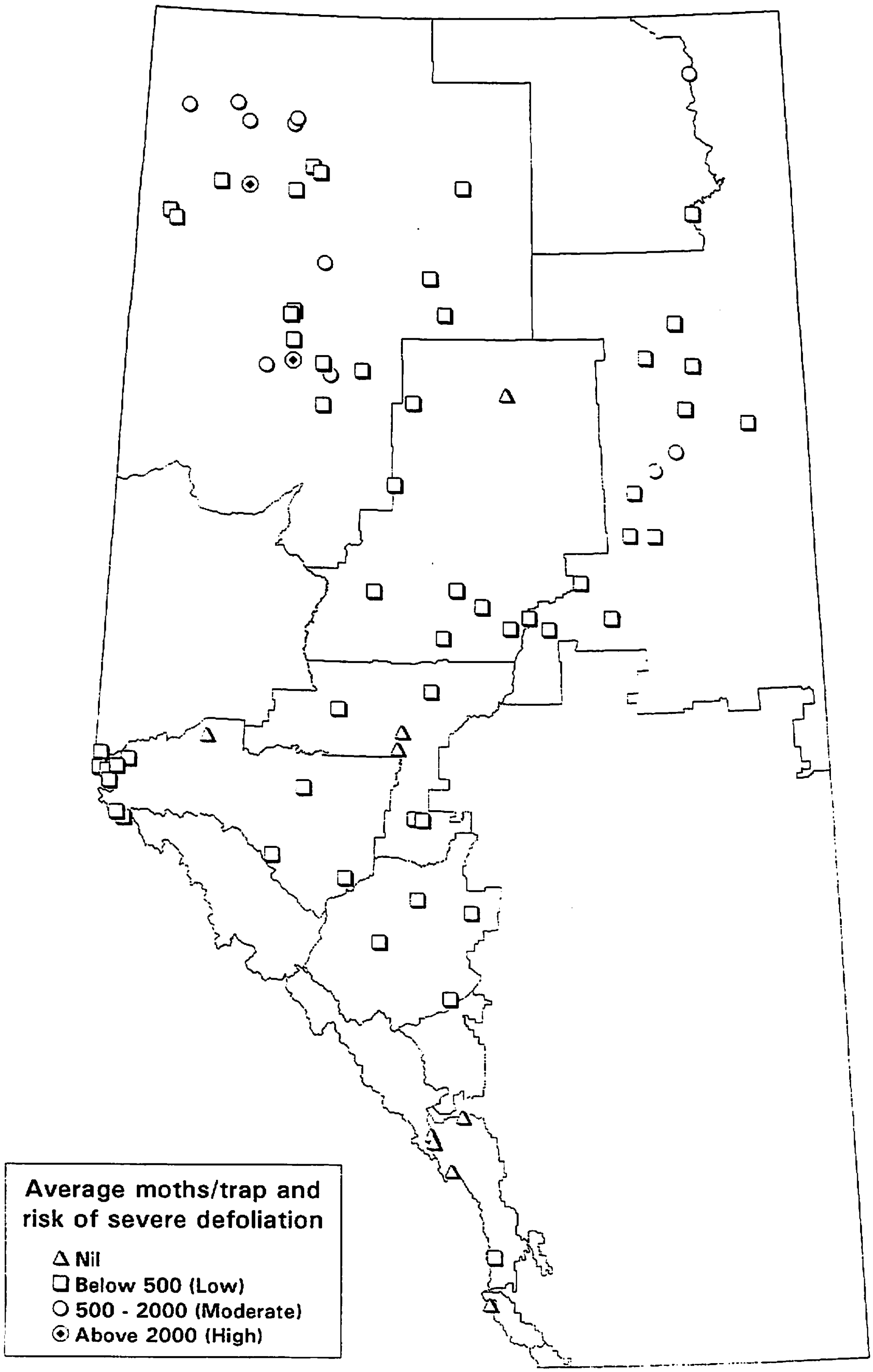

Figure 1. Spruce budworm moth catches in pheromone traps, 1995.

In September 1995, 253 second instar larval survey plots were established in the currently defoliated areas and their vicinities. Based on the second instar counts (less than 188 larvae per 10 m^2), nil to light defoliation is predicted during 1996 in 92% of the plots sprayed twice and in 78% of the plots sprayed once; moderate defoliation (35%-70%) is predicted during 1996, based on the second instar counts (188-540 larvae per 10 m^2 of foliage), in the other sprayed plots. The larval counts in other plots suggest moderate defoliation in 1996 in some stands sprayed in 1992 (Figure 2).

Mountain Pine Beetle

This year, the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, populations were at their lowest level in recent years in Alberta. Pheromone-baited trees were attacked by the beetles at ten out of 55 sites used this year; none of these beetle attacks was successful. Aerial surveys showed no new faders within the Forest Protection Area in Alberta. This decreased beetle activity may be due to the cold, wet summer experienced in southwestern Alberta where beetle activity is normally encountered.

Spruce Beetle

The spruce beetle, *Dendroctonus rufifennis* (Kirby), outbreak continued in northwestern Alberta where an aerial survey detected an estimated 23 771 ha of infested white spruce within the Forest Protection Area. However, ground probing of few selected stands showed no new attacks showing a declining spruce beetle population.

Lindgren funnel traps were set up at 10 sites in western Alberta. The trap catches indicated no outbreak level populations (more than 2.5. beetles per trap per day); beetle populations that can attack live trees (0.5-2.5 beetles per trap per day) were found at four sites. Endemic beetle populations were found at the other six sites.

Growth and yield and stocking

Armillaria

Information from permanent sample plots showed an average annual mortality of 4.5% in 13-year-old naturally regenerated lodgepole pine during the three-year period ending in 1995.

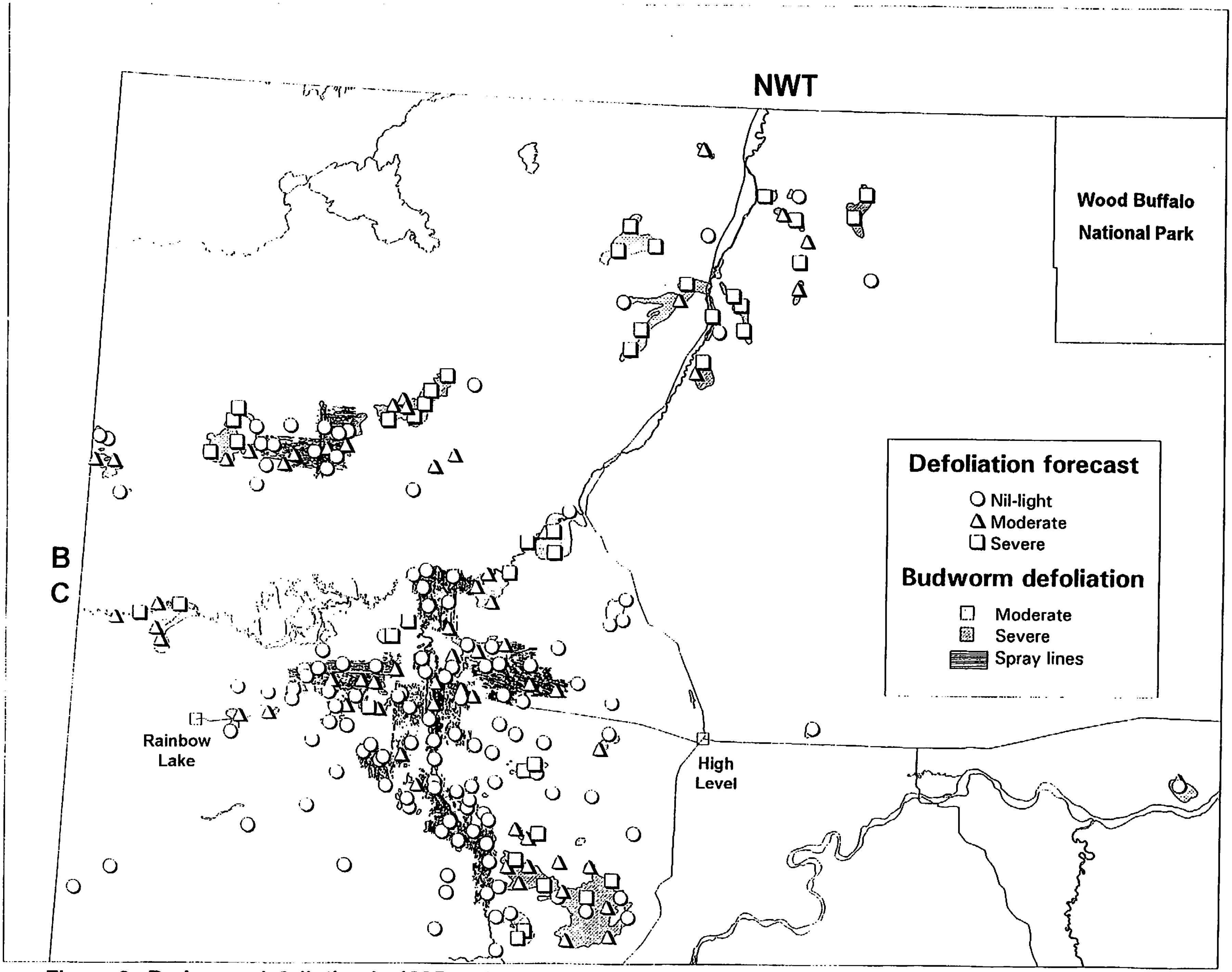

Figure 2. Budworm defoliation in 1995 and forecast for 1996 based on L2 counts, Northwest Boreal Region.

White pine weevil

Permanent sample plots in 14-year-old planted white spruce recorded 15% weevil incidence in tended trees, vs. 7% incidence in untended trees in 1995. In trees monitored since 1992, incremental growth of attacked trees had fully recovered by the third growing season following attack.

Browsing

In the same white spruce permanent sample plots, browsing was recorded on 32% of untended trees but only on 4% of tended trees in 1995. Hares accounted for 66% of the browsing.

Dwarf mistletoe

A cooperative study involving The University of Alberta, Sunpine Forest Products Ltd. and Alberta LFS, was initiated to assess the applicability of existing growth and yield models to infected stands in the foothills northeast of Calgary.

Pest distribution

White pine weevil

Weather data from the 1951-80 period is being used to generate a map of potential white pine weevil distribution in Alberta. The map is based on a minimum temperature of 14°C for oviposition and a degree-day sum of 785 growing days above 7.2°C in the months succeeding oviposition. This map will represent the potential distribution of white pine weevil in Alberta. Ground surveys will substantiate the actual weevil distribution within this potential range.

Regeneration surveys

Collection of young stand pest data

A pilot project in northwestern Alberta studied the collection of information on five major damage agents during regeneration surveys in 6-year-old white spruce plantations. Recording 'presence' or 'absence' of the pests in each plot visited added approximately 20 minutes per 20 ha block to the average survey time of 2.8 hrs.

Appendix I. - Technical details: Aerial spraying of Btk to manage spruce budworm infestation in the Upper Hay District, Northwest Boreal Region, 1995.

OPERATIONAL SPRAYING

INSECTICIDE

- Foray 48B®
- Potency - 12.7 billion international units per litre (BIU/L)
- Water-based formulation
- Dilution - None
- Additions - None
- PCPA No. - 21464
- Micro-contaminants - Nil
- Potency - Guaranteed 12.7 BIU/L (= 10 600 i.u./mg)
  - Observed:

Sample No.	Potency ± SD
1	9782 ± 473
2	7152 ± 466
3	11 224 ± 921
4	9566 ± 330
5	8946 ± 637

AIRCRAFT

Spray Aircraft:
- Two (2) AT502A
- Three (3) AT502B
- One (1) AT401
- Four (4) S2R Thrush

Pointer Aircraft:
- Two (2) Cessna 172
- One (1) Cessna 177
- One (1) Bellanca

SPRAYING

Period: June 3 to 10, 1995

Volume:
- Two (2) litres per hectare - single
- 2 X 2 litres per hectare - double, with a five day interval between the two sprayings

Rate: 25.4 BIU per hectare

Area:	■ Single - 73 524 hectares ■ Double - 37 399 hectares ■ Total - 110 923 hectares

SPRAYING (Continued)

Nozzles:	Micronair AU 4000
No. of Nozzles Per Aircraft:	■ AT502 - Eight (8) nozzles per aircraft ■ AT401 - Six (6) nozzles per aircraft ■ S2R - Six (6) nozzles per aircraft
Flow Rate:	■ AT502A - 10.4 litres/nozzle/minute ■ AT502B - 8.1 litres/nozzle/minute ■ Others - 7.2 litres/nozzle/minute
Spray Speed:	■ S2R - 184 kilometres per hour ■ AT401 - 184 kilometres per hour ■ AT502A - 250 kilometres per hour ■ AT502B - 215 kilometres per hour
Swath Width:	■ S2R - 70 metres ■ AT401 - 70 metres ■ AT502A - 100 metres ■ AT502B - 90 metres
VRU Setting:	■ AT502 - 13 ■ Others - 11
Blade Angle:	■ AT502A - 43° ■ AT502B - 38° ■ Others - 33°
VMD:	■ AT502A: 100 -110 microns ■ AT502B: 105 - 115 microns ■ Others: 95 - 105 microns
Atomizer Rotation:	7000 rpm

Alberta Land and Forest Service Pheromone Monitoring Programs 1995

Eastern Spruce Budworm. Susceptible white spruce stands throughout the forested regions of Alberta were monitored using 92 trapping sites in 1995. At each site, two Multi-Pher I ® traps were placed 40 m apart. Pheromone (Biolure, Consep Inc.) was purchased through C. J. Sanders of the Canadian Forestry Service. Vaportape II provided by Hercon Environmental was used as an insecticide in each trap. Moth counts indicated that 2 locations in the Northwest Boreal Region had a risk of severe defoliation that was rated high and that 8 had a moderate risk (Table 1). Three locations within the Northeast Boreal Region had counts suggesting a moderate risk of severe defoliation. All other trapping sites in the province had low or no risk of severe defoliation.

Table 1. Predictions for severe defoliation of white spruce based on moth counts from pheromone traps in Alberta 1995*

Risk of Severe Defoliation	Average Moth Count / Trap	Number of Locations
Low	< 500	64
Moderate	500-2000	11
High	>2000	2

* Data from 15 sites were not available

Spruce Beetle. Mature and overmature white spruce stands in the Northwest Boreal and Eastern Slopes forests were monitored for spruce beetle activity using 13 trapping sites. Each trapping site consisted of two Lindgren Funnel traps (8 - unit, wet trap option, Phero Tech Inc.) approximately 30 m apart. Three-component lures (Phero Tech Inc.) were deployed in each trap. A spruce beetle index developed by H. Cerezke of the Canadian Forest Service, Northern Forestry Centre, Edmonton was used to assess the potential of spruce beetle populations to attack live trees (Table 2.). Based on the index, four locations in the Northwest Boreal Region had populations capable of attacking live trees although none were at outbreak densities. Other locations had populations that were endemic.

Table 2. Spruce beetle index†

< 0.5	Endemic Population
0.5-2.5	Capable of Attacking Live Trees
>2.5	Outbreak Population

† Index = Average Total Beetle Count / Total Trapping Days

Mountain Pine Beetle. Lodgepole pine stands in the Northern East Slopes and Southern East Slopes Forest regions were monitored using 59 plots. Each plot consisted of three large diameter pines located about 45 m apart and baited with a two-component bait (Phero Tech Inc.). Baited trees were checked one a month to determine if attacks had occurred. Attacks were classified as nil, unsuccessful, or successful. Although trees were attacked at ten sites, none of the attacks were successful indicating a continued reduction in population levels of mountain pine beetle in Alberta.

DED Prevention in Alberta

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Because of the destructive nature of Dutch elm disease (DED) and the threat to American elms in Alberta, Alberta Agriculture Food and Rural Development (AAFRD), plant pathologists and entomologists organized in response to and formed the DED Action Committee in 1976. They recommended that elm plantings be reduced and established cooperative links with nurseries in eastern Canada. They also had gained good cooperation with Agriculture Canada's Plant Quarantine Division and in doing so had reduced the risk of importing diseased nursery stocks of elm into Alberta. In 1978 DED pathogen and its beetle vectors was included under the Alberta Agricultural Pests Act.

Because of the growing concern about the spread of DED and its insect vectors (the European and native elm bark beetles), a DED network was developed in 1988 through the efforts of AAFRD. The network was made up of federal and provincial governments, private industry and special interest groups. At this time, the DED Action Committee was able to get firewood containment units sponsored by the cities of Lethbridge, Medicine Hat, Calgary, Red Deer, and by Alberta Agriculture. These units with insecticide strips inside them were placed at the four ports of entry, Wild Horse, Coutts, Carway and Chief Mountain. They were to hold the wood that had been confiscated by Canada Customs Staff until it could be properly disposed of.

Before 1988, Alberta Environmental Centre and the Alberta Special Crops and Horticultural Research Center monitored for the elm bark beetles using pheromone-baited sticky traps and elm log traps, at the ports of entry and strategic points along Alberta-Saskatchewan border. The network encouraged major cities including Lethbridge, Medicine Hat, Calgary, Red Deer and Edmonton fund and post their own traps. It was felt that by having the cities carry out their own monitoring it would alert key personnel in City Parks Departments to the introduction of DED if any beetles were found. Early detection should enable them to identify, contain and eliminate any infection before DED can be permanently established.

The DED Action Committee at this time encouraged key personnel in each major city to do radio and television interviews to start to raise public levels of awareness about the ongoing threat of DED to Alberta. This was done so that the average citizen could take steps to prevent this disease from being introduced to Alberta. It was stressed that the understanding and cooperation of all Albertans is required to make DED prevention a success. In 1992 it was felt that a video on DED would be of great value for the public awareness campaign. A total of $6,000 was donated from the cities of Lethbridge, Medicine Hat, Calgary, Edmonton, Red Deer, Sherwood Park and TransAlta for this project. The remaining $5,000 was paid by AAFRD. The video is an excellent tool, useful in orienting new summer students working with Canada Customs, doing television interviews, and used in schools as part of the environmental awareness curriculum.

In 1992, the members of the ad-hoc committee had all agreed that the time had come to establish a more formal DED Action Committee. This would enable them to be more recognizable, would assist them in obtaining needed financial support and help make decisions on how best to handle problems with DED in the future. On Feb. 26, 1993 the Society to Prevent Dutch Elm Disease (STOPDED) was formed.

In June 1993, Alberta Agriculture, Food and Rural Development approved funding for a Dutch Elm Disease Initiative (DEDI). The primary focus of this program was to increase public awareness of the threat that DED poses to American elms in Alberta and to advocate steps that should be taken to minimize the risk of introducing DED. The Crop Diversification Centre - South administers the operation of the DED Initiative and employs Janet Feddes-Calpas as the DED Technician for 5.5 months a year.

The responsibilities under the DED initiative are:

1. **DED/Bark Beetle Survey.** This is done to determine if Dutch elm disease (*Ophiostoma ulmi*) and/or its vectors, the smaller European bark beetle (EEBB) (*Scolytus multistriatus*) and the native elm bark beetle (NEBB) (*Hylurgopinus rufipes*) are present in Alberta.
2. **American Elm Inventory.** To estimate the geographical distribution, populations and value of American elms (*Ulmus americana*) in Alberta.
3. **Firewood Confiscation Program.** To ensure that the firewood confiscation program conducted jointly by Alberta Agriculture and Canada Customs operates in an efficient manner.
4. **Public Awareness.** To heighten public awareness of the threat of DED to elms in Alberta and to promote steps that should be taken to prevent its introduction.
5. **DED Response Plan.** To develop an action response plan to help Albertans cope with DED, if and when it is introduced.
6. **Highway Signage Program.** To upgrade highway signage alerting travellers to the dangers of introducing DED and/or its beetle vectors into Alberta on infested elm firewood.
7. **Interprovincial Cooperation.** To encourage more interprovincial cooperation in the control of DED.

Since the initiative began in 1993, a number of projects have been accomplished. Sixty locations had been chosen in Alberta to be monitored for the European and native elm bark beetles. 44 of these locations are provincial parks and recreational areas with the remaining being smaller municipalities and all the Montana-Alberta ports-of-entry. Location and visitation were the main factors in choosing the monitoring sites. Additional firewood drop-off bins along with signs instructing people to drop off their firewood were placed at Travel Alberta Information Centres in Lloydminster, Walsh and the Crowsnest Pass. Local government properly dispose of the firewood collected. Also an additional 14 border crossings have had DED signs installed. Alberta now has all the Alberta-Saskatchewan borders, Alberta-Montana borders and two Alberta-British Columbia crossing points posted. Each location has one sign advising in-coming motorists to not bring firewood into Alberta and one sign thanking out-going motorists for not bringing firewood into Alberta. Public awareness had been pushed by having DED articles placed in various magazines, placing an announcement in the Alberta campground guide, distributing posters and brochures, and by DED workshops and presentations. DED banners were purchased and municipalities are encouraged to put these up in their elm trees to heighten people's awareness. Alberta-Montana borders are visited on a regular basis to ensure that the firewood confiscation program is running efficiently. An inventory package has been sent out to municipalities in Alberta to encourage them to complete a tree inventory. All Agricultural Fieldmen and Assistants were sent DED information packages and encouraged to participate in the prevention of DED in Alberta. Various presentations were made to permanent customs officials and new summer staff. An elm bark beetle identification workshop for municipal employees was put on by Forestry Canada and attended by 8 people from Red Deer, Calgary and Edmonton.

Alberta DEDI is also keeping in close contact with DED prevention programs in other provinces such as British Columbia, Saskatchewan, British Columbia and Manitoba by sharing DED information.

All the larger municipalities such as Edmonton, Calgary, Lethbridge, Medicine Hat, and Red Deer have started their own DED prevention program. Each city monitors for the beetle and also surveys their elm trees for any DED symptoms. Public awareness has been heightened and proper elm tree maintenance has been made a priority.

Since 1994 Alberta has been DED and DED vector free. Last fall Calgary discovered EEBB in the pheromone sticky traps set up throughout the city to monitor for the beetle. EEBB were again found in Calgary's 1995 traps and three EEBB were found for the first time in three Edmonton traps. Although beetles that can carry the fungus were found in both cities the disease has not yet been detected in the province. All remaining traps set up in the province were found to be beetle free. Logs containing EEBB beetles were found in the Alberta-Montana firewood confiscation bins and were properly disposed of.

FOREST VEGETATION MANAGEMENT SPRAYING ALBERTA 1995 - SUMMARY				
Company	**Location**	**Treatment**	**Purpose**	**Ha**
Alberta Newsprint	Whitecourt	Aerial broadcast	Site preparation	60
			Conifer release	252
Blue Ridge Lumber	Whitecourt	Aerial broadcast	Conifer release	3094
Canfor	Grande Prairie	Hack'n'squirt	Conifer release	78
High Level Forest Products	High Level	Aerial broadcast	Conifer release	309
Manning Diver. For. Products	Manning	Aerial broadcast	Conifer release	41
Millar Western Industries	Whitecourt	Aerial broadcast	Site preparation	133
			Conifer release	545
		Ground broadcast	Site preparation	54
			Conifer release	122
		Chemical spacing	P1 thinning	20
Northland Forest Products	Ft. McMurray	Aerial broadcast	Conifer release	46
		Backpack foliar	Conifer release	38
Sundance Forest Products	Edson	Aerial broadcast	Conifer release	100
Vanderwell	Slave Lake	Aerial broadcast	Conifer release	94
Weyerhaeuser	Drayton Valley	Stem injection	Pre-harvest	50
Weyerhaeuser	Edson	Backpack foliar	Conifer release	50
Total	**Alberta**			**4992**

PACIFIC AND YUKON REGION - 1995

STATUS OF IMPORTANT FOREST PESTS

AND

EXPERIMENTAL CONTROL PROJECTS

PREPARED FOR THE

23RD ANNUAL PEST CONTROL FORUM

November, 1995
OTTAWA

PRESENTED BY:

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ABSTRACT

The status of about 24 economically significant pests active in the Pacific and Yukon region in 1995 is presented, with some forecasts for 1996. The summary was compiled from field reports of 9 Forest Insect and Disease Survey rangers with contributions from the forest industry, researchers, and government agencies. The most noteworthy changes in the status of major forest pests in 1995 included increasing populations of **mountain pine beetle, forest tent caterpillar, satin moth, phantom hemlock looper, balsam woolly adelgid** and a higher incidence of **pine needle disease** and **drought** induced mortality. Populations of **spruce beetle, black army cutworm, gypsy moth, European pine shoot moth, large aspen tortrix, birch leaf miners** and **European elm bark beetles** continue to be found. Decreasing populations of **Douglas-fir beetle, balsam bark beetle, spruce budworms, western hemlock looper, Douglas-fir tussock moth, western blackheaded budworm,** and **larch casebearer**, were recorded.

Current research and control trials of some of these pests include: pheromone confusion trials against western spruce budworm; pheromone development for western oak looper; biological control of mountain pine beetle; 12 million dollars spent on ongoing bark beetle surveys and control projects; Btk trials against western spruce budworm and continuing calibration of a pheromone trapping system for western hemlock looper.

SUMMARY OF IMPORTANT PESTS

This summary only includes pest conditions considered to be of interest to participants. Not included are numerous forest diseases that change little from year to year such as root rots, dwarf mistletoes, stem decays, rusts and cankers. Controls for such diseases are most practical and economical as preventative treatments combined with stand management practices. Also not included are impacts of pests of young stands, and nursery losses.

More detailed information of these and other pests active in the Pacific and Yukon Region in 1995 are presented in "Forest Pest Conditions in British Columbia and Yukon" by Natural Resources Canada's Forest Insect and Disease Survey staff, published by Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.

Spruce Beetle

The area of mature white and Engelmann spruce killed by **spruce beetle** in British Columbia in 1995 remained at approximately 110 000 ha. While the total area of damage was similar to 1994 the major infestations shifted from the Prince George Region to the Prince Rupert Region and the Yukon Territory. Infestations of spruce beetle mapped for the second consecutive year in southwest Yukon expanded by 50% to cover 57 000 ha in

1995. As in 1994, activity was centered primarily in the Alsek River Valley and in the Shakwak Valley between Haines Junction and Kluane National Park. Nearly half of the *infested* stands were within Kluane National Park. In some stands all of the mature trees have now been killed. Outbreaks in the Prince Rupert Region increased almost ten-fold to over 16 000 ha. A first-time aerial survey within the newly-declared Tatshenshini Provincial Park found active infestations over more than 8000 ha in scattered patches of mature timber along the Tatshenshini River almost to the Alsek River. An additional 1300 ha of attack was recorded southeast of Atlin along the Sutlahine and Inklin rivers. Numerous patches of recent mortality totaling nearly 5000 ha were mapped near the B.C./Alaska border in "Rainy Hollow" and in the upper Klemer and Kelsall river valleys.

In the Prince George Forest Region the area of spruce beetle caused mortality is down to an estimated 40 000 ha from the 1994 level of over 70 000 ha. The majority of the attack, 30 000 ha, has again occurred in the Mackenzie Forest District, mostly in the Clearwater River drainage northeast of Mackenzie, around Burden Lake and along Manson River. Decreases also occurred in the Prince George Forest District with currently attacked trees rare. Increases were noted in the Ft. St. James and Robson Valley Forest districts.

In the Vancouver, Cariboo, Nelson and Kamloops Forest regions, mortality was mapped over 80, 65, 186 and 800 ha respectively.

Trap trees in conjunction with spruce beetle baits and salvage harvests were used extensively throughout the province to help manage beetle populations.

Mountain Pine Beetle

The area of lodgepole pine and western white pine killed by **mountain pine beetle**, increased slightly to about 40 000 ha. Reports to date indicate a large increase in the number of recently killed, red trees in the southwest area of the Prince George Forest District and continued expansions in the Fort St. James and Robson Valley forest districts. In the Cariboo Region the area of killed pine more than doubled to 3800 ha, with the largest area of attack near Williams Lake. The mountain pine beetle continues to be the most destructive pest in the Kamloops Region with 7 500 ha affected mostly in the Penticton and Merritt districts. Increases were also noted in the Salmon Arm, Kamloops, Lillooet and Clearwater districts. In the Prince Rupert Region the infested area increased by about 15% to more than 6000 ha with significant increases in the Morice Timber Supply Area(TSA) and Tweedsmuir Provincial Park. In the Nelson Region mortality was mapped over almost 6800 ha, up from 2750 ha last year. The most active infestations were in Kootenay National Park where mortality was recorded over 2400 ha. Increasing populations also occurred throughout the East Kootenay and along Arrow Lake. In the Vancouver Region the area of mature lodgepole pine killed by the beetle increased by about 30% to almost 600 ha, mostly near Pemberton.

A CFS/BCFS co-operative trial continued in the Cariboo Forest Region using pheromones to attract secondary bark beetles into mountain pine beetle infested trees.

Attacks by the secondary bark beetles reduce the survival of the mountain pine beetle broods. About 25 000 pheromones in addition to cut and burn treatments were used extensively around the province to control beetle infestations.

Douglas-fir Beetle

Mature Douglas-fir stands killed by this beetle totalled about 3800 ha, down for the second consecutive year from 8800 ha in 1994. In the Cariboo Region recently killed Douglas-fir trees were mapped over 2930 ha in 604 infestations. Nearly 90% of this was in the Chilcotin Military Block near Riske Creek. Decreases were also noted in the Nelson and Kamloops regions with 180 and 400 ha, respectively. Attacks were down in the Prince George Forest District but increased in the Fort St. James and McBride forest districts with total area of attack for the region unchanged at 2500 ha. Increased levels of attack were recorded in the Vancouver Region with over 800 ha recorded. The main area of new attack was over 350 ha in the Sunshine Coast TSA.

Lethal and non-lethal trap trees in conjunction with baits and funnel traps were used in both the Cariboo and Prince George Forest regions to manage populations.

Western Balsam Bark Beetle-Fungus Complex

Mature alpine fir killed by the **balsam bark beetle** were mapped over 132 000 ha in all six forest regions. The majority of the attacks were again in the Prince Rupert and Prince George forest regions with more than 124 000 ha recorded. These estimates are not yet complete and can be expected to rise with additional aerial surveys. Most infestations in the Prince Rupert Region occurred in chronically infested mature stands in the south-central parts of the region including the Bulkley and Morice TSA's. In the Prince George Region over 50 000 ha, up from 33 000 ha in 1994, of mortality was mapped during limited aerial surveys around Williston Lake in the Mackenzie Forest District and along the Sustut River in the Ft. St. James Forest District. Elsewhere, tree mortality continued with 2600 ha in the Kamloops Region, 2100 ha in the Nelson Region, and 1700 ha in both the Vancouver and Cariboo regions.

Budworms

Western spruce budworm populations virtually collapsed across the province. After a major reduction in 1994, populations continued to decline, causing, mostly light defoliation on 2000 ha in the Kamloops Region compared to 14 250 ha in 1994. Defoliation was mapped in widely scattered areas near Barnhartvale, Kamloops, Merritt, Peachland and Chase. In the Vancouver Region populations collapsed following six consecutive years of defoliation mainly in the Nahatlatch River area north of Boston Bar. Ground assessments in the Cariboo Region detected only trace defoliation around Big Bar and Kelly lakes northwest of Clinton.

Western spruce budworm pheromone trapping continued at nine sites in four regions with an average 90 moths/trap(range 1-307), up slightly from the 82 average in 1994. Moth catches in 1994 and 1995 have been the lowest of the last decade. Accordingly, budworm populations are expected to remain at endemic levels for 1996. An experimental trial application of **Btk**, *Bacillus thuringiensis var.kurstaki* was repeated in the Merritt area against western spruce budworm. Dipel 76AF, at 60 BIU/ha in 3.0 L/ha, Dipel 48AF at 50 BIU/ha in 3.9L/ha and Foray 48B at 60 BIU/ha in 4.8L/ha were applied to different 50 ha plots and replicated 3 times. This higher dose and volume may be necessary for the more mountainous terrain, taller trees and probable larger foliage mass.

Also 3 CFS research plots near Merritt were treated with synthetic pheromone to test disruptive mating techniques. Application of the saturated polyvinyl chloride beads by helicopter was in early July. Preliminary analysis of male trapping data indicates that a reduction of 80 to 95 percent was achieved.

Eastern spruce budworm populations, as predicted by egg sampling, decreased in the Prince George Region. Mostly light defoliation was mapped over 27 000 ha compared to 172 000 ha in 1994. This is the lowest level of eastern spruce budworm activity recorded in over 10 years. Most of the defoliation occurred along the Liard and Toad rivers from Beaver River to Sulphur Creek.

Egg mass counts at 600 eggs per $10m^2$ of foliage, the second highest total on record, however indicate that populations will increase dramatically in 1996.

Alpine fir and spruce over more than 70 000 ha, were defoliated by the **two-year-cycle budworm** the majority in the Prince George Forest Region. Moderate and severe defoliation was mapped over 60 000 ha in the Fort St. James Forest District around the Nation Lakes and in the Silver and Ominicetla creek drainages. Less than 1 000 ha of defoliation was recorded in the Nelson Forest Region. Last year over 200 000 ha of budworm damage was recorded with over half of it in the Cariboo Region.

Western Hemlock Looper

Populations collapsed after up to five successive years of defoliation in the Interior Cedar Hemlock zone of British Columbia. Last year only 8000 ha of defoliation of old growth western hemlock and western red cedar was recorded, down from 180 000 ha at the height of the infestation in 1992. Tree mortality averaging 40%, resulting from successive years of severe defoliation was mapped over about 64 000 ha in 1994. An additional 10% of the trees have since died in the Cariboo Region.

The population collapse was due largely to egg parasitism by *Trichogramma minutum*, as forecast from egg and pheromone surveys. The calibration of a pheromone trapping and forecasting system for western hemlock looper continued in 1995. The average number of moths at 23 sites throughout the province decreased to only 24 per trap, down from 168 in 1994 and 1707 in 1993. In the Vancouver Region an average of 180 moths were trapped compared to an average of 9 in the other four forest regions. Defoliation by the looper is not expected in any areas in 1996.

Douglas-fir Tussock Moth

For the second year there was no defoliation of Douglas-fir by tussock moth in the Kamloops Region.. The collapse in 1993 was attributed to naturally occurring infection by the nuclear polyhedrosis virus.

Only half the 1994 average number of adult moths, 11(range 1-55) were caught in pheromone traps at 18 sites in the southern interior this year. This is the lowest number of moths caught since 1987. Nonetheless, at Monte Lake, 55 moths, and Heffley Creek, 54 moths were trapped indicating the possibility of defoliation in these areas in 1996. No moths were caught in 5 traps placed in the southern Cariboo.

Western Blackheaded Budworm

Budworm populations collapsed after defoliating over 6000 ha in parts of the Kamloops and Nelson regions. Populations remained endemic on the Queen Charlotte Islands and on northern Vancouver Island, where significant outbreaks occurred in the 1980's.

Phantom Hemlock Looper

For the third consecutive year, increased **phantom hemlock looper** populations severely defoliated semi-mature and mature Douglas-fir and some western hemlock, over about 10 square blocks in Burnaby. In this residential area, larvae were crawling on houses, cars, fences and patio's. Insect droppings were up to several centimeters deep on sidewalks and boulevards throughout the area.

Although Douglas-fir usually has the capacity to recover from defoliation, repeated severe defoliation may cause top-kill or tree mortality. Some relief in 1996 may occur since in rearings of larval collections over half the adults failed to emerge due to parasitism, disease and unknown causes. Still, large moth flights were reported this fall indicating the possibility of continued high populations next year.

Black Army Cutworm

Black army cutworm killed about 20% of the spruce over 20 ha in a plantation on Blackwater ridge north of Golden in the Nelson Region. Approximately 80% of the herbaceous growth was completely stripped.

Infestations of the black army cutworm were also reported, but only on herbaceous vegetation, in several cut blocks of newly planted spruce and lodgepole pine in the Kamloops, Prince Rupert and Prince George forest regions. Included were two sites near the north end of Takla Lake, three sites north of Meziadin Lake and one site in the upper north Thompson River Valley.

Pheromone trapping was not done this year due to relatively few susceptible, recently burned sites and low counts last year, (average 143 per trap; range 10-370) which successfully forecast this low endemic level.

Larch Casebearer, Sawfly

Larch casebearer populations declined, causing only light defoliation over 68 ha east of Armstrong and south of Coldstream in the Vernon Forest District, down from 285 ha last year. Populations remained at endemic levels in western larch stands in the Nelson Region for the fifth consecutive year. A biological control program against larch casebearer was initiated in 1966, and up to 1987 more than 15 000 adults of *Chrysocharis laricinellae* (Ratzburg) or *Agathis pumila* (Ratzburg) were released. No additional releases are planned.

Exotic larch at the University of British Columbia Research Forest near Vancouver were very lightly defoliated by **larch sawfly**, some for the eighth consecutive year. Exotic larch at Whistler north of Vancouver was defoliated for the first time.

Drought Damage

Drought-killed, semimature lodgepole pine was mapped in patches in the drier portions of the Cranbrook Forest District over 2200 ha. Tree mortality was greatest on the north and east slopes of the Rocky Mountain Trench south of Cranbrook.

In addition to the mortality, roughly an equal number of trees are severely stressed. A third of the lodgepole pine were dead, a third had extensive branch and stem dieback but should survive, and the remaining trees were outwardly healthy. Both dead and stressed trees were under light attack by mountain pine and Ips beetles.

Pine Needle Disease

Discolouration and premature loss of year-old and older needles of lodgepole pine due to infection by **needle disease** was recorded over 600 000 ha down from almost 900 000 ha in 1994. In the Cariboo Forest Region lodgepole pine of all ages over 556 000 ha in 70 large patches from the Chilcotin to Clinton, were lightly and moderately infected by the fungus causing pine needle cast. This is an increase from 495 300 ha in the same areas last year and was the sixth consecutive year of infection. Some trees, especially those repeatedly infected, have lost nearly all their foliage. Defoliation averaged 52% (range 10-80%), at five plots located in representative severely defoliated areas.

Elsewhere damage was widespread throughout the southwestern portion of the Prince George Forest District and the southern portion of the Vanderhoof Forest District, but was much reduced in the Kamloops, Nelson and Prince Rupert regions.

Foliar Diseases of Poplar

Field surveys of hybrid poplars and native cottonwood were conducted as part of a FRDA-sponsored research project on poplar diseases. In October, 1995, a total of 984 trees in a four-year-old hybrid poplar clonal trial were rated for four pests.

Damage by leaf rusts, *Melampsora spp.*, was extremely low this year: only 7% of the trees were rusted at trace levels.

Leaf blotching caused by *Linospora tetraspora* occurred at some level on 79% of the trees and caused high damage levels on 40% of the infected trees.

Leaf spotting caused by *Septoria populicola* occurred on 39% of the trees with high damage levels on 25% of the infected trees.

Foliar discoloration caused by an undescribed genus of eriophyid mite was also recorded on 66% of the trees in the clonal trial. Further study of this pest is planned.

Strong correlations between disease intensity and clonal families were observed. Preliminary results will be confirmed by a rating next year and compared to parallel studies being conducted on the same clones in Oregon.

An unusual leaf blight of native black cottonwood was collected from a nursery near Terrace, B.C. This appears to be the first record of *Guignardia niesslii* in western North America but the characteristic conidial state is not present. It is probable that this fungus belongs in a different, if not new, genus.

Gypsy Moth

A single site with positive trap catches and egg masses in 1994 in Chilliwack, B.C. was treated with **B.t.k.** in 1995. Foray 48B was applied at 50 BIU/ha three times by air over a 352 ha block in May and two ground sprays were applied over a central core of 17 ha in late May and June. To date no male gypsy moth have been recovered following treatment.

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 B.C. Ministry of Forests) program. To date 37 adult male moths have been trapped with approximately 75% of the traps retrieved. Thirty-two males were captured between Vancouver and Hope in 24 traps, while five single trap catches were found at three locations on southern Vancouver Island. Only 39 moths were collected from 9000 traps in 1994 down from 141 in 1993.

Pine Shoot Beetle/European Pine Shoot Moth

Pine shoot beetles were not found during surveys for this introduced pest for a fourth consecutive year. Over 1800 Scots pine at five locations in the Fraser Valley east of Vancouver were assessed. This insect is considered a serious pest in Europe and Asia and was first detected in North America in Ohio in 1992.

European pine shoot moth continued to infest exotic pine trees at low levels, mostly Christmas tree plantations or ornamental plantings in the Fraser and Okanagan valleys.

Port and Adjacent Area Quarantine Surveys

During overview surveys of dunnage in port environs at multiple locations examples of the following were found: **Ambrosia beetle** galleries in exotic hardwoods from Australia; large **Cerambycid** boring's in crating from China; **Scolytid** galleries under bark in crating from Israel and **powder post beetles** active in crating from India. The accumulation and proper disposal of wood waste from ports, with its potential to carry exotic insects and fungi, could pose a risk to Canada's forests.

Special surveys undertaken by FIDS in collaboration with Agriculture & Agrifood Canada to evaluate the potential for introduction of exotic pests associated with dunnage in and around the ports of Greater Vancouver and Prince Rupert, has resulted in additional new records. More than 125 adults of an **Asian ambrosia beetle,** *Xylosandrus germanus,* were trapped in 2 of 24 locations in the Richmond and Surrey area. Two adults of a second species of **ambrosia beetle** from Asia, *Xyleborus perforans*, were discovered on Reifel Island at the mouth of the Fraser River. This is the first record for *X. perforans* in North America. These ambrosia beetles have a wide, mostly hardwood host range. Additional surveys are required to determine in which hosts they occur and if the latter species is established or only represents a recovery of adults flying from infested dunnage on nearby vessels or from discarded crating.

Other records resulting from this limited survey include: multiple recoveries of an **Asian powder post beetle,** *Sinoxylon anale*, from a forested area immediately adjacent to a import location at which crating infested by this species was also found. As well the second Canadian collection and locality record for a **native bark beetle,** *Hylocurus hirtellus*, which attacks willow was obtained. The monitoring techniques employed in this study may also be useful in future forest bio-monitoring and biodiversity studies.

Balsam Woolly Adelgid

A cooperative survey to update the known distribution of **balsam woolly adelgid** in southwestern British Columbia continued in 1995. CFS/FIDS in cooperation with the B.C. Ministry of Forests and forest industry sampled 94 mature and immature stands in selected areas adjacent to the 1992 BWA quarantine zone boundary.

To determine if the adelgid occurred north of the quarantine zone boundary on Vancouver Island, 2 upper crown branches from 5 trees in each of 77 stands containing more than 40% Abies were sampled by helicopter and three nodes per branch were examined. Balsam woolly adelgid was present in 4 widely separated mature stands near Campbell River: at Wowo Lake, 4 of 5 amabilis fir were heavily infested with gouting evident; at a second location, Browns River, two trees were infested; and at the remaining two locations, Pearl Lake and Menzies Bay, single trees were infested. The discovery of an infested grand fir at Menzies Bay, north of Campbell River, confirms the presence of BWA near all locations on Vancouver Island where Abies seedlings are grown for reforestation. Additional sampling of symptomatic fir on Vancouver Island resulted in the discovery of one mature and two young infested amabilis fir stands beyond the quarantine zone and two other sites within the quarantine zone.

On the mainland surveys of symptomatic immature fir stands along the eastern boundary of the quarantine zone confirmed balsam woolly adelgid at 11 of the 12 locations sampled. Five sites were outside of the existing quarantine zone, with confirmation east of the Fraser River for the first time.

A CFS/BCFS cooperative trial to examine the ability of BWA to infest one and two year old container grown Abies seedlings continued in 1995. Live BWA and gouting on artificially infested one year old seedlings after one growing season demonstrated successful reproduction of the adelgid on containerized nursery stock under operational growing conditions. Survey and research trial results will be reviewed by the Plant Protection Advisory Council BWA Committee this fall to determine possible action.

European Elm Bark Beetle

European elm bark beetles were again captured in pheromone baited traps near Kelowna in the Okanagan Valley and for the first time at Grand Forks and Midway. The beetle can vector the Dutch Elm disease. Surveys to date for the fungus have been negative. As one of the few areas to be free of the disease, B.C. exports more than 10 000 elm saplings annually.

Tent Caterpillars

Defoliation of deciduous trees and shrubs by **forest tent caterpillar** in the interior of British Columbia expanded in area to about 108 000 ha in the Cariboo and Prince George forest regions.

In the Prince George Forest Region defoliation of trembling aspen increased in area to almost 55 000 ha, up more than 30% from last year. Populations increased for the third consecutive year affecting 45 000 ha from Ahbau Creek to McLeod Lake. In the Robson Valley the area of defoliation increased to almost 7 000 ha after a decrease last year. Complete defoliation of aspen stands was mapped over 114 separate infestations from west of McBride to McNaughton Lake. Populations in and around Dawson Creek and Taylor, increased for the third consecutive year with defoliation reported over 2700 ha. For the first time in more than 15 years the tent caterpillar has caused serious defoliation east of Fort Nelson with patches totaling several hundred hectares along the Liard River. Mortality of trembling aspen has begun to appear in stands south of Prince George that have been severely defoliated for several consecutive years.

In the Cariboo Region tent caterpillar lightly to severely defoliated mainly trembling aspen over 53 000 ha, about the same as last year. The most widespread and severe defoliation occurred near Quesnel where large populations completely stripped aspen. Severe defoliation was mapped north of Quesnel southeast along the Quesnel River to Deaver Creek, and northwest to the Blackwater River.

Egg mass samples from 11 areas in the Cariboo and Prince George regions, indicate continuing populations for 1996 in all areas. New egg masses per tree averaged 35 at 7 sites near Quesnel, 8 at 2 sites south of Prince George and 4 at 2 sites around McBride. The high number of egg counts around Quesnel indicate the heaviest defoliation will probably occur in this area in 1996. Counts greater than 10 masses per tree usually result in severe defoliation.

Northern tent caterpillar, increased for a fourth consecutive year and defoliated deciduous trees and shrubs in east coastal areas of Vancouver Island and the adjacent Gulf Islands. Populations again increased near Meziadin Lake east of Stewart.

Defoliation of a variety of trees and shrubs was again severe in the Victoria area, on the southern Gulf Islands and near Boston Bar in the lower Fraser Canyon. Increased numbers of larval colonies were noted from Sooke to Campbell River and in the Fraser Canyon. Severe defoliation of fruit trees was reported on Saturna, Texada and Saltspring islands.

Populations increased for the third consecutive year near Meziadin Junction in the western part of the Prince Rupert Region, but remained endemic in the Terrace area.

Satin Moth

Satin moth defoliated trembling aspen and cottonwood over more than 13 000 ha in the Prince George, Cariboo, Kamloops and Nelson forest regions. The largest infestations occurred in the Robson Valley in conjunction with forest tent caterpillar infestations and in the Nelson Region. Almost 7 000 ha of defoliation in scattered patches was reported in the Nelson Region near Golden, Bridesville, Trail and Castlegar. Satin moth larvae were also found throughout the almost 7000 ha of mostly aspen defoliation from McBride to Valemount. Random surveys of the infested stands indicated that approximately 25% of the larvae were satin moth the balance being forest tent caterpillar. Satin moth was first reported in this area last year when large moth flights occurred.

Elsewhere, much smaller infestations were detected. Severe defoliation of trembling aspen was observed in the Bluff Lake area of the Cariboo Region. In the Kamloops Region a 30-ha infestation was noted along the Coquihalla Highway south of Merritt.

Large Aspen Tortrix

Defoliation of trembling aspen by the **large aspen tortrix** continued in the Prince George and Prince Rupert regions in 1995.

Defoliation was mostly moderate and severe over 7000 ha in the Vanderhoof, Mackenzie, Dawson Creek and Fort Nelson forest districts. For the third consecutive year, defoliation was noted over approximately 2000 ha, in the Nechako River Valley from the Sinkut River to west of Fort Fraser. In the Dawson Creek and Mackenzie forest districts over 2500 ha of defoliation was mapped in each district. The tortrix, often in conjunction with the forest tent caterpillar, defoliated aspen north and east of Fort Nelson.

In the Prince Rupert Region severe defoliation was reported over approximately 1000 ha north of Kitwanga between Douse Lake and Cranberry River.

Birch Leaf Miners

Birch leafminer, *Fenusa pusilla,* lightly to severely defoliated white birch for 22 km along Creighton Valley road east of Lumby. For the fourth consecutive year this leafminer defoliated white birch in the lower Fraser Canyon near Yale.

Another **birch leafminer**, *Lyonetia speculella,* severely discolored birch stands in several areas in the West Kootenay of the Nelson Region. Damage was reported in the Tangier River-Jumping Creek area, and along the Illecillewaet, and lower Kaslo rivers. Infestations in the Kamloops Region increased almost three-fold to 2200 ha along Adams Lake and east of Vernon. In the Echo Lake area of the Prince Rupert Region over 200 ha of severe discoloration were recorded in this at least the fifth year of attack.

Jumping Gall Wasp and Oak Leaf Phylloxeran

The discoloration of Garry oaks in the Capital Regional District by **jumping gall wasp** decreased dramatically in 1995 and defoliation by the **oak leaf phylloxeran,** a frequent associate remained static. Near Maple Bay, and North Saanich, where infestations have only been active for a couple of years populations remain high. In the areas where the defoliators have been present for up to 9 years population have declined, largely due to increased levels of predators and parasites.

Western Oak Looper

The **western oak looper** has killed Garry oak and Douglas-fir trees over approximately 25 ha on the southern end of Saltspring Island. In 1994 the looper completely stripped mature Garry oak and Douglas-fir trees in Mount Maxwell Provincial Park, the adjacent ecological reserve and on nearby private lands. Populations have subsided somewhat this year with light to moderate defoliation noted on scattered Garry oak trees. Oak looper pheromone identification work is being done by Simon Fraser University. The chemicals that make up the pheromone have been extracted, identified and synthesized, however one more season of testing will be required before the most effective combination can be determined.

Apple & Cherry Ermine Moth Control

At the request of Agriculture Canada, FIDS staff released apple and cherry ermine moth parasitoids on Vancouver Island. The **ermine moths** have caused persistent and widespread defoliation of fruit and ornamental trees (apple, plum, cherry, hawthorn, mountain ash) and native trees (Pacific crab apple, Saskatoon-berry) for several years in south coastal B.C. The damage is highly visible and has been the subject of numerous enquiries. Larval rearings have shown that little if any biological control has yet occurred with Vancouver Island populations.

In an effort to reduce damage levels a European egg and larval **parasitoid**, *Ageniaspis fuscicollis* obtained by Agriculture Canada, Ottawa from Swiss and German sources were received and released by FIDS at 13 sites in Victoria and on the Saanich Peninsula. Releases were made July 13-24, 1995 and averaged about 900 parasitic wasps per site, 12,000 in total.

Other Noteworthy Pests

Rusty tussock moth, defoliated a single tree in Surrey. The infestation of **cottonwood sawfly**, that had been defoliating black cottonwood on islands in the Fraser River collapsed this year after three consecutive years of infestation. The decline was attributed to insect pathogens and virus isolated from larvae in 1993 when the defoliated area had decreased to 600 ha. The **Asian lady bird beetle**, an introduced predator in the U.S.A. for aphids was widespread and abundant in southwestern British Columbia which led to many calls from a curious public. The **spruce budmoth** in conjunction with the **green spruce aphid**, lightly to moderately defoliated Sitka spruce at Pacific Rim National Park. **Green-striped forest looper** defoliated 700 ha of mature western hemlock north of Kispiox along the Skeena River. A **conifer sawfly** defoliated 200 ha of western hemlock at the head of Phillips Arm northeast of Campbell River. A study to identify and record major pests and environmentally related problems and their impact on **young managed stands** continued in 1995 and will be reported later.

INSECT AND DISEASE CONDITIONS IN THE UNITED STATES - 1995

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SPRUCE BUDWORM

LAKE STATES

Defoliation by spruce budworm in the Lake States in 1995 is not yet available but best estimates are that acreage figures will be similar to 1994.

NEW ENGLAND

Eastern spruce budworm population abundance remains at endemic levels.

WESTERN SPRUCE BUDWORM

REGION 1 (NORTHERN REGION)

For the first time since region-wide record keeping began in 1948, our aerial detection survey did not record any western spruce budworm caused defoliation in the Northern Region. This is the first time in over 45 years that our detections surveys did not see any defoliation. 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 caught only a few moths over large areas where budworm populations have been moderate to high for many years. In one of our most chronic population areas just east of Missoula trap counts have been 807 in 1992, 122 in 1993, 155 in 1994, and 20 in 1995 from 24 traps at the Lubrecht Experimental Forest. With budworm populations at an all time low, it could be several years before defoliation returns to the million hectare levels common during the 70's and 80's.

Infested Area (ha)

Forest/Area	1991	1992	1993	1994	1995
Nez Perce	4,940	19,410	295	0	0
Beaverhead	10,823	16,166	702	0	0
Bitterroot	111,814	3,467	441	0	0
Custer	3,556	0	0	0	0
Deerlodge	144,221	114,243	3,378	787	0
Flathead IR	22	27	0	0	0
Gallatin	12,528	2,560	2,351	0	0
Helena	134,252	168,158	9,046	0	0
L & C	85,065	59,062	476	0	0
Lolo	768,264	11,693	1,035	0	0
Garnets	67,159	5,792	470	0	0
Total	651,206	400,578	18,194	787	0

Control 1995

No operational projects in Fy 95.
None are planned for Fy 96.

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. In the northern Bighorn Mountains of Wyoming, moderate levels of defoliation were visible on more than 1,000 acres.

REGION 3 (SOUTHWESTERN)

Arizona Zone--Western spruce budworm defoliation increased from none detected in 1994 to 2,870 ha detected in 1995. Defoliation was detected on the Apache-Sitgreaves (2,630 ha) and the Kaibab (235 ha) National Forests.

New Mexico Zone--Western spruce budworm defoliation was detected on 73,540 ha of the mixed conifer forest cover type in 1995 compared to 153,360 ha in 1994. Defoliation occurred on the Carson (42,950 ha), Cibola (2,000 ha), Gila (350 ha), Lincoln (290 ha), and Santa Fe (4,065 ha) National Forests and Taos (1,425 ha), Santa Clara (190 ha), and Jemez (110 ha) Pueblo Indian Reservations. Budworm defoliation on State and private lands in northern New Mexico totaled 20,600 ha.

REGION 4 (INTERMOUNTAIN)

No spruce budworm defoliation reported for the third year in a row.

REGION 5 (PACIFIC SOUTHWEST)

Region 5 reports the following: (Refer to Region 5 Ecological Units--Appendix A, B, and C)

Modoc Budworm, *Choristoneura retiniana*

M261G - Modoc Plateau

Feeding was minor and restricted in extent in the Warner Mountains.

"California" Budworm, *Choristoneura carnana californica*

M261A - Klamath Mountains

Very minor feeding was noted in one plantation on the Shasta-Trinity National Forest.

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) reported acreages are based on gross ocular estimates of aerial survey sketchmap polygons. These are:

WSB 42,000 acres

WSB activity is expected to continue in three small localized areas. No larval sampling is expected in 1995. Elsewhere, WSB activity is expected to decline.

Oregon--Current WSB caused defoliation was detected on 15,000 acres. Acreages affected are expected to be smaller for 1996.

REGION 10 (ALASKA)

Spruce Budworm/Spruce Cone Worm

Spruce budworm populations (Choristoneura fumiferana and C. orae) continue to move westward along the Yukon River. Heavy defoliation of white spruce was detected on 235,000 acres. This defoliation is a combination of spruce budworm and to some extent spruce cone worms (Dioryctria reniculelloides) in the Yukon drainage west of Fairbanks. Spruce cone worms were also found in the Anchorage bowl feeding on ornamental spruce although there are no acreage figures for this area. No changes in acres of infestation are expected for 1996.

Black-Headed Budworm

Black-headed budworm, Acleris gloverana, populations crashed this year. Only 14,500 acres were detected in south east Alaska as compared to 194,000 in 1994. The one active area of infestation is on the Taku River next to the Canadian Border. The population crash elsewhere is due to the cyclical nature of the insect infestations. Black-headed budworm levels should stay low for 1996.

JACK PINE BUDWORM

LAKE STATES

Jack pine budworm defoliation was evident on both red and jack pine on a total of 19,588 acres on the Hiawatha National Forest--an increase over last year. Most of the defoliation was light. However, a large stand of red pine adjacent to the Cleveland Cliffs Basin has quite a bit of branch and tip dieback. About 9,740 acres of jack pine has at least 15% tree mortality and dieback. In 1995 there was 16,140 acres of light to moderate defoliation in Wisconsin and 66,490 acres in Minnesota. Acres affected by jack pine budworm in Michigan were negligible in 1995.

GYPSY MOTH STATUS--"NORTH AMERICAN"

NORTHEASTERN AREA

In 1995 the European gypsy moth defoliated 1,449,891 acres of forested land in 14 eastern States. This was a 60 percent increase from the 879,449 acres defoliated in 1994 and a slight decrease from the 1,676,719 acres defoliated in 1993.

Gypsy moth suppression projects in the United States in 1995 totaled 468,658 acres with 402,535 acres treated by 8 cooperating States, 19,971 acres treated by National Forests, and 13,622 acres on other Federal lands including Tribal lands. Nationally gypsy moth eradication projects took place on 85,794 acres in 12 States. In addition to the gypsy moth 85,812 acres of fall cankerworm, forest tent caterpillar, and spruce budworm infested forest land was treated in 1995 on State and private lands, National Forests, and Tribal lands.

This year the Blackwater National Wildlife Refuge was again treated with Gypchek to protect the habitat of the recently threatened Delmarva fox squirrel.

The outlook for 1996 indicates that 9 States anticipate the need to treat gypsy moth populations on about 700,000 acres of State and private land. The Monongahela National Forest in West Virginia plans to treat about 5,000 acres. In addition, the Allegheny National Forest plans to treat about 50,000 acres of cherry scallop shell moth, Hydria spp.

The gypsy moth fungus, Entomophaga maimaiga was a major factor causing collapse of gypsy moth populations throughout the generally infested area.

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 Yellowstone National Park, Wyoming, and one in Post Falls, Idaho. At this time no followup action is planned in 1996.

REGION 2 (ROCKY MOUNTAIN)

No gypsy moths were caught in traps deployed on Federal lands for all States within the Rocky Mountain Region in 1994. In Colorado, 16 moths were caught on private lands--1 in Loveland, Colorado; 1 in Boulder, Colorado; 6 in Aurora, Colorado; and 4 in Lakewood, Colorado. The 6 moths found in Aurora came from a nursery that imported over 100 Christmas tree-sized spruce from Michigan by way of Minnesota. Of the 1,050 gypsy moth traps deployed in Kansas, 1 gypsy moth was trapped at a campsite in Saline County, Kansas. In Nebraska, 73 moths were caught in detection traps on private land in several counties. In South Dakota, detection and delimitation trapping efforts caught 11 gypsy moths on private land in several counties. In Wyoming, 2 moths were caught on private lands in Albany and Park Counties.

REGION 3 (SOUTHWESTERN)

No pest suppression projects were conducted in the Southwestern Region in 1995.

REGION 4 (INTERMOUNTAIN)

No moths were detected in 1995. This eradication project has been one of the few successful large scale projects. In 1996 trapping will be maintained to ensure no recurrence.

REGION 5 (PACIFIC SOUTHWEST)

Region 5 reports the following: (Refer to Region 5 Ecological Units--Appendix A, B, and C)

> Nineteen moths have been trapped in 8 California counties thus far. Egg masses/pupal cases have been found on 1 property in Santa Cruz County. Numbers trapped are about the same as in 1994 with the exception of an area in Santa Cruz County near Felton (6 moths and 1 property with egg masses), and an area in Nevada County near Grass Valley (5 moths). The finds in Nevada County are within a high density delimitation zone established in 1994.

REGION 6 (PACIFIC NORTHWEST)

Gypsy moth eradication projects were conducted by Oregon Department of Agriculture in Jackson and Lane counties. Two ground applications of B.t. were used on 6.25 acres in Jackson County and three aerial applications were made on a 100 acre site in Lane County.

Washington Department of Agriculture treated 6 small sites three times from the ground with B.t. Total area treated was approximately 250 acres.

REGION 8 (SOUTHERN REGION)

In 1995, the North American gypsy moth defoliated 849,584 acres of forest land in the southeastern United States. This is an increase from 452,475 acres in 1993. 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 180,200 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. However, a general population collapse has occurred over much of the northern Virginia area. Cause of the collapse appears to be caused by the fungal pathogen Entomophaga maimaiga.

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 1995, Tennessee treated approximately 41,000 acres for eradication in the northeastern corner of the State. In north central Arkansas 17,000 acres were successfully treated. Trapping efforts in both these States have not identified any additional reproducing population outside the 1995 treatment block.

The State of Georgia treated approximately 1,750 acres in Fannin County, located in the northwestern corner of the state. Post treatment trapping has identified an 800 acre treatment area near the core of the infestation for 1996.

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 1995 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 35,235 acres; 32,528 acres with Btk, and 2,707 acres with mating disruption.

REGION 10 (ALASKA)

Since 1986, pheromone monitoring traps for gypsy moth have been placed throughout Alaska, especially in locations frequented by out-of-state vehicles and port areas. To date, only two male European gypsy moths have been trapped; one near Anchorage in 1987 and the other near Fairbanks in 1992. Approximately 150 traps were placed throughout Alaska from Petersburg to Nome. Neither the Asian nor European gypsy moths were found. Trapping will continue next year.

Gypsy Moth Defoliation by Year and State--All Ownerships

Year	State	Acres Defoliated
1995	CT	3,000
	DE	65,462
	MA	50,000
	MD	93,864
	ME	500
	MI	85,907
	NH	500
	NJ	39,580
	NY	0
	OH	25,620
	PA	132,487
	RI	0
	VA	850,000
	VT	0
	WV	0
Total		1,449,891

GYPSY MOTH STATUS--"ASIAN" (AGM)

NORTHEASTERN AREA

Although no evidence of the Asian gypsy moth on Long Island was reported last year, there was an elevated level of AGM genes in a few spots. This area (750 acres) was treated in 1995 and plans are to treat again in 1996.

With the rising population of the Asian strain in Far East Russia in 1995 both quarantine and monitoring efforts will need to be strengthened. Otherwise, AGM intercepts in the western U.S. are expected to increase.

REGION 6 (PACIFIC NORTHWEST)

Three Asian gypsy moths were trapped in the State of Washington during 1995. Discussions on the proper response to these trap catches are starting this month.

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.

On the basis of this information an extensive program was planned to eradicate the introduction, 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 indicated that the 1994 treatment was largely successful, and re-treatment in 1995 was restricted to approximately 6,000 acres. Evaluation of the 1995 post-treatment monitoring effort is currently in progress.

WEED PREVENTION AND HERBICIDE USE

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 to treat 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. Apthona flea beetles are showing great promise on leafy spurge. Reductions in weed density have been reported in a number of localized areas.

As of January 1, 1995, all National Forests in Idaho will allow only the use of certified weed free hay, straw, and mulch. This prevention strategy is a cooperative effort with the Intermountain Region (R4) and the Idaho Department of Agriculture.

REGION 2 (ROCKY MOUNTAIN)

The Rocky Mountain Region utilizes herbicides as a tool in the management of noxious weeds and undesirable vegetation in range management, in forest tree nursery management, and roadside management projects. Major species treated are sagebrushes, thistles, leafy spurge, and various broadleaf weeds.

Primary herbicides used are:

1994

Herbicide	Approximate Acres
2,4-D	2,619
Picloram (Tordon)	3,375
Glyphosate (Roundup)	430
Dicamba (Banvel)	856

The rodenticide, zinc phosphide, was used to treat 4,080 acres for control of prairie dogs.

Biological control is being used on a number of plants. These include leafy spurge, spotted knapweed, diffuse knapweed, Canada thistle, Russian thistle, musk thistle, bull thistle, puncture vine, larkspur, dalmatian toadflax, and Mediterranean sage.

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 12,000 acres are treated annually with herbicides. Herbicides used included Tordon (picloram), 2,4-D, Dicamba, Glyphosate (Roundup), and Transline (Clopyralid). Treatments were applied primarily using ground equipment.

REGION 6 (Pacific Northwest)

The total treatment with herbicides for use in noxious weed control was 711 acres-up from 434 in 1994.

REGION 8 (SOUTHERN)

In 1995, the Region 8 herbicide program on Federal lands declined from 1994 levels, with approximately 41,000 acres treated. Selective treatments (backpack foliar, cut surface/injection, and streamline) accounted for the bulk of the activity. Little broadcast treatment was done (and that primarily on rights-of-way). Three active ingredients accounted for the bulk of herbicide used; triclopyr, at an average rate of 0.75 lb AI/ac, was the product most used, applied to approximately 30,500 acres; hexazinone, at an average rate of 2.1 lb AI/ac, was applied to approximately 3,000 acres; and glyphosate, at an average rate of 0.9 lb AI/ac, was applied to approximately 4,300 acres.

Herbicides were used for site preparation (approximately 17,800 ac); conifer release (approximately 14,500 ac); wildlife habitat improvement (approximately 3,600 ac); right-of-way maintenance (approximately 1,235 ac); and, general weed control and hardwood release (approximately 2,550 ac).

REGION 10 (ALASKA)

One ongoing study of approximately 50 acres to determine the preferred site-prep method (mechanical vs. chemical) in areas that have not regenerated naturally.

FIRE

REGION 1 (NORTHERN)

Wildfire starts and area burned from all causes on Forest lands in R1.

Year	1991	1992	1993	1994	1995
Starts	1329	1429	383	2740	662
Acres	38,181	56,568	372	147,904	2085

Missoula precipitation total for June, July, and August

Year	1991	1992	1993	1994	1995
Three Month Total (in)	3.81	2.91	4.79	2.68	5.36

REGION 2 (ROCKY MOUNTAIN)

The Rocky Mountain Region experienced significantly less fire activity than in 1994--one of the worst fire seasons in recent years.

REGION 4 (INTERMOUNTAIN)

Information for 1995 not available.

REGION 5 (PACIFIC SOUTHWEST)

Much of California remains dry as of October 31, 1995 and therefore the fire season has not ended. Thus far 1,354 fires have burned 25,936 acres of National Forest System lands in California. On private lands, 5,386 fires have burned 131,924 acres.

REGION 10 (ALASKA)

Average or record rainfall in many parts of Alaska resulted in few fires. Flooding was reported on the Kenai, Prince William Sound, and the Matanuska Valley this fall which may result in an increase of flood damage or Ips beetle infestations for 1996.

STORM DAMAGE

LAKE STATES

A total of 242,070 acres were affected by blowdown in Minnesota from straight-line winds in mid-July 1995, over a 4-day period.

A thunderstorm caused blowdown on about a million acres of forest in the Adirondacks of New York on July 15, 1995. Trees were felled by 100 mph down drafts or "microbursts" as the storm passed through the area. The New York Department of Environmental Conservation is wrestling with ways to deal with this large scale disturbance. Increased fire hazard is, of course, a major concern.

During late May 1995, a tornado ripped across western Massachusetts blowing down approximately 1400 acres of forest. The damage occurred near the town of Great Barrington and salvage efforts are now underway.

REGION 8 (SOUTHERN)

Hurricane Opal came ashore on October 3, 1995 causing considerable damage to portions of Florida, Alabama, Georgia, and North Carolina. In Florida, the damage was scattered, ranging from blowdown of 84,000 cords over 75,000 acres of Blackwater State Forest to felling of single, scattered trees. The Florida Division of Forestry estimates that statewide, 150,000 cords of wood are down and available for salvage. Complete acreage figures are unavailable at this time. Alabama also suffered widespread, but scattered damage. No significant damage was reported by the NFs in Florida. No red-cockaded woodpecker nesting trees were lost on FS-managed lands. Twenty-six of the 67 counties in Alabama were impacted by Opal. Twenty-one million acres of forest lands were affected, with losses estimated at 72 million dollars. Approximately 242.7 MMBF were lost to hurricane damage. The Conecuh NF estimated that 10-15% of the timber on the district was destroyed. Storm damage was less severe in both Georgia and North Carolina. The main source of problems from Opal in both states was the closure of roads, loss of electric power and telephones as a result of fallen trees.

BARK BEETLES

NORTHEASTERN AREA

The common European pine shoot beetle continues to increase its range. As of this moment it has been documented in eight States: Illinois, Indiana, Michigan, Ohio, New York, Pennsylvania, Maryland, and West Virginia. Continued surveys by State and Federal agencies have brought the total number of infested counties in these States to a total of 146 as of November 1995. The latest identification was in New York State in Cayuga County.

As part of the continuing cooperative work on survey and detection insects Bob Haack and Rob Laurence have determined that funnel traps are much more effective in catching beetles than are Theysohn traps. Also, traps may be placed near the border of plantations and still catch beetles.

REGION 2 (ROCKY MOUNTAIN)

Throughout the Region, bark beetle populations appeared to be at endemic levels with an occasional yet small and isolated infestation. Small pockets of mountain pine beetle activity were reported west of Buena Vista, Colorado; near Red Feather Lakes, Colorado; in Boulder Mountain Parks, Colorado; in lodgepole pine in north central Colorado; and in 100- to 200-year-old lodgepole pine, which are of concern, near Cold Springs, Wyoming.

Douglas-fir beetle activity continues to occur in small, widely scattered groups along the Colorado Front Range. Most mortality was on steep inaccessible slopes where western spruce budworm has defoliated trees over the past decade. In 1994, nearly 5,000 Douglas-fir trees died in an area between Sunlight Basin and the Crandell Ranger Station of the Shoshone National Forest, Wyoming. The amount of mortality increased in 1994 by approximately 19 percent over the 1993 figures.

REGION 3 (SOUTHWESTERN)

Arizona Zone--Mortality decreased in the true fir component of Big Ridge on the Kaibab National Forest. Approximately 590 ha were detected for 1995. This mortality is caused by a complex of *Annosus* root disease, *Scolytus* beetles, and western balsam bark beetle.

Roundheaded pine beetle continues to cause mortality on the Safford Range District of the Coronado National Forest. For the second year the number of new attacks has decreased. Approximately 125 ha of mortality was detected this year.

Mountain pine beetle activity increased on the Kaibab National Forest and the Grand Canyon National Park in 1995. Approximately 70 ha of mortality was detected.

New Mexico Zone--Tree mortality caused by the roundheaded pine beetle and in part by the western pine beetle and Mexican pine beetle increased slightly from 9,580 ha in 1994 to 11,840 ha in 1995. As in 1993 and 1994, most of the tree mortality detected occurred on the Lincoln National Forest (4,920 ha) and Mescalero Apache Indian Reservation (6,920 ha).

REGION 4 (INTERMOUNTAIN)

Following are estimates of the number of trees killed and acres infested by bark beetles in Region 4 during 1995. No visible defoliation was detected during aerial or ground surveys in 1995. Region 4 is in the process of digitizing aerial pest detection survey flight maps and the numbers in Table X are rough estimates of pest activity and will likely change when map processing is completed. The category for Western Balsam Bark Beetle has been changed to Subalpine Fir Mortality Complex to more accurately depict causal agents.

Table X.--Bark beetle infestation in Region 4 in 1995 by acres and number of trees killed.

Pest	Trees Killed	Acres Infested
Mountain pine beetle	36,800	29,500
Douglas-fir beetle	47,000	34,700
Ips/Western Pine Beetle	6,800	7,000
Spruce Beetle	27,900	14,700
Fir Engraver Beetle	139,200	74,000
Subalpine Fir Mortality Complex	396,800	254,700
Jeffrey Pine Beetle	8,900	7,000
Total	663,400	421,600

General Overview of Pest Conditions during 1995 in Region 4

Approximately 20,000,000 acres were surveyed in 1995. Mountain pine beetle activity increased slightly in lodgepole, ponderosa, and whitebark pine. The largest outbreak is located on the Dixie National Forest. Smaller outbreaks were located on the Fishlake, Salmon, Manti-LaSal, and Sawtooth National Forests.

Douglas-fir beetle activity remained relatively static regionwide with most mortality located in southern Idaho and central Utah. Areas with extensive mortality are located on the Boise, Sawtooth, and Manti-LaSal National Forests. Western pine beetle activity, located primarily on the Boise and Payette National Forests in southern Idaho, increased slightly. Spruce beetle activity decreased Regionwide with the exception of the Dixie National Forest.

Fir engraver beetle activity decreased Regionwide, with outbreaks on the Fishlake, Manti-LaSal, Toiyabe, Uinta, and Wasatch-Cache National Forests. Killing of subalpine fir by a complex of bark beetle pests and numerous disease pathogens, dubbed Subalpine Fir Mortality Complex, replaced fir engraver beetle as the most extensive tree killer in the Region. Activity was noted on virtually all Forests in the Region. Jeffrey pine beetle activity decreased slightly on the Toiyabe National Forest with most mortality located in the Tahoe Basin.

REGION 5 (PACIFIC SOUTHWEST)

The overall trend in the number of red or fading firs and pines was downward in 1995. However, tree mortality continues at above normal levels in many areas of northern California. Tree mortality during the recent, extended drought has resulted in many stands with large numbers of dead trees.

Table 1. Mortality from within the National Forest System in California - 1995

Province[a]	Acres of Mortality	Volume (MMBF)
Klamath	193,871	NA
Cascade	227,627	NA
IBET	82,661	NA
Sierran	56,647	NA
Southern California	3,112	NA
Total	563,918	NA

a. Klamath = Klamath, Mendocino, Shasta-Trinity, and Six-Rivers National Forests
Cascade = Modoc, Lassen, and Plumas National Forests
IBET = Tahoe, LTBMU, Eldorado and Inyo National Forests
Sierran = Stanislaus, Sierra, and Sequoia National Forests
Southern California = Los Padres, Angeles, San Bernardino, and Cleveland National Forests.
NA. Not available until December.

Mountain pine beetle, Dendroctonus ponderosae

Acres of pine (sugar, ponderosa, and lodgepole pine) attacked by mountain pine beetle are estimated at 50,800 for 1995. This figure is subject to revision until November 30, 1995.

Attacks on sugar pine were scattered because the preferred host is large trees and these are scattered throughout the mixed-conifer type. Attacks on ponderosa pine generally were on single trees or in 5-10 tree groups and again, scattered throughout the host type. Larger group kills occurred in lodgepole pine, but California does not have the expanse of host type typical of the U.S. Rocky Mountains and western Canada.

Western pine beetle, Dendroctonus brevicomis

Mortality from this bark beetle is down in 1995, particularly in the southern Sierra Nevada (M261E). However, attacks remain high in a few locations in the northern part of the Sierra Nevada and parts of the Modoc Plateau (M261G). Western pine beetle and mountain pine beetle were often found in the same ponderosa pine, particularly in the smaller size classes. In scattered large dbh pines, western pine beetle usually is found alone.

Fir engraver, Scolytus ventralis

This engraver continued to be the most important bark beetle in California. White fir mortality continued at high levels in some portions of the Southern Cascades (M261D), the northern portion of the Sierra Nevada (M261E) and the Modoc Plateau (M261G). Over stocking, off-site locations, and drought for much of the past 10 years contributed to the mortality.

Jeffrey pine beetle, Dendroctonus jeffreyi

Mortality caused by Jeffrey pine beetle attacks on pines stressed by drought has been increasing for several years. Losses recently have been heavy in old growth trees in the northern part of Lassen Volcanic National Park and adjacent areas of the Lassen National Forest, particularly the nearby 1000 Lakes Wilderness Area (M261D). Other areas of noted mortality occurred on the Plumas (M261D) and Tahoe National Forests, the Lake Tahoe Basin, and the Inyo National Forest (northern M261E)

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 1995 in these four quadrants was compared to 1994 data to obtain trend information. The average percent increase/decrease for each insect was applied to 1994 estimates for the entire State. The following are the 1995 estimates:

INSECT SPECIES	NO. OF TREES KILLED
Douglas-fir beetle	9,500
Fir Engraver	14,000
Mountain pine beetle	298,000
Western pine beetle	32,200

Total tree mortality was indicated in the sample areas for trees affected by Douglas-fir beetle, fir engraver, and mountain pine beetle remained about the same. A four-fold decrease in tree mortality caused by western pine beetle was reported within the sample area.

Oregon--The following is a summary of bark beetle activity:

INSECT SPECIES	NO. OF TREES KILLED
Douglas-fir beetle	22,200
Western pine beetle	22,000
Mountain pine beetle	500,000
Fir engraver	180,500

REGION 8 (SOUTHERN)

Southern pine beetle populations have rebounded dramatically after declining in 1994. Regionally, SPB losses will approach or perhaps exceed the record-setting outbreak of the mid-1980's. Dollar loss estimates now exceed $250 million. Populations have reached epidemic levels in parts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Arkansas. Interestingly, SPB activity in Texas and Virginia remains moderate to low. These areas were severely impacted between 1993-4.

With regard to National Forest land, the area most seriously impacted is on the National Forests in Mississippi. Over 5,000 infestations have been detected and over 100,000 MBF of beetle-killed timber have been salvaged. The Holly Springs and Homochitto National Forests have even gone to the incident command system, treating this outbreak similar to a forest fire. National Forest personnel from around the Region and Mississippi Forestry Commission staff have been detailed to help suppress the beetle outbreak.

On private land in North Carolina, much of the state east of Raleigh is experiencing increased beetle activity. In South Carolina, 22 of the state's 46 counties are in outbreak status and losses exceeding $100 million to the timber resource are estimated. In Georgia, beetle activity is high along the coastal plain, piedmont and mountains with 11 counties classified as epidemic and over 100 counties with reported activity. In Florida, last year's outbreak in the city of Gainesville has continued and populations have reached outbreak status in 7 north Florida counties, mainly infesting industrial slash pine plantations. In Alabama, 51 counties are in outbreak status and losses exceed $40 million. Mississippi has the highest populations in the northeast corner of the state. Twenty-three counties are classified as outbreak. Louisiana is experiencing an outbreak in the area north of New Orleans and Baton Rouge and also along the border with Arkansas. Sixteen parishes (counties) have been classified as outbreak. SPB activity is highest in southern Arkansas with 7 counties being in outbreak.

In 1995, cooperative suppression projects were funded for the states of Alabama, Florida, North Carolina, South Carolina, Arkansas, and Louisiana. Federal suppression projects were funded on the National Forests in Alabama, North Carolina, Mississippi, Texas, Kisatchie NF, Sumter NF, and Oconee NF. Other Federal lands that have funded projects are the Big Thicket National Preserve, Natchez Trace Parkway, Noxubee Wildlife Refuge, Fort Benning, and Fort Stewart.

Of concern as winter approaches is the large number of spots that are present and the inability to detect spots as the leaves of the hardwoods fade to autumn colors. A large overwintering population sets the stage for serious conditions at the beginning of the 1996 field season.

REGION 10 (ALASKA)

Spruce Bark Beetles

Spruce Bark Beetles, *Dendroctonus rufipennis*, hit record numbers this year; especially on the south half of the Kenai Peninsula, including Kachemak Bay. Mortality in much of that area is expected to be 80% or more of trees greater than 9" DBH. The other area of high mortality is the Copper River drainage.

To put the mortality in perspective, from 1977 to 1991, the average (ongoing and new) infestation was 296,700 acres, with a high in 1982 of 476,000 and a low in 1977 of 12,000. Since 1992, the average has been 715,550. Estimating an average beetle-caused mortality of 5,000 board feet/acre, the approximate volume of dead trees for the last five years was 4,464 million board feet. This year alone, the estimated volume is 1.26 million board feet.

Approximate Acres of (Ongoing and New) Mortality by Year in Thousands

Ownership	1988	1989	1990	1991	1992	1993	1994	1995
National Forest	36.4	10.7	40.5	19.5	28.8	26.2	12.8	35.7
State & Private	141.6	83.3	152.3	191.7	231.9	356.4	375.9	375.0
Native	*	*	*	23.3	118.8	150.8	60.2	241.0
Other Federal	229.6	101.7	57.4	142.2	225.3	191.3	191.0	241.1
Total	407.6	195.7	250.2	376.7	604.8	724.7	639.9	892.8

* Included under State & Private

Spruce bark beetle populations should start to diminish on the Kenai in 1996 due to the loss of host species of requisite size. Acres figures should remain stable for a few years then diminish as the needles drop. Elsewhere, populations may increase due to optimum conditions for beetle flight in 1995.

Engravers

Ips perturbatus beetles have decreased this year. The highest occurrence of Ips was along the Christian and Sheenjek Rivers in Interior Alaska. These trees appear to have been weakened by past flooding. Ips populations may increase in 1996 due to the flooding on the Kenai, Prince William Sound and Matanuska Valley.

OTHER PESTS

ASPEN DEFOLIATOR COMPLEX

Lake States

Aspen defoliator complex affected 36,500 acres in Minnesota in 1995.

BAGWORM

Region 8 (Southern)

Significant defoliation on baldcypress was recorded on 750 to 1,200 acres in southern Louisiana in 1995 by bagworm, Oiketicus abbotii.

BALSAM POPLAR LEAF MINER

Lake States

Balsam poplar leaf miner affected 5,630 acres in Minnesota in 1995.

BASSWOOD THRIPS

Lake States

Moderate to heavy defoliation by basswood thrips was reported on 82,500 acres in Wisconsin in 1995.

BROWNTAIL MOTH

Northeastern Area

Aerial surveys determined that approximately 2,418 acres were defoliated by browntail moth in 1995 in the vicinity of Casco Bay, Maine in 1995. Most of the defoliation (2,258 acres) occurred on islands in the bay. In general, poplar stands were lightly defoliated, oak stands more severely defoliated, and Amelanchier sp. very severly defoliated. A total of 250 acres on two islands were treated with an aerial application of Dimilin. The treatments appeared to be successful.

On Cape Cod, Massachusetts, approximately 2,000 acres are infested with browntail moth. Populations are generally higher on the outer Cape. No treatment is planned.

CYPRESS APHID, CINARA CUPRESSI (BUCKTON)

Region 2 (Rocky Mountain)

In 1995, Colorado experienced a cooler, wetter, and longer spring than in previous years. It is thought that the weather affected the activities of the Cinara sp. populations and, therefore, the parasite populations. A total of 256 mummies have been sent to the International Institute of Biological Control (IIBC) for evaluation since 1992. The parasite evaluations have been completed with overall negative results for possible future biocontrol work. However, there is an interest in pursuing the collection and evaluation of a dipterous predator associated with the Cinara sp. in Colorado for potential biocontrol in Kenya. Forest Health Monitoring (FHM) will continue the Cinara sp. project in 1996.

DOUGLAS-FIR TUSSOCK MOTH

Region 2 (Rocky Mountain)

The outbreak detected in 1993 at West Creek, Pike National Forest, Colorado, expanded greatly in 1994, as predicted, from 250 acres to 6,134 acres of heavy defoliation. Egg deposition was high in many areas indicating the population may expand and fill in the areas between more heavily defoliated sites. The current infestation is the largest on record for Colorado. The reasons for this event are somewhat speculative; however, since the exclusion of fire from the Front Range pine ecosystem Douglas-fir has invaded sites historically occupied by ponderosa pine. This recent outbreak of the Douglas-fir tussock moth is the most intense and largest on record in Region 2. In 1995, an additional 2,000 acres of heavy defoliation occurred.

Region 5 (Pacific Southwest)

Region 5 reports the following: (Refer to Region 5 Ecological Units--Appendix A, B, and C)

Douglas-fir tussock moth, Orgyia pseudotsugata

M261D - Southern Cascades & M261E - Sierra Nevada

No reports of defoliated areas. Traps will not be removed from the field until early November and thus, figures for trap catches are not presently available.

FOREST TENT CATERPILLAR

Northeastern Area

In Minnesota, approximately 9,550 acres of forest tent caterpillar defoliation were reported in 1995. Scattered high populations persist in New York State. Approximately 2,400 acres were treated with B.t. on the Seneca Nation of Indian Lands near Salamanca, New York in 1995.

Region 2 (Rocky Mountain)

Normal levels of tent caterpillar activity were reported for 1994.

Region 5 (Pacific Southwest)

Region 5 reports the following: (Refer to Region 5 Ecological Units--Appendix A, B, and C)

Tent caterpillar, *Malacosoma* sp.

M261D - Southern Cascades & M261E - Sierra Nevada

Defoliation of bitterbrush was very apparent throughout the southern portion of the Southern Cascades section and the northern portion of the Sierra Nevada section. Mortality has not occurred, but the areas will be monitored in 1996 for effects on this important range species.

Region 8 (Southern)

Defoliation of tupelo by the forest tent caterpillar, *Malacosoma disstria*, increased again in 1995. In 1993, 185,000 acres were impacted in the Atchafalaya Basin, south of Baton Rouge, Louisiana; 225,000 acres were impacted in 1994 and 385,000 acres were impacted in 1995. Growth impact would be expected on the 320,000 acres that showed defoliation levels greater than 50 percent.

FRUITTREE LEAFROLLER

Region 8 (Southern)

In Louisiana, the fruittree leafroller, *Archips argyrospilus*, caused approximately 70,000 acres of partial to total defoliation on baldcypress. Growth loss would be expected on 30,000 of those acres. Additional tens of thousands of acres were affected to a variable amount by fruittree leafroller damage along waterways. Scattered heavy to light defoliation occurred in stands with low density population of baldcypress and were not recorded.

HEMLOCK WOOLLY ADELGID

Northeastern Area

Hemlock wooly adelgid continues to expand its range in Massachusetts. It has not been found in Maine, Vermont, or New Hampshire. In New York, the insect has not expanded its range farther north up the Hudson River since 1992. In the mid-Atlantic States it does continue to move west. It is about one-halfway across the State of Pennsylvania, for example.

Region 8 (Southern)

In 1995, 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 1995 as well. These suppression projects would occur in high use recreation areas that have a major hemlock component.

LARCH CASEBEARER

Lake States

Larch casebearer affected approximately 60,000 acres in the Upper Peninsula of Michigan in 1995.

LARCH SAWFLY

Region 10 (Alaska)

A larch sawfly, Pristiphora erichsonii, outbreak seems to be moving west from Canada across interior Alaska. 100,200 acres of defoliation are occurring from the Big Delta River west along the Tanana to Fairbanks and down the Kantishna River. While heavy defoliation normally results in reduced growth rate it also may make the larch susceptible to eastern larch bark beetle, Dendroctonus simplex. Populations are expected to stay the same for 1996.

LARGE ASPEN TORTRIX

Region 10 (Alaska)

Large aspen tortrix, Choristoneura conflictana, defoliated 30,439 acres of aspen stands mainly in the Matanuska/Susitna Valley outside of Anchorage and the Black River drainage east of Fort Yukon. Some growth loss and top-kill can be expected from heavily defoliated hosts; however, mortality is rare. No population change is expected for 1996.

PANDORA MOTH

Region 6 (Pacific Northwest)

Approximately 369,000 acres were reported affected by Pandora moth in 1994 in central Oregon. The outbreak is expected to continue in 1996.

WHITE FIR SAWFLY

Region 5 (Pacific Southwest) (Refer to Region 5 Ecological Units--Appendix A, B, and C)

White fir sawfly, Neodiprion nr. deleoni and abietis

M261D - Southern Cascades

The white fir sawfly infestations in Lassen, Plumas and Shasta Counties have collapsed.

DISEASES

ABIOTIC INJURY - OZONE

Region 5 (Pacific Southwest)

Abiotic Injury - Ozone (M261E) (Refer to Ecological Units--Appendix A, B, and C)

Twenty-six air pollution monitoring plots were revisited on the Sierra National Forest. When compared to injury ratings recorded in 1993, 46% of the plots showed increased injury, 39% no change, and 15% less injury. It is anticipated that future ozone injury ratings may increase if precipitation continues at normal or above levels.

ARMILLARIA ROOT DISEASE

Region 2 (Rocky Mountain)

Armillaria root disease is the most common root disease in Colorado. Presence of the disease affects the management of mixed conifer stands on the Southern Ute Reservation and is a major problem of spruce/fir leave strips in ski areas around Aspen and Crested Butte, Colorado. In South Dakota, where the disease is also very common, there is a high incidence of the disease on the Spearfish and Harney Ranger Districts, Black Hills National Forest--11 percent and 13 percent of total acreage sampled on the Districts, respectively.

BUTTERNUT CANKER

Region 8 (Southern)

Butternut is being killed throughout it's range in North America by a fungus of unknown origin (Sirococcus clavigignenti-juglandacearum). 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 Arkansas, Alabama, South Carolina, Virginia, North Carolina, Georgia, and Tennessee, and infected trees are suspected in 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.

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 230 counties. The acres affected have increased from 0.5 million acres in 1988 to 12.8 million acres in 1995. 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 1996.

DWARF MISTLETOE

Region 2 (Rocky Mountain)

Dwarf mistletoe causes the greatest disease losses in Region 2. In Colorado, nearly 50 percent of the lodgepole pine type is infected with *Arceuthobium americanum*. In Wyoming, it is widespread on the Bighorn and Shoshone National Forests as well. In the ponderosa pine type, losses by infection of *Arceuthobium vaginatum* spp. *cryptopodium* amount to 885,000 cubic feet annually in Colorado.

ELYTRODERMA NEEDLE CAST AND LARCH NEEDLE CAST

Region 4 (Intermountain)

Damage from Elytroderma needlecast was noted on over 3500 acres on the Salmon National Forest. Larch needle cast was also noted on over 500 acres on the Payette National Forest.

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 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 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, 55 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 825 infection centers with over 230 miles of barrier trenches and injected over 5,660 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.

PINE PITCH CANKER

Region 5 (Pacific Southwest)

Pine Pitch Canker (261A, 261B, 263A) (Refer to Region 5 Ecological Units--Appendix A, B, and C)

Range - 15 coastal and adjacent inland counties from San Diego to Mendocino County. Pitch canker has now been found in all three of California's native Monterey pine stands.

Concerns
- Threat to the genetic base of Monterey pine.
- Loss of Monterey pine to nursery industry.
- Spread to other conifers and commercial stands by insect vectors.
- Disease movement via transport of infected trees and tree parts, use of contaminated tools, and use of infected seeds.
- Costly tree removals, particularly those along highways.
- Increased fire hazard.

Action - Slow the Spread Task Force. Further information on the Task Force and Pine Pitch Canker may be obtained from the Chairman, Don Owen, Calif. Dept. Forestry & Fire Protection, 6105 Airport Rd., Redding, CA 96002, (916-224-2494).

PORT ORFORD-CEDAR ROOT DISEASES (M261A)

Region 5 (Pacific Southwest)

Port-Orford-Cedar Root Disease (M261A) (Refer to Region 5 Ecological Regions--Appendix A, B, and C)

This disease was identified in the headwaters of Potato Patch Creek on the Smith River National Recreation Area. This is part of the Klamath River watershed and is the first identification of this disease in native stands of the host in California beyond the Smith River watershed.

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. Concentrated mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan Area. Approximately 500,000 acres of decline have been mapped during aerial detection surveys. Studies suggest that cedar decline is naturally occurring and is caused by some abiotic environmental stress probably associated with the poorly-drained anaerobic soils. The primary ecological effect is to alter stand structure, composition, and the eventual succession to other conifer species. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations, but not extinction, of yellow-cedar.

Ecological Units of the National Hierarchy - Ecoregions and Subregions in California

200 HUMID TEMPERATE DOMAIN

260 Mediterranean Division

261 California Coastal Chaparral Forest and Shrub Province

261A Central California Coast Section (Los Padres NF)

261B Southern California Coast Section (Los Padres NF)

263 California Coastal steppe, mixed & redwood forest

263A Northern California Coast

M260 Mediterranean Regime Mountains Division

M261 Sierran Forest - Alpine Meadows Province

M261A Klamath Mountains Section
(Six Rivers, Klamath, Shasta-Trinity NF)

M261B Northern California Coast Ranges Section
(Six Rivers, Mendocino NF)

M261D Southern Cascades Section
(Shasta-Trinity, Klamath, Lassen NF)

M261E Sierra Nevada Section
(Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Sequoia, Inyo NF)

M261G Modoc Plateau Section
(Klamath, Modoc, Lassen, Shasta-Trinity NF)

M262 California Coastal Range Shrub - Forest - Meadow Province

M262A Central California Coast Ranges Section
(Los Padres NF)

M262B Southern California Mountains and Valleys Section
(Los Padres, Angeles, Cleveland, San Bernardino NF)

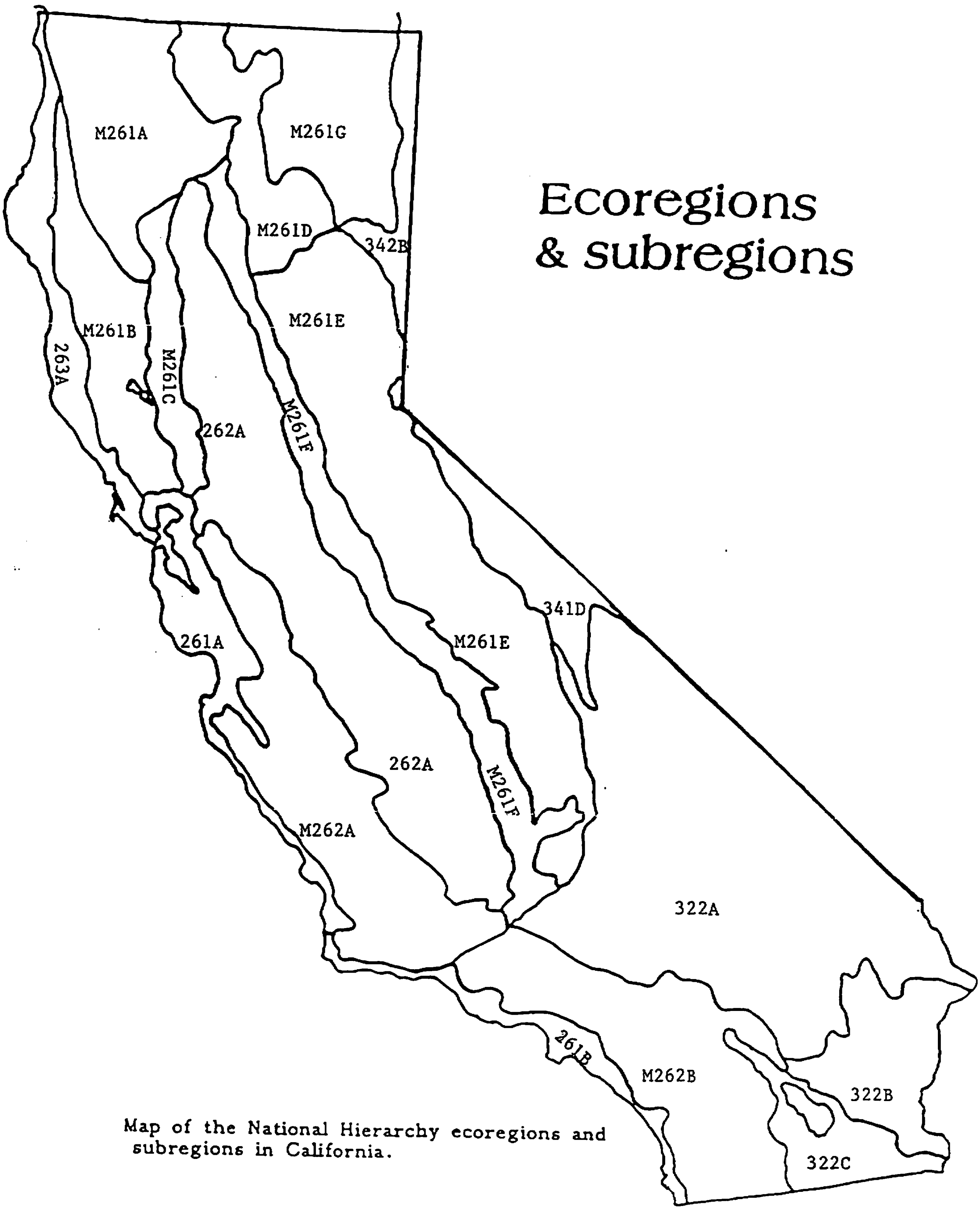
300 DRY DOMAIN

340 Temperate Desert Division

341 Intermountain Semi-Desert and Desert Province

341D Mono Section
(Inyo, Toyabe NF)

APPENDIX B, C, D, E, F, G, H, AND I IN HARD COPY ONLY



Map of the National Hierarchy ecoregions and subregions in California.

Figure 1-4 - Hierarchy of Ecological Units in California

HUMID TEMPERATE DOMAIN

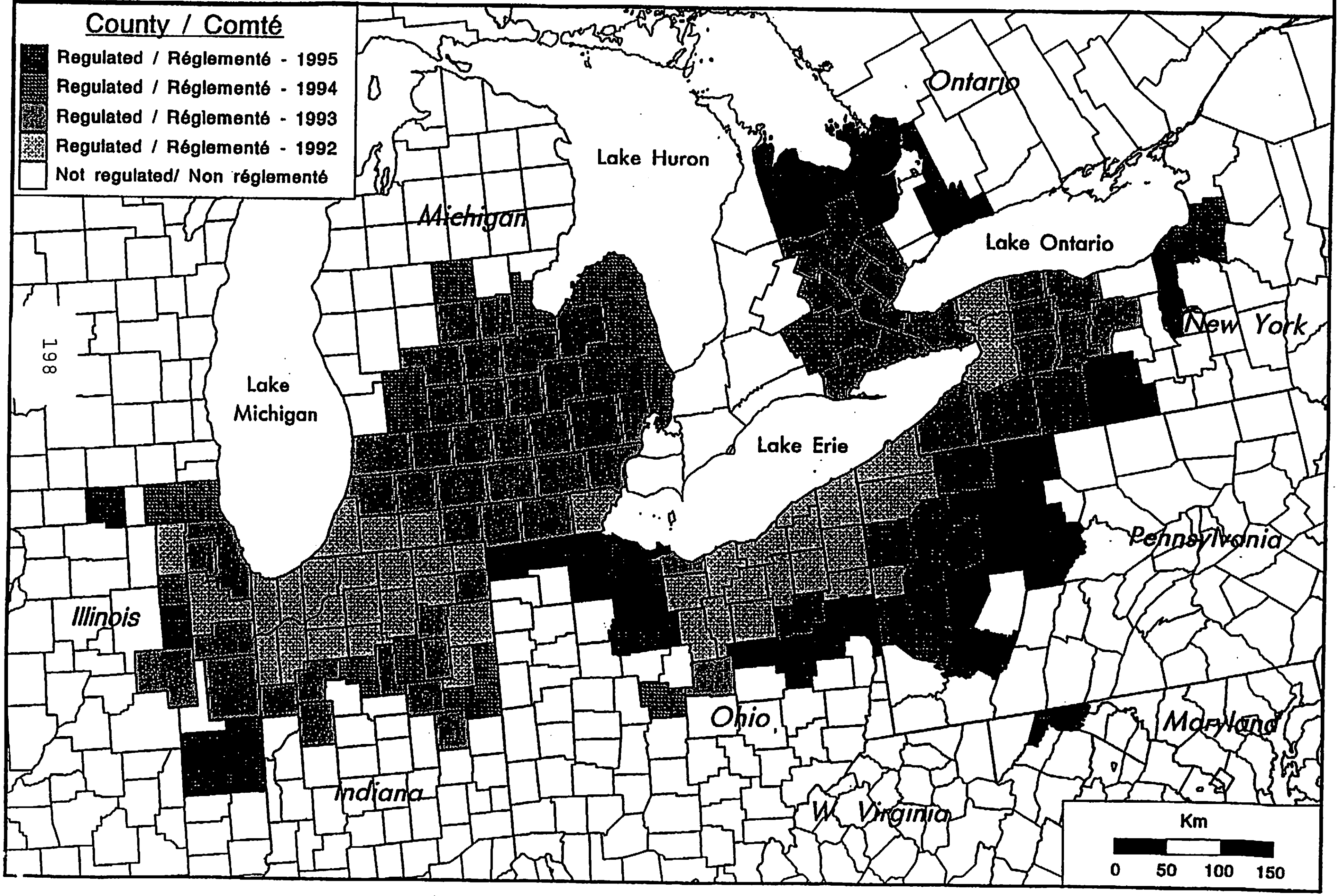
Division	Province	Section
260-Mediterranean	261-CA coastal chaparral forest and shrub	261A-Central CA coast
		261B-Southern CA coast
	262-CA dry steppe	262A-Great Valley
	263-CA coastal steppe, mixed & redwood forest	263A-Northern CA coast
M260-Mediterranean regime mountains	M261-Sierran steppe, mixed & coniferous forest & alpine meadow	M261A-Klamath mountains
		M261B-Northern CA coast ranges
		M261C-Northern CA interior coast ranges
		M261D-Southern Cascades
		M261E-Sierra Nevada
		M261F-Sierra Nevada foothills
		M261G-Modoc plateau
	M262-CA coastal range open woodland, shrub, continuous forest, meadow	M262A-Central CA coast ranges
		M262B-Southern CA mountains & valleys

DRY DOMAIN

Division	Province	Section
320-Tropical/ subtropical desert	322-American semi-desert & desert	322A-Mojave desert
		322B-Sonoran Mojave desert
		322C-Sonoran Colorado desert
340-Temperate desert	341-Intermountain semi-desert & desert	341D-Mono
	342-Intermountain semi-desert	342B-Northwestern basin and range

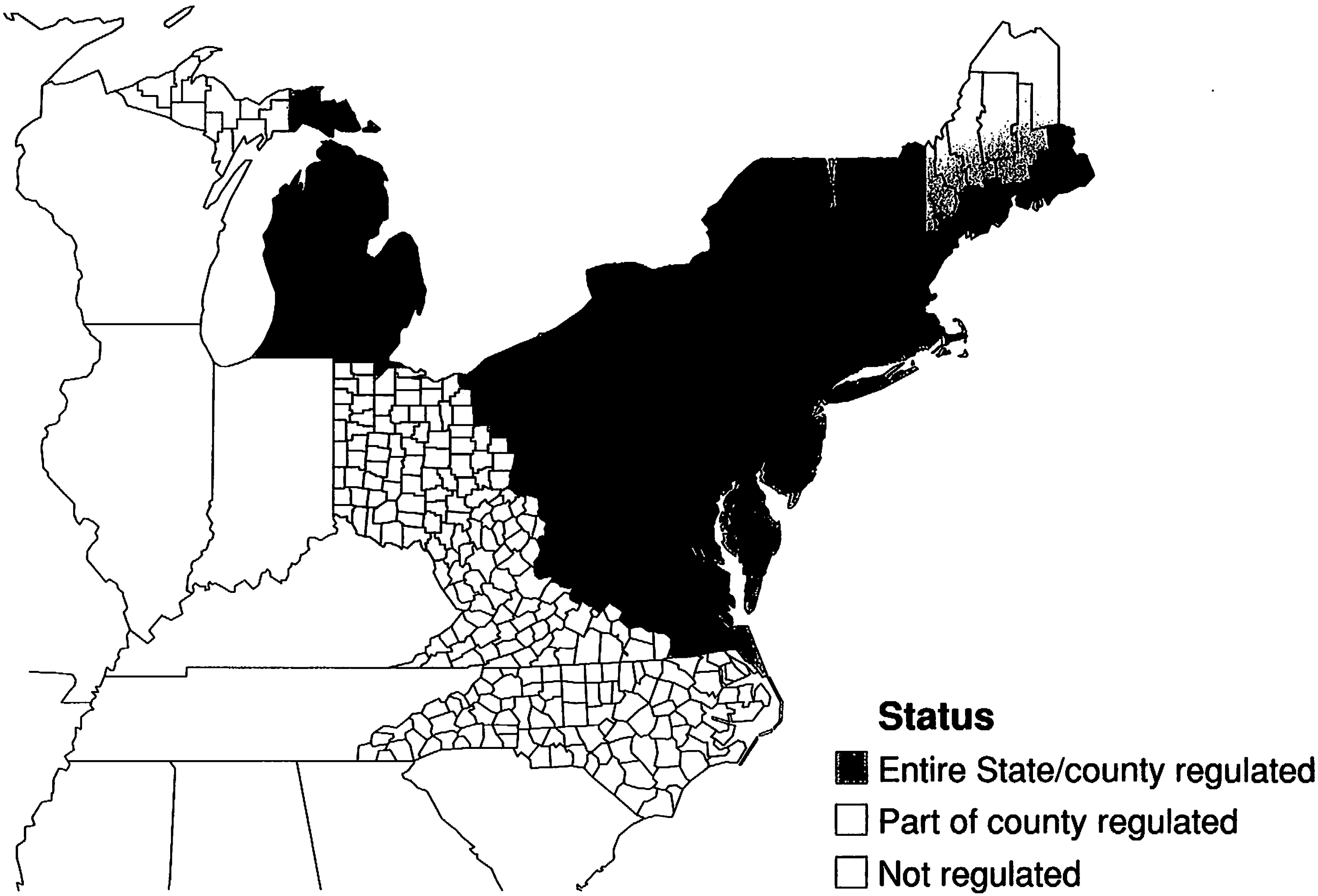
Pine Shoot Beetle / Grand hylésine du pin - *Tomicus piniperda*

North America / Amérique du Nord : 1992 - 1995



Gypsy Moth Regulated Area

Effective August 1994



United States Department of Agriculture
Animal and Plant Inspection Service

Gypsy Moth Quarantine

Federal regulations prohibit the movement of certain articles from those parts of the country regulated (red) for gypsy moth to any unregulated part of the United States. Contact plant regulatory officials in your State department of agriculture or the U.S. Department of Agriculture's Animal and Plant Health Inspection Service or your county extension agent for assistance regarding requirements for moving regulated articles. For detailed information, consult title 7 of the Code of Federal Regulations, part 301.45.

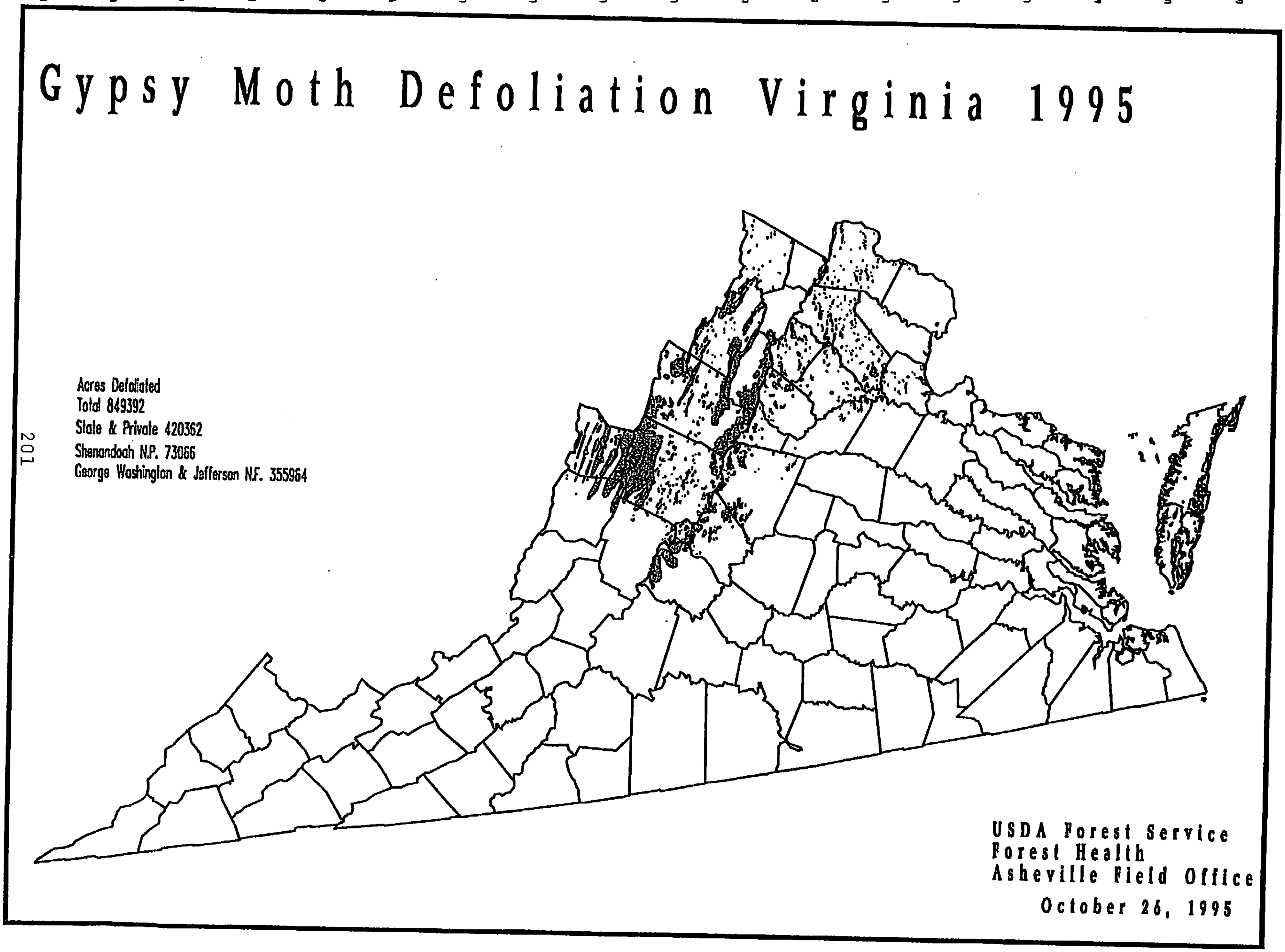
Articles Requiring Inspection and Certification Prior to Movement

- Nursery stock and Christmas trees;
- Logs, pulpwood, and wood chips;
- Mobile homes and associated equipment; and
- Outdoor household articles, such as outdoor furniture, barbecue grills, firewood, doghouses, boats, recreational vehicles, trailers, garbage containers, bicycles, tires, tents, awnings, garden tools, etc.

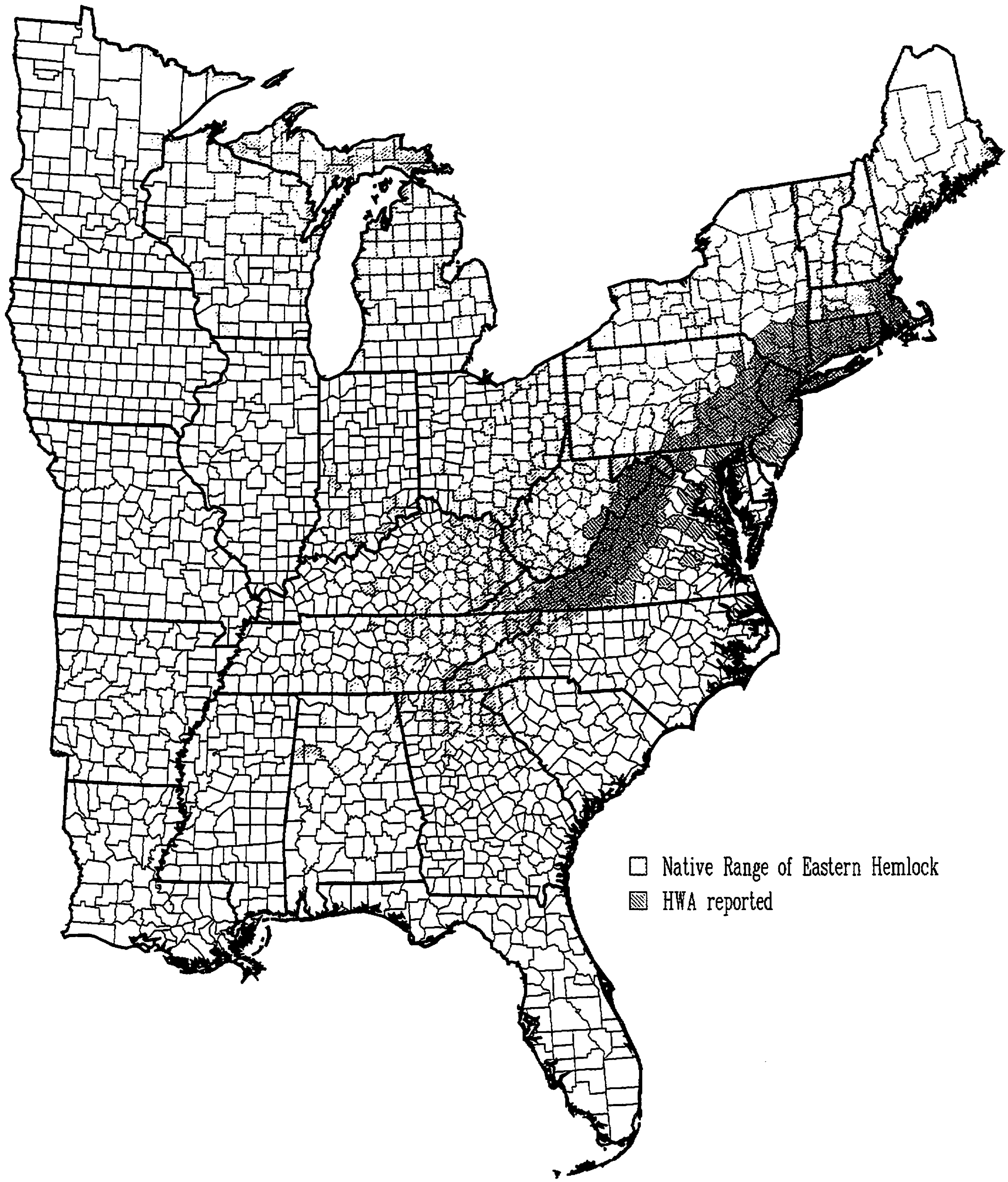
Quarantine Area

The following States are entirely within the quarantine area: Connecticut, Delaware, the District of Columbia, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

Parts of the following States are within the quarantine area:
Maine: All of Androscoggin, Cumberland, Hancock, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, Washington, and York counties; and the southern portions of the counties of Aroostook, Franklin, Oxford, Penobscot, Piscataquis, and Somerset.
Michigan: The counties of Alcona, Allegan, Alpena, Antrim, Arenac, Barry, Bay, Benzie, Berrien, Branch, Calhoun, Cass, Charlevoix, Cheboygan, Chippewa, Clare, Clinton, Crawford, Eaton, Emmet, Genesee, Gladwin, Grand Traverse, Gratiot, Hillsdale, Huron, Ingham, Ionia, Iosco, Isabella, Jackson, Kalamazoo, Kalkaska, Kent, Lake, Lapeer, Leelanau, Lenawee, Livingston, Luce, Mackinac, Macomb, Manistee, Mason, Mecosta, Midland, Missaukee, Monroe, Montcalm, Montmorency, Muskegon, Newaygo, Oakland, Oceana, Ogemaw, Osceola, Oscoda, Otsego, Ottawa, Presque Isle, Roscommon, Saginaw, St. Clair, St. Joseph, Sanilac, Shiawassee, Tuscola, Van Buren, Washtenaw, Wayne, and Wexford.
North Carolina: All of Currituck County and the eastern portion (barrier island) of Dare County.
Ohio: The counties of Ashtabula, Carroll, Columbiana, Cuyahoga, Geauga, Jefferson, Lake, Lucas, Mahoning, Portage, Stark, Summit, and Trumbull.
Virginia: The counties of Accomack, Albemarle, Amelia, Amherst, Arlington, Augusta, Bath, Buckingham, Caroline, Charles City, Chesterfield, Clarke, Culpeper, Cumberland, Dinwiddie, Essex, Fairfax, Fauquier, Fluvanna, Frederick, Gloucester, Goochland, Greene, Greensville, Hanover, Henrico, Highland, Isle of Wight, James City, King and Queen, King George, King William, Lancaster, Loudoun, Louisa, Madison, Mathews, Middlesex, Nelson, New Kent, Northampton, Northumberland, Nottoway, Orange, Page, Powhatan, Prince Edward, Prince George, Prince William, Rappahannock, Richmond, Rockbridge, Rockingham, Shenandoah, Southhampton, Spotsylvania, Stafford, Surry, Sussex, Warren, Westmoreland, and York.
West Virginia: The counties of Barbour, Berkeley, Brooke, Grant, Hampshire, Hancock, Hardy, Jefferson, Marion, Marshall, Mineral, Monongalia, Morgan, Ohio, Pendleton, Pocahontas, Preston, Randolph, Taylor, Tucker, and Wetzel.


Gypsy Moth Defoliation Virginia 1995
Acres Defoliated
Total 849392
State & Private 420362
Shenandoah N.P. 73066
George Washington & Jefferson N.F. 355964
USDA Forest Service
Forest Health
Asheville Field Office
October 26, 1995

Hemlock Woolly Adelgid Distribution - 1993

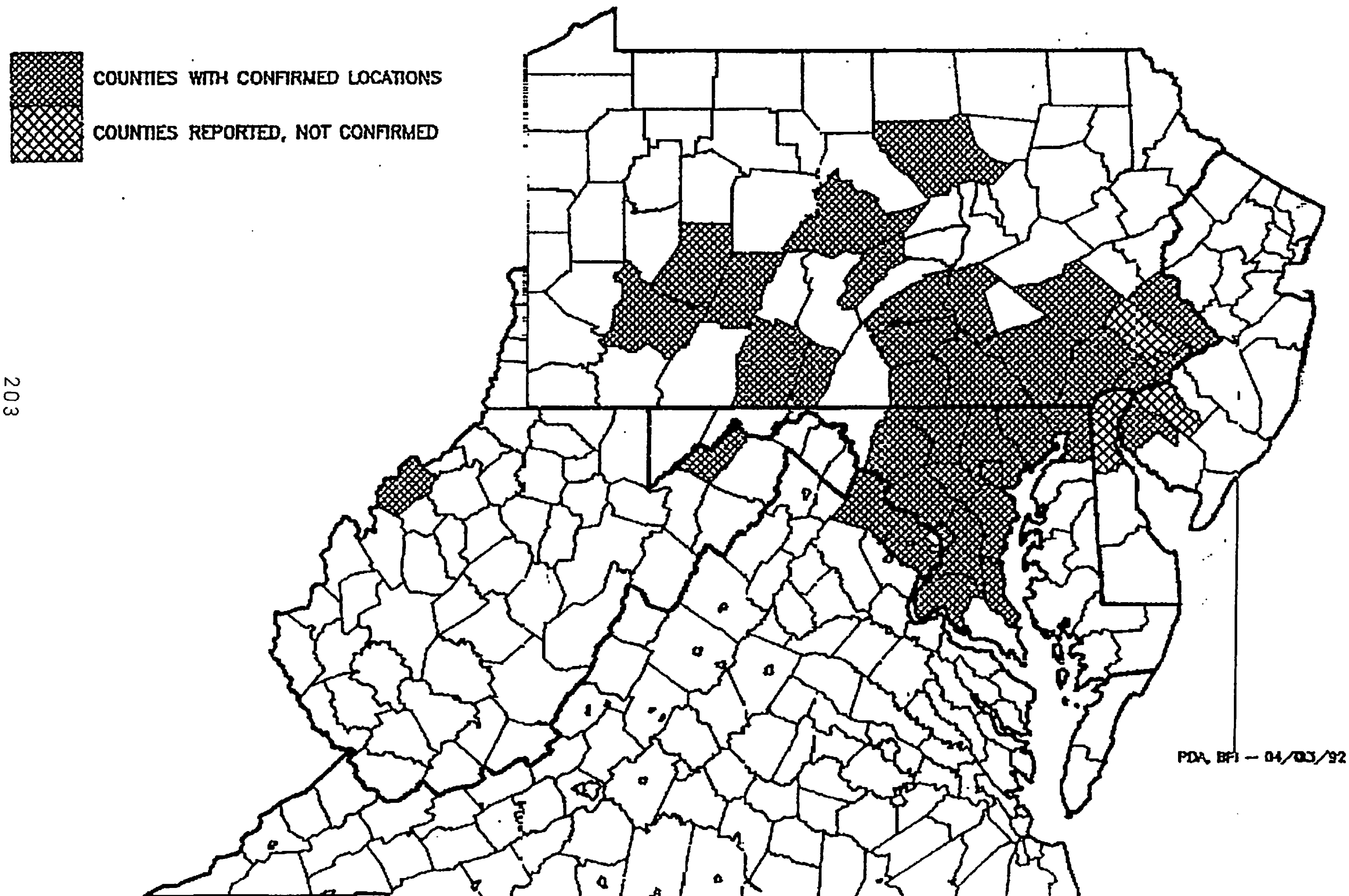


Produced by: USDA Forest Service, Northeastern Area - Forest Health Protection GIS Group

June 1994

TABLE II. MILE-A-MINUTE DISTRIBUTION

PA, MD, WV, DE, VA, DC & NJ

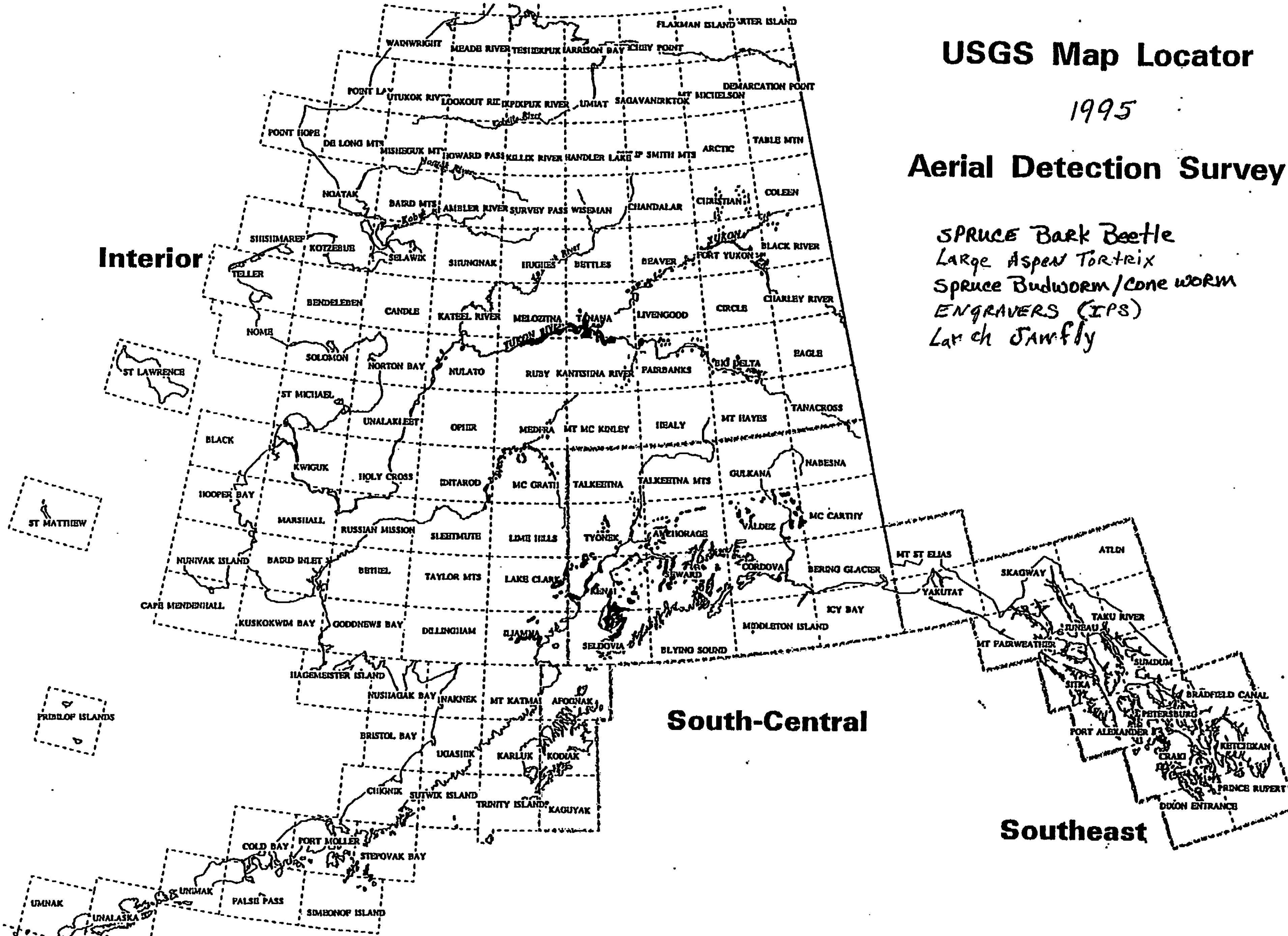


USGS Map Locator

1995

Aerial Detection Survey

SPRUCE Bark Beetle
Large Aspen Tortrix
Spruce Budworm/Cone worm
ENGRAVERS (IPS)
Larch Sawfly



APPENDIX I

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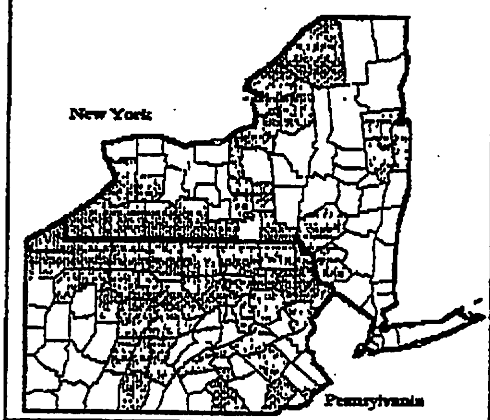
April 19, 1995

Forest Health Highlights

Maple Mortality

Sugar maple mortality occurred during 1995 in portions of southern New York and northern Pennsylvania. The mortality has been linked to a combination of events. Current estimates of sugar maple mortality average 25-30 percent of the trees within portions of the affected area. Some areas sustained as much as 90 percent sugar maple mortality. In Sullivan County, Pennsylvania, more than 30 percent of the maple are dead on at least 35,000 acres, and 10-30 percent of the maples are dead over an additional 45,000 acres. Surveys continue in other counties.

Outbreak area of the native defoliators—forest tent caterpillar, fall cankerworm, elm spanworm, and cherry scallop shell moth–1994.

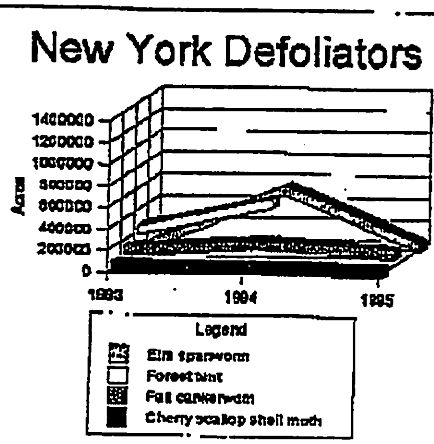


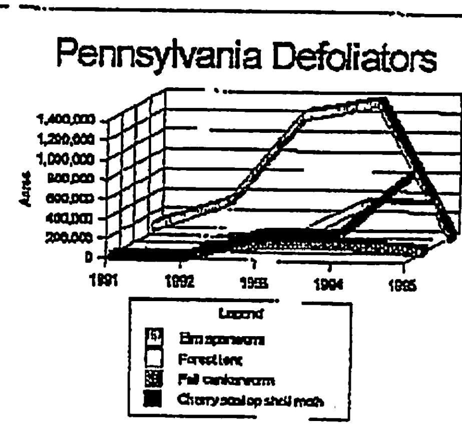
Insects

During the summer of 1994, an infestation of forest tent caterpillars within this region caused nearly 800,000 acres of defoliation affecting several tree species, predominantly sugar maple. Between 1991 and 1994, the elm spanworm, which defoliates sugar maple, as well as, American beech, oaks, and other hardwoods rose to outbreak proportions throughout an estimated 1.8 million acres in Pennsylvania and New York. Also in 1994, the fall cankerworm defoliated 230,000 acres of oak and maple. During the past nine years, the pear thrips damaged sugar maple foliage across hundreds of thousands of acres. Cherry scallop shell moth, a defoliator of black cherry, began to build in numbers during 1991 and in 1994 defoliated a quarter of a million acres.

Disease

Sugar maples will normally refoliate after being severely defoliated. However, in 1994, refoliation did not occur over much of the area due to the presence of a leaf disease. This disease, known as maple anthracnose, affected emerging

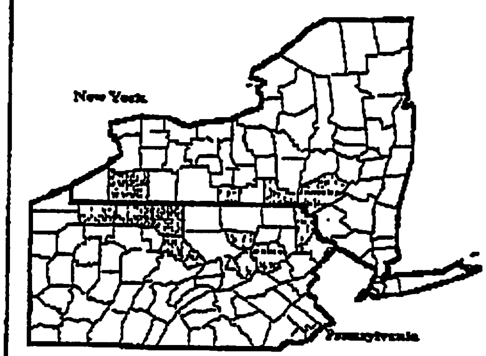




leaves during July and August of 1994. Much of what would have been new foliage for defoliated trees became stunted, twisted, and eventually exhibited grayish black lesions characteristic of the disease. This rendered leaves useless as photosynthetic sources for the trees.

An additional negative consequence of the anthracnose infection was that many of the affected trees did not successfully generate winter-hardy buds. The current thinking is that trees sustaining this defoliation/leaf disease combination became depleted in starch reserves and, consequently, exhibited branch dieback and mortality. In fact, during the 1995 growing season sugar maple mortality was observed over a large portion of northcentral Pennsylvania and southcentral New York.

Areas with significant sugar maple mortality reported as of October 1995.



Drought

During 1991 and 1995, severe drought conditions within the area added significant additional stress. Rainfall throughout northern Pennsylvania and southern New York averaged 3 to 11 inches below normal for April to September 1995. The severity of the 1995 drought has undoubtedly contributed to the amount of maple mortality taking place. Compounding the problem in 1995 is the continued presence of beech bark disease causing mortality to American beech within the northern hardwood forest. Black cherry continued to be defoliated by both cherry scallop shell moth and eastern tent caterpillars in 1995. The total effect is a forest under stress from a variety of sources—insects, diseases, and weather.

Management

During 1994, 56,000 acres were treated with *B.t.* on the Allegheny National Forest and 35,000 acres of State forestland were sprayed by the Pennsylvania Bureau of Forestry to prevent continued defoliation by the elm spanworm. In New York, 4,400 acres were sprayed by the Seneca Nation of Indians. In 1995, an additional 55,000 acres were treated with *B.t.* on the Allegheny National Forest to prevent continued defoliation by the forest tent caterpillar.

At present, salvage removal of dead maple is recommended. While salvage sales seldom recover the full value of a healthy stand, it is a way to limit losses. However, even salvage sales are compromised by the rapid colonization of decay fungi which limits the use of the wood. Though salvage removal of dead or declining maple is possible, salvage operations must be conducted in a manner that minimizes wounding of adjacent trees or damage to otherwise healthy root systems.

Complex Interactions

Insects and diseases are only part of an unfolding ecological story in northern Pennsylvania and southern New York. Maples, both sugar and red, have replaced American beech and hemlock as the major component of these northern hardwood forests. This resulted from extensive logging during the turn of the century, management that favored maple, and the arrival of the beech bark disease. Maples now occupy many sites that they historically did not occupy. Additionally, due to the rapid and extensive logging during the early part of this century the maple forest is relatively even-aged.

Maples are affected by a variety of insects and diseases. Serious outbreaks of forest tent caterpillar were reported within the same area during the early 1970s. Some maple mortality occurred after these outbreaks, as well. Sugar maple declines have been reported in Canada, particularly within the province of Quebec, since the 1930s. No single factor has been associated with sugar maple declines in Canada; though insect defoliation, disease, drought, low soil fertility, open winters, and acid rain have been suggested.

Acid Rain

As in Canada, several factors have been associated with decline of sugar maple in Pennsylvania. Insect outbreaks, disease, drought, and past cutting practices have each played a role in the current decline. Additionally, western Pennsylvania receives high levels of acidic deposition. Soil parent materials underlying portions of western Pennsylvania are low in the essential nutrients—calcium and magnesium. Research scientists at the USDA Northeastern Forest Experiment Station in Warren, PA, and Delaware, OH, and at Pennsylvania State University are trying to unravel how the interacting factors, including soil chemistry, contribute to maple mortality.

It should be noted that as a component of the hardwood forest, sugar maple extends from Wisconsin to Virginia and north throughout eastern Canada. Within this range, sugar maple in parts of Pennsylvania and extreme southern New York are currently under stress from a variety of factors. The North American Maple Project (NAMP) is a maple health monitoring effort conducted by the USDA Forest Service and the Canadian Forest Service. Plots are established by this Project throughout 10 States and 4 Provinces and reflect a maple resource in generally good health. And, mortality is within expected natural ranges (about 0.7 percent/year).

While a very serious problem exists within a portion of the geographical range of sugar maple, other areas not impacted by this variety of stressors still have healthy sugar maples.

For More Information

October 1995

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Forest Health Monitoring in the North

- 678 permanent forest health plots monitored in CT, DE, ME, MD, MA, MI, MN, NH, NJ, PA, RI, VT, WV, and WI
- 233 permanent sugar maple health plots were monitored in the United States (10 States) and Canada (4 Provinces)
- 215,000,000 acres were surveyed for forest health problems

Major Stressors

- insects
- diseases
- droughts, flood, wind, ice
- acid rain and ozone
- whitetail deer

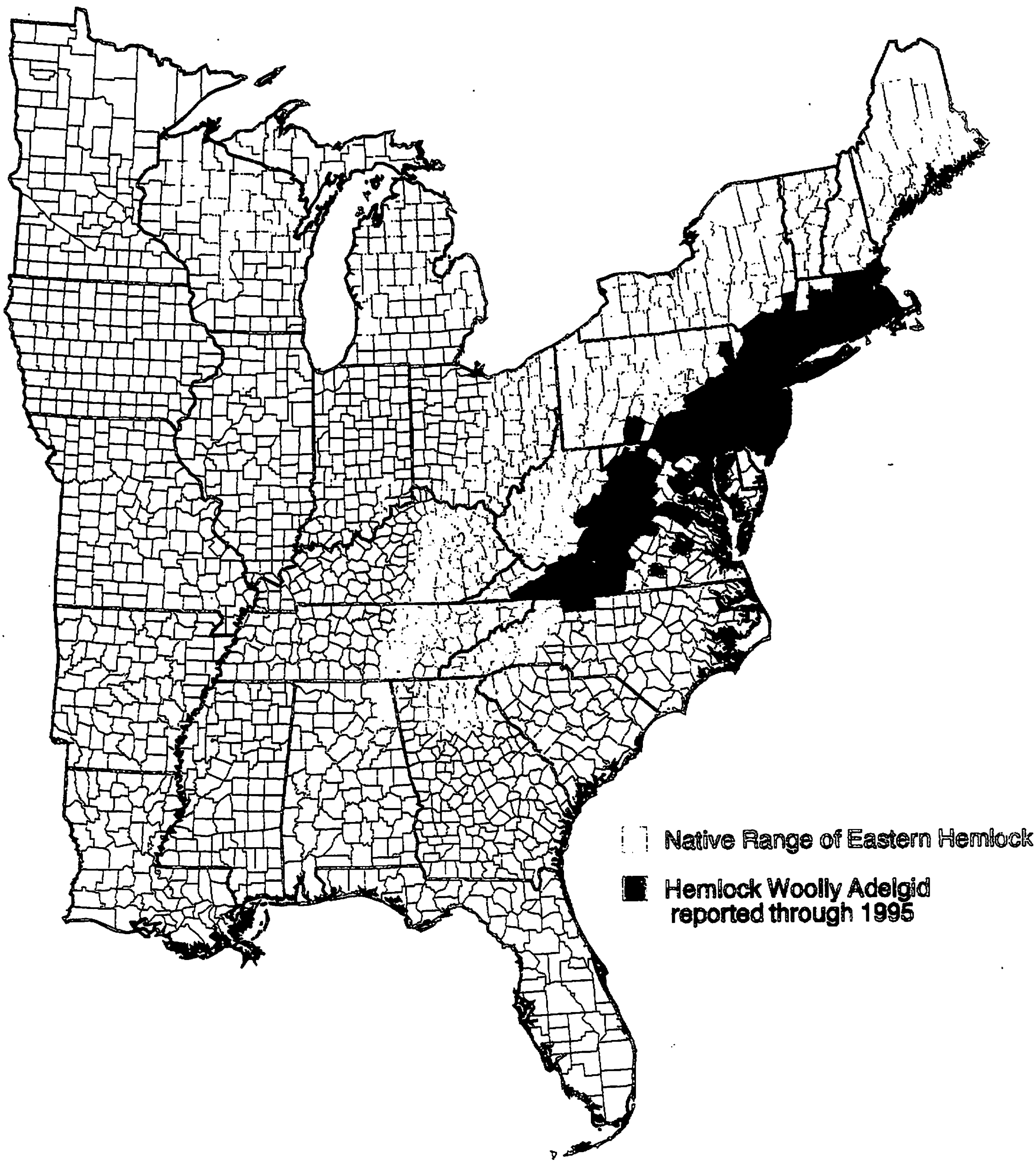
Major Findings

- forests generally healthy
- sugar maple mortality event in PA and NY
- exotic pest problems
  - gypsy moth
  - hemlock woolly adelgid
  - butternut canker
  - dogwood anthracnose

Solutions

- 1,000,000 acres in stewardship in 1994
- 800,000 acres protected from fires in 1994
- 475,000 acres from insects pests in 1995

Hemlock Woolly Adelgid Distribution - 1995



Produced by: USDA Forest Service, Northeastern Area - Forest Health Protection GIS Group

AN OVERVIEW OF RESEARCH ON INSECT PESTS AND TREE DISEASES AT CANADIAN FOREST SERVICE - SAULT STE. MARIE

A report to the 23rd. Annual Pest Control Forum
(Ottawa, Ontario, 21-23 November 1995)

Compiled for Errol Caldwell

Natural Resources Canada
Canadian Forest Service
1219 Queen St. E., P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7

INSECT PESTS

An intensive study of survival and dynamics of natural spruce budworm populations at Black Sturgeon Lake, Ontario, was continued for the 13th consecutive season. Tree mortality is accelerating, yet relative abundance of budworms remains high. Changes in the composition of the natural enemy fauna associated with this outbreak are occurring. A study to develop sampling plans and a model to predict jack pine budworm defoliation was completed. The model is to be incorporated into a decision-support system through integration with a spatial data-set on historical outbreak data.

The second year of a survey comparing natural enemies attacking gypsy moth in established and recently infested portions of its range in Ontario was completed. The parasitoid fauna appears to be poor and dominated by widely-distributed, introduced natural enemies. The pathogen fauna, on the other hand, appears to be relatively rich with introduced fungal pathogens such as *Entomophaga maimaiga* widely distributed as well as several native species of *Paecilomyces* present. Sub-samples will be probed for DNA of nuclear polyhedrosis virus. Releases of the European parasitoid, *Ceranthia samarensis*, were resumed in 1995 with an increase in the rearing stock available for this project.

The long-term goal of research on bacterial pathogens is to provide the scientific basis for commercialization and improved application of new and enhanced *Bacillus thuringiensis* (*B.t.*) products for forest insect control and for the development of improved use strategies. These are obtained by conducting basic research on *B.t.*-forest insect interactions at the molecular, cellular, physiological and ecological level. Current research focuses on factors which determine insecticidal activity of CryI proteins in spruce budworm and gypsy moth by elucidating structural determinants of proteolytic activation and degradation, structural determinants of specificity, i.e. binding and lytic toxin domains, function and identity of potential toxin receptors in midgut epithelium and other potential target tissues, the mechanism of cytolytic activity and the role of midgut conditions and toxin interactions in expression of toxicity. Factors that are limiting the effectiveness and use of *B.t.* in the field are being investigated. These include the role of temperature, residual toxicity, and feeding inhibition in dose acquisition and field efficacy, the role of droplet size, potency, and distribution in dose acquisition, the interaction with budworm parasitoids, and natural variation in susceptibility among spruce budworm populations.

Two experimental aerial spray trials against jack pine budworm were conducted in Sudbury District, Ontario in 1995. Three blocks totalling 250 ha were treated with a single application of Mimic 240LV (Rohm and Haas Canada Inc.) at 70g/2.0L/ha. Another 140 ha was treated with a single application of Dipel 76 AF (Abbott Laboratories) at 30 BIU/1.5L/ha. Both treatments effectively reduced jack pine budworm populations and protected foliage.

In field trials in Manitoba on spruce budworm in 1995, efficacy trials were conducted with the *B.t.* product Dipel AF and a study was conducted with Foray 48B (Novo Nordisk) to determine the influence of course and fine droplets on spray efficacy. The potential for tebufenozide (Mimic) to carry over from one year to the next was assessed. Mimic was also used as the model in a new application strategy using upwind atomizers only; earlier research indicated that most material from downwind atomizers is lost to off-target drift.

Following successful aerial spray trials with nuclear polyhedrosis virus (Disparvirus) and *B.t.* (Foray 48B) on predominantly first instar gypsy moth larvae in Pinery Provincial Park in 1994, a survey was conducted on 15 treated and 5 untreated check plots in 1995. Levels of virus infection, number of pupae in burlap traps, pheromone trap catches and defoliation estimates have been conducted and fall egg mass counts will be undertaken later this year. Defoliation this year was minimal in both treated and untreated plots and other parameters are currently being analyzed. A registration petition for Disparvirus was submitted in 1990 and is still under review. Some minor concerns are not yet resolved, but it is hoped that a registration will be granted in the near future.

Tree growth loss caused by gypsy moth is under investigation. This study examines the effect of gypsy moth defoliation over a 10 year period on the growth of high and low value trees in the Kaladar area. Mortality appears to be limited to low value trees on poor sites classes while both high and low value trees appear to have significantly reduced growth in response to severe defoliation.

In a technology transfer to the Beausoleil First Nation on Christian Island, Ontario, Lecontvirus was used to control redheaded pine sawfly, *Neodiprion lecontei,* in red pine plantations. Some mortality was observed at 2 weeks post-spray and complete mortality at 3 weeks. Larvae from an untreated check area were used to produce more Lecontvirus.

Biotechnology of insects and their viruses includes a team of 5 scientists covering the areas of molecular biology of insect viruses, molecular biology of forest insects, epizootiology, mass production of viruses, insect tissue culture and physiology of insects. The major goal is to develop species specific and environmentally benign recombinant viruses that are effective in controlling insect pests such as the spruce budworm.

Designated areas of the genome of spruce budworm nuclear polyhedrosis virus were characterized and 3 sites, polyhedrin, Egt and p10, were selected for insertion of foreign genes to increase virulence. As a model system, β-gal along with either scorpion toxin or JH-esterase genes were inserted into vectors constructed for each site and introduced into either the polyhedrin or the Egt region. Virus propagation and manipulation were conducted in CF 203 cultured cells. Candidate genes for insertion were selected on the basis of physiological and phenotypic effects caused by an ecdysone analog which upset the natural cascade of molting events. Three genes, ecdysone receptor (Cf EcR), homolog of E75 (CHR2) and the homolog of MHR3 (CHR3) were isolated and characterized. These genes are at various stages of being inserted into either polyhedrin or Egt sites along with a β-gal marker, in the sense and antisense orientations, to overexpress or block the expression of a particular gene. All these gene products are localized in the nucleus, are active without processing and are essential for molting. Therefore, when the recombinant virus replicates in the nucleus, the gene products should be expressed and will not be subject to extra cellular detoxification. Quantitative, qualitative or temporal changes in the expression of these genes should adversely affect the molting cycle. Methods to scale up the production of the virus in spruce budworm larvae in a pilot plant are being developed. Antibodies are being developed for detection assays such as western blots.

Field trials were conducted to evaluate the efficacy of a Phero Tech neem extract on introduced pine sawfly, yellowheaded spruce sawfly, pine false webworm and white pine weevil In the laboratory, the toxicological properties of azadirachtin (Phero Tech neem formulation) were investigated on spruce budworm, introduced pine sawfly and white pine weevil. The toxicological properties of imidacloprid and its systemic action were evaluated on white pine weevil. Toxicological properties of promising natural products, spinosad, *Piper* extracts, synthesized *Piper* compounds, Stopfeed and toosendanin were investigated on spruce budworm and gypsy moth.

Natural products are being studied to determine their importance in plant-insect interactions and plant-fungal interactions with the long-term goal of developing novel insecticides or instituting strategies for breeding resistant trees. Studies are ongoing to investigate the resistance of red maple to defoliation by forest tent caterpillars and to develop possible deterrent or toxic chemicals from red maple, and stimulants from sugar maple. The mechanism whereby certain species of pine trees suffer reduced defoliation or no defoliation by forest insect pests is also under investigation. Isolation and identification of natural phytotoxins from the fungus *Colletotricum dematium* is being studied with a view to providing alternative methods for control forest insect pests and competing vegetation.

Research continues on pine false webworm, *Acantholyda erythrocephala*, which is now found attacking mature red pine as well as trees in plantations. Its population dynamics and complex of natural enemies is being studied. The use of *Trichogramma minutum* as a control agent for eggs of this species is being investigated. Field trials were conducted using a range of dosages of neem applied using a variety of methods such as systemic injection and simulated aerial spray application.

In wind tunnel bioassays, mating behaviour of the jack pine budworm was disrupted by synthetic chemical components of the female sex pheromone. Single components were less effective than the complete blend, but still gave good disruption. Field trials were therefore carried out using the cheapest, readily available component formulated in Hercon strips and a 3-M sprayable bead formulation. The Hercon strips were applied in immature jack pine stands and caused a 100% shutdown of catches of male moths in traps baited with virgin female moths. Egg densities were too low in the young jack pine stands to show any differences. The sprayable formulation was less effective, probably because of problems in applying a sprayable formulation onto trees from the ground. Aerial spray trials are proposed for 1996.

A pheromone-based monitoring system for gyspy moth has been developed by investigating appropriate lure dosages and trap designs and by correlating trap catch with egg mass counts and/or larval counts under burlap bands over a large number of sites across Ontario. Work is continuing on identification of sex pheromones of *Dioryctria* species and a complex of three *Eucosma* species that attack pines in seed orchards and plantations. Oviposition studies have focused on chemical and physical stimuli associated with host foliage that encourage and deter oviposition in four species of *Choristoneura*. Efforts are currently underway to identify naturally occurring deterrent compounds. Phytochemicals controlling oviposition of the fir coneworm, *Dioryctria abietivorella*, have been chemically identified using behavioral and electrophysiological assays.

Data from the spruce budworm pheromone trapping network has been analysed using geostatistical and geographic information system (GIS) techniques. Significant progress has been made in the development of an inexpensive, user-friendly software package to interpellate forest insect survey data collected at geographic points into maps with complete spatial coverage. These resultant contour maps can then be used as thematic layers in a GIS. Maps of male moth captures have been combined with defoliation maps using logistic regression techniques to construct a predictive model for budworm defoliation. These techniques have broad applications for analysing spatial patterns in forest insect pests and predicting future population trends.

Studies on the development of a pheromone-based pest management system for cone beetles (*Conophthorus* spp.) consisted of an operational trial to trap out beetles, experimental testing of a mating deterrent for both sexes, the effects of trap colour on trap catch, and testing of the spatial distribution of pheromone-baited traps. Studies were continued to develop visual traps for cone maggots (*Strobilomyia* spp). Studies were also continued on the insect complex and within-crown distribution and abundance of insects in spruce (*Picea* spp).

Trichogramma spp. have been shown to be useful for controlling insect pests of silvicultural importance. However, for successful use on an operational scale it is necessary to have suitable dispersal equipment. In forestry, where treatment areas may be remote and inaccessible, this means an aerial dispersal system. The requirements for such a system include maintaining parasitoid viability, providing for foliar adhesion of parasitoid eggs to reduce ground predation, and providing adequate swath width and hopper capacity. A system for fixed-wing aircraft that satisfies these requirements is being developed and field tested. Theoretically, up to 100 ha can be treated per sortie, using a 20 m swath width. The secondary effect of *Trichogramma* on other budworm parasites, particularly Tachinids, is being investigated. When spruce budworm egg numbers are reduced, larval parasites tend to have a greater impact.

Insect injuries can often elicit physiological changes in plants that may increase within- and between-plant variation in nutritional and defensive chemistry. This change can affect herbivore performance. The effects of current defoliation of different tree species on gypsy moth growth and development in Ontario are being addressed. Results indicate that 50% defoliation of trembling aspen and white birch significantly reduce female pupal weight after one season of feeding; there was no effect on male pupal weight. Defoliated red oak produce significantly heavier female pupal than non-defoliated trees. Whether or not the results on red oak are a one-time inconsistency or actually reveal something unique about the relationship between gypsy moth and oak remains to be seen. The possibility of a gypsy moth larval pheromone is also being investigated. So far, two extracts of tissue have proven to be significantly attractive on more than one occasion. However, these results cannot be repeated consistently.

Environmental impact studies have included the effects of neem, Mimic and *B.t.* insecticides on aquatic invertebrates in laboratory and controlled field experiments, the development of methods to assess the fate and environmental effects of genetically-engineered viral insecticides for the spruce budworm and a study of the effects of Lepidoptera-specific insecticides on non-target insects and forest songbirds.

Plausible scenarios are being developed using theory and models as to how forest insects may respond to climate change. The influence of landscape features on spruce budworm is being modelled on historical spruce budworm population data as a key component of the spruce budworm decision support system. A process oriented model is being developed for conifer biomass production that links canopy dynamics with a foliage/biomass production model and thus permits a description of photosynthate allocation among stem wood, branch wood, roots and foliage under different defoliation scenarios.

TREE DISEASES

The forest ecosystem classification (FEC) for Ontario can be related to the development and progression of Armillaria root decay. Certain FEC groups have a profound influence on the spread and infection rate.

Work has continued on the microorganisms infecting newly formed wounds in partial cuts. There is a selective influence by the time of year as to what types of organisms will colonize the wounds. Various site preparation methods and their effects on Armillaria root decay have been investigated. A 3-year study on the influences of site preparations on microbial biodiversity is being completed. Certain experimental site preparation techniques can have substantial implications on the populations of what are perceived to be beneficial microbes.

A formulation and inoculation method has been developed for the treatment of aspen stumps with fungi, including *C. purpureum*. One field trial was done last year and it has been repeated this year. *C. purpureum* and another decay fungus are capable of inhibiting resprouting. The physiological state of the plant has a lot to do with the efficacy of the treatments.

A study was initiated using a novel nonsporulating strain of the Dutch elm disease pathogen, *Ophiostoma ulmi*, as a model fungus to investigate, at the molecular level, the mechanism(s) that block the sporulation process. This technology will be employed for the development of biological methods for use as control agents that have the potential to reduce or eliminate the spread of forest pathogens by blocking the sporulation process. The blockage in sporulation has been linked to a single nuclear gene. Molecular karyotyping is being conducted and sporulating and nonsporulating strains are being compared for differences at the messenger RNA level, whereby protein products and cDNA are being examined.

Methods are being developed to assess forest decline in sugar maple and other hardwood species. The host ranges of *Gremmeniella abietina* (scleroderris canker) and *Sphaeropsis sapinea* (Diplodia tip blight) are being studied. The economic impact of forest insects and diseases on young stands is currently being investigated.

SPATIAL ANALYSIS OF SPRUCE BUDWORM PHEROMONE TRAP DATA

D. B. Lyons[1], C. J. Sanders[1], A. M. Liebhold[2], B. G. Pierce[1], P. S. Robertson[1]

[A report prepared for the 23rd Annual Forest Pest Control Forum
21-23 November 1995, Ottawa, Ontario][3]

Abstract

Each year since 1986 pheromone-baited traps are distributed throughout the range of the spruce budworm in North America, by cooperating agencies, and the number of male moths captured is determined. However, these point data cannot be used to analyze spatial patterns in a geographic information system (GIS). A series of software tools, that convert the point data into contour maps for GIS use, have been developed and incorporated into a user-friendly graphic user interface (GUI). Opening the database module from the GUI allows the user to add, edit or delete trap catch and related data. In the geostatistical module, for a subset of the data (i.e., by year and region), the spatial relationship between point data is described using a variogram model and data between points is interpolated using a technique known as kriging. IDRISI®, an inexpensive, fully-functional, raster-based GIS is used to display, manipulate and analyze the kriged output data. The resulting maps have contour intervals showing estimated areas of equal moth densities or 'isomoths'. CorelDRAW!, the vector-based structured drawing program, is used to prepare high quality maps for reporting trap catch results.

As the first step in developing a logistic regression model for predicting spruce budworm defoliation, individual annual defoliation maps (1977-1993) provided by the Forest Insect and Disease Survey Unit were summed in the GIS to produce a probability map showing proportion of years defoliated. The frequency of defoliation map was combined with individual defoliation maps and interpolated pheromone maps (1986-1993) to create a logistic regression model. To predict defoliation for a given year, the logistic regression model was solved using the previous years defoliation map and the previous years pheromone catch as input variables. The resulting map depicts the probability of defoliation for Ontario.

Introduction

To adequately manage forests susceptible to the spruce budworm, , *Choristoneura fumiferana* (Clemens), techniques for monitoring the population dynamics of the insect must be

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implemented. Conventional techniques for monitoring densities (Branch sampling including washing for L_2) are expensive and labour intensive. Moreover extremely large numbers of samples are required for acceptable estimates at low population densities. Aerial surveys provide useful data for spatial analysis, but only defoliation greater than about 30% is detectable from the air and aircraft time is expensive.

The discovery, elucidation and synthesis of a sex pheromone for the spruce budworm provided another potential monitoring tool. When used as a bait in a trap, the pheromone attracts large numbers of male moths. The distribution of traps in suitable habitats requires minimal effort. Inexperienced personnel can be quickly trained in trap setup and deployment.

The trap-catch data have several potential uses. The major application will probably be to detect increasing densities of endemic populations to trigger more intensive sampling by conventional methods. The value of the traps for this purpose has been demonstrated in Quebec (Boulet 1992). We describe here the development of techniques for converting the trap-catch data into a format suitable for analysis in a GIS, and their application for refining the predictions of defoliation in the following year. Application for assessing changes in low density populations have been described elsewhere and are still under development.

Pheromone traps sample moths at individual points in two-dimensional space. Geostatistics have shown considerable promise for interpolating point sample data for other entomological systems into contour maps (Liebhold 1993). After transforming the data into coverage themes for a GIS, we are exploring the use of these contour maps as variables in predictive models. The specific objectives of this report are to briefly discuss the pheromone trapping network, describe a series of software tools that we have designed to convert point data from pheromone traps to contour maps for use in a GIS, and to report on the use of these contour maps in a logistic regression model to predict future defoliation by the spruce budworm in Ontario.

Pheromone Trapping Network

The spruce budworm pheromone trapping network had its origins at the conclusion of the CANUSA spruce budworm project. The traps are placed in the field using standard sampling protocols so that data will be comparable from region to region. The recommended protocol is a triangular cluster of three pheromone traps at each location, with a distance of 40 m between traps. Traps are non-saturating Multi-Pher® traps with Biolures® (Consep Membrane Inc., Bend, OR) pheromone lures. Individual traps are placed 2 m above the ground at a distance of 0.5 m from live foliage. Traps are left in the field from pupation of the larvae until the end of the adult flight. The location of traps are recorded in Universal Transverse Mercator (UTM) coordinates to the nearest 10 km by 10 km square. Traps are deployed by federal (e.g., Canadian Forest Service Forest Insect and Disease Survey; USDA Forest Service State and & Private Forestry), provincial (e.g., Nova Scotia Ministy of Natural Resources, New Brunswick Department of Natural Resources and Energy, PQ Ministère de l'Énergie et des Ressources) and state (Maine, New York, Vermont, New Hampshire, Minnesota, Michigan) government agencies as well as private industry (e.g., J.D. Irving Ltd., International Paper Co.). Individual jurisdictions have utilized the trap-catch data for their own purposes, but in addition the data are sent to a coordinator for analysis on a continent-wide basis.

Software Tools

After ten years of gathering catch statistics for spruce budworm pheromone traps, there is now a sufficient data set to analyze temporal and spatial patterns in male moth densities and relate these to other population parameters for spruce budworm. To this end, we required a technique for converting the point sample data (Fig. 1) into contour maps to be used as thematic layers in a GIS. We wanted a system that was inexpensive, user friendly and would operate on a personal computer platform running MS-DOS® and Windows® 3.x. We have designed a set of software tools to perform this conversion that meets these criteria.

What we have developed is a combination of commercial software, public domain software and software we developed in-house all of which operate under a shell or graphic user interface (GUI) written in Visual Basic® (Microsoft Corp., Redmond, WA). Commercial software accessed by the GUI include a database (Access®, Microsoft Corp.), a projection conversion utility (The Geographic Calculator®, Blue Marble Geographics, Gardiner, ME), a GIS (IDRISI®, Graduate School of Geography, Clark University, Worcester, MA) and a structured drawing program (CorelDRAW!, Corel, Ottawa, Ontario). Geostatistical functions are performed by four Fortran programs from GSLIB (Stanford Center for Reservoir Forecasting, School of Earth Science, Stanford University, Stanford, CA), a public domain library of geostatistical software tools. These programs are available with source code and were compiled as Windows executables using Microsoft Fortran Power Sation®. File formatting, data conversion and other housekeeping functions are done using the C++ programming language.

After opening the GUI (Fig. 2), the user has the option of selecting from four small buttons or six large buttons. The small buttons allow the user to open the 'Help' utility, 'Configure' the system, 'Minimize' the program to an icon or 'Exit' the program. The help utility is the user manual for the system in hypertext format. The large buttons provide access to a file format conversion utility, the projection conversion utility, the GIS and the drawing program. The most important buttons, however, are the 'Database' and 'Kriging' buttons. The former allows the user to edit, update and enter pheromone trap data and associated data and the latter opens the geostatistical module where the interpolation process takes place.

After pressing the Kriging button, the user selects a working directory in which to save the output files and then selects a region and a year from which to make a map. The regions for which individual maps can be made include Ontario, Quebec, Maritimes, Newfoundland, North East or New Brunswick. The system then extracts the appropriate data from the database into a point data file. File format conversions for processing are automatically undertaken by the system. An IDRISI point vector file is also created at this time, so that the samples points can be overlaid on the resulting map. The system then opens The Geographic Calculator and converts the coordinate data into an equidistant azimuthal projection. This projection, unlike geodetic and UTM projections, conserves true distance between points over large areas. The data then processed by the four GSLIB programs. The z-values (i.e., the number of male moths) are first transformed into normal scores by NSCORE. Lag or distance

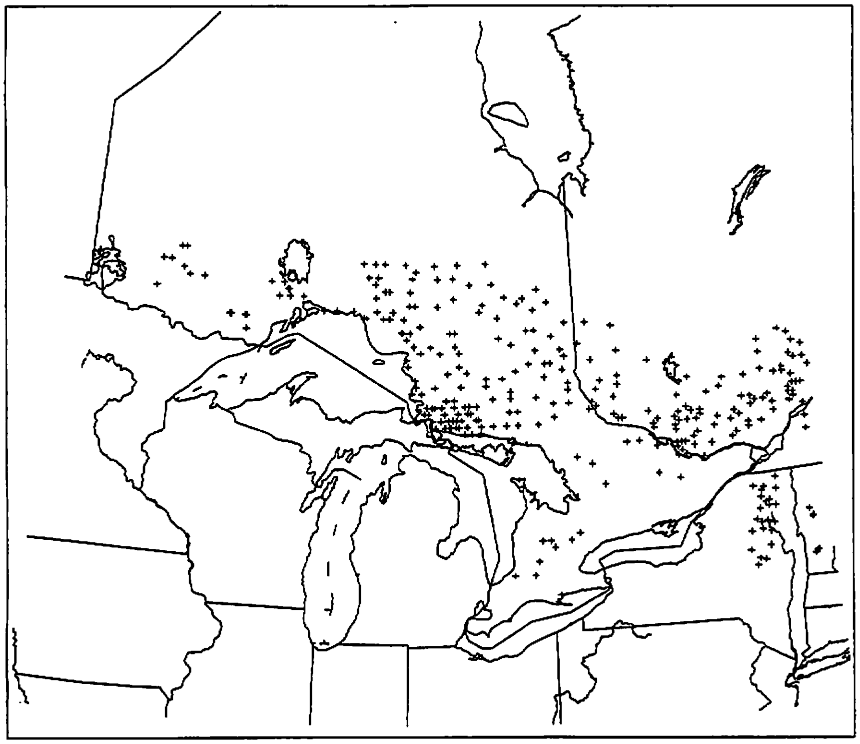

Fig. 1. Vector map of Ontario showing spruce budworm pheromone trap locations as point data for 1993.

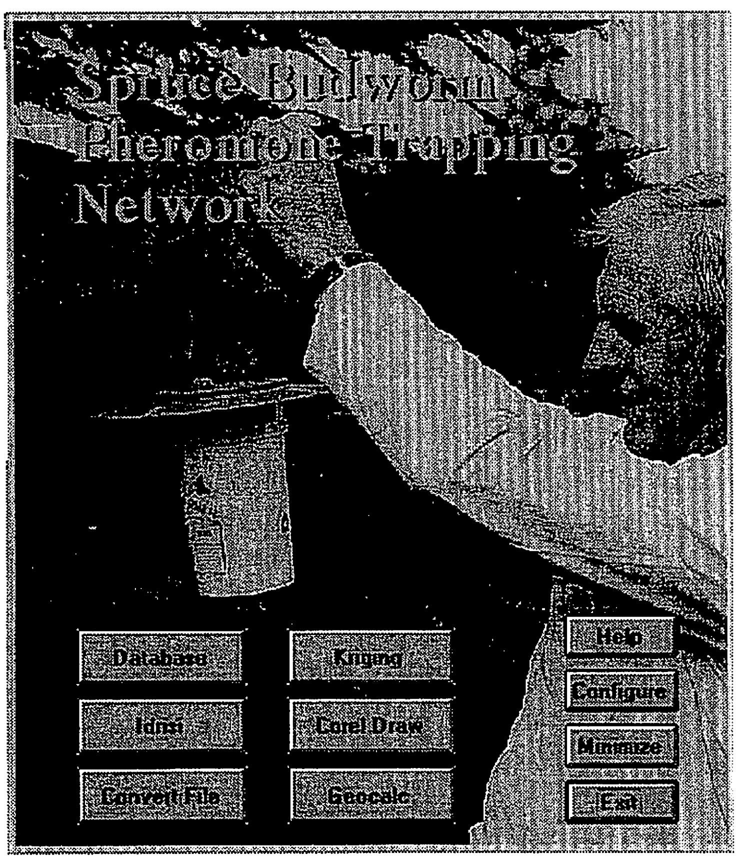

Fig. 2. Graphic user interface (GUI) for the data management system for spruce budworm pheromone trapping network.

classes for a varigram are created by GAMV2. Pairs of points are put into lag classes based on the distances between the points. OKB2D performs the two-dimension ordinary block kriging or interpolation and BACKTR does a backtransformation of the z-values. The ouput from GAMV2 is displayed in a graph (Fig. 3) and the user is prompted to select parameter values to fit a variogram model to the observed lag classes. A variogram is an autocorrelation function that relates semivariance to distance. As pairs of points become further apart in space they should be less correlated. Kriging is comparable to obtaining a weighted average estimate for a raster based on the observed value of nearby rasters (i.e. within the specified search radius). The variogram model determines how much weight is given to each raster used in the kriged estimate based on its distance from the raster being estimated. For a spherical model, which is the most commonly used model, the user selects the sill (the value on the abscissa where the distribution reaches the plateau), the nugget (the intersection with the abscissa axis) and the range (the ordinate axis value where the distribution reaches the plateau). A plot button displays the selected function on the graph and the user can modify the parameter values until the best fit, by visual inspection, is obtained. These parameter values for the model are then used for kriging the data. The user must also select a search radius to be used for kriging. The kriging output is then converted to an IDRISI image file and IDRISI is used to reclassify the continuous z-values into categorical z-values. We used seven classes (1-10, 11-30, 31-100, 101-300, 301-1000, 1001-3000, and >3000 male moths) to display densities of spruce budworm moths.

The output map can be displayed and manipulated in IDRISI® (Fig. 4) or exported to the drawing program for annotation and production of a publication quality map (Fig. 5). The continuous variable maps produced by the kriging process can also be used as variables in predictive models such as the one described below for predicting the probability of defoliation in Ontario. The maps can also be used to investigate spatial and temporal patterns in budworm population studies. The described system can also be used, with minor modification, to produce interpolated maps from any type of insect point sampling data.

Model Development

Year to year variation in lure potency meant that the pheromone trap catch in a given year had to be corrected to a standard year before comparisons could be made. The 1992 pheromone data was selected as the standard and was therefore not corrected. To overcome this problem large quantities of pheromone have been stockpiled so that the baits should be fairly comparable from year to year. In 1990, 1991, 1993, 1994, 1995, lures were compared directly with the 1992 lure by placing both lures in the field together and comparing trap catches using regression analysis to construct correction functions. For the years 1986 to 1989, direct comparisons were not possible, so comparisons were based on second instar larval densities between the given year and 1992. The pheromone trap catch as a function of larval density in 1992 was used to estimate pheromone trap catch from larval densities in a given year. Similar regressions could then be constructed to correct the pheromone trap catch for these years. The correction function has the form:

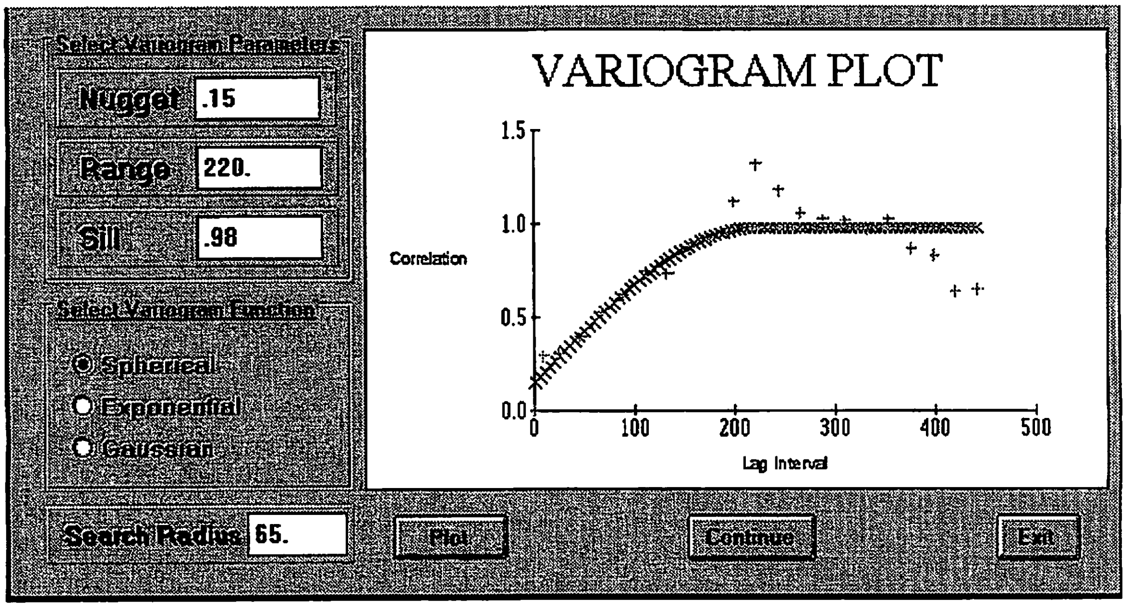

Fig. 3. Variogram model window in the geostatistical module of the data management system for the spruce budworm pheromone trapping network .

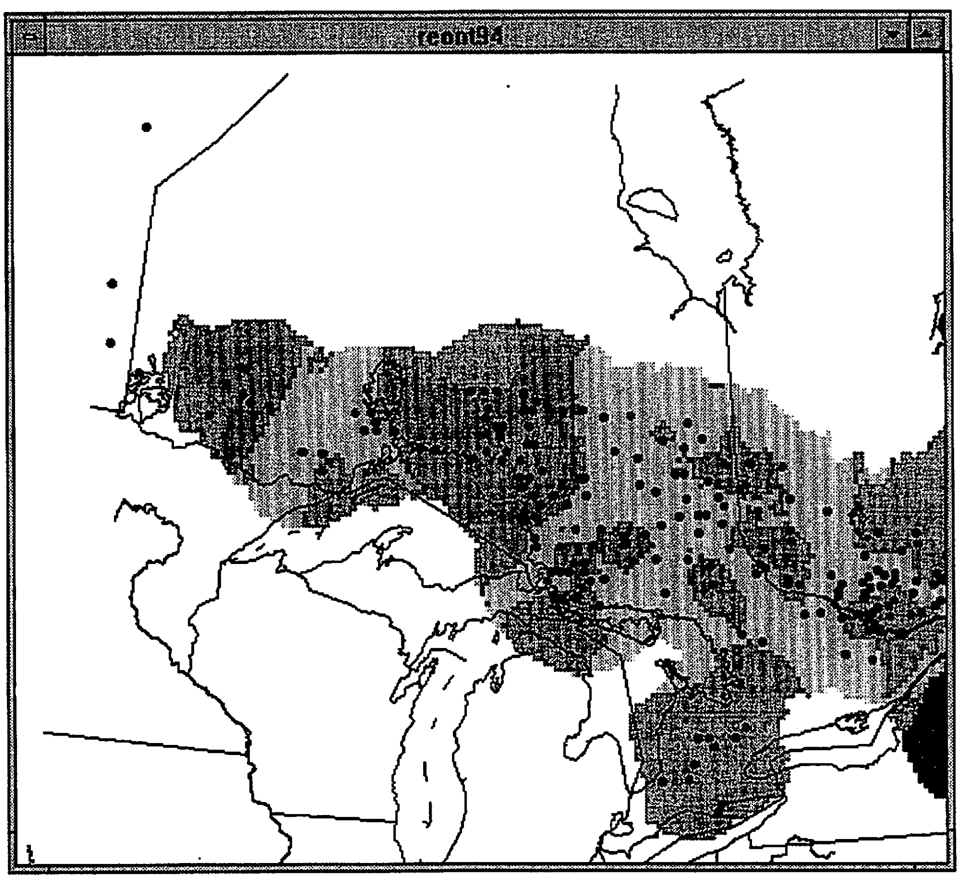

Fig. 4. Kriged pheromone trap data for the spruce budworm in Ontario in 1993 displayed as a contour map in IDRISI.

$$\log(cc+1) = x + y \log(uc+1)$$

where uc is the uncorrected trap catch and cc is the corrected trap catch. x and y are estimated parameters from the linear regression analysis. These corrections were applied to the kriged estimates prior to model construction.

Table 1: Parameter values for the correction function (eq. 2) to correct for year to year variation in pheromone lure potency.

Year	x	y
1986	1.317	0.785
1987	1.494	0.743
1988	2.192	0.574
1989	1.628	0.634
1990	1.516	0.740
1991	0.817	0.764
1992	-	-
1993	0.019	1.022

A map was created that could be used to eliminate areas from the contour maps of pheromone trap catch that were beyond the boundaries of Ontario. To create this map, a vector map which included the extents of the province was extracted from the Central Intelligence Agency (CIA) world map which is available as a public domain file via file transfer protocol (FTP) from various Internet sources. All vectors were deleted from the file, except the provincial borders and water boundaries of Ontario. The map, in geodetic coordinates (i.e., latitude/longitude), was converted to the same equidistant azimuthal projection as the pheromone trap catch maps using GeoCalc®. The vector polygon file for Ontario was then used to create a raster map (Fig. 6), using the POLYGON to RASTER function in IDRISI®, with the same extents and resolution as the pheromone trap catch maps. The rasterized map of Ontario had values of 1 within the landmass boundaries and values of 0 outside of this area.

The kriging process, used in estimating pheromone trap catch values for each raster, not only interpolates raster values amongst sample points within the search radius specified (i.e., 150 km), but also extrapolates values for rasters beyond the shell of data points. If enough points are available near a raster, values are estimated for rasters up to 150 km beyond the nearest sample point. To minimize this effect, we wanted to create a map for each year to mask out estimates that were more than 50 km beyond the nearest sample point. To this end, we

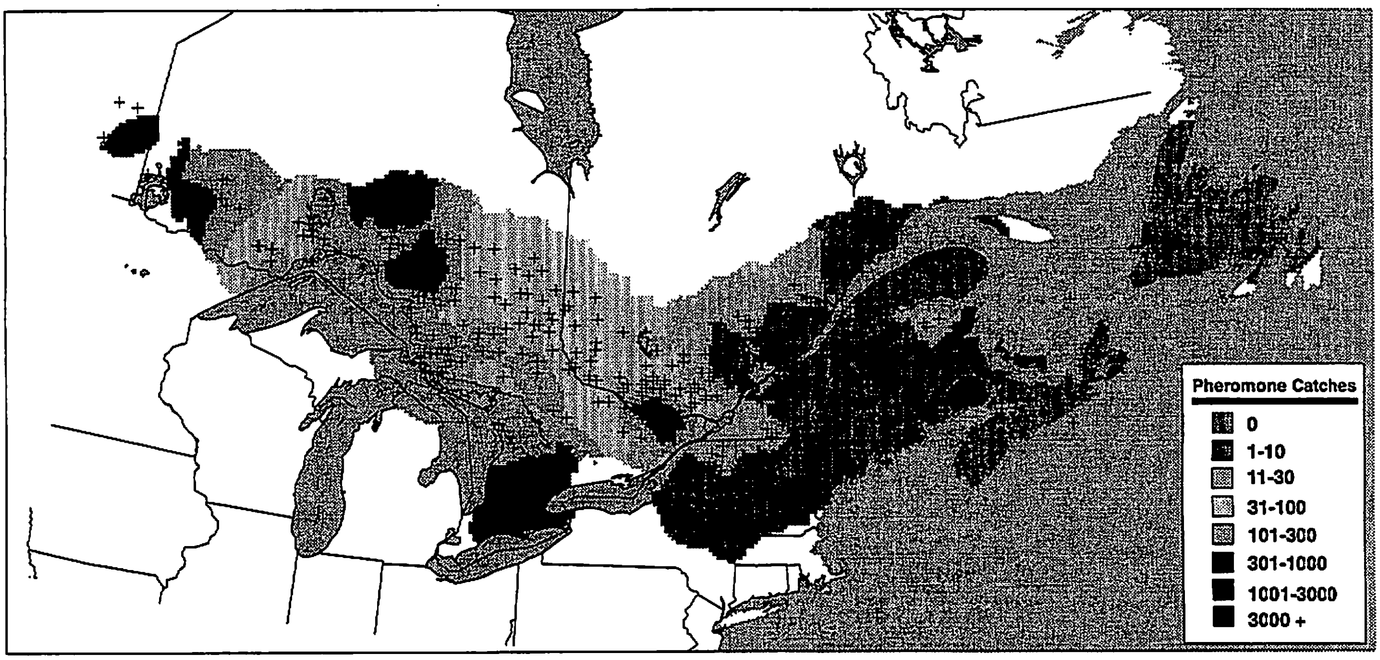

Fig. 5. The 1993 pheromone trap contour map annotated and enhanced using the structured drawing program, CorelDRAW!.

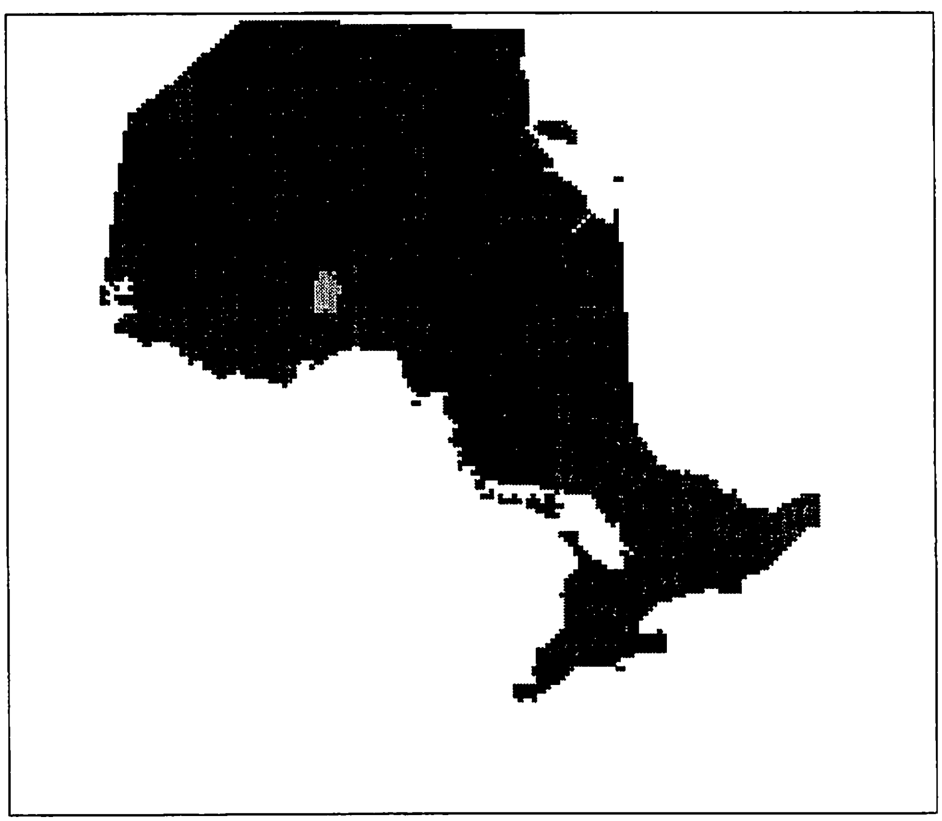

Fig. 6. Rasterized map of Ontario used to exclude values outside of the area of interest in the logistic regression analysis.

converted the annual vector files of sample points to raster maps in IDRISI® and used its DISTANCE function to create new raster maps, for each sample year, with concentric circles of rasters around the individual rasters. The attribute values of these resultant rasters are the distances from the sample point rasters. Raster values greater than 50 km were classified to 0 and rasters values less than or equal to 50 km were classified to 1 using the RECLASS function in IDRISI® to create new maps. An example of one of these maps is shown in Figure 7.

Individual defoliation maps for Ontario, for the years 1977 to 1993, were obtained from the Forest Insect and Disease Survey Unit, Canadian Forest Service - Sault Ste. Marie. The maps had been digitized from hand drawn defoliation polygons using ArcInfo® (Environmental Systems Research Institute, Inc., Redlands, CA). The projection attributes were as follows: 1st parallel, 443,000; 2nd parallel, 533,000; central meridian, -850,000; latitude of origin, 0; false easting 930,000; and false northing 6,430,000. The maps were exported from ArcInfo® and converted to an equidistant azimuthal projection with the following attributes: false northing 48.10 false easting, -84.17; latitude of true scale 48 6 0.000 N; longitude of central meridian 84 10 12.0000 W. These vector maps were then rasterized using IDRISI® into a map with 176 by 166 rasters. The resolution of the defoliation maps (e.g., Fig. 8) was 10 km by 10 km to be compatible with the interpolated pheromone maps. To obtain a frequency of defoliation map (Fig. 9), the 17 defoliation maps for individual years were summed in the GIS. Thus, each raster had a potential value of 0-17. The maximum observed value for an individual raster was 14.

A logistic regression model was constructed, using PROC LOGISTIC (SAS 1985), to predict the probability of defoliation ($p_{(t+1)}$) in the next year (t+1) from the defoliation (def_t) and pheromone trap catch ($phero_t$) in the current year (t) (e.g., Fig. 10) and the frequency of defoliation (deffreq) in the previous years using the following:

$$\mathrm{logit}(p_{(t+1)}) = A + B\log(phero_t+1) + C\log(deffreq+1) + D\,def_t$$

where:

$$p_{(t+1)} = \frac{e^{\mathrm{logit}(p_{(t+1)})}}{1+e^{\mathrm{logit}(p_{(t+1)})}} \qquad (3)$$

and A, B, C and D are estimated parameters. Image files, formatted for IDRISI®, of individual current-year's defoliation (1986-1993), individual current-year's pheromone trap catch (1986 to 1992) and combined frequency of defoliation (1986 to 1992) were used as independent variables in the logistic regression model. Individual maps of next-year's defoliation (1987 to 1993) were input as the dependent variable. Rasters with values of zero in the Ontario image file and the 50 km-distance image files were treated as missing values in the SAS routine. A concordance value for the model of 96% was obtained for the parameter values A=-17.1594, B=3.1102, C=7.2256 and D=2.5871.

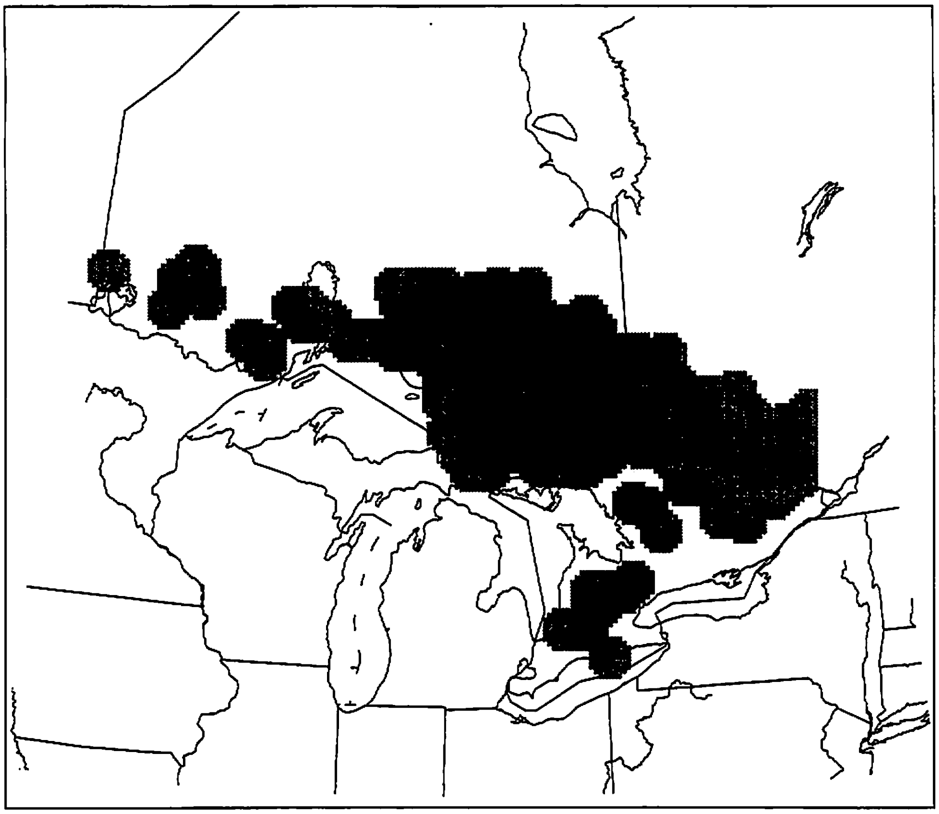

Fig. 7. A map created using the DISTANCE function in IDRISI to eliminate estimates more than 50 km from sample points.

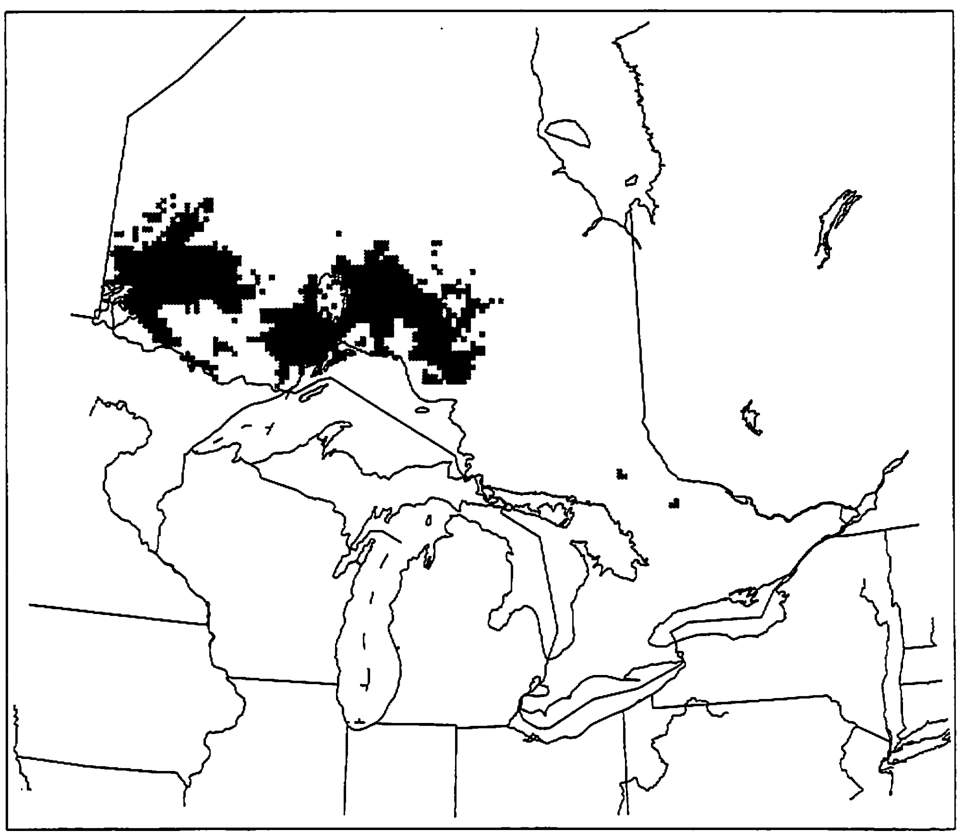

Fig. 8. A rasterized map of spruce budworm defoliation in Ontario in 1993.

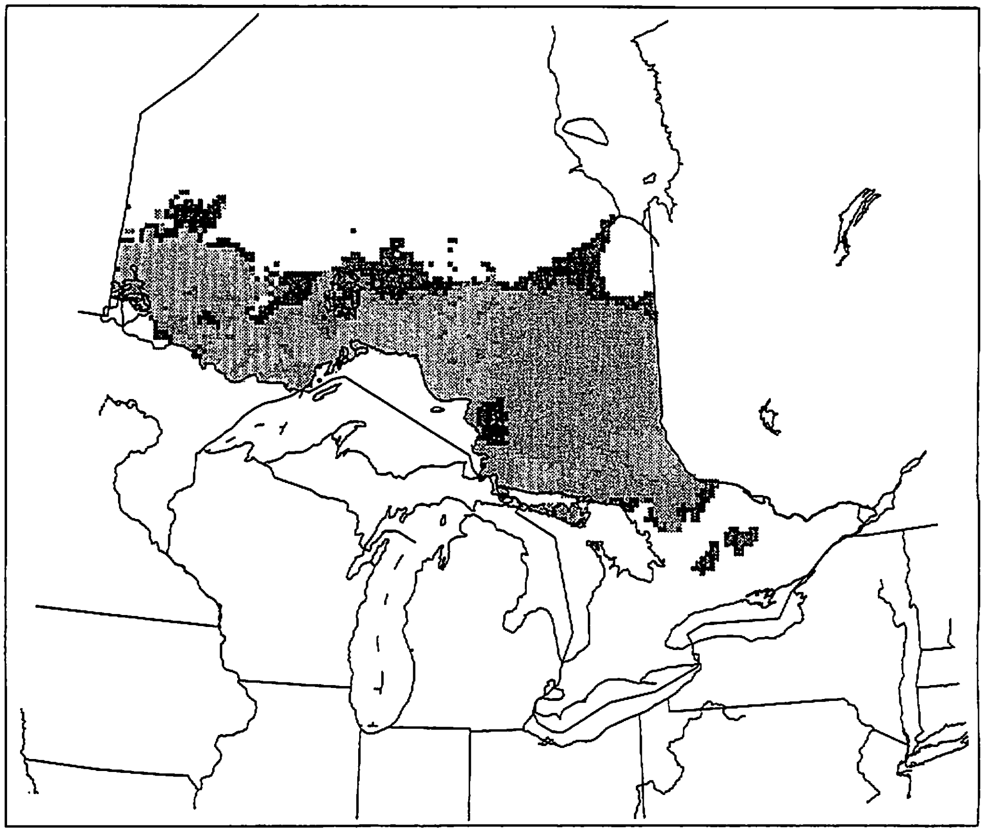

Fig. 9. A map showing the frequency of defoliation for each raster of Ontario between 1977-1993.

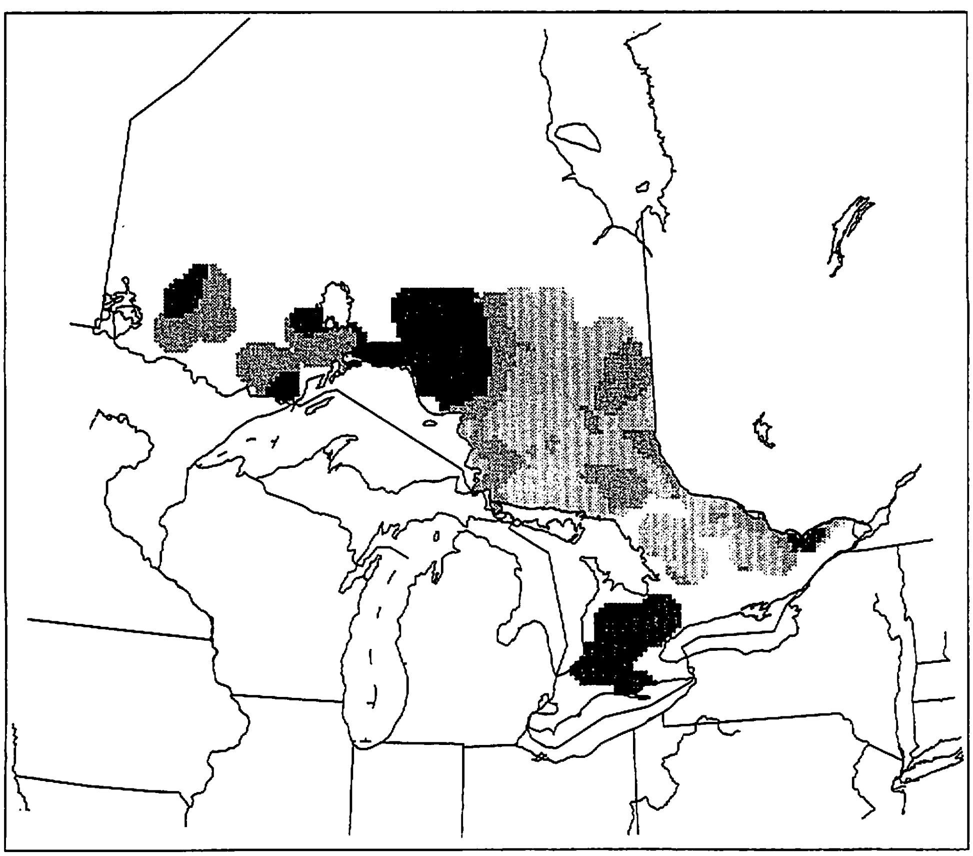

Fig. 10. The pheromone trap catch contour map for 1993 after the Ontario and 50 km mask maps were used to eliminate excess extrapolated areas.

Model Prediction

To construct a probability of defoliation (p_{94}) map for 1994, the defoliation map for 1993 (def_{93}) and the interpolated map of pheromone trap catches for 1993 ($phero_{93}$) were used to solve the logistic regression equation. The result is a map with a probability estimate for each raster within the area of interest. The RECLASS function of IDRISI was then used to create a map of probability contours with intervals of 20% (Fig. 11). The next step in the process will be to compare the probability map with a map of observed defoliation for 1994. Probability levels will be compared with actual defoliation to determine what value will be most useful for prediction.

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Liebhold, A. M., R. E. Rossi, W. P. Kemp. 1993. Geostatistics and geographic information systems in applied insect ecology. Annu. Rev. Entomol. 38: 303-327.

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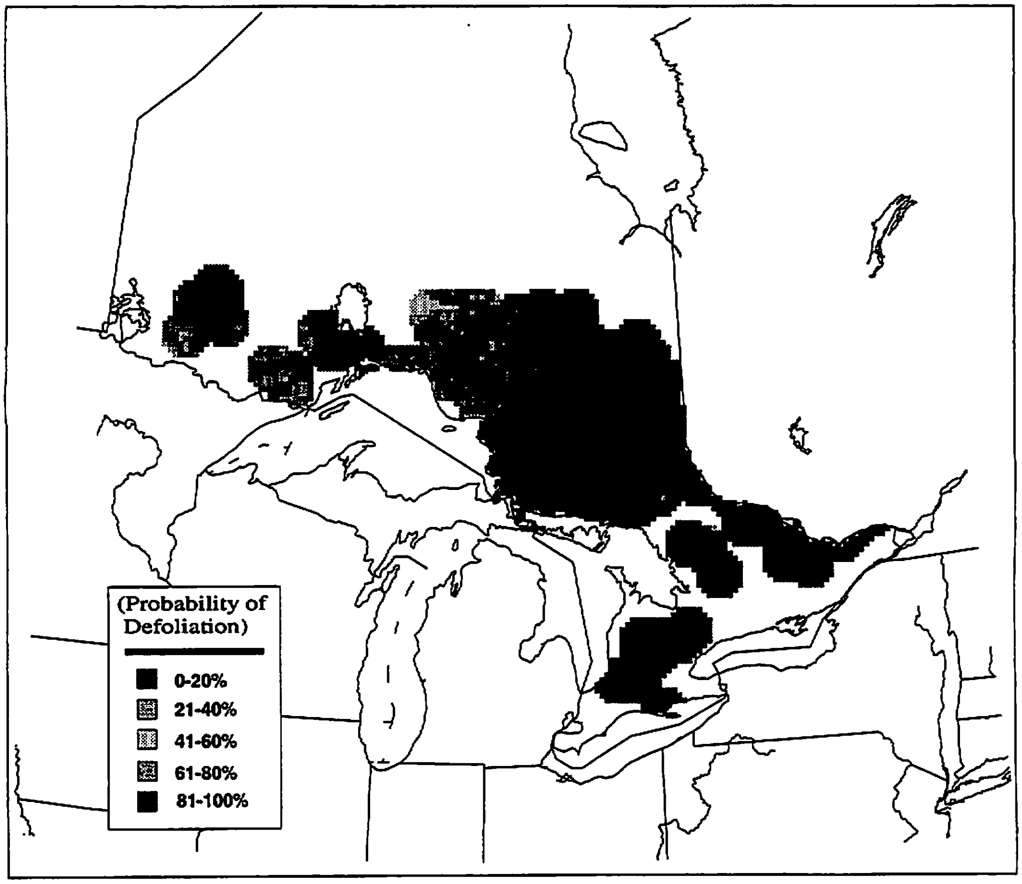

Fig. 11. Probability of defoliation by the spruce budworm in Ontario in 1994 as predicted by the logistic regression model.

The Efficacy of Dipel 76AF on Jack Pine Budworm in Ontario: 1995 Trial

by

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The Efficacy of Dipel 76AF on Jack Pine Budworm in Ontario: 1995 Trial

Introduction

The jack pine budworm, *Choristoneura pinus pinus* Free., is the most destructive pest of jack pine in Ontario. Infestations typically last only 3-5 years, but high budworm populations can completely defoliate mature jack pine in a single year resulting in growth loss, top mortality, or even whole tree mortality. During the last major jack pine budworm outbreak in Ontario in the mid 1980's, several B.t. formulations were tested and used in experimental and operational control programs and found to be very effective against this pest.

In 1992 and 1993, defoliation caused by the jack pine budworm was detected in several areas of the Central Region in northern Ontario. By 1994, the infestation had expanded to cover some 419,000 ha. Egg mass and overwintering larval surveys conducted by the Canadian Forest Service indicated that, although populations had declined in some areas, the outbreak would continue in parts of the Central and Northeast regions in 1995.

Since 1985, B.t. has been the only material used in aerial spraying programs conducted by the Ontario Ministry of Natural Resources. During that time, a total of some 840,000 ha were treated. The objective of this study was to test the efficacy of Dipel 76AF against the jack pine budworm.

Methods

Study Area: The two areas selected for treatment totalled 137 ha and were located in 70–90 year old jack pine stands northwest of the City of Sudbury in Ermatinger Township. Jack pine budworm defoliation was first detected in this township in 1993 and moderate to severe levels of defoliation were mapped again in 1994. A visual inspection of the treated stands in May 1995, showed that they were in good condition with only light levels of previous defoliation.

Jack pine branch samples collected from each block during the winter showed average overwintering second instar (L2) populations of 73.4 and 57.3 larvae per branch in Blocks 1 and 2 respectively. These L2 densities would normally produce high 3rd and 4th instar densities and cause moderate to severe levels of jack pine defoliation.

Treatments: Each block was treated with a single application of Dipel 76AF at a rate of 30BIU/1.5*l*/ha. Both blocks were treated on the morning of June 21, 1995 using a Cessna 188 Ag-Truck equipped with Micronair AU4000 rotary atomizers. The aircraft was also equipped with a differential GPS guidance system and an on-board datalogger to monitor spray parameters during the spray session (Table 1). Wind conditions were assessed on site by ground crews and remained within acceptable limits (< 12 kph) throughout the spray session.

Timing: Accumulated degree day estimates for the study area were calculated from daily maximum and minimum temperatures obtained from the Sudbury weather office. This information was used to estimate the timing of jack pine budworm emergence and to schedule various field activities. Starting in early June, insect and host development information was gathered daily from several plots near the spray blocks. On each sample date, 50 larvae were collected from foliage sampled at each plot and examined under a microscope to determine larval instar. One hundred host shoots were examined on each sample date to assess the extent of shoot elongation and needle flare. Insect and host development indices were then calculated to track and forecast development rates. Treatment was targeted for indices of 3.5 for the insect and 4.0 for the host. At this stage, there is approximately a 50:50 ratio of 3rd and 4th instar larvae, host shoots are elongating, and jack pine needles have started to separate from each other.

Assessment: A total of 170 trees were sampled in the two blocks (Block 1 = 70 trees; Block 2 = 100 trees) and another 160 trees were sampled in unsprayed check plots. The assessment trees were not grouped into plots but were distributed along transect lines that ran perpendicular to the expected flight lines. A single mid-crown branch was collected from each tree a few days prior to treatment to assess prespray larval densities. Each branch was examined twice in the laboratory to ensure that prespray population estimates were accurate (95%).

Postspray surveys were conducted in July when most budworm had reached the pupal or adult stage and feeding was complete. A single mid-crown branch was removed from each tree, the current defoliation was estimated, and the branch was shipped to the laboratory for examination. Again, each branch was examined twice and all emerged pupae were counted. Any budworm still in the pupal or larval stage were kept until adult emergence or until the insect died. Budworm survival was estimated by calculating the ratio of emerged adults to prespray larval densities.

Data Analysis: Earlier studies have shown that jack pine staminate flowers have a significant influence on jack pine budworm population densities within and between trees in a stand. Therefore, spray efficacy is usually assessed separately for trees with and without staminate flowers. However, in 1995, staminate flowers were observed on only 7% of the sampled jack pine in the study area. A comparison of prespray jack pine budworm populations and defoliation showed no significant difference ($p = .05$) between the two groups so data from both groups were pooled for this analysis.

Results

Jack Pine Budworm Populations: Overwintering L2 surveys showed high jack pine budworm populations in both study blocks. However, prespray samples collected in June revealed unexpectedly low 3rd and 4th instar larval densities in the spray blocks (Table 2) and in many other locations throughout the infestation. Overall, the average number of prespray larvae per branch in the treatment blocks was 5.7 (SD ± 9.3) and 5.1 (SD ± 9.6) in the check plots.

Timing: Cool temperatures throughout northeastern Ontario in April and May delayed jack pine budworm emergence until early June. This was followed by abnormally warm temperatures (25–35°C) from June 16–26 that resulted in rapid budworm development. Insect and host development indices for June 21 were approximately 4.7 and 3.5 respectively (Figure 1). This indicates that most larvae were in the 5th instar with some 4th and 6th instars present. Foliar development had not reached the optimal rating of 4.0 but further delay would have resulted in higher prespray defoliation.

Table 1. Summary of conditions measured during the 1995 Dipel 76AF spray trial against jack pine budworm in Ontario.

Item	**Block 1**	**Block 2**
Air Temperature (°C)	12	14
RH (%)	66	62
Atomizer (RPM)	6100	6200
Flow rate (l/min)	18.7	20.2
Application Rate (l/ha)	1.26	1.39
Area Sprayed (ha)	53.8	84.0

Field Efficacy: A summary of pre- and postspray jack pine budworm densities, and host defoliation estimates for each block is presented in Table 2. Prespray budworm populations in the spray blocks and check plots were not significantly different ($p = .74$), however, adult emergence rates and defoliations rates were significantly lower in the spray blocks ($p < .001$). Overall, defoliation rates averaged 1% (SD ± 3%) in the spray blocks compared to 13% (SD ± 16%) in the untreated checks. Budworm survival rates were nearly 6 times greater in the checks (.081) than in the areas treated with Dipel 76AF (.014). Differences between spray blocks and check plots are illustrated in greater detail when trees with similar prespray budworm populations were compared (Table 3). Adult survival and defoliation were consistently lower on trees treated with Dipel 76AF than on untreated trees (Figures 2 and 3).

Table 2. Average prespray jack pine budworm larval densities, postspray adult emergence, and host defoliation in blocks aerially treated with a single application of Dipel 76AF (30BIU/1.5l/ha).

Location	**Avg. prespray larvae/branch**	**Avg. number adults/br**	**Avg. defoliation (%)**
Block 1	5.4 ± 10.2	0.014 ± 0.119	0.5 ± 1.5
Block 2	5.9 ± 8.7	0.050 ± 0.219	1.3 ± 4.4
Checks	5.1 ± 9.6	0.312 ± 0.952	13.2 ± 16.4

± Standard Deviation

Table 3. Jack pine budworm adult emergence and host defoliation at increasing prespray population densities in blocks treated with a single application of Dipel 76AF (30BIU/1.5l/ha).

Prespray larvae per branch	Prespray larvae to adult survival		Avg defoliation (%)	
	Dipel	Checks	Dipel	Checks
0	-	-	.4 ± 1.1	6.1 ± 7.2
1-3	.023 ± .138	.121 ± .302	3.5 ± 1.1	8.8 ± 12.2
4-6	.015 ± .051	.028 ± .106	1.7 ± 3.6	11.6 ± 12.3
7-9	0	.065 ± .113	.6 ± 1.3	25.0 ± 20.1
10+	.005 ± .021	.051 ± .088	2.2 ± 7.0	31.8 ± 22.1

± Standard Deviation

Discussion

The cause of the unexpected reduction in budworm populations between the overwintering L2 larvae and the actively feeding L3/L4 instars is not known. In some areas of the infestation, high levels of defoliation were observed on understory jack pine, white pine, white spruce and balsam fir. This suggests that, upon emergence, there was significant dispersal of young larvae within the forest canopy. The cause of this suspected dispersal is not clear as there appeared to be an abundant food supply available to the emerging larvae. As noted earlier, however, there was a very low incidence of staminate flowers throughout the study area in 1995. Staminate flowers seem to play a key role in jack pine budworm population dynamics and their absence may be an important factor in the collapse of these outbreaks and the substantial decline in larval populations this summer. Egg mass data from the 1995 survey also indicate a collapse of budworm populations over much of the infestation.

Despite the unexpectedly low budworm populations, there were enough larvae within the treatment blocks to have caused moderate levels of host defoliation if left unprotected (Table 3; Figure 2). Budworm survival rates to the adult stage, and host defoliation rates were significantly lower in the blocks treated with Dipel 76AF than in the untreated check plots. At low to moderate budworm population densities, a single application of Dipel 76AF applied at a rate of 30BIU/1.5l/ha was extremely effective in reducing budworm populations and in protecting host foliage.

Fig. 1 Jack pine budworm and host development, 1995. Antrim Township

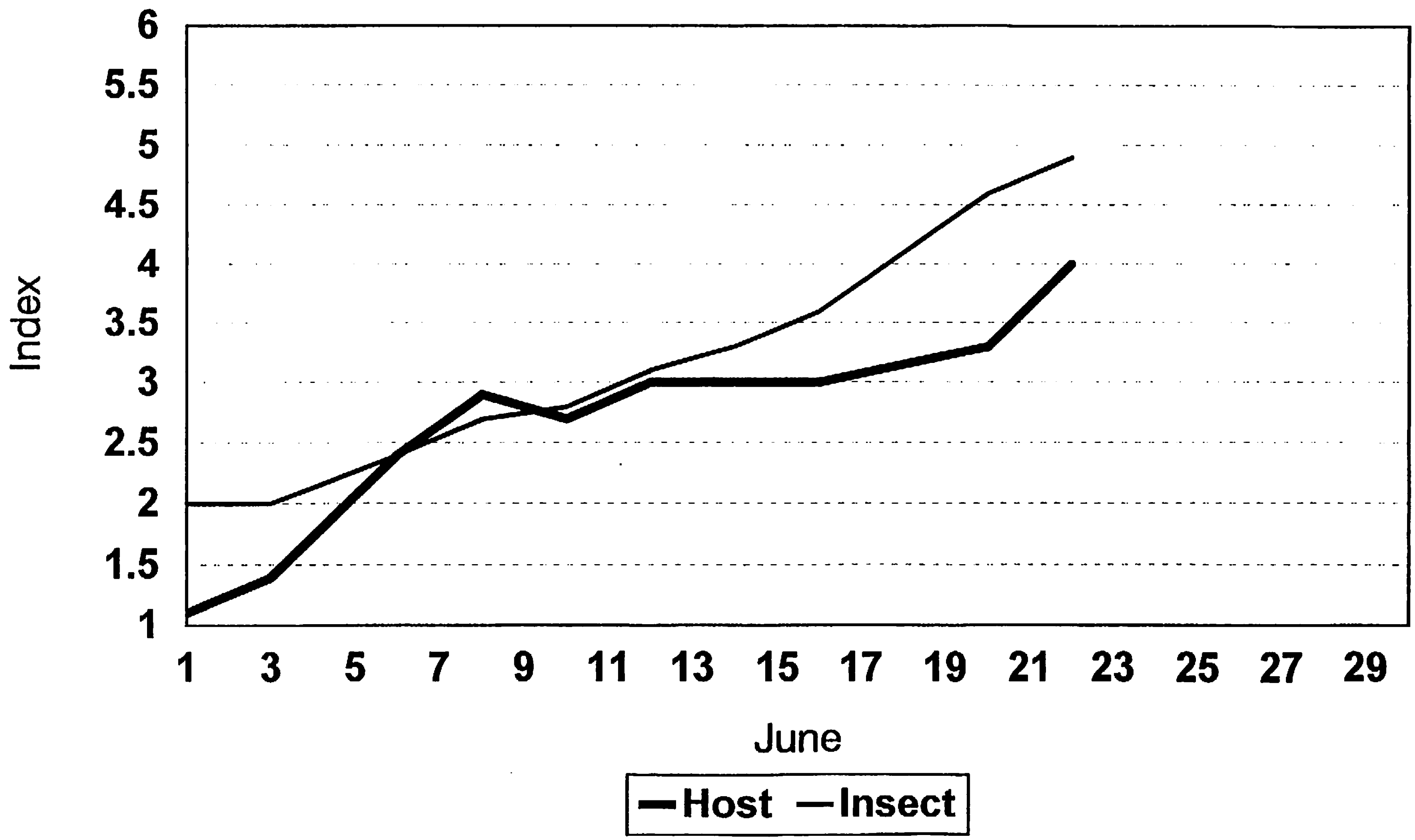


Figure 2. Jack pine budworm: defoliation rates at increasing prespray larval densities.

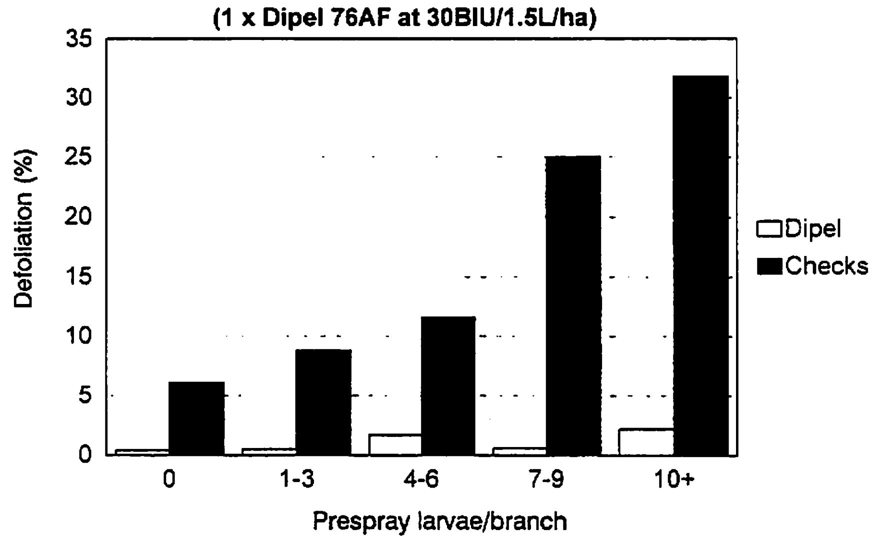
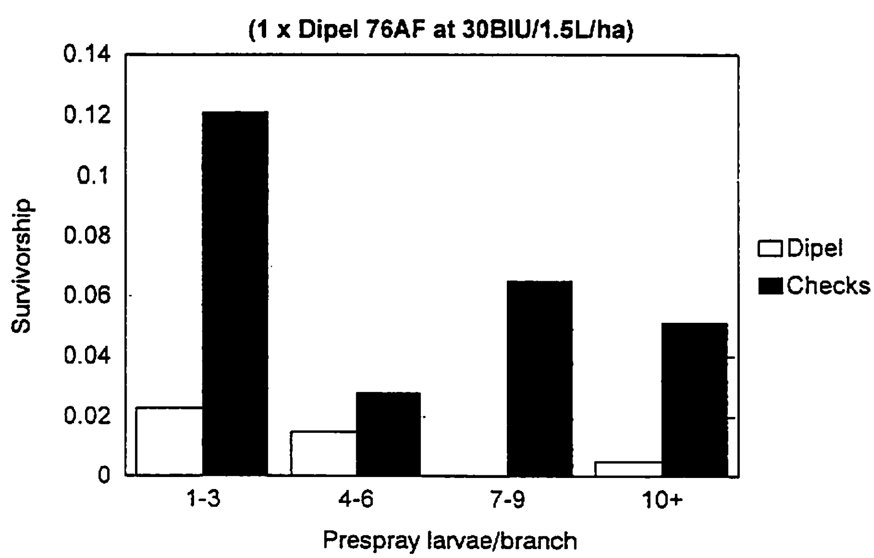


Figure 3. Jack pine budworm: Prespray larva-to-adult survival.



The Efficacy of MIMIC 240 LV on Jack Pine Budworm in Ontario: 1995 Trial

by

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The Efficacy of MIMIC 240 LV on Jack Pine Budworm in Ontario: 1995 Trial

Introduction

The current jack pine budworm outbreak in the Central Region f Ontario began in 1992. The infestation expanded in 1993 and by 1994, moderate to severe defoliation was mapped over an area of some 419 000 ha. Egg mass and overwintering larval surveys (L2) conducted by the Canadian Forest Service indicated that, although populations had declined in some areas of the infestation, the outbreak would continue in parts of the Central and Northeast regions in 1995. In 1994, the Ontario Ministry of Natural Resources and E.B. Eddy Forest Products Ltd. conducted aerial spraying operations over some 21,500 ha with the biological insecticide *Bacillus thuringiensis* (B.t.). The 1995 operational spraying program against the jack pine budworm totalled 50,000 ha.

In 1994, experimental trials were conducted in Ontario to determine the efficacy of single and double applications of RH5992 against the jack pine budworm. Results showed that a double application of RH5992 (70g/2.0*l*/ha per application) was very effective in reducing jack pine budworm populations and protecting foliage. Results were somewhat less clear in the block treated with a single application (70g/2.0*l*/ha), although where spray deposit was high, population reduction and foliage protection levels were acceptable. It was recommended, therefore, that additional trials be conducted to assess the efficacy of a single application of RH5992 on jack pine budworm.

Methods

Study Area: Overwintering jack pine budworm populations were evaluated at a number of locations throughout the area currently infested in northern Ontario. Based on L2 populations, stand conditions, and proximity to operational spray blocks, three blocks totalling 252 ha were selected for treatment in Roberts Township in the Central Region. Jack pine budworm defoliation was first recorded in this area in 1994 and the forecast was for continued moderate to severe defoliation in 1995. As in the 1994 trials, a 100 m buffer was left unsprayed along streams and lakes in or near the blocks.

Treatments: Each block received a single application of MIMIC 240 LV at a rate of 70g/2.0*l*/ha. Spraying occurred on the mornings of June 18 and 19 when budworm larvae were primarily 4th and 5th instars (Figure 1). As in 1994, the MIMIC was applied with a Cessna 188 Ag-Truck equipped with 4 Micronair AU4000 rotary atomizers and spray parameters were monitored with an on-board data logging system (Table 1).

Wind conditions were somewhat unstable during the first spray session on June 18. Gusting winds forced termination of the spray session after completion of spraying in Block 3. On June

19, light winds (<10 kph) enabled completion of Blocks 1 and 2. A summary of conditions during each spray session is presented in Table 1.

Timing: Accumulated degree-day estimates for the study area were calculated from daily maximum and minimum temperatures obtained from the Sudbury weather office. This information was used to estimate jack pine budworm emergence and to schedule various field activities. Host and insect development information was gathered daily from several plots near the study site. Larvae (n = 50) were collected from each plot and their instar was determined by microscopic examination. Host shoots (n = 100) were examined to determine the extent of shoot elongation and needle flare. Insect and host development indices were calculated for each location on each sample date and used to track and forecast development rates.

Assessment: Branch samples were collected from two stands within the study area during the winter to assess overwintering jack pine budworm larval populations (L2). The samples were processed in a 2% sodium hydroxide wash to remove the L2 larvae. Counts indicated that overwintering budworm populations were high in the study area and that moderate to severe levels of defoliation should occur this summer.

Prespray branch samples were collected several days before treatment from a total of 250 trees within the spray blocks (Block 1 = 80; Block 2 = 70; Block 3 = 100) and from 160 trees in unsprayed stands. The assessment trees were not grouped into plots but were distributed along transect lines that ran perpendicular to the flight lines in each block. A single mid-crown branch (60 cm) was sampled from each tree and returned to the laboratory for examination. Each branch was examined twice by different examiners to ensure that larval counts were accurate (95%).

Postspray surveys were conducted in July when most budworm had reached the pupal or adult stage and feeding was complete. A single mid-crown branch was removed from each tree, the current defoliation was estimated, and the sample shipped to the laboratory. Branches were examined in the laboratory and all emerged pupae counted. Any remaining larvae were reared on jack pine foliage until adult emergence occurred or until the insect died.

Data Analysis: Earlier studies have shown that jack pine staminate flowers have a significant influence on budworm population densities. Therefore, assessment of spray efficacy is normally presented separately for trees with and without staminate flowers. In 1995, however, staminate flowers were observed on only 17 (7%) of the 250 jack pine assessed in the spray blocks. Comparison of prespray populations and defoliation showed no significant difference ($p = 0.5$) between the two groups so data from both groups were pooled for the 1995 analysis.

Results

Jack Pine Budworm Populations: Surveys conducted during the winter showed high jack pine budworm L2 populations overwintering in the study blocks. For example. in stands 102 and 259, average L2/branch counts were 121 and 163 respectively. Prespray samples, however, revealed surprisingly low 3rd and 4th instar densities in each block (Table 2). The explanation for the significant reduction in budworm densities between the overwintering L2 stage and the active L3/L4 stage is not known. High levels of understory defoliation on jack pine, balsam fir, and white spruce suggests that there may have been significant dispersal of budworm larvae from the overstory upon emergence of the L2 larvae. The cause of this suspected dispersal is not clear as there appeared to be an abundant food supply available to the emerging larvae. The very low incidence of staminate flowers noted earlier may have been a key factor triggering the apparent L2 dispersal.

Table 1. Summary of conditions measured during the 1995 MIMIC 240 LV spray trial against jack pine budworm in Ontario.

Item	June 18	June 19	
	Block 3	**Block 1**	**Block2**
Air Temp (°C)	20	24	25
RH (%)	94.5	73.7	71.6
Atomizer RPM	5700	5600	5700
Flow Rate (*l*/min)	25.5	26.1	25.8
Application Rate (*l*/ha)	1.82	1.88	1.88
Area Sprayed (ha)	74.2	118.5	59.3

Timing: Much of Ontario experienced abnormally cool temperatures in April and May. Jack pine budworm emergence occurred in early June throughout the infestation and warm daytime temperatures (25 – 35 °C) from June 16–26 resulted in rapid larval development. Insect and host indices for June 18 and 19 indicate that most larvae were in the 4th and 5th instars (Figure 1). Host foliage had not reached the optimal level of development (Host Index = 4.0) but further delay would have resulted in higher prespray defoliation levels.

Field Efficacy: A summary of pre- and postspray jack pine budworm densities and defoliation levels in each treatment block is presented in Table 2. Overall, average prespray larval densities were 2.4 (SD ± 3.7) in the spray blocks and 5.1 (SD ± 9.6) in the check plots. Adult survival averaged 0.2 (SD ± 0.6) and 0.3 (SD ± 1.0) in the spray and check plots respectively. Defoliation levels averaged 5% (SD ± 6%) in the treatment blocks and 13% (SD ± 16%) in the checks. When defoliation levels were compared at increasing prespray population densities, they were approximately 50% lower in the treatment blocks than in the check plots (Table 3; Figure 2). Population reduction attributable to the treatments (Abbott's Formula) showed little effect of treatment in Block 1 (17%) and 0% in Blocks 2 and 3. However, adult survival in spray blocks was substantially lower than in checks at the higher prespray population densities (Table 3; Figure 3).

Table 2. Average prespray jack pine budworm larval densities, postspray adult emergence, and host defoliation in blocks aerially treated with a single application of MIMIC 240 LV (70g/2.0*l*/ha).

Location	Avg. prespray larvae/branch	Avg. adult emergence	Avg. defoliation (%)
Block 1	2.2 ± 2.6	0.1 ± 0.4	4 ± 6
Block 2	2.8 ± 5.6	0.3 ± 0.7	6 ± 7
Block 3	2.4 ± 2.6	0.2 ± 0.7	6 ± 6
Checks	5.1 ± 9.6	0.3 ± 1.0	13 ± 16

± Standard Deviation

Table 3. Jack pine budworm adult emergence and host defoliation at increasing prespray population densities in blocks treated with a single application of MIMIC 240 LV (70g/2.0*l*/ha)

Prespray larvae per branch	Prespray larvae to adult survival		Avg. defoliation (%)	
	MIMIC	Checks	MIMIC	Checks
0	-	-	4 ± 6	6 ± 7
1-3	.138 ± .342	.121 ± .302	5 ± 6	9 ± 12
4-6	.039 ± .123	.028 ± .106	6 ± 6	12 ± 12
7-9	.043 ± .112	.064 ± .113	7 ± 8	25 ± 20
10+	.013 ± .022	.051 ± .088	16 ± 6	32 ± 22

± Standard Deviation

Discussion

The high overwintering L2 budworm populations recorded in the study area should have produced prespray larval densities significantly higher than those observed in 1995. This natural reduction in populations was also detected in some other areas of the infestation, including some stands used for check plots. It would appear, therefore, that the current outbreak of jack pine budworm in the Central Region is beginning to collapse. Preliminary egg mass data from the 1995 survey also supports this conclusion.

Unfortunately, assessment of aerial spraying trials conducted during the declining phase of an outbreak is often complicated by the inherent instability of pest populations during this phase.

For example, estimates of population reduction attributable to the treatment were substantially lower for the single application in 1995 compared to 1994 (Table 4). This was in part due to the low budworm survival rates observed in some check plots. Overall, however, budworm survival rates were lower in the treated areas compared to the checks, especially at the higher prespray larval densities. It has also been observed that, in the collapsing phase of a jack pine budworm outbreak, the relationship between egg mass or L2 populations and subsequent defoliation is much more variable, and thus less predictable, than in the earlier phases of the outbreak. Defoliation levels were down throughout much of the outbreak area in 1995. However, results in the spray blocks show significantly lower defoliation levels (T-test; $p < .001$) than in the unsprayed checks.

Table 4. Comparison of areas treated with a single application of MIMIC 240 LV in 1994 and 1995 in Ontartio.

	1994	**1995**
Avg. prespray population	13.7	2.4
Trees with flowers (%)	31	7
Avg. defoliation (%)	26	5
Population reduction (%)	70-100	0-17

Despite the unexpectedly low prespray larval populations, results of the 1995 trial showed that a single application of MIMIC 240 LV kept defoliation levels significantly lower than those observed in unsprayed check plots and support observations made in 1994 when prespray budworm populations were substantially higher.

Figure 1. Jack pine budworm and host development 1995.
Hutton Township

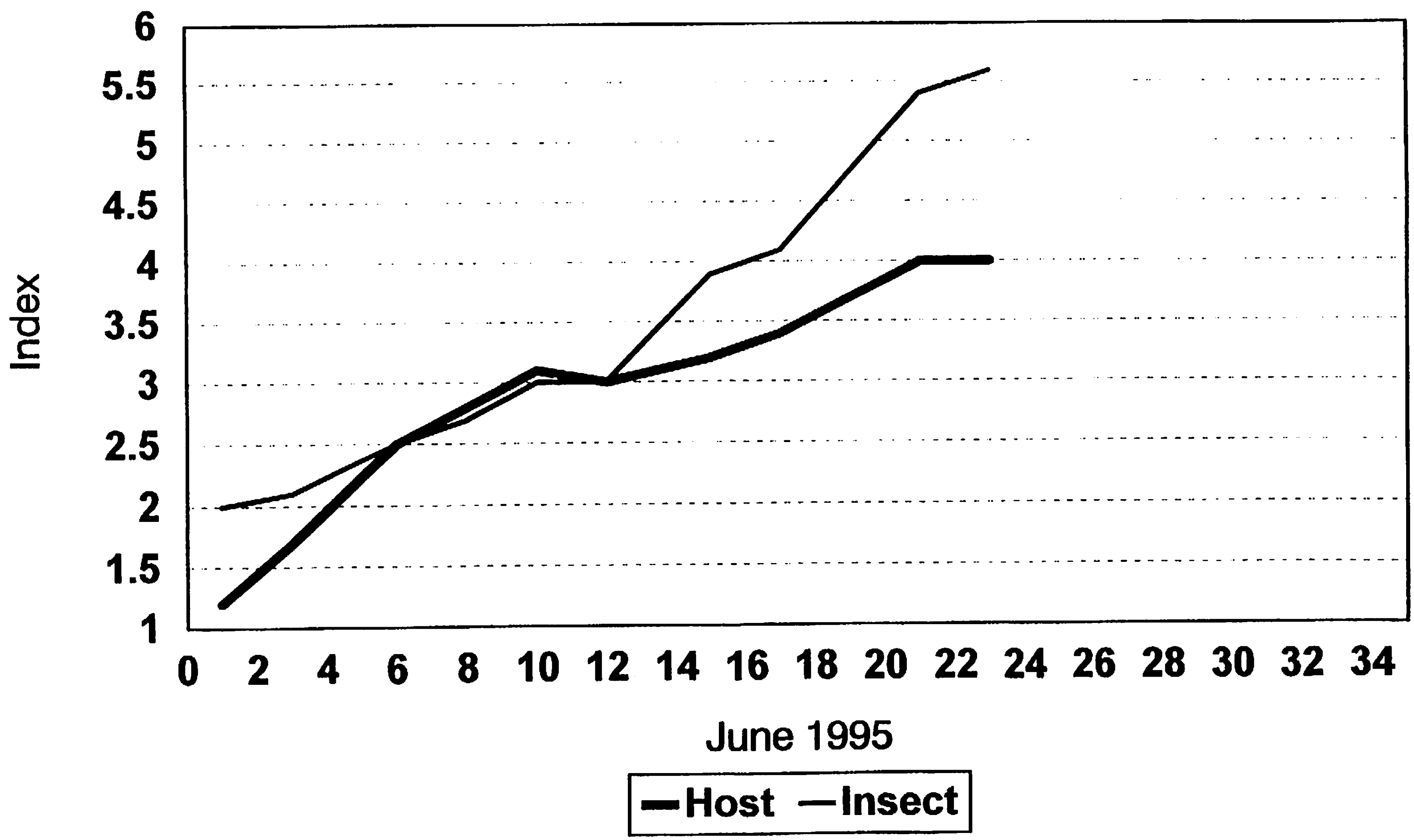


Figure 2. Jack pine budworm: defoliation rates at increasing prespray larval densities.

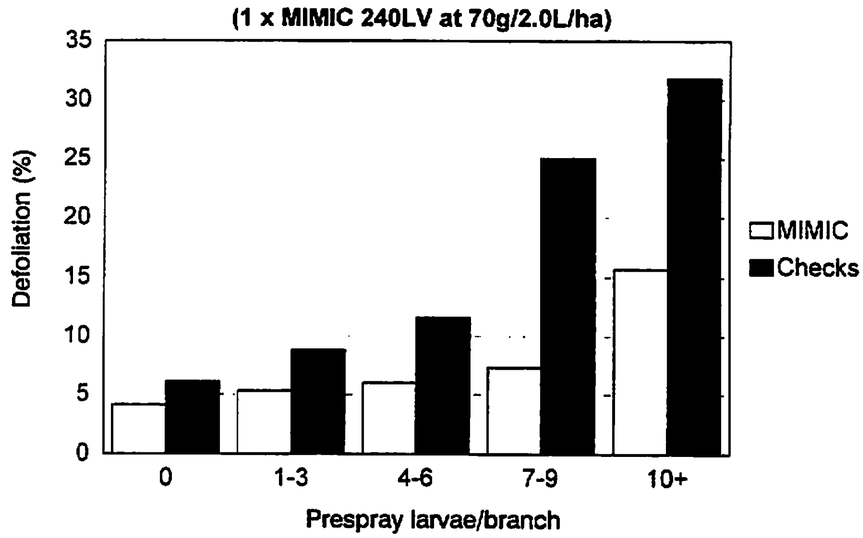
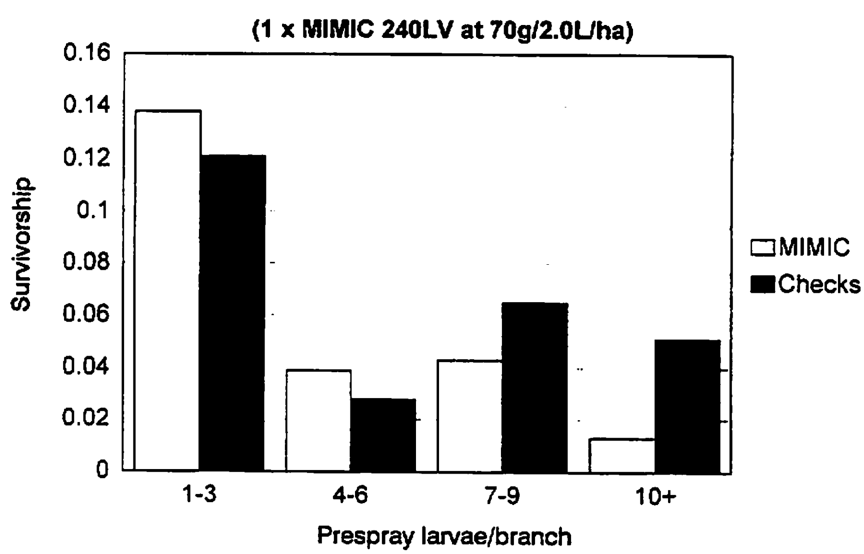


Figure 3. Jack pine budworm: prespray larva-to-adult survival.



DETERMINATION OF OPTIMUM DROP SIZES OF RH5992 (MIMIC® 2F) AGAINST SPRUCE BUDWORM LARVAE FOR STOMACH AND CONTACT TOXICITY

BY

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CANADIAN FOREST SERVICE

JULY, 1995

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ABSTRACT

Two dilution rates of Mimic® representing applied field dosages of 17.5 and 70 grams/ha were tested for stomach and contact toxicity against spruce budworm larvae. Spray drops of varying sizes were generated with a spinning disk drop generator, and collected on silk strands then transferred to needles and fed to various instar budworm larvae or applied topically to the dorsal surface of the larvae. In all, five series of experiments were conducted. Ten or 20% glycerine was added to each mixture to increase the stability of formulation and the generation of uniform droplets.

The results show that the 70g/ha concentration was significantly more toxic to budworm larvae than the 17.5 g/ha formulation. ED_{50} for stomach toxicity against fifth instar of the 70 g/ha mix with 10% glycerine was 52 μm drop and ED_{95} was 135μm. Mimic® has both stomach and contact toxicity. Stomach toxicity is 15 times greater than contact toxicity. Contact toxicity in these tests is similar to fenitrothion, although Helson has found Mimic® 5.20 times more toxic than fenitrothion as a contact insecticide.

DÉTERMINATION DE LA TAILLE OPTIMALE DES GOUTTELETTES DE RH5992 (MIMIC® 2F) QUANT À LA TOXICITÉ STOMACALE ET À LA TOXICITÉ DE CONTACT POUR LES LARVES DE TORDEUSE DES BOURGEONS DE L'ÉPINETTE

PAR

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JUILLET 1995

RÉSUMÉ

Nous avons mis à l'essai deux concentrations de Mimic®, correspondant à des taux d'application au champ de 17,5 et 70 g/ha, afin d'en étudier la toxicité stomacale et la toxicité de contact pour les larves de tordeuse des bourgeons de l'épinette. Au moyen d'un générateur de gouttelettes à disque rotatif, nous avons produit des gouttelettes de taille variable, que nous avons recueillies sur des fils de soie et transférées à des aiguilles. Ensuite, nous avons fait ingurgiter les gouttelettes à des larves de stades divers ou les avons appliquées directement sur le dos de ces insectes. En tout, nous avons ainsi réalisé cinq séries d'expériences. Nous avons ajouté 10 ou 20% de glycérine à chaque préparation, afin d'en augmenter la stabilité et d'assurer l'uniformité des gouttelettes.

La concentration de 70 g/ha a été significativement plus toxique pour les larves de tordeuse que celle de 17,5 g/ha. En ce qui concerne la toxicité stomacale pour les larves du cinquème stade, la concentration de 70 g/ha avec 10% de glycérine avait une DE_{50} équivalant à une gouttelette de 52 μm et une DE_{95} équivalant à une gouttelette de 135 μm. Le Mimic® possède à la fois une toxicité stomacale et une toxicité de contact, mais la première est 15 fois plus élevée que la seconde. Au cours de nos expériences, la toxicité de contact du produit s'est avérée semblable à celle du fénitrothion, mais Helson a constaté, que le Mimic® était 5,20 fois plus toxique que le fénitrothion comme insecticide de contact.

DETERMINATION OF OPTIMUM DROP SIZES OF RH5992 (MIMIC® 2F) AGAINST SPRUCE BUDWORM LARVAE FOR STOMACH AND CONTACT TOXICITY

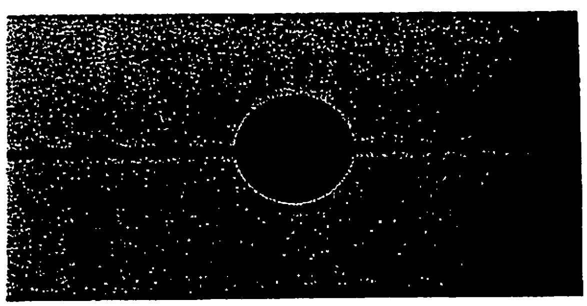
INTRODUCTION

Mimic® (RH5992) was found very promising insecticide against spruce budworm larvae during laboratory evaluation for stomach, contact and residual toxicity by Helson et al. (1991). A collaborative research agreement was signed between Rohm and Haas Canada Inc. and the Canadian Forest Service to conduct various laboratory and field studies for registration of Mimic® 2F against spruce budworm in 1992. In order to optimize field applications of Mimic® 2F, a study to determine optimum drop sizes of field dilutions of Mimic® 2F for stomach and contact toxicity was carried out under this agreement at Canadian Forest Service - Maritimes Region. The objective was to determine drop sizes for the ED_{50} and ED_{95} values of single drops of field dilutions of Mimic® 2F against fifth instar spruce budworm larvae, and to determine the biologically active droplet spectrum needed for aerial application.

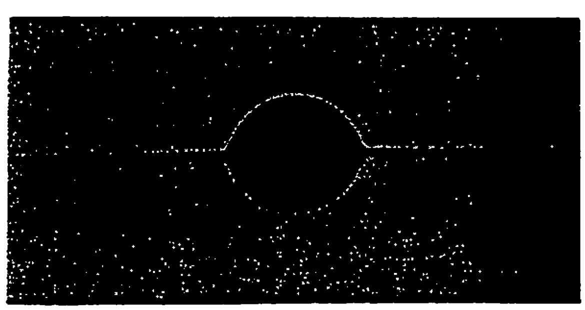
It was difficult to produce stable drops during the preliminary evaluation of dilutions used in the 1992 field trials (i.e. 17.5 and 70 g AI/ha in 2 litre of H_20) i.e., solid particles of formulations were settling and the drops were evaporating from silk strands of harps (Fig. 4) which were used as collection surfaces for droplets. It was impossible to size drops of these formulations (Fig. 1A). To overcome this deficiency five, ten and 20% glycerine was added in the formulations in order to increase the stability of suspended Mimic® particles. Subsequently it was determined that five percent glycerine did not satisfactorily stabilize the drops and they evaporated quickly and round droplets, necessary for sizing, were not formed. However, stable suspensions and round drops were produced with 10% and 20% glycerine and were used in the final testing (Fig. 1B and 1C). Selection of drop size criteria for laboratory tests was based on information of the impaction efficiency of fenitrothion droplets on new needles and on budworm microhabitat silk in the field and their toxicity in the laboratory (Nigam 1987 and Picot et al. 1986). These data indicated that droplets from 20-110 µm were most effective when impaction and toxicity were taken into consideration. Thus, a drop size range of 20-110 µm was used in laboratory experiments of Mimic®. Tests with 17.5 g AI/ha were abandoned after initial biological testing due to low mortality (60%) from 100 µm drops. Hence, the droplet study concentrated on the 70 g AI/ha formulation using droplets in the 20-110 µm diameter range to determine the effective droplet sizes for ED_{50} and ED_{95} values of Mimic® against fifth instar spruce budworm larvae.

FIGURE 1: Mimic® droplets of 70 g/ha in 2L water formulation with different concentrations of additional glycerine.

1A. Mimic® droplet with no additional glycerine (21.9 microns - short axis of this elongated drop).



1B. Mimic® droplet with 10% addition-all glycerine (93.8 microns diameter).



1C. Mimic® droplet with 20% addition-al glycerine (100.0 microns diameter).

MATERIALS AND METHODS

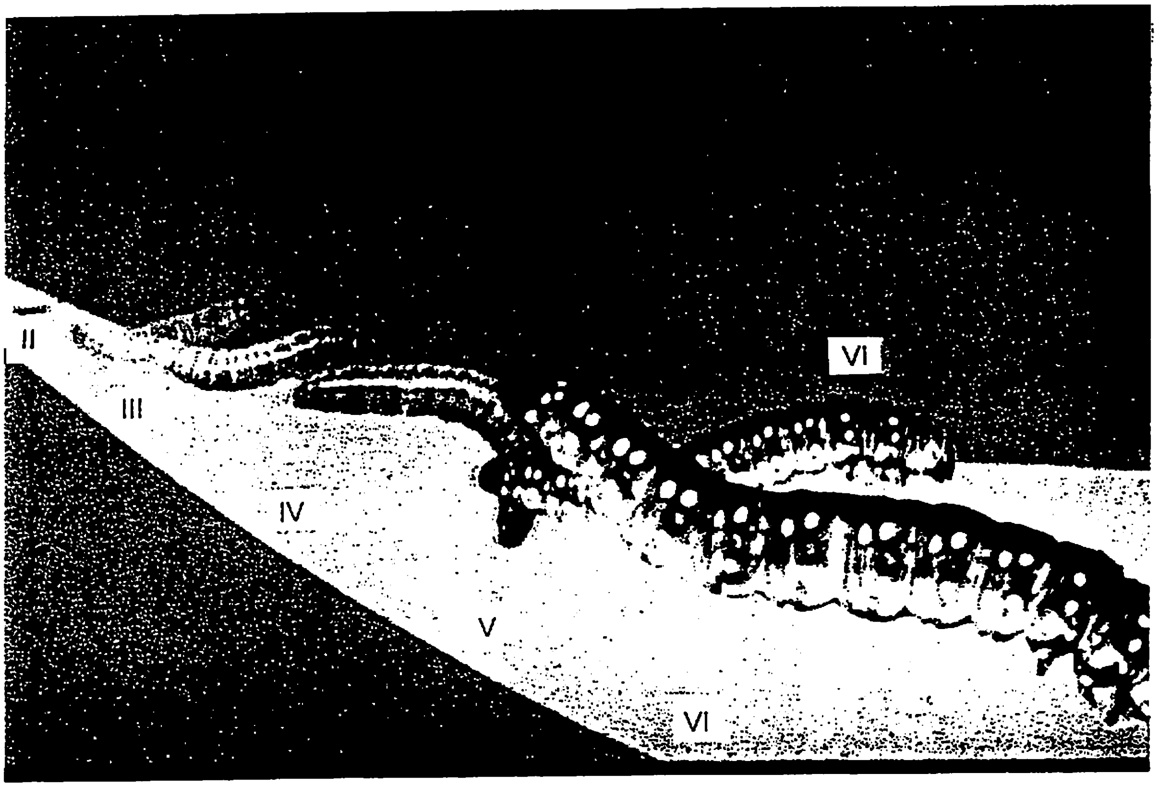
Insects: Postdiapause second instar spruce budworm larvae were obtained from Forest Pest Management Institute, Sault Ste. Marie, Ontario. The cheesecloth strips containing these larvae were kept refrigerated at 4°C until they were needed. The cheese cloth was sprayed with 5% Javex solution in water to prevent mold after removing from refrigerator, and just before setting them in trays for emergence. Emergence of larvae commenced within 24 hr. after exposure to 20°C. The larvae were reared on an artificial diet (McMorran 1965). Approximately 10 active larvae were set up by brush or a piece of cheesecloth containing approximately 10 larvae in each diet cup. These cups were then placed in Conviron growth chambers which were set with a photoperiod of 16:8 (L:D) h, and with temperature and humidity varying according to the time of day, i.e., they were changed at 0600, 2000 and 2200 h. Night temperatures were lower than day and humidity was vice versa.

Two growth chambers were used, with one set at a lower temperature and humidity range (14°C-18°C, RH 50-55%) and the other at a higher temperature and humidity range (20-24° and 55-70% RH). As budworm larval growth is temperature dependent we manipulated the rate of instar development and scheduled larvae of various instars as needed. Most of the time larvae were reared at the higher temperature and humidity regime. Most of the tests were carried out with fifth instars (L5) while fourth instars (L4) were used in preliminary tests of Mimic® (Fig. 2). Late L4 were sorted from diet cups for L5 tests and were reared for 48 h on balsam fir foliage to acclimatize them to the change of diet. After the first twenty-four h period larvae which had not moulted i.e., L4, were removed from the dish so that only freshly moulted L5 remained. These larvae were allowed to feed on foliage for another twenty four h. These L5 were then starved for 24 h before treatment in order to stabilize their gut contents. The starved L5 larvae used in tests were 2 days ± 12 h old. Similarly, to prepare L4 larvae for tests, third instar (L3) larvae were sorted from diet cups, acclimatized on foliage, sorted after moulting to L4, maintained on foliage for the same time periods as the L5, and starved for twenty-four h prior to treatment, at which time they were 2 days ± 12 h old.

Insecticide formulation and final dilutions: RH-5992 or Mimic® was supplied as 2F formulation (Lot No. 7-37190914) by Rohm and Haas Co. RH-5992 2F is an aqueous flowable formulation containing 240 g AI/L, i.e. 24% A.I. w/v.

Preliminary laboratory droplet studies were carried out using the 17.5 g AI/ha formulation. In the final studies the 70 g AI/ha in 2L of distilled water formulation was used. These dilutions were not stable as materials separated very quickly in the droplet generating system and produced irregular shaped droplets when captured on silk or on the sampling harps (Fig. 1A). To overcome this problem glycerine in various concentrations was added to stabilize the final dilution and maintain the suspension. Initially, 5% glycerine was added (tests M1-2), then 10% glycerine, to provide better stability and rounder droplets (tests M3-M51) (Fig. 1B). Since mortality results were highly variable, the glycerine

FIGURE 2: Larval instars of the eastern spruce budworm.



Instars IV and V were used for the Mimic® study.

content was increased to 20% (tests M52-74) to improve the uniformity of the suspended Mimic® particles in each droplet (Fig. 1C). This concentration of glycerine provided more consistency in mortality results.

One hundred ml of fresh formulation was prepared for each test using the following stock concentrates:

<u>Stock Concentrates</u>:

(i) 0.5% (wt/vol.) Erio acid red dye in distilled water and filtered to remove undissolved particulate material.

(ii) 50% glycerine in distilled water

(iii) 24% (AI wt/vol) RH-5992 2F (aqueous flowable) concentrate containing undisclosed percentage of water, glycerine and other trade secret ingredients.

<u>Ingredients for 70g/ha in 2L H_2O containing 10% glycerine</u>

(a) 40 ml of 0.5% Erio acid red dye for 0.2% concentration.

(b) 20 ml of 50% glycerine in distilled water for 10% concentration.

(c) 14.58 ml of 24% RH-5992 2F concentrate for 3.5% concentration of AI.

(d) 25.42 ml of distilled water*.

* Note: Total amount of water approximately 84 to 86% [100-13.7 (0.2 + 10 + 3.5 = 13.7) = 86.3] depending upon trade secret % of various ingredients in 2F concentrate.

<u>Ingredients for 70g/ha in 2L H_2O containing 20% glycerine</u>

(a) 40 ml of 0.5% Erio acid red dye for 0.2% concentration.

(b) 40 ml of 50% glycerine in distilled water for 20% concentration of glycerine.

(c) 14.58 ml of 24% RH-5992 2F concentrate for 3.5% concentration of AI.

(d) 5.42 ml of distilled water. Total amount of water was approximately 74-76% depending upon trade secret % of various ingredients in 2F concentrate.

Balsam fir foliage:

A continuous supply of balsam fir foliage was maintained in the laboratory by growing batches of 4 year old potted plants to different stages of bud flushing in Conviron walk-in growth chambers. These potted plants were grown from seeds in planting containers in our greenhouse. After one year, these seedlings were transplanted outside for normal growth under natural weather conditions. When seedlings began their third year of age, they were transplanted into pots. They were allowed to grow outside for two growing seasons in the pots to establish their roots. These 4 year potted plants were maintained in cold rooms during summer (April-August) to keep them dormant. They were transferred to growth chambers on a regular basis and grown to the required bud flush stages. The temperature regimes during cold storage varied slightly during spring, fall and winter depending on their status of dormancy, especially in the autumn when potted plants brought from the outside were placed in lower temperature growth chambers (-5°C to +5°C) for hardening off and for giving sufficient dormancy before transferring to growth chambers for flushing.

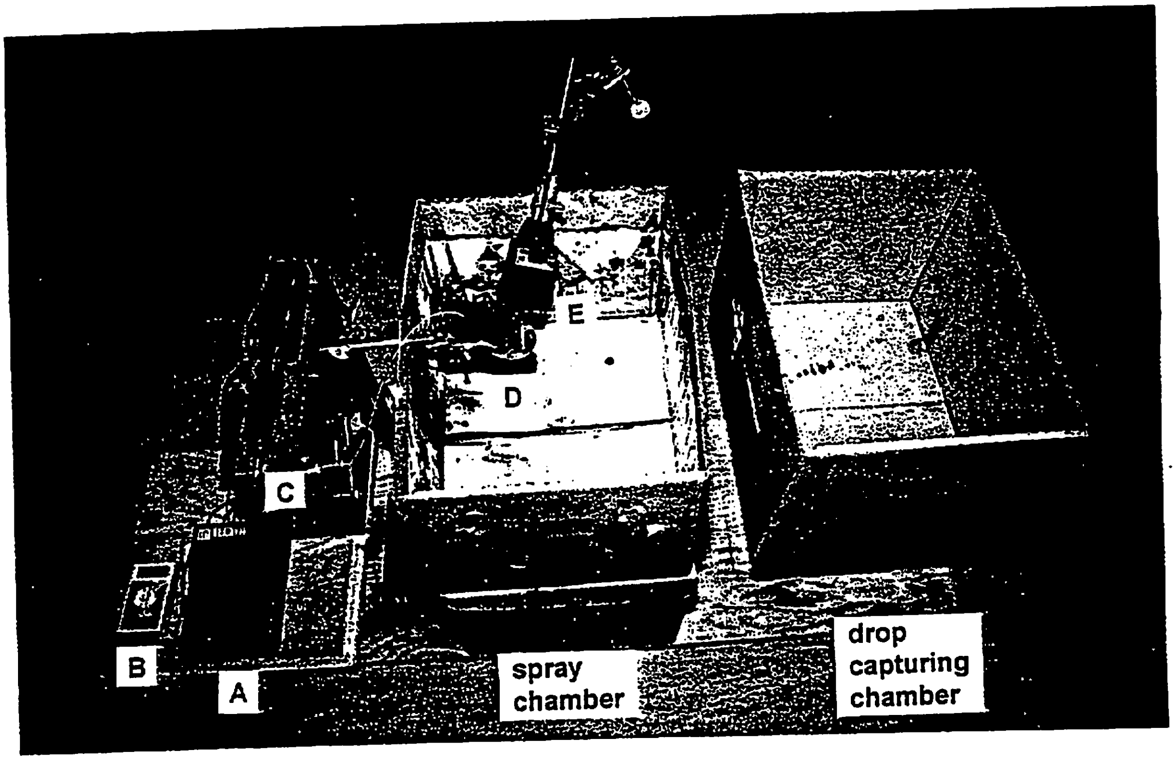
Dormant potted plants were sprayed with 5% Javex to prevent fungal growth and fumigated with Vapona to kill insects and mites before transferring to the Vapona-free growth chamber used for flushing. The growth chambers were maintained at 80% relative humidity, the photoperiod was set at 16:8 (L:D) h and the lights were kept at half intensity between 0600 and 0800 h. and 1800-2200 h. and at full intensity (13,450 lux) from 0800 to 1800 h. The temperature regime during the day was 24°C from 0800 to 1800 h and at night 18°C from 2200 to 0600 h. These above conditions were maintained in both the Vapona growth chamber and Vapona-free growth chamber. The potted plants were kept for one week in the Vapona chamber. Bud flushing of trees in the growth chambers varied from 3 days to 3 weeks depending upon their hardening off condition and the cold storage period, while the most common duration to flush was 7 to 9 days. Needles from bud classes 4 and 5 were used for dosing (Fig. 5).

INSECTICIDE TREATMENT

Droplet Generation

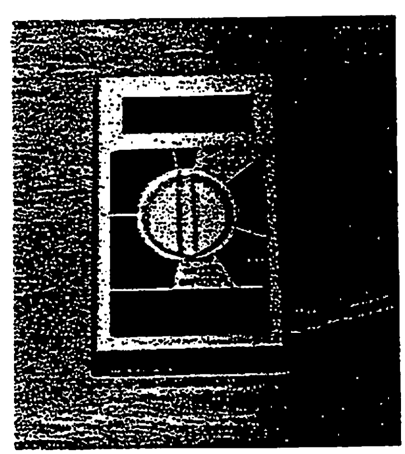
Droplets were generated by using a modified Mini ULVA atomizing system (Micron Agri Sprayers Canada Inc.). A 5 cm diameter mini spinning disc was rotated by using a DC power supply (Tech II Rail Power 1400 Model, Rectifier Corp.). A mini digital multimeter (Micronta, Intertan Canada Ltd.), was used to measure voltage and a Hobbico Digital Mini-Tach (Hobby Service) was used for measurement of RPM of the spinning disc. Syringe pump Model 341B (Sage Instruments, Orion Research Incorporated) equipped with a 50 ml syringe was used to control flow rate of insecticide formulations in the spinning disc (Fig. 3 and 3A to 3E). The required drop sizes were produced by changing the spinning disc rotation rate (between 3 and 13K rev-min-1) and the liquid flow rate (of 1.1 or 1.7 ml/minute).

FIGURE 3 : Mimic® spray unit and components 3A and 3B.



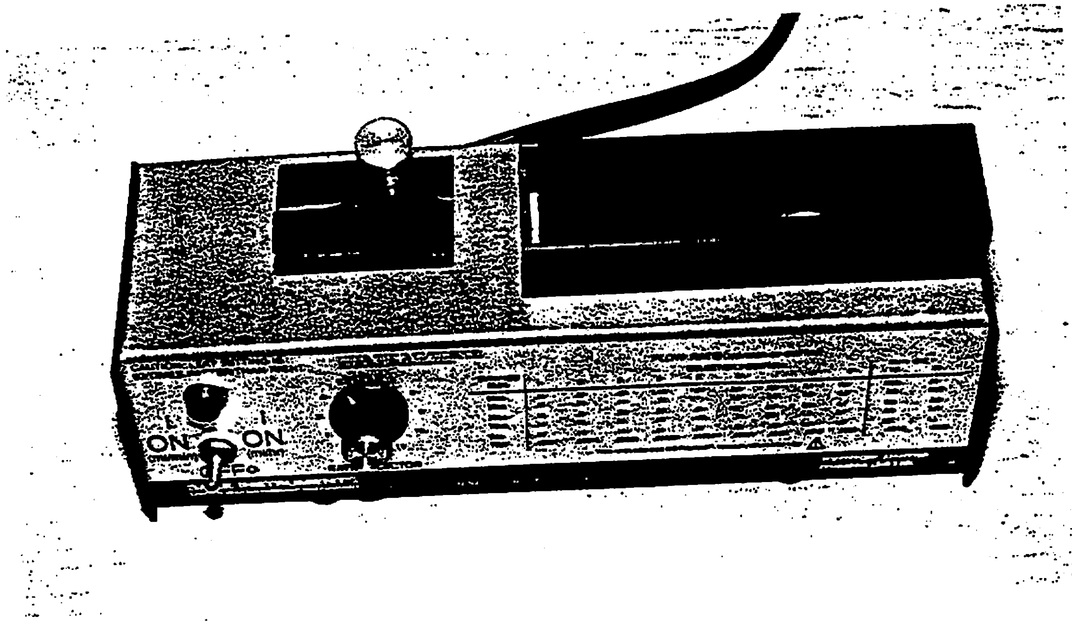
3. Mimic® spray unit, showing at left, control equipment; centre, spray chamber; right, drop capture chamber. A. Power supply B. Multimeter C. Syringe pump D. Spinning disk E. Tachometer

3A. Tech II Rail Power 1400 Model (DC Power Supply).

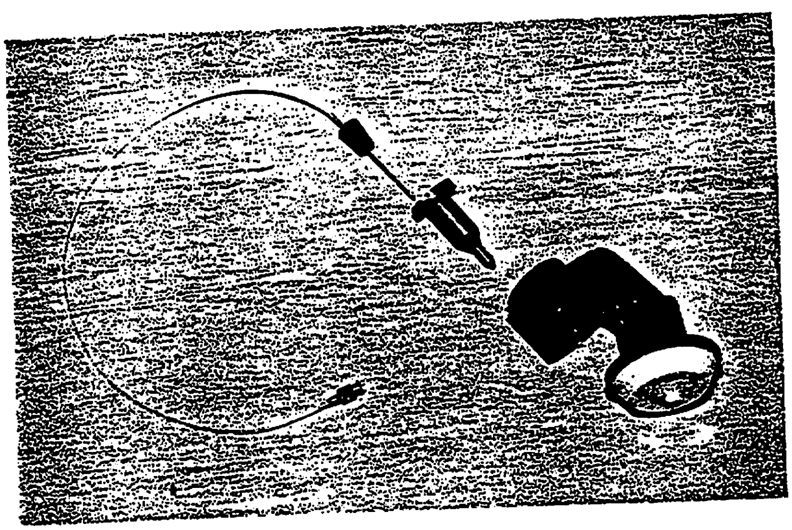


3B. Micronta Mini Digital Multimeter.

FIGURE 3 (Continued): Mimic® spray unit components 3C-3E.



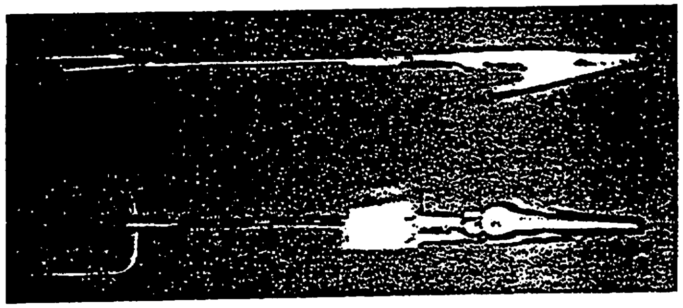
3C. Sage Syringe Pump Model 341B.



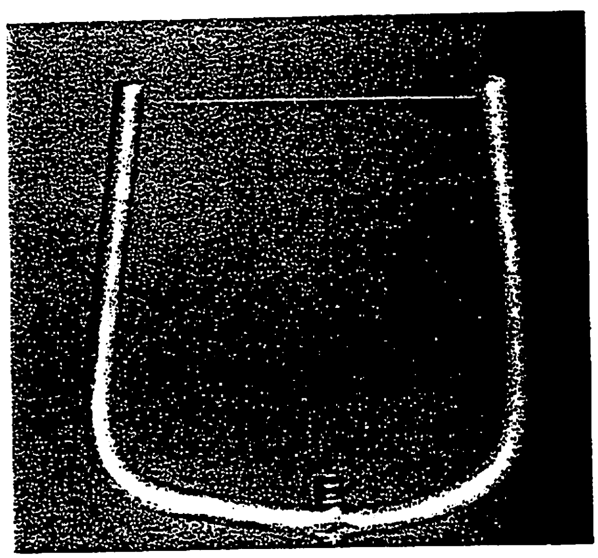
3D. Mini ULVA atomizer spinning disk (modified), showing delivery tubing and restrictor.

3E. Hobbico Digital Mini-Tach.

FIGURE 4: Harp droplet collectors.



4A. Harps used for droplet collection; actual length 13 cm, distance between tines 2 cm.



4B. Tine portion of a harp showing budworm silk strand which collected droplets.

Narrow spectrum drop size ranges were captured on budworm silk (2 µm diameter) strung on harps (Fig. 4) by passing poly-disperse droplets through a vertical slot (10 cm x 3 cm) in the spray chamber and horizontal slots in the drop capturing chamber. Drops of successively larger size classes were captured through the horizontal slots at increasing distances from the disc due to differences in aerodynamic drag exerted on different drop sizes (Walton and Prewett, 1949). Drops with diameters from 20 to 110 µm in 10 µm classes were captured for toxicity tests.

Drops were produced inside a fume hood, under still air conditions so that small drops could not be dislodged by air currents from the silk of the harps. High humidity was created in the drop capturing chamber by placing wet sponges and towels in it. This improved droplet capture on the silk of the harps.

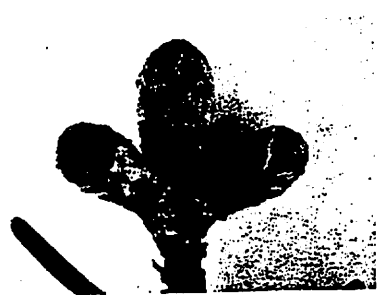
A Leitz Diaplan Scientific and Clinical compound microscope Model No. 0512 8340 was used to measure drops. The objective and eye pieces were 10X. The right eye piece was fitted with an ocular micrometer having a least count of 3.1 µm. The sized droplets were transferred directly from the harps to balsam fir needles from bud classes 4 and 5 (Fig. 5) for ingestion tests or to the dorsal surface of mid-body segment of larvae for contact toxicity tests. This was done with the aid of a Wild Zoom Stereomicroscope (Wild M7A). To capture smaller drops a finer thickness of silk was used. Treated needles were inserted individually into 0 size corks which had been partially split at the tapered end, with the treated area of needle exposed to the larva for ingestion. Each cork with a treated needle was inserted in a 1/4 dram glass vial (9 x 30mm) containing one twenty-four h starved larva. The treated needles were presented to larvae with least chance of contact with the droplets (Fig. 6).

In contact toxicity tests, treated individual larvae were placed in separate vials and fed untreated needles. These needles were inserted into the partially split cork which was inserted into the vial as above. Details of drop sizes and number of larvae used in each experiment are shown in the plans for each experiment along with the total number of tests used in each experiment (Appendices I to IV). Control insects were fed needles without any treatment or needles treated with a 10 or 20% glycerine blank.

Post Treatment Condition, Observation and Analysis:
Vials with treated foliage with insects were kept on a lab bench top at 20 ± 0.5°C and 40 ± 10% RH. After one day of treatment, the larvae were transferred from the vials to creamer cups containing fresh foliage, with only one larva/creamer cup. Control larvae were handled in a similar manner. Larvae were observed at intervals of 1, 3, 6 and 9 days and fresh foliage was added as required after three days. A detailed record was maintained for each larva on portion of the dosed needle consumed, the occurrence of head capsule separation, feeding and webbing activities, frass production, moulting to next instar and general health condition of larva including mortality up to nine day post treatment. Mortality at nine days was used in probit analyses. Log dose probit regressions were computed using SAS Institute program (Proc Probit, SAS Institute, Feb 1990).

FIGURE 5: Auger's bud development classes for balsam fir (From Morris et al 1984).

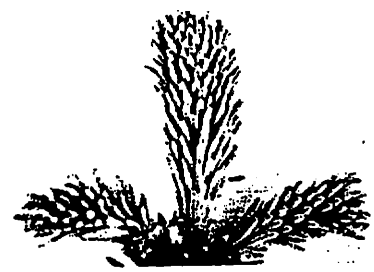
Class 1: The bud is resinous and enveloped by a membrane.



Class 2: The bud is swollen, and 10 to 35 percent of the needles are visible.

Class 3: All needles are visible, but the bud has not begun to flare.

Class 4: The bud is flaring—optimal time to start spraying.

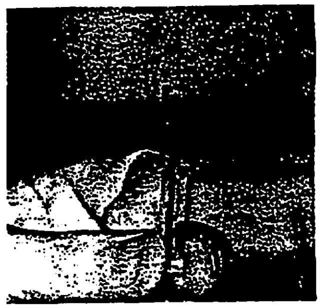


Class 5: The shoot is elongating.

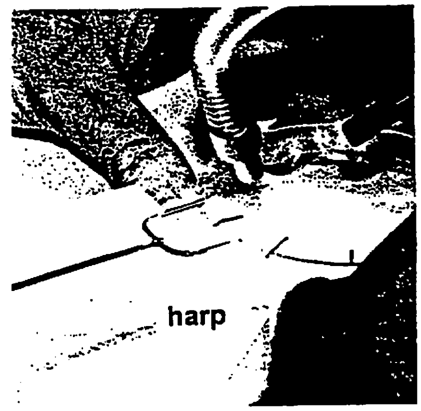
Figure 4—Auger's classes of bud development for balsam fir, *Abies balsamea* Mill. Note that spraying should take place when the majority of buds are in Class 4. (Photos by Quebec Department of Energy and Resources.)

Needles from bud development classes 4 and 5 were used for dosing larvae and more developed current foliage was used for pre- and post-treatment food sources.

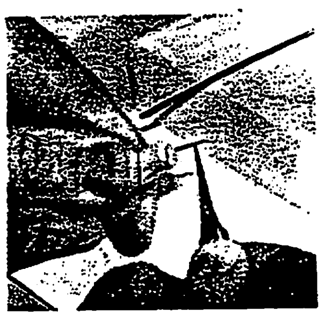
FIGURE 6: Sequence of steps followed to present a single insecticide dose for stomach toxicity to a larva.



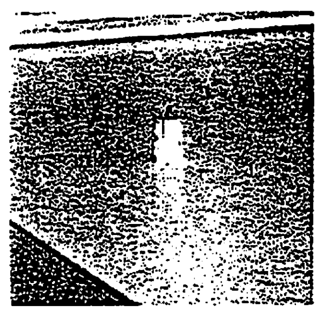
6A. Twenty-four h starved larva hanging from a brush by its silk strand and being placed in a shell vial.



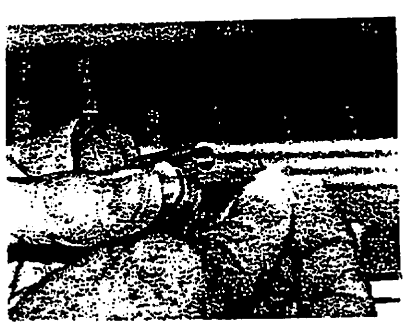
6B. Mimic® droplet being transferred from a harp silk strand to a balsam fir needle.



6C. Treated needle being inserted into a slit cork (size 0).



6D. Fir needle in a cork with treated portion exposed.



6E. Cork with fir needle being inserted into a 1/4 dram shell vial containing a starved budworm larva.

6F. Current foliage of balsam fir used for post-treatment food source.

EXPERIMENTS AND RESULTS

Five experiments were conducted involving 83 tests (Appendix III). Four experiments involved L5 and one used L4. Three experiments with L5 were for stomach toxicity and one for contact toxicity. A preliminary experiment for stomach toxicity was done with L4. The experimental details i.e., objective, plan of experiment, number of tests analyzed, results (Table 1a-5a), probit analysis (Table 1b-5b) and regression lines (Fig. 7-9) are given for experiments one to five. Drop sizes in µm of diameter causing 50 and 95% mortality are expressed as Effective Doses (ED_{50} and ED_{95}). LD_{50} and LD_{95} were also calculated and expressed as µg AI/mg body weight and µg AI/larva. Average body weight of L5 and L4 are given in each experiment. Results of probit analysis for individual experiments are further discussed in "Remarks". Only one experiment was conducted with the 17.5 g tank mix. This formulation gave 58% mortality in the 90-100 µm class droplets, hence, further testing with larger droplets was abandoned due to the original criteria of desired droplet sizes, based on the fenitrothion experience. Drop sizes for ED_{50} and ED_{95} values for this formulation were 92 and 216 µm respectively with the ED_{95} size being an extrapolated value (Table 1b).

Experiment 2-5 involved the 70 g AI mix with 10 or 20% glycerine for stomach and contact toxicity. Drop sizes for ED_{50} and ED_{95} values for stomach toxicity against L5 of 70 g formulation with 10% glycerine were 52 and 135 µm, while with 20% glycerine, drop sizes were 57 and 116 µm for ED_{50} and ED_{95} respectively. ED_{50} and ED_{95} values with the 20% glycerine formulation had narrower fiducial limits and steeper slopes i.e., response was more uniform as compared to the 10% glycerine formulation (Expt. 2 & 3 and Fig. 7 & 8). However, mortality appears to be reduced in smaller droplet sizes of 20% glycerine formulation when compared to 10% glycerine formulation (Table 2a & 3a).

In contact toxicity experiments with 70 g AI and 10% glycerine against L5, Mimic® exhibited some contact activity, although mortality from contact toxicity was less than from stomach toxicity for this instar. For example, the ED_{50} value (133 µm) for contact toxicity is practically the same as the ED_{95} value (135 µm) for stomach toxicity against L5 (Expt. 2 & 4). For practical purposes, contact toxicity is half of stomach toxicity on the basis of drop size.

When LD_{50} is expressed in µg AI/mg body weight, and stomach toxicity (0.0004 µg) and contact toxicity (0.006 µg) are compared, it is evident that Mimic® is 15 times more toxic as a stomach poison than as a contact poison. Its contact toxicity (0.006 µg/mg) to L5 is approximately the same as contact toxicity of fenitrothion (0.007 µg/mg) (Nigam 1990 unpublished). Only two tests were done with L4's (Expt. 5) using the 70 g AI and 10% glycerine formulation for stomach toxicity with two droplet classes tested (30-40 and 40-50 µm). When mortality of L4's is compared with mortality of L5's for the same classes of droplets sizes, L4's appear to be more susceptible (Expt. 2 & 5). However, when LD_{50}'s (µg/mg body wt) for stomach toxicity are compared then both instars require the same amount of AI i.e. 0.0004 µg. L4's require smaller droplet sizes and less active ingredient because their body weight is approximately 3.5 times less than L5 (Expt. 2 & 5).

SUMMARY & DISCUSSION

The results are summarized under the following headings:

(1) Efficacy of 17.5 g and 70 g/ha formulation against L5.

The formulation containing 17.5 g AI/ha in 2 litre was very dilute and gave poor toxicity in the desired droplet size range, while 70 g AI formulation gave effective mortality with the same drop sizes.

(2) Effect of 10% and 20% glycerine on the toxicity to L5 of 70 g AI/ha formulation.

Addition of 10% glycerine improved the physical stability of suspension, droplet formation and capture but there was great variation in mortality. The addition of 20% glycerine reduced variation in mortality within and among droplet size classes, but toxicity was slightly inhibited.

(3) Optimum concentration of glycerine and of other adjuvants.

The optimum concentration of glycerine should be determined if glycerine is going to be used in field formulations for releasing the maximum potency of Mimic® for stomach toxicity. Glycerine was chosen for these experiments as it was already present in the 2F product. If glycerine is not an economical additive it can be replaced by 10% ethylene glycol as this has been used in field experiments with Orthene® against spruce budworm to prevent evaporation and freezing of water formulations in tank mixes and during spraying (Armstrong J.A. and Nigam P.C., 1975). Alternatively, any other registered adjuvant can be used which increases the stability of suspension and the homogeneity of Mimic® particles in droplets at field dilutions. Regardless which material is selected, the adjuvant should be environmentally compatible or benign.

(4) Stomach toxicity vs contact toxicity against L5.

Mimic® has both stomach and contact toxicity. Contact toxicity is approximately 15 times less than stomach toxicity. However, its contact toxicity to L5 is approximately equal to contact toxicity of fenitrothion. Helson (1991 unpublished) has found Mimic® 5.20 times more toxic than fenitrothion as a contact poison and its contact toxicity is equivalent to aminocarb.

(5) Susceptibility of L4 and L5 to Mimic®

Fourth instar larvae of spruce budworm (L4) are more susceptible than fifth-instar larvae (L5), because L4 weight is about 3.5 times less than L5.

It is recommended that formulation of Mimic® be improved before further field testing. Total volume of the 70 g AI/ha formulation should be reduced from 2 litres to 1 litre/ha, which will increase the concentration of active ingredient from 3.5% to 7% and will produce more potent droplets. This will increase effectiveness as observed in 17.5 g AI vs 70 g AI/ha formulations. The present 70 g AI/ha in 2 litres contains 94 to 96% inert diluent (H_20), which is too high and gives very dilute droplets. This amount of diluent increases the cost of application, as spray aircraft must transport too much water relative to AI.

ACKNOWLEDGEMENT

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EXPERIMENT NO. 1

Objective:

To determine droplet sizes of 17.5 g AI/ha Mimic® formulation with 10 % glycerine for ED_{50} and ED_{95} values against fifth-instar spruce budworm larvae for ingestion (stomach toxicity).

Plan of Experiment:

Treatments - Four (3 droplet size classes 30-40, 60-70, 90-100 µm and control).

Concentration of AI in formulation -	3.6%
No. of larvae per replication -	Approx. 30
No. of replications -	1
Total No. larvae treated in analysis -	81
Control or Untreated larvae -	29
No. of mortality observations -	4 at an interval of 1, 3, 6 and 9 days after treatment. Nine days cumulative mortality used for analysis.
Tests analyzed (Appendix III & IV) -	M5 - M7
Tests excluded -	None

Table 1a. Dose and cumulative mortality at nine days from treatment of 17.5 g AI/ha formulation with 10% glycerine against fifth instar spruce budworm for ingestion.

Droplet Size Class (µm)	Mean Droplet Diameter (µm) ± Standard Dev.	Mean Active Ingredient (µg) ± Standard Dev.	Dead / Total Tested	Mortality	
				Percent	Corrected Percentage
30 - 40	35.13 ± 2.53	0.00020 ± 0.00004	3/29	10.34	7.14
60 - 70	66.25 ± 2.04	0.00134 ± 0.00012	5/25	20.00	17.14
90 - 100	94.71 ± 1.89	0.00390 ± 0.00024	16/27	59.26	57.80
Total Treated			24/81	29.63	27.12
Control or Check			1/29	3.45	-

Table 1b: Summary of PROBIT ANALYSIS+.

	Slope+ ± SE	Drop DIA (µm)	F.L. (95%)	Slope+ ± SE	µg/mg body wt.⊕	F.L. (95%)
ED_{50} & LD_{50}	4.42 ± 1.76	91.89	75.98 - 182.65	1.48 ± 0.59	0.00051	0.00029 - 0.00387
ED_{95} & LD_{95}		216.25	135.52 - 8201.0		0.00771	0.00179 - 613.14
				Slope+ ± SE	µg/larva	F.L.
			LD_{50}	1.48 ± 0.59	0.00356	0.00202 - 0.02708
			LD_{95}		0.05400	0.01251 - 4292.0

+ Base Log 10 F.L. = Fiducial Limits (95%) ⊕ = Average weight per larva = 7.0 mg

Remarks: Further testing was abandoned due to low mortality of 90-100 µm droplets because 3.6% active ingredient in the formulation appeared to be too low.

EXPERIMENT NO. 2

Objective:

To determine droplet sizes of 70 g AI/ha Mimic® formulation with 10% glycerine for ED_{50} and ED_{95} values against fifth-instar spruce budworm larvae for ingestion (stomach toxicity).

Plan of Experiment:

Treatments - Eight (7 droplet size classes 30-40, 40-50, 50-60, 60-70, 80-90, 90-100, 100-110 µm and control).

Concentration of AI in formulation -	14.6%
No. of larvae per replication -	Approx. 30
No. of replications -	3 to 5 (Appendix IA)
Total No. larvae treated in analysis -	709
Control or Untreated larvae -	284
No. of mortality observations -	Four at an interval at 1, 3, 6, and 9 days after treatment. Nine days cumulative mortality used for analysis.
Tests analyzed -	M5-11, M14-18, M20-21, M26-28, M32-34, M40-44
Tests excluded -	M4, M35-37, (>10% control mortality)

Table 2a. Dose and cumulative mortality at nine days from treatment of 70 g AI/ha formulation with 10% glycerine against fifth instar spruce budworm for ingestion.

Droplet Size Class (µm)	Mean Droplet Diameter (µm) ± Standard Dev.	Mean Active Ingredient (µg) ± Standard Dev.	Dead / Total Tested	Mortality	
				Percent	Corrected Percentage
30 - 40	33.62 ± 2.24	0.00071 ± 0.00014	32/115	27.83	25.17
40 - 50	41.79 ± 2.00	0.00135 ± 0.00021	43/112	38.39	36.12
50 - 60	51.42 ± 1.71	0.00250 ± 0.00025	54/117	46.15	44.17
60 - 70	64.29 ± 2.50	0.00489 ± 0.00058	81/112	72.32	71.30
80 - 90	84.78 ± 2.55	0.01120 ± 0.00101	100/139	71.94	70.91
90 - 100	98.35 ± 2.11	0.01746 ± 0.00110	28/30	93.33	93.09
100 - 110	101.49 ± 2.42	0.01919 ± 0.00142	80/84	95.24	95.06
Total Treated			418/709	58.96	57.45
Control or Check			10/284	3.55	-

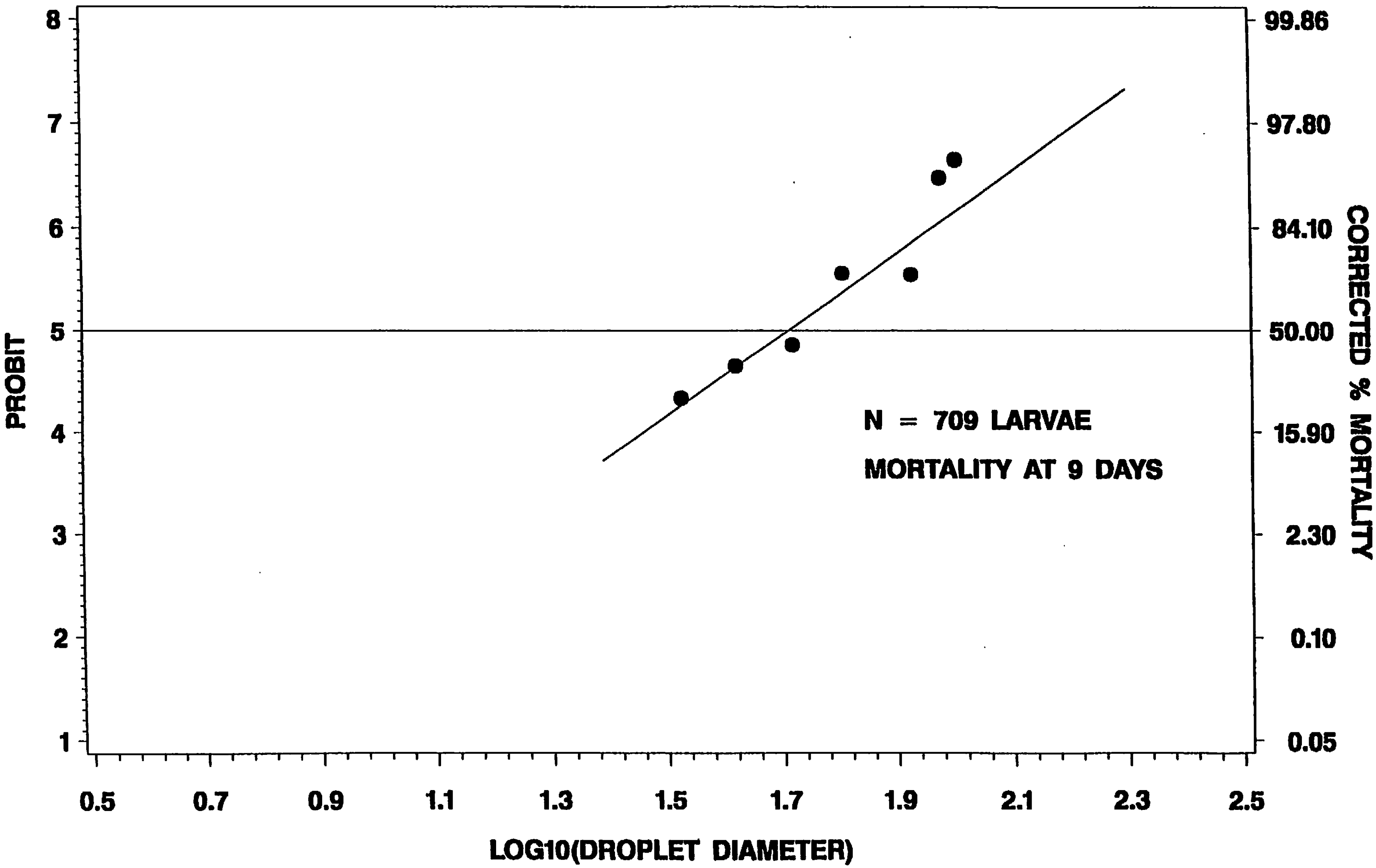
Table 2b: Summary of PROBIT ANALYSIS+. The regression line is given in Fig. 7.

	Slope+ ± SE	Drop DIA (µm)	F.L. (95%)	Slope+ ± SE	µg/mg body wt.⊕	F.L. (95%)
ED_{50} & LD_{50}	3.96 ± 0.62	51.74	43.07 - 59.71	1.32 ± 0.20	0.00036	0.00021 - 0.00056
ED_{95} & LD_{95}		134.80	102.81 - 243.28		0.00640	0.00285 - 0.03725
				Slope+ ± SE	µg/larva	F.L.
			LD_{50}	1.32 ± 0.20	0.00255	0.00148 - 0.00392
			LD_{95}		0.04477	0.01993 - 0.26075

+ Base Log 10   F.L. = Fiducial Limits (95%) ⊕ = Average weight per larva = 7.0 mg

Remarks: Fiducial limits are very broad. There is great variation in mortality within and between drop size classes (Appendix 1A) probably due to uneven distribution of active ingredient in droplets.

Figure 7. Ld – p Line of Single Droplets Of Mimic® (RH5992) By Ingestion of 70 g AI/Ha, with 10% Glycerine Against V Instar Spruce Budworm Larvae



EXPERIMENT NO. 3

Objective:

To determine droplet sizes of 70 g AI/ha Mimic® formulation with 20% glycerine for ED_{50} and ED_{95} values against fifth-instar spruce budworm larvae for ingestion (stomach toxicity).

Plan of Experiment:

Treatments - Eight (7 droplet size classes 20-30, 30-40, 40-50, 50-60, 60-70, 80-90, 90-100 µm and control).

Concentration of AI in formulation -	14.6%
No. of larvae per replication -	Approx. 30
No. of replications -	3 (Appendix IB)
Total No. larvae treated in analysis -	607
Control or Untreated larvae -	201
No. of mortality observations -	Four at an interval at 1, 3, 6, and 9 days after treatment. Nine days cumulative mortality used for analysis.
Tests analyzed -	M52-60, M62-73.
Tests excluded -	None

Table 3a. Dose and cumulative mortality at nine days from treatment of 70 g AI/ha formulation with 20% glycerine against fifth instar spruce budworm for ingestion.

Droplet Size Class (μm)	Mean Droplet Diameter (μm) ± Standard Dev.	Mean Active Ingredient (μg) ± Standard Dev.	Dead / Total Tested	Mortality	
				Percent	Corrected Percentage
20 - 30	29.81 ± 0.72	0.00049 ± 0.00003	8/86	9.30	7.45
30 - 40	37.11 ± 2.42	0.00095 ± 0.00017	10/87	11.49	9.70
40 - 50	47.86 ± 2.18	0.00202 ± 0.00027	34/87	39.08	37.84
50 - 60	58.58 ± 1.46	0.00369 ± 0.00027	54/87	62.07	61.30
60 - 70	64.95 ± 2.93	0.00505 ± 0.00068	57/88	64.77	64.06
80 - 90	88.88 ± 1.74	0.01288 ± 0.00073	73/86	84.88	84.58
90 - 100	96.94 ± 2.36	0.01672 ± 0.00121	73/86	84.88	84.58
Total Treated			309/607	50.91	49.91
Control or Check			4/201	1.99	-

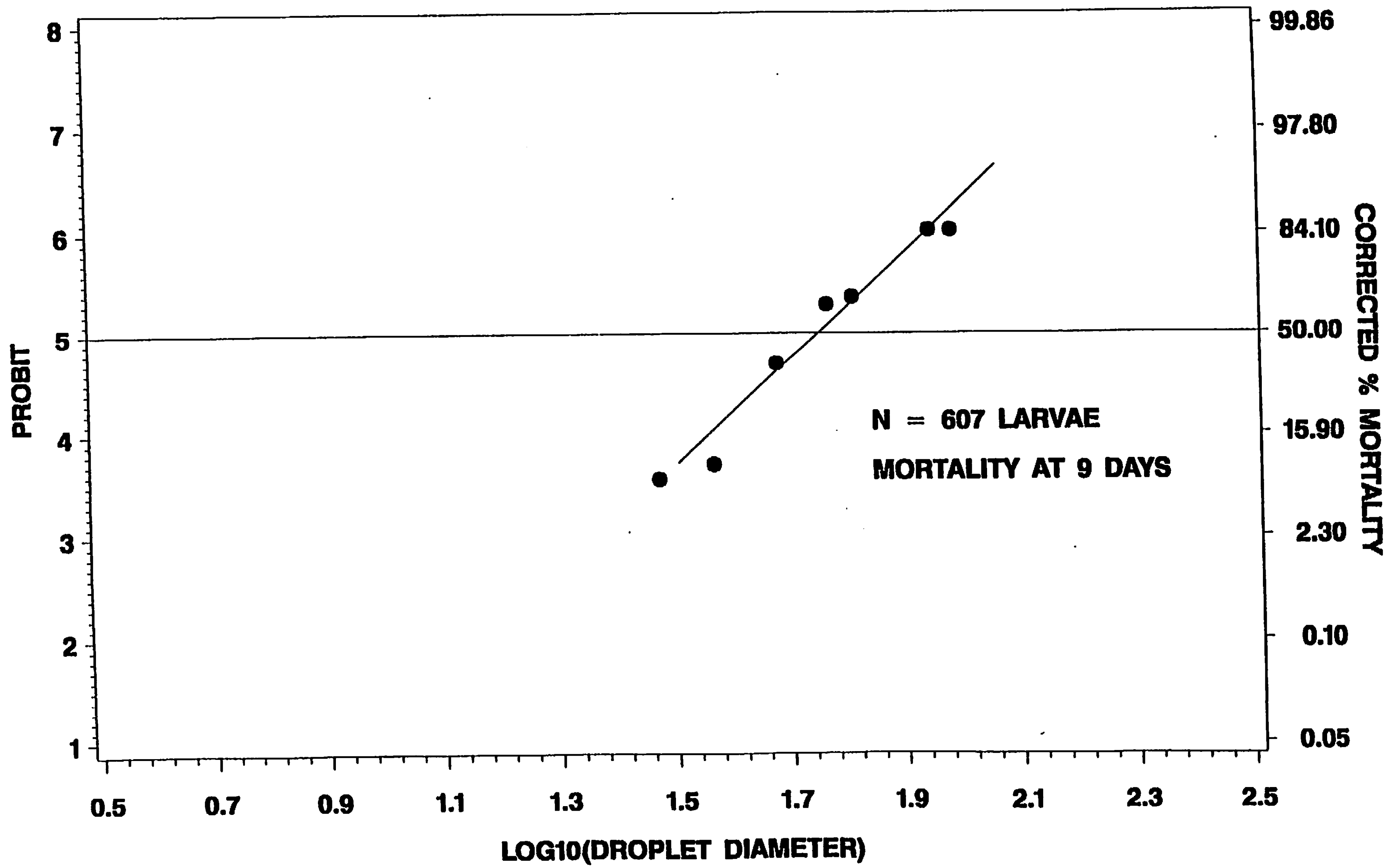
Table 3b: Summary of PROBIT ANALYSIS+. The regression line is given in Fig. 8.

	Slope+ ± SE	Drop DIA (μm)	F.L. (95%)	Slope+ ± SE	μg/mg body wt.⊕	F.L. (95%)
ED_{50} & LD_{50}	5.25 ± 0.42	56.60	53.67 - 59.62	1.75 ± 0.13	0.00048	0.00041 - 0.00056
ED_{95} & LD_{95}		116.44	105.09 - 133.22		0.00414	0.00304 - 0.00620
				Slope+ ± SE	μg/larva	F.L.
			LD_{50}	1.75 ± 0.13	0.00334	0.00285 - 0.00390
			LD_{95}		0.02897	0.02130 - 0.04337

+ Base Log 10 F.L. = Fiducial Limits (95%) ⊕ = Average weight per larva = 7.0 mg

Remarks: Fiducial limits are narrower than those found for the 10% glycerine formulation. There is relatively low variation in mortality within and in between drop size classes (Appendix IB) compared to the 10% glycerine treatment. ED_{50} size is higher and the ED_{95} size is lower and the slope of the Ld-p line is steeper in comparison with the 10% glycerine formulation.

Figure 8. Ld-p Line of Single Droplets Of Mimic® (RH5992) By Ingestion of 70 g AI/Ha, with 20% Glycerine Against V Instar Spruce Budworm Larvae



EXPERIMENT NO. 4

Objective:

To determine droplet sizes of 70 g AI/ha Mimic® formulation with 10% glycerine for ED_{50} and ED_{95} values against fifth-instar for contact toxicity.

Plan of Experiment:

Treatments - Six (5 droplet size classes, 30-40, 50-60, 60-70, 80-90, 100-110 µm and control).

Concentration of AI in formulation -	14.6%
No. of larvae per replication -	Approx. 30
No. of replications -	3 to 4 (Appendix II)
Total No. larvae treated in analysis -	495
Control or Untreated larvae -	201
No. of mortality observations -	Four at an interval at 1, 3, 6, and 9 days after treatment. Nine days cumulative mortality used for analysis.
Tests analyzed -	M19-31, M38-39, M46-51, M75-79, M81-83
Tests excluded -	None

Table 4a. Dose and cumulative mortality at nine days from treatment of 70 g AI/ha formulation with 10% glycerine against fifth instar spruce budworm for contact toxicity.

Droplet Size Class (µm)	Mean Droplet Diameter (µm) ± Standard Dev.	Mean Active Ingredient (µg) ± Standard Dev.	Dead / Total Tested	Mortality	
				Percent	Corrected Percentage
30 - 40	34.79 ± 2.70	0.00078 ± 0.00018	18/109	16.51	14.82
50 - 60	56.03 ± 2.47	0.00324 ± 0.00042	18/78	23.08	21.52
60 - 70	62.26 ± 1.78	0.00443 ± 0.00039	17/100	17.00	15.31
80 - 90	82.00 ± 1.63	0.01012 ± 0.00063	35/117	29.91	28.49
100 - 110	101.62 ± 2.89	0.01928 ± 0.00173	46/91	50.55	49.55
Total Treated			134/495	27.09	25.59
Control or Check			4/201	1.99	-

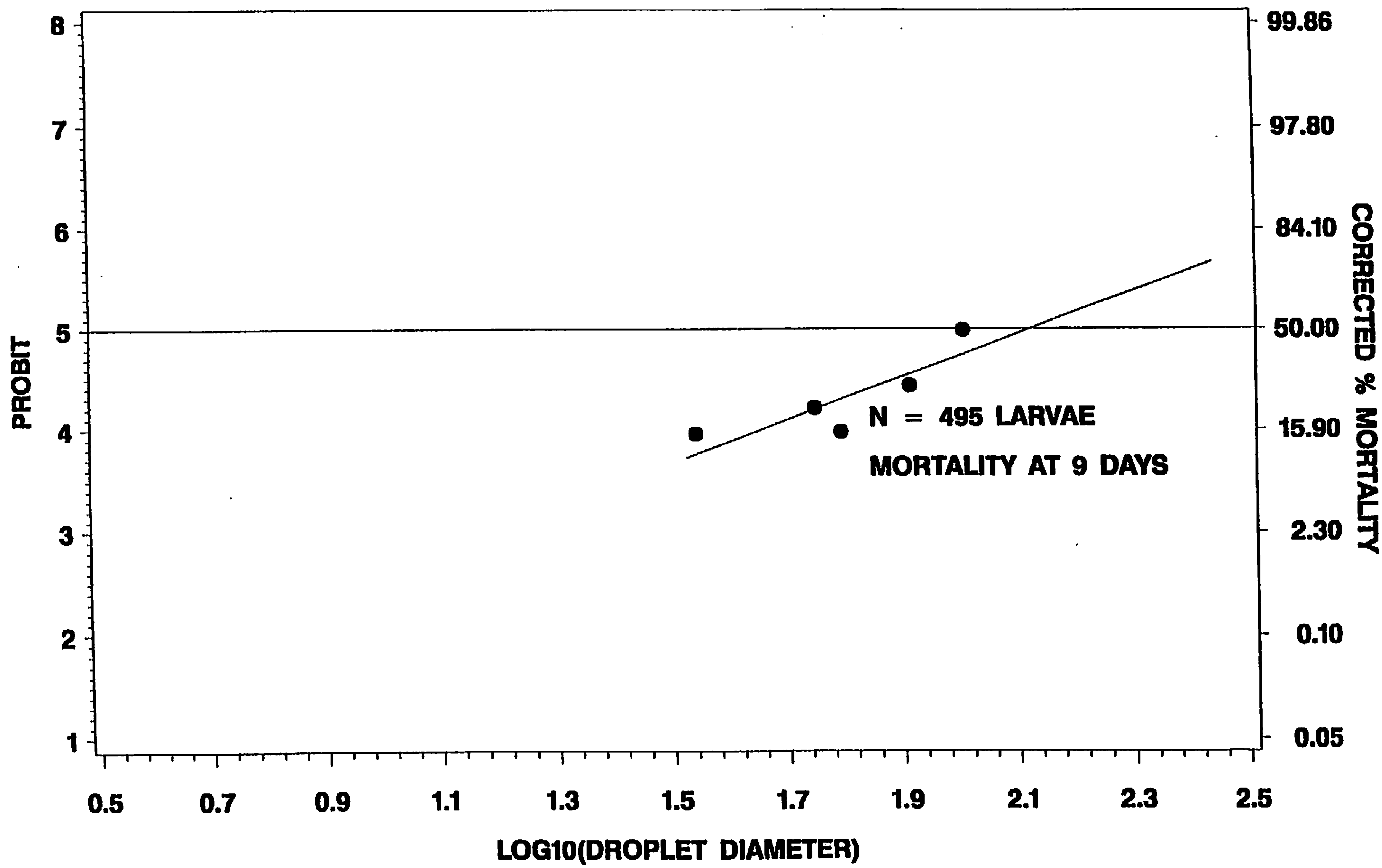
Table 4b: Summary of PROBIT ANALYSIS+. The regression line is given in Fig. 9.

	Slope+ ± SE	Drop DIA (µm)	F.L. (95%)	Slope+ ± SE	µg/mg body wt.⊕	F.L. (95%)
ED_{50} & LD_{50}	2.14 ± 0.79	133.04	-	0.72 ± 0.26	0.00612	-
ED_{95} & LD_{95}		780.23	-		11.93801	-
				Slope+ ± SE	µg/larva	F.L.
			LD_{50}	0.72 ± 0.26	0.04282	-
			LD_{95}		8.35661	-

+ Base Log 10 F.L. = Fiducial Limits (95%) ⊕ = Average weight per larva = 7.0 mg

Remarks: Mortality with the 100-110 µm size class was close to 50% and larger size classes were not tested, so ED_{50} and ED_{95} are extrapolated values. No fiducial limits were found due to insufficient data. To calculate a proper regression of contact toxicity larger droplet size classes should be tested.

Figure 9 . Ld–p Line of Single Droplets Of Mimic® (RH5992) By Contact of 70 g AI/Ha with 10% Glycerine Against V Instar Spruce Budworm Larvae



EXPERIMENT NO. 5

<u>Objective:</u>

To determine droplet sizes of 70 g AI/ha Mimic® formulation with 10% glycerine for ED_{50} and ED_{95} values against fourth-instar spruce budworm larvae for ingestion (stomach toxicity).

<u>Plan of Preliminary Experiment:</u>

Treatments - Three (2 droplet size, 30-40, 40-50 µm and control).

Concentration of AI in formulation -	14.6%
No. of larvae per replication -	Approx. 30
No. of replications -	1
Total No. larvae treated in analysis -	57
Control or Untreated larvae -	29
No. of mortality observations -	Four at an interval at 1, 3, 6, and 9 days after treatment. Nine days cumulative mortality used for analysis.
Tests analyzed -	M12-13
Tests excluded -	None

Table 5a. Dose and cumulative mortality at nine days from treatment of 70 g AI/ha formulation with 10% glycerine against fourth instar spruce budworm for ingestion.

Droplet Size Class (µm)	Mean Droplet Diameter (µm) ± Standard Dev.	Mean Active Ingredient (µg) ± Standard Dev.	Dead / Total Tested	Mortality	
				Percent	Corrected Percentage
30 - 40	32.52 ± 2.12	0.00064 ± 0.00014	12/28	42.86	42.86
40 - 50	43.01 ± 2.87	0.00148 ± 0.00032	20/29	68.97	68.97
Total Treated			32/57	56.14	56.14
Control or Check			0/29	0.00	-

Table 5b: Summary of PROBIT ANALYSIS+.

	Slope+ ± SE	Drop DIA (µm)	F.L. (µm)	Slope+ ± SE	µg/mg body wt.⊕	F.L.
ED_{50} & LD_{50}	5.56 ± 2.80	35.04	0.10 - 42.04	1.85 ± 0.93	0.00040	0 - 0.00069
ED_{95} & LD_{95}		69.25	50.11 - -		0.00308	0.00117 - -
				Slope+ ± SE	µg/larva	F.L.
			LD_{50}	1.85 ± 0.93	0.00079	0 - 0.00138
			LD_{95}		0.00617	0.00234 - -

+ Base Log 10 F.L. = Fiducial Limits (95%) ⊕ = Average weight per larva = 2.0 mg

Remarks: This is a preliminary experiment. ED_{95} is extrapolated. There is insufficient data to perform a proper analysis.

Appendices I A & B
Mortality in Replications of Experiments 2 and 3 for 70 g Formulation Against L5, Observations @ 9 Days for Ingestion Toxicity

Droplet Size Class (µm)	R1			R2			R3			R4			R5			Totals		
	Test #	D/T	%	Test #	D/T	%	Test #	D/T	%	Test #	D/T	%	Test #	D/T	%	No. of Tests	D/T	%
Tests and Mortality for Experiment 2 with 10% Glycerine (Appen. IA)																		
30-40	M8	8/28	28.6	M14	12/30	40.0	M20	6/29	20.7	M26	6/28	21.4				4	32/115	27.8
40-50	M11	5/28	17.8	M32	16/28	57.1	M35	21/27	77.8	M40	10/29	34.5	M43	12/27	44.4	5	64/139	46.0
50-60	M9	9/30	30.0	M17	18/29	62.1	M21	13/30	43.3	M36	23/28	82.1	M41	14/28	50.0	5	77/145	53.1
60-70	M10	16/27	59.3	M15	21/30	70.0	M23	21/26	80.8	M44	23/29	79.3				4	81/112	72.3
80-90	M18	23/27	85.2	M22	7/29	24.1	M27	16/26	61.5	M33	29/30	96.7	M42	25/27	92.6	5	100/139	71.9
90-100	M4	27/28	96.4	M34	28/30	93.3	M37	27/28	96.4							3	82/86	95.3
100-110	M16	28/30	93.3	M24	27/28	96.4	M28	25/26	96.2							3	80/84	95.2
1. Cumulative untreated control mortality was 18/339 = 5.3% 2. 10% glycerine controls had mortality of 4/89 = 4.5%																		
Tests and Mortality for Experiment 2 with 20% Glycerine (Appen. IB)																		
20-30	M52	3/28	10.7	M55	5/30	16.7	M58	0/28	0.0							3	8/86	9.3
30-40	M53	4/30	13.3	M62	3/29	10.3	M68	3/28	10.7							3	10/87	11.5
40-50	M56	11/28	39.3	M65	10/29	34.5	M71	13/30	43.3							3	34/87	39.1
50-60	M59	15/28	53.4	M63	22/30	73.3	M69	17/29	58.6							3	54/87	62.1
60-70	M60	15/30	50.0	M66	22/30	73.3	M72	20/28	71.4							3	57/88	64.8
80-90	M54	24/29	82.8	M64	27/29	93.1	M70	22/28	78.6							3	73/86	84.9
90-100	M57	24/28	85.7	M67	23/29	79.3	M73	26/29	86.7							3	73/86	84.9
1. Cumulative untreated control mortality was 4/201 = 2.0% 2. 20% glycerine control had mortality of 1/57 = 1.8%																		

Appendix II
Mortality in Replications of Experiment 4 for 70 g Formulation Against L5, Observations @ 9 Days for Contact Toxicity

10% Glycerine															
Droplet Size	R1			R2			R3			R4			Totals		
Class (µm)	Test #	D/T	%	Test #	D/T	%	Test #	D/T	%	Test #	D/T	%	No. of Tests	D/T	%
30-40	M29	0/19	0.0	M46	9/30	30.0	M50	6/30	20.0	M75	3/30	10.0	4	18/109	16.5
50-60	M38	4/20	20.0	M76	9/29	31.0	M78	5/29	17.2				3	18/78	23.1
60-70	M30	1/17	5.9	M47	5/28	17.8	M51	8/25	32.0	M81	3/30	10.0	4	17/100	17.0
80-90	M49	10/29	34.5	M77	14/29	48.3	M79	8/29	27.6	M82	3/30	10.0	4	35/117	29.9
100-110	M31	10/18	55.6	M39	14/20	70.0	M48	15/28	53.6	M83	7/25	28.1	4	46/91	50.5

1. Cumulative untreated control mortality was 4/201 = 2.0%

2. 10% glycerine control had mortality of 3/30 or 10.0%

Appendix III

RH5992 - Master Sheet
All Mimic® Tests Excluding Untreated Controls
(0.2% Erio Acid Red Dye)

Field Dose Equiv.	Test #	Treated Day Date	Instar	Size Class (µm)	Formulation % Conc. (AI)	% Glycerine	Type of Tox. Test
70 g	M1	Fri. Aug. 28, 1992	L4	50-60	14.6	5	Ingestion
17.5 g	M2	Tues. Sept. 01, 1992	L5	50-60	3.6	5	Ingestion
17.5 g	M3	Wed. Sept. 02, 1992	L4	30-40	3.6	10	Ingestion
70 g	M4	Thur. Sept. 03, 1992	L5	90-100	14.6	10	Ingestion
17.5 g	M5	Tues. Sept. 08, 1992	L5	30-40	3.6	10	Ingestion
17.5 g	M6	Tues. Sept. 08, 1992	L5	60-70	3.6	10	Ingestion
17.5 g	M7	Tues. Sept. 08, 1992	L5	90-100	3.6	10	Ingestion
70 g	M8	Wed. Sept. 09, 1992	L5	30-40	14.6	10	Ingestion
70 g	M9	Wed. Sept. 09, 1992	L5	50-60	14.6	10	Ingestion
70 g	M10	Wed. Sept. 09, 1992	L5	60-70	14.6	10	Ingestion
70 g	M11	Wed. Sept. 09, 1992	L5	40-50	14.6	10	Ingestion
70 g	M12	Wed. Sept. 30, 1992	L4	30-40	14.6	10	Ingestion
70 g	M13	Wed. Sept. 30, 1992	L4	40-50	14.6	10	Ingestion
0	M12A	Wed. Sept. 30, 1992	L4	30-40	0	10	Glycerine control
70 g	M14	Tues. Oct. 06, 1992	L5	30-40	14.6	10	Ingestion
70 g	M15	Tues. Oct. 06, 1992	L5	60-70	14.6	10	Ingestion
70 g	M16	Tues. Oct. 06, 1992	L5	100-110	14.6	10	Ingestion
70 g	M17	Wed. Oct. 07, 1992	L5	50-60	14.6	10	Ingestion
70 g	M18	Wed. Oct. 07, 1992	L5	80-90	14.6	10	Ingestion
0	M19	Wed. Oct. 07, 1992	L5	50-60	0	10	Glycerine Control
70 g	M20	Tues. Oct. 13, 1992	L5	30-40	14.6	10	Ingestion
70 g	M21	Tues. Oct. 13, 1992	L5	50-60	14.6	10	Ingestion
70 g	M22	Tues. Oct. 13, 1992	L5	80-90	14.6	10	Ingestion
70 g	M23	Wed. Oct. 14, 1992	L5	60-70	14.6	10	Ingestion
70 g	M24	Wed. Oct. 14, 1992	L5	100-110	14.6	10	Ingestion
0	M25	Wed. Oct. 14, 1992	L5	60-70	0	10	Glycerine control

Appendix III (Continued)

Field Dose Equiv.	Test #	Treated Day Date	Instar	Size Class (µm)	Formulation % Conc. (AI)	% Glycerine	Type of Tox. Test
70 g	M26	Thurs. Oct. 15, 1992	L5	30-40	14.6	10	Ingestion
70 g	M27	Thurs. Oct. 15, 1992	L5	80-90	14.6	10	Ingestion
70 g	M28	Thurs. Oct. 15, 1992	L5	100-110	14.6	10	Ingestion
70 g	M29	Thurs. Nov. 5, 1992	L5	30-40	14.6	10	Contact
70 g	M30	Thurs. Nov. 5, 1992	L5	60-70	14.6	10	Contact
70 g	M31	Thurs. Nov. 5, 1992	L5	100-110	14.6	10	Contact
70 g	M32	Tues. Nov. 10, 1992	L5	40-50	14.6	10	Ingestion
70 g	M33	Tues. Nov. 10, 1992	L5	80-90	14.6	10	Ingestion
70 g	M34	Tues. Nov. 10, 1992	L5	90-100	14.6	10	Ingestion
70 g	M35	Weds. Nov. 11, 1992	L5	40-50	14.6	10	Ingestion
70 g	M36	Weds. Nov. 11, 1992	L5	50-60	14.6	10	Ingestion
70 g	M37	Weds. Nov. 11, 1992	L5	90-100	14.6	10	Ingestion
70 g	M38	Thurs. Nov. 12, 1992	L5	50-60	14.6	10	Contact
70 g	M39	Thurs. Nov. 12, 1992	L5	100-110	14.6	10	Contact
70 g	M40	Tues. Nov. 17, 1992	L5	40-50	14.6	10	Ingestion
70 g	M41	Tues. Nov. 17, 1992	L5	50-60	14.6	10	Ingestion
70 g	M42	Tues. Nov. 17, 1992	L5	80-90	14.6	10	Ingestion
70 g	M43	Weds. Nov. 18, 1992	L5	40-50	14.6	10	Ingestion
70 g	M44	Weds. Nov. 18, 1992	L5	60-70	14.6	10	Ingestion
0 g	M45	Weds. Nov. 18, 1992	L5	50-60	0	10	Glycerine control
70 g	M46	Tues. Nov. 24, 1992	L5	30-40	14.6	10	Contact
70 g	M47	Tues. Nov. 24, 1992	L5	60-70	14.6	10	Contact
70 g	M48	Tues. Nov. 24, 1992	L5	100-110	14.6	10	Contact
70 g	M49	Wed. Nov. 25, 1992	L5	80-90	14.6	10	Contact
70 g	M50	Wed. Nov. 25, 1992	L5	30-40	14.6	10	Contact
70 g	M51	Wed. Nov. 25, 1992	L5	60-70	14.6	10	Contact
70 g	M52	Tues. Dec. 8, 1992	L5	20-30	14.6	20	Ingestion
70 g	M53	Tues. Dec. 8, 1992	L5	30-40	14.6	20	Ingestion
70 g	M54	Tues. Dec. 8, 1992	L5	80-90	14.6	20	Ingestion
70 g	M55	Wed. Dec. 9, 1992	L5	20-30	14.6	20	Ingestion
70 g	M56	Wed. Dec. 9, 1992	L5	40-50	14.6	20	Ingestion

Appendix III (Continued)

Field Dose Equiv.	Test #	Treated Day Date	Instar	Size Class (µm)	Formulation % Conc. (AI)	% Glycerine	Type of Tox. Test
70 g	M57	Wed. Dec. 9, 1992	L5	90-100	14.6	20	Ingestion
70 g	M58	Thurs. Dec. 10, 1992	L5	20-30	14.6	20	Ingestion
70 g	M59	Thurs. Dec. 10, 1992	L5	50-60	14.6	20	Ingestion
70 g	M60	Thurs. Dec. 10, 1992	L5	60-70	14.6	20	Ingestion
0	M61	Thurs. Dec. 10, 1992	L5	50-60	0	20	Glycerine Control
70 g	M62	Tues. Jan 12, 1993	L5	30-40	14.6	20	Ingestion
70 g	M63	Tues. Jan 12, 1993	L5	50-60	14.6	20	Ingestion
70 g	M64	Tues. Jan 12, 1993	L5	80-90	14.6	20	Ingestion
70 g	M65	Wed. Jan 13, 1993	L5	40-50	14.6	20	Ingestion
70 g	M66	Wed. Jan 13, 1993	L5	60-70	14.6	20	Ingestion
70 g	M67	Wed. Jan 13, 1993	L5	90-100	14.6	20	Ingestion
70 g	M68	Thurs. Jan 14, 1993	L5	30-40	14.6	20	Ingestion
70 g	M69	Thurs. Jan 14, 1993	L5	50-60	14.6	20	Ingestion
70 g	M70	Thurs. Jan 14, 1993	L5	80-90	14.6	20	Ingestion
70 g	M71	Tues. Jan 19, 1993	L5	40-50	14.6	20	Ingestion
70 g	M72	Tues. Jan 19, 1993	L5	60-70	14.6	20	Ingestion
70 g	M73	Tues. Jan. 19, 1993	L5	90-100	14.6	20	Ingestion
0	M74	Tues. Jan. 19, 1993	L5	50-60	0	20	Glycerine control
70 g	M75	Wed. Jan. 20, 1993	L5	30-40	14.6	10	Contact
70 g	M76	Wed. Jan. 20, 1993	L5	50-60	14.6	10	Contact
70 g	M77	Wed. Jan. 20, 1993	L5	80-90	14.6	10	Contact
70 g	M78	Thurs. Jan. 21, 1993	L5	50-60	14.6	10	Contact
70 g	M79	Thurs. Jan. 21, 1993	L5	80-90	14.6	10	Contact
0	M80	Thurs. Jan. 21, 1993	L5	50-60	0	10	Glycerine control
70 g	M81	Tues. Feb. 9, 1993	L5	60-70	14.6	10	Contact
70 g	M82	Tues. Feb. 9, 1993	L5	80-90	14.6	10	Contact
70 g	M83	Tues. Feb. 9, 1993	L5	100-110	14.6	10	Contact

Appendix IV

RH5992 - Master List
All Untreated Control Mortalities Used in Mimic® Tests

Control Test #	Set Up Day	Set Up Date	Instar	Applicable to Treatment Test #	D/T	Mortality Percent
CM1	Fri.	Aug. 28/92	L4	M1	1/30	3.3
CM2	Tues.	Sept. 01/92	L5	M2	3/30	10.0
CM3	Wed.	Sept. 02/92	L4	M3	5/30	16.7
CM4	Thur.	Sept. 03/92	L5	M4	3/27	11.1
CM 5-7	Thur.	Sept. 08/92	L5	M5-M7	1/29	3.4
CM 8-11	Wed.	Sept. 09/92	L5	M8-M11	5/50	10.0
CM 12-13	Wed.	Sept. 30/92	L4	M12-M13	0/29	0.0
CM 14-16	Tues.	Oct. 06/92	L5	M14-M16	0/29	0.0
CM 17-19	Wed.	Oct. 07/92	L5	M17-M19	0/30	0.0
CM 20-22	Tues.	Oct. 13/92	L5	M20-M22	0/28	0.0
CM 23-25	Wed.	Oct. 14/92	L5	M23-M25	0/29	0.0
CM 26-28	Thur.	Oct. 15/92	L5	M26-M28	0/29	0.0
CM 29-31	Thur.	Nov. 5/92	L5	M29-M31	2/30	6.7
CM 32-34	Tues.	Nov. 10/92	L5	M32-M34	1/29	3.4
CM 35-37	Wed.	Nov. 11/92	L5	M35-M37	5/30	16.7
CM 38-39	Thur.	Nov. 12/92	L5	M38-M39	0/30	0.0
CM 40-42	Tues.	Nov. 17/92	L5	M40-M42	1/28	3.6
CM 43-45	Wed.	Nov. 18/92	L5	M43-M45	3/30	10.0
CM 46-48	Tues.	Nov. 24/92	L5	M46-M48	0/27	0.0
CM 49-51	Wed.	Nov. 25/92	L5	M49-M51	0/28	0.0
CM 52-54	Tues.	Dec. 8/92	L5	M52-M54	0/29	0.0
CM 55-57	Wed.	Dec. 9/92	L5	M55-M57	0/29	0.0
CM 58-61	Thur.	Dec. 10/92	L5	M58-M61	1/29	3.4
CM 62-64	Tues.	Jan. 12/93	L5	M62-M64	0/30	0.0
CM 65-67	Wed.	Jan. 13/93	L5	M65-M67	2/25	8.0
CM 68-70	Thurs.	Jan. 14/93	L5	M68-M70	0/29	0.0
CM 71-74	Tues.	Jan. 19/93	L5	M71-M74	1/30	3.3
CM 75-77	Wed.	Jan. 20/93	L5	M75-M77	0/29	0.0
CM 78-80	Thurs.	Jan. 21/93	L5	M78-M80	1/30	3.3
CM 81-83	Tues.	Feb. 9/93	L5	M81-M83	1/27	3.7

Appendix V
Sources of Equipment

Mini ULVA atomizing system
Micron Agri Sprayers Canada Inc.
R.R. #3
Walkerton, ON
N0G 2V0

DC power supply
Tech II Rail Power 1400 Model
Rectifier Corp.
Edison, NJ
08817 USA

Mini digital multimeter
Micronta
Intertan Canada Ltd.
279 Bayview Drive
Barrie, ON
L4M 4W5

Digital mini-tach
Hobbico Digital Mini-Tach - Hobby Service
1610 Interstate Drive
Champaign, IL
6182 USA

Syringe pump
Sage Instruments
Orion Research Incorporated
529 Main Street
Boston, MA
02129, USA

Contact and Residual Toxicity of Mimic® and Fenitrothion Against Spruce Budworm Larvae

by

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and Forest Protection Technical Committee
Government Conference Centre, Ottawa
November 20-23, 1995

1. Canadian Forest Service - Fredericton
2. Canadian Forest Service - Sault Ste. Marie

Contact and Residual Toxicity of Mimic® and Fenitrothion Against Spruce Budworm Larvae

Mimic® has shown potential to control spruce budworm larvae (Helson et al 1992) and field experiments have given promising results (Cadogan et al 1994). In 1995, it has been used in R & D blocks and operational trials at the rate of 70 g AI/ha in one application or two applications of 35 g AI/ha in volumes varying from 0.5 to 2 L (Davies 1995). The optimum drop spectrum for 70 g AI/ha in 2 L was found to be 50 - 116 µm in the laboratory on the basis of ED_{50} and ED_{95} values for stomach toxicity alone (Nigam and Holmes 1995).

It is approximately 5 to 15 times less toxic as a contact than as a stomach insecticide depending upon its formulation (Table 1). Contact toxicity is also found against agricultural lepidopterous larvae by Smagghe & Degheele (1994). Its contact and residual toxicities could play a significant role in controlling spruce budworm as evident from tables 2 and 3. It is approximately equal or 5 times more toxic as a contact insecticide than fenitrothion and its residual toxicity is much greater than fenitrothion taking into consideration dosage and duration of effective mortality.

The mortality of second instars observed in the field by Retnakaran in 1994 may be due to contact by first instars with residues present in the field, as fifth instar budworm larvae require 0.006 µg AI/mg body weight for contact toxicity. First instars will require minute amounts due to less weight. It appears that contact toxicity and long residual toxicity of this insecticide may have an added advantage in population management of spruce budworm. It could be used to treat first instars and the strategy of spraying could be changed to time it with egg hatching instead of fourth and fifth instars. It seems to be benign to other components of the forest ecosystem especially the entomophagous insects(McFadden 1995; Smagghe & Degheele 1994).

References

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Table 1. Stomach vs Contact Toxicity of Mimic® (2F) Against Spruce Budworm Larvae

Instar	Stomach LD_{50}	Contact LD_{50}	Ratio
Fifth instar	0.0004 µg/mg	0.006 µg/mg	15.0
Sixth instar	0.006 µg/larva	0.032 µg/larva	5.3

Table 2. Contact Toxicity of Mimic® and Fenitrothion Against Fifth Instar Spruce Budworm Larvae

Insecticides	Treatments			
	Single Droplets		Potter Tower Spraying	
	LD_{50} (µg/mg)	Ratio	ED_{50} (µg/cm^2)	Ratio
Mimic®	0.006	1.1	0.072	5.2
Fenitrothion	0.007	1.0	0.375	1.0

Table 3. Residual Toxicity of Mimic® (2F) and Fenitrothion Against Fifth Instar Spruce Budworm Larvae

				Corrected % Mortality after 11 days						
				Weathering period of residues in days						
Insecticide	**Year**	**Deposit (g AI/ha)**	**Tree Species**	**0**	**1**	**3**	**5**	**7**	**10**	**20**
Mimic®	1990	50	white spruce	100	97	86	88	58	74	75
Mimic®	1990	50	balsam fir	100	98	98	94	100	83	77
Fenitrothion EC	1991	200	white spruce	97	75	39	12	0	0	-
Mimic®	1991	25	white spruce	93	92	92	84	66	51	-
Mimic®	1991	25	balsam fir	88	93	97	86	74	72	8

Potted trees were sprayed and placed outdoors under natural weathering conditions.

Buds were clipped from treated trees after weathering period (days) and fifth instar larvae were exposed to these buds in the laboratory for 3 days and then transferred to fresh untreated foliage. Final mortality was recorded after 11 days.

Environmental Chemistry of Forestry Insecticides

Project No. FP-72, Environmental and Ecological Chemistry

[Study No. FP-72/02, Environmental Chemistry of Insect Management Products]

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Effects of Additives in Some Commercial Formulations of Azadirachtin on the Phytophagous Spider Mite, *Tetranychus Urticae* Koch.

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ABSTRACT

Pure azadirachtin-A (AZ-A) and four neem-based formulations (RH, MO, PT and AT) containing the insecticide isomer were tested for their repellency, toxicity and oviposition deterrence against the phytophagous two-spotted spider mite (*Tetranychus urticae* Koch). Mites were placed on treated and untreated aspen (*Populus tremuloides* Michx.) leaf discs and their fecundity, feeding rate and mortality were assessed. Results indicated that the effects of AZ-A on *T. urticae* varied with formulation type and AZ-A concentration. Significant reductions in feeding and oviposition, which correlated with AZ-A concentrations, were recorded concomitantly with a significant increase in repellency. Leaf discs treated with increasing concentrations of the formulations showed increased mortality of *T. urticae*, reduction in the total number of eggs laid, reduced % of eggs hatched and reduced survival of emerged mites. The deterrent and biological effects decreased in the order AT>PT>MO>RH>AZ-A.

INTRODUCTION

Outbreaks of mites in greenhouses are usually controlled by the use of conventional broad-spectrum synthetic pesticides having miticidal properties (Hardman *et al.*, 1995; Hall and Thacker, 1993). However, in recent years the emphasis to control the pest populations has shifted steadily from the use of traditional chemicals towards more specific and environmentally friendly biological pesticides, which are either microbial or biochemical in origin. These pesticides are distinguished from the conventional chemicals by their natural occurrence and nontoxic mode of action to the target pest (McClintock *et al.*, 1994). Among the natural pesticides, azadirachtin (AZ), a mixture of nine structurally-related tetranortriterpenoid isomers isolated from the kernels of neem tree or Indian lilac, *Azadirachta indica* A. Juss (Meliaceae) (Govindachari *et al.*, 1992), has been the focus of much research in recent years because of its insecticidal, antifeedant and growth-inhibiting properties to various pests (Rembold, 1989). The major isomer, azadirachtin-A (AZ-A), has high insecticidal and miticidal activities, and is relatively safe to non-target and beneficial organisms (Schmutterer, 1990). Two neem-based formulations [Margosan-O®, containing 0.3 % AZ and 14 % neem oil (W.R. Grace and Co., Columbia, MD) and Azatin®, containing 3 % AZ, 4 % naphthalene and 2 % *n*-butanol (AgriDyne Tech. Inc., Salt Lake City, UT)] are commercially available in USA (Mansour *et al.*, 1993).

Considerable information is found in the literature regarding the biological activity of neem-based formulations on mites (Mansour *et al.*, 1993; Jacobson *et al.*, 1978; Schauer and Schmutterer, 1981; Mansour and Ascher, 1984; Mansour *et al.*, 1987; Dimetry *et al.*, 1993). Solvents in neem seed kernel extracts (Mansour and Ascher, 1983; Mansour *et al.*, 1986; 1987) and formulation additives (Mansour *et al.*, 1993; Dimetry *et al.*, 1993) are reported to influence the mortality, repellency and fecundity of mites. However, none of the data reported so far compared the miticidal properties of pure AZ-A with the two commercial preparations of neem seed extracts (Margosan-O and Azatin) containing AZ-A in order to evaluate quantitatively and unambiguously, the biological effects of the active ingredient and the additives present in the two formulations on mites. Here we report the results of laboratory experiments that were conducted to determine the effects of pure AZ-A and four of its formulations [two experimental, RH-9999-20WP® (Rohm and Haas Co., Spring House, PA, USA) and Neem PTI-EC4® (Phero Tech Inc., Delta, BC, Canada); and the two commercial formulations, Margosan-O and Azatin, mentioned above] on the two-spotted spider mite, *Tetranychus urticae* Koch. We measured repellency, feeding, mortality, fecundity and related biological effects of the five materials.

METHODS AND MATERIALS

Azadirachtin-A and Formulations

Pure AZ-A (> 95 % purity, Sigma Chemical Co., St. Louis, MO), two commercial formulations (Margosan-O and Azatin) and two experimental formulations (RH-9999 and Neem PTI-EC4), hereafter referred to as AZ-A, MO, AT, RH and PT, respectively, were used in the study. The nature and precise composition of the various formulations are proprietary information of the manufacturers and were unavailable. Usually, these formulations contained a mixture of concentrated neem material with AZ-A as the active component, plus solvents, UV screeners, antioxidants and surfactants. The AZ-A content (wt. %) in the formulations, determined by liquid chromatography (Sundaram and Curry, 1993), was: RH 19.7, MO 0.31, PT 3.95 and AT 3.10. Four concentrations of the test materials, ranging from 313 to 2500 µg/mL, were prepared in methanol and tested against the mites.

Leaf Discs and Mites

Leaf discs (diam. 4.2 cm) cut from greenhouse-grown poplar (*Populus tremuloides* Michx.) seedlings were used. The mites, *T. urticae*, used were reared on poplar plants kept in quarantine at the research centre.

Method

To study the repellency of female adult *T. urticae*, one-half of the lower surface of each leaf disc was treated separately with 25.0 µL of the individual test solutions using a pre-calibrated Gilson Pipetman®P fitted with a standard 200-µL plastic pipet tip. Using the pipet tip, the solution was spread uniformly to cover, completely, half the surface area of each disc. The other half was covered with 25 µL of methanol and served as the control. The liquid film on the leaf discs was dried in a current of dry nitrogen and then the discs were placed, with the treated (lower) surface upwards, in a petri dish (diam. 9 cm) lined with moist cotton wool (Cadogan and Laing, 1977). Ten adult female *T. urticae* were then placed on a plastic disc (diam. 0.4 cm), fixed to the centre of each leaf disc, using a fine camel's-hair brush. The petri dish units were placed in an environmental chamber (Controlled Environments, Winnipeg, Canada) kept at 20 ± 1°C, RH 80 % and 16:8 (light:dark) photoperiod. Ten replicate leaf discs were used per concentration of each material. The four concentrations ($\mu g/cm^2$) of AZ-A used in the study were 1.13, 2.26, 4.51 and 9.02. At 24-h after treatment, the number of mites that moved to the treated and control half-discs [repellency (mites which had left the discs were considered as repelled)], the number of eggs laid on each half (treated and control) and mortality of mites were recorded. Mites were recorded as dead when they did not respond to gentle prodding. Percent repellency was calculated using a modification of the Abbott's formula (Abbott, 1925), [(% mites in control – % mites in treated)/(% mites in control)×100].

The effects of AZ-A concentration and formulation additives on feeding activity, egg production and fertilization, and survival of emerging mites after hatching were studied as above with the following changes. Newly emerged female mites were placed singly on aspen leaf discs treated on both halves with a total of 50 μL of different concentrations (1.13–9.02 $\mu g/cm^2$) of AZ-A and the formulations. Thirty replicate leaf discs were used per concentration and a similar number of discs, treated with methanol only, acted as controls. The petri dish units were maintained in the environmental chamber as described earlier. The total number of feeding scars (leaf abrasions) and eggs laid on the treated and control discs were recorded over a period of 7 days. The eggs were sized using a Wild M3 Heerbrugg microscope fitted with MMS 235 measuring device. The mortality of the mites, % hatch of eggs and the incubation period were also recorded. The number of feeding scars on each leaf disc per mite per day represented the feeding rate of mites.

Statistical Analyses

For each parameter measured, the data were analysed using the analysis of variance test [ANOVA (Ryan *et al.*, 1985)] and Student-Newman-Keuls (S-N-K) test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Repellency

Percent repellency gradually increased with AZ-A concentration (Table 1) and differed significantly (S-N-K test, $\alpha \leq 0.05$) with the type of formulation, decreasing in the order AT>PT>MO>RH>AZ-A. This indicated that the additives in AT had the highest irritant and concomitant repellent effect on the mites as the pure AZ-A had a less pronounced effect. However, it is relevant to point out that neem-based commercial formulations are crude products. In addition to AZ-A and its isomers, formulations do contain a host of other terpenoids such as nimbin, gedunin, salannin, vilasinin and their derivatives, along with lipids and sulfur-containing compounds (Ley *et al.*, 1993). Therefore, it stands to reason that their ability to repel *T. urticae* could be due to the combined influence (based on their relative concentrations) of AZ-isomers, other terpenoids, lipids, sulfur-containing compounds and formulation additives. The structure-activity relationships of formulation ingredients, the mechanisms underlying the irritant effects of these materials and the type of sensing organs of mites involved are yet to be fully explored.

Mortality and Oviposition Deterrence

No significant difference in 24-h mortality was detected for AZ-A (Table 2) when the concentration was increased eight-fold from 1.13 to 9.02 $\mu g/cm^2$ (S-N-K test, $\alpha > 0.05$). However, significant effects on mortality were noted ($\alpha \leq 0.05$) when concentrations of the formulations increased. For example, with the increase in concentration from 1.13 to 9.02 $\mu g/cm^2$, the % mortality increased from 2 % (MO) or 3 % (AT) to 6 %. With RH and PT, the trend was similar albeit at a slightly lower rate, increasing only from 3 to 5 %.

The percent oviposition deterrence (% OD), calculated from the formula [(eggs in control – eggs in treated)/(total eggs in treated and control)×100], was dose-related and increased gradually with increase in concentration of AZ-A and other additives in the formulations (Table 2). The increase in % OD with

TABLE 1
Concentration Effects of AZ-A and its Four Formulations on Percent Repellency (Corrected) of Adult Female *T. Urticae* From Aspen Leaf Discs, 24 h After Treatment

Concn. of AZ-A (μg/cm²)	% Repellency (corrected)[q] ± SD				
	AZ-A	RH	MO	PT	AT
1.13	56 ± 4^{a}	61 ± 2^{ab}	74 ± 5^{cd}	75 ± 6^{cd}	80 ± 4^{cde}
2.26	65 ± 3^{ab}	69 ± 3^{bc}	79 ± 4^{cd}	84 ± 3^{de}	92 ± 3^{ef}
4.51	70 ± 5^{bc}	75 ± 4^{cd}	85 ± 6^{de}	88 ± 4^{ef}	96 ± 4^{fg}
9.02	76 ± 4^{c}	84 ± 3^{d}	90 ± 3^{e}	92 ± 2^{ef}	97 ± 3^{fg}

q: Values with the same superscript letters in the same columns or in the same rows are not significantly different from one another (S-N-K test, $\alpha > 0.05$).

TABLE 2
Percent Mortality[q] (% M)* and Oviposition Deterrence[s] (% OD) of Adult Female *T. Urticae* on Aspen Leaf Discs, 24 h After Treatment With AZ-A and Four of its Formulations

Concn. of AZ-A (μg/cm²)	AZ-A		RH		MO		PT		AT	
	% M	% OD	% M	% OD	% M	% OD	% M	% OD	% M	% OD
1.13	2^{a}	55.6^{u}	3^{a}	67.6^{v}	2^{a}	74.3^{v}	3^{a}	77.4^{w}	3^{a}	79.2^{w}
2.26	2^{a}	59.5^{uv}	3^{a}	70.3^{v}	3^{a}	78.6^{w}	3^{a}	78.8^{w}	4^{ab}	84.6^{wx}
4.51	3^{a}	64.9^{v}	4^{ab}	81.8^{w}	4^{ab}	86.3^{x}	5^{b}	87.5^{x}	4^{ab}	89.7^{x}
9.02	3^{a}	69.1^{v}	5^{b}	86.8^{x}	6^{b}	93.2^{y}	5^{b}	93.6^{y}	6^{b}	95.3^{y}

q,s: Values with the same superscript letters in the same columns or in the same rows are not significantly different from one another (q: S-N-K test, $\alpha > 0.05$; s: ANOVA $P > 0.05$).

* Mortality data included the mites on treated and control halves of leaf disc.

concentration could be attributed to feeding inhibition and irritant effects of the formulations, causing depression of reproductive activity. In addition to concentration dependence, the % OD also varied according to the type of formulation used in testing. The % OD values decreased in the same order, concomitant to repellency [higher for AT (range 79.2 to 95.3 %) and lower for AZ-A (range 55.6–69.1 %)] at all the four concentration levels studied.

Concentration Effects on Feeding, Reproduction and Mortality

Significant reductions in the total number of feeding scars, fecundity (no. eggs/mite/d), eggs produced per mite during the 7-d period and % reduction in no. of eggs/mite/7 d (Table 3) were found for all the five formulations studied at the two concentration levels (1.13 and 9.02 $\mu g/cm^2$) (ANOVA $P \leq 0.05$). It is apparent from the data in Table 3 that all these parameters were dose- and formulation-related. The number of feeding scars/mite/day in the treated leaf discs was significantly lower compared to the control discs and it decreased considerably with increase in concentration. The concentration-related decrease in feeding activity was somewhat related to the number of *T. urticae* which avoided the treated discs. The data in Table 3 suggest that the depression in feeding activity was related to formulation type and it was severe with AT and less so with AZ-A. Oviposition (fecundity) was severely reduced as the concentration of AZ-A increased. These observations are in agreement with Dimetry *et al.* (1993). Among the formulations, AT had the most pronounced detrimental effect on the production of eggs by *T. urticae*, subsequently the severity diminished in the order PT>MO>RH>AZ-A. Even at the low concentration (1.13 $\mu g/cm^2$), a reduction in total fecundity (per mite per 7 d) was observed, ranging from 33.9 % (AZ-A) to 72.1 % (AT). The role of additives in the suppression of egg production, and the mechanisms involved therein, are still poorly understood. Despite the reduction in number of eggs produced, our data suggest that the egg size on treated leaf discs was similar to that of the control (diam.~140 μm) and was not influenced either by concentration or formulation type.

TABLE 3
Concentration Effects of AZ-A and its Four Formulations on Feeding, Reproduction and Mortality of Newly Emerged *T. Urticae* From Young Female Mites Placed on Treated Aspen Leaf Discs for 7 Days at 1.13 and 9.02 μg/cm² Concentrations

Parameter	Con-trol	AZ-A		RH		MO		PT		AT	
		1.13	9.02	1.13	9.02	1.13	9.02	1.13	9.02	1.13	9.02
Av. no. of [a] feeding scars/mite/d	1.67	1.48	0.61	1.33	0.54	1.21	0.40	1.02	0.31	0.81	0.23
Fecundity[a] (Av. no. of eggs/mite/d)	6.8	3.3	1.2	2.6	0.66	2.0	0.54	1.4	0.34	1.1	0.19
Av. no. of [a] eggs/mite/ 7 d	47.4	23.4	8.4	18.1	4.6	14.1	3.8	9.9	2.4	7.7	1.3
Reduction[a] in no. of eggs/mite/ 7 d (%)	–	33.9	69.9	44.7	82.3	54.2	85.2	65.5	90.4	72.1	94.7
Egg diam. (av.)(μm)	141	140	141	141	139	141	140	141	140	139	141
Egg hatch[a] (av.)(%)	98	92	74	86	69	86	69	88	64	84	66
Mortality[b] (%)	0	11	84	14	86	13	88	17	94	21	98
Incubation period (d)	4.4	4.6	5.2	4.7	5.5	4.9	6.1	5.0	6.2	5.2	6.3

a,b: For each formulation, values at the two different concentrations are significantly different from each other (a: ANOVA $P \leq 0.05$; b: S-N-K test, $\alpha \leq 0.05$).

The number of eggs which hatched during the 7-d interval was influenced, to some extent, by the concentration and it was pronounced, especially at 9.02 $\mu g/cm^2$. For example, the % hatch ranged from 84 to 92 at the lower concentration level compared to only 64 to 74 at the higher concentration. However, % mortality was significantly concentration-dependent. At 9.02 $\mu g/cm^2$, it was severe with all the formulations as well as the pure AZ-A; nevertheless, it was very pronounced, especially with the PT and AT formulations. Depending on the type of formulation used for treatment, marked differences in the incubation period of the eggs were observed between the treated and control sets at both concentration levels. Usually, the incubation period was longer at the higher concentration and it varied according to the formulation type.

The concentration effects of each formulation on % repellency and % OD were analysed by linear regression analysis using the model $y = a + bx$. They were positively correlated, and the equations with numerical values for a (intercept) and b (slope), along with the correlation coefficient, r, for the formulations are listed below.

Formulation	% Repellency	% OD
AZ-A	$y = 57.3 + 2.25\,x,\ r = 0.857$	$y = 55.4 + 1.63\,x,\ r = 0.920$
RH	$y = 60.9 + 2.69\,x,\ r = 0.937$	$y = 66.1 + 2.48\,x,\ r = 0.893$
MO	$y = 73.9 + 1.91\,x,\ r = 0.916$	$y = 73.2 + 2.34\,x,\ r = 0.952$
PT	$y = 76.9 + 1.84\,x,\ r = 0.782$	$y = 75.3 + 2.13\,x,\ r = 0.946$
AT	$y = 84.0 + 1.71\,x,\ r = 0.581$	$y = 79.2 + 1.90\,x,\ r = 0.925$

CONCLUSIONS

The active ingredient, AZ-A, and the different additives in the neem-based formulations influenced the repellency, fecundity, feeding rate, reproduction and mortality of *T. urticae* females under controlled laboratory conditions. The effects observed were dose- and formulation-related.

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UPDATE ON EXOTIC FOREST PESTS AND PLANT QUARANTINE ISSUES

gypsy moth policy

Agriculture and Agri-food Canada (AAFC) finalized its gypsy moth policy, which defines AAFC's role in the management of the North American gypsy moth (NAGM), in July of 1995. Under this policy, NAGM is recognized as being established in parts of four provinces: Ontario, Quebec, New Brunswick and Nova Scotia. AAFC will not be responsible for eradicating NAGM from a province with established populations of NAGM. Recent studies have indicated that NAGM is mainly a nuisance pest in urban and recreational areas. It is not anticipated that this insect will impact significantly of Canada's forest due to the lack of natural oak stands in Canadian forests. The biggest potential impact of NAGM is on trade of Canada's forest products, especially the export of Christmas trees to Mexico. AAFC is currently negotiating phytosanitary certification requirements with its trading partners to ensure the continued access to foreign markets for Canadian forest products from the affected regions.

Asian gypsy moth

Detection surveys conducted in 1995 have discovered two single male gypsy moths (one in New Westminster, BC and one in Langley,BC) which were identified as being Asian gypsy moth (AGM) using the both the mithochondrial and FS1 marker DNA tests. The BC Plant Protection Advisory Committee has recommended that AAFC conduct delimitation trapping at a rate of 64 traps per square mile around each find. Meanwhile the United States Department of Agriculture has indicated that they would prefer that AAFC take immediate steps to eradicate AGM at both locations by either aerial spraying with BTk or by mass trapping at a rate of nine traps per acre (5000 per square mile). A decision is pending further review by AAFC officials.

gypsy moth genetic marker survey

AAFC, in cooperation with CFS, DNR and the provinces conducted a survey in 1995 to determine the genetic variation within the North American gypsy moth population in eastern Canada. Over all, eighteen sites were selected for sampling, including nine high risk sites (military bases and port sites) and nine low risk sites (general forest) in four provinces. A total of 1800 moths were submitted from the test sites to the Central Plant Quarantine Lab in Nepean for DNA analysis. Results should be published by the summer of 1996.

gypsy moth domestic regulations

AAFC will undertake to develop plant quarantine regulations to prevent the artificial spread by persons of gypsy moth from infested areas in eastern Canada and the United States to uninfested areas of North America. Planned discussions will take place early in 1996 between representatives from AAFC and plant quarantine officials from the United States and Mexico to develop a harmonized gypsy moth regulations for the NAPPO region countries. AAFC will be contacting the provinces and other involved stakeholders early in the new year to illicit comments regarding the development of the domestic gypsy moth regulations. It is anticipated that this will be done by distributing a draft directive to all the major stakeholders for input in early 1996.

pine shoot beetle

Surveys conducted by AAFC and CFS have identified the presence of *Tomicus piniperda* in three additional counties of southern Ontario, bringing the total of infested counties to thirteen in that province. In the United States the pest has been identified in more than 140 counties in eight states, including: Illinois, Indiana, Maryland, Michigan, New York, Ohio, Pennsylvania and West Virginia. AAFC finalized a directive in October of 1995 which outlines the requirements for certifying pine Christmas trees,nursery stock and logs with bark attached from regulated to non-infested areas. This directive is being revised to allow for shipments of Christmas trees into the Metropolitan Toronto area from surrounding infested areas. Also, a section will be added to allow for the import of pine logs for processing purposes to pre-approved establishments.

Forest Pest Management Committee

The Plant Protection Division of AAFC and the Canadian Forest Service (CFS) have recently formed a committee which meets bi-monthly to discuss plant quarantine issues relative to Canada's forest sector. This committee has formed a number of pest specific working groups to review and make recommendations regarding specific plant quarantine pests or issues. In 1995 two such groups met to review the present AAFC directives regarding dutch elm disease and scleroderris canker. Recommendations from these groups will be incorporated into policy revisions concerning these pests in early 1996. In addition to serving as an advisory body concerning plant quarantine issues relative to forestry the FPMC acts as a means to coordinate various aspects of plant quarantine, including: surveys, diagnostic, research, etc., at the federal level.

Dutch elm disease

The dutch elm disease working group has recommended that AAFC expand the current regulated areas to include all provinces except British Columbia, Alberta and NewFoundland within the regulated area for Dutch elm disease. It was also recommended that imports of disease free elm material from infested to non-infested areas(considering the advance of new technologies)be allowed under approved conditions, e.g., tissue culture. AAFC will undergo consultations with the provinces and affected industries early in 1996 prior to changing the present directives.

scleroderris canker

The scleroderris canker working group has recommended that directives be amended so that only living plants of *Pinus* material are regulated from areas infested with the European strain of the variety abietina. AAFC will undergo consultations with the provinces and affected industries early in 1996 prior to changing the present directives.

Import of unmanufactured wood products from off-continent

AAFC, like its counterpart in the United States, is developing regulations to govern the importation of unmanufactured wood products from all areas except the continental United States. Under the proposed regulations wood products (logs, lumber, etc.) from off continent sources will have to be debarked and either kiln dried or treated thermally to achieve a temperature of 52°C at the core of the wood for a minimum of 30 minutes. All requests to import unmanufactured wood, except for wood of tropical species, or those which have been treated as above will have to undergo a pest risk assessment to determine its status for importation.

Dunnage policy

AAFC realizing that wood dunnage poses a high risk of introducing exotic forest pests has recently implemented import regulations regarding the handling of wood dunnage at Canadian sea ports. Under the new regulations, all wood dunnage will have to be maintained at specific designated port sites which will be inspected periodically by AAFC inspectors. Any dunnage which contains bark or signs of living pests will have to be disposed of by the port authorities or other responsible persons in a manner approved by AAFC.

Christmas trees to Mexico

Mexican phytosanitary regulations require all Christmas trees of *Pinus* and all wreaths from Canada to be fumigated with methyl bromide. Christmas trees, other than pine trees, from gypsy moth free counties can be certified for exports to Mexico based upon a general field inspection by AAFC, and all the trees must be mechanically shaken prior to being exported. Trees from gypsy moth infested areas must meet the same requirements as trees from other areas and must also be pre-inspected by Mexican inspectors who will conduct joint inspections with AAFC inspectors. This year five shippers from the province of Quebec have agreed to participate and pay the cost for the trial Mexico/AAFC pre-clearance inspection. Following the 1995 shipping season AAFC will continue to negotiate with Mexican officials in attempt to have the Mexicans recognize AAFC's certification program to avoid the need for pre-clearance by Mexican inspectors in the future.

De-regulation of European pine shoot moth

In October of 1995 AAFC de-regulated *Rhyacionia bouliana* following a review of the pest which indicated that it was established throughout most of Canada's pine forested regions. Until recently, all pines destined to British Columbia had to be fumigated with methyl bromide to protect that province from EPSM. However, the pest is now known to be well established within the province of British Columbia and no active programs to eradicate the pest are being applied within the province.

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1. National research trials for the fungus - Chondrostereum purpureum

Chondrostereum purpureum (*Cp*) is an indigenous fungal pathogen which infects woody plants through recent wounds. In this way, *Cp* may be utilized with mechanical vegetation control techniques to increase the control of hardwood species which sprout or sucker from stumps and roots.

During 1994/95, a national research protocol was developed with the following objectives:
1) demonstrate and compare the field efficacy of two different *Cp* treatments (isolate/formulation combinations) on target species (trembling aspen, Sitka alder, speckled alder, red maple);
2) examine the relative importance of formulation and fungal isolate as factors determining the efficacy of *Cp* treatments; 3) determine the degree of variation in efficacy both within and between major Canadian forest regions. The experimental design included five replications with eight treatments: six combinations of two *Cp* isolates/ formulations, brushsaw only, brushsaw + triclopyr. There were three research areas: Ontario (trembling aspen, speckled alder); British Columbia - trembling aspen, Sitka alder and New Brunswick - trembling aspen, red maple.

The researchers directly involved with the New Brunswick component of the national research protocol included: *Dr. Doug Pitt* and *Dr. Dean Thompson*, Canadian Forest Service, Sault Ste. Marie, ON; *Dr. Glen Sampson*, Nova Scotia Agricultural College, Truro, N.S. and *Mr. Len Lanteigne*, Canadian Forest Service, Fredericton, N.B.

A 2 ha site of trembling aspen was selected (Scotch Lake). The trembling aspen was 3-5 m in height and 6-10 cm ground line diameter. A 5 ha site of red maple was selected (Acadia Forest Experimental Station). The red maple was 4-6 m in height and 10-25 cm ground line diameter.

In May'95 buffers were established around 40 plots (8 treatments x 5 replications), through the use of brush saws and trenching equipment (trembling aspen). Height, crown width and stem diameter (D15) were recorded for trees within each treatment plot.

In June'95, the treatments were applied. A weather station was installed at each site to record solar radiation, rain fall, air temperature and relative humidity over the period from two days prior to treatment through to seven days post-treatment. In October'95, samples of stumps were selected to conduct laboratory analysis to identify the fungus causing the infection.

Preliminary results should be available early in 1996. Additional field and laboratory evaluation will be conducted during the 1996 growing season. Results, conclusions and recommendations related to the efficacy of Chondrostereum purpureum on major hardwood competitors should be available in 1996.

2. Forest nursery weed research/technology transfer

In 1994, 60 million seedlings were shipped from forest nurseries within the Atlantic Provinces, of which 96% were container seedlings. Competing vegetation was a major problem resulting in mortality, decreased growth, increased production costs and provision of an ecological niche for other harmful organisms (i.e. fungi, insects).

The Canadian Forest Nursery Weed Management Association (CFNWMA) was formed in 1984 and has hosted meetings annually to discuss the problems/solutions associated with weed problems within forest nurseries. There are five regional representatives which form the executive of the CFNWMA: *Dave Trotter* - British Columbia, *Jonathan Mathews* - Prairie Provinces, *Mike Irvine* - Ontario, *Roger Touchette* - Quebec and *Len Lanteigne* - Atlantic Provinces. During 1994/95, the executive members were involved with the User Requested Minor Use Registration Pilot Project. The candidate product for forest nursery use pattern was GALLERY (isoxaben) - DowElanco Canada Inc. Extensive research was conducted to evaluate crop tolerance and efficacy of this preemergent herbicide in forest nurseries. In July 1995, GALLERY received registration for forest nursery use pattern.

Although there are various herbicides registered for forest nursery use pattern, there is no herbicidal product that can be applied over actively growing forest seedlings to control broadleaf weeds. The CFNWMA will continue to work in this area of vegetation control for forest nurseries.

3. **The impact of vegetation management alternatives on vegetation succession, wood supply and selected environmental impacts within the Acadian Forest Region**
(L. Lanteigne and D. Pitt Canadian Forest Service; B. Brunsdon J.D. Irving Ltd.; W. Bell Ontario Ministry of Natural Resources)

This research project was initiated in 1994 within the Fundy Model Forest. The objectives of the study is to gain a greater understanding of the biological, environmental and economic effects of various vegetation management alternatives that may ultimately be used in an integrated forest vegetation management strategy in the Acadian Forest Region. Also, this multiple-use approach to vegetation management would be more socially acceptable than traditional vegetation management practices. The knowledge acquired from the impact of vegetation management alternatives on successional development, crop trees and selected environmental parameters would facilitate a decision-making process for vegetation management based on alternatives, multiple-use objectives and environmental impacts.

The goals of the study are to: 1) determine the short-term (5-years) effects of various vegetation management alternatives on the survival and growth of artificially regenerated conifer seedlings and competing vegetation; 2) establish sites to study the long-term impact of forest vegetation management strategies on crop tree response and successional development; 3) develop demonstration sites that would be utilized for technology transfer and public education.

The study will evaluate seven vegetation management alternatives within the Acadian Forest Region: no control, complete control, chemical (glyphosate, triclopyr), manual (brush saws), livestock grazing (sheep) and biological (Chondrostereum purpureum, Bialaphos). Also, timing of treatments for livestock grazing will be included. Broadcast and directed foliar applications of glyphosate and triclopyr will also be evaluated.

During 1994/95, treatments were applied and morphological data was collected for crop trees and competing vegetation. Preliminary results indicate that the 1994 sheep grazing resulted in severe damage to crop trees (jack pine) and minimal defoliation of competing vegetation (red maple, white birch, trembling aspen, hazel). During the 1995 grazing treatment, the sheep digested Kalmia augustifolia which resulted in severe nausea, disorientation, grinding of teeth and depression. A veterinarian administered activated charcoal and B-vitamin which resulted in a rapid recovery for the sheep ... the sheep were sent back to the farm! A paper will be written on this aspect of the project during 1995/96.

POSTER SESSION

Efficacy of Aerial Applications of Bacillus thuringiensis and MIMIC 240LV against the Hemlock Looper

Rick West

Abstract

Two aqueous formulations of Bacillus thuringiensis (B.t.), ABG6387 and ABG6414 and the biochemical tebufenozide, MIMIC 240LV, were applied over precommercially-thinned stands of balsam fir infested with the eastern hemlock looper. Efficacy was evaluated in terms of spray deposit, population reduction and degree of defoliation of current and year-old foliage.

Low Cost GPS-GIS Tracking of Spray Aircraft

Bill May, Delio Tortosa, Taylor Scarr

Dose transfer mechanisms of B.t. in the spruce budworm micro-habitat after aerial application

P.C. Nigam, S.E. Holmes and E. Kettela

Forest Pest Control Forum
Colloque sur la repression des ravageurs forestiers

Conference Centre, Ottawa
Centre de conferences, Ottawa

November 29, 1995

Dr. Claire Franklin
Executive Director
Pest Management Regulatory Agency
Health Canada
Tunney's Pasture
Ottawa, Ontario
K1A 0L2

Dear Dr. Franklin:

At the twenty-third Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 21-22, 1995, an issue regarding the registration of Mimic (RH5992, tebufenazide) was openly discussed during the issues Debate Session and led to a resolution requesting action from your organization.

As you are probably aware the insecticide Mimic has been demonstrated to be an effective product for spruce and jack pine budworm control. Recent information indicates it is also effective in the control of hemlock looper. In addition, this product is acknowledged by Environment Canada and the Canadian Forestry Service to be an environmentally preferred alternative to fenitrothion which the Regulatory Agency has recently indicated will be eliminated from broad scale application and registration for forest protection programs. In the opinion of the Forum members there is sufficient scientific information on Mimic to warrant at least a temporary, if not a full registration. The Forest Pest Control Forum requests the Regulatory Agency to finalize the registration of this product as soon as possible.

Since early 1995 there have been several bureaucratic delays in registering Mimic by several federal departments involved in its review. Potential users of this product will be making decisions on product utilization for next year's operational programs by early February, 1996. In fairness to potential users and in the interests of the public to provide more environmentally acceptable alternatives for pest control, we urge that your Agency grant at least a temporary registration by the end of December, 1995. Given that a temporary registration is most likely at this time, may we recommend either waiving the need for a discussion document or reducing the discussion period to 30 days in order to meet our suggested target date.

Issues at the Forum are openly debated. Our request reflects the 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 request. We look forward to your reply which will be conveyed to all members who attended this year's Forest Pest Control forum.

Thank you very much for your cooperation in this matter.

Yours sincerely,

B.H. Moody

Forest Pest Control Forum
Steering Committee Chairman
Dr. Ben Moody
Tel: (819) 997-1107

ARWestwood

Forest Pest Control Forum
Issues Debate Chairman
Dr. Richard Westwood
Tel: (204) 945-8444

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November 29, 1995

Dr. Claire Franklin
Executive Director,
Pest Management Regulatory Agency
Health Canada
Tunney's Pasture
Ottawa, Ontario
K1A 0L2

Dear Dr. Franklin:

At the twenty-third Annual Forest Pest Control Forum held at the Conference Centre in Ottawa, November 21-22, 1995, an issue regarding the Regulatory Agency's participation at the Forum was openly discussed during the issues Debate Session and led to a resolution requesting action from your organization.

At the 1995 Forest Pest Control Forum, as is often the case, several key regulatory concerns arose from forestry stakeholders. These concerns could not be adequately addressed due to the limited participation of the Regulatory Agency staff at this year's Forum.

The annual Forest Pest Control Forum provides one of the few opportunities for forestry stakeholders and pesticide regulators to interact and provide information of mutual interest and benefit to both groups. Consequently, the Forum participants wish to stress the importance of the Regulatory Agency's interaction with forestry stakeholders and request adequate, formal representation at future Forum meetings. Full participation by Regulatory staff will give them a more complete appreciation of the forestry stakeholders' concerns and at the same time allow them to address those concerns.

There was some indication this year that Regulatory Agency staff did not receive information regarding Forum meeting dates early enough to allow for their full participation. In order to encourage and facilitate increased participation by the Regulatory Agency, the Forest Pest Control Forum will ensure that the Agency is given sufficient notice of the Forum meeting dates in the future. Meeting dates are generally at the same time every year in Ottawa. Next year's Forum will be held November 19 to 21, 1996.

Issues at the Forum are openly debated. Our request reflects the 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 request. We look forward to your reply which will be conveyed to all members who attended this year's Forest Pest Control forum.

Thank you very much for your cooperation in this matter.

Yours sincerely,

Forest Pest Control Forum
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ISSUE 3: THE ANNUAL FOREST PEST CONTROL FORUM

- WHEREAS the Canadian Forest Service has been subjected to a federal government program review which will reduce its operations and funding considerably, and

- WHEREAS these reductions will include staff reductions, reorganization of its science program, and

- WHEREAS these changes in programs such as Forest Insect and Disease Survey (FIDS) and other areas will impact the steering committee and annual agenda for the forum, and

- WHEREAS the CFS research program will be reorganized into 10 networks, some of which will have a direct role in pest research.

- Be it resolved that the forum expresses its support to the CFS to modify its representation on the steering committee to replace current FIDS Heads with lead managers of the 6 research networks with a pest research role.

- Be it resolved that the revised steering committee be charged with the responsibility of thoroughly reviewing the future organization, mandate, structure, location and name of the forum in order to address the need for an annual forum relating to the science and issues associated with an integrated approach to forest pest management.

Forum Issues Chairperson &

Steering Committee Chairperson