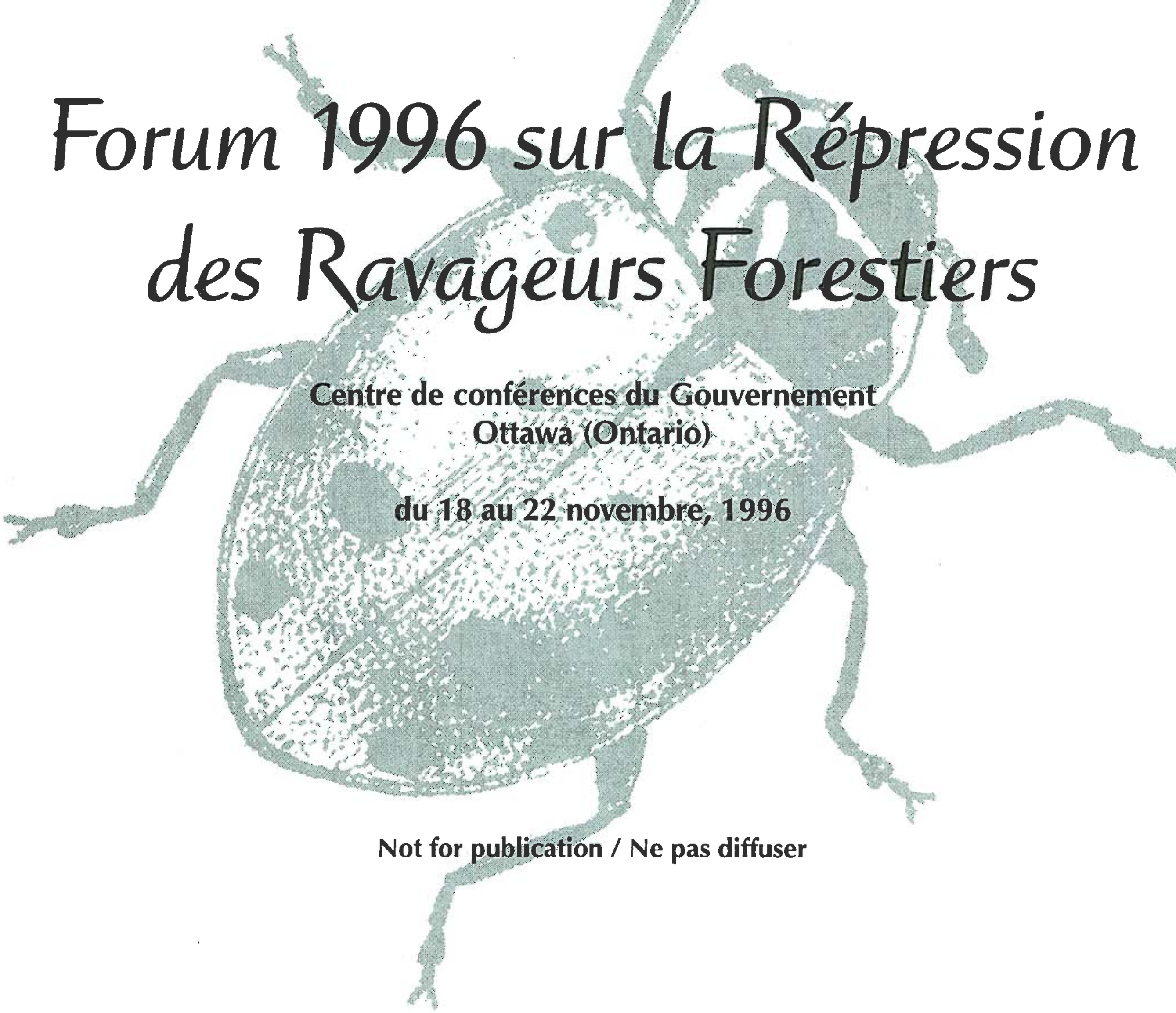
1996 Forest Pest Management Forum

Government Conference Centre
Ottawa, Ontario

November 18–22, 1997



Forum 1996 sur la Répression des Ravageurs Forestiers

Centre de conférences du Gouvernement
Ottawa (Ontario)

du 18 au 22 novembre, 1996

Not for publication / Ne pas diffuser

Natural Resources Canada | Ressources naturelles Canada
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 représentamts 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.

Rodney Smith
Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts
Ottawa, Ontario / Ottawa (Ontario)
April 1997 / avril 1997

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Liste des personnes présentes

Abbot Laboratories
Richard Groen
Stephen Nicholson

Alberta Land and Forest Service
Hideji Ono

Algonquin College
Mark Stabbs

Agriculture and Agrifood Canada
Hong Chen
Nancy Kummen
Doreen Walter

Bacentocon Tech. International
Barry Tyler

B.C. Ministry of Forests
Tim Ebata, Victoria

Bioforest Technologies
Eileen Harvey

Canadian Forest Service, Natural Resources Canada
Mamdouh Abou-Zaid, Great Lakes Forestry Centre
Eric Allen, Pacific Forestry Centre
Jean Bérubé, Laurentian Forestry Centre
Rob Bourcher, Great Lakes Forestry Centre
Peter Boxall, Northern Forestry Centre
Errol Caldwell, Great Lakes Forestry Centre
Peter Copis, Petawawa
Michel Cussson, Laurentian Forestry Centre
Hubert Crummey, NFLD
Eldon Ereleigh, Atlantic Forestry Centre
Richard A. Fleming, Great Lakes Forestry Centre
Richard Hamelin, Laurentian Forestry Centre
Ellen Healey, Ottawa
Blair Helson, Great Lakes Forestry Centre
Gordon House, Great Lakes Forestry Centre
Jim Hudak, NFLD
Les Humble, Pacific Forestry Centre

Gaston LaFlamme, Laurentian Forestry Centre
Dave Lemkay, Petawawa
Barry Lyons, Great Lakes Forestry Centre
Dave MacLean, Atlantic Forestry Centre
Ken Mallett, Northern Forestry Centre
John McFarlane, Great Lakes Forestry Centre
Doug McRae, Great Lakes Forestry Centre
Bill Meades, Great Lakes Forestry Centre
Ben Moody, Ottawa
Ariabe Plourde, Laurentian Forestry Centre
Jacques Regniere, Laurentian Forestry Centre
Wayne Richards, Great Lakes Forestry Centre
Les Safvanajik, Pacific Forestry Centre
Chris Sanders, Great Lakes Forestry Centre
Rodney Smith, Great Lakes Forestry Centre
Tom Sterner, Alantic Forestry Centre
John Sweeney, Atlantic Forestry Centre
Graham Theurston, Atlantic Forestry Centre
Rick West, NFLD
Gerrit van Raalte, Atlantic Forestry Centre

Canadian Institute of Forestry
Roxanne Comeau

Eastern Ontario Model Forests
Brian Barkley
Jim Cayford

Forest Protection Ltd.
David Davies
Peter Amirault

Forintek
Tony Byne

J.D. Irving Ltd.
Gaeton Pelletier

New Brunswick Dept. of Natural Resources
Nelson Carter, Fredericton

Nova Scotia Dept. of Natural Resources
Eric Georgeson, Shubenacadie

Manitoba Ministry of Natural Resources
Richard Westwood, Winnipeg

Ministere des Ressources Naturelles
Michel Auger
Bruno Boulet
Michel Chabot

Pest Management Regulatory Agency
Wendy Sexosmith

Rohm and Haas
Craig English, Winnipeg
Al McFadden, Guelph

Spray Efficacy Research Group (SERG)
Bud Irving

Unisverité Laval
Eric Bauce

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

FINAL PROGRAM

1996

FOREST PEST

MANAGEMENT

FORUM

SUSSEX ROOM

GOVERNMENT CONFERENCE CENTRE

OTTAWA, ONTARIO

NOVEMBER 18-22, 1996

Natural Resources Canada | Ressources naturelles Canada

Canadian Forest Service | Service canadien des forêts

PROGRAM

All meetings in Sussex Room. Poster session and coffee in Sussex Lounge

MONDAY, NOVEMBER 18

0830-1700	**Meeting of the Forest Protection Technology Committee**
1700-1900	**Meeting of the Forest Pest Management Forum Steering Committee (closed)**

TUESDAY, NOVEMBER 19

0830-0900	**Welcoming Address**	Peter Hall

FOREST PEST STATUS AND OPERATIONAL/EXPERIMENTAL TRIALS

Chair - Dr. Tom Sterner

0900-1700	British Columbia	Tim Ebata
	Alberta	Hideji Ono
	Saskatchewan	To be announced
	Manitoba	Richard Westwood
	Ontario	Taylor Scarr/Gordon Howse
	Quebec	Michel Auger/Alain Dupont
	New Brunswick	Nelson Carter/Dave Davies/Graham Thurston
	Nova Scotia	Eric Georgeson
	Prince Edward Island	To be announced
	Newfoundland	Hubert Crummey/Rick West
	Forest Industry	To be announced
	US Forest Service	Dan Kucera
	Other	Doreen Walter

WEDNESDAY, NOVEMBER 20

ACCOMPLISHMENTS OF GREEN PLAN INTEGRATED FOREST PEST MANAGEMENT INITIATIVE

Chair - Ellen Healey

0830-0850	Introduction to IFPM Initiative	Errol Caldwell
0850-0910	Silvicultural Approaches to Insect Management	David MacLean
0910-0930	Integrated Pest Management in Seed Orchards	Jon Sweeney
0930-0950	Budworm Ecology Group	Eldon Eveleigh
0950-1030	***Coffee / Posters***	
1030-1050	Pest Impacts Working Group	Ken Mallett
1050-1110	Management of Root Diseases	Jean Bérubé
1110-1130	Stem Cankers of Forest Trees	Jean Bérubé
1130-1150	Biological Control of Competing Vegetation (BICOVER)	Mamdouh Abouh-Zaid
1150-1330	***Buffet Luncheon / Posters - Sussex Lounge***	
1330-1350	Viral Pathogens Working Group	Michel Cusson
1350-1410	Semiochemical/Pheromones Network	Chris Sanders
1410-1430	Biological Control Working Group	Rob Bourchier
1430-1450	Natural Products for Insect Control	Blair Helson
1450-1530	***Coffee / Posters***	
1530-1550	Spray Efficacy Research Group (SERG)	Bud Irving
1550-1610	Decision Support Systems	David MacLean
1610-1630	Integrated Pest Management Course	Eileen Harvey
1630-1700	Wrap up Discussions	
1700-1800	***Poster Session***	

THURSDAY, NOVEMBER 21

FUTURE DIRECTION OF SCIENCE NETWORKS OF CFS AND ITS PARTNERS

Chair - Peter Hall

0830-0850	Introduction to CFS Science Networks	Ellen Healey
0850-0910	Pest Management Methods	Errol Caldwell
0910-0930	Forest Ecosystem Processes	Jacques Régnière
0930-0950	Effects of Forest Practices	Les Safranyik
0950-1030	***Coffee / Posters***	
1030-1050	Forest Health	Wade Bowers
1050-1110	Plant Biotechnology and Advanced Genetics	Richard Hamelin
1110-1130	Socioeconomics	Peter Boxall
1130-1150	Biodiversity	Lee Humble
1150-1330	***Lunch / Posters***	
1330-1350	Landscape Management	David MacLean
1350-1410	Climate Change	Richard Fleming
1410-1430	Fire	Doug McRae
1430-1450	Model Forest Network	Dan Welsh
1450-1520	***Coffee/Posters***	

GENERAL SCIENTIFIC PRESENTATIONS

1520-1540	Silvicultural Control of Spruce Budworm	Éric Bauce
1540-1600	Spruce Budworm DSS and Protection Policies	David MacLean

TABLING OF ISSUES

1600-1700	Tabling of issues raised at the Forest Pest Management Forum (Resolution of issues 1400, Friday, November 22)	Richard Westwood

FRIDAY, NOVEMBER 22

Note: The following sessions are open to all Forum participants

MEETING OF FOREST PEST MANAGEMENT CAUCUS

Chair - Richard Westwood

0830-0845	Welcome	
0845-0915	Status of Pest Management Regulatory Agency Cost Recovery Initiative	L. Javor
0915-0945	Registration of Gypsy Moth Virus	Errol Caldwell
0945-1015	Status of Minor Use Working Group	Wayne Ormrod
1015-1030	*Coffee*	
1030-1100	Minor Use Program Minor Use Coordinator for Forestry Minor Use Fund - Where Is It?	Eileen Harvey
1100-1200	Draft Quarantine Policies for: a) Gypsy Moth b) Pine Shoot Beetle	Marcel Dawson
1200-1300	*Lunch*	
1300-1330	Letter of Response to Plant Products Co. Ltd.	
1330-1400	Caucus Business Financial Report Appointment of New Chairperson	Roxanne Comeau

RESOLUTION OF ISSUES

1400-1500	Resolution of Issues Raised at the Forest Pest Management Forum	Richard Westwood

FOREST PEST MANAGEMENT FORUM

Poster Session

Sussex Lounge

Viewing Times

Wednesday November 20th:	0950-1030	Coffee
	1150-1330	Buffet Luncheon in Sussex Lounge
	1450-1530	Coffee
	1700-1800	
Thursday November 21st:	0950-1030	Coffee
	1150-1330	Lunch Not Served in Sussex Lounge
	1450-1520	Coffee

List of Posters

1. B. Lyons, B. Helson, R. Bourchier
Effects of azadirachtin-based insecticides on the egg parisitoid *Trichograma minutum*, Riley (Hymenoptera: Trichogrammatidae)

2. B. Helson, B. Lyons, P. de Groot
Development of neem seed extract containing azadirachtin for forest insect management

3. B. Helson, M. Abou-Zaid, J.T. Arnason
Red maple possesses phytochemicals which deter the feeding of forest tent caterpillar larvae

4. D. Wheeler, M.B. Isman
Trichilia from Costa Rica - A potential source of botanical insecticides

5. M.B. Isman, P.J. Gunning, K.M. Spollen
Tropical timber species as sources of botanical insecticides

6. J.A. Findlay
Natural insect toxins from endophytic fungi: Towards biorational insect control

7. J.T. Arnason, T. Durst, P. Sanchez
Botanical insecticides from the Meliaceze and Piperaceae

PROGRAMME FINAL

FORUM

1996 SUR LA

RÉPRESSION DES

RAVAGEURS

FORESTIERS

SALLE SUSSEX
CENTRE DE CONFÉRENCE DU GOUVERNEMENT
OTTAWA (ONTARIO)
DU 18 AU 22 NOVEMBRE 1996

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

PROGRAMME

Toutes les réunions auront lieu dans la Salle Sussex. Les présentations par affiches et les pauses café dans le Hall Sussex

Le lundi 18 novembre

08 h 30 - 17 h 00 Réunion du Comité de technologie de protection de la forêt.

17 h 00 - 19 h 00 Réunion du Comité d'organisation du forum concernant la lutte intégrée contre les ravageurs forestiers (fermé)

Le mardi 19 novembre

08 h 30 - 09 h 00	Mot d'ouverture	Peter Hall

SITUATION DES RAVAGEURS FORESTIERS ET TESTS OPÉRATIONELS/EXPÉRIMENTAUX

Président - Dr Tom Sterner

09 h 00 - 17 h 00	Colombie-Britannique	Tim Ebata
	Alberta	Hidiji Ono
	Saskatchewan	À annoncer
	Manitoba	Richard Westwood
	Ontario	Taylor Scarr / Gordon Howse
	Québec	Michel Auger / Alain Dupont
	Nouveau-Brunswick	Nelson Carter / Dave Davies/Graham Thurston
	Nouvelle Écosse	Eric Georgeson
	Île du Prince Édouard	À annoncer
	Terre-Neuve	Hubert Crummey
	Industrie forestière	À annoncer
	Service Forestier E.-U.	Dan Kucera
	Autres	Doreen Walter

Le mercredi 20 novembre

RÉALISATIONS DANS LE CADRE DE L'INITIATIVE DU PLAN VERT CONCERNANT LA LUTTE INTÉGRÉE CONTRE LES RAVAGEURS FORESTIERS

Présidente - Ellen Healey

08 h 30 - 08 h 50	Introduction en vue de l'Initiative LCRF	Errol Caldwell
08 h 50 - 09 h 10	Approches concernant la lutte sylvicole contre les insectes	David MacLean
09 h 10 - 09 h 30	Lutte intégrée contre les ravageurs forestiers dans les vergers à graines	Jon Sweeney
09 h 30 - 09 h 50	Groupe de l'écologie de la tordeuse des bourgeons de l'épinette	Eldon Eveleigh
09 h 50 - 10 h 30	**Pause café / Présentations par affiches**	
10 h 30 - 10 h 50	Groupe de travail sur l'impact des ravageurs forestiers	Ken Mallett
10 h 50 - 11 h 10	Lutte contre les pourridiés des arbres forestiers	Jean Bérubé
11 h 10 - 11 h 30	Chancres de la tige des essences forestières	Jean Bérubé
11 h 30 - 11 h 50	Agent de lutte biologique BICOVER contre la végétation concurrente	Mamdouh Abouh-Zaid
11 h 50 - 13 h 30	**Déjeuner style buffet / Présentations par affiches - Hall Sussex**	
13 h 30 - 13 h 50	Groupe de travail sur les virus	Michel Cusson
13 h 50 - 14 h 10	Groupe de travail sur les écomones/phéromones	Chris Sanders
14 h 10 - 14 h 30	Groupe de travail sur la lutte biologique	Rob Bouchier
14 h 30 - 14 h 50	Produits naturels de lutte contre les insectes	Blair Helson
14 h 50 - 15 h 30	**Pause café / Présentations par affiches**	
15 h 30 - 15 h 50	Groupe de recherche sur l'efficacité des pulvérisations (SERG)	Bud Irving
15 h 50 - 16 h 10	Systèmes d'aide à la décision	David MacLean
16 h 10 - 16 h 30	Cours de perfectionnement sur la lutte contre les ravageurs forestiers	Eileen Harvey
16 h 30 - 17 h 00	Discussions sommaires	
17 h 00 - 18 h 00	**Séance d'affiches**	

Le jeudi 21 novembre

ORIENTATIONS FUTURES DES RÉSEAUX SCIENTIFIQUES DU SCF ET DE SES PARTENAIRES

Président - Peter Hall

08 h 30 - 08 h 50	Introduction des réseaux scientifiques du SCF	Ellen Healy
08 h 50 - 09 h 10	Méthodes de répression des ravageurs forestiers	Errol Caldwell
09 h 10 - 09 h 30	Processus d'écosystèmes forestiers	Jacques Régnière
09 h 30 - 09 h 50	Effets des pratiques forestières	Les Safranyik
09 h 50 - 10 h 30	**Pause café / Présentations par affiches**	
10 h 30 - 10 h 50	Santé de la forêt	Wade Bower
10 h 50 - 11 h 10	Biotechnologie des plantes et la génétique de pointe	Richard Hamelin
11 h 10 - 11 h 30	Recherche socio-économique	Peter Boxall
11 h 30 - 11 h 50	Biodiversité	Lee Humble
11 h 50 - 13 h 30	**Déjeuner / Présentations par affiches**	
13 h 30 - 13 h 50	Aménagement des paysages	David MacLean
13 h 50 - 14 h 10	Changements climatiques	Richard Fleming
14 h 10 - 14 h 30	Les incendies	Doug McRae
14 h 30 - 14 h 50	Réseau des Forèts Modèles	Dan Welsh
14 h 50 - 15 h 20	**Pause café / Présentations par affiches**	

PRÉSENTATIONS GÉNÉRALES SCIENTIFIQUES

15 h 20 - 15 h 40	Contrôle sylvicole de la tordeuse de bourgeons de l'épinette	Éric Bauce
15 h 40 - 16 h 00	Systèmes d'aide à la décision sur les tactiques de protection contre la tordeuse de bourgeons de l'épinette	David MacLean

PRÉSENTATION DES ENJEUX

16 h 00 - 17 h 00	Présentation des enjeux soulevés lors du forum sur la répression des ravageurs forestiers (Résolutions de problèmes le vendredi, 22 novembre à 14 h 00)	Richard Westwood

Le vendredi 22 novembre

Avis: les séances suivantes sont ouvertes à tous les participants

RÉUNION DU COMITÉ SUR LA LUTTE CONTRE LES RAVAGEURS FORESTIERS

Président - Richard Westwood

08 h 30 - 08 h 45 Mot de bienvenue

08 h 45 - 09 h 15 État de l'Initiative de recouvrement de fonds dans le cadre de l'Agence de réglementation de la lutte antiparasitaire — L. Javor

09 h 15 - 09 h 45 Homologation du virus de la spongieuse — Errol Caldwell

09 h 45 - 10 h 15 Situation du groupe de travail sur des usages limitésé — Wayne Ormrod

10 h 15 - 10 h 30 **Pause café**

10 h 30 - 11 h 00 Programme sur les usages limités — Eileen Harvey
- Coordonateur de travail limité en foresterie
- Financement pour le travail limité - où est-il?

11 h 00 - 12 h 00 Ébauche de projets de quarantaine pour : — Marcel Dawson
- a) La spongieuse
- b) Grand hylésine des pins (*Tomicus* spp.)

12 h 00 - 13 h 00 **Déjeuner**

13 h 00 - 13 h 30 Lettre de réponse adressée à Plant Products Co. Ltd.

13 h 30 - 14 h 00 Affaires du comitéRoxanne Comeau
- Rapport financier
- Nomination du nouveau président

RÉSOLUTION DES ENJEUX

14 h 00 - 15 h 00 Résolution des enjeux soulevés lors du Forum sur la répression des ravageurs forestiers — Richard Westwood

Présentations par Affiches

Hall Sussex

Périodes d'Observation

Le mercredi 20 novembre: 09 h 50 - 10 h 39 Pause café
11 h 50 - 13 h 30 Déjeuner style buffet dans le Hall Sussex
14 h 50 - 15 h 30 Pause café
17 h 00 - 18 h 00

Le jeudi 21 novembre: 09 h 50 - 10 h 30 Pause café
11 h 50 - 13 h 30 Le déjeuner ne sera pas servi dans le Hall Sussex
14 h 50 - 15 h 20 Pause café

Liste des Affiches

1. B. Lyons, B. Helson, R Bourchier
Effets des insecticides à base d'azadirachtine contre les oophages *Trichograma minutum*, Riley (*Hymenoptera : Trichogrammatidae*)

2. B. Helson, B. Lyons, P. de Groot
Développement d'un extrait des semences du neem contenant de l'azadirachtine pour la répression des ravageurs forestiers

3. B. Helson, M. Abou-Zaid, J.T. Arnason
L'érable rouge possède des substances phytochimiques qui empêchent l'alimentation des larves de la livrée des forêts.

4. D. Wheeler, M.B. Isman
Trichilia originaire de Costa Rica : Une source potentielle d'insecticides végétaux

5. M.B. Isman, P.J. Gunning, K.M. Spollen
Essences forestières tropicales comme source d'insecticides végétaux

6. J.A. Findlay
Toxines naturelles des insectes de provenance de champignons endophytiques en vue de la répression biorationelle des insectes.

7. J.T. Amason, T. Durst, P. Sanchez
Insecticides végétaux provenant des Méliacées et des Pipéracées

8. G.M. Strunz, H. Findlay
Utilisation de produits naturels comme agents de contrôle contre les ravageurs : synthèse des alkaloïdes amides insecticides non saturés et des pépiracés

9. G.M. Strunz, R. Bethell, H. Finlay, M. Dumas, N. Boyonoski, P. White
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10. B. Pendrel, R. Simpson, D. Coy
Surveillance des populations endémiques de ravageurs dans la Forêt Modèle de Fundy

11. M. Cusson, M. Laforge, D. Doucet, C. Cloutier, D.B. Stoltz
Modifications des activités de l'hormone estérase juvenile et du degré d'ecdisteroïde dans les larves de la tordeuse de bourgeons de l'épinette, *Choristoneura fumiferana* atteint par la guêpe parasite *Tranosema rostrale*

12. M. Cusson, J. Delisle
Règles de reproduction hormonale chez *Choristoneura fumiferana* et *C. rosaceana*

13. J. Régnière, M. Cusson
Écologie de la tordeuse de bourgeons de l'épinette : Recherche et applications dans la répression des ravageurs

14. D. MacLean, K. Porter
Système d'aide à la décision concernant la tordeuse de bourgeons de l'épinette

15. Q. Su, T. Needham, D.A. MacLean
Défeuillaison et croissance du sapin baumier dans les peuplements mixtes de sapins et de feuillus au nord du Nouveau-Brunswick

16. R. J. Hall, W.J.A. Volney, K. Knowles
Évaluation des risques et de la vulnérabilité des peuplements à la défeuillaison causée par la tordeuse de bourgeons de pin gris

17. R. Lavallée, G. Daoust, A. Plourde
Lutte intégrée contre les ravageurs pour minimiser les dommages causés par le charançon du pin blanc

18. R.I. Alfaro, J.A. McLean, R. McIntosh, J.H. Borden, E. Tomlin, J. King, A. Yanchuk, G. Kiss, C. Yin, Y. El-Kassaby, K. Lewis
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19. R. McIntosh, J.A. McLean, R.I. Alfaro, G. Kiss
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20. S. Smith, I. Bellocq
Mortalité du charançon du pin blanc et dommages des ravageurs en rapport avec le pratiques sylvicoles sur le pin gris

21. C. Hébert, L. Jobin
Nouveaux outils d'échantillonnage et connaissances nouvelles du comportement des papillons nocturnes pour améliorer un système de prévoyance concernant l'arpenteuse de la pruche

22. T.L. Shore, B.G. Riel, L. Safranyik
Un système d'aide à la décision pour le dendroctone du pin ponderosa

23. L. Safranyik, T.L. Shore, R.A. Benton, D.A. Linton
Espacement et éclaircie dans les peuplements de pin tordu latifolié pour réduire leur susceptibilité au dendroctone du pin pondérosa

24. R. Hamelin, G. Laflamme
Chancre sclerodérrien : Surveillance moléculaire et opérations de lutte

Abstracts/Résumés

Allocution présentée lors du Forum national de répression des ravageurs forestiers, le 19 novembre 1996

(Presentation at the National Pest Forum, November 19, 1996)

T. Ebata

Ce rapport décrit brièvement les dommages causés par les ravageurs en Colombie-Britannique en 1996, ainsi que les programmes opérationnels de lutte contre les ravageurs et les essais expérimentaux réalisés dans la province au cours de la même période. Des statistiques de base choisies sur les forêts de la Colombie-Britannique sont également présentées à des fins de comparaison avec les autres provinces. Les principales sources de préoccupation sont liées : à diverses espèces de scolytes infestant le pin, l'épinette, le douglas vert et le sapin subalpin (énumérés par ordre d'importance); à des défoliateurs : la tordeuse occidentale de l'épinette, la chenille à houppes du douglas , l'arpenteuse de la pruche de l'Ouest; à des maladies affectant les aiguilles de pin, dont le rouge (*Lophodermella concolor*), qui a causé des dommages importants dans toute la partie intérieure de la province au cours des trois dernières années et qui commence à compromettre la croissance des arbres touchés; à des infections chroniques par le faux-gui, à des maladies des racines et de la tige; à des espèces de charançons des pousses terminales; et à des espèces introduites telles que la spongieuse et le puceron lanigère du sapin.

Le préservation de la santé des forêts est à la base même du Code de pratiques forestières du ministère des forêts de la Colombie-Britannique. Ainsi, tous les plans opérationnels doivent comporter une évaluation de la santé des forêts. Neuf des « meilleures pratiques » énoncées dans le Code présentent un lien direct avec la santé des forêts. FRBC finance toute une série de projets de recherche liés à la santé des forêts, notamment sur les effets des ravageurs sur les paysages, les ravageurs des produits ligneux, les effets des ravageurs sur la croissance et le rendement, la répression des ravageurs exotiques et introduits et les réactions des ravageurs aux coupes partielles.

Le point sur les principaux ravageurs forestiers et sur les campagnes de lutte contre les ravageurs et les essais sur le terrain réalisés en Alberta en 1996

(Important Forest Pest Conditions, Pest Management Operations and Field Trials in Alberta, 1996)

H. Ono, J. Belanger, C. Kominek, M. Maximchuk, S. Ranasinghe, A. Sproule et J. Feder-Calpas

Ce sommaire décrit les dégâts causés par certains des principaux ravageurs forestiers et contient des prévisions concernant les dommages prévus en 1997 en Alberta. Sont également passés en revue les résultats du programme de lutte contre la tordeuse des bourgeons de l'épinette, de divers relevés effectués sur le terrain, d'essais d'insecticides et du programme de piégeage à l'aide de phéromones.

En 1996, la superficie ravagée par la tordeuse des bourgeons de l'épinette en Alberta a diminué de 46 % par rapport à 1995. Les populations du dendroctone de l'épinette, du dendroctone du pin ponderosa et de la livrée des forêts se sont maintenues à des niveaux endémiques en 1996. Les données recueillies à l'aide de pièges à phéromone et par dénombrement des chenilles du deuxième stade laissent entrevoir une réduction considérable des effectifs de la tordeuse des bourgeons de l'épinette en 1997 par rapport aux niveaux enregistrés en 1996.

Une préparation non diluée de Foray 48B a été appliquée par voie aérienne sur plus de 110 026 hectares dans le nord de l'Alberta. Les résultats du dénombrement des chenilles du deuxième stade laissent présager une défoliation nulle à légère (inférieure à 35 %) dans la majorité des peuplements traités en 1997.

Les pulvérisations aériennes de Mimic ont donné d'excellents résultats contre la tordeuse des bourgeons de l'épinette. Les traitements au Thuricide se sont également révélés efficaces contre ce ravageur. Aucune différence significative n'a été relevée entre le nombre moyen d'adultes de la tordeuse des bourgeons de l'épinette capturés dans les pièges Multi-Pher I appâtés à l'aide de la phéromone couramment utilisée et le nombre moyen récupéré dans les pièges contenant l'hormone produite par Phero Tech Inc., Delta (C.-B.).

Les résultats de la campagne de lutte contre la maladie hollandaise de l'orme (Dutch Elm Disease Initiative - DEDI) entreprise en Alberta sont passés en revue. À ce jour, aucun arbre infecté n'a encore été découvert dans la province. Le *Critical Pest Management Control Council* a toutefois été invité à examiner la question afin d'être en mesure d'intervenir rapidement si jamais la maladie est découverte dans la province. Jusqu'ici, la présence du scolyte européen de l'orme a été signalée à Calgary, à Edmonton et à Vauxhall. Du bois de chauffage infesté par ce scolyte a été trouvé dans plusieurs ports d'entrée en Alberta.

Les ravageurs forestiers au Manitoba en 1996

(Forest Pests in Manitoba, 1996)

A.R. Westwood, K. Knowles, Y. Beaubien, L. Pines, L. Matwee, R. Khan et J. Skuba

Ce rapport décrit les dommages causés par les principaux insectes nuisibles des forêts et les principales maladies des arbres, ainsi que les mesures de lutte entreprises et un certain nombre d'inventaires spécialisés réalisés au Manitoba en 1996. Parmi les ravageurs mentionnés figurent la tordeuse des bourgeons de l'épinette et la tordeuse du pin gris. Les inventaires effectués avaient pour but de réévaluer le degré de régénération dans des parcelles établies à cette fin (*Regeneration Performance Assessment Plots*) et d'estimer les taux de carie chez le peuplier faux-tremble, de chancre de la tige chez le pin et de pourridié-agaric. Pour une deuxième année consécutive, une évaluation de l'état de santé des forêts a été menée à bien dans le cadre de relevés sur la régénération et l'établissement des forêts. Les résultats de cette initiative sont présentés. La détection de la maladie hollandaise de l'orme et la lutte contre cette maladie demeurent une préoccupation importante au Manitoba. Il convient de noter que dans la majorité des municipalités participant à l'accord de financement ratifié entre la province et les municipalités, les pertes causées annuellement par la maladie hollandaise de l'orme sont demeurées inférieures à 3,6 %. Des recommandations visant à réduire les effets du chancre de la tige chez le pin rouge durant les éclaircies commerciales sont fournies. Les résultats des applications d'herbicides effectuées en 1996 sont présentées de façon synthétique dans un tableau.

Principaux ravageurs forestiers en Ontario - État de la situation en 1996

(Status of Important Pests in Ontario, 1996)

G.M. Howse, M.J. Applejohn et T.A. Scarr

Ce rapport décrit l'étendue des dégâts causés par les principaux insectes nuisibles des forêts, dont la tordeuse des bourgeons de l'épinette, la tordeuse du pin gris, la spongieuse, la livrée des forêts, la tordeuse du tremble et la noctuelle décolorée, en 1996, en Ontario. On y trouve également une description des dommages plus circonscrits mais néanmoins graves causés par la tordeuse printanière du chêne et le pamphile à tête rouge, une espèce introduite. Les populations de la tordeuse des bourgeons de l'épinette se sont effondrées, la superficie des secteurs modérément à gravement défoliés par le ravageur étant la plus faible enregistrée depuis 1968. Les effectifs de la tordeuse du pin gris et de la spongieuse ont également décliné, tandis que ceux de la livrée des forêts ont augmenté. Les dommages dus au vent et à la neige et les effets de la dessiccation hivernale sont également décrits.

Programme de vaporisation aérienne contre la tordeuse du pin gris sur les pins blancs de l'Ontario en 1996

(Aerial Spray Program Against Jack Pine Budworm on White Pine in Ontario, 1996)

T.A. Scarr

En 1996, le ministère des Richesses naturelles de l'Ontario a mis en oeuvre un programme de vaporisation aérienne pour protéger les pins blancs contre la défoliation par la tordeuse du pin gris, *Choristoneura pinus pinus* (Free). Un total de 24 372 ha ont été traités lors d'une vaporisation unique de *Bt* (Foray 48B) à 30 mui/2,31 litres/ha. La vaporisation s'est faite en hélicoptère du 14 au 24 juin 1996.

Les résultats démontrent que le traitement a réussi à réduire la défoliation, bien que les populations de tordeuses du pin gris et la gravité de la défoliation varient d'un bloc vaporisé à un autre et d'un bloc de contrôle à un autre, ce qui est souvent le cas avec les infestations de le tordeuse du pin gris. La défoliation moyenne ne dépassait pas 20 pour 100.

La spongieuse au Nouveau-Brunswick :
suivi des activités entreprises en 1995 et situation actuelle
(The Gypsy Moth in New Brunswick :
Follow-up to Activities in 1995 and Current Status)
N. Carter et D. Lavigne

Ce rapport décrit l'étendue des dégâts causés par la spongieuse au Nouveau-Brunswick ainsi que les divers essais et programmes de surveillance mis en oeuvre contre le ravageur. Les mesures suivantes ont été entreprises contre la spongieuse en 1996 : i) détermination des taux de survie hivernale des masses d'oeufs dans plusieurs régions; ii) surveillance à des fins de suivi dans trois sites ayant fait l'objet en 1995 d'une application au sol à petite échelle du virus de la polyédrose nucléaire; iii) relevés au moyen de pièges à phéromone et dénombrements des masses d'oeufs visant à mettre en évidence une modification éventuelle de l'aire de répartition du ravageur dans la province. En outre, on a organisé des rencontres avec des représentants d'Agriculture et Agroalimentaire Canada afin de discuter de l'application éventuelle d'un règlement établissant des zones de quarantaine et régissant le déplacement de matériel potentiellement infesté dans la province.

Élaboration d'un nouveau programme de lutte
contre la tenthrède à tête jaune de l'épinette (*Pikonema alaskensis (Roh.)*)
(Development of an Alternative Pest Management Programme for the
Yellowheaded Spruce Sawfly *(Pikonema alaskensis (Roh.))*
N. Carter

Ce rapport contient une description sommaire des travaux réalisés en 1996 dans le cadre d'un programme visant à mettre au point de nouvelles méthodes de lutte contre la tenthrède à tête jaune de l'épinette en vue de leur utilisation dans les plantations d'épinette noire du Nouveau-Brunswick. Dans le cadre de ce programme conjoint inter agence, on a évalué l'efficacité d'une phéromone, d'un parasite des oeufs, de nématodes, du NEEM, du trichlorfon, du malathion et de l'acéphate. Un compte rendu des travaux exécutés dans le cadre de deux volets de ces essais est présenté dans les rapports de Hartling et Bourchier et de Carter *et al.* (voir ci-dessous).

Évaluation de l'efficacité de deux *Trichogramma* spp. parasites des oeufs
contre la tenthrède à tête jaune de l'épinette
(Assessment of Two *Trichogramma* spp. on Egg Parasitism
of the Yellowheaded Spruce Sawfly)
L. Hartling et R. Bourchier

Les auteurs présentent les résultats d'une série d'expériences réalisées avec des parasites des oeufs contre la tenthrède à tête jaune de l'épinette dans le cadre des essais décrits par Carter (voir ci-dessus). À première vue, il semble que les lâchers inondatifs de deux espèces de *Trichogramma* n'aient pas donné les résultats escomptés, bien qu'ils aient été un succès sur le plan technique. Sur le terrain, le taux de parasitisme était pratiquement nul. En laboratoire, aucun oeuf de la tenthrède à tête jaune de l'épinette n'a été parasité par *T. minutum.* Cette situation était peut-être liée au développement embryonnaire du ravageur.

Évaluation du potentiel insecticide du trichlorfon, du malathion et de l'acéphate contre la tenthrède à tête jaune de l'épinette

(Assessment of Trichlorfon, Malathion and Acephate
for the Control of the Yellowheaded Spruce Sawfly)

N. Carter, W. Patterson et D. Lavigne

Les auteurs présentent les résultats d'une évaluation expérimentale de trois pesticides contre la tenthrède à tête jaune de l'épinette réalisée dans le cadre des essais décrits par Carter (voir ci-dessus). Des doses sont recommandées pour chacun des pesticides.

Étendue des dommages causés par quelques ravageurs forestiers en Nouvelle-Écosse Rapport préparé en prévision du Forum national de répression des ravageurs forestiers, tenu à Ottawa, en novembre 1996

(Status of Some Forest Pest s in Nova Scotia
Prepared for the 1996 Forest Pest Management Forum
November, 1996, Ottawa)

E. Georgeson

Ce rapport décrit brièvement les dommages causés par les principaux ravageurs forestiers en Nouvelle-Écosse en 1996. Si les conditions hivernales clémentes ont favorisé la survie des insectes, les conditions fraîches et humides enregistrées au cours du printemps et de l'été se sont révélées particulièrement néfastes pour les défoliateurs forestiers. Les populations de défoliateurs actifs en début de saison, dont le papillon satiné et l'arpenteuse du printemps, responsables de graves défoliations en 1995, se sont effondrées. Une étude a révélé que le taux de survie des oeufs en hiver s'établissait à seulement 62,8 %. Des dénombrements effectués en été ont indiqué que les effectifs larvaires de la spongieuse étaient plus faibles que prévus. Les parasites, en particulier *Compsilura concinnata*, semblent avoir jouer un rôle déterminant dans la réduction des effectifs de la spongieuse dans certains secteurs, les taux de parasitisme s'élevant à plus de 50 %. Les populations établies de la spongieuse sont demeurées stables dans l'ouest de la province. Une augmentation générale des effectifs de la tordeuse à tête noire de l'épinette a été observée. L'extension de l'aire de répartition du dendroctone de l'épinette s'est poursuivie dans la province. L'infestation prévue de la livrée des forêts ne s'est pas concrétisée. Aucune défoliation due à la tordeuse des bourgeons de l'épinette n'a été signalée. L'accroissement général des populations de la chenille a houppes blanches s'est poursuivie. Une augmentation des effectifs de l'arpenteuse de la pruche a été observée pour une troisième année consécutive à l'échelle de la province.

Compte rendu du programme de pulvérisation aérienne de 1996 contre l'arpenteuse de la pruche en Nouvelle-Écosse

(The 1996 Nova Scotia Hemlock Looper Aerial Treatment Program Report)

E. Georgeson

Les résultats d'une campagne de pulvérisation aérienne de *Bacillus thuringiensis kurstaki* (Btk) dirigée contre l'arpenteuse de la pruche dans l'île du Cap-Breton sont présentés. Plus de 2 000 ha de forêts de sapin baumier gravement à très gravement infestées par l'arpenteuse ont reçu deux applications des formulations Foray 48B et 76B. Les autorités provinciales ont indiqué que les traitements avaient causé une forte réduction des effectifs larvaires et permis de protéger le nouveau feuillage, en dépit des conditions météorologiques défavorables.

Insectes forestiers à Terre-Neuve : situation actuelle et prévisions pour 1997

(Forest Insect Status and Forecast for 1997 in Newfoundland)

H. Crummey

L'auteur décrit les dommages causés par les principaux ravageurs forestiers à Terre-Neuve en 1996. L'infestation par l'arpenteuse de la pruche s'est intensifiée dans l'ouest et le nord de la province, et des foyers d'infestation isolés ont été signalés dans le centre-est et l'est de l'île. L'infestation causée par le diprion du sapin dans l'ouest de la province semble prendre de l'ampleur et s'étendre vers l'est en direction des grands peuplements de sapin baumier de grande valeur ayant fait l'objet d'éclaircies précommerciales. L'auteur décrit les dégâts causés par la tordeuse à tête noire de l'épinette, la tordeuse des bourgeons de l'épinette et la tenthrède à tête jaune de l'épinette et présente les résultats d'une application de *Bacillus thuringiensis* (Bt) entreprise en 1996 contre l'arpenteuse de la pruche dans des peuplements de sapin baumier de l'ouest et du nord de la province. Les traitements ont permis de réduire considérablement les dommages dus à la défoliation. Des prévisions concernant les programmes de lutte planifiés pour 1997 contre l'arpenteuse de la pruche et le diprion du sapin sont également présentées.

Compte rendu d'un atelier sur l'arpenteuse de la pruche et mise sur pied d'un réseau d'information sur l'arpenteuse de la pruche

(Hemlock Looper Workshop and Network)

R.J. West

L'auteur décrit brièvement les principales conclusions d'un atelier sur l'arpenteuse de la pruche qui s'est tenu à Fredericton (Nouveau-Brunswick), le 6 octobre, dans le cadre de la réunion annuelle de la Société entomologique du Canada. Il présente également un aperçu des projets de recherche récents et des recommandations concernant les interventions futures tant dans le domaine de la recherche qu'au plan opérationnel. Il décrit les progrès accomplis dans la mise sur pied d'un réseau d'information sur l'arpenteuse de la pruche visant à faciliter la diffusion des plans de projets de recherche et des plans opérationnels au cours du printemps de même que des résultats de ces projets à l'automne.

Élaboration d'une stratégie de lutte contre l'arpenteuse de la pruche
(Development of Control Tactics Against the Hemlock Looper)
R.J. West

L'auteur décrit des stratégies de lutte inondative et massive élaborées pour la région de l'Atlantique. Les stratégies de lutte inondative décrites ont été utilisées dans le cadre d'une série d'applications expérimentales de diverses formulations/doses de *Bacillus thuringiensis* (Bt), de fénitrothion, de diflubenzuron, d'aldicarbe et de téfubénozide réalisées entre 1985 et 1996. L'auteur présente également les résultats d'un projet de production massive du champignon entomopathogène *Entomophaga aulica* et d'une recherche sur des virus de la polyédrose nucléaire. Les stratégies de lutte inondative étudiées prévoyaient le lâcher d'ennemis naturels, la sélection d'espèces de parasitoïdes exotiques, l'identification de parasitoïdes à des fins d'introduction dans d'autres régions du Canada et l'évaluation de l'efficacité d'un protozoaire parasite.

Les ravageurs forestiers au Nouveau-Brunswick : état de la situation en 1996
(Forest Pest Status Report for New Brunswick in 1996)
N. Carter

Ce rapport décrit brièvement les dommages infligés aux feuillus et aux résineux par les insectes nuisibles des forêts et les résultats de programmes de surveillance des maladies des feuillus et des résineux. De façon générale, on n'a signalé aucune infestation grave causée par la tordeuse des bourgeons de l'épinette, la tordeuse à tête noire de l'épinette, l'arpenteuse de la pruche, la tenthrède à tête jaune de l'épinette, le diprion du sapin, la tenthrède du mélèze ou divers ravageurs des vergers à graines. Une campagne de surveillance de faible intensité n'a révélé aucune modification des taux d'infection par le chancre scléroderrien et le chancre du mélèze d'Europe. La présente infestation causée par la livrée des forêts, un défoliateur des feuillus, est pratiquement terminée; en revanche, les effectifs du papillon satiné augmentent progressivement, et l'on craint que le ravageur ne cause des défoliations graves en 1997. Enfin, la présence du chancre du noyer n'a encore pas été détectée dans la province.

Survey of Forest Insects and Diseases in Quebec in 1996
(Sommaire du Relevé des insecte et des maladies des arbres
au Québec en 1996)

C. Bordeleau and M. Auger

In coniferous forests, damage caused by the principal defoliating insects increased in 1996. The spruce budworm continued to cause significant defoliation in western Quebec, while the hemlock looper was the chief problem in the eastern part of the province. On the other hand, there was a marked regression this year of local infestations by the jack pine budworm. In deciduous forests, the main problems were the birch casebearer and the aspen twoleaf tier, while the white pine weevil and the yellowheaded spruce sawfly caused the most damage in plantations.

Here are the year's highlights:

- slow progression of the spruce budworm infestation in the Outaouais region
- spectacular increase in hemlock looper populations at fir stands in the northeastern part of the Gaspé - Magdalen Islands region
- regression of jack pine budworm populations in the Mauricie - Bois Francs region
- continued regression of the forest tent caterpillar infestation in the Mauricie - Bois Francs region
- maintenance at endemic levels of gypsy moth populations, throughout nearly its entire range in the province
- damage by birch casebearer in several regions of the province
- defoliation by aspen twoleaf tier in some parts of Abitibi-Temiscaming, Lanaudière and Mauricie - Bois Francs
- significant local defoliation by yellowheaded spruce sawfly in central and eastern Quebec.

Presentation at the National Pest Forum, November 19, 1996,
Government Conference Centre, Ottawa

Presented by Tim Ebata, MSc., RPF
Forest Health Project Specialist, B.C. Ministry of Forests

A. Pest Status Report for B.C.

In order to impress upon you the importance of B.C. forests and how it relates to other provinces, I have included some selected B.C. Forest Statistics (available on the BC MoF HomePage (http://www.for.gov.bc.ca/pab/publctns/bcfacts/bcfacts.htm)

B.C. Total Area:		94 780 000 ha
• Productive forest land in tree farm licences and timber supply areas		45 353 000 ha
• Mature		26 957 000 ha
• Immature forests		14 779 000 ha
• Not stocked - (much of this area will have some trees and/or is inoperable; more valuable left as wildlife habitat.)		3 617 000 ha
Inventory volume: (1992)		
• Mature		8 588 000 000 cubic m
• Estimated growth rate (total operable area)		2.56 cubic m/ha/yr
Land ownership:		94% public
Allowable annual cut:		
• regulated lands (Crown and private land and timber licences within TFLs) (1994) B.C. total:		71 540 912 cubic metres
• Area harvested: (1992-93)		
	Crown lands	196 601 ha
	Private lands	24 998 ha
	Total	221 599 ha
• Volume harvested: (1992-93)		
	Crown land	72.2 million cubic m
	Federal land and Native reserves	0.2 million cubic m
	private	6.4 million cubic m
	Total	78.8 million cubic m
Estimated area of the productive forest harvested:		22 per cent

Reforestation: (1992-93)
Planted: ('92-93) 215 606 000 seedlings on 184 823 hectares (Crown and private land)
Prescribed natural regeneration = 50 per cent of all harvested areas
Seedling survival rate (after 2 years) = 87 per cent
Total number seedlings planted to date: more than three billion (three billionth planted in 1993-1994 season)

Pests of Concern in British Columbia:

- –bark beetles (in order of importance)- pine, spruce, Douglas-fir and subalpine fir (little managment known for balsam bark beetle)
- –defoliators - Western spruce budworm, Douglas-fir tussock moth, Western hemolock looper, others
- –pine needle diseases - Lophodermella concolor has been severe throughout the interior for the last three years and is starting to affect growth.
- –chronic infection by dwarf mistletoes, root diseases, stem diseases, leader weevils
- –introduced pests - gypsy moth, balsam woolly adelgid

Area damaged in 1996 in B.C. - Breakdown of B.C. pest damage statistics (CFS data only)

Bark Beetles:

Spruce Beetle	77,000 ha
Mountain Pine Beetle	56,000 ha
Western Balsam Bark Beetle	132,000 ha
Douglas-fir beetle	no data

(note: Not all of the BC Ministry of Forests aerial survey data is included in this summary.)

Defoliators:

Neodiprion abietis complex	24,000 ha
Western blackheaded budworm	9500 ha
Green striped forest looper	20,000 ha
Two-year cycle budworm	250,000 ha
Western spruce budworm	5,000 ha
Eastern spruce budworm	6,500 ha
Forest tent caterpillar	95,000 ha
Northern tent caterpillar	3,000 ha
Large aspen tortrix	7,000 ha

Pine Needle Cast	710,000 ha

Other pests not noted but are significant are root diseases, dwarf mistletoes, terminal weevils, pine stem diseases, decays and animal damage

••Gypsy moth - no asians, scattered moth collections
• BWA - infested zone expanded

B. Operational Pest Management Activities in B.C.

There are several major initiatives that are underway that are influencing forest management in B.C.

- BC MoF is implementing Forest Practices Code Act of B.C., and its Regulations, recommended "best practices" are described in Guide Books. There are 9 for forest health alone. These practices do not carry the weight of law but provide the preferred method of achieving a particular forest management objective. Full compliance will be requred by June/97. Forest Health (a.k.a. pest management) is embedded into the code mainly under the requirement for a forest health assessment in operational plans

- Take over CFS overview survey - the Ministry of Forests is developing an overview survey training package with the assistance of CFS Forest Health Network staff. This package consists of a day long classroom session and in-flight practice/test session, a stand-alone video, and a CD-ROM training tool. Currently, MoF district staff relied on the CFS for survey of defoliators and other pests while those districts with operational bark beetle management programs conducted their own detailed aerial surveys. The detailed data was sent to CFS for digitization and roll-up into the national database. With the loss of FIDS, all districts will be obliged to collect this data through district staff or contractors. Data will be sent to CFS in digital format but compatability issues abound with the CFS GIS being ARCINFO while the MoF uses IGDS format.

- Training initiatives - because of the change in legislation, forest industry, government and contractors require training to get them up to speed on the content of the legislation and contents and use of forest health guidebooks. Courses are being prepared for all of these topics.

- New opportunities through Forest Renewal B.C. funding - An added surcharge on stumpage levied on the forest industry is being utilized to enhance forest productivity, repair damaged ecosystems, increase opportunities in value-added industries - all leading to the creation of a sustained forest-based economy, community stability and jobs. Numerous opportunities have arised for forest health in research, inventories and enhanced treatments. To date, approximately $2 million per year has been allocated to forest health related activities.

- Calculating unsalvaged losses - Two separate initiatives are being driven by the recent request by the B.C. Chief Forester for more accurate estimates of annual unsalvaged losses due to pests and other agents for the Timber Supply Analysis. He noted a huge discrepency between MoF estimates and CFS FIDS totals of annual volume losses. One of these intitiatives is using the services of CFS's David McLean for modelling unsalvaged losses in the Prince George Timber Supply Area.

- Operational surveys and treatments for managing bark beetles and defoliator outbreaks - since 1985, the MoF has been operationally managing bark beetle infestations, mainly mountain pine beetle, in an effort to prevent outbreaks and sustain existing mature timber supplies. Defoliators, primarily in the drier Kamloops Forest Region, have been monitored and in some extra-ordinary cases, sprayed with B.t. in operational suppression treatments. NPV has also been successfully attributed to suppressing an outbreak of Douglas-fir Tussock Moth. Both defoliator populations have since crashed and an ongoing monitoring program as well as growth and yield studies have been maintained.

- Root disease and other pests handled through silviculture prescriptions and stand management prescriptions. Phellinus root rot, Armillaria root disease and Tomentosus root disease are the main root pathogens in B.C. Survey design and treatment recommendations require improvement but root disease is considered in all silviculture (pre-harvest) and stand management (spacing, pruning, fertilizing) prescriptions.

- PC-based BB infestation and project tracking systems; operational trials database - District and regions require tools to track operational beetle management activities and expenditures. Also, operational forest health trials are now tracked on an MS-Access database and maintained as a living database on the ministry's intra-net.

- Summary of Base (non-FRBC) Forest Health Expenditures (95/96):

aerial surveys	$200,000
ground surveys	$794,000
fall and burn	$2,179,000
MSMA	$1,270,000
pheromones	$468,000
defoliator spraying	$175,000
other (trials, misc.)	$2,165,000
TOTAL	**$7,251,000**

C. Experimental Trials in B.C.

- FRBC is funding a wide variety of forest health research but it must support FRBC's mandate, not the ministry of Forests'. Major topic areas are landscape pest effects (role of pests in forest ecosystems), wood products pests, pest impacts on growth and yield, exotic and introduced pest management, pest responses to partial cuts and enhanced forestry treatments, and new forest health treatments. The forest health research community is taking full advantage of this opportunity and we foresee great advances in the management of pests in B.C.
- The MoF is continuing to develop pest extensions for the Forest Vegetation Simulator, FVS (formerly PROGNOSIS) for root disease and defoliators. A user friendly Window-based front-end has been written to aid in the use of the model for running custom simulations.
- MoF Regions and Districts establish and maintain research and operational trials on specific problems; much of it is collaborative but more is being done by MoF staff.

Results are generally not published in refereed journals but are usually are distributed through internal reports.

- MoF research is involved in answering operational questions pertaining to pest impacts, biology, ecosystem function, detection methods, treatment methods and prevention.

24th Annual Pest Control Forum

Important Forest Pest Conditions, Pest Management Operations, and Field Trials in Alberta, 1996

Presented by: H. Ono, Alberta Land and Forest Service

Contributors: Alberta Land & Forest Service
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November 1996
OTTAWA

Abstract

This summary report was compiled from field reports of regional forest health officers of the of Land and Forest Service (L&FS) in four forest regions in Alberta and survey reports of Forest Health Network Technicians at the Northern Forestry Centre, Canadian Forest Service (CFS). It contains the current conditions of some economically important forest pests, and the outlook for pest conditions in 1997, in Alberta. The results of the spruce budworm management program are also summarized. In addition, the results of field surveys, trials on insecticides, and the trapping program using pheromones are given in this report.

In 1996, the extent of spruce budworm infestations in Alberta decreased by 46% compared to 1995. Spruce beetle, mountain pine beetle, and forest tent caterpillar populations remained at endemic levels during 1996. Pheromone trap catches, and second instar budworm surveys predict substantially lower levels of budworm infestations in the province in 1997, compared to 1996 infestations.

Undiluted Foray 48B® was aerially sprayed over 110,026 ha in northern Alberta and based on the second instar survey results, nil-light (below 35%) defoliation is expected in most of the sprayed stands in 1997.

Aerial spraying of Mimic® provided excellent spruce budworm control. Spraying of Thuricide® also provided satisfactory spruce budworm control. There was no significant difference between the average number of spruce budworm moths trapped in Multi-Pher I traps baited with standard pheromone compared with those baited with pheromone produced by Phero Tech Inc., Delta, B.C.

The Dutch Elm Disease Initiative (DEDI) in Alberta is described. To date Dutch Elm Disease (DED) has not been found in Alberta; however, a proposal was submitted to the Critical Pest Management Council to deal with DED, in case the disease is found in Alberta. So far, the small European elm bark beetle (SEEBB) has been collected from Calgary, Edmonton and Vauxhall. Firewood infested with SEEBB has also been detected at several ports of entry to Alberta.

1.0 IMPORTANT FOREST PEST CONDITIONS

This report includes the conditions of some important forest pests on whom current survey data are available. Numerous forest diseases such as stem decays, dwarf mistletoe, rusts and cankers, though important, are not included in this report.

1.1 Eastern Spruce Budworm

The spruce budworm, *Choristoneura fumiferana* (Clemens), infestations in the province are located in the Northwest and Northeast Boreal Regions (Figure 1). The aerially visible budworm defoliation in the forest management area of the province is estimated to be 108,703 ha. This is a 46% drop in the budworm-defoliated area, compared to that in 1995. This drop in defoliated area, as predicted by the results of the second instar survey done in 1995, was in the stands sprayed with Btk in 1995 (Figure 2). No new budworm outbreaks were detected during 1996.

Spruce budworm-defoliated area is expected to drop substantially in 1997 as shown by the results of a second instar survey done in the Northwest Boreal and Northeast Boreal Regions of the province. In the Northwest Boreal Region, almost all the plots in the sprayed area had counts indicating nil-light defoliation in 1997. In this region, budworm defoliation is expected to be moderate to severe (over 35%) in the unsprayed stands in northeastern area (Figure 3a). Similarly, all the plots in the sprayed area in the Northeast Boreal Region are expected to have nil-light defoliation in 1997 (Figure 3b).

Pheromone traps were deployed province wide at 86 sites that are not currently defoliated by the budworm. Data from these traps predict high potential for spruce budworm outbreaks at two sites in the Northwest Boreal Region. Budworm outbreak risk is moderate at two sites in the Northeast Boreal Region, five sites in the Northern East Slopes Region and three sites in the Northwest Boreal Region . Risk of budworm outbreaks is nil-low at the other sites (see section 2.1 for details).

1.2 Spruce Beetle

In 1995, there were an estimated 23,771 ha infested by the spruce beetle, *Dendroctonus rufipennis* (Kirby), in the Northwest Boreal Region in Alberta. An aerial survey conducted by CFS personnel in July 1996 showed no new spruce beetle-infested white spruce stands in this region. Out of the infested area, 364 ha were salvaged in 1995/96 season; another 650 ha are scheduled to be harvested through salvage operations in 1996/97.

Spruce beetle counts in Lindgren funnel traps deployed at five sites within the infested area in the Northwest Boreal Region showed endemic populations (see section 2.2 for details).

Aerial surveys were conducted through the cooperative efforts of CFS and LFS.

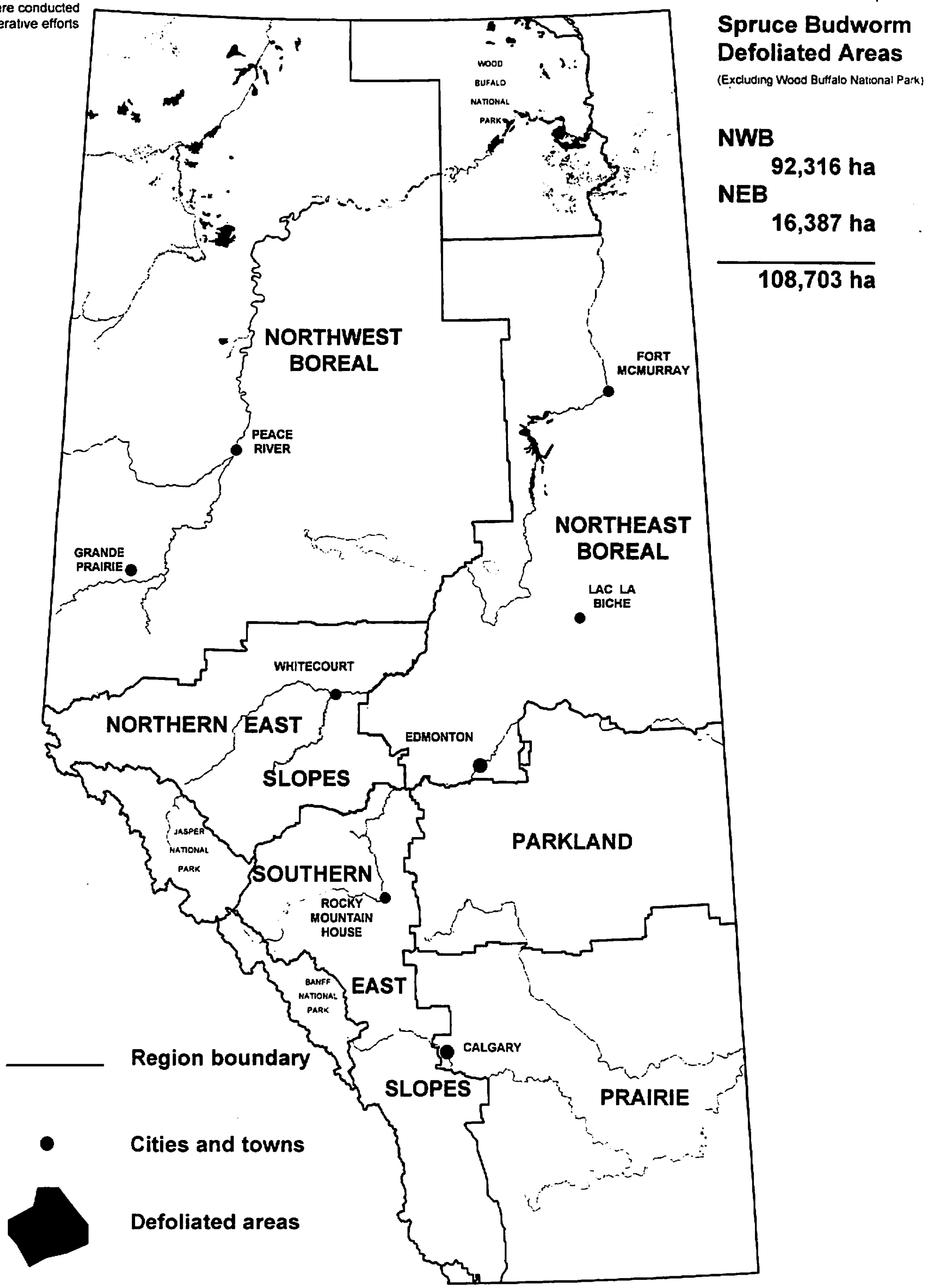

Figure 1. Spruce budworm defoliation in Alberta, 1996.

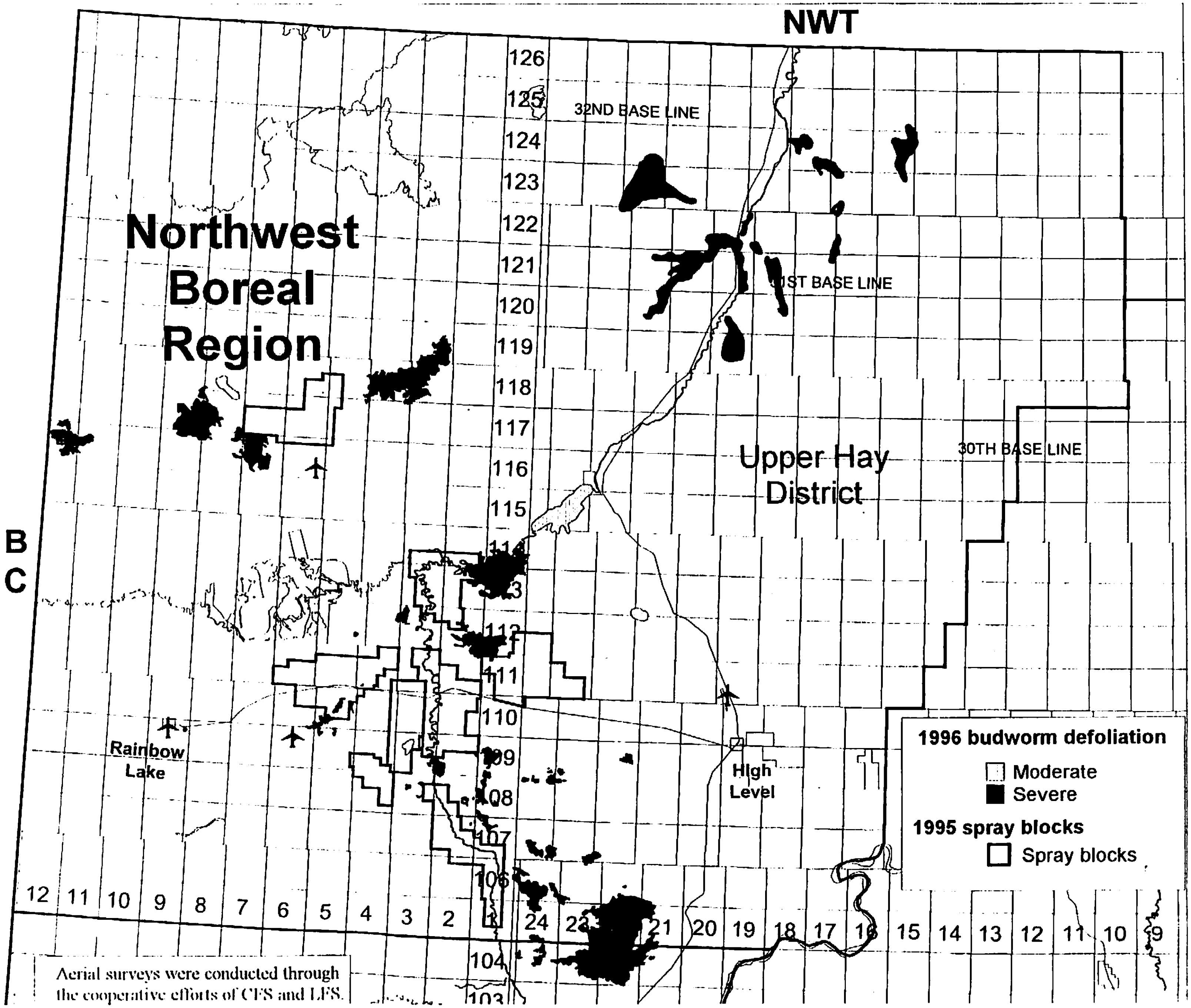

Figure 2. Areas sprayed with Btk in 1995 and areas defoliated by spruce budworm in 1996, Northwest Boreal Region, Alberta.

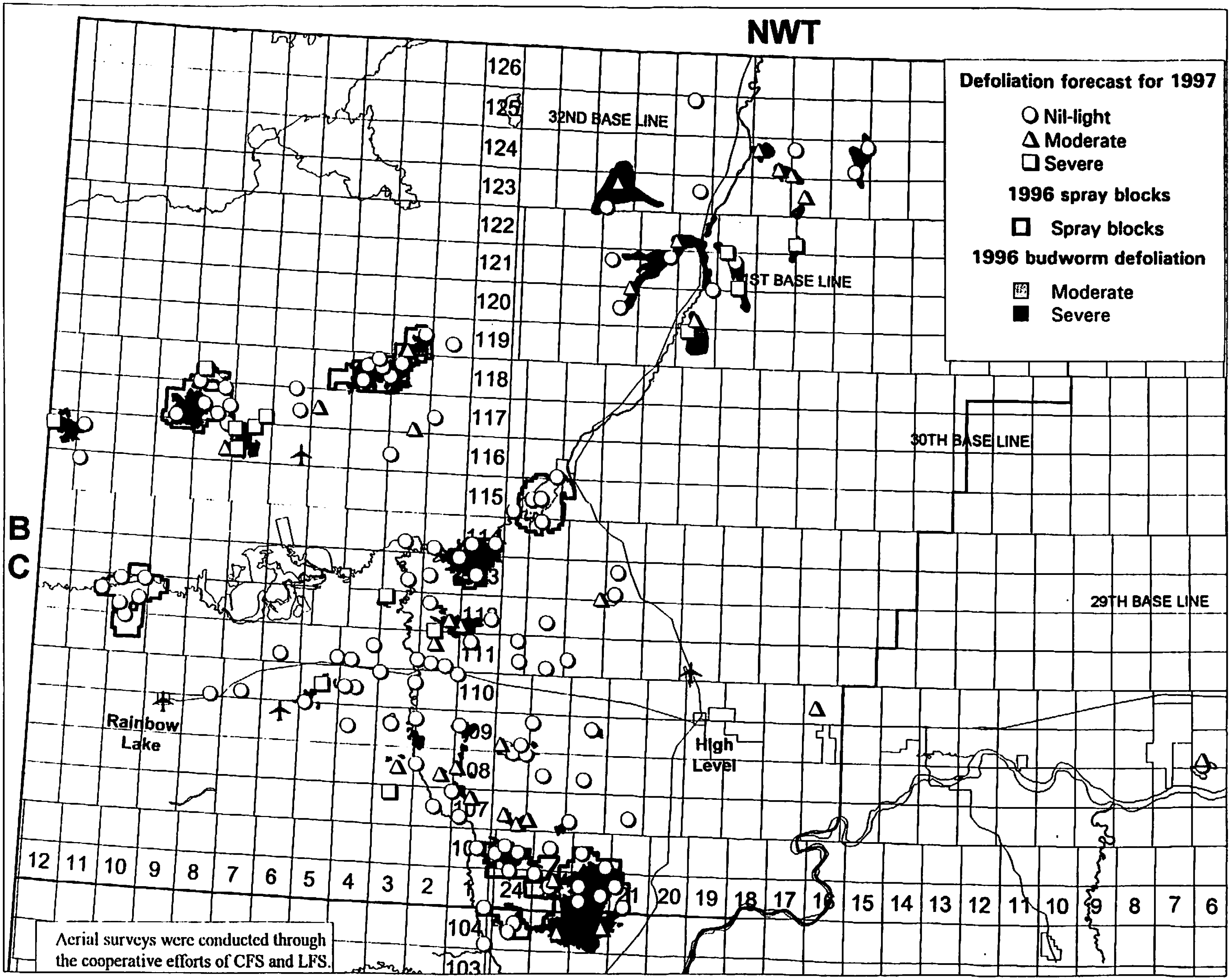

Figure 3a. Areas sprayed with Btk in 1996 and predicted budworm defoliation in 1997 based on L2 counts in Northwest Boreal Region, Alberta.

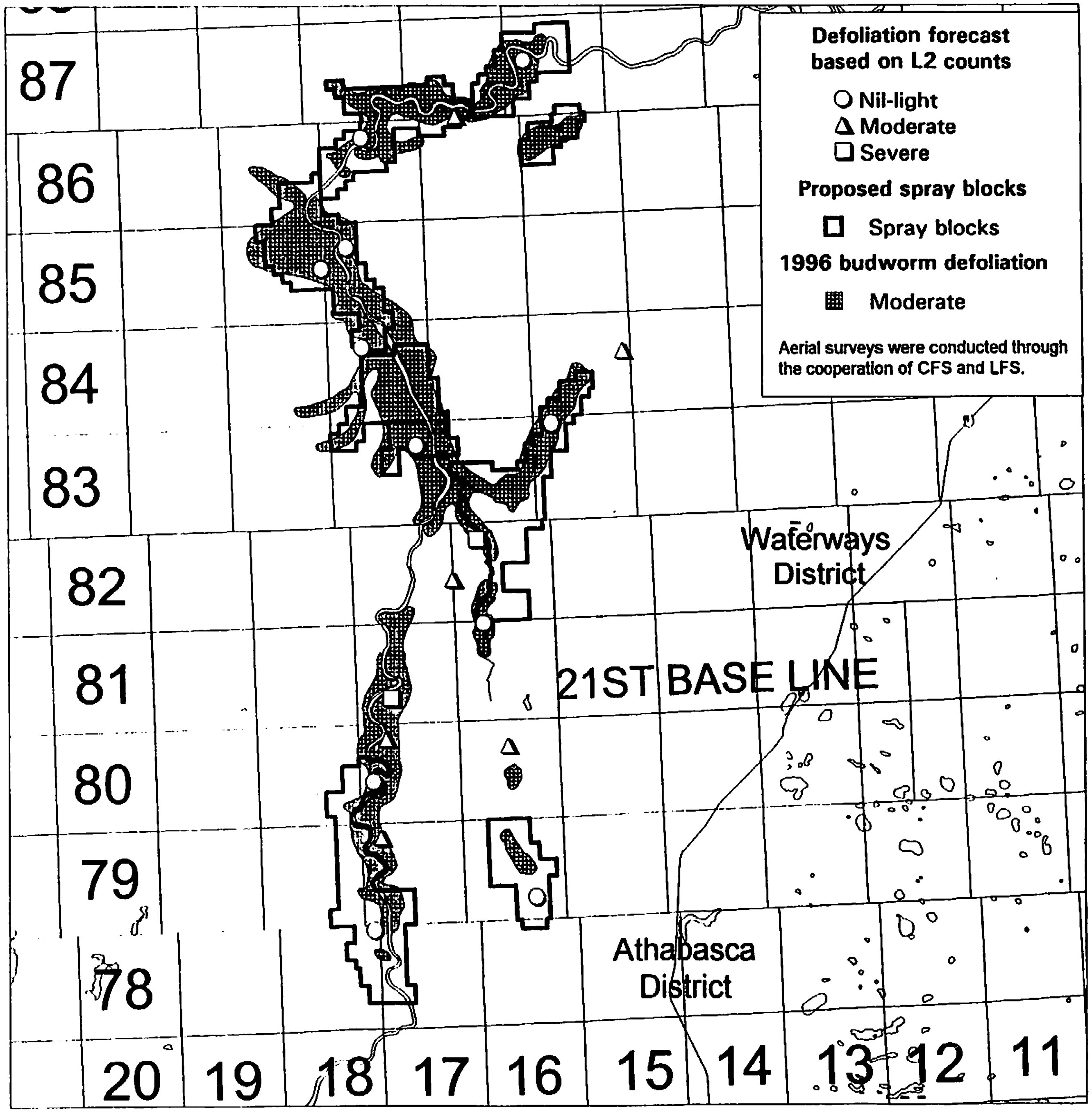

Figure 3b. Areas sprayed with Btk in 1996 and predicted budworm defoliation in 1997 based on L2 counts in Northeast Boreal Region, Alberta.

1.3 Mountain Pine Beetle

No mountain pine beetle, *Dendroctonus ponderosae* Hopkins, infestations were detected during an aerial survey carried out jointly by L&FS, CFS and Parks Canada personnel in 1996. This survey was carried out mainly along the major river valleys in the Southern East Slopes Region and Northern East Slopes Region bordering B.C. There were six beetle attacks in pheromone-baited over-mature lodgepole pines in the Northern East Slopes Region as well as six beetle attacks in the Southern East Slopes Region. All the attacked trees were debarked (see section 2.3 for details).

1.4 Forest Tent Caterpillar

During 1996, the extent of forest tent caterpillar, *Malacosoma disstria* Hubner, defoliation was estimated to be 132,738 ha. This was a 40% decrease compared to the defoliated area in 1995. The defoliated area was scattered throughout the province. During the aerial surveys done in collaboration with CFS personnel, light defoliation was observed over 3,038 ha in Elk Island area in the Parkland Region. Light-moderate defoliation was observed over 43,585 ha in Grande Prairie in Northwest Boreal Region, Cold Lake in the Northeast Boreal Region and Elk Island. Moderate defoliation was observed over 3,818 ha north of Peace River, Hawk Hills and Nina Lake, all in the Northwest Boreal Region. Moderate to severe defoliation was observed over 81,359 ha in Hawk Hills and Peace River; and severe defoliation was observed over 938 ha in Keg River and Guy in the Northwest Boreal Region (Figure 4).

1.5 Other Aspen Defoliators

The area defoliated by other aspen defoliators {large aspen tortrix, *Choristoneura conflictana* (Wlk.) and Bruce spanworm, *Operophtera bruceata* (Hulst)} was estimated to be 10,034 ha. and was confined to the Northeast Boreal Region. Aerial surveys done in collaboration with CFS personnel showed 628 ha of light defoliation and 9,406 ha of light-moderate defoliation in the Cold Lake area east of Lac La Biche (Figure 4).

1.6 Western Gall Rust

A high hazard corridor for western gall rust has been identified along the foothills in Alberta. This appears to run for about 200 km from Hinton north to Grande Prairie. A project is being planned to quantify gall rust damage in this area.

1.7 Dutch Elm Disease

Dutch Elm Disease (DED) has not been found in Alberta; however, in response to the discovery of potential DED vectors, the Dutch Elm Disease Initiative (DEDI) was undertaken. This program, funded by Alberta Agriculture, Food and Rural Development (AAFRD), focuses on increasing public awareness of this disease and advocating steps to minimize DED introduction.

The DEDI consists of seven programs: Monitoring DED and its vectors; maintaining an inventory of American elms in Alberta; monitoring for beetle-infested firewood at ports-of-entry; public awareness; developing a DED action plan; and encouraging interprovincial cooperation for DED control.

Highway signs advising motorists not to bring elm wood into Alberta have been posted and firewood drop-off/confiscation bins have been placed at several ports-of-entry. Public awareness about this disease has been increased by media advertisements, posters and brochures. Municipalities have been encouraged to initiate DED prevention programs and complete elm inventories.

Many large municipalities such as Edmonton, Calgary, Lethbridge, Medicine Hat, St. Alberta and Red Deer have started DED prevention programs. These include monitoring for DED vectors and elm tree maintenance. Altogether vector monitoring programs have been carried out at 97 locations across the province.

In mid-July, AAFRD proposed declaring DED as a critical pest so as to implement a Critical Pest Management Response Plan. The DED Technical Advisory Committee submitted a proposal to the Critical Pest Management Council on a five year plan to meet the DED threat.

To-date, Small European Elm Bark Beetle (SEEBB) has been trapped for three consecutive years in Calgary, two consecutive years in Edmonton and once in Vauxhall. Beetle-infested firewood has been confiscated at three ports-of-entry.

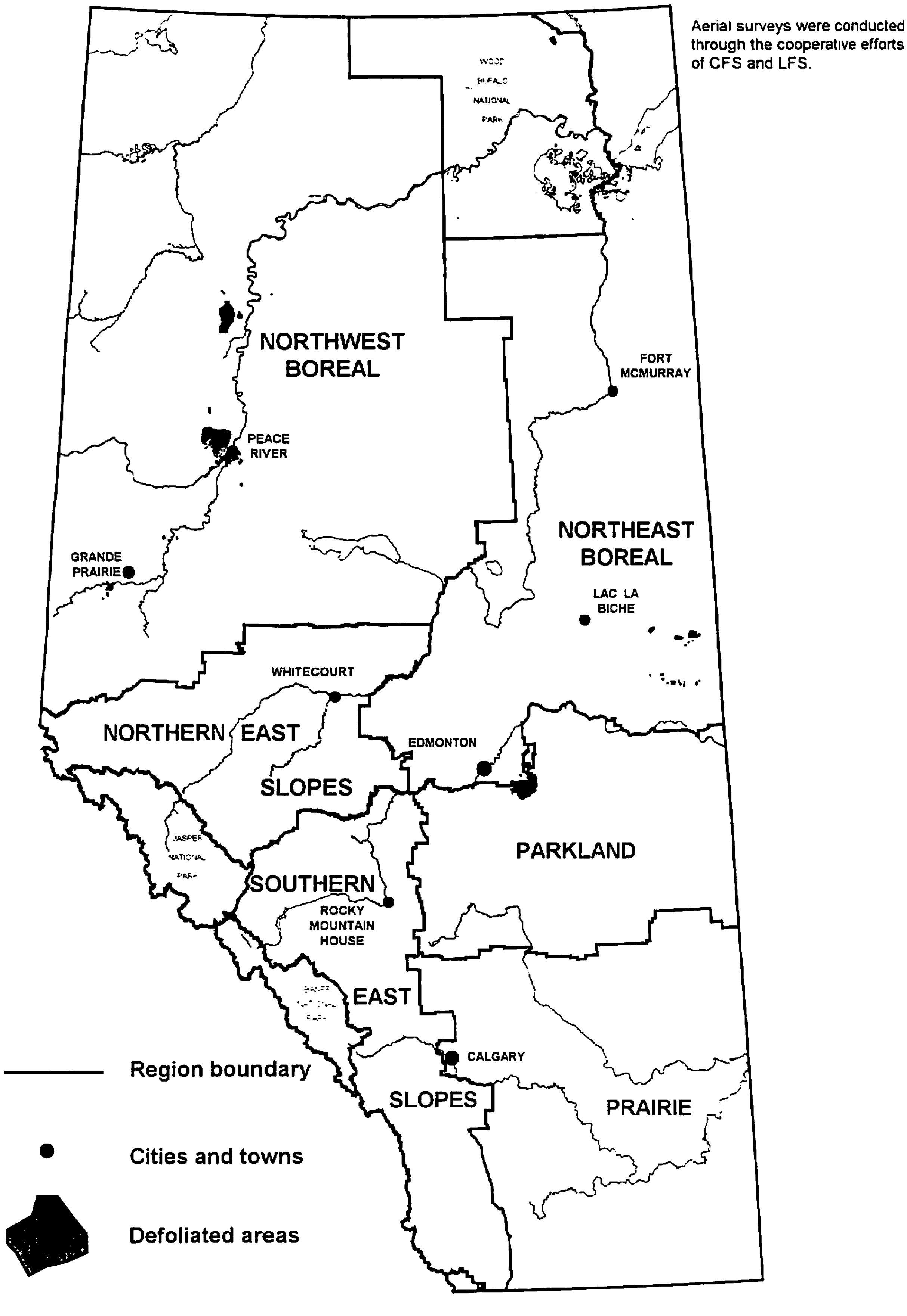

Figure 4. Areas defoliated by forest tent caterpillar and large aspen tortrix in Alberta, 1996.

2.0 Pheromone Trap Monitoring Program

In Alberta, pheromone-baited traps/trees are used to monitor important pests such as the eastern spruce budworm, spruce beetle and mountain pine beetle populations. This forms part of the Alberta Forest Pest Outbreak Warning System (AFPOWS).

2.1 Eastern Spruce Budworm

Spruce budworm populations, in stands that are not currently defoliated but carrying a high risk of an infestation, were monitored province wide by using traps baited with female sex pheromones. In 1996, there were 86 trap sites. At each site, two Multi-Pher I® traps baited with sex pheromones (Biolure, Consep Inc.) were placed approximately 40 m apart. This pheromone was obtained through C. Sanders of the CFS. Each trap had an insecticide strip (Vaportape II, Hercon Environmental, USA) at the bottom of the cylinder. Traps were deployed in mid-June and collected in mid-August. The moth count from each trap was recorded.

The predictions based on these moth counts are shown in Figure 5. These show that the risk of budworm outbreaks is low in the Southern East Slopes Region. In the Northern East Slopes Region, there is a moderate risk of a budworm outbreak in the Foothills District where noticeable increase in trap counts was observed. There was a similar trend in 1994 in this area indicating possible occurrence of two-year budworm. The other areas in this region have a low risk of budworm outbreaks. In the Northeast Boreal Region with a current budworm outbreak, moderate budworm counts (500-2000 per trap) were recorded at two sites; the other trap sites had low (below 500 moths per trap) moth counts. In the Northwest Boreal Region, two trap sites located near existing defoliated areas had high (over 2000 moths per trap) moth counts indicating possible outbreaks in 1997; three other sites located near the existing budworm infestations had moderate counts. Trap counts at all the other sites in this region indicated low risk of a budworm outbreak in 1997.

2.2 Spruce Beetle

Lindgren Funnel Traps (8-unit, wet option, Phero Tech Inc., B.C.) were deployed, two per site, at 5 sites near mature/over-mature white spruce stands in the Northwest Boreal Region. Traps were placed about 30 m apart in mid-May. Each trap was baited with the three-component lures supplied by Phero Tech Inc. Trap sites were visited and beetles were collected at 7-10 day intervals until late July. A spruce beetle index (Herb Cerezke, Canadian Forest Service) for each trap site was worked out by calculating the number of beetles per trapping day. This index was used to predict the status of beetle population in the stand.

The results of this program showed that the spruce beetle populations at these five sites are at endemic levels, i.e., beetle index of less than 0.5 beetles per trap per trapping day.

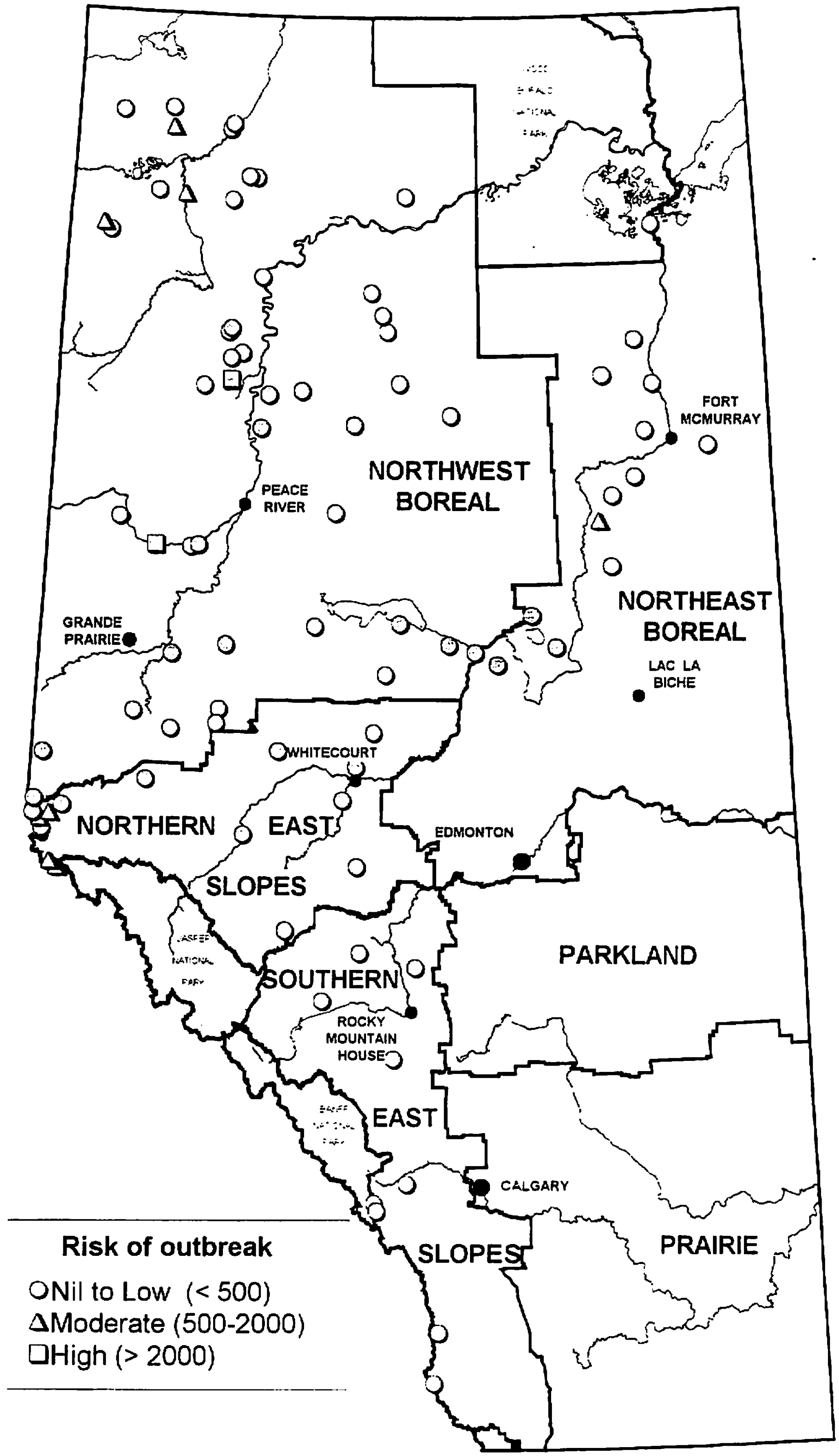

Figure 5. Risk of spruce budworm outbreak in 1997 based on 1996 moth counts in pheromone traps in Alberta.

2.3 Mountain Pine Beetle

Increased mountain pine beetle activity was observed in 1996 in the Spray Lakes reservoir area adjacent to Banff National Park. To monitor beetle activity, two-component baits (Phero Tech Inc.) were used at 25 sites in the Northern East Slopes Region and at 33 sites in the Southern East Slopes Region bordering Banff/Jasper National Parks and B.C. At each site, three dominant, mature lodgepole pines located about 45 m apart were baited at approximately two m above ground level. Baited-trees were checked monthly from June to August to check the beetle attacks.

Beetle-attacked trees were found at six sites in the Northern East Slopes Region. All these attacks were on over-mature lodgepole pines in the Willmore Wilderness Park sandwiched between the Jasper National Park and the B.C. border. In the Southern East Slopes Region, beetle-attacked trees were found at six sites in the Rocky Mountains Forest Reserve bordering the Jasper, and Banff National Parks; four sites were east of Canmore and the other two sites were near Blairmore. All the beetle-attacked trees were debarked.

2.4 Field Comparison of Budworm Pheromones

In Alberta, the female spruce budworm sex pheromone Biolure (Consep Inc., USA) has been used to monitor budworm populations in the high budworm-risk white spruce stands with no visible defoliation. Recently, Phero Tech Inc., B.C. has manufactured a similar pheromone. This year, these two pheromones were used in a comparative study in the field.

2.4.1 Materials and Methods

This field study was carried out in the Upper Hay District, Northwest Boreal Region, in Alberta during June-August, 1996. Nine pheromone trap sites were selected for this study. They were selected on the basis of 1995 second instar counts to represent stands with different levels of expected defoliation in 1996, i.e., severe (1), moderate (5) and light (2). In mid-June, two Multi-Pher I traps baited with Biolure pheromones and two similar traps baited with Phero Tech pheromones were placed at each site. These traps were placed at random, about 30 m apart from one another. Each trap contained an insecticidal strip (Vaportape II, Hercon International, USA). These traps were collected in mid-August and the number of moths in each trap was recorded.

The data were summarized to calculate the average number of moths per trap at each location baited with each kind of pheromone. A paired t-test was carried out on the summarized data. The average number of moths per trap was plotted against the plot number (Figure 5a).

2.4.2 Results and Discussion

There was no significant difference ($t = 0.47$, $p<0.01$)) between the average number of moths per trap baited with Biolure pheromone vs. Phero Tech pheromone. This was true for all the trap sites irrespective of the expected severity of budworm defoliation, i.e., level of budworm population. Thus, it appears that either pheromone would give comparable results under conditions found in Alberta.

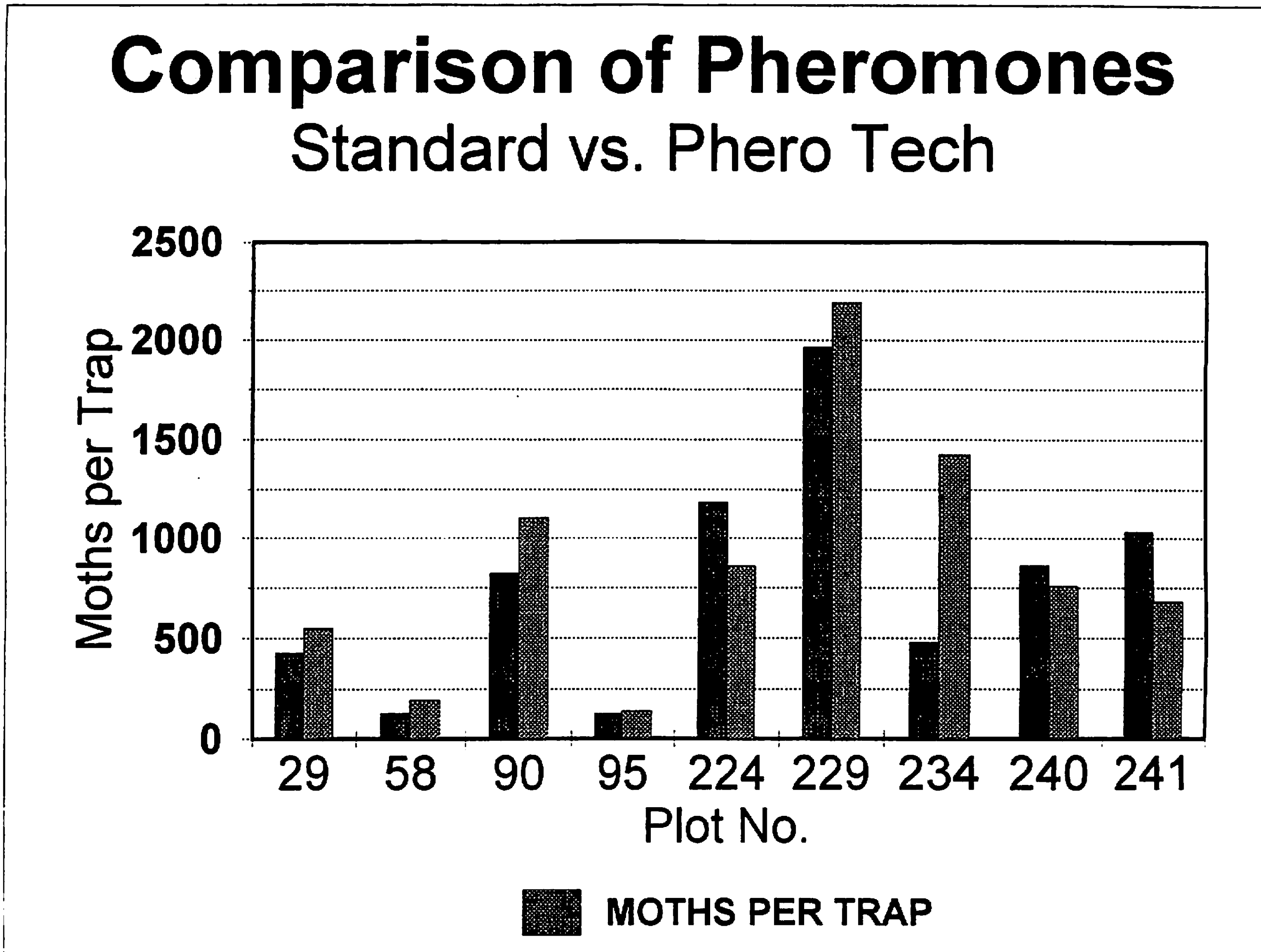

Figure 5a. Comparison of budworm moth counts in Biolure vs. Phero Tech pheromone-baited traps in Alberta, 1996.

3.0 SPRUCE BUDWORM MANAGEMENT PROGRAM

Undiluted Foray 48B® (Abbott Laboratories, USA) was aerially sprayed at a volume of 2.0 litres per ha (25.4 BIU/ha) over 110,026 ha of mature white spruce stands that were expected to be moderately to severely defoliated by the spruce budworm in northern Alberta. Aerial spraying began during the second week of June, about one week behind schedule, due to unusually cold and wet spring conditions. Small spray aircraft (see Appendix I for details) equipped with Micronair AU 4000 nozzles were used. These were guided by a SATLOC Forestar® Differential Global Positioning System installed in the lead spray aircraft in each echelon.

In the Northwest Boreal Region, 65,088 ha were sprayed twice with a minimum five day-interval between the sprayings. Another 17,651 ha were sprayed once (Figure 3a). In the Northeast Boreal Region, 24,066 ha were sprayed twice, and another 3,221 ha were sprayed once (Figure 3b). Aerial spraying was carried out when most of the budworms were either in their fifth or sixth instars.

The budworm populations in the sprayed areas were sampled before, and after spraying to find the efficacy of spraying. The procedures given in our "Spruce Budworm Sampling Manual" were followed. In the Northeast Boreal Region, 10 sample plots (one in each of six spray blocks and in each of four unsprayed stands) were established. In the Northwest Boreal Region, 27 plots (21 in sprayed blocks and six in unsprayed stands) were established similarly. Each plot was composed of four dominant/co-dominant white spruce whose upper mid-crowns were accessible for sampling with a 14 m pole pruner. Two 45-cm, mid-crown branch tips were collected before and after spraying from each sample tree. The number and stage of development of budworms and the width of each branch sample were recorded. The budworm counts were standardized by calculating the number of budworms per 10 m^2 of foliage. Budworm mortality in each tree was calculated by using the average standardized pre- and postspray counts per tree. Mean budworm mortality in each plot was calculated by averaging the budworm mortality in the four trees per plot. Abbott's formula was used to calculate the net budworm mortality (spray efficacy) in the sprayed plots.

The results of this spray program are shown in Figures 6 and 7. Prespray sampling showed budworm populations that would cause severe (>70%) defoliation (over 540 budworms per 10 m^2 of foliage) in 66% of the plots to be sprayed in the Northeast Boreal Region and in 76% of the plots to be sprayed in the Northwest Region; the other plots to be sprayed had populations that would cause moderate (35%-70%) defoliation. Postspray counts showed that in 83% of the sprayed plots in the Northeast Boreal Region, budworm populations were reduced to levels that would cause nil-light (<35%) defoliation (Figure 7). Similar results were observed in 57% of the sprayed plots in the Northwest Boreal Region (Figure 6). A second instar survey was carried out in August/September in the sprayed area in both these regions; the results of these surveys showed that the budworm populations in the sprayed areas were reduced to levels that would cause nil-light defoliation in 1997 (Figures 3a and 3b). Budworm mortality observed in the sprayed plots did not appear to relate to the number of sprayings.

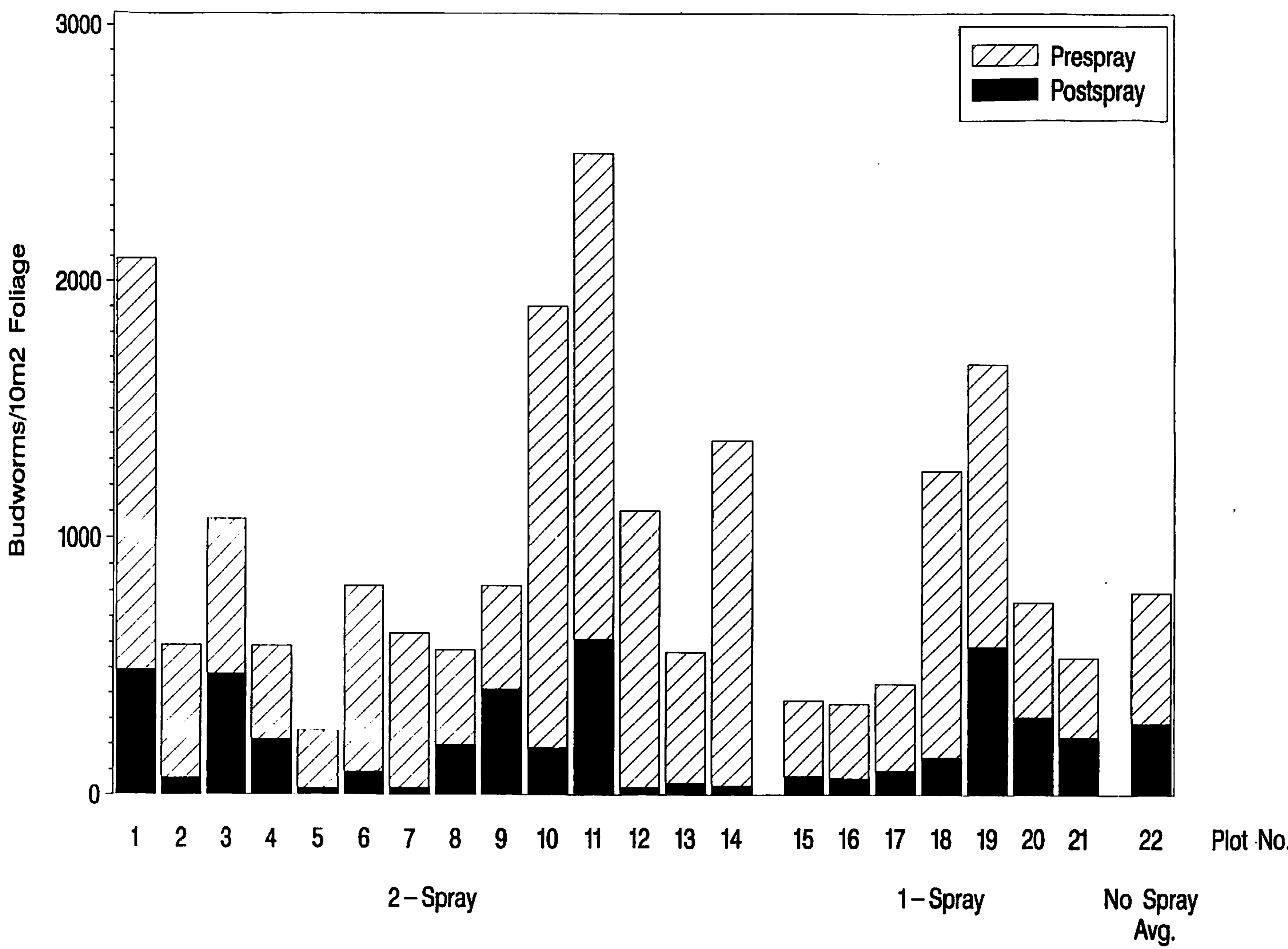

Figure 6. Comparison of pre- and postspray budworm counts in sprayed plots and averaged unsprayed check plots, Northwest Boreal Region, Alberta, 1996.

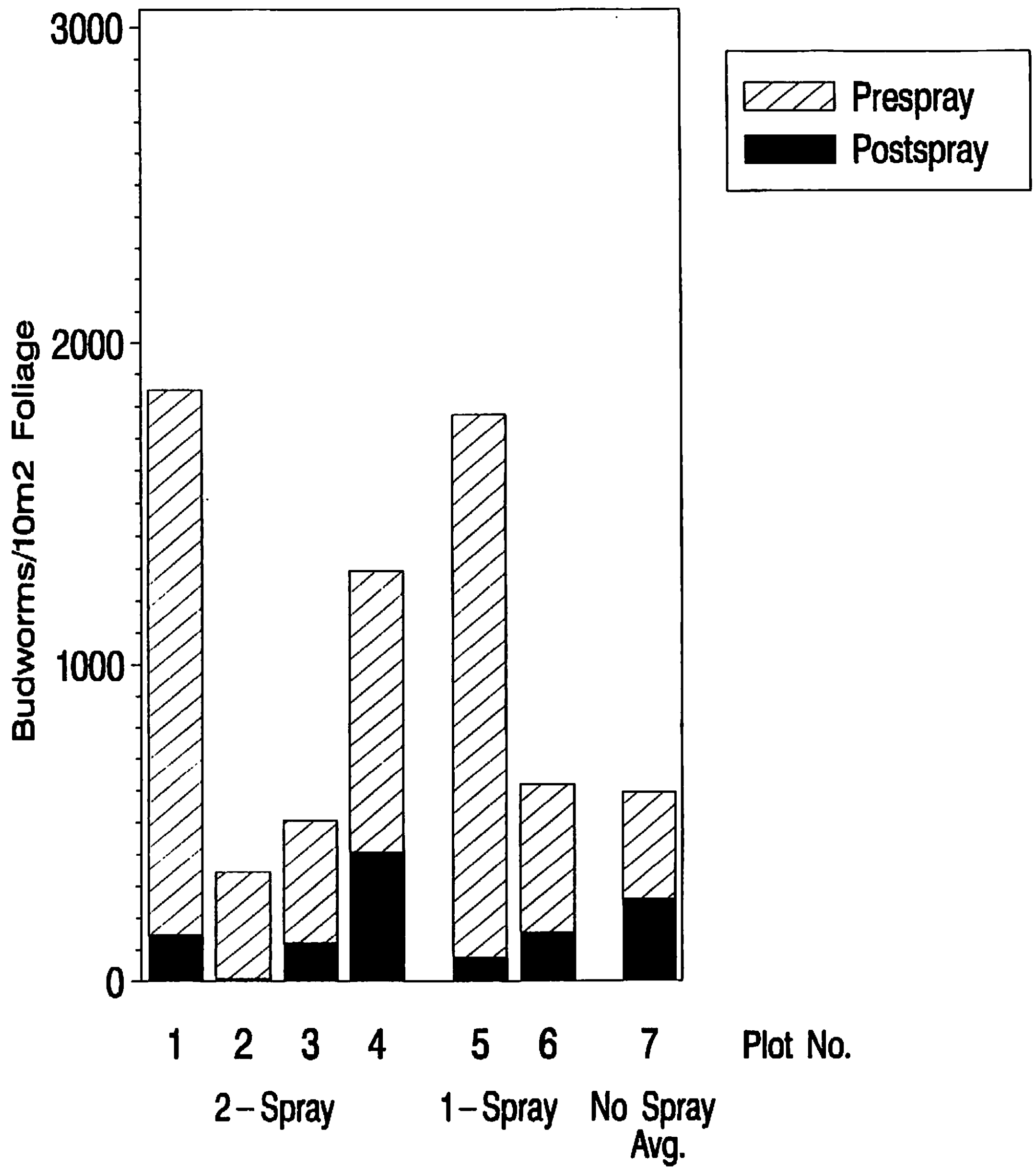

Figure 7. Comparison of pre- and postspray budworm counts in sprayed plots and averaged unsprayed check plots, Northeast Boreal Region, Alberta, 1996.

4.0 FIELD TRIALS & OBSERVATIONS

4.1 Insecticides

So far, a limited number of Btk formulations have been used in Alberta to control the spruce budworm. To increase the availability of alternative insecticides for budworm control, two other insecticides (Mimic 240LV® (=Tebufenozide), Rohm and Haas Canada, Inc. and Thuricide 48LV®, Sandoz Inc., USA) were field-tested. The insecticides were supplied gratis by the respective companies.

4.1.1 Materials and Methods.

This field trial was carried out in the Northwest Boreal Region during June-July of 1996. Three budworm-infested, mature (over 80 years old) white spruce blocks were selected for this study. The spray block 11 was 149 ha, block 12 was 215 ha and block 13 was 222 ha. In each block, one plot was established by using the procedure given in the "Spruce Budworm Sampling Manual". An unsprayed check plot was established in a similar block not slated for spraying. Each plot was composed of four dominant/co-dominant white spruce whose upper mid-crowns were accessible to collect branch samples by using a 14-m pole pruner.

The prespray budworm populations in the plots were assessed by following the procedure given in the above manual. Two 45-cm branch tips were collected from the upper mid-crown of each tree in the plot. The number and stage of development of the budworms and the branch width at mid-point were recorded.

The budworm counts from each sample were standardized by converting to number per 10 m^2 of foliage. The standardized per- and postspray counts from the two branches were used to calculate the present budworm kill per each tree. The budworm kill in each of the four trees was used to calculate the mean percent budworm kill per plot. Abbott's formula was used to find the percent control efficacy (net budworm kill due to spraying).

In September 1996, a second instar budworm count was done in the experimental plots by following the procedures given in the "Spruce Budworm Sampling Manual".

In mid-late June, Mimic was aerially sprayed at a dose of 70 g a.i. per ha (0.300 L of Mimic mixed with 1.700 L of pond water). Block 11 received two sprayings with five days in between the sprayings; block 12 received one application. Block 13 was sprayed twice at 2.08 L/ha (26.42 BIU/ha) with Thuricide 48LV. A small fixed-wing aircraft (AT502) equipped with eight Micronair AU 4000 spray nozzles was used for this spraying, guided by a Satloc Forestar Differential Global Positioning System. All sprayings were done at a relative humidity of over 30% with no rain within six hours and a wind velocity below 15 kmph (see Appendix I for the other technical details of spraying).

4.1.2 Results and Discussion

The results of this field trial are given in Table 1.

Table 1. Results of a field trial on using Mimic, and Thuricide to control spruce budworm in northern Alberta, 1996.

Treatment	Budworm Count/10 m^2 of Foliage ± S.D[a]		Budworm Kill (%)		Second Instar Count/10 m^2 of Foliage[d]
	Prespray	Postspray	Observed[b]	Calculated[c]	
MIMIC X 1	2151±1087	57±82	97.8%	90.1%	0.0
MIMIC X 2	1195±1137	12±23	99.5%	98.5%	10.3
THURI-CIDE X 2	909±591	162±153	85.0%	51.3%	11.1
CHECK	1535±1033	462±93	52.6%	---	447.0

[a]Mean of budworm counts on eight branch samples per plot
[b]Mean budworm kill observed in fours trees per plot
[c]Mean budworm kill corrected by using Abott's formula
[d]Mean of budworm counts in four branch samples per plot

These results show that Mimic 240LV provided excellent budworm control in severely infested (> 2000 prespray budworm count per 10 m^2 of foliage), mature white spruce stands in Alberta. The residual budworm populations (second instar) in Mimic-sprayed plots were reduced to levels that would keep any defoliation nil-light (below 35%) in 1997. There does not appear to be a substantial difference in budworm kill between plots sprayed once vs. twice with Mimic. If one spraying can provide good control then it will save operational application costs significantly. On the other hand, in its present formulation, Mimic needs a ready supply of a large quantity of water for dilution. This would be a major logistic concern in a large scale spray program. There is also some concern about the effect of Mimic on aquatic fauna, molluscs in particular. This might be an added concern in northern Alberta where water bodies are abundant in forested land. Because of the chemical nature of this insecticide, it is necessary to have public information sessions to let the general public express their concerns about using a chemical insecticide on public land in Alberta.

Thuricide also provided satisfactory budworm control. Unlike Mimic, this product does not need water for dilution. This product is bound to get better public acceptance because similar Btk-based products have been used in Alberta for spruce budworm control.

Appendix I. Technical details of operational Btk spraying in Alberta, 1996

INSECTICIDE

- Foray 48B®
- Active ingredient: *Bacillus thruringiensis* var. kurstaki
- Formulation: water-based
- Additions: none
- Dilution: none
- PCPA NO. 21464
- Micro-contaminants: nil
- Potency: Guaranteed: 10,600 i.u./mg (12.7 BIU/L)
  Observed: 10,195± 623
  9,894± 997
  9,436± 905
  11,443± 942
  11,215±1259
- Supplier: Abbott Laboratories, Chicago, Ill, USA

AIRCRAFT

- NWBR:

	Spray	Pointer
NWBR:	Two AT 502A	C 210
	Four AT 502B	C 177
	Three S2R	C 172
NEBR:	Four AT 401	C 177RG

- Guidance System: SATLOC Forestar® Differential Global Positioning System in each lead spray aircraft

SPRAYING

- Nozzle system: Micronair AU4000 with a flowmeter
- Nozzles:

No./aircraft:	AT 502	eight
	AT 401	six
	S2R	six
Blade angle:	AT502A	43°
	AT502B	40°
	others	33°
VRU setting	AT502A	13
	others	11

- Spray speed

AT 502A	250 km/h
AT 502B	225 km/h
others	190 km/h

▸ Atomizer rotation speed:		7000 rpm
▸ Flow rate per nozzle		AT 502A 10.4 L/min AT 502B 8.1 L/min others 7.2 L/min
▸ VMD 100-110μ		AT 502A AT 502B 105-115μ others 95-105μ
▸ Swath width		AT 502A 100 m AT 502B 90 m others 70 m
▸ Spray rate		2.0 L/ha/application
▸ Spray period	NWBR NEBR	June 10 - 21 June 12 - 23
▸ Area sprayed including	NWBR	65,088 ha twice 2,922 ha in Metis land 17,651 ha once including 3,330 ha in Metis land
	NEBR	24,066 ha twice 3,221 ha once

SPRAY WEATHER PARAMETERS

▸ Temperature	5° - 30°C
▸ Relative humidity	over 30%
▸ Wind	under 15 km/h
▸ Precipitation	none within six hours

FOREST PESTS IN MANITOBA - 1996

PREPARED FOR THE
1996 FOREST PEST MANAGEMENT FORUM
NOVEMBER 18-22, 1996

OTTAWA

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Spruce Budworm

The spruce budworm, *Choristoneura fumiferana,* infestation in Manitoba increased in size in 1996 to 70,000 ha. Approximately 50,000 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, and Grindstone Peninsula. The infestation in the Duck Mountain Provincial Forest and Louisiana Pacific Canada FML increased to approximately 20,000 ha. Based on defoliation predictions derived from the 1995 egg mass surveys an operational budworm suppression program was implemented in the Pine Falls Paper Co. Forest Management License Area and in Duck Mountain Provincial Forest/Louisiana Pacific FML in 1996.

The bacterial insecticide, *Bacillus thuringiensis* (*Bt*) was aerially applied to 6,627 ha. The *Bt* operational spray project was carried out at three locations. The treatment areas were Maskwa River (4,956 ha) and Observation Point (343 ha) in the Pine Falls Paper Co. Forest Management License (FML) area and in Duck Mountain Provincial Forest/Louisiana Pacific FML (3,140ha). A double application was made at all locations for a total spray area of 13,254 ha.

The Maskwa River spray block was opened on June 9, 1996. The Observation Point block was opened June 11, 1996. The Duck Mountain spray block was not opened until June 16, 1996. Spray block openings coincided with a shoot development index 4.0 (Auger's Class) and peak 4th instar spruce budworm larval development. Thuricide 48 LV was applied by two Ayers Thrush S2R fixed wing aircraft each equipped with eight AU 5000 Micronair rotary atomizers. A single application consisted of a dosage of 30 Biological International Units (BIU) per ha in a volume of 2.4 litres per ha. In cooperation with Rohm and Haas Canada Ltd., an experimental aerial spray project with Mimic® (RH5992, tebufenazide) flowable was carried out at Great Falls in the Pine Falls Paper Co. FML area. An area of 216 ha was treated with Mimic. An area 116 ha received a single application at 70 grams active ingredient (a.i.) per ha and 110 ha received a single application at 100 grams active ingredient (a.i.) per ha. The product was applied by an Ayers Thrush S2R fixed wing aircraft equipped with eight AU 5000 Micronair rotary atomizers. The insecticide applications were carried out on June 15, 1996.

Pre and post spray surveys were carried out to determine application timing and spray efficacy. Average pre spray budworm larval numbers per 45 cm branch sample ranged from 0.2 at Maskwa River in the Pine Falls Paper Co. FML area to 16.2 at Duck Mountain . 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. Unlike 1994 and 1995 spray programs which had excellent levels of larval control, results were fair to above average depending on spray block. In the 1996 program. The population reduction in the treated areas ranged from 21% at Duck Mountain to 56% at Observation Point (Table 1). Larval density data was transformed to stabilize the large variation, using $\log_{10}(x+1)$. Statistical analysis (ANOVA) indicated no significant difference in budworm mortality between treated and control blocks at $p \leq 0.05$ for *Bt* and Mimic treatments.

Table 1: Spruce Budworm - percent reduction in larval numbers

Location	Treatment	Larval Mortality
Duck Mountain	Thuricide 48LV-30 BIU/ha - 2x	21%
Duck Mountain	Untreated	16%
Observation Point	Thuricide 48LV - 30 BIU/ha - 2x	56%
Observation Point	Untreated	29%
Maskwa River	Thuricide 48LV - 30 BIU/ha - 2x	22%
Maskwa River	Untreated	17%
Great Falls	Mimic 70 grams a.i./ha	28%
Great Falls	Mimic 100 grams a.i./ha	51%
Great Falls	Untreated	35%

Table 2: Spruce Budworm - 1996 defoliation and predictions for 1997

Location	Treatment	1996 Defoliation	Egg Masses per $10m^2$	1997 Prediction
Duck Mt.	Thuricide 48LV 30 BIU/ha - 2x	55%	56	Light-moderate
Duck Mt.	Untreated	17%	43	Light-moderate
Observation Pt.	Thuricide 48LV 30 BIU/ha - 2x	8%	10	Light
Observation Pt.	Untreated	45%	31	Severe
Maskwa River	Thuricide 48LV 30 BIU/ha - 2x	6%	4	Light
Maskwa River	Untreated	41%	312	Severe
Great Falls	Mimic 70 grams a.i./ha	41%	39	Light-moderate
Great Falls	Mimic 100 grams a.i./ha	56%	74	Moderate
Great Falls	Untreated	73%	372	Severe

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 1996, the total number of male moths marginally decreased 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	'96
Pherocon 1C	2060	419	229	323	391	179	73	160	241	187	195	176
Multipher					59	47	34	106	33	39	40	27

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 cones and level of larval survival. From branches collected in the fall, the number of pollen cone 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	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96
% staminate buds	4	9	15	72	26	37	61	47	77	52	30

Since 1986, there has been no visible defoliation observed at the 12 trapping locations. This year, one egg mass has been found to date and some shoot defoliation has been recorded, on collected branches, at several sites. Branch assessment for defoliation, egg masses, and pollen cone buds is progressing.

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 Health and Ecology section 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 vigor. The trees are assessed every 3 years until age 21.

In 1996, a third pest assessment was conducted on the 1987 permanent silvicultural RPA plots. These included 23 plantations or 255 plots with white spruce, black spruce, and jack pine. Data from this sampling program is being entered into the customized MNR, Forest Health and Ecology Pest Survey System. Data entry and analysis is ongoing.

Aspen Decay Survey

In recent years trembling aspen has gained in importance as a commercial species. There is 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 in Manitoba, range from 20% to 40%. With aspen utilization for other products increasing, a damage appraisal survey was initiated to determine if these cull factors are appropriate when aspen is used for manufacturing composite board products (oriented strand board, particle board and paper board). The survey will eventually include all forest management units (FMU) in which aspen has the potential to be commercially important. The survey has been completed in southeastern Manitoba in FMU's 20 and 23 and in the Duck Mountains (FMU 13) in western Manitoba. During the 1996 field season the survey has continued in FMU's 10 and 11. A report on FMU 10 will be completed this winter.

Trembling aspen stands in the immature class (approximately 30 to 49 years), mature class (50 to 70 years) and overmature class (71+ years) were included in the survey. Sample plots were randomly placed in the various stand types with each plot consisting of nine sample trees. Sample trees were felled and sectioned into one metre bolts. Stem decay tracings made in the field were digitized into a computerized format and assessed for volume loss. In addition to assessing decay, the volume loss to Hypoxylon canker and the incidence of butt rot and poplar wood borer attack were assessed. The results by FMU are as follows:

Table 5: Advanced Decay

Maturity	Southeast FMU 20	Southeast FMU 23	Duck Mountain FMU 13
Immature (30 to 49 years)	1.0%	3.6%	2.0%
Mature (50 to 70 years)	3.8%	4.0%	7.0%
Overmature (71+ years)	6.7%	12.1%	7.2%

Table 6: Incidence of Poplar Woodborer

Maturity	FMU 20	FMU 23	FMU 13
Immature (30 to 49 years)	37.7%	35.9%	7.4%
Mature (50 to 70 years)	38.3%	54.9%	29.4%
Overmature (71 + years)	44.4%	62.9%	26.8%

Table 7: Incidence of Butt Rot

Maturity	FMU 20	FMU 23	FMU 13
Immature (30 to 49 years)	24%	37%	36%
Mature (50 to 70 years)	44%	49%	44%
Overmature (71 + years)	54%	65%	51%

Table 8: Volume Loss to Hypoxylon Canker

FMU 20	FMU 23	FMU 13
6.9%	10.2%	3.6%

Pine Stem Canker

Stem cankering of both red and jack pine has been monitored in Sandilands Provincial Forest in southeastern Manitoba since 1990. The cankering is caused by *Sphaeropsis pinea* and/or *Ceratocystis minor.* Two 30m x 30m plots were established in both Jack and Red pine plantations in 1990 to monitor the impact of the stem canker disease. A canker severity index (includes number and size of cankers on a tree) was developed. From 1990 to 1996 the severity index in the jack pine plots has increased on average 64% annually in one plot and 19% in the other. In the red pine plots the annual increase in the severity index was 11% and 15%. Tree mortality was 8% and 11% in the jack pine plots and 5% and 6% in the red pine plots.

Armillaria Root Disease

In Belair Provincial Forest in eastern Manitoba dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) causes substantial timber volume loss in jack pine (*Pinus banksiana* Lamb.) forests. During the 1970's approximately 1,300 hectares (ha) of infested jack pine was harvested and planted to red pine (*Pinus resinosa* Ait.), a species resistant to dwarf mistletoe. In 1982 Armillaria root disease (*Armillaria ostoyae* (Romagn.) Herink) centres were discovered in the planted red pine. Five permanent sample plots were established within root disease infection centres in red pine plantations of ages eight, ten and eleven years to monitor the impact of Armillaria root disease. The initial tree mortality due to Armillaria root disease in the five plots was 24.8%, 21.2%, 11.1%, 10.3% and 10.1%. During the period of 1984 to 1992 annual mortality attributed to Armillaria generally declined from a high of 9% to 0.5%. From 1991 to 1996 there has being no mortality to Armillaria in three of the plots and none in two of the plots since 1992.

In 1986 approximately 100 red pine and 100 jack pine seedlings were planted in two of the sample plots to determine if there was any difference in susceptibility to Armillaria root disease. Despite no mortality in the original planted trees since 1992, there has been root disease mortality in the planted 1986 seedlings (approximately 7% to 10% in jack pine and 20% in red pine).

DUTCH ELM DISEASE

During the late 1960's and early 1970's Dutch Elm Disease (DED) surveys were carried out in Manitoba by the Canadian Forestry Service (CFS) Forest Insect and Disease Survey (FIDS). This survey first discovered DED at Curran Park in Brandon and in Selkirk and Hydro Parks at Selkirk in 1975.

Since its initial discovery, DED has gradually spread and intensified throughout southern Manitoba. By the late 1980's DED occurred from the Ontario-Manitoba boundary to the Saskatchewan-Manitoba Boundary. The disease has also spread northward, reaching Dauphin in 1989 and Swan River in 1992. In 1995 DED was discovered along the North Duck River and also north of the Porcupine Provincial Forest along the Red Deer River, approximately three kilometres from the Manitoba-Saskatchewan boundary. Substantial infection was found along the Swan and Roaring Rivers in 1996.

In 1976 a specific survey for DED was established. This survey was a cooperative effort between the Canadian Forestry Service, Manitoba Department of Agriculture and the Parks Branch of the Provincial Department of Tourism and Recreation. Diseased and hazard (dead and dying trees with the potential to harbour bark beetles) trees marked for removal by the survey were removed by a Parks Branch sanitation crew and private contractors. The Manitoba Department of Agriculture employed two inspectors to coordinate public education, surveys and sanitation for the DED program. The program was carried out in this manner under the Manitoba Department of Agriculture's Plant Pest and Disease Act from 1976 to 1979. This Act had been revised in 1967 to make specific reference to DED.

In 1980 the DED program became the responsibility of a single agency, the Forestry Branch of the Manitoba Department of Natural Resources. In 1981 the Department of Natural Resources developed the DED Act and Regulations. Also in 1981 a DED cost sharing agreement (CSA) program was developed between the Province of Manitoba and participating communities. It became apparent that DED could not be controlled in wild stands and the program then focused management activities within communities and their surrounding buffer areas. Traditionally, pruning of elms, basal spraying of elms to reduce elm bark beetle populations, fungicide injections and tree replacement have been cost shared by the Province and the participant community. In recent years, general tree care, Provincially approved education and training courses and site specific inventories have been included.

Initially 18 communities became involved in DED cost sharing agreements with the province. Through the 1980's the number of participating communities increased reaching a maximum of 45 by the late 1980's. Due to provincial funding reductions and some communities opting to leave the program, the number of participating communities has fluctuated between 33 and 40 since 1990. Provincial funding for the DED program reached its maximum of approximately $2 million annually in the late 1980's, but has since declined to its current level of approximately $1.3 million annually. Concurrent with the reduction in funding, the number of CSA communities have been reduced.

The DED survey and tree removals are the responsibility of the Province except in Brandon and Swan River where the removals are carried out by these communities themselves. The City of Winnipeg carries out its own survey and removals, while provincial crews operate in buffer zones around the city.

During the early years of the DED program (late 1970's to early 1980's) tree removals were in the 4,000 to 8,000 range annually. The number of removals increased steadily through the 1980's to a maximum of over 26,000 (includes 11,000 within the City of Winnipeg) in 1990. In recent years (1993-1996), there has been approximately 10,000 to 16,000 tree removals annually (4,000 to 8,000 in Winnipeg and 6,000 to 8,000 elsewhere in the province).

In 1996, the DED surveillance program ran for approximately three months. This program encompassed 33 CSA communities as well as 7 buffer zone municipalities around the City of Winnipeg and other selected towns and cities. 7,300 elms were marked for removal (4,130 within CSA communities and 3,070 in buffer zones surrounding CSA communities). Of this total, 99 consisted of firewood piles, 886 trees were diagnosed as having DED and the remainder were classified as hazards. In the City of Winnipeg, 7,842 were slated for removal, 4,497 of which were diagnosed as having DED and the remaining classified as hazards. In addition, the City of Winnipeg commonly identifies approximately 300 firewood piles on a yearly basis. Other major urban centres with disease included Brandon, Dauphin, Morden, Portage la Prairie, Steinbach, Selkirk and Winkler. Overall, elms marked for removal decreased slightly over 1995.

The range of Dutch Elm Disease remained similar to 1995. 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.

From April 1, 1995 to March 31, 1996 the Provincial DED Sanitation crews removed 5,425 diseased and hazard elms; the City of Winnipeg removed approximately 9,032 in 1995 and the City of Brandon removed 104.

Research efforts which the Province of Manitoba has participated in or supported financially has focused on native elm bark beetle activity and control, fungicide tree injections and resistance to DED. Pheromone trapping for the European elm bark beetle, *Scolytus multistriatus*, has been carried out for a number of years. The City of Winnipeg Insect Control Branch has occasionally trapped these beetles within the City and, in 1996, caught three at Beaudry Provincial Park using tanglefoot bands. Beetles were trapped only one year in rural Manitoba (at Emerson in 1989), however, there is no evidence of an established population in Manitoba.

In 1996, a site specific urban tree inventory was initiated in the CSA communities. This inventory utilizes Global Positioning Satellite technology to produce a community map with accurate tree locations by species. This system will greatly enhance the efficiency of the DED survey and sanitation programs and facilitate better overall management of the urban forest. To date the inventory has been completed for Selkirk, Steinbach and Brandon (done by City of Brandon staff). An inventory of Gretna was initiated by Village of Gretna staff but not completed in 1996. The City of Winnipeg initiated a DED management research study in 1996 which is examining a variety of intensive survey and removal strategies in combination with fungicide injections and using community involvement. Results are pending. Within the majority of cost sharing agreement communities the DED program has been successful at maintaining annual losses below the 3% level.

1996 Integrated Forest Renewal Program Pest Survey

This was the second year of incorporating forest health measurements into the Manitoba forest regeneration and free to grow surveys. Provincial surveys are implemented in areas not under Forest Management License, but on forested lands directly managed by the Province. In 1996, the Provincial regeneration surveys covered 1628 ha (135 stands). The method had some modifications from 1995, but still continued with damage categories rather than pest identification. Forest health codes were not considered in forty-six of these stands as they were less than five years old. Past experience has shown detection efforts for the more damaging pests in stands less than five years of age had minimal success. Of the remaining 89 stands, 44 fell within the five to seven year range which is the age expected to be targeted by the regeneration survey in the near future. The remaining 45 stands ranged from eight to 13 years old (ie. stands depleted more than 7 years earlier).

Five stands within the five to seven year old target age were selected for followup pest survey based on the forest health measurements which indicated potential problems when the regeneration surveys were carried out. Three of these stands did not have significant forest health problems. Forest health data from the regeneration survey for the fourth stand proved incorrect. In the fifth stand the regeneration survey indicated significant pest problems which were confirmed in by the followup detailed pest survey..

Success at picking up targeted pests within the regeneration survey improved in the older age stands. Of eleven stands in the regeneration survey for the 8 to 13 year old age group that had indications of pest problems, five stands had pests which could potentially impact the stand yield. These included Dwarf mistletoe, (*Arceuthobium americanum*) in jack pine; Armillaria root disease, *(Armillaria ostayae)* in jack pine and black spruce; Warren root collar weevil, *(Hylobius warreni)* in jack pine and black spruce: heavy hazel competition in black spruce and hypoxylon canker *(Hypoxylon mannatum)* in trembling aspen. In order to determine how sensitive the pest measurements were, three of the eleven stands having minor pest problems based on the regeneration survey were revisited. These stands were found to have minimal damage. Three stands which were revisited that had indications of significant problems but were found to have no major pest problems.

. A major shift in the method of collecting forest health data in the provincial free to grow survey occurred in 1996. A list of 13 unacceptable tree categories by pest, host and the severity of the damage was provided to the surveyors. Surveyors were trained to identify and record from the list of pests rather than record damage. Trees falling into these categories are considered unacceptable and as such were not included in the tree counts. Forty-eight stands (1600 ha) were surveyed in 1996. Initial results from this survey are very promising. A total of 48 stands were surveyed across the province.

Twenty-seven stands were surveyed in the southeast region of the province and the twelve stands were highlighted by the provincial free to grow survey as containing pest problems. Followup visits in the southeast region found western gall rust on jack pine, leaning trees due to heavy snow conditions on jack pine and stem canker on both red and jack pine. There were also several stands with heavy western gall rust infection, some having rust caused stem cankers. These were especially prevalent in plantations. Three stands that the free to grow survey indicated were pest free were also checked and measurements from the free to grow survey were found to be accurate.

In the Northwest region of the province 10 stands were subject to the free to grow survey and three had indications of pest problems. These included one that had dwarf mistletoe mapped but not significantly affecting the stand: one jack pine stand that had Armillaria and Warren root collar weevil scattered throughout with some pockets forming; one that had significant armillaria killed scattered jack pine throughout; and one with light white pine weevil attack. Two check pest surveys were carried out on stands that were classified as pest free by the free to grow survey and the analysis was found to be accurate.

Once the results are fully interpreted, the system of collecting forest health data in these two surveys will be adjusted prior to province wide (regional and industry) implementation. Further work will be required to develop threshold levels for follow up forest health assessments and to develop recommendations on a stand by stand basis. Once the method is functioning 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 baseline data. 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 of a repeated nature; linked to certain geographic locations, stand type, or forestry practice; and to use data to direct research needs including ways to reduce impact on future volume losses. The best cost-benefit is to identify and prevent inherited problems from the preceding stand from affecting new stands (pre-harvest prescriptions), and to recommend modification in reforestation and stand tending activities to minimize pest impact.

Pest Specific Assessments

In 1994 a pre-harvest assessment conducted in an overmature, site class 2 jack pine stand in the Sandilands Provincial Forest found the percentage area infected by Armillaria root rot (*Armillaria* sp.) to be 74.5%. A 4.0 ha area had stumps removed after harvest to test the potential of stump removal as a treatment for destroying residual armillaria. Comparisons between the performance of planted stock will be conducted in the stumped versus non-stumped areas. If stock grow and survive in the stumped area (it had a very low number of stems per acre when cutting it) the economics of stumping could be evaluated.

Commercial thinning of many plantations in the eastern part of Manitoba is now becoming significant and tests to thin using a variety of criteria, including forest health considerations are underway. Test plantations were surveyed with parallel compassed lines spaced 150 metres apart. Initial observations in Red pine stands showed incidence of Diplodia stem canker, *Sphaeropsis sapinea*; Armillaria root disease, *Armillaria* spp.; and tip dieback, suspected to be *Rhizosphaera kalkhoffii*. Stem canker occurrence was observed fairly frequently. Armillaria root disease and tip dieback infected trees intersected the survey lines only a few times and were single tree occurrences rather than pocket formations. After reviewing the literature available on stem canker and the data from our stem canker permanent plots, the following steps were recommended to reduce the impact of the stem canker disease in the Red pine stands during the commercial thinning operation in Manitoba:

1. Use both stem canker and tip dieback as selection criteria whenever possible. Consider removing cankered trees even if it creates an opening. Trees with stem cankers have reduced timber increment due to dead stem tissue in the cankered area and timber degradation from blue stain. Dead tops which can occur from girdling by main stem cankers affect the length of the usable bole.

2. Completely remove infected trees from the site to reduce the spread of spores to the remaining trees as these trees are a source of infection to the remaining trees, even after felling.

3. Wounding should be minimized as the fungus is an opportunist, generally attacking trees which have been predisposed by drought, or with fresh wounds from insects, hail, frost or mechanical damage.

4. Epidemics are promoted by wet spring weather which is favourable for spore production, dispersal and infection. However, spores are dispersed from early spring until late autumn by splashing rain. Thinning should be confined to late fall, and early winter.

Vegetation Management

Table 9: 1996 Herbicide application summary in Manitoba.

USER	Purpose	Method	Product	Rate l/ha	Area treated (ha.)
MNR Forestry	Site prep.	Ground - Forcan 500	Velpar L	17.0	138
MNR Forestry	Release	Ground	Vision	5.0	14
MNR Forestry	Site prep.	Ground - Brackie	Vision	3.0	233
MNR Forestry	Release	Aerial - Fixed wing	Vision	3.5	482
Repap Manitoba	Release	Aerial - fixed wing	Vision	5.0	420
Pine Falls Paper Inc.	Release	Aerial - rotary	Vision	4.0	385
Pine Falls Paper Inc.	Site Prep.	Ground - Brackie	Vision	2.5	322
Total					1994

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STATUS OF IMPORTANT FOREST PESTS IN ONTARIO IN 1996

by

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STATUS OF IMPORTANT FOREST PESTS IN ONTARIO IN 1996

OVERVIEW

There were significant changes in the status of several major forest pests in 1996. Populations of the spruce budworm (*Choristoneura fumiferana* Clem.) declined drastically this year, with the lowest area of moderate-to-severe defoliation recorded since 1968. The jack pine budworm (*Choristoneura pinus pinus* Free.) and gypsy moth (*Lymatria dispar* [L.]) also declined, but forest tent caterpillar (*Malacosoma disstria* Hbn.) populations increased in 1996.

The weather during spring and early summer 1996 was cold and wet with insect and host development delayed by one to two weeks depending on location.

This joint report, Ontario Ministry of Natural Resources and the Canadian Forest Service, was made possible through contributions from OMNR to expand the field survey from what would be undertaken under the national Forest Health Network.

EASTERN SPRUCE BUDWORM

There was a drastic decline in spruce budworm populations in 1996. The total area of moderate-to-severe defoliation, as determined by ground and aerial surveys, was 435 931 ha compared with 3 451 118 ha in 1995 (Table 1). Most of the decline occurred in northwestern Ontario where large areas of defoliation have occurred between the western Hearst District and the Manitoba border for a number of years. These infestations virtually collapsed with only remnant pockets of mainly moderate defoliation persisting (Fig. 1).

In Sioux Lookout District, very small pockets of moderate defoliation occurred around the town of Sioux Lookout and around the east end of Lac Seul. Small patches of moderate defoliation were mapped north of the towns of Dryden and Vermillion Bay in Dryden District, and extending north along Highway 105 south of Ear Falls in Red Lake District. Additional pockets of defoliation that formed a wide arc from Trout Lake through McDonough Township to Longlegged Lake were also mapped in the Red Lake District. In Kenora District, several widely separated patches of defoliation occurred between Werner Lake and Gassy Narrows, the largest of which was located west of the White Dog Indian Reserve near the Manitoba border. A few very small areas of defoliation were also mapped on islands in the western part of Lake of the Woods. Numerous pockets of moderate defoliation were observed across the southern Fort Frances District between the town of Atikokan and Spohn Township. The largest of these occurred between Namakan Lake and the Pipestone River and in Dance and Miscampbell townships.

Numerous areas of moderate defoliation were mapped in the southeast corner of the Thunder Bay District between the international border and Dog Lake. The largest of these occurred in four pockets north of the city of Thunder Bay between Horne Township and Walkinshaw Lake. Several sizeable patches of moderate defoliation were mapped in the Muskeg Lake-Mooseland Lake-Geikie Lake area. As well, a cluster of very small patches of moderate defoliation was mapped east of Highway 527 between Pebble Lake and Hicks Lake. Several small pockets of severe defoliation occurred east of Upper Wolf Lake.

Defoliation was more severe in the Nipigon District. Two sizeable areas of mainly severe defoliation occurred on the northwest shore of Lake Nipigon, north and south of Wabinosh Bay and north and south of Waweig Lake. Numerous smaller pockets of severe defoliation were scattered across the northern part of the district between the northwest shore of Lake Nipigon and Chipman Lake northeast of Longlac. A single large area of severe defoliation was mapped on the Black Bay Peninsula on the north shore of Lake Superior.

In northeastern Ontario, medium-to-heavy infestations persisted in the northern Wawa District between the eastern boundary of Pukaskwa National Park and the town of Dubreuilville. However, infestations in adjoining areas of Hearst District collapsed, with only two small pockets remaining. These were located north of Calstock in Rogers Township and near Big Skunk Lake in Arnott Township. In Chapleau District, a small infestation discovered near Biscotasing in 1995 expanded considerably this year to encompass parts of 12 townships between Carew and Smith townships in the north to Kelso and Bazett townships in the south. A small infestation near the city of Sault Ste. Marie in the Sault Ste. Marie District declined in intensity, with only moderate defoliation recorded. A similar decline in defoliation intensity was also apparent in the infestation near the village of Warren, which straddles the Sudbury-North Bay District boundary.

In southern Ontario, the infestation in the northwest corner of Algonquin Park District declined in size and broke up into a number of scattered pockets of defoliation between Wilkes and Hunter townships. In the Pembroke District, three small infestations were mapped south of the town of Pembroke in Stafford and Wilberforce townships along with numerous smaller pockets in the Bonnecherre and Madawaska River valleys between Douglas and Arnprior. A number of small pockets were mapped in the Almonte-Arnprior-Kanata area of Kemptville District. Infestations in the Larose Forest area of the Kemptville District collapsed, with the exception of a single small area near Lemieux. A single small pocket of very heavy defoliation persisted in Balsam Lake Provincial Park, Tweed District and a new, small infestation was found on planted white spruce (*Picea glauca* [Moench] Voss) north of Claremont in Maple District.

The total area of spruce budworm-caused tree mortality increased by 408 786 ha to 8 319 210 ha in 1996 (Fig. 2). The largest increases occurred in Thunder Bay, Nipigon, Kenora and Wawa districts with smaller increases in Hearst, Dryden, Fort Frances, Red Lake and Sioux Lookout districts.

Egg-mass surveys were conducted under contract to the Ontario Ministry of Natural Resources. A total of 209 samples were collected from 147 locations throughout Ontario. Overall, there was a 15% decrease in the average number of egg masses for locations sampled in 1995 and 1996. For 1997, further declines in populations and the extent of defoliation is expected.

Table 1. Gross area of moderate-to-severe defoliation caused by the eastern spruce budworm in Ontario 1993-1996

Region District	Area (ha)			
	1993	1994	1995	1996
Northwest				
Dryden	997 273	507 430	601 490	4 695
Fort Frances	422 244	506 878	373 401	43 004
Kenora	850 187	571 555	513 141	12 725
Nipigon	2 583 644	355 699	95 569	60 164
Red Lake	638 964	559 847	392 031	3 964
Sioux Lookout	556 122	367 437	576 055	6 138
Thunder Bay	1 247 302	1 004 558	521 802	117 971
	7 295 736	3 873 404	3 073 489	248 661
Northeast				
Chapleau	0	0	2 695	31 433
Cochrane	11 647	0	0	0
Hearst	268 208	42 245	53 413	3 334
Wawa	1 370 822	241 340	221 446	81 136
	1 650 677	283 585	277 554	115 903
Central				
Algonquin Park	20 405	57 405	33 692	10 234
Bancroft	0	0	1 828	0
North Bay	10 468	27 995	28 269	26 116
Parry Sound	0	0	0	438
Pembroke	0	0	645	3 826
Sault Ste. Marie	4 639	915	2 713	3 194
Sudbury	9 150	22 640	26 371	22 501
	44 662	108 955	93 518	66 309
Southern				
Cambridge	0	20	0	0
Kemptville	85	570	5 638	4 880
Maple	0	0	7	0
Midhurst	17	97	97	0
Tweed	0	0	815	178
	102	687	6 557	5 058
TOTAL	8 991 177	4 266 631	3 451 118	435 931

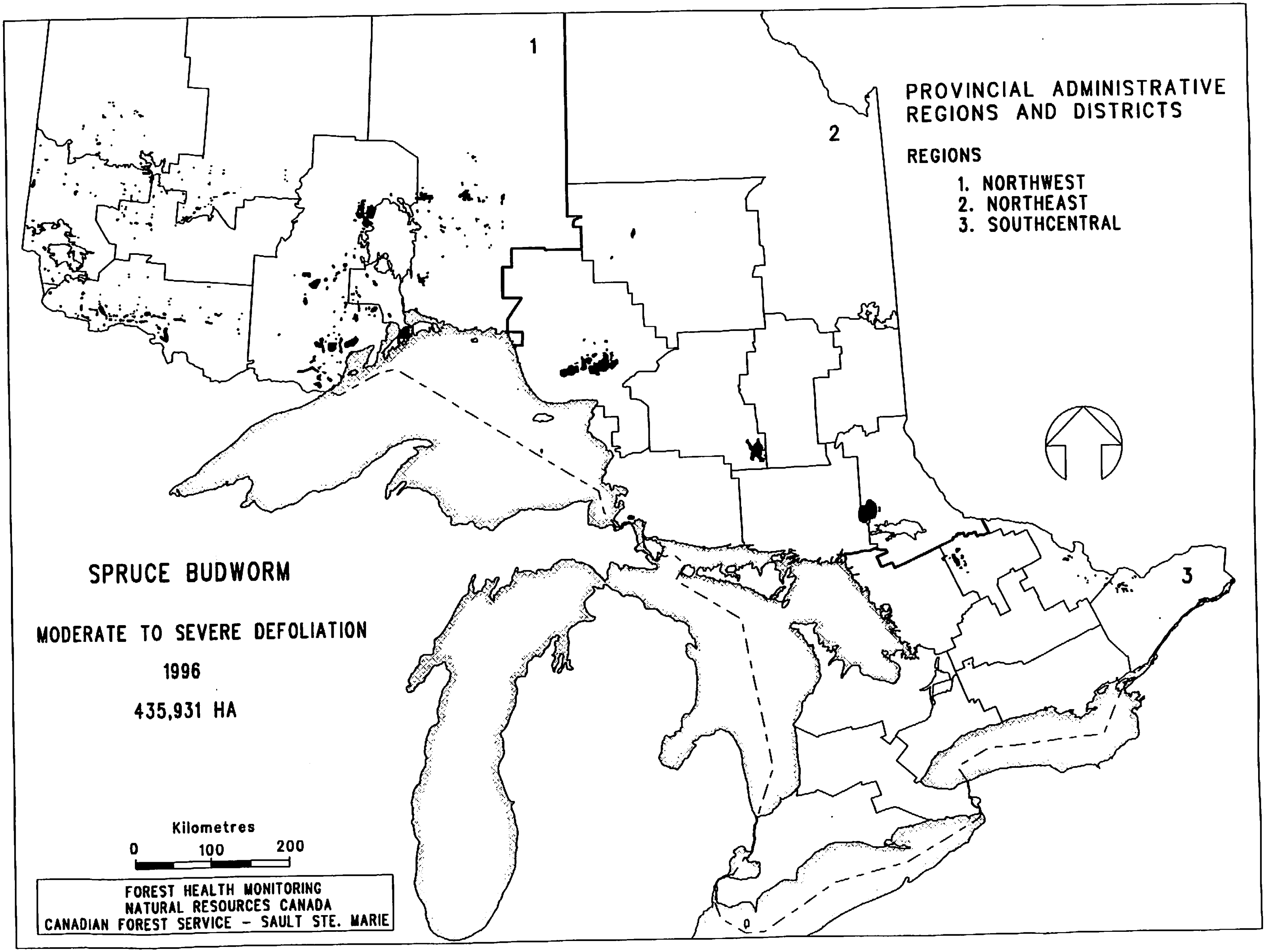

Figure 1. Spruce budworm defoliation in 1996.

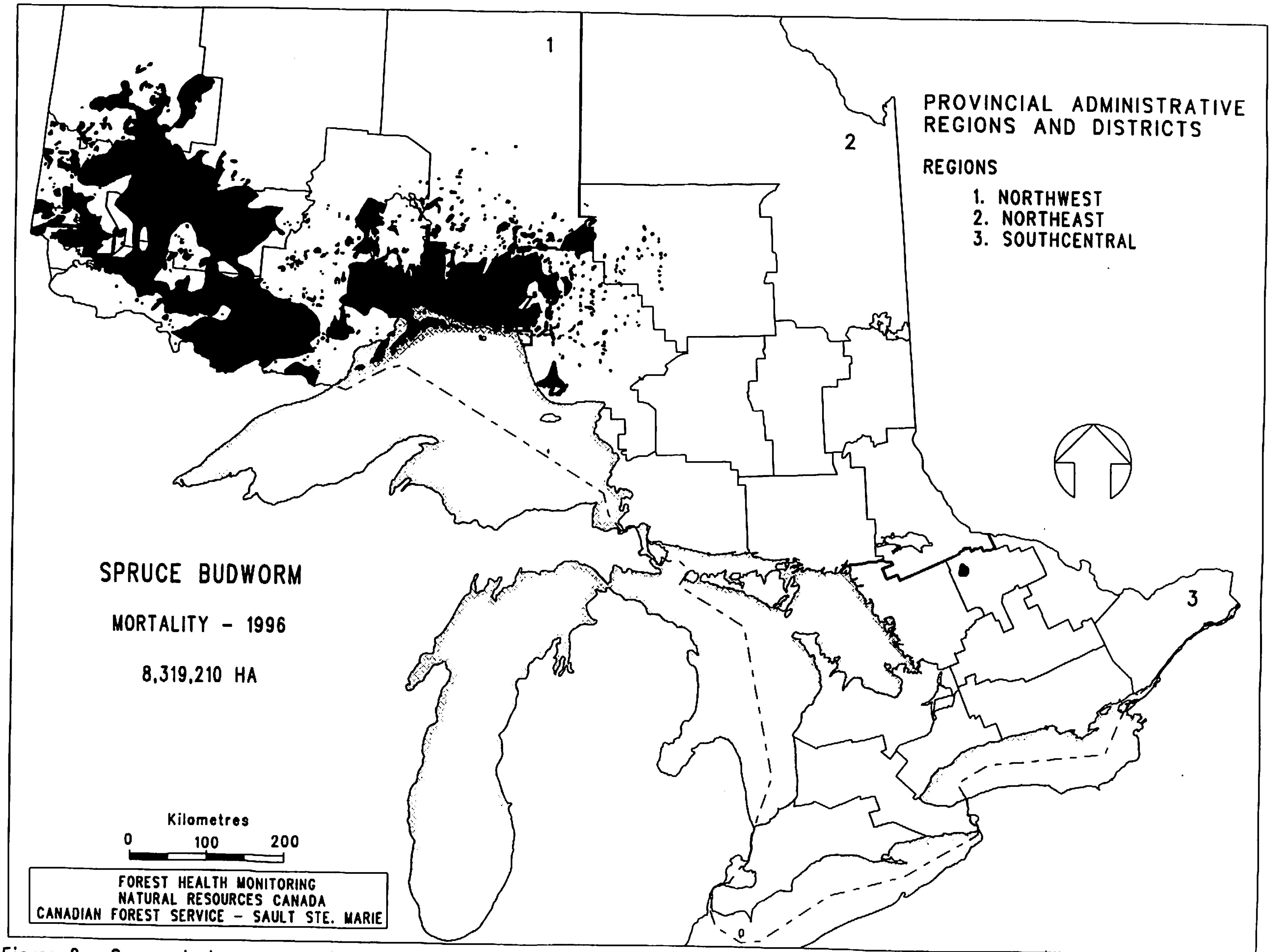

Figure 2. Spruce budworm caused tree mortality in 1996.

JACK PINE BUDWORM

Jack pine budworm infestations developed much as predicted by egg mass counts made in the fall of 1995. The total area of moderate-to-severe defoliation in 1996 was 103 851 ha down from 293 292 ha last year (Table 2). Most of the remaining defoliation was in the northern Parry Sound District, with lesser amounts of damage in adjacent areas of Sudbury and North Bay districts (Fig. 3). The largest infestation was located between the north part of Harrison Township and the hamlet of Still River, extending from the Georgian Bay coast inland to Kawigamog Lake. A second narrow band of infestation occurred along the Georgian Bay shoreline from Henvey Inlet north to the western channel of the French River. A third pocket of defoliation occurred along the French River straddling the Parry Sound, Sudbury and North Bay district boundaries between Lake Nipissing and the Byrne Lake-Island Lake area. A number of smaller pockets of damage were mapped between the West Bay of Lake Nipissing in North Bay District and Allen Township, Sudbury District. Most of the defoliation in the aforementioned areas was moderate with occasional patches of severe damage. A cluster of small pockets of mainly moderate defoliation was mapped between Lake Traverse in White Township in the southeast Algonquin Park District and the Alice-Frazer townships area of the central Pembroke District. Small pockets of defoliation were mapped near Mackey, Chalk River, and Petawawa in Pembroke District. Single pockets of severe defoliation persisted in Vrooman Township, Timmins District and de Gaulle Township, Chapleau District.

Egg-mass surveys were conducted under contract to the Ontario Ministry of Natural Resources. A total of 104 locations were sampled. Overall, there was a 94% decrease in egg masses for locations sampled in 1995 and 1996. There were only 6 egg-masses found on jack pine samples. Very little defoliation is expected in 1997.

Table 2: Gross area of moderate-to-severe defoliation by the jack pine budworm in Ontario 1993-1996

Region District	Area (ha)			
	1993	1994	1995	1996
Northeast				
Chapleau	0	0	1 256	522
Timmins	0	3 450	3 076	723
	0	3 450	4 332	1 245
Central				
Algonquin Park	380	1 590	6 312	4 365
North Bay	19 035	25 052	27 289	19 397
Parry Sound	91 645	106 898	129 272	55 289
Pembroke	4 202	3 875	7 077	3 317
Sault Ste. Marie	1 095	1 240	2 962	0
Sudbury	165 840	277 129	116 031	20 238
Temagami	50	110	17	0
	282 247	415 894	288 960	102 606
TOTAL	282 247	419 344	293 292	103 851

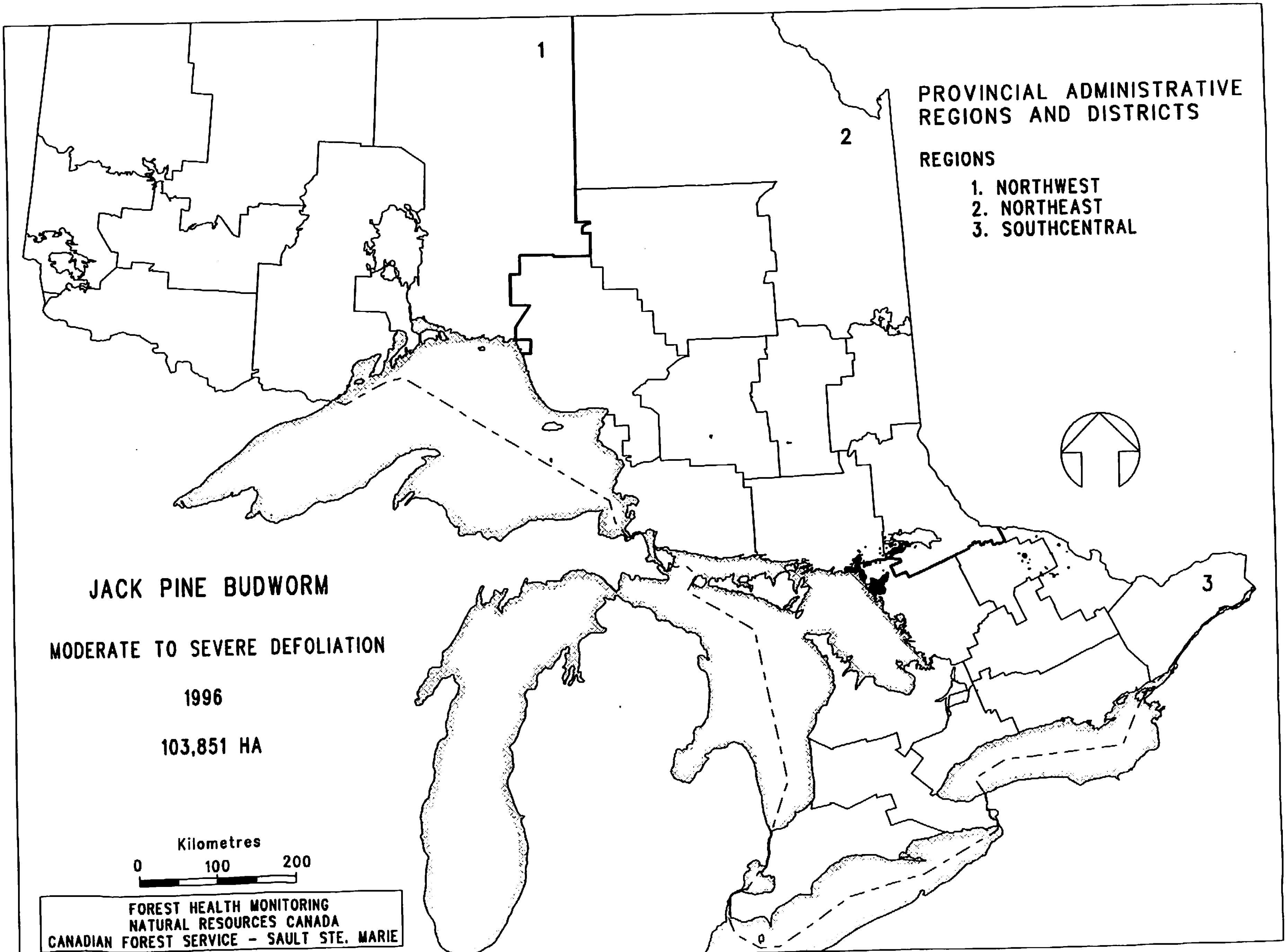

Figure 3. Jack pine budworm defoliation in 1996.

GYPSY MOTH

Gypsy moth infestations declined substantially in Ontario in 1996. The total area of moderate-to-severe defoliation was 7 214 ha this year compared with 19 879 ha in 1995 (Tables 3 and 4). Most of the defoliation was again in the Sudbury District, mainly in and around the city of Sudbury (Fig. 4). The largest pocket of defoliation was located mainly in Garson Township roughly between the town of Garson and the Sudbury Airport. A second sizeable pocket was located south of Guilletville in Blezard Township. Numerous smaller pockets were mapped around the city of Sudbury and a single small patch of defoliation was found north of Highway 17 near the village of Webwood. Most of the defoliation in these areas occurred in small stands of red oak (*Quercus rubra* L.), trembling aspen (*Populus tremuloides* Michx.), and white birch (*Betula papyrifera* Marsh.). In Sault Ste. Marie District several small pockets of defoliation were mapped on the north sides of Lake Dubourne and Granary Lake northeast of the town of Blind River.

A small infestation, which encompassed some 2 413 ha near the Magnetewan Indian Reserve in Parry Sound District in 1995, subsided this year with only occasional pockets of light damage observed.

In southern Ontario, a total of 919 ha of moderate-to-severe defoliation were mapped in Colchester South and Gosfield South townships between the towns of Harrow and Kingsville in Aylmer District. These infestations occurred in mixed hardwood stands with a high oak content.

As in previous years, a pheromone trapping program was carried out in northern Ontario parks and campgrounds. Results were similar to previous years in that moths were caught in North Bay, Temagami, Sudbury, Sault Ste. Marie, Wawa, Timmins, Kirkland Lake and Chapleau districts. A single moth was caught in northwestern Ontario in Lake Nipigon Provincial Park.

Egg mass surveys were not conducted for gypsy moth in 1996; therefore, forecasts are based on historical trends and speculation. Based on these criteria, it is expected that the area of defoliation will likely increase in 1997 and that new infestations will probably be found.

Table 3. Gypsy moth infestations in Ontario 1981-1996

Year	Gross Area of Moderate-to-Severe Defoliation (ha)
1981	1 450
1982	4 870
1983	40 954
1984	80 624
1985	246 342
1986	160 776
1987	12 678
1988	29 693
1989	81 640
1990	77 648
1991	347 416
1992	34 460
1993	9 784
1994	5 645
1995	19 879
1996	7 214

Table 4. Gross area of moderate-to-severe defoliation by the gypsy moth in Ontario 1994-1996

Region District	Area (ha)		
	1994	1995	1996
Central			
Parry Sound	0	2 413	0
Sault Ste. Marie	0	225	87
Sudbury	5 543	17 033	6 208
	5 543	19 671	6 295
Southern			
Aylmer	102	208	919
	102	208	919
TOTAL	5 645	19 879	7 214

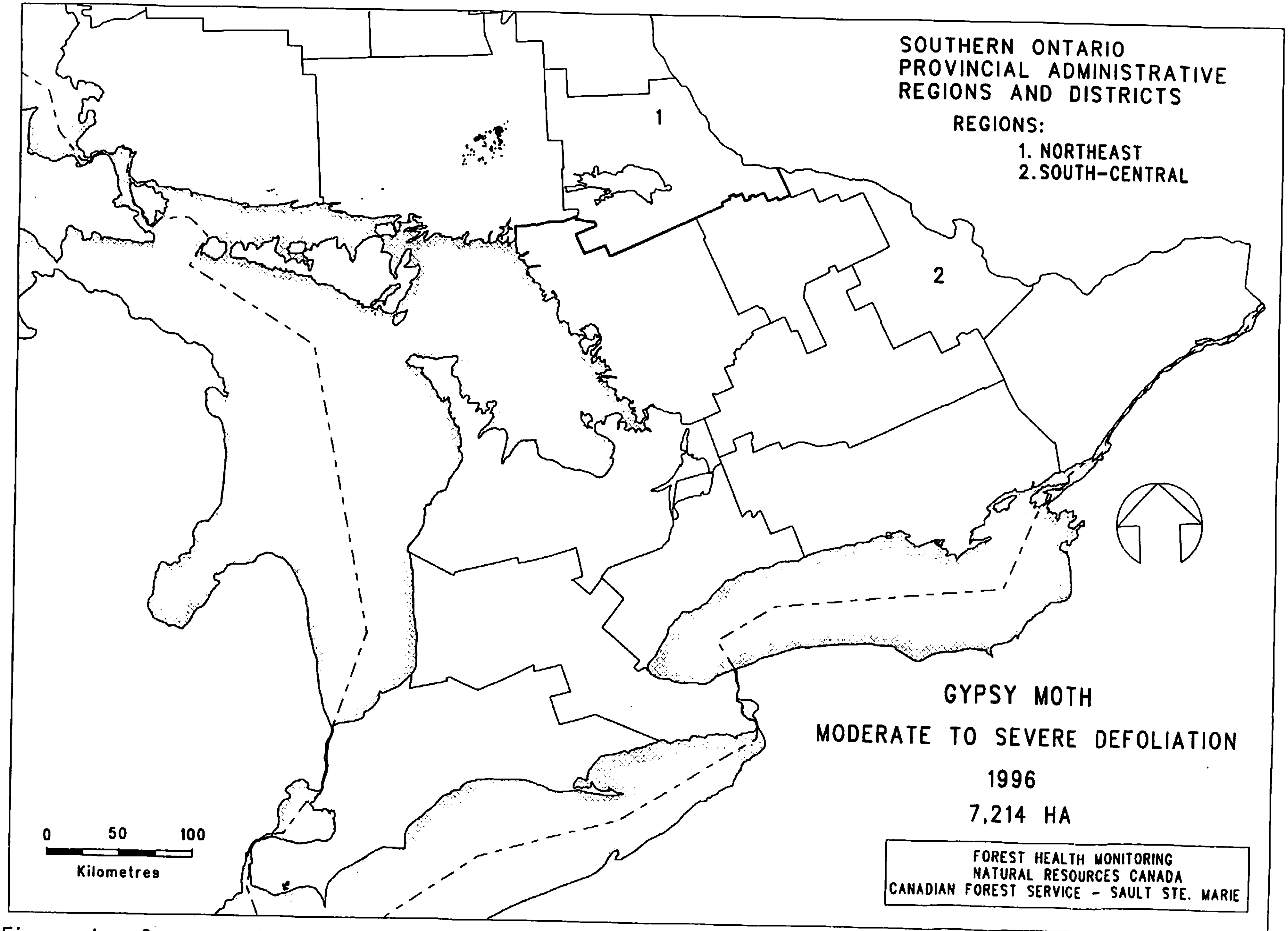

Figure 4. Gypsy moth defoliation in 1996.

FOREST TENT CATERPILLAR

Populations of this pest increased considerably in the northeast region of Ontario in 1996. The total area of moderate-to-severe defoliation reached 854 269 ha up from 243 135 recorded in 1995 (Table 5). Virtually all of the defoliation occurred in adjacent parts of the southwest Cochrane District, the southeast Hearst District and the northern Timmins District with small extensions into neighbouring corners of the northwest Kirkland Lake District and northeast Chapleau District (Fig. 5). Small pockets of damage persisted in the Kemptville District in the Winchester Bog area of Mountain Township and east and west of Vars in Cumberland Township. In the former township the forest tent caterpillar fed in conjunction with the aspen twoleaf tier and in the latter, it fed along with the gypsy moth.

Egg band counts to predict population levels, spread and defoliation were not done in 1996, but, as with gypsy moth, forecasts can be made based on historical trends. The large increase in defoliation in 1996 may be the start of a new outbreak in Ontario which in the past has reached 20 million ha or more.

Table 5. Gross area of moderate-to-severe defoliation caused by the forest tent caterpillar 1993-1996

Region District	Area (ha)			
	1993	1994	1995	1996
Northeast				
Chapleau	1 520	0	0	2 953
Cochrane	141 389	116 720	165 988	512 022
Hearst	358 541	49 340	72 329	255 094
Kirkland Lake	0	0	0	1 881
Timmins	0	0	3 470	80 693
Wawa	31 457	0	0	0
	532 907	166 060	241 787	852 643
Central				
Bancroft	31 628	0	0	0
North Bay	19 025	0	0	0
Sudbury	34 810	0	0	0
	85 463	0	0	0
Southern				
Tweed	14 413	0	0	0
Kemptville	22 473	0	1 338	1 626
	36 886	0	1 338	1 626
TOTAL	655 256	166 060	243 125	854 269

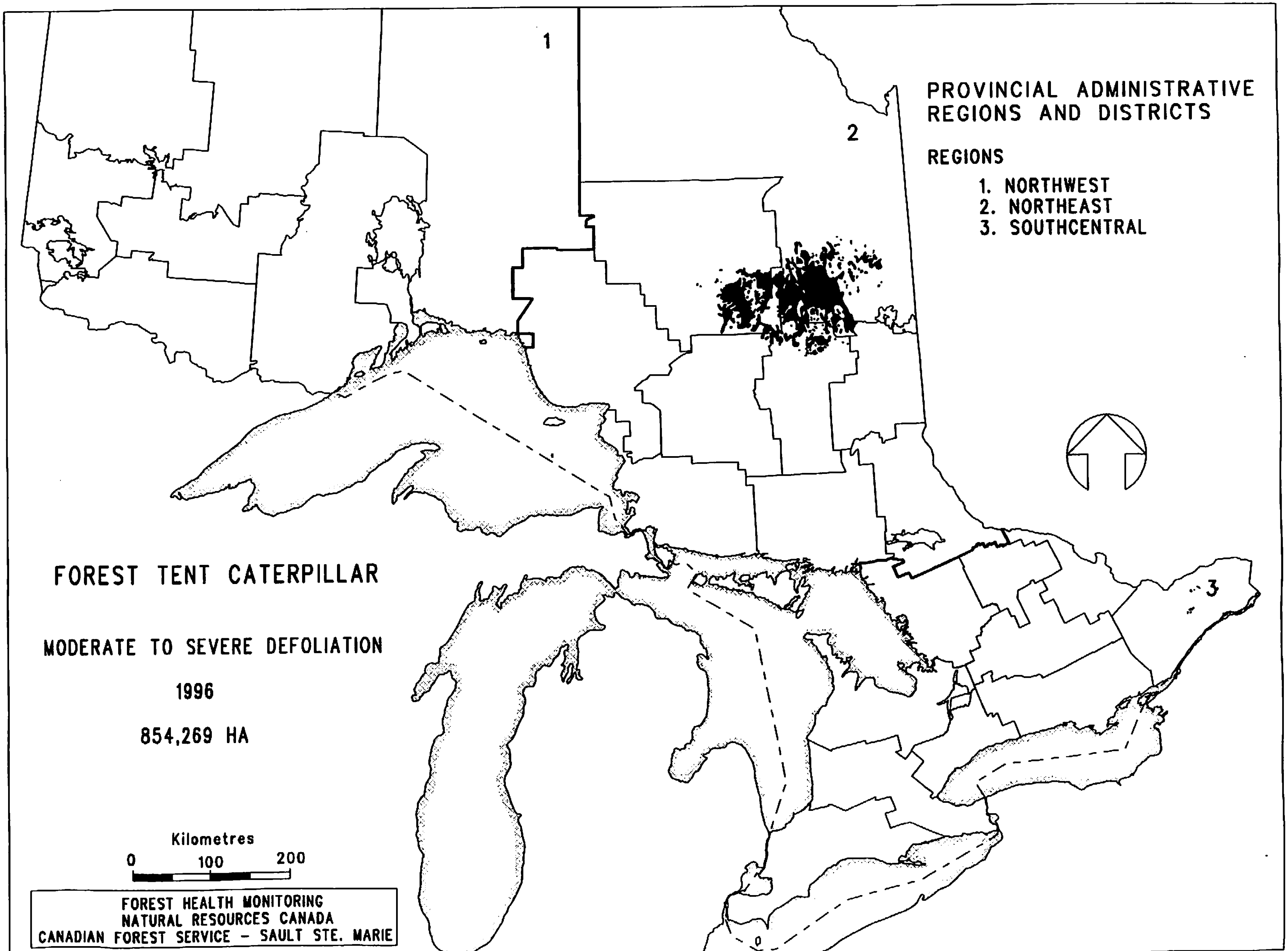

Figure 5. Forest tent caterpillar defoliation in 1996.

LARGE ASPEN TORTRIX

A total area of 50 461 ha of moderate-to-severe defoliation was mapped in adjacent areas of Thunder Bay and Nipigon districts in 1996. The insect defoliated trembling aspen stands in a wide area around the north shore of Lake Superior between Schreiber and the northwest tip of Thunder Bay including parts of the Black Bay Peninsula and St. Ignace and Simpson Islands. Damaged aspen stands were also mapped north along the Nipigon River between Red Rock and Purdom and Ledger townships. Single pockets of defoliation were detected east of Jellicoe near Partridge Lake and northeast of Beardmore near Tyrol Lake. A single pocket of defoliation was also reported in a 1 ha trembling aspen stand on the Garden River First Nation lands in Sault Ste. Marie District.

ASPEN TWOLEAF TIER

Populations of this early season pest remained high in northeastern Ontario, although there was a slight decline in the total area of moderate-to-severe defoliation. Aerial and ground mapping disclosed a total area of 3 900 196 ha of moderate-to-severe defoliation, compared with 4 802 965 ha in 1995 (Table 6).

The largest infestation this year was located in adjacent areas of the southwest Hearst District, the eastern Wawa District and the northeast corner of Chapleau District. A second large infestation occupied most of the southern Sudbury District extending into adjacent parts of the west-central North Bay District and the northwest corner of Parry Sound District. A third large infestation encompassed the southeast corner of North Bay District, the northeast portion of Algonquin Park District and the northern part of Pembroke District. A smaller area of infestation was mapped in a long narrow band along the Ottawa River on the eastern edge of Temagami District and the northeast corner of North Bay District. Numerous small pockets of defoliation were mapped in Kirkland Lake, Timmins and Chapleau districts and around the periphery of larger infestations in Wawa, Hearst and Sudbury districts.

Table 6. Gross area of moderate-to-severe defoliation by the aspen twoleaf tier in Ontario in 1995 and 1996

Region District	Area (ha)	
	1995	1996
Central		
Algonquin Park	416 724	298 105
Bancroft	62 298	8 238
North Bay	403 829	328 613
Parry Sound	39 587	32 640
Pembroke	92 512	130 884
Sault Ste. Marie	109	16 044
Sudbury	385 548	803 559
Temagami	393 856	68 635
	1 794 463	1 686 718
Northeast		
Chapleau	925 202	342 543
Hearst	0	496 768
Kirkland Lake	926 977	9 018
Timmins	1 156 323	25 973
Wawa	0	1 339 176
	3 008 502	2 213 478
TOTAL	4 802 965	3 900 196

OAK LEAF SHREDDER

This serious oak defoliator caused defoliation in excess of 75% in a large red oak stand near Lafontaine in Tiny Township, Midhurst District. It also caused 20 to 50% defoliation of red oak near the city of Sault Ste. Marie and in the Maple Ridge area of Sault Ste. Marie District.

PINE FALSE WEBWORM

Infestations of this introduced pest increased and intensified in the Oro Township area of Midhurst District. A number of red pine (*Pinus resinosa* Ait.) and white pine (*Pinus strobus* L.) plantations, along with some natural white pine were heavily defoliated. Some salvage cutting has been done in severely damaged stands but mortality appears imminent in the remaining trees in these stands. Small areas of heavy infestation were also observed in 10-12 m Scots pine (*Pinus sylvestris* L.) and red pine plantations in Essa and Holland townships, Midhurst District. The insect also caused 30% defoliation of 1-m-tall white pine at the OMNR arboretum in Korah Township, Sault Ste. Marie District.

WIND AND SNOW DAMAGE

Heavy snow and high winds in November 1995 caused severe damage to jack pine stands at several locations in Nipigon District and one location in Thunder Bay District. The damage was exacerbated by high winds in June of 1996, which further damaged stands in the same areas. Broken branches, snapped stems and blowndown trees were mapped over a sizeable area near Nakina and smaller patches of damage were detected by aerial surveys in Kowkash, Gzowski and Esnagami townships. Jack pine and, to a lesser extent, black spruce (*Picea mariana* [Mill.] BSP), were the species most commonly damaged. The total area within which damage was recorded was 66 892 ha. Plans for salvage of some of the damaged timber are being formulated.

WINTER DRYING

This phenomenon is caused by warm and dry weather conditions in late winter and early spring. Water lost from the foliage of conifers cannot be replaced by frozen stems and root systems, which causes the foliage to dry out. It later turns brown and falls off the tree. Usually no permanent damage results, but in severe cases buds containing the next year's growth are killed, occasionally resulting in death of branches or stems.

Winter drying was prevalent throughout much of southern and central Ontario in 1996. Trees in exposed situations such as plantations, roadsides, along shorelines and open grown or ornamentals were most seriously damaged. Red pine, Scots pine and white pine were the most affected species, particularly in plantations in southern Ontario along with ornamentals in Kirkland Lake and Chapleau districts. Mature open grown white pine along Highway 69 between the Naiscoot River and Parry Sound, Parry Sound District, sustained 60% foliar damage. Similarly, damage was evident on mature open grown white pine in Strathcona Township, Temagami District.

AERIAL SPRAY PROGRAM AGAINST JACK PINE BUDWORM ON WHITE PINE IN ONTARIO, 1996

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Report presented to the 24th Annual Forest Pest Control Forum/1996 Forest Pest Management Forum, Ottawa, November 18-22, 1996

Introduction

Jack pine budworm (*Choristoneura pinus pinus* Free.) is the most important defoliator of jack pine Ontario. Outbreaks of this insect are characterized by rapid population increase, 2-4 years of severe defoliation, and then rapid population collapse. Jack pine is considered the preferred host, with other pines being attacked when growing adjacent to or in mixture with jack pine.

In the districts of Parry Sound and Sudbury, however, the jack pine budworm has persisted in an outbreak phase for several years, and has been attacking white pine in both pure white pine and mixed white pine and jack pine stands. The insect showed no difficulty in completing the its life cycle on white pine. In addition to feeding on white pine, the budworm is laying its eggs and overwintering on this host. Damage was occurring to both mature overstory trees and to regeneration.

Although a decline in jack pine budworm populations was forecasted for 1996, several stands still had high overwintering populations in 1995/96 and would likely suffer severe defoliation in 1996. Therefore, an aerial spray program was conducted in 1996 to reduce mortality and growth loss of the white pine that could result from another year of defoliation.

The area of moderate-to-severe defoliation was:

1993	282,247 ha
1994	419,344 ha
1995	293,292 ha

Although the jack pine budworm outbreak did decline in 1996, there were still 103,851 ha of moderate-to-severe defoliation that year (see Howse et. al in these proceedings).

Funding for the program was obtained from the Forestry Futures Trust, and in-kind contributions from Tembec Forest Products Group and OMNR.

Objectives

The objective of the spray program was to protect at least 50% of the foliage of the white pine resource to reduce tree mortality and growth loss, thereby ensuring the continuation of the shelterwood management system and wood supply.

Forest Description

Stands selected for protection met the following criteria:

1) Crown production forest, site classes X,1,2, or 3.
2) species composition of 30% or more white pine or red pine by basal area.

3) for Sudbury Crown Management Unit, stands had to have less than 50% hardwood composition. Georgian Bay Crown Management Unit (Parry Sound District) could contain more than 50% hardwood composition.
4) no age limit
5) at least moderate levels of defoliation in 1993, 1994, or 1995.
6) moderate-to-severe defoliation forecasted for 1996

Approximately 73% of the treatment area was being managed under a shelterwood system.

Treatment

A total of 24,372 ha were treated with a single application of B.t.k. (*Bacillus thuringiemsis* var. *kurstaki)*, applied at 30BIU/2.4litres/ha. The B.t.k. was Foray 48B supplied by Abbott Laboratories Ltd. The higher volume application of Foray 48B was selected over that of Foray 76B, which was used in previous jack pine budworm control programs, because the higher volume Foray 48B was thought to have a better possibility of reaching the understory trees in the multi-storied shelterwood stands.

Three Bell 206B helicopters flying in parallel were used to apply the B.t using Beecomist rotary atomizers. Navigation was by a Robertson R22 helicopter. Flight paths of the spray aircraft were tracked using a Garmin Survey II and ArcView II GPS-GIS system developed by OMNR and ELIRIS Inc. A Cessna 172 was used by OMNR to audit the flight and spray operations.

Spraying commenced June 14, 1996, and finished June 24, 1996. Budworm larvae were primarily in the 3rd and 4th instars at the beginning of the spray, and had reached the 5th and 6th instars by the time the spray program was completed.

Results

The spray program was successful in protecting the foliage of the white pine against defoliation by jack pine budworm. Jack pine budworm defoliation varied among and within stands, as is characteristic for this insect.

As shown in Figure 1, defoliation of white pine in unsprayed check plots was typically twice that in the spray blocks. Foliage protection on jack pine (Figure 2) was also effective, but with a smaller difference between treated and check plots than occurred on white pine.

An on-going study is being conducted to determine the impacts of the budworm on the white pine resource.

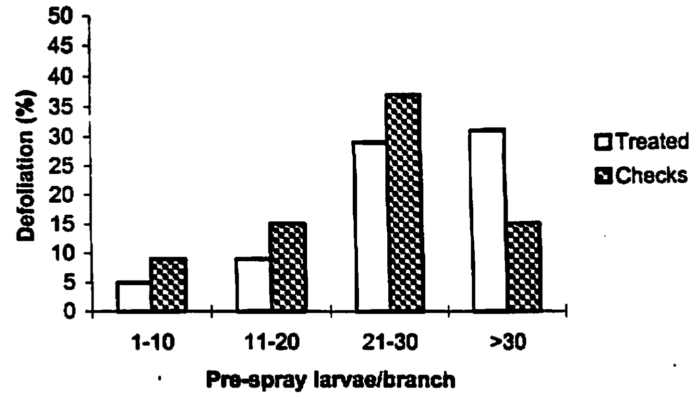

Figure 1. White pine defoliation at increasing pre-spray larval densities of jack pine budworm in plots treated with a single application of Foray 48B (30 BIU/2.4litres/ha)

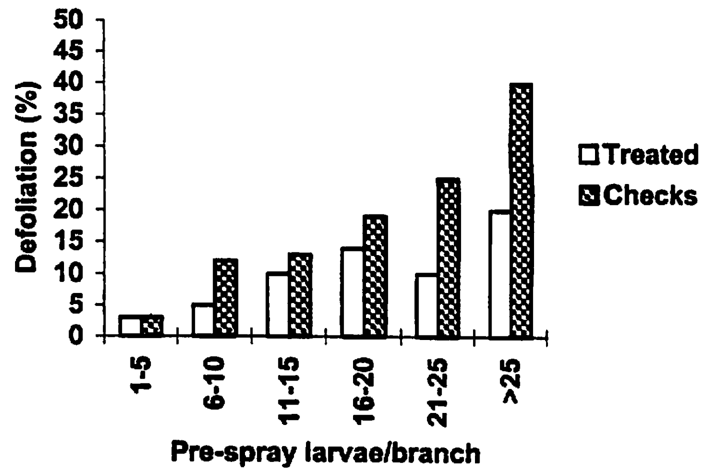

Figure 2. Jack pine defoliation at increasing pre-spray larval densities of jack pine budworm in plots treated with a single application of Foray 48B (30BIU/2.4 litres/ha).

Future Programs

The forecast for 1997 is a decline in both jack pine budworm and spruce budworm populations. No control programs are planned at this time for either insect.

Tembec Forest Products Group participated in the program by providing staff for block security. Much of the work in this program was performed by contractors, including:

- development of the project description and submission to Ontario Ministry of Environment and Energy for approval.
- timing and assessment of the spray operations
- aerial application
- project supervision and block security
- GPS-GIS monitoring

With continued reductions in OMNR staffing, future programs are likely to include a significant degree of contracting of services.

Navigation of aircraft was done using a bird dog aircraft. With the increasing availability and capability of GPS navigation systems, future programs will likely use this technology as the spray companies acquire and apply them.

SOMMAIRE DU RELEVÉ DES INSECTES ET DES MALADIES DES ARBRES AU QUÉBEC EN 1996

PAR
CLÉMENT BORDELEAU
MICHEL AUGER

DIRECTION DE LA CONSERVATION DES FORÊTS
MINISTÈRE DES RESSOURCES NATURELLES DU QUÉBEC

Rapport préparé pour le Forum sur la répression des ravageurs forestiers, Ottawa, du 18 au 22 novembre 1996

RÉSUMÉ

Les dégâts causés par les principaux insectes défoliateurs des résineux se sont accrus en 1996. La tordeuse des bourgeons de l'épinette a continué de causer des défoliations importantes dans l'ouest de la province alors que l'arpenteuse de la pruche a été le problème le plus important relevé dans l'est du Québec. Les infestations locales de la tordeuse du pin gris ont connu par contre une régression marquée cette année. Le porte-case du bouleau ainsi que la noctuelle décolorée ont été les principaux problèmes entomologiques détectés dans les forêts feuillues. Le charançon du pin blanc et la tenthrède à tête jaune de l'épinette demeurent les ravageurs qui causent le plus de dommages dans les plantations.

Les principaux faits marquants de l'année sont :

- la faible progression de l'infestation de la tordeuse des bourgeons de l'épinette dans la région de l'Outaouais;
- l'augmentation spectaculaire des populations de l'arpenteuse de la pruche dans les sapinières du nord-est de la région de la Gaspésie—Îles-de-la-Madeleine;
- la régression des populations de la tordeuse du pin gris dans l'ensemble des foyers d'infestation de la région de l'Outaouais;
- la poursuite de la régression de l'infestation de la livrée des forêts dans la région de la Mauricie—Bois-Francs;
- le maintien à un niveau endémique des populations de la spongieuse dans la presque totalité de son aire de distribution dans la province;
- les dégâts causés par le porte-case du bouleau dans plusieurs régions de la province;
- les défoliations causées par la noctuelle décolorée dans certains secteurs des régions de l'Abitibi-Témiscamingue, de Lanaudière et de la Mauricie—Bois-Francs;
- les défoliations importantes causées localement par la tenthrède à tête jaune de l'épinette au centre et dans l'est du Québec.

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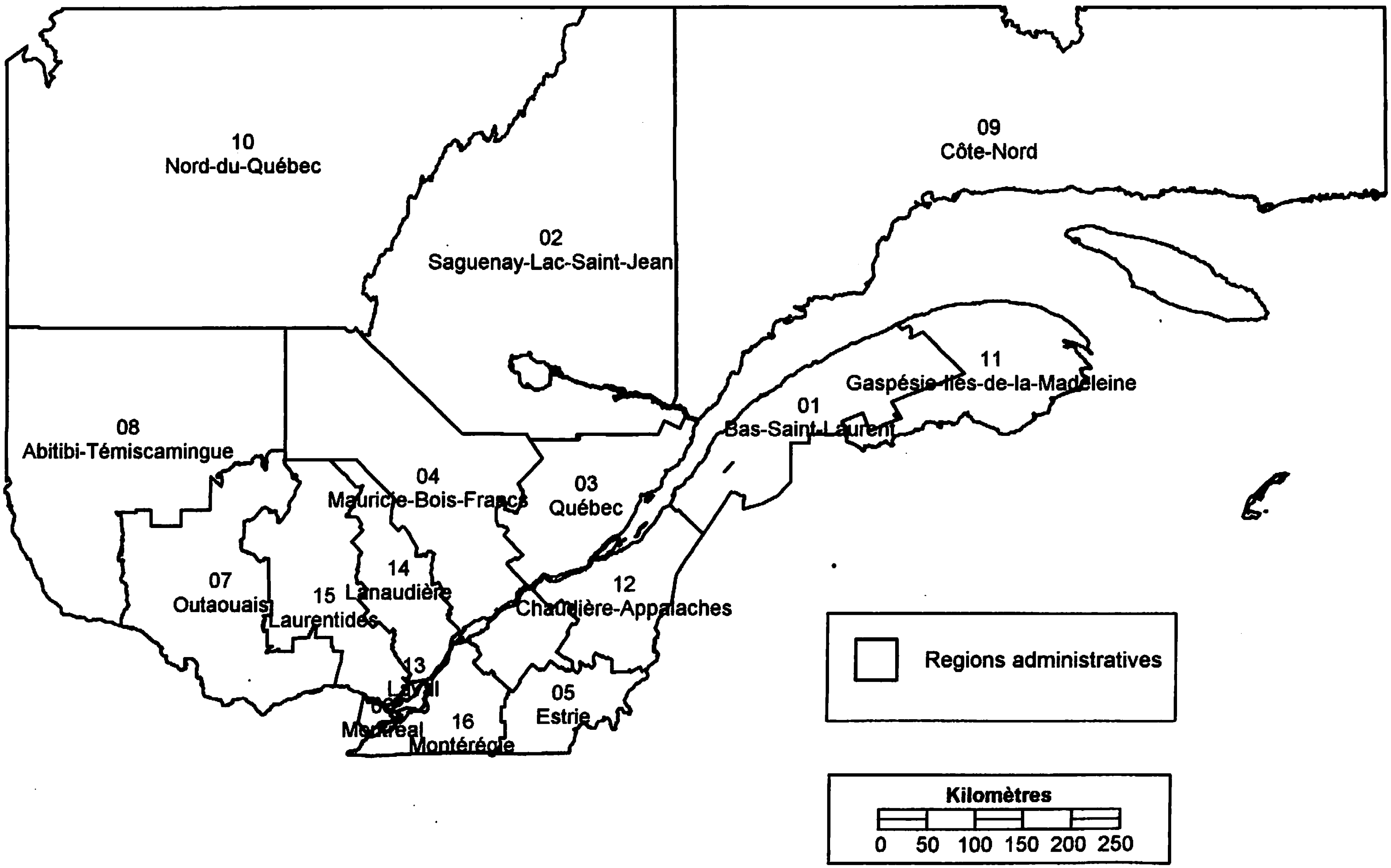
LES RÉGIONS ADMINISTRATIVES AU QUÉBEC



Ministère des Ressources naturelles
Direction de la Conservation des forêts

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

INFESTATION

L'infestation de tordeuses relevée depuis 1992 dans la région de l'Outaouais n'a pas connu de progression importante en 1996. Les populations sont généralement demeurées confinées dans les mêmes endroits que l'an dernier, soit dans le périmètre délimité par les localités de Fort-Coulonge, Kazabazua et Gatineau. L'infestation n'a également pas progressé dans les plantations d'épinettes blanches infestées depuis l'année dernière près de Drummondville dans la région de la Mauricie—Bois-Francs. Aucun dégât attribuable à la tordeuse n'a été relevé ailleurs dans la province, à l'exception de quelques îlots de défoliations légères aux Îles-de-la-Madeleine. Dans la région de l'Outaouais, quelques nouveaux foyers de superficies restreintes ont toutefois été relevés légèrement plus au nord et à l'est de la zone d'infestation de 1995 (lacs Sainte-Marie, Perkins) ainsi que le long de la rivière Gatineau et sur l'Île-du-Grand-Calumet. L'intensité des attaques y a été comme l'année dernière, très intense. Les dégâts ont été cependant moins importants qu'en 1995 dans le foyer situé dans la région de la Mauricie—Bois-Francs. La superficie totale infestée au Québec en 1996 couvre 5 234 hectares, comparativement à 4 703 hectares en 1995. Les dégâts se sont avérés modérés ou graves sur au-delà de 87 % de la superficie défoliée.

Tableau 1 - Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette au Québec en 1996

Régions administratives	**Niveaux de défoliation**			**Total**
	Léger	**Modéré**	**Grave**	
Outaouais	638 (309)*	784 (653)	3 778 (3 657)	5 200 (4 619)
Mauricie—Bois-Francs	25 (11)	9 (29)	0 (44)	34 (84)
Grand total	663 (320)	793 (682)	3 778 (3 701)	5 234 (4 703)

* ( ) = Superficies affectées en 1995

PRÉVISIONS

L'inventaire des larves en hibernation (L2) a été réalisé dans quelque 275 sites répartis dans toute la province. Les résultats partiels indiquent que la situation en 1997 devrait être relativement semblable à celle de cette année. Des populations de tordeuses ont été relevées dans toutes les régions de la province, mais les défoliations demeureront circonscrites dans le même périmètre qu'en 1996. Les dégâts continueront d'être importants sur ces territoires, particulièrement dans le bassin de la rivière Gatineau. Aucune expansion majeure de l'infestation n'a été décelée à date à l'extérieur de l'aire infestée cette année.

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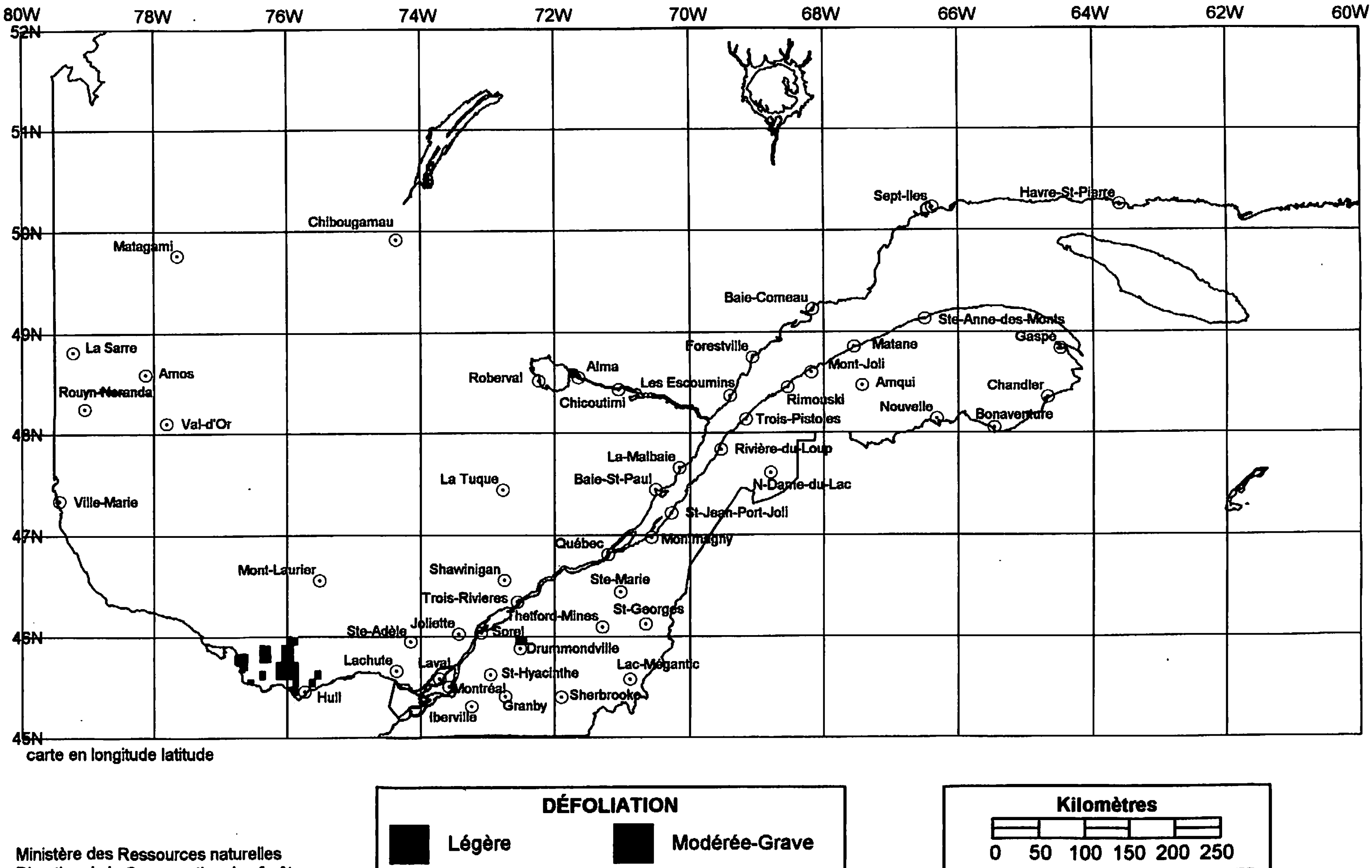
TORDEUSE DES BOURGEONS DE L'ÉPINETTE
DÉFOLIATION ANNUELLE 1996



Ministère des Ressources naturelles
Direction de la Conservation des forêts

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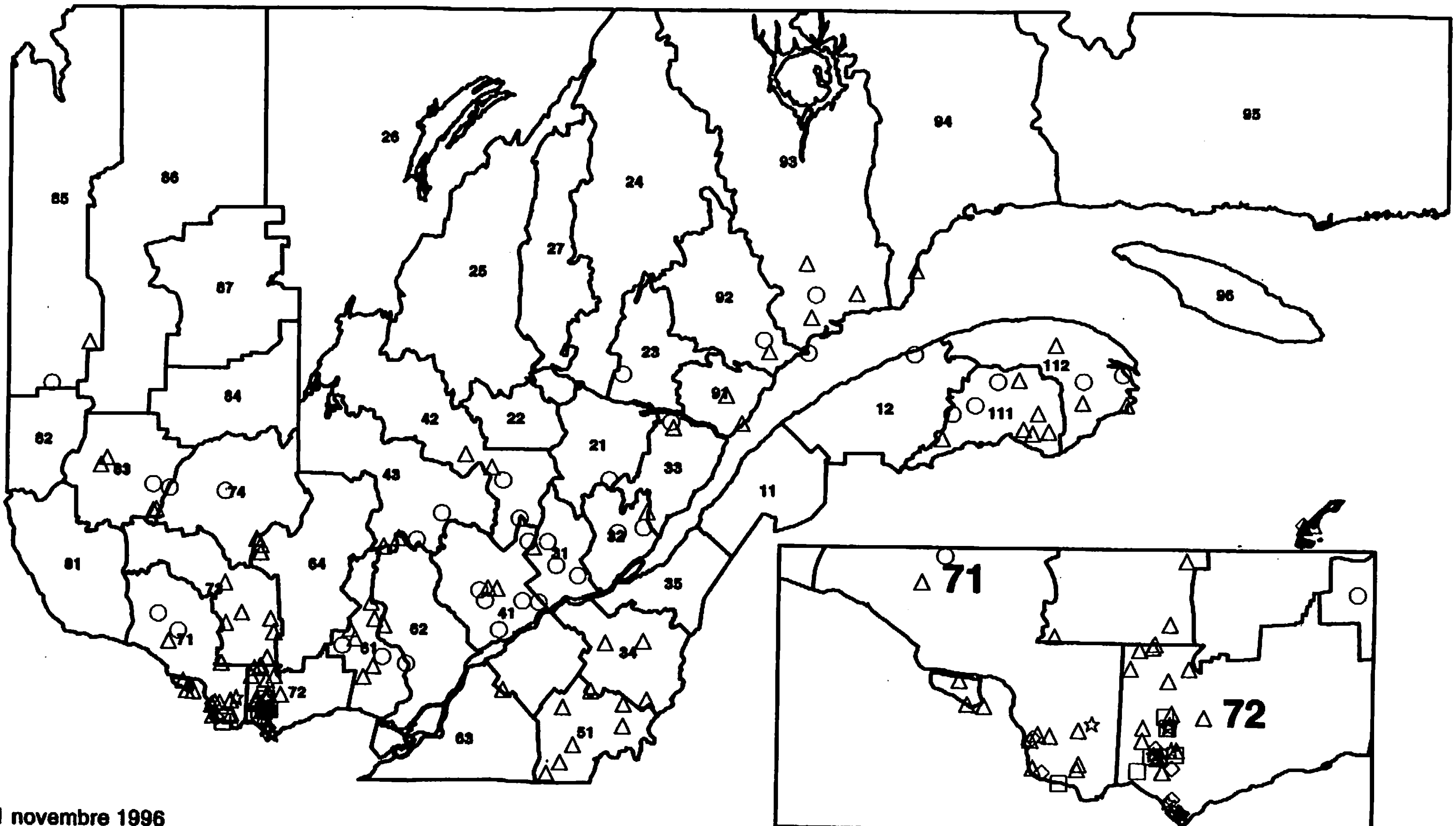
Niveau de population des larves en hibernation de la tordeuse des bourgeons de l'épinette 1996 (Sapin)



11 novembre 1996

Unité de gestion	POPULATION DES L2					
	○ Nul	0	◇ Moyen	189 à 540	☆ Très élevé	1185 et plus
	△ Faible	1 à 188	□ Élevé	541 à 1184		

ARPENTEUSE DE LA PRUCHE
Lambdina fiscellaria fiscellaria (Guen.)

INFESTATION

Les populations de l'arpenteuse de la pruche ont progressé de façon spectaculaire dans la région de la Gaspésie—Îles-de-la-Madeleine en 1996. Les dégâts causés par l'insecte ont été localisés dans plusieurs secteurs situés au nord-est de la péninsule gaspésienne, principalement dans les bassins des rivières York, Saint-Jean et Darmouth ainsi que dans le parc national de Forillon. Quelque 7 850 hectares de forêts y ont été défoliés cette année alors qu'en 1995, aucune défoliation n'y était visible. L'ensemble des peuplements affectés feront l'objet d'un programme de récupération.

Des infestations locales ont encore été signalées cette année au sud-ouest de l'Île d'Anticosti; celles-ci sont fragmentées en de nombreux petits foyers dispersés le long du littoral, entre la Pointe du Sud-Ouest et Anse-aux-Fraises. Des dégâts modérés à graves y ont été relevés sur près de 1 000 hectares. Un foyer isolé couvrant quelque 90 hectares ainsi qu'un second couvrant 32 hectares ont été finalement relevés au nord de Natashquan (région de la Côte-Nord) et au nord du lac Matane (région du Bas-Saint-Laurent). L'infestation relevée en 1995 sur une île du réservoir Kipawa (région de l'Abitibi-Témiscamingue) a chuté complètement cette année. Les aires infestées par l'arpenteuse en 1996 totalisent quelque 8 900 hectares, comparativement à près de 700 hectares en 1995.

Tableau 2 - Superficies (ha) affectées par l'arpenteuse de la pruche au Québec en 1996

Régions administratives	Niveaux de défoliation			Total
	Léger	Modéré	Grave	
Bas-Saint-Laurent	0 (0)*	32 (0)	0 (0)	32 (0)
Abitibi—Témiscamingue	0 (0)	0 (0)	0 (25)	0 (25)
Côte-Nord	20 (55)	279 (160)	760 (457)	1 059 (672)
Gaspésie—Îles-de-la-Madeleine	1 730 (0)	4 071 (0)	2 047 (0)	7 848 (0)
Grand total	1 750 (55)	4 382 (160)	2 807 (482)	8 939 (697)

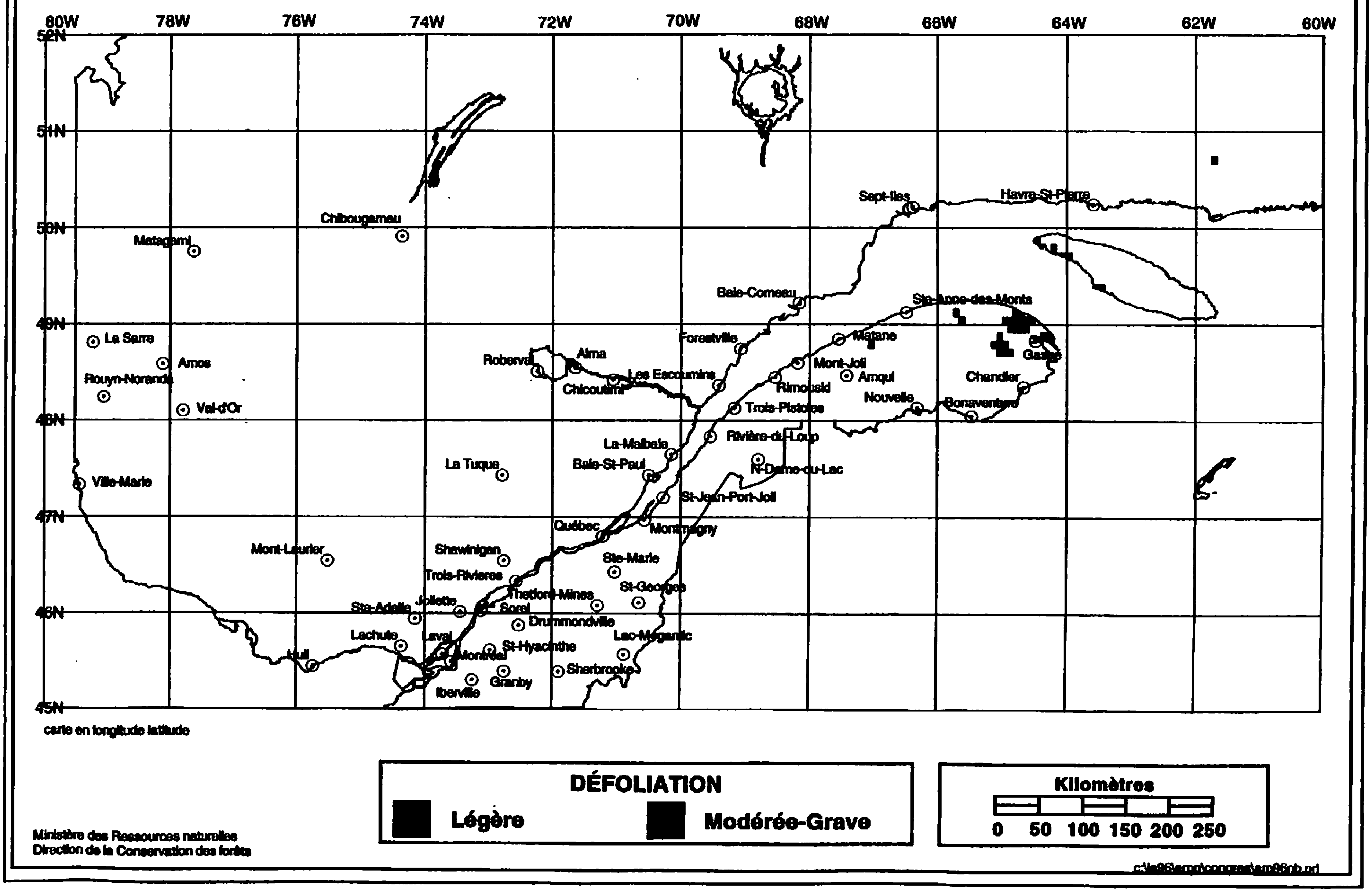
* ( ) = Superficies affectées en 1995

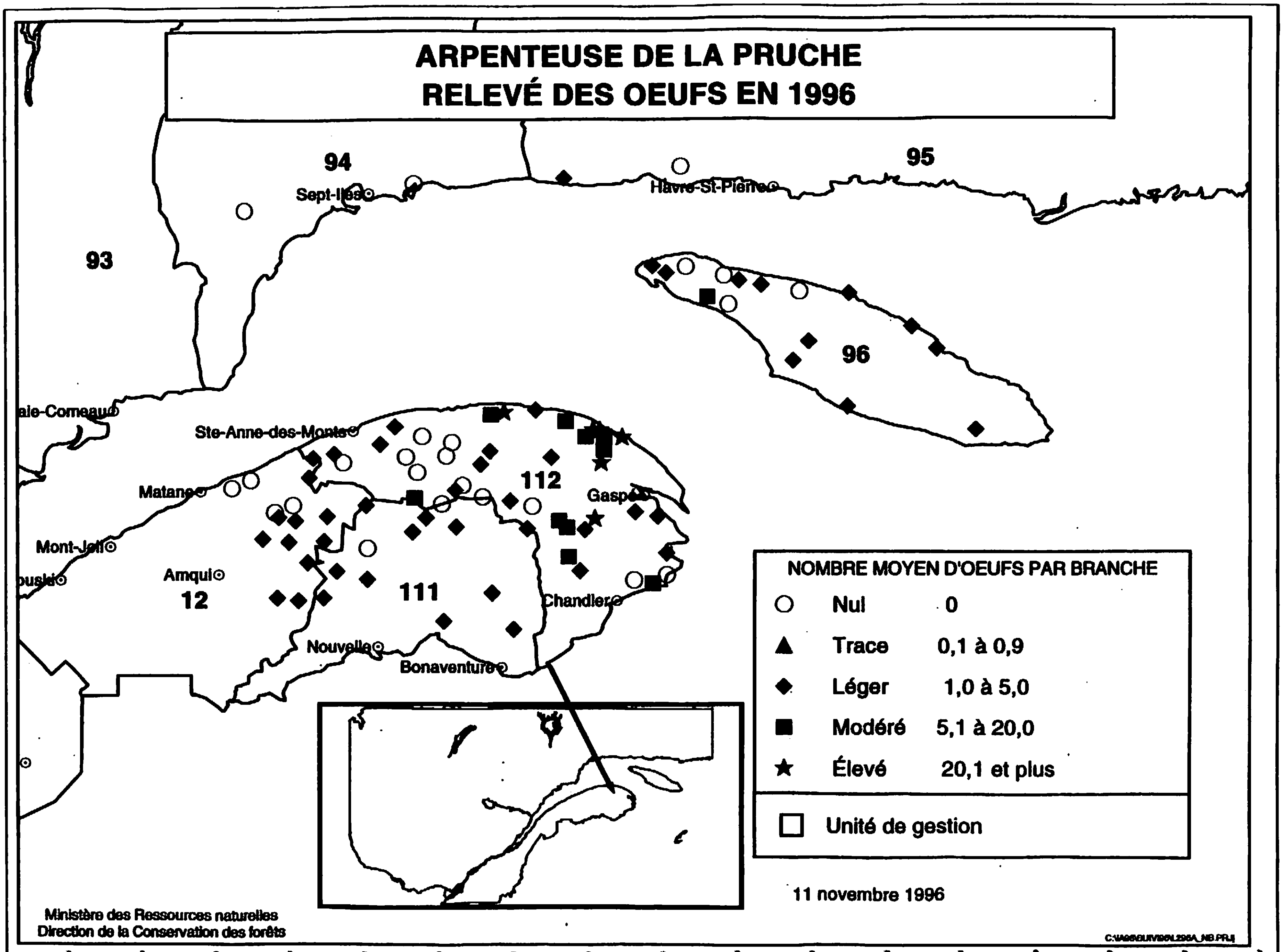
...

PRÉVISIONS

Un relevé des œufs a été effectué à l'automne dans les régions de l'est du Québec. Il a été dirigé prioritairement dans la péninsule gaspésienne et sur l'Île d'Anticosti. Les stations du réseau de pièges à phéromone, où la capture moyenne de papillons par piège était supérieure à 500, ont également fait l'objet d'un échantillonnage. Les résultats des relevés indiquent que les populations d'arpenteuses ont atteint un niveau susceptible de causer, en 1997, des dégâts modérés à graves sur des étendues importantes de massifs forestiers dispersés entre et au pourtour des foyers détectés en 1996 au nord-est de la péninsule gaspésienne. Aucune expansion majeure des infestations n'est par contre prévue sur l'Île d'Anticosti; les dégâts demeureront localisés au sud-ouest de l'Île.

ARPENTEUSE DE LA PRUCHE
DÉFOLIATION ANNUELLE 1996




ARPENTEUSE DE LA PRUCHE
RELEVÉ DES OEUFS EN 1996
93
94
95
96
12
111
112
Sept-Îles
Havre-St-Pierre
Baie-Comeau
Ste-Anne-des-Monts
Matane
Mont-Joli
Rimouski
Amqui
Gaspé
Chandler
Nouvelle
Bonaventure
NOMBRE MOYEN D'OEUFS PAR BRANCHE
Nul 0
Trace 0,1 à 0,9
Léger 1,0 à 5,0
Modéré 5,1 à 20,0
Élevé 20,1 et plus
Unité de gestion
11 novembre 1996
Ministère des Ressources naturelles
Direction de la Conservation des forêts

TORDEUSE DU PIN GRIS
Choristoneura pinus pinus Free.

INFESTATION

Les populations de la tordeuse du pin gris ont chuté dans l'ensemble des foyers locaux d'infestation relevés depuis quelques années dans la région de l'Outaouais. Des dégâts annuels importants n'ont été enregistrés que dans une plantation de pins gris localisée près de Kazabazua, et ceux-ci y ont été beaucoup moins intenses que l'année dernière. La mortalité des arbres est cependant apparue dans cette plantation. Dans les autres foyers, des défoliations variant de légères à graves ont été occasionnellement observées sur des tiges dispersées à l'intérieur des peuplements.

Tableau 3 - Superficies (ha) affectées par la tordeuse du pin gris au Québec en 1996

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Élevé	
Outaouais	228 (57)*	84 (650)	0 (543)	312 (1 250)

* ( ) = Superficies affectées en 1995

PRÉVISIONS

Les résultats du relevé des larves en hibernation (L2) qui a été réalisé dans les aires qui ont été infestées au cours des dernières années ne sont pas encore disponibles.

SPONGIEUSE
Lymantria dispar (L.)

INFESTATION

Les populations de la spongieuse continuent de se maintenir généralement à un niveau endémique dans l'ensemble de son aire de distribution au Québec. En 1996, des dégâts variant de légers à graves n'ont été relevés que dans quelques foyers de faibles superficies localisés dans les régions de la Montérégie, de Lanaudière et de la Mauricie—Bois-Francs. Au cours des trois années antérieures, aucune défoliation attribuable à l'insecte n'avait été rapportée.

...

LIVRÉE DES FORÊTS
Malacosoma disstria Hbn.

INFESTATION

Le déclin marqué de l'épidémie de la livrée des forêts observé en 1995 dans la région de la Mauricie—Bois-Francs s'est poursuivi cette année. Les populations ne se sont maintenues que dans quelques foyers localisés sur la rive sud du Saint-Laurent. Les dégâts ont été relevés sur quelque 700 hectares, comparativement à 4 700 hectares l'année dernière. Bien qu'aucun dégât important n'ait été signalé ailleurs au Québec, la présence de l'insecte a été relevée fréquemment dans l'ouest de la province.

TORDEUSE DU TREMBLE
Choristoneura conflictana (Wlk.)

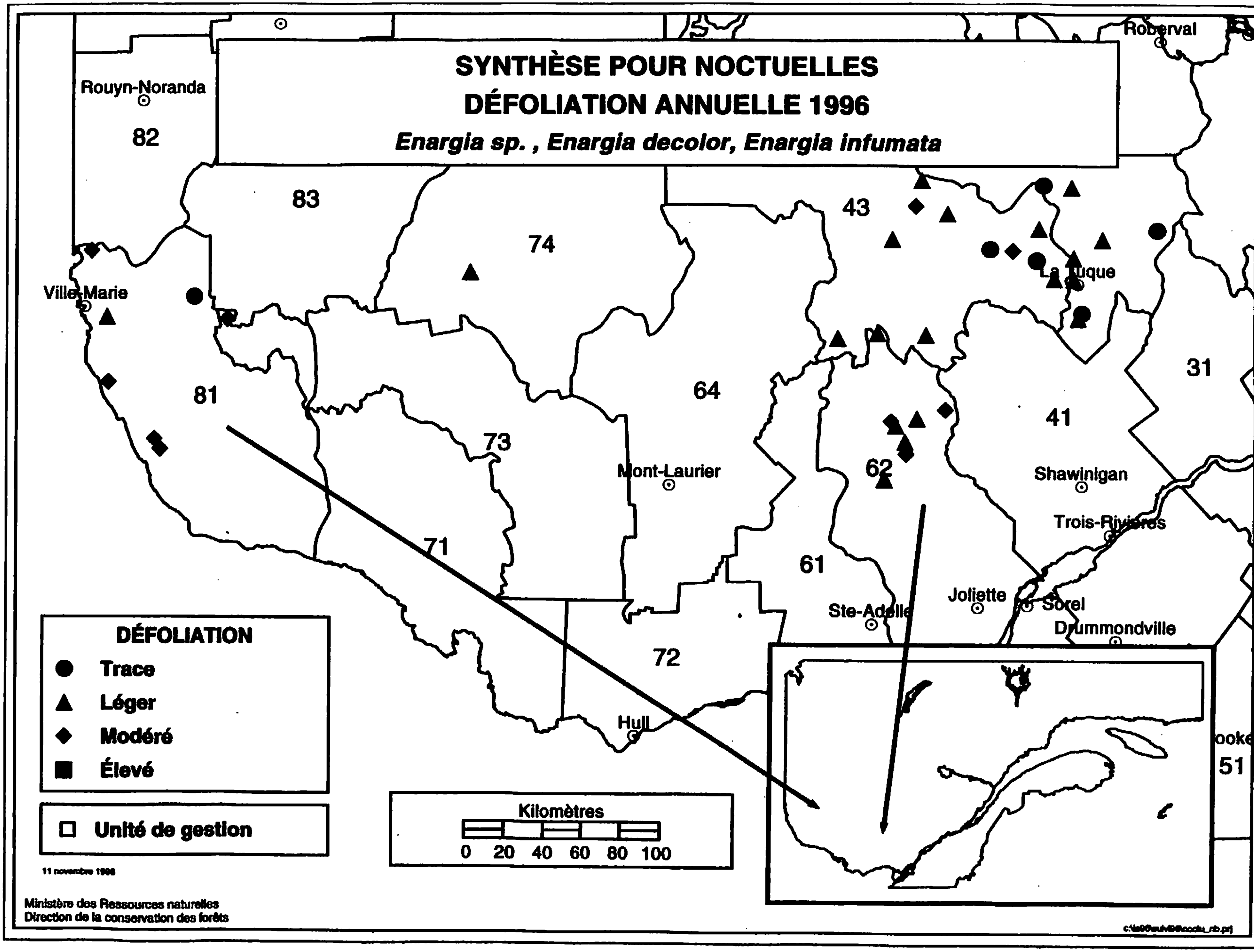
INFESTATION

Les dégâts causés par la tordeuse du tremble ont été généralement peu importants en 1996. Les populations de cet insecte avaient connu, l'année dernière, une baisse marquée dans la plupart des secteurs alors infestés. Cette année, seules quelques infestations locales ont été rapportées dans les régions de l'Estrie, de l'Outaouais et de Chaudière-Appalaches. Les superficies défoliées ont été généralement restreintes.

NOCTUELLE DÉCOLORÉE
Enargia decolor (Wlk.)

INFESTATION

La noctuelle décolorée cause depuis 1994 des défoliations importantes dans quelques régions du Québec. Souvent retrouvée en association avec la noctuelle enfumée, *Enargia infumata*, il est parfois difficile d'attribuer l'importance des dégâts à l'une ou à l'autre des deux espèces. En 1996, des défoliations ont été encore relevées au sud-ouest de la région de l'Abitibi-Témiscamingue (secteur de Ville-Marie), au nord de la région de Lanaudière (secteur du réservoir Taureau) ainsi qu'au centre-ouest de la région de la Mauricie—Bois-Francs (secteur de La Tuque). Dans l'ensemble de ces régions, les dégâts se sont avérés à la baisse par rapport à l'année dernière et leur distribution a été plus irrégulière. Ils ont été principalement de niveau léger à modéré. Des défoliations légères ont également été observées en plusieurs endroits au sud-ouest de la région de l'Outaouais alors que les infestations rapportées en 1994 et 1995 dans la région du Saguenay—Lac-Saint-Jean ont chuté complètement cette année.


SYNTHÈSE POUR NOCTUELLES
DÉFOLIATION ANNUELLE 1996
Enargia sp. , Enargia decolor, Enargia infumata
Roberval
Rouyn-Noranda
82
83
74
43
La Tuque
Ville-Marie
31
81
64
41
73
Mont-Laurier
62
Shawinigan
Trois-Rivières
71
61
Joliette
Sorel
Ste-Adèle
Drummondville
72
Hull
51
DÉFOLIATION
Trace
Léger
Modéré
Élevé
Unité de gestion
Kilomètres
0 20 40 60 80 100
11 novembre 1996
Ministère des Ressources naturelles
Direction de la conservation des forêts

PORTE-CASE DU BOULEAU
Coleophora serratella (L.)

INFESTATION

Le porte-case du bouleau a, encore cette année, causé des défoliations notables sur le bouleau à papier dans plusieurs régions du Québec. Les peuplements touchés se situent dans les régions de la Mauricie—Bois-Francs, du Saguenay—Lac-Saint-Jean, de la Côte-Nord et également dans les régions du Bas-Saint-Laurent et de la Gaspésie—Îles-de-la-Madeleine. Les dégâts ont été cependant généralement moins intenses que l'année dernière; ils ont varié de légers à modérés, comparativement à modérés à graves en 1995. La mortalité d'arbres a été relevée localement dans quelques secteurs où l'insecte fait des ravages depuis 1994.

PLANTATIONS

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

Des défoliations importantes ont été encore relevées localement cette année dans des plantations d'épinettes des régions de Québec, de Chaudière-Appalaches, du Bas-Saint-Laurent et de la Gaspésie—Îles-de-la-Madeleine. L'évolution des populations de ce ravageur a varié selon les sites et les dégâts demeurent généralement circonscrits dans quelques plantations. L'épinette noire s'avère l'essence la plus susceptible à l'insecte. Dans la majorité des cas, des défoliations graves ne sont pas observées plus de deux ans. Lorsque celles-ci persistent plus longtemps, on observe de la mortalité qui varie avec la durée de l'infestation.

FOREST PEST STATUS REPORT FOR NEW BRUNSWICK IN 1996

(Prepared for the Forest Pest Management Forum, held in Ottawa, Nov.18-22,1996)[1]

INSECT PESTS OF SOFTWOODS

SPRUCE BUDWORM (*Choristoneura fumiferana* (Clem.)): This perennial pest of the spruce-fir forests of New Brunswick has had its populations decline substantially since 1983 when moderate and severe defoliation was mapped over 2.028 million hectares, the second greatest area to the 3.567 million ha recorded back in 1975 (the year when moderate-severe defoliation occurred over 55 million ha in eastern North America). No defoliation was recorded in 1993 and 1994, and only 4 000 ha was detected in 1995. No defoliation was recorded in 1996 and no operational controls were applied.

The forecast survey for predicting populations for 1997 consisted of samples of overwintering L2 larvae (on standard 75-cm mid-crown branches) taken at 503 sites distributed around the whole Province. Of all the sites sampled, only 3 had detectable Low populations, viz. one had an average of 2 larvae/75-cm branch and two had 1 larva/75-cm branch.

This was consistent with a province-wide pheromone trapping survey also conducted by DNRE in New Brunswick this year. Of 101 traps placed out at a subset of the operational L2 plots, 99 were retrieved. Catches of moths were low, viz. 53% were negative, 41% had 1-10 moths/trap, 3% had 11-20 moths/trap, and 3% had >20 moths/trap. A number of supplementary L2 samples have been taken in the vicinity of the sites with the highest catches to see whether these numbers of moths indicate any small, local populations of concern. Data are not available at this time.

Also, the Canadian Forest Service and J.D. Irving Limited (JDI) supplemented the DNRE pheromone trapping survey to assist in the interpretation of the data. DNRE processed the traps for JDI who placed 25 in the southeast area (Sussex District) and 25 in the northwest area (Black Brook District). Only 4 traps in the southeast had any moths, ie. 114 and 73 moths in their Parkindale Seed Orchard, 23 moths at the Sussex Tree Nursery, and a single moth at Phillipstown Road. At Black Brook, 20 traps were positive with catches ranging from 1-55 moths/trap. Supplementary L2 sampling will be done at these locations with high catches to see if any damaging populations exist (data not yet available).

No control is required in 1997 as results of the fall survey of overwintering larvae and data from the pheromone traps confirm that populations are consistently low throughout the Province.

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1 Presented by: N. Carter
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Fredericton, N.B. E3B 5H1

BLACKHEADED BUDWORM (*Acleris variana* (Fern.)): Populations of this native pest are traditionally not of major concern in New Brunswick, though past outbreaks have been recorded in the early and mid part of this century. In 1995, two small pockets of defoliation (948 ha Light, and 991 ha Moderate) were detected in the northwest part of the Province somewhat close to the Quebec border. An egg survey in the fall of that year detected only low populations and hence no significant damage was predicted for 1996. The prediction was correct, as summer larval and aerial surveys did not detect anything of significance. Consequently, there was no egg survey this fall. Although no damage is anticipated, the area will again be monitored next year.

HEMLOCK LOOPER (*Lambdina fiscellaria fiscellaria* Gn.): Although not a perennial pest of the forests of New Brunswick, a minor outbreak occurred in northwestern, northcentral and southwestern parts of the Province between 1989 and 1993 (coinciding with similar increases in Maine). Several small operational control programs were conducted in 1990, 1991, and 1993. Since then, however, no defoliation has been detected in the Province and no controls needed. Consequently, egg surveys were suspended in 1994 until such time as conditions again warrant their conduct.

Pheromone trap catch data collected by the former Forest Insect and Disease Survey of the Canadian Forest Service in the past few years have detected only endemic populations below damaging thresholds. Results from 96 pheromone traps placed at various locations around the Province by DNRE this year tell the same story: 36 were negative; 56 had ≤10 male moths/trap; 1 had 12; 1 had 14; and 2 had 22/trap.

In addition, J.D. Irving Limited placed out 24 traps in the southeast (Sussex District) and 25 in the northwest (Black Brook District). Only one trap (at the Sussex Tree Nursery) was negative. Moth catches in the other traps ranged from 12-160 moths/trap (mostly 30-100/trap). In the northwest, 18 traps were positive with catches ranging from 1-37 moths/trap. Due to the sensitivity of the hemlock looper lure to attract male moths and data on catch levels from other areas, these moth counts are not expected to indicate populations capable of causing any significant defoliation in 1997.

The Canadian Forest Service also placed out traps but data are not yet available.

YELLOWHEADED SPRUCE SAWFLY (*Pikonema alaskensis* (Roh.)): Populations of this traditionally endemic native insect began to increase in the southeastern part of the Province in the early 1990s. At first, damage was restricted to road-side spruce trees and very few occurrences in black spruce plantations. By 1994, however, damage was more frequently encountered and had finally caused enough damage to be of concern in a number of plantations on Crown land and some on the freehold limits of J.D. Irving Limited (JDI).

Ground and aerial surveys in the fall of 1994 and spring of 1995 identified 5 significantly attacked plantations on Crown land and several on JDI property. This led to the conduct of preliminary studies on the local biology of this insect in New Brunswick (by DNRE), and the conduct of single-tree control trials by the Canadian Forest Service, using NEEM and nematodes, in the summer of 1995. Surveys in the fall of that year detected sawfly populations in a total of 31 plantations on Crown land and 6 on JDI property, a significant increase over the previous year. This subsequently led to the conduct of a series of cooperative alternative pest management trials in the summer of 1996 (reported in detail elsewhere).

Surveys were conducted this fall to determine the current status of populations and damage. Although 3 newly attacked plantations were detected on Crown land the survey confirmed an overall amelioration of conditions as most of the damaged plantations showed only light defoliation this summer. These included 10 of last year's most heavily attacked plantations which were used for various control trials this summer. Their fate had they been left untreated is not known, though pre-spray larval counts in them and comparative levels in the damaged untreated check area suggest they would have suffered significant damage. Only seven untreated plantations from 1995 and 3 newly attacked ones appeared to have increases in populations and/or damage. Monitoring will be required in 1997 to determine the progression of the outbreak. Operational controls and/or research plans are not yet determined.

BALSAM FIR SAWFLY (*Neodiprion abietis* (Harr.)): Damage caused by this insect was noted at a few locations in southwestern New Brunswick in 1995 and there was a concern that it might be a pest of significance to Christmas tree growers in the region in 1996. Consequently, general monitoring was done throughout the summer. By June 5, fir shoots were fully flushed but it was not until June 25 that the first eggs were seen. The first larvae were not seen until July 18, when it was determined that hatch had only recently begun. By August 8, some defoliation of one-year-old needles was becoming evident. A road-side survey was conducted throughout the general area of western Charlotte County and several of the main roads leading to the area from Fredericton. The only damage detected occurred between St. George and Lepreau in the southeastern portion of the County. The general area will again be monitored in 1997 to see whether populations are increasing and worth more attention.

LARCH SAWFLY (*Pristiphora erichsonii* (Htg.)): Anecdotal reports were received about scattered trees being defoliated at several scattered locations in southern parts of the Province. Observations will be made next year to see whether more extensive damage occurs.

SEED ORCHARD PESTS: This was the ninth year that DNRE monitored pests in Provincial forest tree seed orchards. Surveys were conducted for major defoliators as well as cone-infesting pests of first and second generation seed orchards. Particular attention in early summer was focused on the yellowheaded spruce sawfly which had damaged some trees in one white spruce seed orchard and one black spruce seed orchard in 1995. Ground treatments were applied to the white spruce last year but no treatments were necessary in either area this summer. Although cone maggot (*Strobilomyia neanthracina* Mich.) numbers dropped noticeably on the white spruce at Queensbury from 1995, considerable damage was caused by maggot feeding in white spruce cones at Pokiok in 1996. One or two other cone maggot species (*S. varia* (Huckett) and/or *S. laricis* Michelsen) were responsible for heavy seed loss in larch cones at Queensbury in 1996. Due to the large reserve of seed in storage, no controls were applied this year.

Other defoliators (eg. spruce budworm and spruce budmoth) and cone-infesting insects (eg. fir and spruce coneworms, and spruce seed moth) were found in low numbers.

DISEASES OF SOFTWOODS

The Canadian Forest Service continued low-level monitoring of Scleroderris canker, and European larch canker. Results currently indicate there is no need for a change in status of these fungal pests.

INSECT PESTS OF HARDWOODS

FOREST TENT CATERPILLAR (*Malacosoma disstria* Hbn.)): This periodic pest of poplar and several other hardwood species began its most recent outbreak in New Brunswick about 1991, slightly more than a decade since the last one began. The current outbreak appears to have virtually collapsed as indicated by an aerial survey conducted by the CFS this summer, revealing only 33 000 ha of defoliation which was considerably less than 435 000 ha mapped last year. The current outbreak was much less severe than the preceding one (Table 1).

Table 1. Area of defoliation caused by forest tent caterpillar in the current and preceding outbreaks in New Brunswick.

YEAR	AREA (HA)	YEAR	AREA (HA)
1978	Trace	1985-1990	nil
1979	37 000	1991	31 000
1980	177 600	1992	77 500
1981	775 300	1993	196 000
1982	1 389 000	1994	392 000
1983	1 119 000	1995	435 000
1984	94 000	1996	33 000

Source: CFS-Maritimes Annual FIDS Reports.

The main area of defoliation on poplar south of Fredericton virtually disappeared in 1996. Defoliation was mostly found in eastern parts of the province (Figure 1). There was concern, however, that in some areas, especially in eastern York and Kent Counties, that local high populations of satin moth contributed to the overall damage (see below). During outbreak years there is always a lot of interest from the media and the public wondering about this pest in and around communities. The lack of such interest this year is probably a good indication that the populations have substantially collapsed in most regions. Natural causes such as disease and parasitism usually bring about these collapses.

SATIN MOTH (*Leucoma salicis* (L.)): Populations of this insect pest of poplars and willows have gradually increased in the past few years according to recent reports of the former Forest Insect and Disease Survey of the Canadian Forest Service.

Observations in 1996 confirmed populations were prevalent in eastern York and Kent Counties in eastern New Brunswick. In these areas defoliation occurred in addition to/or in concert with feeding by the forest tent caterpillar (see above). Field observations (by the CFS) in late August found severe defoliation by skeletonizing early-instar satin moth larvae. Several field checks from

Rogersville to Coles Island confirmed the tremendous abundance of 1996-laid egg masses on the stems of trembling aspen. Areas of severe defoliation approximated the areas of defoliation delineated in late June. Such high populations of early instar satin moth larvae in August possibly represents the defoliating populations in June overlapping the typical defoliation period for forest tent caterpillar. It is not possible therefore to apportion the defoliation to each insect. There were also anecdotal reports of very high populations of satin moth near Coles Island and Moncton in July. The high numbers of hibernating satin moth larvae, and the degree and extent of late season defoliation would indicate the potential for significant defoliation in 1997.

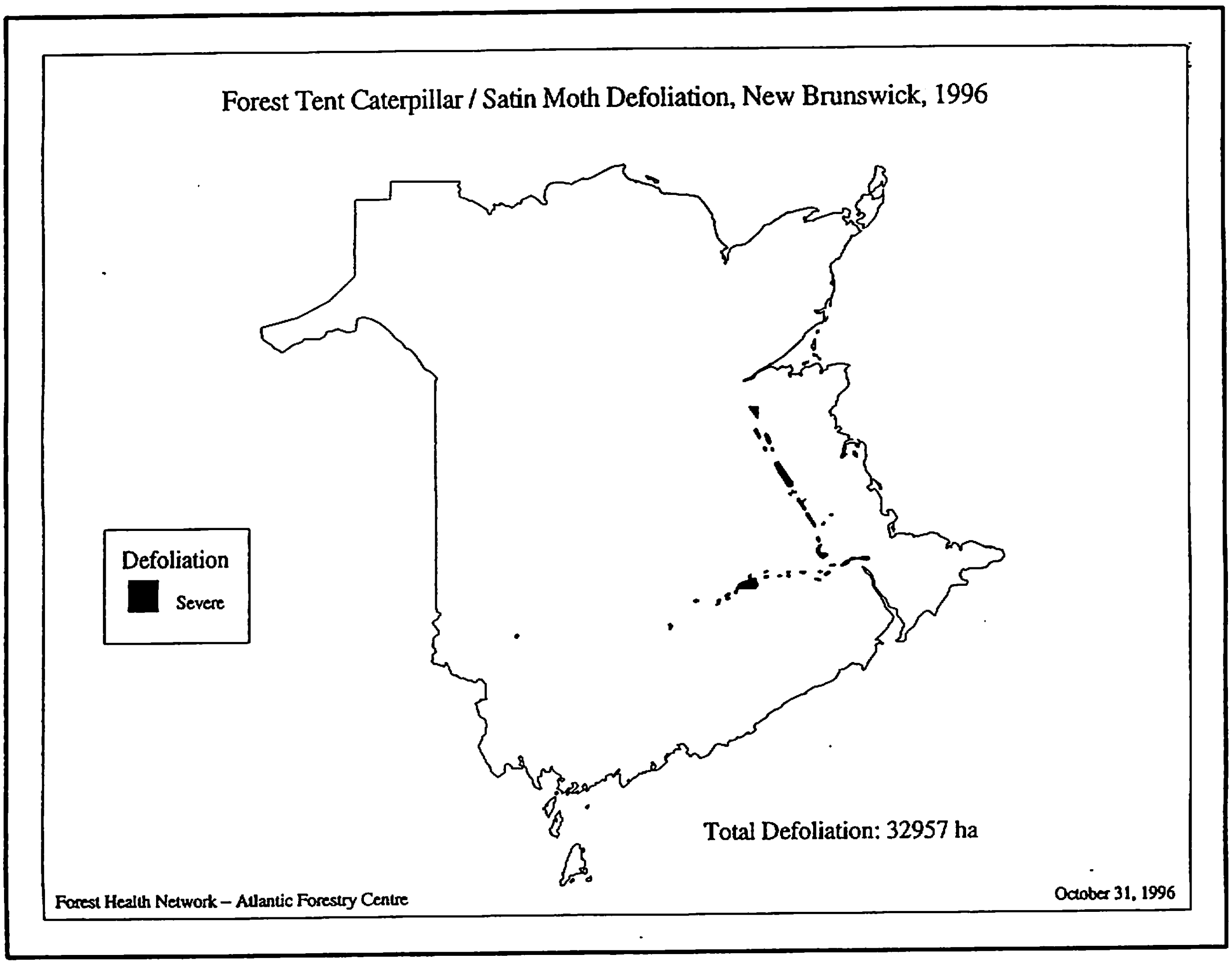

Figure 1. Defoliation caused by forest tent caterpillar and satin moth in New Brunswick in 1996 (Source: Canadian Forest Service-Atlantic).

GYPSY MOTH (*Lymantria dispar* (L.)): In 1996, only a subset of previously detected positive locations were sampled so that greater emphasis could be placed on conducting searches in the leading edge surrounding these locations with higher sampling intensities in areas with higher pheromone trap catches. A total of 458 locations (DNRE - 452; AAFC - 3; CFS-Atlantic - 3) were surveyed for the presence of gypsy moth egg masses or life stages other than male moths (eg. larval or pupal skins). New egg masses were found at 55 locations and evidence of other life stages were found at another 22 locations for a total of 77 positive sites. Of this total, 71 were previously known to be positive, and 6 were new locations. Of these 6, 4 locations had new egg masses and 2 had other life stages. The new sites are as follows: 2 at Indian Lake West (Sheffield Parish); north of Coles Island (Johnston Parish); Lower Gagetown (Gagetown Parish); north of Morrisdale (Westfield Parish); and south of Henderson Settlement (Springfield Parish). These represent relatively minor extensions to the generally infested zones in New Brunswick, with only the one location north of Morrisdale occurring within a Parish not already in the Quarantine zones regulated by AAFC.

Despite the apparently high overwintering survival noted from studies done in the spring, survivorship during the summer of 1996 appeared to be very low. A general decline in the number of new egg masses found in a majority of sites was noted. This was confirmed by a comparison of the percent difference in the number of new egg masses found per person-hour of searching at 80 locations sampled in the fall of 1995 and 1996. Reductions were noted at 75% of these locations; no change at 11%; and increases were seen in only 14%. Of particular interest were 23 locations with new egg masses in the fall of 1995 but no new egg masses in the fall of 1996. This decreasing trend was also evident in egg mass searching results conducted for two untreated sites which were intensively searched for egg masses in the spring and fall of 1996. At these sites there was a 98% decrease in the number of new egg masses due to cumulative natural (unquantified) causes. Although sampling noted high levels of late instar larval parasitism, it did not appear to be higher than parasitism levels seen in previous years. Furthermore, levels of nuclear polyhedrosis virus (npv) were virtually non-extistant, and there was no evidence of the fungus *Entomophaga maimaiga* in any of the sites sampled.

DISEASES OF HARDWOODS

The Canadian Forest Service continued low-level monitoring of Butternut canker. Results currently indicate there is no need for a change in status of this fungal pest (ie. to date it still has not been detected in the Province).

THE GYPSY MOTH IN NEW BRUNSWICK: FOLLOW-UP TO ACTIVITIES IN 1995 AND CURRENT STATUS

(Prepared for the Forest Pest Management Forum, held in Ottawa, Nov.18-22,1996)

GYPSY MOTH (*Lymantria dispar* L.): Actions pertaining to the Gypsy Moth in New Brunswick in 1996 consisted of: i) examination of overwinter survival of egg masses at several locations; ii) follow-up monitoring at three sites where small-scale ground release of nuclearpolyhedrosis virus (npv) was done in 1995; and iii) pheromone trapping and egg mass surveys to examine changes in the distribution of the insect in the Province. In addition, meetings were held with officials of Agriculture and Agri-Food Canada regarding their establishment of Quarantine Zones and Domestic Movement Regulations.

Overwinter Survival: This was the fourth year that DNRE conducted a study of the overwinter survival of Gypsy Moth egg masses (Table 1). Whereas a decrease in size might indicate declining populations, only minor differences were noted in egg mass size between years thus indicating that the general health of the populations has not changed appreciably in these areas during the period. Nonetheless there was a marked increase in survivorship both in percent (90.4%) of egg masses having at least one egg hatch and the absolute percent (70.1%) of eggs that hatched (Table 1). Despite the lack of insulation, due to a poor snow cover last winter, there was very high survival even from egg masses that were collected from heights above the normal snowline. Apparently, they were not subjected to lethal winter temperatures.

Table 1. Comparison of mean gypsy moth egg mass size and over wintering survival at selected sites in New Brunswick from 1993 to 1996.

	Year			
Category:	1993	1994	1995	1996
% of egg masses with hatch	39.7%	42.7%	47.7%	90.4%
% of eggs hatched from egg masses with hatch	16.8%	66.6%	83.4%	77.5%
% of eggs hatched from all egg masses	7.8%	28.5%	31.8%	70.1%
avg. no. eggs/egg mass	502	501	513	528
avg. egg mass length (cm)	3.4	3.0	3.4	3.2
avg. egg mass width (cm)	1.8	1.8	2.0	1.6
avg. egg mass area (sq cm)	6.1	5.4	7.0	5.4

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Of interest this year, was one astonishing egg mass that successfully produced an astounding 1819 larvae (97% hatch)! It measured 7.4 cm x 2.0 cm but had no visible signs of being a composite of two separate egg masses. There were another 56 eggs (half of which appeared normal and the other half had collapsed) that failed to hatch for an overall total of 1875 eggs. This is the largest egg mass ever encountered in any of our studies.

Also of interest, this year was the first that DNRE has observed any egg parasites. A total of 14 parasites were obtained from 4 separate egg masses that had been collected (May 8/96) in Charlotte County (Mosher Road). Two egg masses each produced 4 parasites and two others each produced 3 parasites. All are chalcids of the subfamily Eupelminae which were sent to the National Identification Section of Agriculture and Agri-Food Canada (AAFC) in Ottawa for identification. Recent communications from them confirm the specimens are male and female adults of *Anastatus japonicus* Ashmead, formerly known as *A. disparis* Ruschka. Interestingly, 5800 specimens of this species were released (Magasi, 1983. CFS-MFRC, Inf. Rept. M-X-149) in New Brunswick in 1983 <5 km west of where the current specimens were collected. This is the first report of it since then. The only other report of gypsy moth egg parasitism in New Brunswick was in 1994 when *Ooencyrtus kuvanae* (How.) was reported from an egg mass collected in Fredericton (Smith and Harrison, 1995. CFS-MR, Inf. Rept. M-X-194E).

NPV Monitoring: At the three sites treated last year, populations had been significantly reduced (though not eradicated) due to the combined actions of: virus release, natural factors, and a fall egg mass collection and destruction program (the latter was done as a commitment to the land owners who had given permission for the npv release trial). To follow the persistence or overwintering of the npv, egg masses were collected in the fall of 1995 and spring of 1996. Each egg mass was kept separate from collection throughout all subsequent handling. The egg masses were allowed to hatch at room temperature in the spring. A subset of 400 larvae were individually reared on Bell diet until death or sacrificed at third instar. The presence of npv was determined by microscopic diagnosis and genetic probing.

A total of 300 larvae (reared from fall egg mass collections) and 100 larvae (from spring collections) were examined. Those larvae which were diagnosed by genetic probe were done through the courtesy of Dr. Nick Payne and Mr. Peter Ebling of the CFS in Sault Ste. Marie.

For the pooled data, the apparent npv infection rate in all larvae reared from spring-collected egg masses was 19% (Table 2). This compared favourably with 12% obtained from all larvae reared from fall-collected egg masses. These limited data show an apparent carryover of npv sufficient to cause a low-level infection of some of the population one year after treatment. Not surprisingly, differences between apparent carryover rates were not consistent between sites. At site 1, it was 37% spring cf 4% fall; at site 2, it was 3% spring cf 4% fall; and at site 3, it was 18% spring cf 29% fall.

An effort was also made to determine the infection rate of larvae collected in the field during the normal development of the insect on these sites. Due to the scarcity of larvae, it was decided to make a single collection of late instar larvae when, based on experience in 1995, infection rate would be greatest. Fifty larvae were individually collected from each site and each was diagnosed for npv by microscopic examination or genetic probe (Table 3). Only 2 larvae (from site 1) were determined to have npv infection by microscopic diagnosis, and none was detected by genetic probe. Therefore, despite the potential carryover, indicated from the studies on larvae collected from egg masses described above, there did not appear to be enough inoculum to cause elevated infection in the residual low populations that were on these sites. It would have been interesting had there been higher residual populations to monitor, but as noted above, the egg masses were removed as a prior commitment to the landowners.

Table 2. Apparent carryover, or between generation, infection of gypsy moth larvae with npv at three sites where npv had been directly applied to egg masses in the spring of 1995.

Site Number	Egg Mass Collection Date	Total Number Larvae	Larvae with NPV			Larvae Without NPV
			Micro-scopic	DNA Probe	Total	
1	Fall '95	100	3 (3%)	1 (1%)	4 (4%)	96 (96%)
	Spring'96	32	11 (34%)	1 (3%)	12 (37%)	20 (63%)
	Total	132	14 (11%)	2 (2%)	16 (12%)	116 (88%)
2	Fall '95	100	3 (3%)	1 (1%)	4 (4%)	96 (96%)
	Spring'96	34	1 (3%)	0 (0%)	1 (3%)	33 (97%)
	Total	134	4 (3%)	1 (1%)	5 (4%)	129 (96%)
3	Fall '95	100	29 (29%)	0 (0%)	29 (29%)	71 (71%)
	Spring'96	34	5 (15%)	1 (3%)	6 (18%)	28 (82%)
	Total	134	34 (25%)	1 (1%)	35 (26%)	99 (74%)
POOLED	**Fall '95**	**300**	**35 (12%)**	**2 (1%)**	**37 (12%)**	**263 (88%)**
	Spring'96	**100**	**17 (17%)**	**2 (2%)**	**19 (19%)**	**81 (81%)**
	Total	**400**	**52 (13%)**	**4 (1%)**	**56 (14%)**	**344 (86%)**

Table 3. Virus infection in field-collected larvae from sites treated in 1995. Collections were made in July 1996 during expected peak period of larval mortality due to npv infection.

Site Number	Total Larvae	Larvae with NPV		Larvae without NPV
		Microscopic Diagnostics	DNA Probe	
1	50	2 (4%)	0 (0%)	48 (96%)
2	50	0 (0%)	0 (0%)	50 (100%)
3	50	0 (0%)	0 (0%)	50 (100%)
Pooled	**150**	**2 (1%)**	**0 (0%)**	**148 (99%)**

For comparative purposes, two untreated sites were also monitored to examine normal npv infection rates (Table 4). There were 400 and 344 larvae collected at each site, respectively. At the former site one larva was diagnosed microscopically as npv infected and one was found to be positive by genetic probe. None was positive at the other site. These results, along with field observations throughout the summer, indicate that npv, though present, does not appear at this time to be a major active natural control factor in the populations that are gradually becoming more established and expanding their range in New Brunswick.

Table 4. Virus infection in field-collected larvae from two untreated sites in the summer of 1996 in southcentral New Brunswick.

Site Number	Total Larvae	Larvae with NPV: Microscopic Diagnosis	Larvae with NPV: DNA Probe	Larvae without NPV
1	400	1 (<1%)	1 (<1%)	398 (>99%)
2	344	0 (0%)	0 (0%)	344 (100%)
Pooled	**744**	**1 (<1%)**	**1 (<1%)**	**742 (>99%)**

There were no symptoms of the fungal pathogen, *Entomophaga maimaiga*, either this year in any of the areas examined. This pathogen was recorded in southwestern New Brunswick in 1993, but has not been encountered since. There has not been a rigorous survey, however, to determine its range within southwestern or other parts of New Brunswick where gypsy moth has been found. Limited observations of the occurrence of parasites in the few study sites did not suggest any significant increase above levels encountered over the past few years.

Monitoring Surveys: To date there has not been any consistent relationship between the numbers of male moths caught in pheromone traps and the subsequent success of finding egg masses or other life stages in New Brunswick. In past years, this was attributed to prevailing winds bringing moths into the Province from the eastern United States. More recently, the gradual establishment of local populations have undoubtedly contributed to the redistribution of "home-grown" moths to areas in the proximity of populations as well as to areas some distance away. Consequently, the results and usefullness of pheromone trapping for this purpose must be viewed with caution. Nonetheless, three levels of trapping were implemented in 1996, viz.: i) Intensive Trapping; ii) Early Detection Survey; and iii) a Leading Edge Survey.

The intensive trapping was done by DNRE as the final commitment to the landowners referred to above. Other traps were placed out by DNRE (Forest Pest Management, Regional and Parks staff) and cooperating agencies (ie. mainly Agriculture and Agri-Food Canada, Canadian Forest Service, the City of Fredericton and some private cooperators), who gratefully provided their information to DNRE for overall compilation.

i) INTENSIVE TRAPPING: A total of 150 multipher non-saturating traps baited with gypsy moth pheromone lures were placed at the three sites treated with npv in 1995 (see above for other activities in these areas). Traps were placed at a density of 25/ha prior to first male moth emergence, in an effort to reduce mating. A total of 3470 male moths were caught (Table 5). Although an exhaustive search was not done, egg masses were detected in the fall indicating a surviving population within the area.

Table 5. Summary of catches of male gypsy moth adults in pheromone traps placed out for various purposes in 1996 in New Brunswick. (Information provided to DNRE courtesy of the agencies noted).

Survey Type	Agency	Trap Type	No. of traps placed out	No. of traps not found	Trap Catch Classes (Number of male moths)						Total male moths	Avg. male moths /trap
					0	1-5	6-10	11-20	21-30	>30		
Intensive Trapping	DNRE	Multipher	150	0 (0%)	0 (0%)	14 (9%)	25 (17%)	52 (35%)	21 (4%)	38 (25%)	3470	23.1
Early Detection	DNRE	Delta	118	11 (9%)	76 (64%)	24 (21%)	3 (2.5%)	1 (%)	3 (2.5%)	0 (0%)	165	1.5
	AAFC	Delta	33	3 (9%)	22 (66%)	3 (9%)	2 (6%)	2 (6%)	1 (4%)	0 (0%)	77	2.4
	CFS	Delta	41	1 (2%)	36 (88%)	4 (10%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4	0.1
City of F'ton	FTON	Delta	269	23 (8%)	120 (45%)	96 (36%)	22 (8%)	8 (3%)	0 (0%)	0 (0%)	471	1.9
Leading Edge	DNRE	Delta	375	6 (1.5%)	38 (10%)	170 (46%)	65 (17.5%)	43 (11%)	40 (10.5%)	13 (3.5%)	2967	8.0
	AAFC	Delta	117	6 (5%)	63 (54%)	47 (40%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	90	0.7

ii) EARLY DETECTION SURVEY: This survey was conducted predominately in northern and southeastern New Brunswick where to-date there have been no positive finds of any life stages of gypsy moth other than male moths in previous trapping surveys. Trapping was also conducted in Provincial Parks, some of which were known to have gypsy moth life stages present. A total of 118 baited delta traps (three interior sides sticky) were placed out by DNRE. Agriculture and Agri-Food Canada placed an additional 33 traps at nurseries and mills in southern New Brunswick; and CFS-Atlantic placed 25 traps at Fundy and 16 traps (1 lost) at Kouchibouquac National Parks. Overall, the results of these trapping efforts (Table 5) indicate that at present northern and southeastern portions of the Province appear to be free of this pest (Figure 1).

A total of 269 baited delta traps were distributed throughout the City of Fredericton with trap densities higher in those areas of the City where gypsy moth life stages other than male moths had previously been found. A total of 471 male moths were caught with trap catches ranging from 0 to 16 moths/trap, averaging 1.9 moths/trap (Table 5). Overall, trap catches are down compared to trap catches noted from previous years.

EARLY DETECTION SURVEY

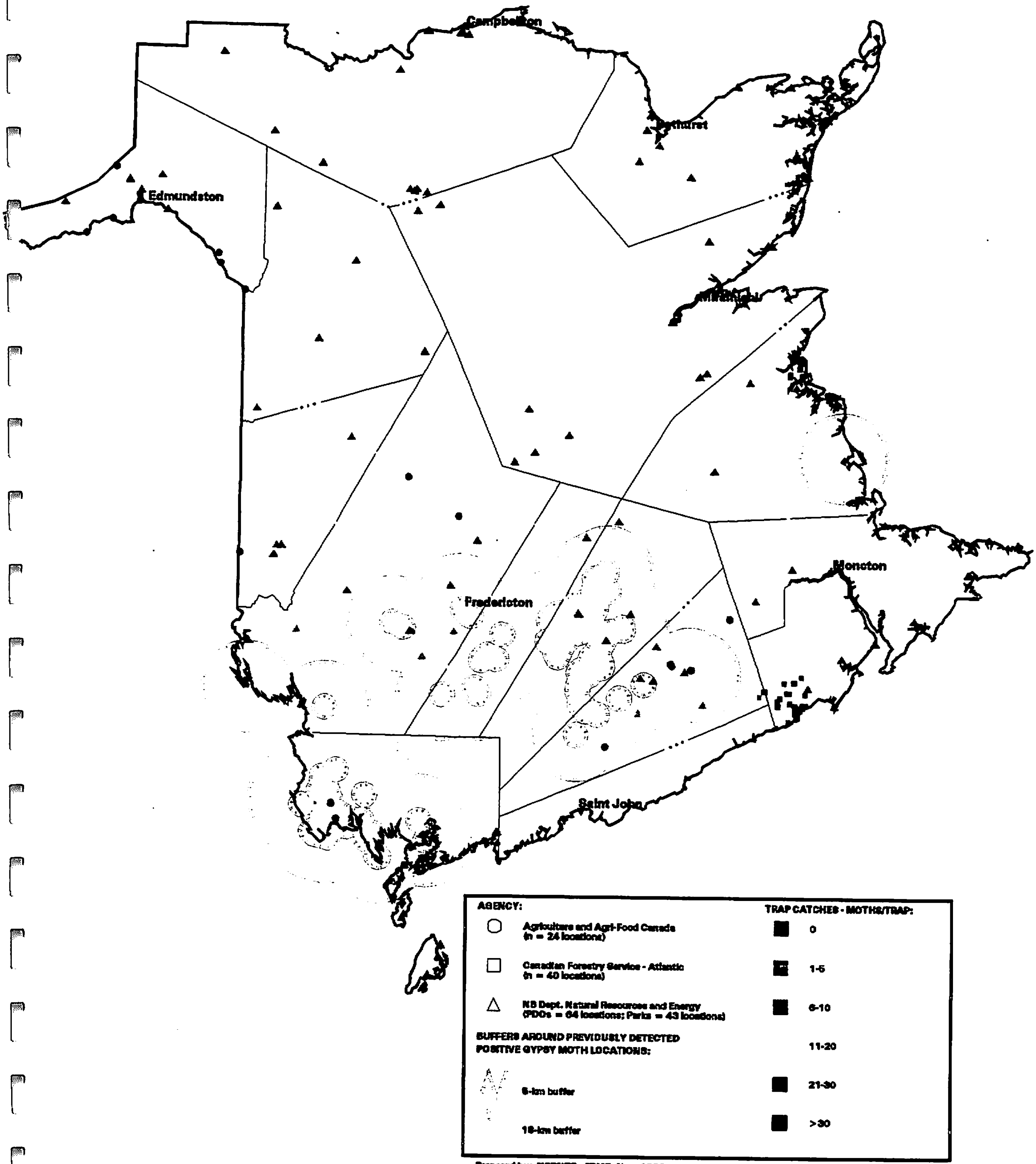

Figure 1. Location of gypsy moth pheromone traps placed out for an Early Detection Survey in New Brunswick in 1996.

iii) LEADING EDGE SURVEY: This survey was conducted by placing out pheromone traps along roads radiating away from sites previously known to have gypsy moth life stages present. The intent was to use traps with high catch numbers as an aid in where to prioritize and concentrate searching for other life stages which, by their presence, would confirm a local population at that site. A total of 375 traps were placed out by DNRE at approximately 3-km spacing along selected roads out to 18-km away from locations known to have egg masses. In addition, 117 traps were placed by Agriculture and Agri-Food Canada outside the 18-km zone.

For the most part, results were generally as expected with very few traps being negative (10%) (Table 5), and in most cases a general decline in catches as the traps got farther away from the infested sites (Figure 2). A total of 2967 moths were caught for an average of 8.0 moths/trap. Whereas catches up to 20 moths/trap have not been uncommon in the past, it was decided to focus most of the egg mass searching at those locations having catches of 21-30 moths/trap and >30 moths/trap. This effort led to the confirmation of only three new positive sites.

FALL EGG MASS FORECAST SURVEY: A total of 458 locations were surveyed for the presence of gypsy moth egg masses or any signs of life stages other than male moths (eg. larval or pupal skins). New egg masses were found at 55 locations and other evidence of life stages were found at another 22 locations for a total of 77 positive sites. Of these, 71 were previously known to be positive, and 6 were new locations. Four of the latter had new egg masses and two had other life stages. The new sites are as follows: 2 at Indian Lake West; north of Coles Island; Lower Gagetown; north of Morrisdale; and south of Henderson Settlement. These represent relatively minor extensions to the generally infested zones in New Brunswick (Figure 3). Only the one location north of Morrisdale occurred within a Parish (Westfield) not already in the Quarantine zones regulated by AAFC.

Despite the apparently high overwintering survival noted from studies done in the spring, survivorship during the summer of 1996 appeared to be very low. A general decline in the number of new egg masses found in a majority of sites was noted. This was confirmed by a comparison of the percent difference in the number of new egg masses found per person-hour of searching at 80 locations sampled in the fall of 1995 and 1996. Reductions were noted at 75% of these locations; no change at 11%; and increases were seen in only 14%. Of particular interest were 23 locations with new egg masses in the fall of 1995 but no new egg masses in the fall of 1996. This decreasing trend was also evident in egg mass searching results conducted for two untreated sites which were intensively searched for egg masses in the spring and fall of 1996 (Table 5). At these sites there was a 98% decrease in the number of new egg masses due to cumulative natural (unquantified) causes. Although sampling noted high levels of late instar larval parasitism, it did not appear to be higher than parasitism levels seen in previous years. Furthermore, levels of nuclear polyhedrosis virus (npv) were virtually non-extistant, and there was no evidence of the fungus *Entomophaga maimaiga* in any of the sites sampled.

LEADING EDGE SURVEY

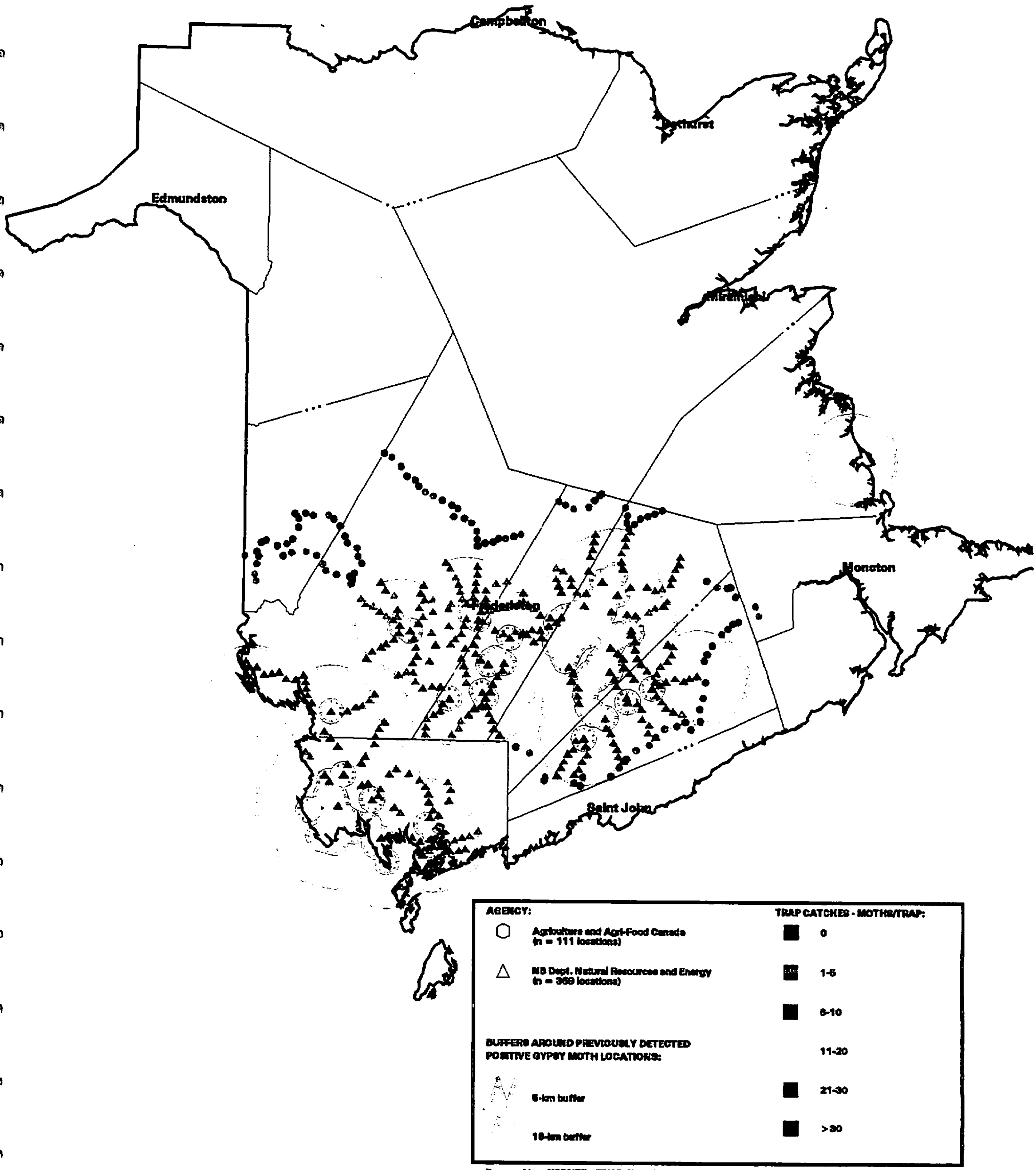

Figure 2. Location of gypsy moth pheromone traps placed out for a Leading Edge Survey in New Brunswick in 1996.

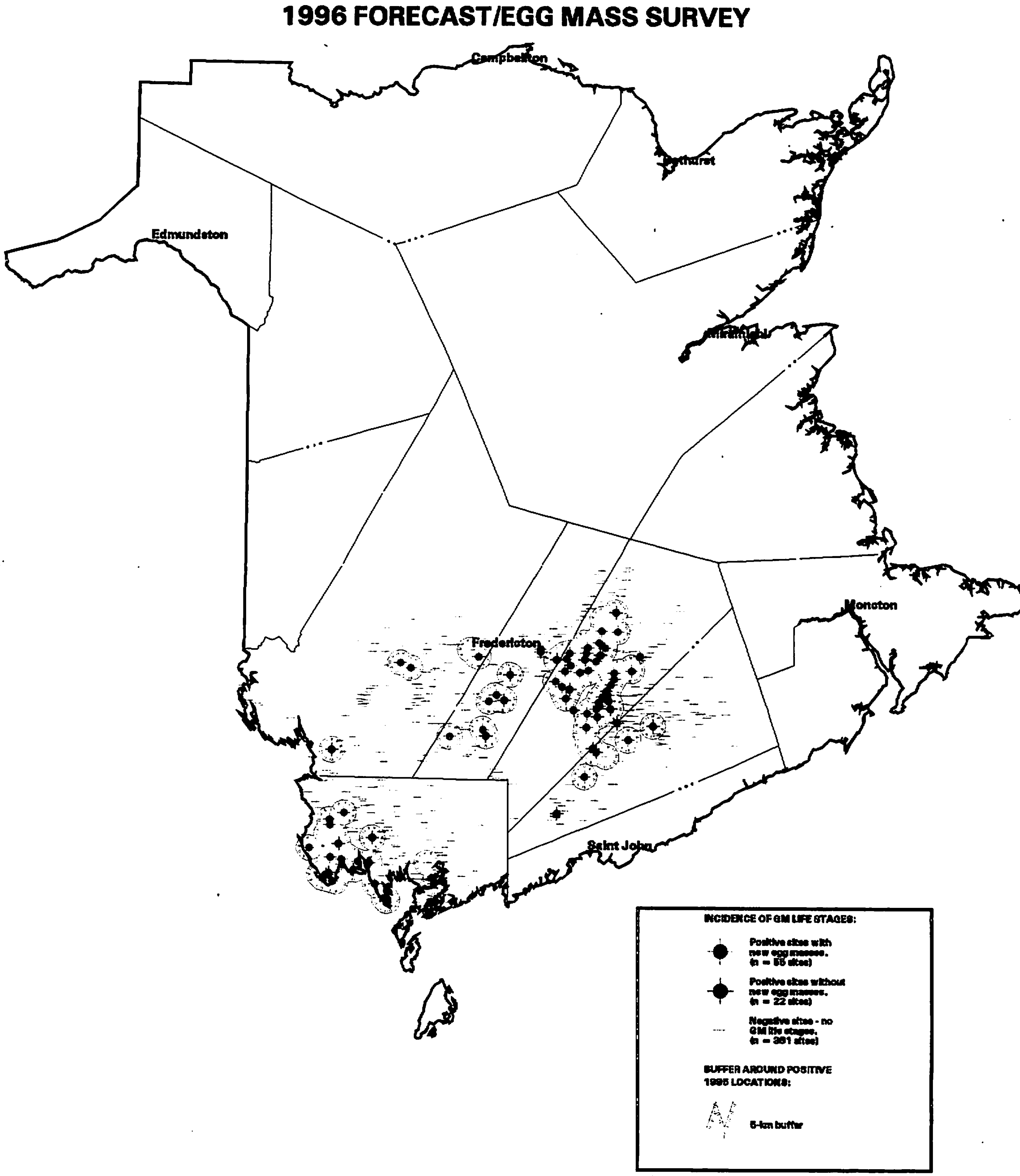

Figure 3. Locations sampled in the fall of 1996 for gypsy moth egg masses or life stages other than male moths.

With the exception of one location (Sunpoke Lake) where 300 egg masses were found, the number of new egg masses in known positive locations appear to be lower than last year. This is consistent with the results from two untreated sites (referred to above) which were intensively searched in both the spring and fall of 1996. At both sites there was an apparent 98% decrease in populations due to cumulative natural (unquantified) causes (Table 6). Although sampling had revealed high levels of late instar larval parasitism, it did not seem to be higher than in previous years. Furthermore, levels of virus were virtually non-extistant, and there were no signs of the fungus *Entomophaga maimaiga*.

Table 6. Changes in gypsy moth egg mass density at two sites sampled in the spring[1] and fall of 1996.

Site Number	Spring 1996	Fall 1996	Percent Change
	New Egg Masses In Fall 1995	New Egg Masses In Fall 1996	
1	1690	28	-98.3
2	529	10	-98.1
Total	**2219**	**38**	**-98.3**

[1] count of egg masses (new in Fall 1995) conducted in the spring of 1996 after egg hatch.

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Development of an Alternative Pest Management Programme for the Yellowheaded Spruce Sawfly (*Pikonema alaskensis* (Roh.))

(Prepared for the Forest Pest Management Forum, held in Ottawa, Nov.18-22,1996)

INTRODUCTION

During the past several years in southeastern New Brunswick, there has been in increase in the presence of the yellowheaded spruce sawfly (*Pikonema alaskensis* (Roh.)) in black spruce plantations in the vicinity of Fundy National Park. Similar population increases have also been reported in Quebec and Maine. As the situation changed dramatically in New Brunswick between 1994 and 1995 (approximately 4-fold increase in number of plantations affected), the need and opportunity arose to investigate various alternative controls in the event the situation continued to worsen and an operational control program became necessary in the future. Specifically, there was a desire to look for alternatives to the chemical insecticide fenitrothion which, despite its regulatory acceptability for use, is still considered by many to be environmentally undesirable. Furthermore, there are no biological control products registered for use against this insect and the most commonly-known biological insecticide, *Bacillus thuringiensis* (B.t.), is ineffective against sawflies.

Plans for the 1996 project were based on: biological and survey information collected in 1995 and a few ground application trials also done that year; discussion with partners in the Fundy Model Forest; and an overview of the status of pesticides currently registered for use against "sawflies". As a result, the products initially chosen were: Pheromone, Egg Parasite, Nematodes, NEEM, Malathion, and Trichlorfon. During the season, one of the industrial landowners in the area, J.D.Irving Limited, obtained a permit to apply another insecticide (Acephate) to one of their heavily-infested plantations thus providing an opportunity to add another treatment for overall comparison. Because of the different alternatives which were selected and the ultimate sources of funding to meet requirements, the project became a funding and implementation partnership between various agencies. Collaborators for the implementation of the project were:

N.B. Department of Natural Resources and Energy
Natural Resources Canada (CFS-Fredericton & Sault Ste. Marie)
Forest Protection Limited
N.B. Research and Productivity Council
J.D. Irving Limited
University of Toronto

Presented by: N. Carter
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Major funding for the project was provided by:

N.B. Department of Natural Resources and Energy
Canada Dept. Natural Resources (Canadian Forest Service)
Forest Protection Limited
Fundy Model Forest
Ontario Ministry of Natural Resources
Societe de Protection des Forets Contre les Insects et Maladies (SOPFIM)
3-M Canada Inc.

In addition, quantities of product were donated by:

NEEM - W.R. Grace & Co.
Malathion - Cheminova
Trichlorfon - Bayer Inc.

TREATMENTS

Because this sawfly overwinters in the soil, areas to be treated were selected from plantations known to be infested in the fall of 1995. Also considered were accessibility, plantation age and tree size, as well as the status of sawfly damage in them. Although many alternative treatments were contemplated, those finally chosen were largely dictated by product availability, notably for all except Trichlorfon and Malathion, and the need to acquire appropriate federal and provincial research permits (specifying buffer zones and other conditions). Considering that the intent was to apply the treatments by helicopter, these factors combined to limit the size and number of replicates which could be done. Ultimately, all were done by helicopter except the egg parasite release which became a direct placement of parasites on individual trees.

In keeping with the collaborative nature of the overall project, several agencies took the lead in conducting and assessing different treatments. The N.B. Research and Productivity Council was responsible for the Pheromone treatment. The CFS-Fredericton was responsible for the Nematodes, NEEM and natural biocontrols. The N.B. Department of Natural Resources and Energy was responsible for the Egg Parasite (in collaboration with CFS-Sault Ste. Marie and University of Toronto), Trichlorfon, Malathion, and Acephate.

For various reasons, notably receipt of insufficient product (ie. NEEM), lower-than-expected populations in some plots, and inclement weather at application time, some last minute changes had to be made resulting in the deletion of several areas and/or application rates. Thus, final treatments applied were (Table 1):

Table 1. Summary of alternative treatments applied for experimental control of Yellowheaded Spruce Sawfly *in* New Brunswick in 1996.

TREATMENT	BLOCK	AREA (ha)	RATE*
Pheromone	11	5	100gai/39L/ha
Egg Parasite	F	6 trees 6 trees 5 trees	$5x10^5$ *T.m.* $10x10^6$ *T.m.* $5x10^5$ *T.m.*
	I-6	8 trees 8 trees	$5x10^5$ *T.m.* $5x10^5$ *T.p.*
Nematodes	6	10	$2x10^9$n/62.5L/ha
NEEM	I-3	11	25gai/ 6L/ha
	9	15	50gai/12L/ha
	I-1	14	100gai/24L/ha
Trichlorfon	D	17	250gai/ 6L/ha
	B	10	500gai/12L/ha
	E	3	750gai/18L/ha
	4	13	1000gai/24L/ha
Malathion	2	16	125gai/ 6L/ha
Acephate	I-6	5	650gai/24L/ha

* gai = grams of active ingredient; *T.m.* = *Trichogramma minutum*; *T.p.* = *T. platneri*.
n = nematodes.

Following are status reports on two segments of these cooperative efforts, viz.:

Assessment of Two *Trichogramma* spp. on Egg Parasitism of the Yellowheaded spruce sawfly.

Assessment of Trichlorfon, Malathion and Acephate for the Control of Yellowheaded Spruce Sawfly.

Results of other activities will be presented elsewhere.

Assessment of Two *Trichogramma* spp. on Egg Parasitism of the Yellowheaded Spruce Sawfly

(by L. Hartling[1] and R. Bourchier[2])

Objectives

The primary objective of this project was to evaluate innundative releases of two species of the egg parasitoid *Trichogramma* (ie. *T. minutum* and *T. platneri*) against yellowheaded spruce sawfly (*Pikonema alaskensis* (Roh.)).

The secondary objective was to assess natural egg parasitism existing in the field and, if possible, to collect any parasitized sawfly eggs to start a yellowheaded spruce sawfly specific line of *Trichogramma* for potential use in future releases.

Other objectives, done by DNRE outside the framework of the collaborative project, were: to look for parasitoid drift and parasitism of sawfly eggs on trees surrounding designated point-release trees; and assess parasitism of sawfly eggs by *T. minutum* in a laboratory setting.

Site Selection/Release Rates

Two black spruce plantations in the Fundy Model Forest in southeastern New Brunswick were selected for the *Trichogramma* releases. Both plantations were established in 1989, and the trees are currently 1.5 to 2.5 metres tall. Population densities of yellowheaded spruce sawfly varied significantly at the two sites. Estimates of pre-release sawfly populations in Plantation F averaged 20 adults/person-hour of searching, and 6 eggs/100 shoots compared to 102 adults/person-hour of searching, and 90 eggs/100 shoots in Plantation I-6.

Individual trees within the sawfly-infested portion of each plantation were selected for point releases. In Plantation F, 23 trees (minimum 45-metres apart) were randomized into treatments of: 50 000 *T. minutum* females/tree (n=6 trees); 100 000 *T. minutum* females/tree (n=6 trees); 50 000 *T. platneri* females/tree (n=5 trees); and controls (n=6 trees). In Plantation I-6, 24 marked trees (minimum 50-metres apart) were blocked into two groupings (100-m apart) of 4 trees each, for treatments consisting of: 50 000 *T. minutum* females/tree (n=8 trees); 50 000 *T. platneri* females/tree (n=8 trees); and controls (n=8 trees).

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Timing of Releases

Timing the parasite releases to coincide with the presence of host sawfly eggs was determined from on-site monitoring of adult sawfly emergence/activity, ratio of females:males, and egg laying. Monitoring was based on labour-intensive visual observations on individual trees, as well as using pheromone traps and ground adult-emergence traps. Early predictions of adult emergence and anticipated egg deposition were made using baseline degree day relationships developed in 1995 and applying these to current-year degree day accumulations based on several regional, and one near-by temporary, weather stations. Predictions were also made using a sophisticated computer model (BioSIM), and early detection of sawfly emergence at other more phenologically-advanced sites.

The activity pattern of the parasitoids was determined by attaching groups of sentinel flour moth eggs to the release trees and replacing them every two days over a two-week period. To determine the emergence pattern of each parasitoid species, vials of *Trichogramma*-parasitized flour moth eggs were placed in the field and retrieved at regular intervals. This material has yet to be processed.

RESULTS

Innundative Releases: Actual efficacy of the innundative releases was determined by assessing parasitism of sawfly eggs found on shoots collected from each release tree. In Plantation F, eggs on a minimum of 5 750 shoots were examined from those collected 10 days after the release. In Plantation I-6, eggs on a minimum of 4 800 shoots were examined by collecting shoots 7 and 13 days after the release. Although complete analyses of weather and release protocols are yet to be completed, **preliminary information suggests that the release, while appearing to be a technical success, was not encouraging,** as only one parasitized egg was found on any of the 33 release trees. In addition, 3 parasitized sawfly eggs were recovered from a tree adjacent to a *T. platneri* release tree. As well, a single egg suspected to be parasitized was found on a tree near a *T. minutum* release tree. **More details will be reported at a later date.**

Natural Parasitism: Natural parasitism was almost undetectable within the numerous searches of trees in black spruce plantations near the Fundy coast, and in the white and black spruce provincial seed orchards near Fredericton, as well as on ornamental black and white spruce trees on the grounds of the Hugh John Flemming Forestry Centre in Fredericton where some parasitized eggs were collected in 1995. **Of the thousands of sawfly-infested shoots examined, only two eggs were found to be parasitized.** A single parasitized egg was found in each of two black spruce plantations near the Fundy coast. A single *Trichogramma* (species yet to be determined) emerged from one of these eggs. Of interest, and possibly only coincidently, the parasitized egg was found 80 metres from the site where *T. platneri* was released in 1995.

Lab Tests: A total of 42 sawfly eggs were exposed to *T. minutum* in a laboratory setting, but none became parasitized. Sawfly embryo development was observed to be quite advanced at the time, though it is unknown if that made the eggs unsuitable as hosts.

Assessment of Trichlorfon, Malathion and Acephate for Control of the Yellowheaded Spruce Sawfly

(by N. Carter, W. Patterson and D. Lavigne)[1]

Objectives

The application of treatments was to achieve two objectives. First, to provide foliage protection for the promotion of tree growth on infested trees; and second, to reduce populations of yellowheaded spruce sawfly in the treated part of the plantations.

The original intent was to apply Trichlorfon and Malathion at three rates (ie. each at 250, 500, and 1000 gai/ha) in a dose response manner to compare between treatments; and also to determine whether lower rates would be sufficient , so future use, if required, could be at a level which would mitigate any adverse environmental effects there might be. Unfortunately, last minute changes (caused by rain and unanticipated need to use buffer zones for water) were necessary resulting in only one treatment rate for Malathion (ie. 125 gai/ha), and four rates for Trichlorfon (ie. 250, 500, 750, and 1000 gai/ha), as well as the opportunistic single application of Acephate (at 650 gai/ha) by J.D. Irving Limited. One Malathion block was cancelled due to low populations of sawfly larvae, revealed during pre-spray sampling.

Timing

To facilitate these objectives it was decided to apply treatments early in the development of the larvae when they were approaching/or were mostly in the second larval instar. Based on observations in 1995, it was expected that at that time the insects would be relatively easy to spot with the naked eye thereby facilitating counting them for population assessment. Also, at that time they would primarily still be on current-year shoots and no significant feeding damage would be evident.

Larval collections were randomly made several days apart within each plantation. Infested trees were located and various numbers of larvae collected, returned from the field, and assigned to appropriate instars using headcapsule measurements made using a microscope. The areas were treated when larvae were predominately in the second instar.

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Pre-spray Population Assessment

Because of the uneven distribution of this insect, both within and between trees, biased sampling was used to avoid the fruitless "assessment" of branches with no larvae. Thus, after monitoring adult emergence, egg deposition and larval emergence in all areas candidate trees and branches were marked for sampling.

Pre- and post-spray populations were assessed using a non-destructive sample of up to 100 trees (numbers varied due to the last minute changes that were made in treatment applications), on which one 20-cm branch tip/tree was marked for assessment. In the field, crews carefully tallied all the current-year shoots and larvae they saw on selected branch tips, using only a gentle rotation of the shoots to expose the larvae. It was noticed that at this stage of development the larvae held on tightly to the needles and were not easily dislodged. These same branch tips were also to be assessed for feeding damage at the end of the season, hence the reason for not removing them or the larvae (ie. non-destructive sampling).

Spray Equipment

All applications were made by a Bell Jet Ranger 206B helicopter equipped with boom and CP nozzles (.062@90° + 20° Boom Tilt). Relevant parameters are summarized in Table 1.

Table 1. Summary of operational spray parameters.

TREATMENT			EQUIPMENT SETTINGS			Track Spacing (metres)
PRODUCT	gai/ha	L/ha	Number of Nozzles	Flow Rate (L/min)	Boom Pressure (kPa)	
Trichlorfon	250	6	13	23.3	170	20
Trichlorfon	500	12	27	46.6	170	20
Trichlorfon	750	18	40	70.0	170	20
Trichlorfon	1000	24	52	93.0	170-210	20
Malathion	125	6	13	23.3	170	20
Acephate	650	24	52	93.0	170	20

Weather

On-site weather instrumentation was not set up to record rainfall nor other parameters (except for maximum and minumum temperature in Block B). The following information is from field notes of general weather in the vicinity of the treated areas.

July 7: Block 2 (16 ha; Malathion @ 125 gai/ha) and Block 4 (13 ha; Trichlorfon @ 1000 gai/ha) treated in the evening under calm, sunny conditions.

July 8: Morning showers; rained steady from noon to 5:00pm. Block B (10 ha; Trichlorfon @ 500 gai/ha), Block D (17 ha; Trichlorfon @ 250 gai/ha), and Block E (3 ha; Trichlorfon @ 750 gai/ha) treated in the evening.

July 9: Heavy rain in all areas in the morning.

July 10: Showers in the morning; clear rest of the day.

July 17: Generally sunny. Block I-6 (5 ha; Acephate @650 gai/ha) treated in the evening.

July 18,19: Sunny.

RESULTS

Larval Reduction

During the normal development of late-instar yellowheaded spruce sawfly larvae and their feeding, there is a characteristic re-distribution of larvae from current-year needles back to previous-years needles prior to dropping to the soil to pupate after feeding is complete. It was decided, therefore, that the measure of impact on larvae would be the change in numbers on treated versus non-treated branch tips approximately one-week after treatment. In essence, this was a proxy for larval mortality, since re-distribution of larvae on the shoots could account for numerical reductions in addition to mortality.

The initial step in analysis was the examination of pre-spray larval populations at the block level. This revealed differences in overall mean larval densities between treatments (Table 2). Because these differences in initial densities imply different potentials for feeding damage, the data were stratified into several larvae/shoot population ranges, to minimize these differences, for further analyses (Table 3). Ranges were arbitrarily chosen to have 30 or more samples in classes wherever possible (though not always attained especially in the higher populatioin classes). Also, the larvae/shoot basis was probably more reflective of population density, rather than larvae/branch, since the number or shoots on the 20-cm sample branches varied considerably.

The number of larvae in the untreated plots decreased by 26.6% on average during the interval between assessments (Table 2). In the area treated at the lowest dose of Trichlorfon (250 gai/ha), there was only a slightly higher reduction to 32.8%, indicating very little or no impact on larvae at this application rate. Applications of Trichlorfon at 500 and 750 gai/ha each resulted in approximately 75% reduction. Consequently, if that level of population reduction were deemed acceptable, the lower of these two rates could be considered. Despite being applied to the area with the highest population level, Trichlorfon at the highest application rate (1000 gai/ha) produced the greatest reduction in larval counts (97.6%). Because it approached 100%, this suggests 1000 gai/ha is probably the maximum rate that would need to be applied against the yellowheaded spruce sawfly.

Table 2. Summary of treatments, mean pre-spray larval populations of yellowheaded spruce sawfly, mean population reduction, and mean percent current defoliation in treated and untreated black spruce plantations in 1996 in New Brunswick.

Treatment*	Number of samples	Larvae per shoot	Larvae/ 20-cm branch	% Reduction in pop'n	% Current Defol'n
Mal. 125	98	0.368	6.4	51.8	21.8
Tri. 250	100	0.499	9.9	32.8	44.1
Tri. 500	100	0.403	8.6	76.2	9.4
Tri. 750	60	0.505	7.6	75.0	8.3
Tri.1000	100	0.876	14.8	97.6	8.7
Ace. 650	89	0.314	5.3	88.4	9.1
Control	150	0.390	6.0	26.6	32.6

* Mal.125 = Malathion @125gai/ha
Tri.250 = Trichlorfon @250gai/ha
Tri.500 = Trichlorfon @500gai/ha
Tri. 750 = Trichlorfon @750gai/ha
Tri.1000 = Trichlorfon @1000gai/ha
Ace. 650 = Acephate @650gai/ha

The single application of Malathion (125 gai/ha) at half the lowest dosage of Trichlorfon resulted in a greater population reduction (51.8%), suggesting greater toxicity of this material compared to Trichlorfon. By inference, the application rate of Malathion at a greater rate (possibly 250 to 500 gai/ha) would probably be sufficient to give good control of this insect, rather than using a rate as high as 1000 gai/ha, though this is speculation which could be verified in other tests.

The single application of Acephate at 650 gai/ha gave slightly lower, but somewhat similar, results to those of Trichlorfon at 1000 gai/ha, thus also suggesting 1000 gai/ha as a reasonable upper limit to apply Acephate to control yellowheaded spruce sawfly. Further testing could verify this and/or other acceptable rates.

Population reductions within each treatment were fairly consistent across the four arbitrary larvae/shoot classes that were chosen (Figure 1).

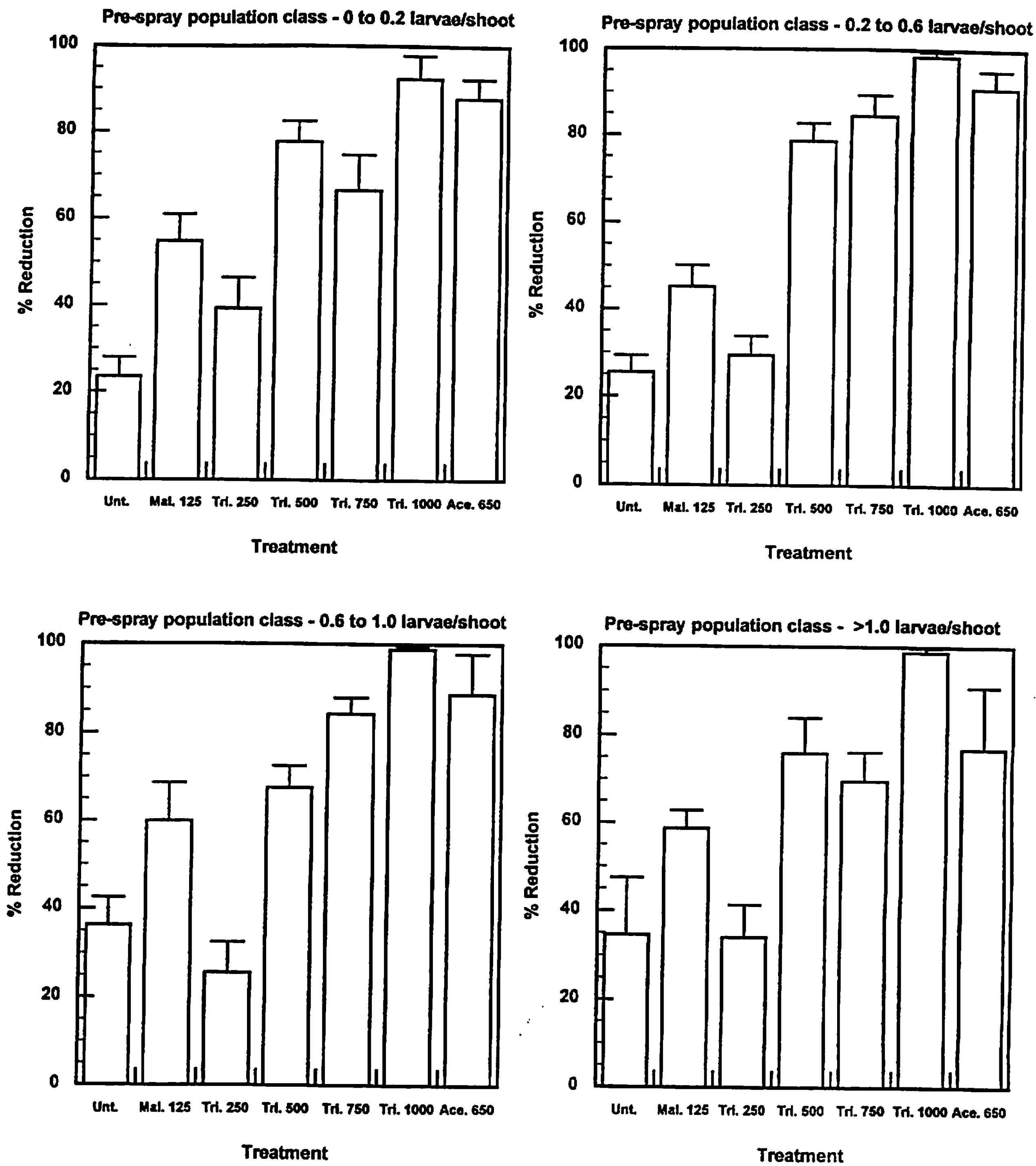

Figure 1. Mean percent reduction in populations of yellowheaded spruce sawfly for each treated and untreated plantation as a function of pre-spray larvae/shoot population class.

Foliage Protection

The benefits of treatment were also examined from the perspective of prevention of defoliation of current-year needles. Results at the block level are presented in Table 2, which as previously mentioned, limits comparisons because of differences in pre-spray larval populations between each block. To minimize these differences, the defoliation data were calculated for the same larval classes as before. Results are presented in Table 3 and Figure 2. The data were also subjected to curvilinear correlation analyses (Figure 3).

These data again demonstrate that there was no protection afforded by Trichlorfon at 250 gai/ha, consistent with the observation that there was virtually no impact on the larvae at this application rate. Mean defoliation in the plots treated with Malathion, at 125 gai/ha, was lower than in untreated plots, though differences were generally not significant thus suggesting a higher application rate would be required for foliage protection.

For the three other Trichlorfon application rates and the single Acephate rate, there was little difference in mean defoliation in the lower two population classes. As populations increased, however, defoliation in the plots treated with Trichlorfon at the highest rate (1000 gai/ha) tended to have lower mean defoliation, though statistical differences were not readily apparent due to low sample sizes in the higher population classes.

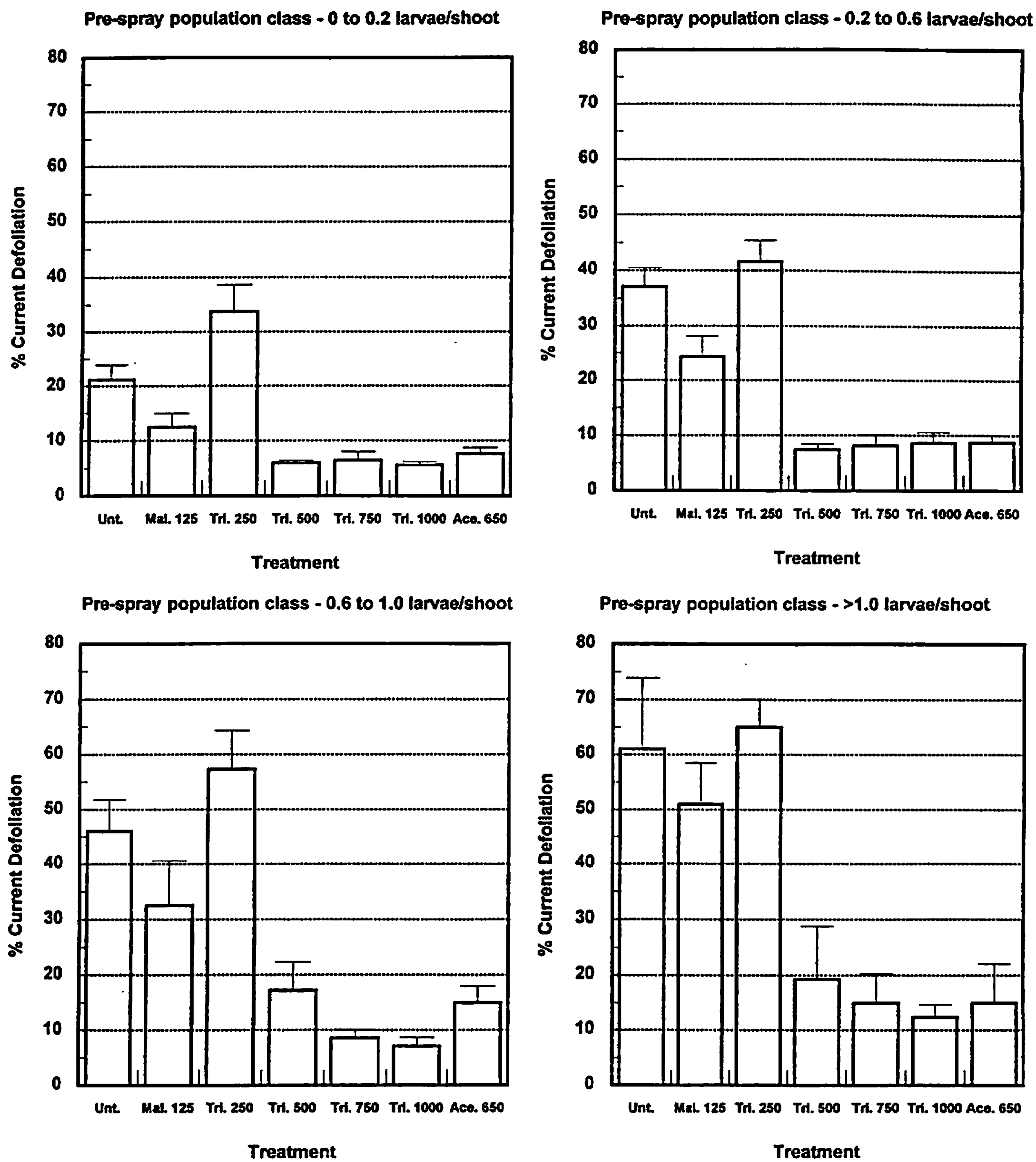

Figure 2. Mean percent current defoliation of black spruce for each treated and untreated plantation as a function of pre-spray larvae/shoot population class.

Table 3. Summary of mean percent reduction in numbers of yellowheaded spruce sawfly larvae and percent current defoliation for treated and untreated samples stratified by selected pre-spray larval ranges.

Pre-Spray Larvae/shoot (range)	Treatment[1]	Number of Samples	Larvae per shoot	Larvae per 20-cm	% Reduction in Population	% Current Defoliation
>0<0.2	M @ 125	41	0.099	2.7	54.8	12.5
	T @ 250	33	0.112	3.2	39.3	33.8
	T @ 500	41	0.104	3.3	77.8	6.0
	T @ 750	26	0.107	2.3	66.6	6.5
	T @1000	17	0.122	4.1	92.4	5.6
	A @ 650	48	0.100	2.3	87.8	7.7
	Control	62	0.107	1.9	23.5	21.2
>0.2<0.6	M @ 125	40	0.359	6.0	45.3	24.2
	T @ 250	41	0.366	9.4	29.5	41.6
	T @ 500	34	0.335	7.4	78.7	7.3
	T @ 750	16	0.357	7.2	84.5	8.1
	T @1000	28	0.423	9.6	98.4	8.6
	A @ 650	27	0.360	6.0	91.1	8.7
	Control	61	0.383	6.5	25.5	37.1
>0.6<1.0	M @ 125	12	0.833	12.8	60.0	32.5
	T @ 250	13	0.861	15.8	25.7	57.3
	T @ 500	18	0.785	15.9	67.6	17.2
	T @ 750	11	0.815	11.6	84.4	8.6
	T @1000	28	0.805	13.9	98.8	7.1
	A @ 650	10	0.815	12.8	88.8	15.0
	Control	21	0.768	10.9	36.3	46.0
>1.0	M @ 125	5	1.538	23.6	58.8	51.0
	T @ 250	13	1.538	22.5	34.2	65.0
	T @ 500	7	1.507	26.3	76.0	19.3
	T @ 750	7	1.839	21.6	69.7	15.0
	T @1000	27	1.860	28.0	98.8	12.4
	A @ 650	4	1.313	18.8	77.0	15.0
	Control	6	2.070	25.2	34.6	61.0
Pooled	M @ 125	98	0.368	6.4	51.8	21.8
	T @ 250	100	0.499	9.9	32.8	44.1
	T @ 500	100	0.403	8.6	76.2	9.4
	T @ 750	60	0.505	7.6	75.0	8.3
	T @1000	100	0.876	14.8	97.6	8.7
	A @ 650	89	0.314	5.3	88.4	9.1
	Control	150	0.390	6.0	26.6	32.6

1 M@ 125 = Malathion @ 125gai/ha; T@250 = Trichlorfon @ 250gai/ha
T@ 500 = Trichlorfon @ 500gai/ha; T@750 = Trichlorfon @ 750gai/ha
T@1000 = Trichlorfon @1000gai/ha; A@650 = Acaphate @ 650gai/ha

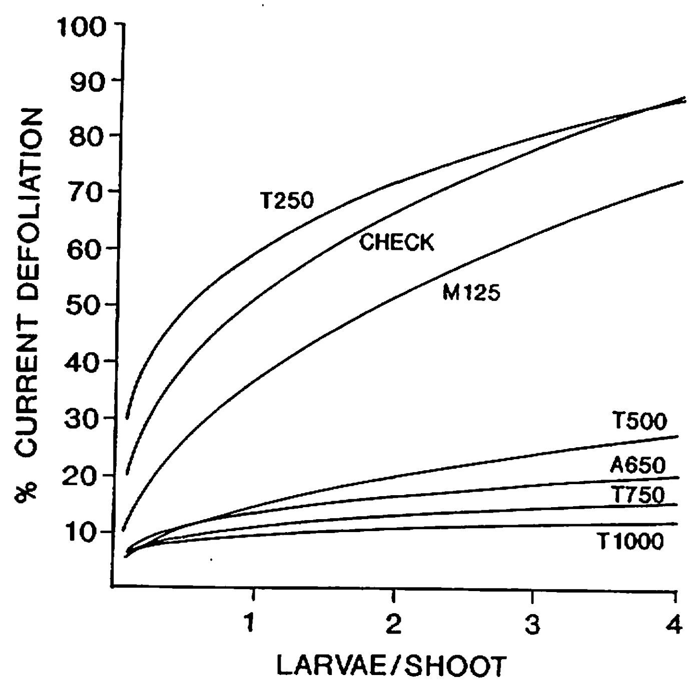

Figure 3. Current defoliation of young black spruce as a function of pre-spray populations of yellowheaded spruce sawfly in treated and untreated plantations in New Brunswick in 1996.

CONCLUSION

Trees in the untreated check area were damaged indicating that areas, with similar populations, selected for treatment were also at risk of attack (Figure 3). Further evidence comes from Block D, which had little benefit of treatment from the lowest rate of Trichlorfon (250 gai/ha). Population reduction (32.8%) was not much different from the check area (26.6%) and mean current defoliation was even higher (44.1% cf 32.6%). Higher mean defoliation in Block D probably reflects its higher mean pre-spray populations (0.499 larvae/shoot cf 0.390 larvae/shoot). These data suggest that 250 gai/ha of Trichlorfon is too low a dose to provide any significant protection to black spruce from yellowheaded spruce sawfly.

Within the Trichlorfon treatments, the highest application rate (1000 gai/ha) gave the best protection despite having the highest pre-spray populations (0.876 larvae/shoot). There was little to choose from between the rates of 500 and 750 gai/ha which gave similar population reduction (76% and 75%, respectively), but lower than that for the highest treatment rate (almost 98%).

Application of Malathion at 125 gai/ha resulted in slightly higher population reduction (51.8%) than the lowest dosage rate (250 gai/ha) of Trichlorfon (32.8%) and the check (26.6%), suggesting/confirming this insecticide is more toxic than Trichlorfon; and a dosage rate higher than 125 gai/ha is needed for adequate protection. Perhaps Malathion at 250 or 500 gai/ha might be sufficient rather than as high a 1000 gai/ha, but that remains to be demonstrated.

Results with Acephate at 650 gai/ha suggest it is somewhat similar to the highest aplication rate of Trichlorfon, and therefore, perhaps 1000 gai/ha would also be a reasonable upper limit for this insecticide for use against the yellowheaded spruce sawfly.

STATUS OF SOME FOREST PESTS IN NOVA SCOTIA PREPARED FOR THE 1996 FOREST PEST MANAGEMENT FORUM NOVEMBER, 1996 OTTAWA

Eric Georgeson, Provincial Entomologist
Nova Scotia Department of Natural Resources
Integrated Pest Management Section
P.O. Box 130 Shubenacadie, N.S. B0N 2H0

PLEASE NOTE:

This is only a preliminary report since data is still being analysed and assembled at the time of writing. For a more finished report please contact me at the following address sometime early in 1997.

Eric Georgeson, Provincial Entomologist
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Integrated Pest Management Section
P.O. Box 130 Shubenacadie, N.S. B0N 2H0
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Fax: (902) 758-3210

FOREST PEST MANAGEMENT FORUM 1996

LIST OF FIGURES

Integrated Pest Management (IPM) is a section within the Forest Protection Subdivision of the Nova Scotia Department of Natural Resources. The main responsibilities of this section are to:

a) identify, monitor, and assess insect populations and forest disease conditions in Nova Scotia (primarily forest pests).
b) organizes and conduct the vegetation management spray operation on Crown Land and control of noxious weeds in Provincial Parks.
c) we also recommend management strategies and carry out forest insect and disease education project and displays.

There are also 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 weed in Provincial Parks.

Integrated Pest Management has offices in Shubenacadie and a seasonal lab in Belmont. The lab is otherwise know 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:

The winter of 1995-96 was another mild one with little snowfall. The spring and summer were much cooler than normal with above average rainfall. The mild winter was good for insect survival but the cool wet spring and summer was particularly hard on forest defoliators. The earlier defoliators such as Satin moth and Spring canker worm that caused so much public concern in 1995 virtually disappeared and what specimens were sent to lab were diseased and parasited. An overwinter egg survival study on Gypsy moth found that there was a survival rate of only 62.8 %. The Gypsy moth population larvae counts taken later in the summer was lower than expected. Parasites, especially compsilura concinnata seemed to play a major role in some areas with over 50% of Gypsy moth population infected.

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

IPM conducted an aerial survey to determine the extent of defoliation caused by the spruce budworm. No defoliation was found in 1996. A province wide pheromone trap system was set up with 130 traps. No moths were captured.

The annual L-2 survey was completed by Nova Scotia Department of Natural Resources staff with 57 sample points being taken. The results of the L-2 wash survey was zero overwintering population in the sample points (Figure 1). 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.

Eastern Blackheaded Budworm, *Acleris variana (Fern):*

Significant larvae finds of this insect were made during hemlock looper larvae searches in Crowdis Mtn., Cape Breton (Figure 3). Also, reports from Pictou, Antigonish, and Guysborough Counties indicate a general build up of this insect.

Spruce Beetle, *Dendroctonus rufipennis:*

The beetle population is still expanding in distribution and density across the province. New areas of infestation are being reported in Cape Breton Island and Cumberland County along with a general expansion in older beetle established areas (Figure 4). There was no survey in 1996. We are planning a major aerial survey in 1997.

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

We did not get the expected outbreak of this insect that we were looking for. Light tap catches have dropped 97%. Approximately 1300 ha of defoliated aspen was noted, primarily in the Annapolis Basin area (Figure 5).

Rosy Maple Moth, *Dryocampa r. rubicunda (F.):*

The Rosy maple moth population has started to drop after three years. light trap catches have dropped by 75% from 1995 catch numbers. No reports of defoliation were reported for this insect.

Gypsy Moth, *Lymantria dispar (L.):*

Gypsy moth populations remained stable in areas where populations are already established in western Nova Scotia (Figure 6). 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.

White Marked Tussock Moth, *Orgyia leucostigma (J.E. Smith):*

The general population increase for the white marked tussock moth continued during 1996. Reports have come in from all the northern mainland counties, (Cumberland, Pictou, Colchester, Antigonish and Guysborough) of larvae finds as well as reports of scattered areas of defoliation. In the Cape Breton highlands moderate defoliation was found on approximately 214 hectares of balsam fir (Figure 7). A major survey is planned for 1997.

***<u>Hemlock Looper</u>**, Lambdina f. Fiscellaria (Guen.):*

The hemlock looper population for the third year in a row increased across the province. An aerial survey done in August, 1996 mapped 14,000 hectares of visible defoliation in Cape Breton (Figure 8). Pheromone traps were placed province wide. 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 Cumberland, Pictou, Colchester, Hants, Antigonish and Guysborough Counties on the mainland. Some pheromone trap catches on Cape Breton Island contained over 4,000 moths per trap.

The 1996 province wide hemlock looper egg survey is still underway and we are expecting to process 500 points. This should give us a good idea of "area at risk". The 1995 egg wash identified 75,000 hectares of woodland at risk and upon that information the 1996 treatment program was based.

Depending on the hemlock looper egg survey and what is found, a possible treatment program using Btk on the looper could occur in 1997.

FIGURE 1

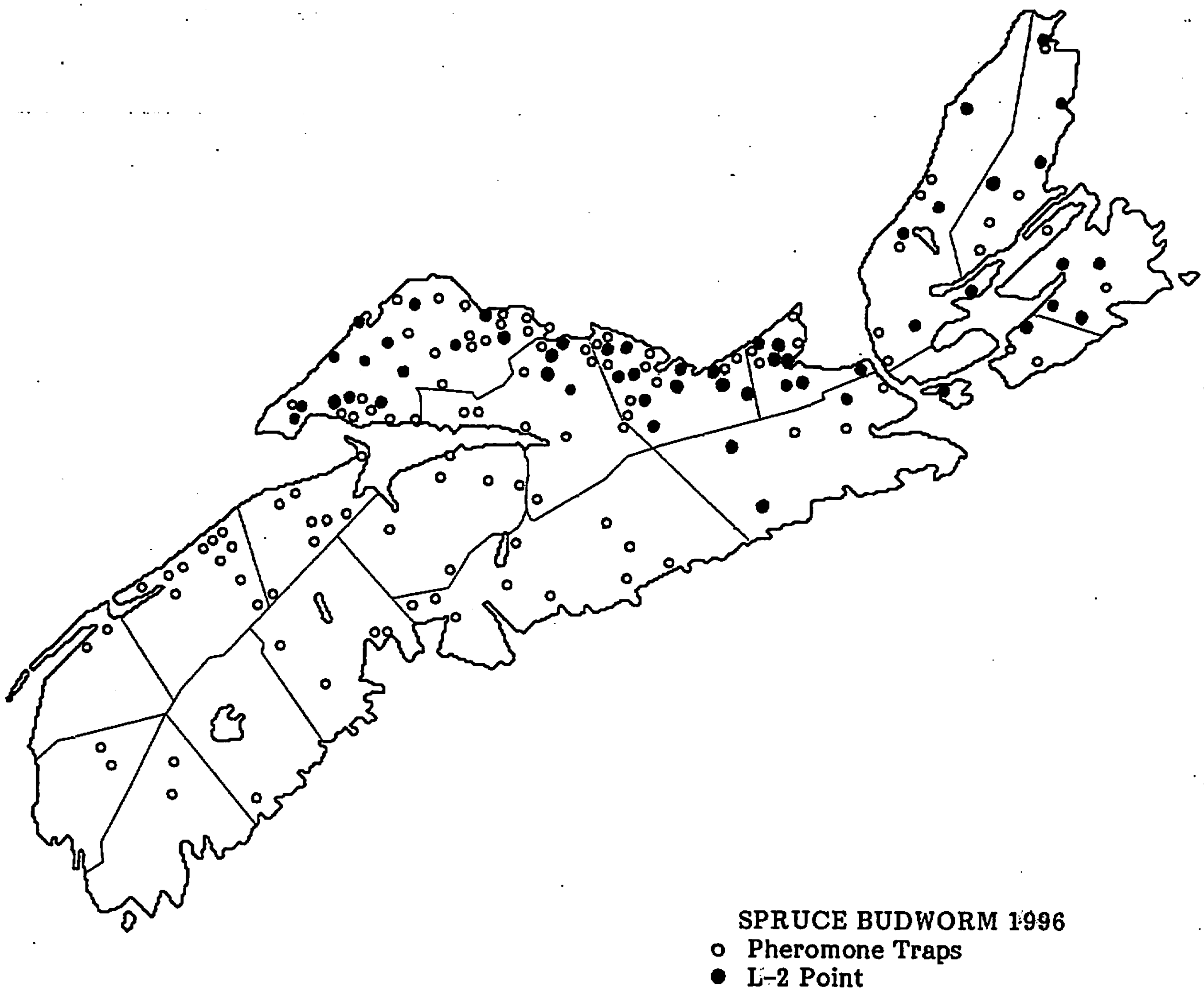


FIGURE 2

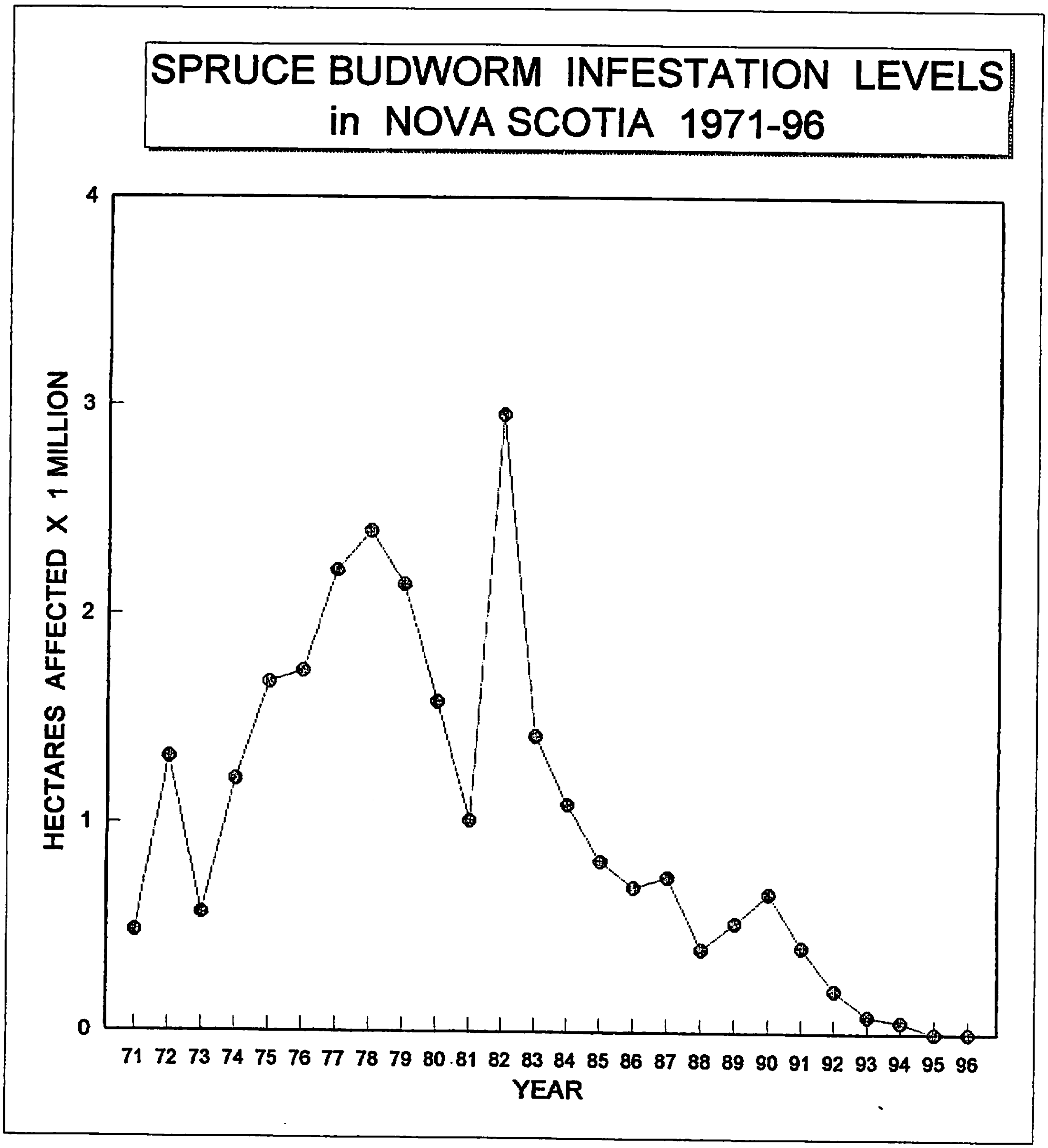

SPRUCE BUDWORM INFESTATION LEVELS
in NOVA SCOTIA 1971-96
HECTARES AFFECTED X 1 MILLION
4
3
2
1
0
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
YEAR

FIGURE 3

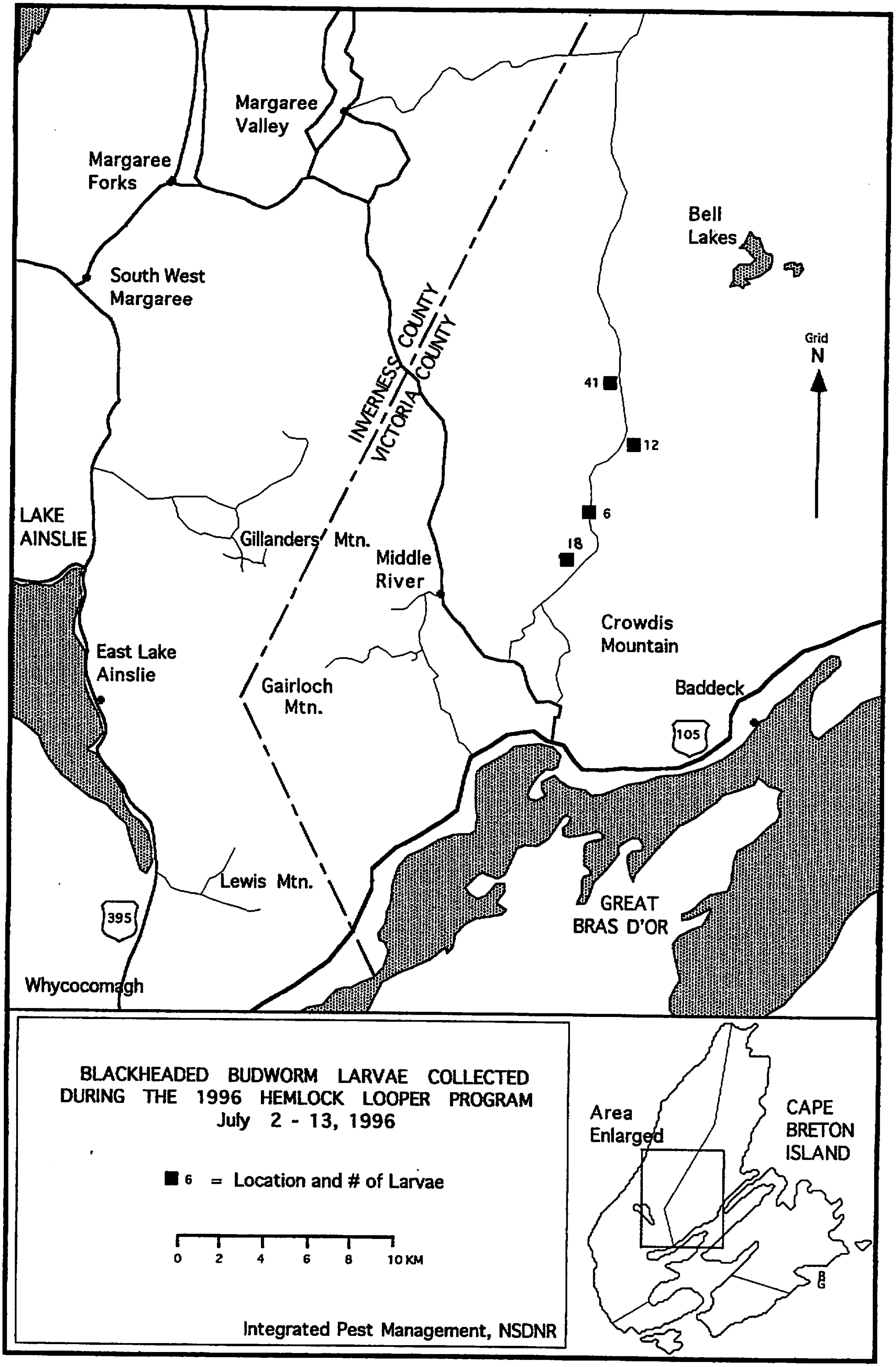

Margaree
Valley
Margaree
Forks
South West
Margaree
Bell
Lakes
INVERNESS COUNTY
VICTORIA COUNTY
Grid
N
41
12
6
18
LAKE
AINSLIE
Gillanders' Mtn.
Middle
River
Crowdis
Mountain
East Lake
Ainslie
Gairloch
Mtn.
Baddeck
105
Lewis Mtn.
395
GREAT
BRAS D'OR
Whycocomagh
BLACKHEADED BUDWORM LARVAE COLLECTED
DURING THE 1996 HEMLOCK LOOPER PROGRAM
July 2 - 13, 1996
6 = Location and # of Larvae
0 2 4 6 8 10 KM
Integrated Pest Management, NSDNR
Area
Enlarged
CAPE
BRETON
ISLAND

FIGURE 4

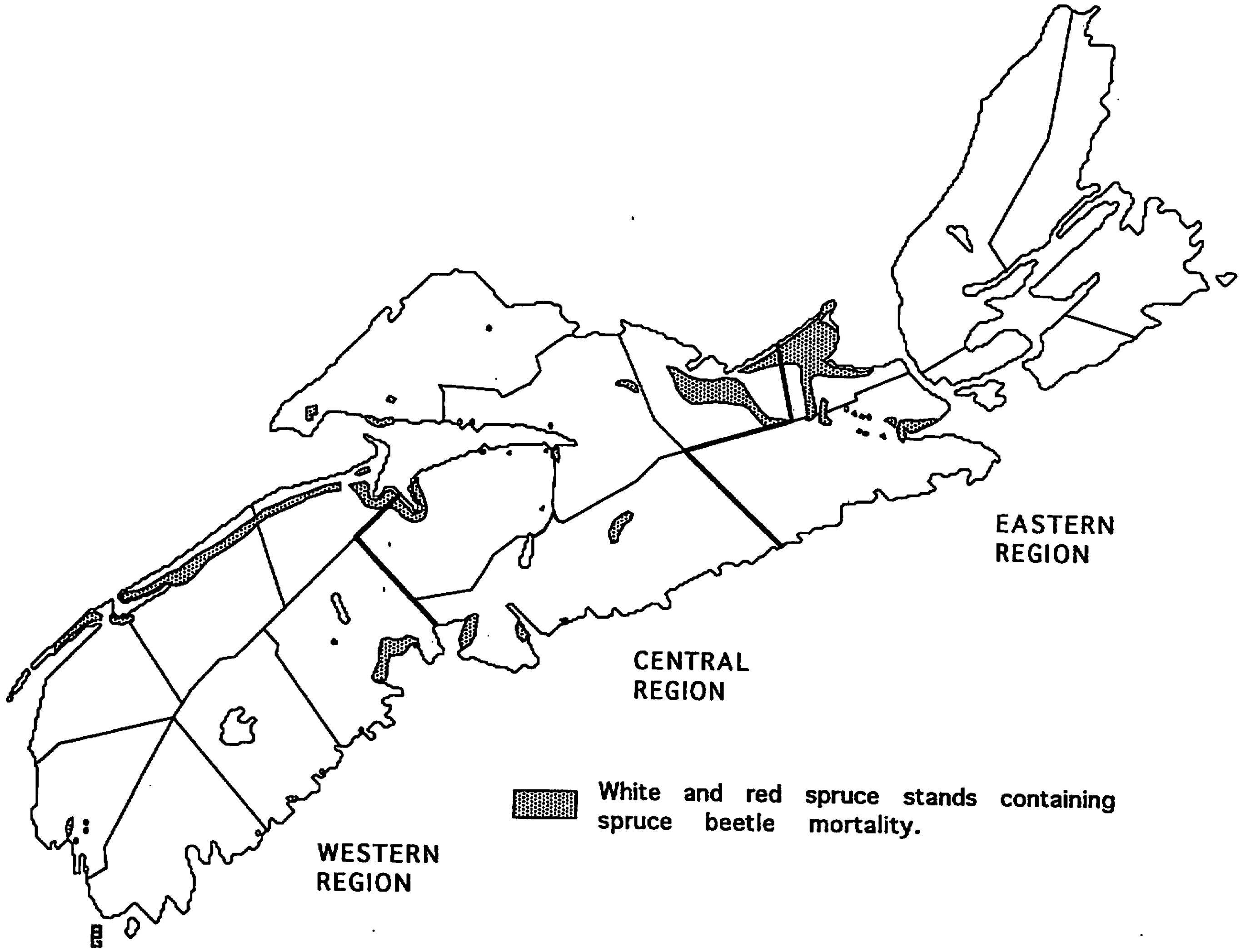

EASTERN
REGION
CENTRAL
REGION
WESTERN
REGION
White and red spruce stands containing spruce beetle mortality.

FIGURE 5

Forest Tent Caterpillar Defoliation, Nova Scotia, 1996

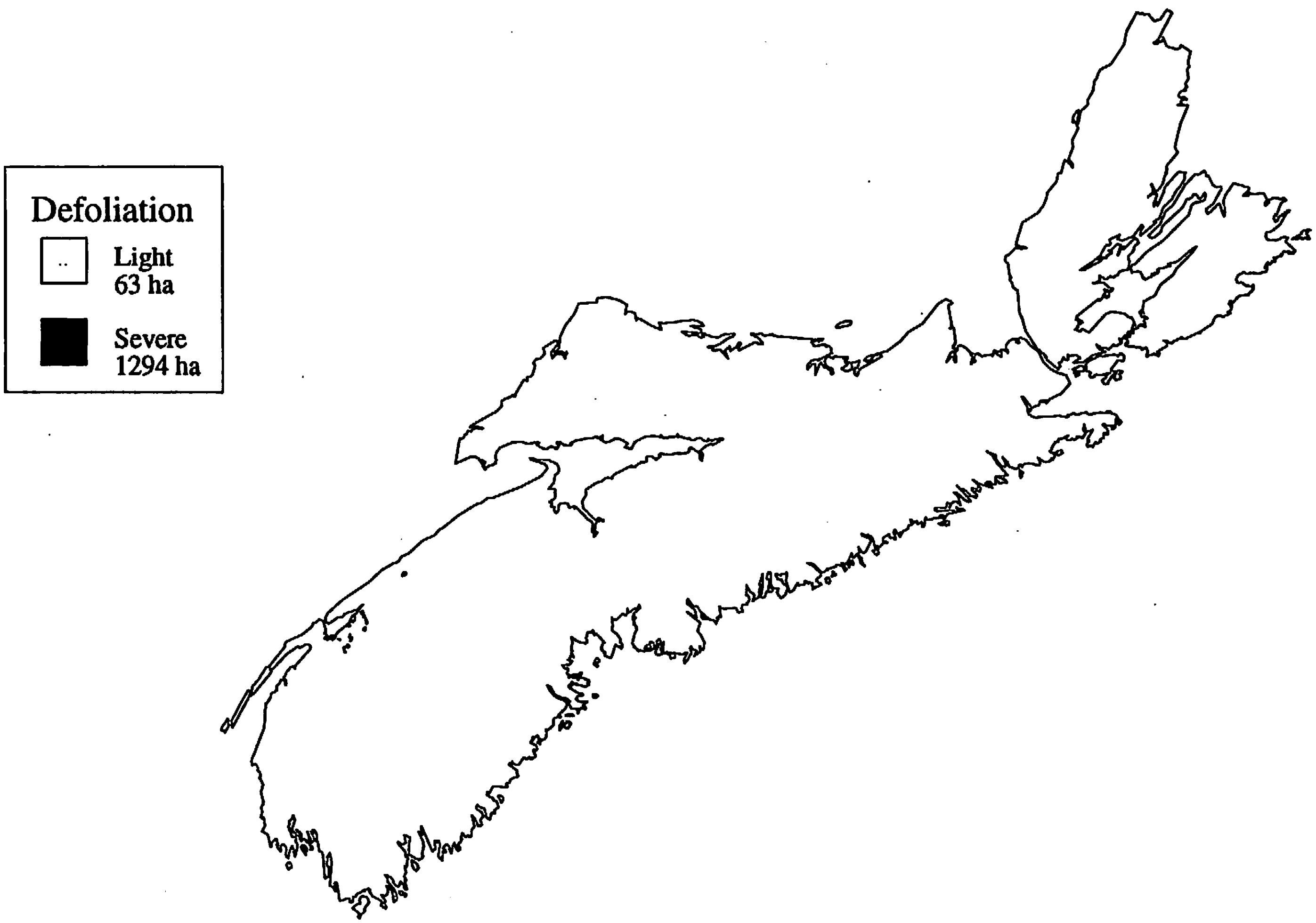


FIGURE 6

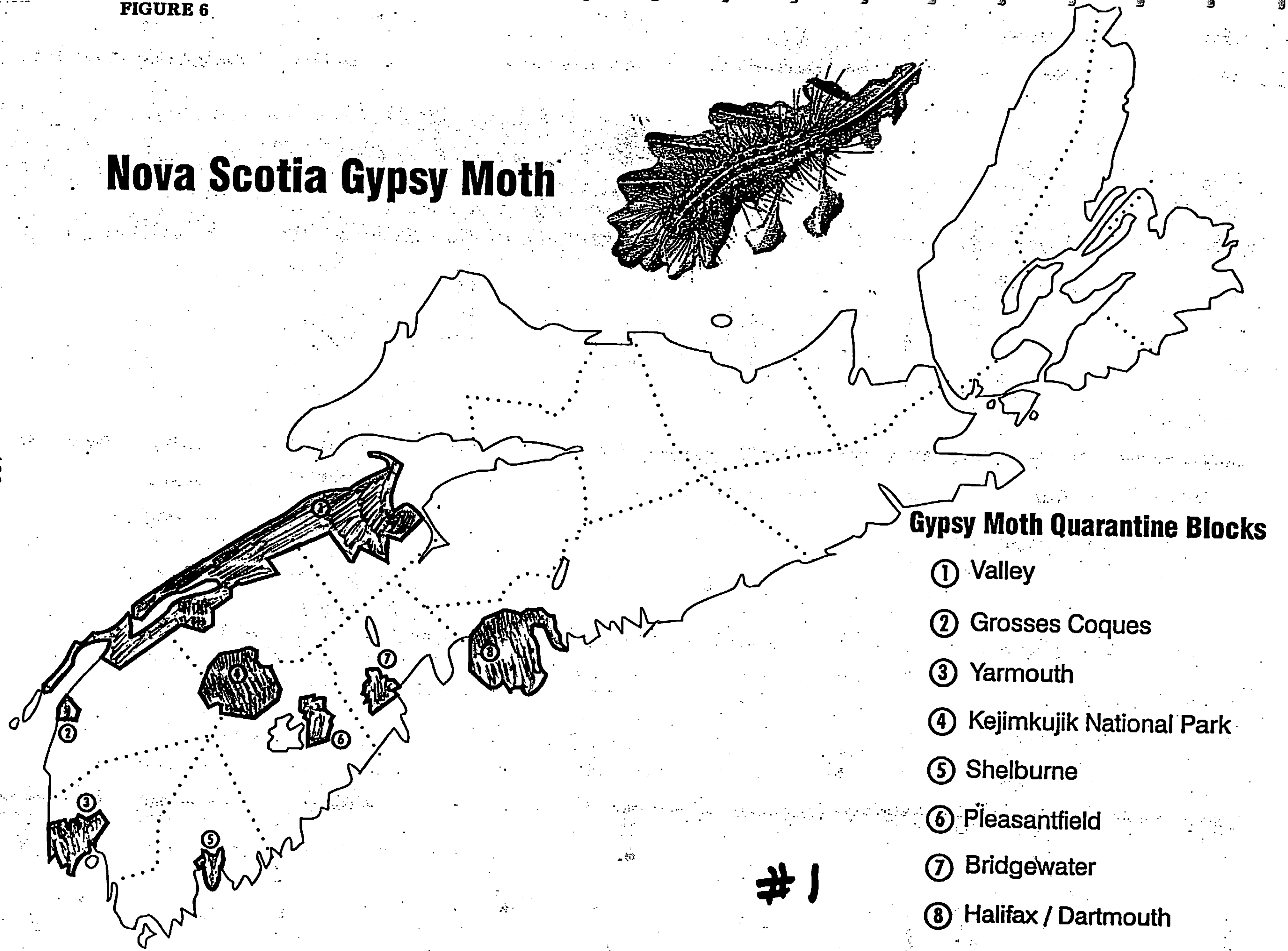

Nova Scotia Gypsy Moth
Gypsy Moth Quarantine Blocks
① Valley
② Grosses Coques
③ Yarmouth
④ Kejimkujik National Park
⑤ Shelburne
⑥ Pleasantfield
⑦ Bridgewater
⑧ Halifax / Dartmouth
#1

FIGURE 7

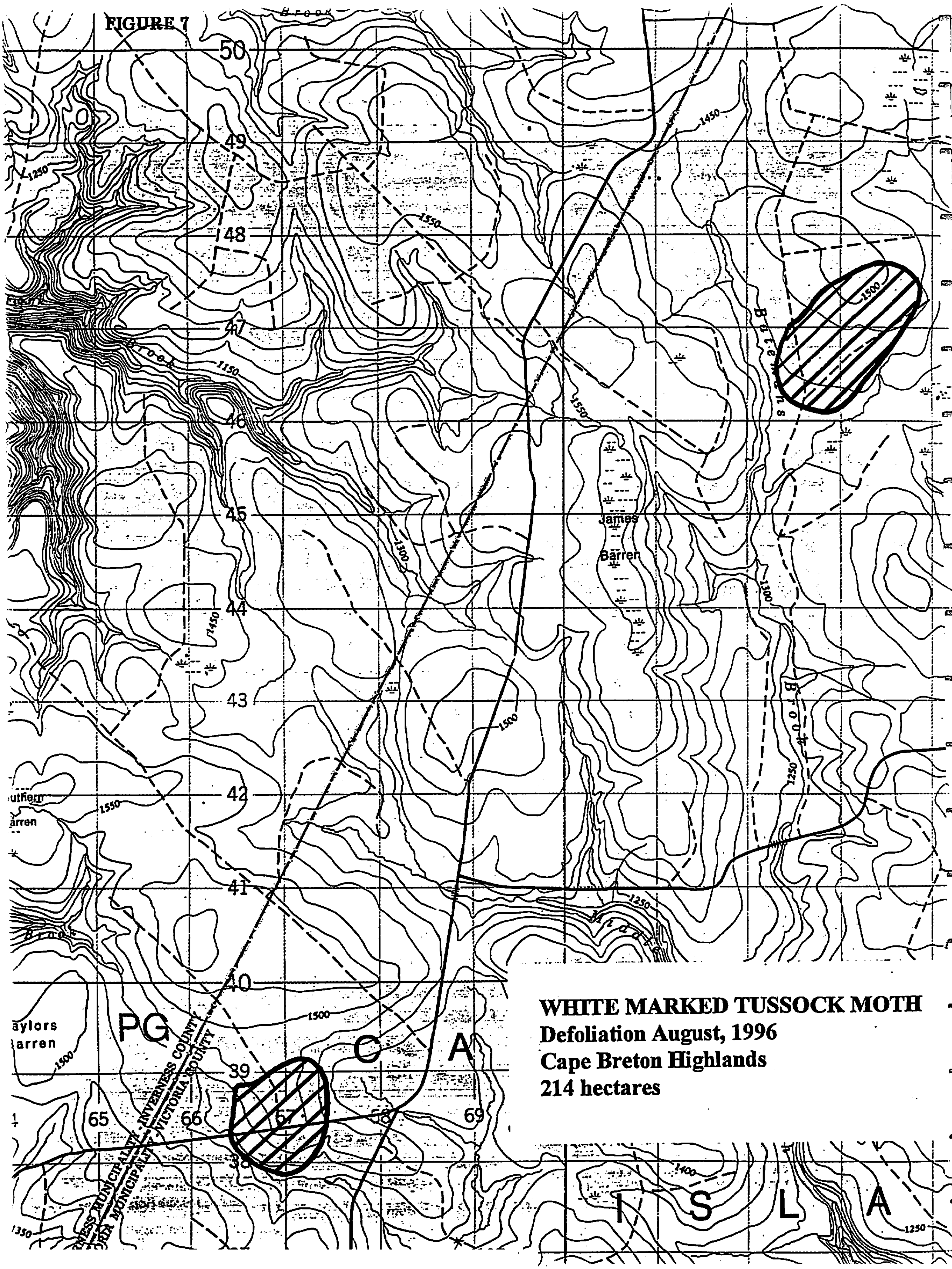
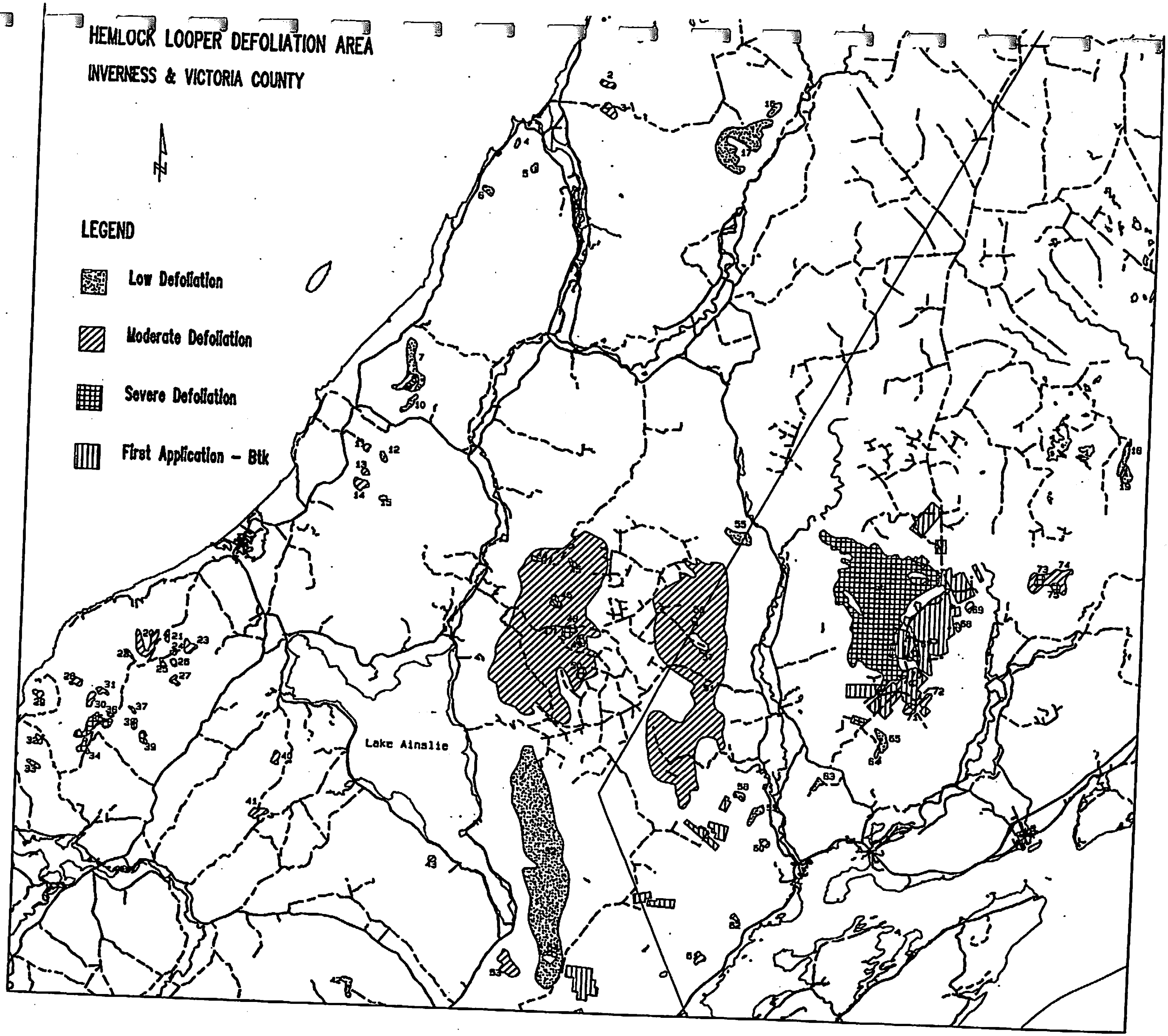

WHITE MARKED TUSSOCK MOTH
Defoliation August, 1996
Cape Breton Highlands
214 hectares
James Barren
Southern Barren
Taylors Barren
Brook
INVERNESS MUNICIPALITY - INVERNESS COUNTY
VICTORIA MUNICIPALITY - VICTORIA COUNTY
PG
C
A
I S L A
50
49
48
47
46
45
44
43
42
41
40
39
38
65
66
67
68
69
1250
1550
1450
1150
1500
1300
1400
1350

FIGURE 8


HEMLOCK LOOPER DEFOLIATION AREA
INVERNESS & VICTORIA COUNTY
LEGEND
Low Defoliation
Moderate Defoliation
Severe Defoliation
First Application - Btk
Lake Ainslie

DRAFT REPORT

THE 1996 NOVA SCOTIA HEMLOCK LOOPER AERIAL TREATMENT PROGRAM REPORT

INTEGRATED PEST MANAGEMENT (IPM)
FOREST PROTECTION SUB-DIVISION
NSDNR

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Background

The hemlock looper Lambdina fiscellaria fiscellaria (Guen.) occurs naturally in our forest, as well as in almost all spruce and fir regions of North America. Their population levels can increase quickly but rarely last more than five years. However, their effect on the forest during that time can be devastating.

Damage by the hemlock looper is mainly found in pure stands of mature and over mature balsam fir, or those mixed with white spruce and occasionally black spruce. Also, when populations are high, balsam fir will be heavily affected when growing in hardwood stands. Apart from defoliation, feeding damage causes growth reduction and death of affected parts of the tree, and eventually tree mortality. This damage is accelerated because the larvae is a wasteful foliage eater. The young larvae eat the edges of the needles, leaving a central filament that eventually dries, curls and yellows. The older larvae move from one needle to another, nibbling rather than eating the whole needle, and often feeding only at its base causing the needle to redden and die. In severe outbreaks, even immature balsam fir trees are defoliated causing extensive damage.

When severe outbreaks occur on balsam fir trees, all needles may be eaten during one summer, and the defoliated trees generally die during the winter or the following spring. If defoliation is partial and no continued defoliation occurs the following year, the tree will survive, but its annual growth will be reduced. Defoliation on white spruce is generally less severe, except on trees of small diameter growing under severely affected balsam fir trees. In very severe outbreaks, these spruce trees will eventually die. Black spruce is generally defoliated less and damage is not as severe.

The hemlock looper egg survey was first expanded in 1994 due to a large increase in adult moth catches in our pheromone trap system. This increase was most dramatic in the Cape Breton Highlands area where the forest is composed largely of balsam fir, the preferred host of the looper in Atlantic Canada.

In 1995 the first visible defoliation caused by the hemlock looper was observed in the Crowdis Mountain area of Cape Breton, totalling 67 hectares (Fig 1). During October and November of that year, 191 hemlock looper egg survey points were collected and processed to extract the eggs from the tree foliage so they can be counted. Using these egg counts the larval population level and the expected defoliation that could occur in 1996 was determined.

Based on the results of this survey, 77,687 hectares of softwood in Victoria and Inverness counties had been determined as being at risk to feeding damage by hemlock looper larvae in 1996. This is an increase of 74,228 hectares over the 1994 figure of 3459 hectares. (Fig 2)

The shortage of time after the decision to have a spray program was made determined that, for the most part, only crown land would be treated in the 1996 program.

Treatment Program

A) Area Treated:

Areas that fell in the high and extreme hemlock looper population levels (based on egg counts) were divided into twenty-two treatment blocks. (Table 1). These blocks had to be composed of at least 40% of balsam fir. The size of the blocks ranged from 5.0 hectares to 644 hectares with a total area of 2010.3 hectares. (Fig. 3)

B) Biocide and Applications:

The product used was a biological agent, Bacillus thuringiensis kurstaki (Btk). Two formulations were used: Foray 76B and 48B. Both are registered for aerial application in forestry against the hemlock looper.

A double application separated by approximately a one week period was applied to each block. Foray 76B was applied at the rate of 1.5 litres/hectare and 48B at 2.4 litres per hectare. The treatment blocks were divided so that some received two applications of 48B and the other half two applications of 76B. This was done to determine if one formulation had better results than the other. (Fig. 4 and Fig. 5)

C) Criteria for Timing of Spray Application:

The timing of any spray application depends on two critical factors: insect development and the weather. Monitor crews in the field, taking samples on June 18, 1996, observed that the hemlock looper hatch had already started in warmer locations within the treatment areas. The warm weekend of June 15, 1996 was most likely when egg hatch began in Cape Breton. Because hemlock looper eggs have such a long hatch period, it is advisable to wait at least one week after the first sign of looper larvae before starting treatment. This allows for the maximum number of hatched larvae before the first application is applied. A week between applications is necessary to allow the looper eggs that had not hatched in time for the first spray to hatch. (Fig. 6)

All treatment blocks were opened for the morning spray session on June 25, 1996. We were very fortunate that the hemlock looper larvae spent a long time in the first and second larval instar stage, (possibly due to bad weather and cool temperature); this allowed us to spray them before they could do significant foliage damage which typically occurs in the third and later instar stage.

The second critical factor that influenced the treatment was weather. Once the blocks are opened spray days are divided into spray sessions. Generally, a spray day can have two sessions. One starting in the morning at dawn, (approximately 5 am) and running until spray conditions deteriorate due to wind and heat thermals (usually between 8:00 and 9:00 am). The second session is in the evening, usually running from 7:00 pm until dark, again depending on local weather conditions. A session is further divided up into "loads". A load is defined as the time a spray aircraft team with a full tank of biocide can remain on the treatment area before they have to return to the airstrip to be refilled with biocide. Table 2 shows the outline of how sessions went during the project. Table 3 gives a breakdown of application dates and rates for the program.

D) Spray Aircraft and Navigation

Two Cessna 188 Ag Trucks were contracted from Forest Protection Limited to be used on the program. Each plane was equipped with four micron air AV 4000 and Ag Nav/Campbell or Trimble/Campbell CRIO data logging systems.

The aerial navigation system used in the 1996 hemlock looper treatment program involved two Hughes 500 helicopters. Two types of navigation techniques were used; visual navigation (reliance on visual checkpoints and aerial photographs) and navigation by electronic guidance involving a Global Positioning System (GPS).

Each navigational aircraft crewed by a pilot and navigator acted as aerial flags or posts by hovering over precise landmarks at opposite ends of each treatment line in the blocks. The GPS component of navigation involved utilizing pre selected waypoints located at the corners of each treatment areas. This system allowed for efficient and accurate navigation to the treatment sites in spray sessions involving multiple treatment areas.

Assessment of Treatment

A) General

The degree of defoliation to a tree is normally determined by the population density of the pest insect. The hemlock looper is no exception to this rule. The higher the population the more significant the foliage loss. The most notable difference between looper and other forest pests, such as spruce budworm, is the patchy nature of their population distribution. This normally makes sampling and acquiring reliable data very difficult. However, due to the high population density in Cape Breton for 1996 that this was not too much of a problem. The biggest problem working with hemlock looper is the long egg hatch time. In 1996 the hatch started June 15, 1996 and continued on until past the 27th of June. Plots were established in both treatment blocks and non-treatment areas (control plots). The three main purposes of these plots were: to determine the effects of the treatment on larvae population (knock down); foliage saved; and for the timing of applications.

Two blocks were dropped before the program started. These were block No. 12 and No. 22. They were dropped mainly because of small size, and difficulty to fit into flight time and line configuration.

B) Weather and Hemlock Looper Development:

Weather was unstable to say the least. Over 192mm (7.5 inches) of rain fell in July. This was about four inches above normal.

Poor weather resulted in a loss of 77% of the possible spray days. Even though this resulted in the program going on longer than expected, the development of the looper was slower due to the cool, wet days and cold nights. This worked to our advantage and gave us time to treat the looper before heavy defoliation occurred.

C) Larval Mortality

The standard method used to evaluate the efficiency of any insecticide is the Abbott Formula. The calculations are based on pre and post spray insect populations in both treatment and check plots. The results are then usually expressed in terms of percentage reduction of survival for the insect. For example if no treatment occurred then the reduction of survival would be zero. In other words, there was no insect mortality caused by the spray. The reduction of survival for the treatment blocks (Table 4) ranged from a low of 73.1% to a high of 99.9%. Considering the density of the hemlock looper larvae in a number of treatment areas, especially block number 7, this prevented serious defoliation. (Table 4)

There was little difference in the reduction of survival between Foray 76B and Foray 48B. The percentage for Foray 76B was 94.7 while Foray 48B was 94.1.

D) Foliage Protected:

Foliage saved is calculated by means of developing a regression curse based on check plot data. Essentially, what is looked at are the pre spring populations of hemlock looper in the check plot and the amount of defoliation they cause at various population levels. Once the regression line is developed then the expected level of defoliation can be predicted. The relative percent of foliage saved is based on the difference of what we expected to be lost in the treatment blocks and what was actually lost.

The results were very good showing that the larvae knock down occurred at the critical time, resulting in the needed foliage protection. Two different situations were looked at: 1) current foliage growth saved and 2) current growth plus two previous years of foliage growth.(Table 5)

For current growth the results ranged from 43.8% to 84.2%. The overall percentage of current foliage saved was 66.8%. When the current growth is combined with two years previous growth ranged from 31.4% to 87.4%. The lower minimum is reflecting 1995 defoliation that already existed on the study branches. Even with this possible over estimation of defoliation, 63.2% of the expected loss of foliage was averted.

When comparing how much foliage was saved in those blocks treated with Foray 48B to those treated with Foray 76B, no obvious difference can be noted. (Table 6).

Table 6: Comparing Foliage Saved and the Two Btk Formulations

	Relative Current % Foliage Saved	Relative Current + 2 Previous Years Foliage Saved
Foray 48B	68.8	63.8
Foray 76B	61.1	61.3

Comparing expected defoliation to actual defoliation directly, the results are also extremely encouraging. For example, in block 7 which had the highest larval population counts, (100% of the foliage) was expected to be lost. After the biocide treatments only 20% of the foliage was lost (Table 7). When looking at current foliage along with two years previous growth, the results are generally the same for block 7. Thus the story repeats itself for the others blocks in the treatment program.

E) <u>Aerial Defoliation Survey</u>

An aerial defoliation survey was done by IPM staff during August 1996 to map visible defoliation caused by the hemlock looper. The categories were based on the following percentages of defoliation:

	Low:	6 - 29%
	Moderate:	30 - 69%
	High:	70 - 100%

The areas mapped (Fig. 9) showed that there was 3114.0 ha in the low category; 8198.0 ha in the moderate category; and 2734.0 ha with high defoliation. This was a total of 14046 ha with some level of hemlock looper feeding damage. Please keep in mind that this is only visible damage as seen from our aircraft. Some ground surveys have found heavy feeding damage in the lower half of the trees in the stands. There are also cases where the balsam fir under an overstory of hardwood have been destroyed.

During the treatment program some of the uneven block edges were not treated. Trees in these dropped areas suffered high defoliation as compared to the trees in the surrounding treatment areas, which at most had low defoliation. In some cases the line between sprayed and non-sprayed showed up very clearly from the air.

SUMMARY

Over 2000 hectares of balsam fir in Cape Breton, NS was aerially treated with Bacillus thuringiensis kurstaki (Btk) for hemlock looper in 1996. This area was divided up into 22 treatment blocks based on high and extreme hemlock looper population levels.

The Btk formulations used were Foray 48B and 76B. A double application was applied aerially at 1.5 litres/hectare for 76B and 2.4 litres/hectare for the Foray 48B. The time of applications were separated by approximately one week. The spray aircraft used were two Cessne 188 Ag Trucks with four mincron air AV 4000 on each aircraft. These aircraft were contracted from Forest Protection Ltd., New Brunswick.

Two types of navigation techniques were used; visual navigation and navigation by electronic guidance involving a Global Positioning System (GPS). Two NSDNR Hughes 500 helicopters were used as navigator aircraft.

Results of the treatment program indicate that the program was success. Biocide application was timed to knock down the larvae at the critical time in its development, resulting in very good foliage protection. We were able to achieve this despite periods of unstable weather.

Reduction of larval survival in treated areas ranged from 73.1% to 99.9%. The overall reduction was 92.3%.

For current foliage growth the results saved ranged from 43.8% to 84.2%. The overall current foliage saved was 66.8%.

When the current growth is combined with two year previous foliage growth, the range of foliage saved is from 31.4% to 87.4%. The lower minimum is reflecting 1995 defoliation that already existed on the older study shoots. Even with this possible over estimation of defoliation, 63.2% of the expected loss of foliage was averted.

These results are very good considering the difficulties that can occur applying a bilogical agent such as Btk. The Provincial Entomologist is most happy with the results.

Table 1: Treatment Blocks

BLOCK #	BLOCK NAMES	AREA IN HECTARES	Bt FORMULATION	COUNTY
1.	Crowdis Mtn. #1	79.8 ha	48B	Victoria Co.
2.	Crowdis Mtn. #2	26.8 ha	48B	Victoria Co.
3.	Crowdis Mtn. #3	18.8 ha	48B	Victoria Co.
4.	Crowdis Mtn. #4	20.5 ha	48B	Victoria Co.
5.	Crowdis Mtn. #5	135.9 ha	48B	Victoria Co.
6.	Crowdis Mtn. #6	9.7 ha	48B	Victoria Co.
7.	Crowdis Mtn. #7	644.0 ha	76B	Victoria Co.
8.	Crowdis Mtn. #8	161.8 ha	48B	Victoria Co.
9.	Crowdis Mtn. #9.	63.7 ha	48B	Victoria Co.
10.	Crowdis Mtn. #10	363.1 ha	76B	Victoria Co.
11.	Crowdis Mtn. #11	22.0 ha	76B	Victoria Co.
12.	Crowdis Mtn. #12	16.4 ha	48B	Victoria Co.
13.	Crowdis Mtn. #13	73.3 ha	48B	Victoria Co.
14.	Black Brook North #14	16.0 ha	48B	Victoria Co.
15.	Black Brook South #15	5.0 ha	48B	Victoria Co.
16.	McNaughton Brook East #16	33.0 ha	48B	Victoria Co.
17.	McNaughton Brook West #17	37.0 ha	48B	Victoria Co.
18.	Humes Road East #18	38.0 ha	48B	Victoria Co.
19.	Humes Road West #19	22.0 ha	48B	Victoria/Inverness
20.	Lewis Mountain #20	194.2 ha	48B	Inverness Co.
21.	Lewis Mountain #21	14.3 ha	48B	Inverness Co.
22.	MacMillan Mountain #22	15.0 ha	48B	Inverness Co.

Table 2 - Treatment Sessions by day during the 1996 Hemlock Looper Spray Program.

June 25, 96:	am - session, 1st Application Started	July 5, 96	am - poor weather, heavy fog
	pm - standby, cancelled poor weather		pm - standby cancelled, fog
June 26, 96:	am - standby, cancelled rain and fog	July 6, 96	am - poor weather, heavy fog
	pm - no standby, rain and fog		pm - standby cancelled, rain and fog
June 27, 96	am - no standby, rain	July 7, 96	am - standby, cancelled, high winds
	pm - standby, cancelled wind		pm - session
June 28, 96	am - standby, cancelled wind	July 8, 96	am - session
	pm - session		pm - standby, cancelled rain and wind
June 29, 96	am - session	July 9, 96	am - no standby, heavy rain and electric storm
	pm - session		pm - no standby, rain and fog
June 30, 96	am - session, 1st Application	July 10, 96	am - no standby, heavy fog
	pm - between applications, wait period		pm - standby, cancelled wind and fog
July 1, 96	am - between applications, wait period	July 11, 96	am - standby, cancelled wind
	pm - between applications, wait period		pm - standby, cancelled wind
July 2, 96	am - between applications, wait period	July 12, 96	am - standby, cancelled, wind
	pm - between applications, wait period		pm - session
July 3, 96	am - between applications, wait period	July 13, 96	am - session -
	pm - standby, cancelled fog, 2nd Application Started		PROGRAM COMPLETE
July 4, 96	am - poor weather, rain and fog		
	pm - poor weather, rain and fog		

TABLE 3: BLOCKS TREATMENT DATES (1996) AND APPLICATIONS RATES

BLOCK #	BLOCK NAME	TREAT.	PROPOSED AREA - ha	COUNTY	BIOCIDE USED	PLANNED APPLICATION RATES l/ha	1ST APPLICATION			2ND APPLICATION			REMARKS
							DATE TREATED	AM/PM	ACTUAL APPLICATION RATE l/ha	DATE TREATED	AM/PM	ACTUAL APPLICATION RATE l/ha	
1	Crowdis Mtn #1	Yes	79.8	Victoria	Foray 48B	2.4	June 29	pm	2.5	July 12	pm	2.8	
2	Crowdis Mtn #2	Yes	26.8	Victoria	Foray 48B	2.4	June 29	pm	2.5	July 12	pm	2.8	
3	Crowdis Mtn #3	Yes	18.8	Victoria	Foray 48B	2.4	June 29	pm	2.5	July 12	pm	2.8	
4	Crowdis Mtn #4	Yes	20.5	Victoria	Foray 48B	2.4	June 29	pm	2.5	July 13	am	3.4	
5	Crowdis Mtn #5	Yes	135.9	Victoria	Foray 48B	2.4	June 29,30	pm,am	3.0	July 13	am	3.4	
6	Crowdis Mtn #6	Yes	9.7	Victoria	Foray 48B	2.4	June 30	am	3.4	July 13	am	3.4	
7	Crowdis Mtn #7	Yes	644.0	Victoria	Foray 76B	1.5	June 25,28	am,pm	1.3	July 7, 8	pm, am	1.6, 1.4	
8	Crowdis Mtn #8	Yes	161.8	Victoria	Foray 48B	2.4	June 30	am	3.4	July 12	pm	2.8	
9	Crowdis Mtn #9	Yes	63.7	Victoria	Foray 48B	2.4	June 30	am	2.0	July 13	am	3.6	
10	Crowdis Mtn #10	Yes	363.1	Victoria	Foray 76B	1.5	June 28	pm	1.6	July 8	am	1.4	
11	Crowdis Mtn #11	Yes	22.0	Victoria	Foray 76B	1.5	June 28	pm	1.6	July 8	am	1.4	
12	Crowdis Mtn #12	No	16.4	Victoria	Foray 48B	2.4	N/A	N/A	N/A	N/A	N/A	N/A	Dropped
13	Crowdis Mtn #13	Yes	73.3	Victoria	Foray 48B	2.4	June 30	am	3.4	July 13	am	3.6	
14	Black Brook N.	Yes	16.0	Victoria	Foray 48B	2.4	June 30	am	2.0	N/A	N/A	N/A	No 2nd Application
15	Black Brook S.	No	5.0	Victoria	Foray 48B	2.4	June 30	am	2.0	N/A	N/A	N/A	No 2nd Application
16	McNaughlan Brook E.	Yes	33.0	Victoria	Foray 48B	2.4	June 30	am	2.0	July 13	am	3.6	
17	McNaughlan Brook W.	Yes	37.0	Victoria	Foray 48B	2.4	June 30	am	2.0	July 13	am	3.6	
18	Humes Road E.	Yes	38.0	Victoria	Foray 48B	2.4	June 30	am	2.0	July 8	am	2.8	
19	Humes Road W.	Yes	22.0	Victoria	Foray 48B	2.4	June 30	am	2.0	July 8	am	2.8	
20	Lewis Mtn. #20	Yes	194.2	Inverness	Foray 48B	2.4	June 29	am	2.1	July 8	am	2.8	
21	Lewis Mtn. #21	Yes	14.3	Inverness	Foray 48B	2.4	June 29	am	2.1	July 8	am	2.8	
22	MacMillan Mtn.	No	15.0	Inverness	Foray 48B	2.4	N/A	N/A	N/A	N/A	N/A	N/A	Dropped

Table 4: Results of the 1996 Hemlock Looper Treatment Program

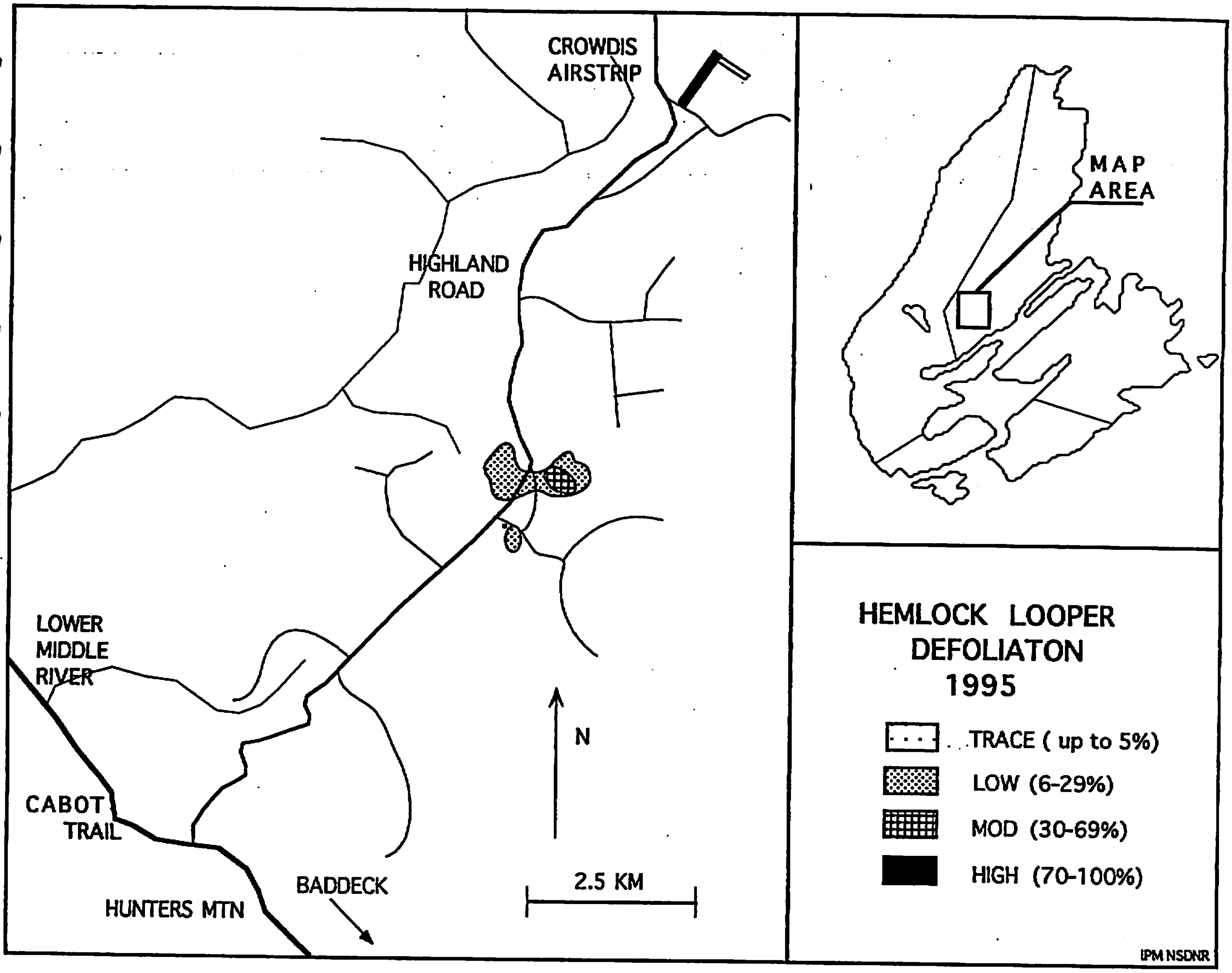
		HEMLOCK LOOPER	
BLOCK NUMBER	NAME	AVERAGE PRE-SPRAY POPULATION m2	PERCENT OF REDUCTION IN SURVIVAL
1, 2, 3	Crowdis	39.0	91.2
4, 5, 6	Crowdis	191.5	99.9
7	Crowdis	302.9	93.5
8	Crowdis	38.6	93.4
9, 10, 11	Crowdis	146.9	95.9
12*	N/A	N/A	N/A
13	Crowdis	105.0	95.1
14, 15, 16, 17, 18, 19	Keppoch	35.6	96.2
20, 21	Keppoch	72.1	73.1
22*	N/A	N/A	N/A

[* Blocks where dropped from program.]

Table 5: Relative percentage foliage saved, both for current growth and current plus the two previous year's growth.

		CURRENT FOLIAGE	CURRENT + 2 PREV. YEARS FOLIAGE
BLOCKS	PRESPRAY HL COUNTS m2	RELATIVE % FOLIGAE SAVED	RELATIVE % FOLIAGE SAVED
1, 2, 3	39.0	57.3	31.4
4, 5, 6	191.5	48.4	59.8
7	302.9	78.4	75.8
8	38.6	77.3	71.5
9, 10, 11	146.9	43.8	46.8
13	105.0	65.4	56.0
14, 15, 16, 17, 18, 19	35.6	84.2	87.4
20, 21	72.1	80.0	76.5

FIGURE 1



CROWDIS
AIRSTRIP
HIGHLAND
ROAD
LOWER
MIDDLE
RIVER
CABOT
TRAIL
HUNTERS MTN
BADDECK
N
2.5 KM
MAP
AREA
HEMLOCK LOOPER
DEFOLIATON
1995
TRACE (up to 5%)
LOW (6-29%)
MOD (30-69%)
HIGH (70-100%)
IPM NSDNR

FIGURE 2

NOVA SCOTIA
HEMLOCK LOOPER EGG SURVEY
MAY 1995

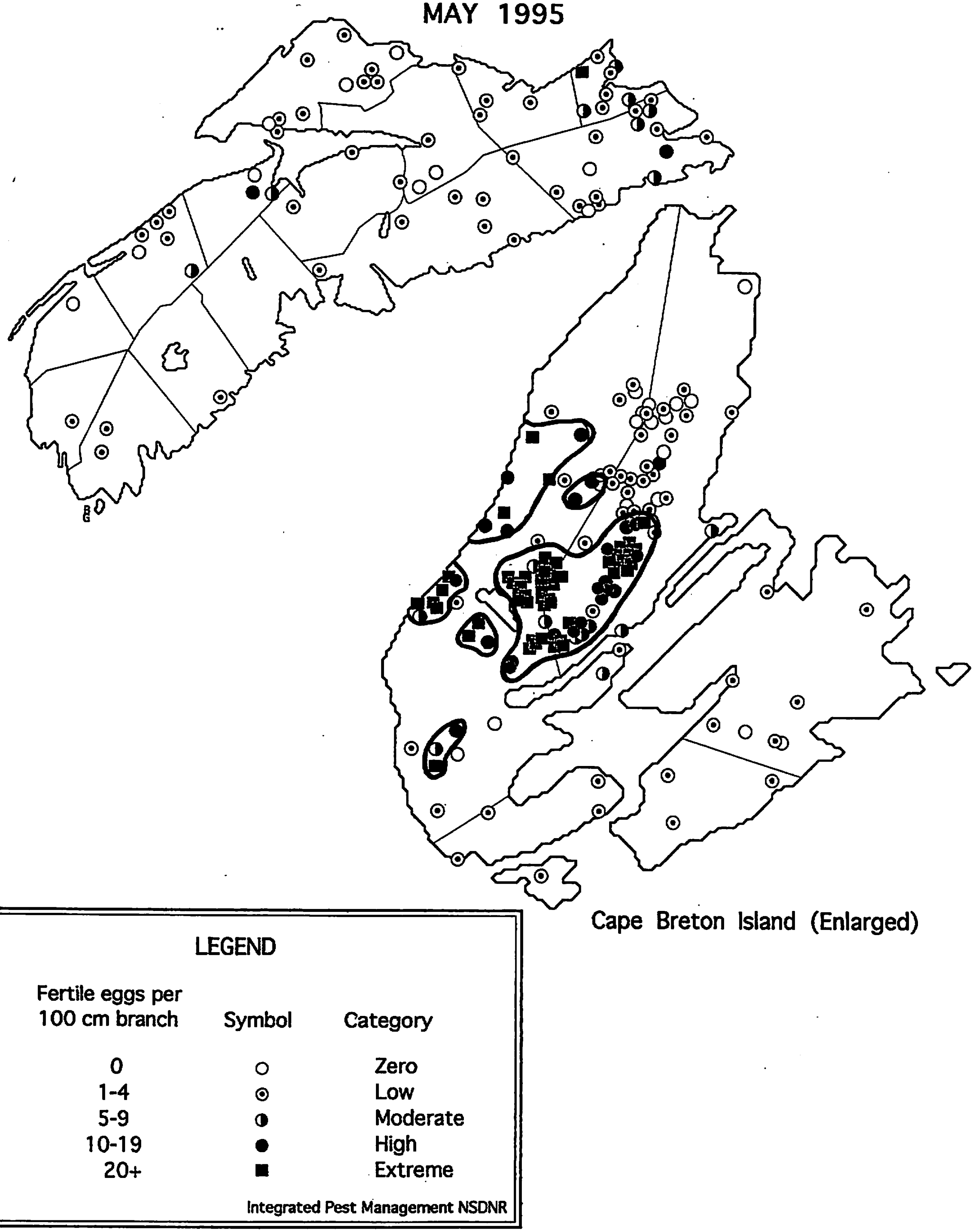


FIGURE 3

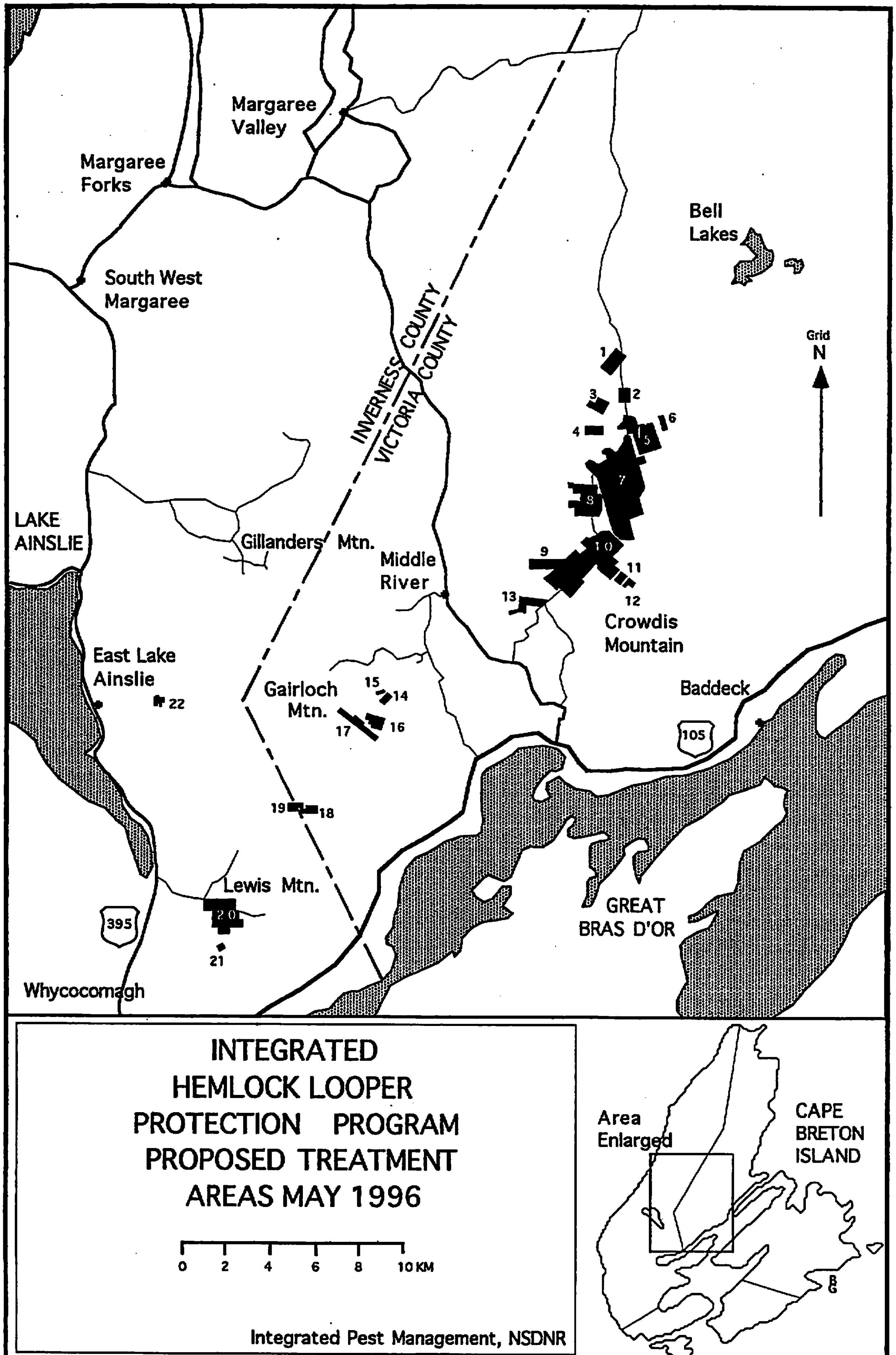

Margaree
Valley
Margaree
Forks
South West
Margaree
Bell
Lakes
Grid
N
INVERNESS COUNTY
VICTORIA COUNTY
1
2
3
4
5
6
7
8
9
10
11
12
13
LAKE
AINSLIE
Gillanders' Mtn.
Middle
River
Crowdis
Mountain
East Lake
Ainslie
22
Gairloch
Mtn.
15
14
16
17
Baddeck
105
19
18
Lewis Mtn.
20
21
395
GREAT
BRAS D'OR
Whycocomagh
INTEGRATED
HEMLOCK LOOPER
PROTECTION PROGRAM
PROPOSED TREATMENT
AREAS MAY 1996
0 2 4 6 8 10 KM
Integrated Pest Management, NSDNR
Area
Enlarged
CAPE
BRETON
ISLAND

FIGURE 4

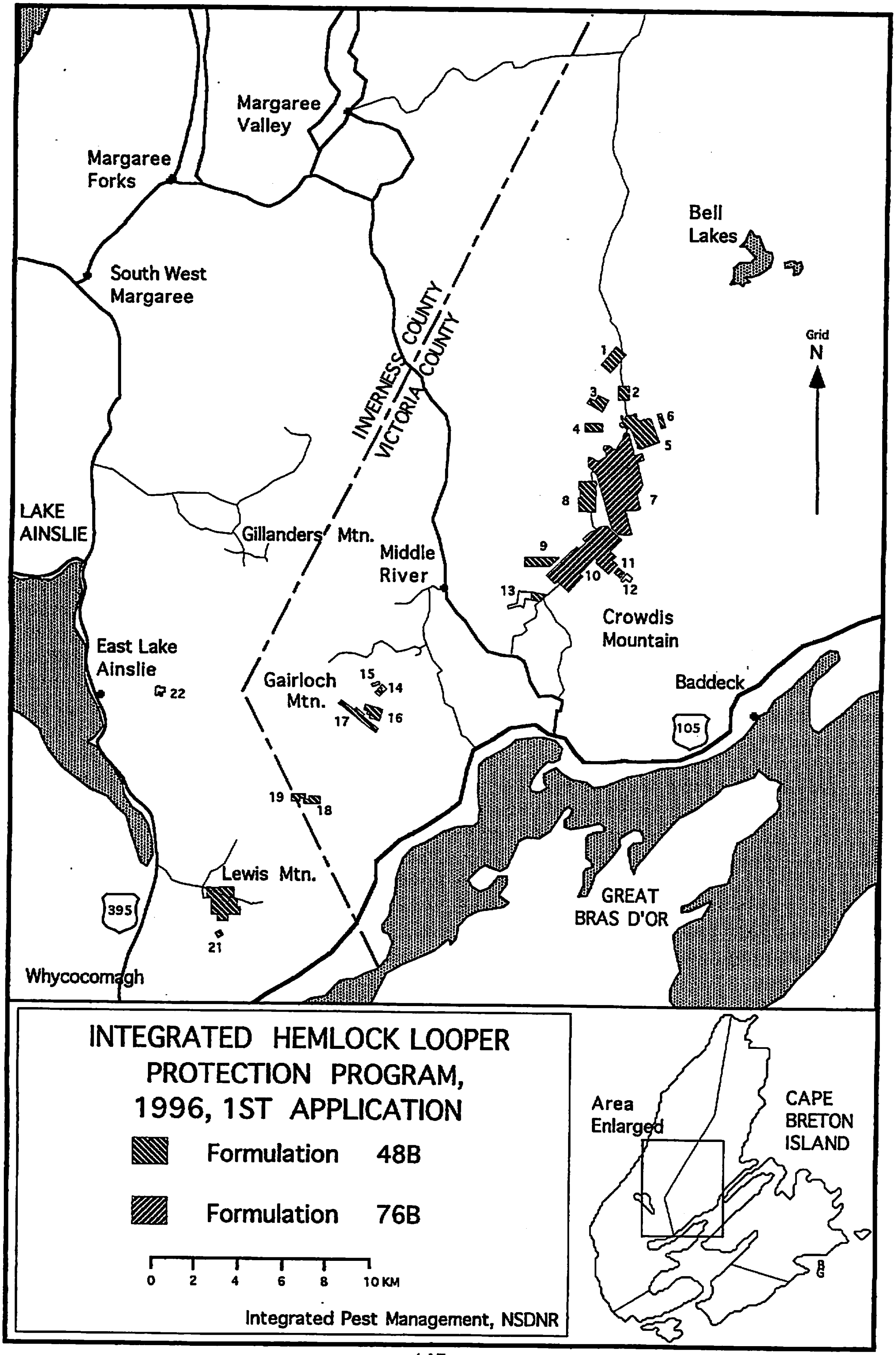

Margaree Valley
Margaree Forks
South West Margaree
Bell Lakes
Grid N
INVERNESS COUNTY
VICTORIA COUNTY
LAKE AINSLIE
Gillanders' Mtn.
Middle River
Crowdis Mountain
East Lake Ainslie
Gairloch Mtn.
Baddeck
105
395
Lewis Mtn.
GREAT BRAS D'OR
Whycocomagh
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
21
22
INTEGRATED HEMLOCK LOOPER PROTECTION PROGRAM, 1996, 1ST APPLICATION
Formulation 48B
Formulation 76B
0 2 4 6 8 10 KM
Integrated Pest Management, NSDNR
Area Enlarged
CAPE BRETON ISLAND

FIGURE 5

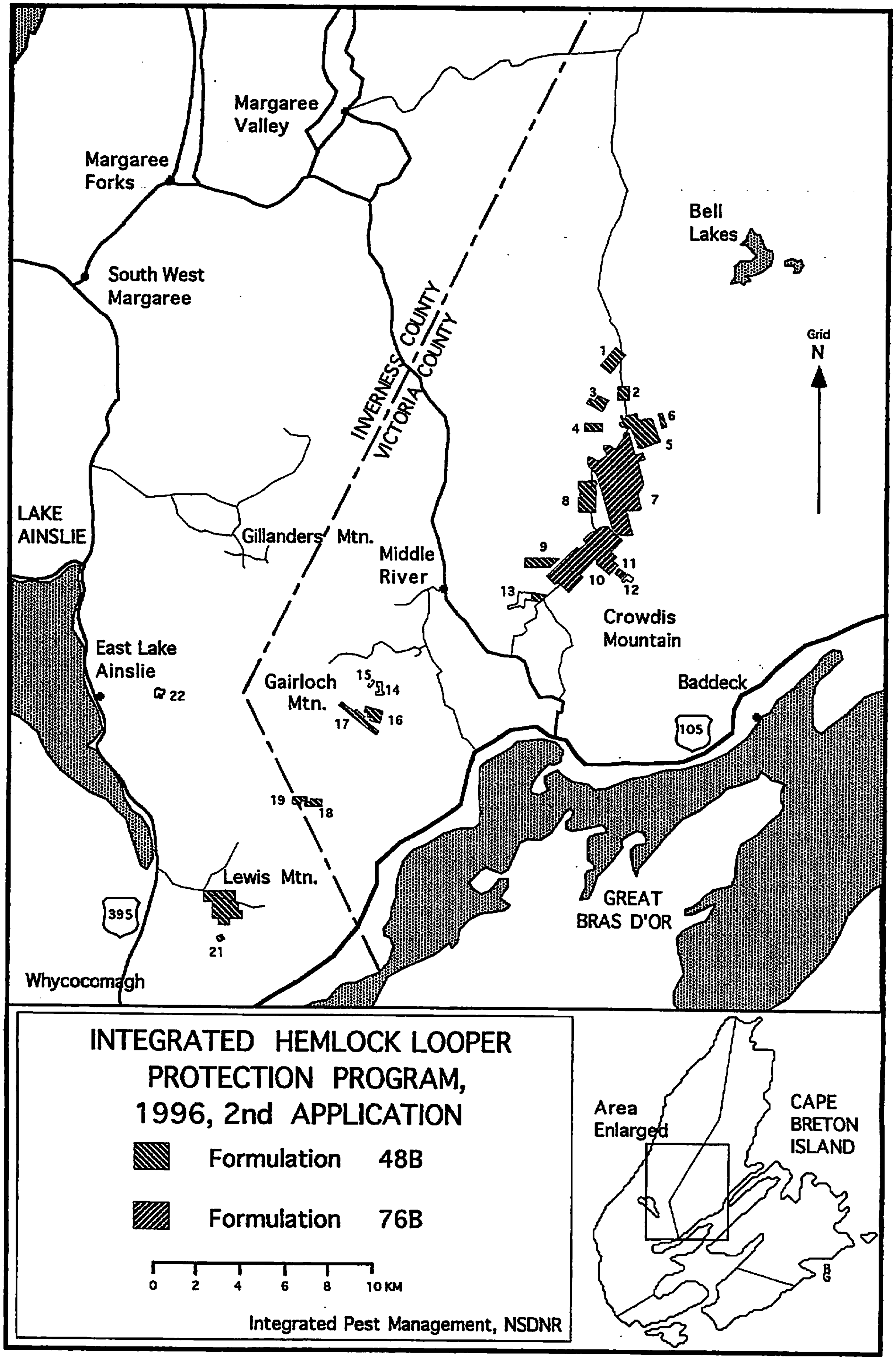

Margaree Valley
Margaree Forks
South West Margaree
Bell Lakes
Grid N
INVERNESS COUNTY
VICTORIA COUNTY
LAKE AINSLIE
Gillanders' Mtn.
Middle River
Crowdis Mountain
East Lake Ainslie
Gairloch Mtn.
Baddeck
105
Lewis Mtn.
395
GREAT BRAS D'OR
Whycocomagh
INTEGRATED HEMLOCK LOOPER PROTECTION PROGRAM, 1996, 2nd APPLICATION
Formulation 48B
Formulation 76B
0 2 4 6 8 10 KM
Integrated Pest Management, NSDNR
Area Enlarged
CAPE BRETON ISLAND

FIGURE 6

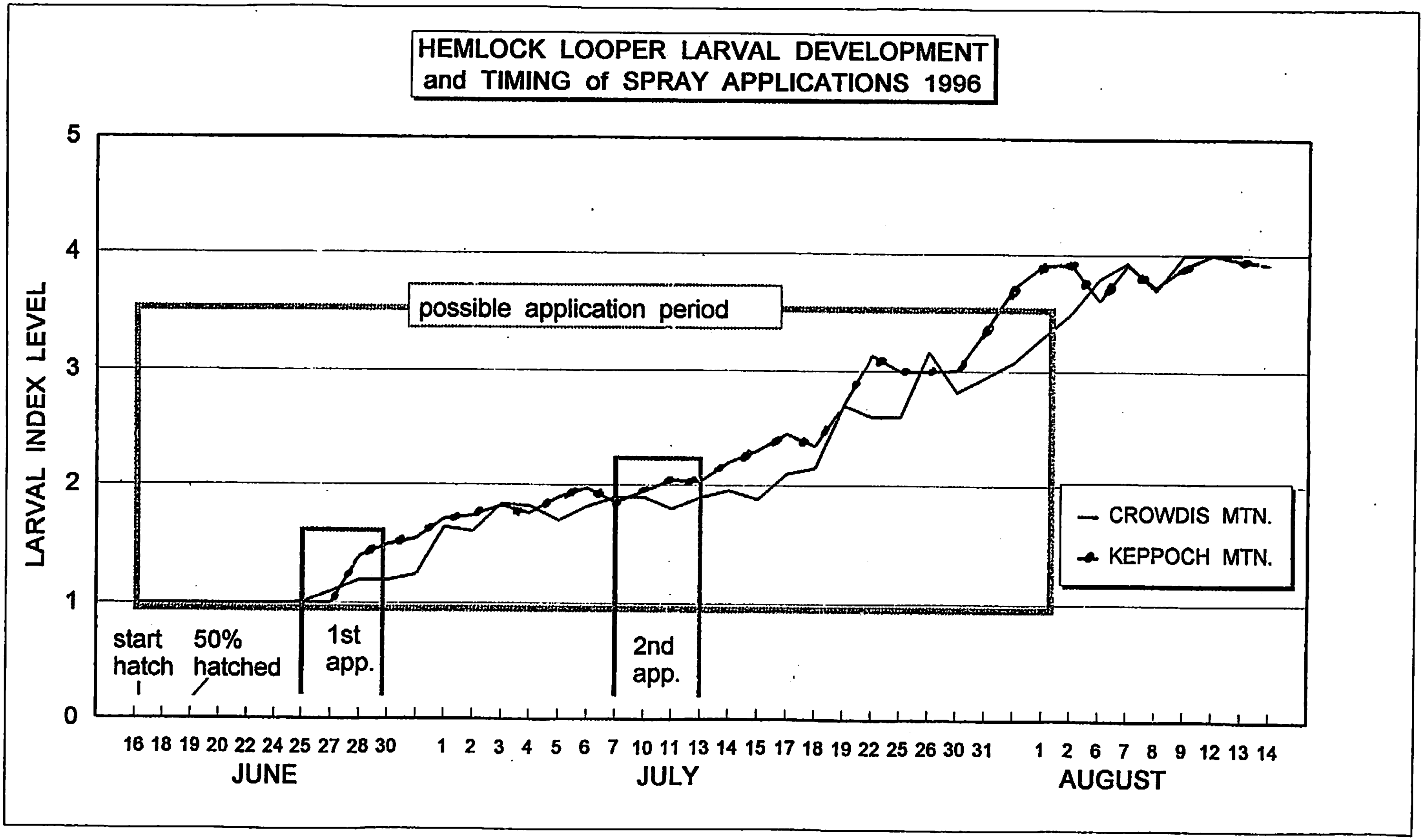
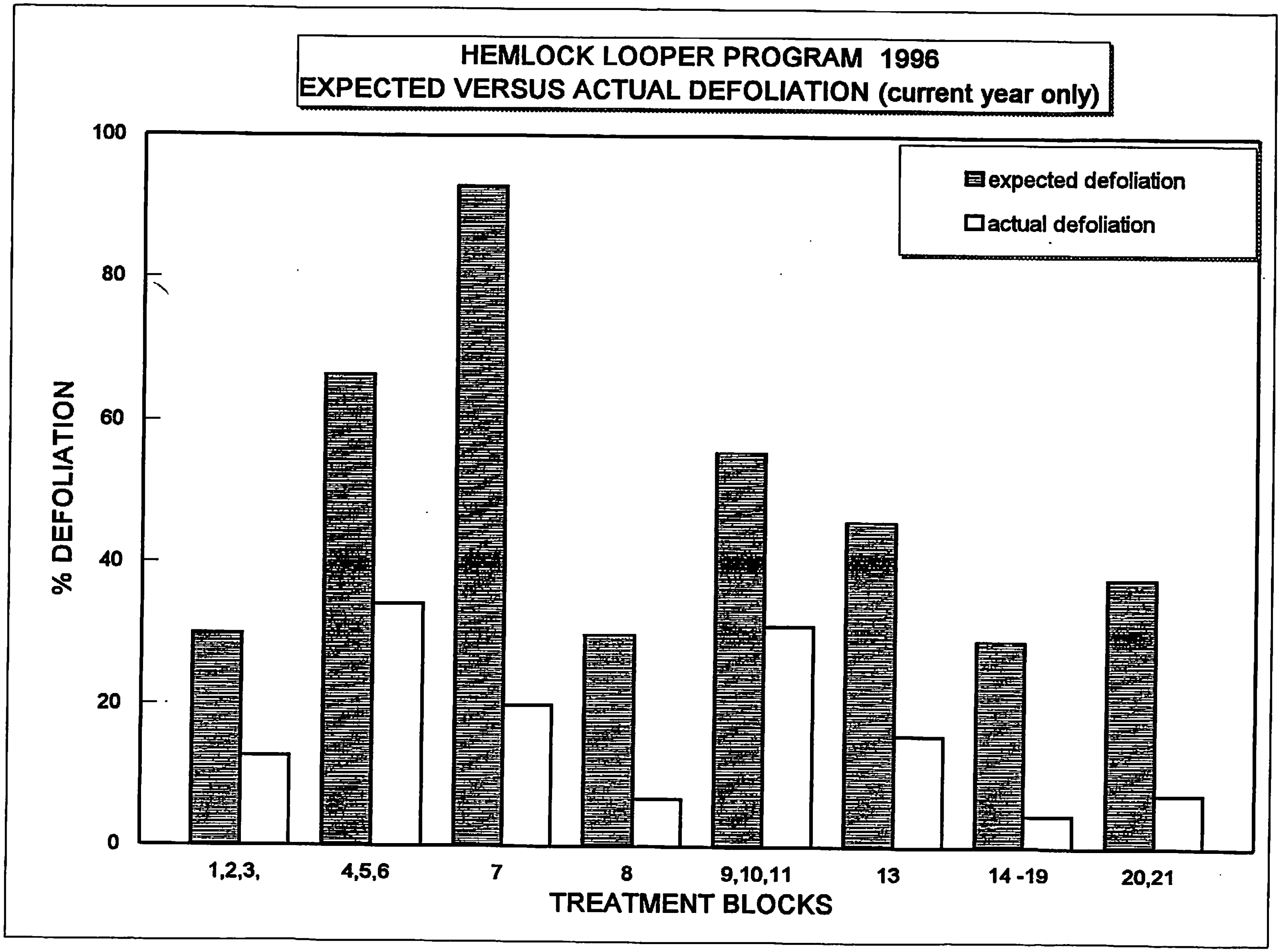
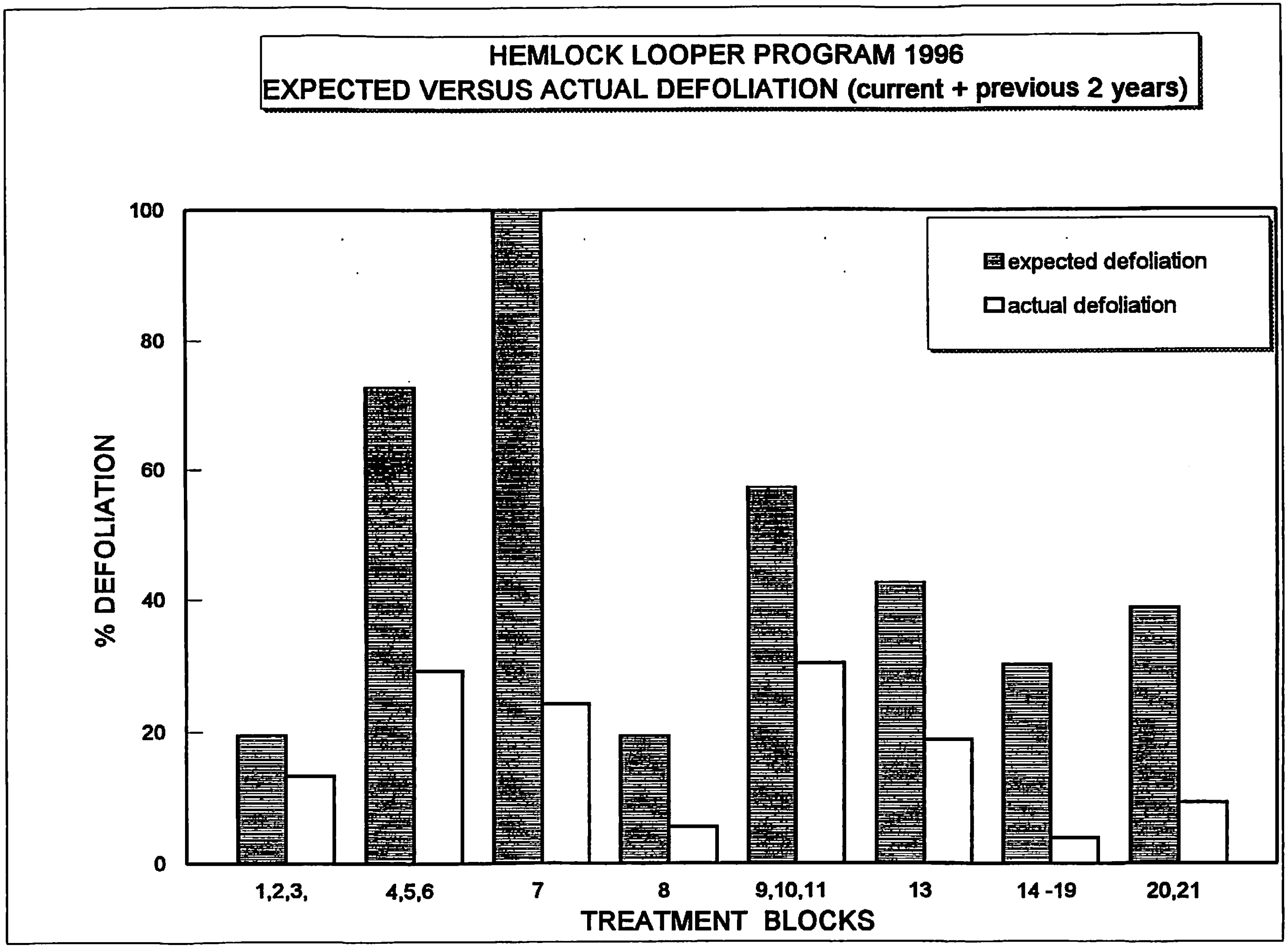

HEMLOCK LOOPER LARVAL DEVELOPMENT
and TIMING of SPRAY APPLICATIONS 1996
LARVAL INDEX LEVEL
0
1
2
3
4
5
possible application period
start hatch
50% hatched
1st app.
2nd app.
CROWDIS MTN.
KEPPOCH MTN.
16 18 19 20 22 24 25 27 28 30
JUNE
1 2 3 4 5 6 7 10 11 13 14 15 17 18 19 22 25 26 30 31
JULY
1 2 6 7 8 9 12 13 14
AUGUST

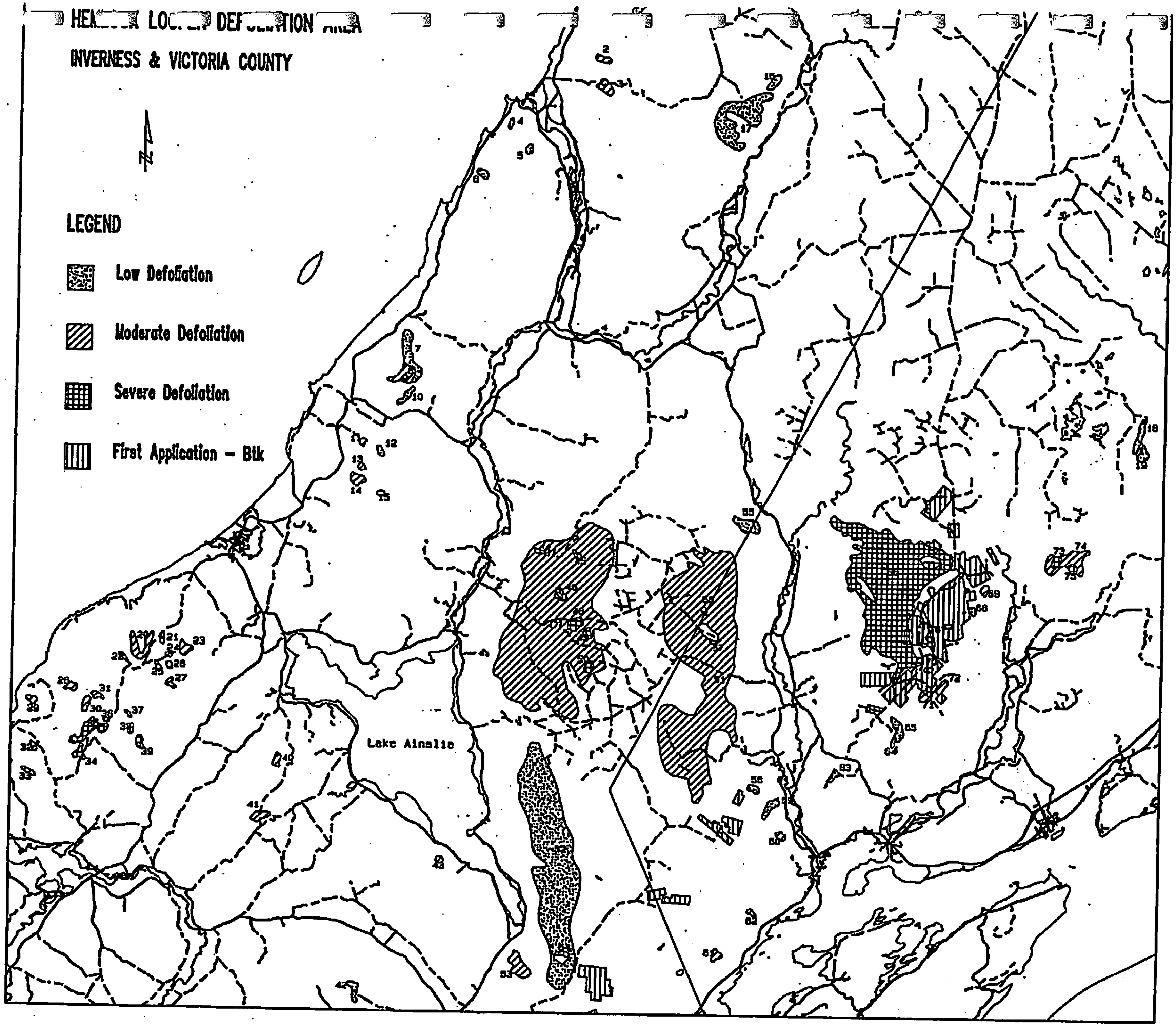
FIGURE 7



HEMLOCK LOOPER PROGRAM 1996
EXPECTED VERSUS ACTUAL DEFOLIATION (current year only)
expected defoliation
actual defoliation
% DEFOLIATION
100
80
60
40
20
0
1,2,3,
4,5,6
7
8
9,10,11
13
14 -19
20,21
TREATMENT BLOCKS

FIGURE 8


HEMLOCK LOOPER PROGRAM 1996
EXPECTED VERSUS ACTUAL DEFOLIATION (current + previous 2 years)
expected defoliation
actual defoliation
% DEFOLIATION
0
20
40
60
80
100
1,2,3,
4,5,6
7
8
9,10,11
13
14 -19
20,21
TREATMENT BLOCKS


INVERNESS & VICTORIA COUNTY
LEGEND
Low Defoliation
Moderate Defoliation
Severe Defoliation
First Application - Btk
Lake Ainslie

FOREST INSECT STATUS IN 1996 AND FORECAST FOR 1997 IN NEWFOUNDLAND

(Prepared by H. Crummey, Insect & Disease Control Section, Newfoundland Forest Service)
(for Annual Forest Pest Control Forum Report - Ottawa, Nov. 1996)

HEMLOCK LOOPER POPULATION STATUS IN 1996

Forecast for 1996

A specific forest insect defoliation forecast for 1996 was generated by the Department of Forest Resources and Agrifoods - Newfoundland Forest Service (NFS) with cooperation from Natural Resources Canada - Canadian Forest Service (CFS)-Newfoundland and Labrador Region. This forecast formed the basis for determining the need for a control program in 1996 and provided the outline to initiate identification of proposed treatment areas. Although the forecast survey was Island wide, sample plots were mainly concentrated in susceptible forest type on commercial forest. The hemlock looper forecast for 1996 covered only the expected moderate and severe defoliation categories on mainly productive, commercial forest. In total, some 189 000 ha of moderate and severe defoliation were expected with approximately 150 000 ha of this in productive forest.

Control Program, 1996

In 1996, the Newfoundland Forest Service (NFS) conducted a hemlock looper control program in western and northern Newfoundland. The proposed control program was to treat from 80 000 ha up to approximately 95 000 ha of mainly balsam fir forest using two applications of biological insecticide (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.

Spray operations were based out of the paved airstrip at Port au Choix in northern Newfoundland, and the airports at Deer Lake and Stephenville in western Newfoundland. Spray aircraft for the project consisted of four (4) teams of single-engine Dromader M-18 aircraft, 4 aircraft per team.

Spray blocks were located in west-central, western and northern Newfoundland in the forecast areas. A total of 69 208 ha were treated, consisting of fifty-seven (57) blocks, including one (1) block and three (3) extensions treated after defoliation was noticed during the program (Table 1). Of the total area, 6 035 ha (approximately 9 %) received one application, 54 074 ha (approx. 78 %) received two applications, and 9 099 ha (approx. 13 %) received three applications. All applications were made at 30 BIU per hectare per application. Spray missions began in the evening of June 22 and ended the morning of July 30. There were significant delays due to precipitation and wind. Precipitation occurred on 21 of the 39 day spray window.

Looper population levels were reduced in treated areas compared with untreated areas. Defoliation differed between treated and untreated locations especially where treatment was not delayed because of poor weather. The 1996 annual aerial survey to map defoliation was used to 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 weather caused significant delays in treatment 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.

A complicating factor was the appearance of a fungal disease in the population during the late larval (feeding) period which caused a dramatic decrease in numbers where it occurred. It is unknown how extensive this disease factor was in relation to the total infestation.

The 1996 hemlock looper spray program was considered successful in minimizing potential defoliation by reducing population levels. The weather-caused delays did not allow for the necessary ideal timing of applications or the detailed assessment normally carried out. The aerial defoliation assessment did however corroborate the observations in the field.

Hemlock Looper Status in 1996

The hemlock looper infestation had been increasing in western Newfoundland over the past few years and had increased in northern Newfoundland, particularly around Hawkes Bay. Scattered pockets of infestation had occurred over east-central and eastern areas. In 1994, about 14 000 ha were defoliated with about 11 000 ha in moderate and severe category. Control programs were carried out in 1993 and 1994 and 1995, on 15 424 ha, 10 719 ha and 48 000 ha respectively.

The defoliation survey in 1996. The survey differed from other years in that it was not a broad island-wide survey but a more concentrated effort focused mainly on productive forest areas in susceptible stands. The compilation of results also concentrated on moderate and severe infestation. Defoliation in 1996 was observed on 51 300 ha with 27 700 ha in the moderate and severe category in western and northern Newfoundland with pockets of defoliation in central and eastern locations.

BALSAM FIR SAWFLY AND POPULATION STATUS IN 1996

The infestation of this insect in western Newfoundland became noticeable in 1991 around Bottom Brook - TCH in District 14, and continues to be a problem in young and semi-mature balsam fir. In 1994, defoliation occurred on 1 216 ha in the area, with smaller patches detected near Wheelers Brook and Little Grand Lake. In 1995, high population levels were recorded from Southwest Brook north to Trout Brook and west to Harry's River and moderate and severe defoliation was observed on 12 600 ha. In 1996, the infestation increased with expanded boundaries and defoliation was detected on 19 700 ha with 15 400 ha in the moderate and severe category. The infestation appears to be increasing and expanding eastward into larger areas of valuable balsam fir PCT stands.

OTHER INSECTS

The blackheaded budworm infestation on the Great Northern Peninsula continued in 1996. In 1994, some 300 ha were defoliated, 1 400 ha in 1995 and 1 800 ha in 1996, all in the moderate and severe categories.

The eastern spruce budworm continues an endemic levels, with no defoliation mapped aerially and no reports on detected activity.

The yellowheaded spruce sawfly did cause some defoliation in black spruce plantation in central Newfoundland during 1996.

FOREST INSECT STATUS FORECAST FOR 1997

The annual fall survey to determine overwintering population levels of both the hemlock looper and the balsam fir sawfly were carried out. The main concentration of sample points were in productive, commercial forest in western and northern NF in the areas of current infestation although there was an island-wide component. Approximately 800 points were sampled. Results have been used to generate a defoliation forecast for both these insects.

Hemlock Looper

The 1997 defoliation forecast for hemlock looper indicates a total moderate and severe of 26 314 ha with a gross volume of 1.7 million m^3 ; 22 240 ha of the total area forecast being productive forest.

Balsam Fir Sawfly

The 1997 defoliation forecast for balsam fir sawfly indicates a total moderate and severe of about 54 000 ha with a gross volume of 3.2 million m^3 ; 41 000 ha of the total area forecast being productive forest.

Other Insects

It is anticipated that the other insects mentioned will remain at about the same level in 1997.

CONTROL PROGRAM FOR 1997

At this time, a significant reduction in infestation is predicted. It is estimated that a control program in the order of about 10 000 ha for hemlock looper might be required. This is presently being looked at.

The impact of the balsam fir sawfly is also being evaluated. At present, the options for control action are being pursued. A program in the order of perhaps 20 000 ha could be required.

1996 FOREST PEST MANAGEMENT FORUM

HEMLOCK LOOPER WORKSHOP AND NETWORK

R.J. West
Canadian Forest Service - Atlantic Region - Newfoundland
November 1996

Workshop. A workshop was held in Fredericton on October 6th during the Entomological Society of Canada's Annual Meeting. Recent research was summarized and actions at research and operational levels were recommended. The following is an edited version of the workshop presentations made by the participants named. Unabridged summaries will be circulated in December.

Looper Network. Rick West and Ed Kettela will set up a looper network over the winter with the intention of circulating research/operational plans in the spring and research/operational results in the fall. Anyone interested in contributing to the network or receiving the fall and spring updates should contact Rick at rwest@nefc.forestry.ca, 709-772-2386 (phone), 709-772-2576 (fax) or Ed at 506-452-3500 (phone). The first distribution is planned for December 1996.

Highlights of Hemlock Looper Workshop:

1. **Adults on Birch.** Christian Hébert (CFS-Quebec) observed thousands of moths (99% males) aggregating on white birch trees at night. The most attractive trees were small ones having highly curled bark. Apparently, the males were feeding under these small bark flaps or in bark crevices. This behavior occurred throughout the night, beginning at dusk and moths leaving at dawn. During the same nights, male attraction toward pheromone traps peaked between 10 PM and 1 AM, after male moths were already present in abundance on white birch. This phenomenon raises some questions, the first being "Can this relationship between male looper moths and white birch trees bias pheromone traps results?" Another question might be, "Does male feeding on white birch trees increase reproductive success of the looper?" and if the answer is yes, what about the importance of white birch in looper population dynamics ?

2. **Populations from different geographical areas and instar number** (C. Hébert). In 1956, Carroll stated that Newfoundland looper populations had 4 larval instars compared to 5 in Ontario. In the early '90s, Hartling et al. (1991) reported 5 instars populations for New Brunswick. During the early '70s, Luc Jobin observed that Anticosti island populations had 4 larval instars. Thus, in 1994, a population from Anticosti island and another one from the Beauce region (about 70 km south of Quebec city) were brought to the lab. Eggs were obtained and upon hatching, were placed on 3 different host trees: balsam fir, hemlock and sugar maple, the last two species being absent from Anticosti. Five trees of each species were selected for foliage collection and 15 larvae of each population were reared on foliage taken from each tree of each species. Thus, a total of 75 larvae were reared on different host tree for each population. Results confirmed that there was 4 instars for the Anticosti population and 5 for the Beauce population. However, more important with respect to

reproductive biology is the fact that male pupae of the Anticosti population were smaller than those of the Beauce population. If male moths are smaller, we must have interrogations about their ability to *flight*, their longevity, their response to pheromone... Moreover, female pupae were also smaller for the Anticosti population than those of the Beauce region. Smaller females mean lower fecundity and thus relationships between male moth captures in pheromone traps and egg densities may be quite different for Anticosti or Newfoundland populations than relationships for New Brunswick populations. The problem we have actually in Quebec is that we do not know if this is a climatic and thus latitudinal effect or a biogeographical effect. Thus, actually, we cannot be absolutely sure that Gaspesie populations, where 7500 ha have been defoliated this year, have 4 or 5 instars. More complex is the case of the Côte-Nord region where the only known data, in 1930, states that fecundity was around 80 eggs, that suggest 4 instar populations.

3. **Reproductive behavior** (J. Delisle, CFS-Quebec). A study examined:
   a) the influence of temperature during adult development on the reproductive performance of males (as determined by their ability to acquire mates on successive nights), and
   b) the combined effect of male previous matings and temperature on female reproductive output under a 12L:12D photoperiodic regime.

The mating success of a 2-day-old male paired with a 1-day old female was approximately 50% at either 20 , 15 or 10 C. However, the ability of males to repeatedly remate declined on successive nights and was more pronounced at the lower temperatures. While the weight of the spermatophore produced by males on consecutive matings decreased markedly, it did not affect female fecundity, at any temperature conditions. Similarly, within a temperature regime, male mating history had little impact on female longevity. However, temperature did affect the age specific fecundity pattern, with females held at 10 C taking more than 10 days to lay 50% of their eggs compared to 6 and 4 days at 15 and 20 C,

The time at which mating was initiated did not vary with male previous matings, however, individuals held at 20 C mated significantly later in the night (4.5h after the L-off) than those at 15 or 10 C (4 and 3.5 h after L-off, respectively). In contrast, copulation lasted significantly longer when males had mated previously, with the effect being more pronounced at cooler than at warmer temperatures. This agrees with the temperature-related changes in the onset and duration of calling previously reported by West and Bowers, (1994. Environ. Entomol. 23: 122-129), suggesting that females determined the onset time of mating in this species.

Based on the information available on the reproductive biology of the western hemlock looper (WHL) (Ostaff et al., 1974. Can. Ent.106: 659-665), the two strains appear to differ with respect to their reproductive potential, as well as mating periodicity. At 20 C, the EHL had higher fecundity (150 eggs) than the WHL (100 eggs) although both exhibited similar longevity (20 days). Furthermore, mating was initiated earlier in the night (4h after L-offs) in the EHL than the WHL (6h after L-offs).

4. **Population sampling** (C. Hébert).

Eggs: Damage predictions are usually done on the basis of egg densities on 1-m branches (at least in the east). The branches are broken in small pieces, soaked in a 2% bleach solution and washed and filtrated to complete the extraction process. This is a long tedious process to obtain estimates of egg populations.

In 1993, we decided to try to sample looper eggs with "oviposition traps", a technique commonly used to sample mosquito eggs. The first trials, where substrates were simply hanged on a branch, were a total failure. In 1994, we decided to use the Luminoc trap to attract females toward the oviposition shelter. Four different substrates were tested with or without the Luminoc. The substrates were placed around a shelter, a small cylinder pierced with 6 holes. A smaller substrate was also placed inside the shelter. The shelter was either unattached or attached to the Luminoc and simply hanged on a branch at about 4 m. Moths were free to leave the shelter which simply serves to attract female moths toward an interesting place where they can lay eggs. Substrates tested were the cheese-cloth, a flossy silk, and two foam sponge, one brown and the other white. Results clearly showed that the white foamy sponge was highly efficient to sample eggs of the looper.

In 1995, we used the same oviposition shelter in 10 different sites on Anticosti island to test it in a wide range of population densities and to compare density estimates with those of the conventional technique (1-m branch). Oviposition shelters provided estimates that are about 10-20 times higher than the branch method. Moreover, there was a good correlation between the two estimates. The oviposition shelter technique may help to discriminate low to moderate populations.

Advantages of this new approach are numerous. Sample processing and counting would only require a minute or two and thus for the same cost, we would be able to cover a larger territory or having more sampling plots per unit area. Finally, the method is tough, eggs are firmly attached within the substrate.

Pupae (health status): A new pupation shelter developed by Luc Jobin has proved to be highly efficient to sample HL pupae and many parasitoids. Sampling time is reduced because pupae do not have to be removed from the trunk as for the burlap band method. Examination of the causes of mortality in collected pupae can help determine if populations are in declining or increasing phases.

5. **Pheromone trapping**. Bruce Pendrel (CFS-Fredericton) presented a quick review of pheromone, egg, larval and defoliation survey data supplied by various cooperators (Allan Van Sickle CFS-Victoria, Wade Bowers CFS-NF, and Eric Georgeson NS). Typical trap catches and frequency distributions over a number of sample traps were described. Plots of moths per trap vs. defoliation using Newfoundland (Bowers) and Maritimes (Pendrel, Georgeson) data, suggest that 750 moths per trap may be the threshold levels where defoliation from eastern hemlock looper can be expected, however there is poor correlation between moth numbers and defoliation levels. No correlations between moth catch and either egg or larval counts were apparent for the Newfoundland data although some relationship between larval counts and moth number was apparent from B.C. western hemlock looper data in 1992 and 1993 when larger populations were available. GIS based defoliation maps are becoming available, and are important tools in the analysis of population change. Interpolated surfaces of pheromone traps for Cape Breton Island in 1995 predicted with reasonable accuracy where defoliation occurred during 1996. This spatial approach may be much more fruitful than attempting correlations with branch sampling data.

6. **Viruses** (Dave Levin U. Victoria, Imre Otvos CFS-Victoria and Chris Lucarotti CFS-Fredericton). Nuclear polyhedrosis viruses (NPVs) belong to a class of insect viruses whose strains are species-specific. NPVs, therefore, are attractive from an ecological point of view. They have been used with success in forestry against the European Pine Sawfly, Douglas Fir Tussock Moth and Gypsy Moth. However, NPVs are costly to develop for the small forestry market and virulent strains are not always

readily available in nature. NPV is present but has not been found at high levels in looper populations, and this suggests low virulence. DNA of NPV isolated from eastern hemlock looper in Newfoundland and New Brunswick is distinct from the related western hemlook looper and oak looper in British Columbia although there is considerable overlap in banding-patterns. Current objectives include the construction of physical maps of both EHL-NPV and WHL-NPV, determination of the extent of cross-hybridization and location of baculovirus whose functions are known to be important in NPV virulence and host-specificity, development of a cell culture system for in vitro propagation of the EHL-NPV and WHL-NPV) and determination of the incidence of NPV's in wild populations.

7. ***Entomophaga.*** (Faye Murrin Memorial U., Dave Tyrrell CFS-Great Lakes). The fungus, *Entomophaga aulicae*, is thought to cause the collapse of hemlock looper outbreaks in Newfoundland and is commonly recovered from mature larvae in the second year of an outbreak. *E. aulicae* has potential as an inundative tactic because it is already an established species in Newfoundland's forests and it is likely to affect few non-target species. An application of this pathogen might also have an inoculative effect when the fungus spreads from larvae initially infected to uninfected larvae. Mass production of hyphal bodies and their dissemination in the field, would constitute a convenient and effective method of augmenting low levels of the fungus during the pre-outbreak phase of the hemlock looper and may also be of value as an insecticide to be applied during outbreaks.

   Research, conducted throughout 1983-1995 by Dr. Nolan and Dr. Murrin of Memorial University with financial support and technical cooperation from CFS-NLR, was conducted to characterize and artificially mass-produce the fungus. The following summarizes the progress on this project.

   Detailed studies on the life cycle of the fungus and how it invades the insect body have been completed and methods of culturing the fungus on defined medium developed. Protoplasts are the initial and only developmental stage within the larval hemocoel until the walled hyphal bodies are formed in the dead or dying host larva. The fungal protoplasts utilize the nutrients in the insect hemolymph to weaken the host larvae (Nolan 1988). The hyphal body produces the conidiophore, which emerges from the cadaver and then produces the infective conidium. Hyphal body production in-vitro also leads to conidium production.

   Mass fermentation studies have defined the media and growing conditions, and use of the partition fermentation conditions have greatly increased the hyphal body production. Over 7 billion fungal hyphal bodies can be cultured with a medium at the 10-litre fermentation level in 6 days at facilities at Memorial University. The patented medium has application to support hyphal body and conidium production of *E. aulicae* isolates from widely separated geographical regions in Canada as well as other species of *Entomophaga*. Additional *E. aulicae* isolates need to be recovered from the field to obtain an inoculum that is more virulent and osmotically stable than the present inoculum. The initiation of larger scale production of fungal material and field trials is dependent on the success of further laboratory studies. Fermentation facilities are available in St. John's to produce hyphal bodies in quantities of 7,000 litres or more, once consistent efficacy in the laboratory is demonstrated. The biology of *E. aulicae* in the field requires significant attention.

8. **Gregarines** (Chris Lucarotti CFS-Fredericton) A protozoan was recently discovered in the guts of hemlock looper larvae in the Maritimes and was identified as a eugregarine (*Leidyana* sp.). This protozoan may have a debilitating effect on the hemlock looper, substantially extending the larval period. Although direct mortality may be of some importance, the indirect effects of gregarines may be substantial because the extended larval period allows other mortality factors such as birds.

predators, parasites and pathogens additional time to attack loopers. Surveys of hemlock looper populations in New Brunswick indicated that 50% of looper larvae were infected with gregarines in 1993 and in 1994, 80% of looper larvae were infected.

It has always been difficult to explain why looper outbreaks are most severe in Newfoundland and Anticosti Island. If this is due to lack of a biological mortality factor found in areas where the looper is present but rarely a significant threat, then the finding of any agent that is found in high incidence in such areas is of great interest. A total of 873 hemlock looper larvae were collected from 5 Newfoundland sites in 1995 and a similar number was collected in 1996 from the Hawkes Bay and Steady Brook (Marble Mountain) areas. None of these larvae contained eugregarines. It appears that eugregarines have potential as biological control agents in Newfoundland and perhaps Anticostic and Cape Breton Islands as well.

9. **Parasites**. Sentinel surveys are being undertaken in Ontario by Rob Bourchier (CFS-Great Lakes) to identify local parasitoid complexes. A larval parasitoid with good host-searching ability and specific to the hemlock looper would be useful as a biocontrol candidate in Newfoundland (and possibly Cape Breton and Anticosti Islands) (see report on Development of Controls).

10. **Population Dynamics** (Allan Carroll CFS-St. John's). The ability to forecast the impact of natural disturbances such as hemlock looper outbreaks on the composition and productivity of forest ecosystems is critical to adaptive forest management programs. However, the extreme spatial variability of hemlock looper populations has precluded predictions of their abundance and distribution within forests. Consequently, forecasts of their impacts on forest landscapes has been rendered impracticable. Given the frequency and severity of hemlock looper defoliation, detailed knowledge of the spatial dynamics of populations, enabling quantification of the pattern of future outbreaks, has become critical to sustainable forestry in Newfoundland.

    For several tree species, stand conditions affect the fitness of associated insect herbivores. Observations indicate that hemlock looper defoliation predominates in mature, slow-growing balsam fir stands suggesting that stand vigour is important to the spatial distribution of looper populations. During 1994, an investigation was initiated to elucidate the relationship between forest stand conditions and hemlock looper fitness. Specifically, the study was designed to critically evaluate the hypothesis that hemlock looper fitness is negatively related to physiological vigour (i.e. growth rate) of balsam fir trees due to vigour-related decreases in foliage quality.

    The relationship between hemlock looper fitness and balsam fir vigour was assessed through manipulations of stand conditions. During 1994, experimental blocks were delineated and silvicultural manipulations were initiated. Four "vigour" levels were chosen to represent the range of balsam fir growing conditions in Newfoundland. In order of increasing vigour, the manipulations were: root pruning (RP), control (C), thinning (T) and thinning in combination with fertilization (TF). Manipulations were randomized within 30 × 30m blocks and replicated three times to create a randomized, complete-block design. Throughout the summer of 1994, T and TF plots were thinned to achieve a spacing of 2m between trees. For the RP plots, roots were pruned along the east and west sides of all trees in each plot at the end of the growing season. Roots were pruned by cutting trenches 30 cm deep within 50 cm of the root collar of each tree. In early spring 1995, TF plots were fertilized with nitrogen, phosphorous and potassium applied at a rate of 150 kg ha^{-1} of each element. Changes in foliage morphology/phenology and chemistry relative to each vigour level were assessed during the 1995 and 1996 growing seasons. The corresponding impact of vigour-related changes to foliage on hemlock looper survival were evaluated in laboratory and field trials.

Looper survival was highest in the "moderate-vigour" stands, declining in both the stressed root-pruned stands and the vigorous thinned and fertilized stands. Impacts to larval survival were related to complex changes in both the chemical and phenological characteristics of foliage. In RP plots the amount of available protein (i.e. nitrogen:tannin ratio), and in TF plots the amount of carbohydrates, were significantly lower than the moderate-vigour C and T plots. In terms of foliar phenology, balsam fir vigour drastically affected the timing of bud development, thereby interrupting the synchrony between bud burst and looper egg hatch. In RP plots buds burst ca. 4 days later, and in TF plots they burst ca. 5 days earlier than the C and T plots. Quantification of stand conditions that influence hemlock looper fitness will enable predictions regarding the spatial distribution of populations in balsam fir forests. Efforts are currently underway to develop remote-sensing techniques to extrapolate the relationship between balsam fir stand vigour and hemlock looper fitness to the landscape level.

11. **Decision-Support Systems** (A. Carroll). In 1988, a project was initiated to develop a decision-support system to facilitate integrated management of eastern hemlock looper populations across insular Newfoundland. The hemlock looper decision-support system (HLDSS) consists of individual deterministic models constructed to predict probabilities of defoliation, subsequent timber mortality and decay, risk of impending outbreaks and regional larval phenology. Each model was embedded in a geographic information system, combined with the provincial forest inventory database (collected and maintained by the Newfoundland Department of Natural Resources), and linked to a graphical user interface. HLDSS allows users to display and modify certain rule bases, such as those that identify stand eligibility for control tactics, expected efficacies of various control measures, and mortality volume thresholds, prior to each prediction run. Predictions can be generated that calculate risk of defoliation, timber mortality and decay based on stand characteristics and past, present and expected hemlock looper population levels.

    Until recently, there has been no occasion to examine the predictive capacity of HLDSS. However, an increase in hemlock looper populations across insular Newfoundland during 1994 provided an opportunity to evaluate some of the models that comprise the present system. Predictions of the extent and distribution of hemlock looper defoliation form the basis of the current decision-support system. Accordingly, the area and number of forest stands actually defoliated by the hemlock looper in the Corner Brook region of Newfoundland in 1995 was directly compared with that predicted by the defoliation risk models of HLDSS. Whereas 12,290 ha of forest and 1,884 stands were defoliated by the hemlock looper in the study area, the decision-support system predicted a significant probability of defoliation for only 1649 ha and 262 stands.

    The limited predictive capacity of HLDSS can be attributed to extensive natural and anthropogenic alterations to the forests of insular Newfoundland during the last several decades. Specifically, extensive harvesting and widespread outbreaks by insect defoliators have reduced the distribution and abundance of mature and over-mature balsam fir stands over historical levels. Given the preference of hemlock looper for old versus young balsam fir, a reduction in the distribution and abundance of these stands has almost certainly influenced the dynamics of looper populations thereby precluding predictions of defoliation risk derived from historical population patterns. Ongoing research toward the development of process-based models simulating the interaction between hemlock looper and balsam fir forests will yield more accurate predictions of looper impacts.

12. **Operational Spraying.** Rick West (CFS-St. John's) and Ed Kettela (CFS-Fredericton) confirmed that existing operational options are limited to *B.t.* and MIMIC. N. Carter (N.B.), E. Georgensen (N.S.) and H. Crummey (NF.) identified the need for more controls. There was general consensus that consultations with the public and press need to be improved.

In 1996 tests in Newfoundland, aqueous formulations of B.t. (ABG6414 and ABG6432) and MIMIC 240 LV were applied at a rate of 2 L/ha (B.t. - 35 BIU/ha, two applications one week apart against L2 and L3, respectively), MIMIC 70 g.a.i./ha, one application either mid-way during larval hatch or against L2) against moderate and high populations of the hemlock looper in Newfoundland in 1996. Treatments with the exception of the early MIMIC application were delayed by two weeks due to wet weather. Most of the defoliation occurred by mid-July and considerable damage was done by L1 and L2 larvae. The wet weather contributed to an outbreak of *Entomophaga* which caused a collapse of late-stage larvae and pupae in the experimental area. Feeding damage would have been extremely severe if the *Entomophaga* outbreak did not occur. Field data and bioassays with sprayed foliage indicated that the insecticides tested performed well. Sprayed foliage is being processed at CFS-Sault Ste. Marie to determine levels of active ingredient of *B.t.* (K. van Frankenhuyzen - ADAM kits) and tefubenozide (D. Thompson - G.C.). These data will be used to determine correlations with bioassay results

13. **Mating Disruption.** There is some corporate interest in developing the hemlock looper pheromone as a mating disruptant. This will be pursued over the winter.

14. **Perspectives of a Forest Manager.** Nelson Carter (N.B. Dept. of Natural Resources and Energy) with input from Hubert Crummey (Nfld. Dept. of Forestry and Agrifoods), and Eric Georgeson (N.S. Dept. of Natural Resources) reviewed the hemlock looper problem from the perspective of a forest manager. A proactive stance is recommended in view of the rapid and serious impact of this insect.

Costs: The cost of control has increased substantially in the past decade as there has been a reduction in the use of chemical insecticide and an increase in the use of the more costly biological insecticide, *B.t.* Costs as high as $50/ha are now often incurred for programs that could cost half that amount. For programs that are <100 000 ha, this might be an acceptable cost (ie. $5 million). If, however, the program were up to a million ha or more in size (not an uncommon occurrence with past outbreaks of spruce budworm), it would be interesting to see how the decision- makers would react to a bill of $50+ million. Undoubtedly, some hard choices would have to be made. Forest managers, including the ultimate political decision-makers, need affordable and acceptable control options or losses of significant fibre and non-fibre resources, including possible old growth forests and ecological reserves, are inevitable. Costs vary between jurisdictions depending on many factors such as: number and type of aircraft, dosage rates and number of applications, logistical/operational considerations, etc.

Surveys: Any sign of population increase is important. Aerial surveys are valuable in the delimitation of damage and follow-up egg surveys provide a forecast of outbreak extent and severity for the ensuing year, essential for protection planning. There is still some uncertainty about when to class areas in the moderate range. In this case, it is not unusual to err on the side of caution and expect damage because it is easier to cancel spray blocks than it is to add them, or leave areas untreated when they should have been protected. More intensive sampling (if time, cost and opportunity permit) is another possibility to aid in making the forecast more precise before determining final protection plans. The benefit of increased sampling is evident as the elimination of one 10 000-ha block represents a saving of half a million dollars. From the New Brunswick perspective it is not the absolute number of eggs that is important, but rather a relative scale that is dependable for predicting moderate or greater damage. In this regard, our current thinking is that sampling branches and extracting the eggs is appropriate once outbreak levels are attained. This is done with a single visit to field sampling sites (followed by laboratory processing to extract the eggs) rather than putting out some type of "trap" and having to make a second trip to the field to obtain the trap for processing. The use of pheromone traps to capture male moths and the use of 'Kriging' to produce a surface map of differing levels of populations is a technique of interest for future use, especially between outbreaks.

Alternative Controls: Fungi, viruses, and other microbials are still in various stages of research and development; many have been under study for several decades (especially fungi). For the forest manager this gets to be a tiresome wait! Host-specific parasitoids are not expected to be available on a commercial scale for operational application. Assuming environmental acceptability has been achieved, appropriate agents must be affordable, available, and efficaceous.

Operational Options: Present control options are limited. Federal regulatory cancellation of large-scale aerial application of fenitrothion (the only practical chemical that was available) after 1998 leaves the more expensive *B.t.* as the most probable option. Whereas there are several different *B.t.* products registered, competition as a means to keep costs down is greatly reduced by corporate mergers. Furthermore, there is concern about the inconsistent results obtained with *B.t.* and a growing concern over the acceptability of using these products. Instances of strong lobbying against the use of *B.t.* occurred in Newfoundland and Nova Scotia this past summer. Similar concerns were raised in Vancouver, British Columbia, a few years ago when *B.t.* was sprayed over the city to eradicate the Asian Gypsy Moth. If biological products such as *B.t.* are removed, there are virtually no control options left to combat an outbreak of hemlock looper. Newly-registered MIMIC has some potential but is likely to encounter similar public opposition as *B.t.* The development of pheromone-mating disruption strategies are recommended because they have the potential to have minimal non-target impact and hence be the safest environmental option to choose.

Population Monitoring and DSS: It is recognised that process-based studies need to be long-term and are difficult to finance. Concerns include the predictability and appropriateness of historically-based DSS, especially in areas where the models were not developed (i.e. using the EHL-DSS in N.B.).

Public Information: Inaccurate and unsubstantiated public statements regarding insect control operations need to be addressed.

1996 FOREST PEST MANAGEMENT FORUM

Development of Control Tactics against the Hemlock Looper

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Inundative and inoculative control tactics to manage populations of the hemlock looper have been under development for the past five decades. Inundative tactics involve application of a mass-produced product and generally are intended for employment during outbreaks to prevent damage over the short-term. Inoculative tactics involve the importation and introduction of a known or potential natural enemy of the pest insect and represent a long-term approach. Successful establishment of the introduced natural enemy augments the existing complex of natural enemies, permanently suppressing the pest densities to less damaging levels, and perhaps reducing the frequency of outbreaks. There is also the potential for non-lethal forms of control, including disruption of mating by application of pheromone, and modifying silvicultural and harvesting schedules to reduce the impact of the looper.

Inundative Control Tactics

A. Experimental Spray Programs against the Hemlock Looper (1985-1996)

Various formulations and dosages of *Bacillus thuringiensis* (*B.t.*), fenitrothion, diflubenzuron, aldicarb and tefubenozide were evaluated for efficacy in experimental spray programs conducted during 1985, 1986, 1987, 1988, 1995 and 1996. *Bacillus thuringiensis* formulations persist only for a few days and are lethal to a narrow range of species, affecting mainly lepidopterous larvae. Fenitrothion is an organophosphorous insecticide, and is toxic to a wide range of invertebrates and is somewhat toxic to small birds at operational doses. Aldicarb is a carbamate insecticide and like fenitrothion is broadly toxic to invertebrates, however, it has little impact on birds. Diflubenzuron is an insect growth regulator and is toxic to immature insects and some aquatic invertebrates. Tefubenozide is a synthetic biochemical insecticide that precipates a premature moult resulting in larval starvation. Other than feeding lepidoptera, tefubenozide negatively affects few species.

1985: Water-based formulations of *B.t.* (Thuricide 48 LV, Thuricide 64B, Futura), fenitrothion (Sumithion technical grade, Sumithion 20F), diflubenzuron (Dimilin) and aldicarb (Matacil 180F) were tested for efficacy. Double applications of Thuricide 64B at 30 BIU/ha, double applications of Dimilin at 70 g.a.i./ha and double applications of technical grade Sumithion at 210 g.a.i./ha resulted in population reduction, however, foliage protection was not demonstrated (Raske *et al.* 1986, West *et al.* 1987).

1986: Water-based formulations of diflubenzuron (Dimilin 25WP) and fenitrothion (Sumithion technical grade, Sumithion 20F) were tested. All formulations tested resulted in population reduction. however only the fenitrothion formulations provided foliage protection (Raske and Retnakaran 1987).

1987: Oil-based formulations of *B.t.* (Dipel 132, Dipel 176 and Dipel 264), water-based formulations of diflubenzuron (Dimilin 25 WP and Dimilin Flowable), and oil-based formulations of fenitrothion

(Sumithion technical grade and Folithion technical grade) were tested. Single and double applications of the *B.t.* formulations and early applications of fenitrothion targeted against first-instar larvae resulted in excellent foliage protection (West *et al.* 1989, Raske *et al.* 1992). Double applications of Dimilin 25 WP provided good foliage protection, however, Dimilin Flowable was ineffective (Raske *et al.* 1992, Retnakaran *et al.* 1988). Deposit characteristics of the formulations tested were determined (Raske *et al.* 1989, Sundaram *et al.* 1988, Sundaram A. *et al.* 1987, Sundaram K.M.S. *et al.* 1987).

1988: Oil-based formulations of B.t. (Dipel 176 and Dipel 264), a water-based B.t. formulation (Futura XLV), and an oil-based formulation of diflubenzuron (Dimilin ODC) were tested. Early application of Dipel 176 and 264 provided excellent foliage protection whereas the applications of Futura XLV and Dimilin ODC provided inadequate foliage protection (West *et al.* 1992).

1995: Water-based formulations of *B.t.* (ABG6387 and ABG6414), and the biochemical tebufenozide (MIMIC 240LV) were tested against light-to-moderate infestations. The formulations of *Bacillus thuringiensis* were applied twice at rates of 19.3-24.1 BIU in 1.54-1.93 L/ha for ABG6387 and 33.2-36.0 BIU in 1.67-1.80 L/ha for ABG6414. Tefubenozide was applied once at rate of 65.1 g.a.i. in 1.86 L/ha and twice at a rate of 33.4-35.4 in 1.91-2.02 L/ha. MIMIC 240LV and ABG6387, ABG6414 reduced larval numbers and reduced defoliation in balsam fir forests with low to moderate populations of the hemlock looper, despite rainfall within 4-18 h of application (West *et al. In press*).

1996: Aqueous formulations of B.t. (ABG6414 and ABG6432) and MIMIC 240 LV were applied at a rate of 2 L/ha (B.t. - 35 BIU/ha, two applications one week apart against L2 and L3, respectively), MIMIC 70 g.a.i./ha, one application either mid-way during larval hatch or against L2) against moderate and high populations of the hemlock looper in Newfoundland in 1996. Treatments with the exception of the early MIMIC application were delayed by two weeks due to wet weather. Most of the defoliation occurred by mid-July and considerable damage was done by L1 and L2 larvae. The wet weather contributed to an outbreak of *Entomophaga* which caused a collapse of late-stage larvae and pupae in the experimental area. Feeding damage would have been extremely severe if the *Entomophaga* outbreak did not occur. Field data and bioassays with sprayed foliage indicated that the insecticides tested performed well. Sprayed foliage is being processed at CFS-Sault Ste. Marie to determine levels of active ingredient of *B.t.* (K. van Frankenhuyzen - ADAM kits) and tefubenozide (D. Thompson - G.C.). These data will be used to determine correlations with bioassay results.

B. Mass-production of an Entomopathogenic Fungus

The fungus, *Entomophaga aulicae*, is thought to cause the collapse of hemlock looper outbreaks in Newfoundland and is commonly recovered from mature larvae in the second year of an outbreak. *E. aulicae* has potential as an inundative tactic because it is already an established species in Newfoundland's forests and it is likely to affect few non-target species. An application of this pathogen might also have an inoculative effect when the fungus spreads from larvae initially infected to uninfected larvae. Mass production of hyphal bodies and their dissemination in the field, would constitute a convenient and effective method of augmenting low levels of the fungus during the pre-outbreak phase of the hemlock looper and may also be of value as an insecticide to be applied during outbreaks.

Research, conducted throughout 1983-1995 by Dr. Nolan and Dr. Murrin of Memorial University with financial support and technical cooperation from CFS-NLR, was conducted to characterize and artificially mass-produce the fungus. The following summarizes the progress on this project.

Detailed studies on the life cycle of the fungus and how it invades the insect body have been completed and methods of culturing the fungus on defined medium developed. Protoplasts are the initial and only developmental stage within the larval hemocoel until the walled hyphal bodies are formed in the dead or dying host larva. The fungal protoplasts utilize the nutrients in the insect hemolymph to weaken the host larvae (Nolan 1988). The hyphal body produces the conidiophore, which emerges from the cadaver and then produces the infective conidium (Murrin and Nolan 1987, Murrin and Nolan 1989). Hyphal body production in-vitro also leads to conidium production (Nolan 1993).

Mass fermentation studies have defined the media and growing conditions, and use of the partition fermentation conditions have greatly increased the hyphal body production (Nolan 1986, Nolan 1990, Nolan 1993, McDonald and Nolan 1995). Over 7 billion fungal hyphal bodies can be cultured with a medium at the 10-litre fermentation level in 6 days at facilities at Memorial University. The patented medium has application to support hyphal body and conidium production of *E. aulicae* isolates from widely separated geographical regions in Canada as well as other species of *Entomophaga*. Additional *E. aulicae* isolates need to be recovered from the field to obtain an inoculum that is more virulent and osmotically stable than the present inoculum. The initiation of larger scale production of fungal material and field trials is dependent on the success of further laboratory studies. Fermentation facilities are available in St. John's to produce hyphal bodies in quantities of 7,000 litres or more, once consistent efficacy in the laboratory is demonstrated. The biology of *E. aulicae* in the field requires significant attention.

C. Nuclear Polyhedrosis Viruses

Nuclear polyhedrosis viruses (NPVs) belong to a class of insect viruses whose strains are species-specific. NPVs, therefore, are attractive from an ecological point of view. They have been used with success in forestry against the European Pine Sawfly, Douglas Fir Tussock Moth and Gypsy Moth. However, NPVs are costly to develop for the small forestry market and virulent strains are not always readily available in nature. NPV is present but has not been found at high levels in looper populations, and this suggests low virulence. DNA of NPV isolated from eastern hemlock looper in Newfoundland and New Brunswick is distinct from the related western hemlook looper and oak looper in British Columbia although there is considerable overlap in banding-patterns. Current objectives include the construction of physical maps of both EHL-NPV and WHL-NPV, determination of the extent of cross-hybridization and location of baculovirus whose functions are known to be important in NPV virulence and host-specificity, development of a cell culture system for in vitro propagation of the EHL-NPV and WHL-NPV) and determination of the incidence of NPV's in wild populations (Dr. C. Lucarotti, CFS-Fredericton, and Dr. D. Levin, U. of Victoria, personal communication).

Inoculative Control Tactics

A. Natural Enemies of the Hemlock Looper in Newfoundland

Natural enemies of the looper help to limit the size and duration of looper outbreaks and are important in keeping looper numbers low between outbreaks. However, the present complex of natural enemies (Otvos 1973) nevertheless fails to prevent widespread tree mortality and potential natural enemies should be considered for introduction from other areas of Canada or the world. Parasitization of the egg and early larval stages of the hemlock looper is generally low. These life stages represent unfilled niches that could be exploited by new introductions. Such introductions would also have the advantage of reducing the level of defoliation during the year of attack because the parasitized loopers would die before reaching the most damaging stages. The most common parasite now is *Winthemia occidentis*, a fly obtained from the western hemlock looper and oak looper in British Columbia and introduced in 1949-51. The success of this introduction is indicative of the potential of the inoculative strategy.

B. Screening of Exotic Parasitoids

A cooperative project was undertaken during 1991-1995 with the International Institute of Biological Control to identify parasitoid species suitable for screening against the hemlock looper. Twenty geometrid species were recovered from annual surveys in coniferous forests in the Swiss Alps and of these three were identified as sources for four parasitoids considered suitable for screening: *Epirrita autumnata*, *Agriopis aurantiaria* and *Poecilopsis isabellae*. Two univoltine species of *Dusona* (Hymenoptera: Ichneumonidae), *D. contumax ex. A. aurantiaria* and *D.* sp. *ex. P. isabellae*, and two univoltine species of *Aleiodes* (Hymenoptera: Braconidae), *A. gastritor ex. E. autumnata* and *A.* sp. *ex. P. isabellae*, were reared in the laboratory and exposed to their native hosts to determine adult longevity, attack frequency and duration, and egg production. Small numbers of these parasitoids were shipped to Newfoundland and screened in the laboratory against the hemlock looper. The parasitoids screened did not readily attack and none developed on hemlock looper larvae. All parasitoid eggs recovered from the hemlock looper larvae attacked were encapsulated. *D. contumax*, *Dusona* sp. *ex P. isabellae, A. gastritor* and *Aleoides* sp. *ex P. isabellae* are not recommended for introduction against the eastern hemlock looper.

In 1997, lab screening of *Cotesia jucunda* (Ichneumonidae) from Sweden on EHL if the parasitoid is available.

C. Identification of Parasitoids Suitable for Introduction from other Parts of Canada

Additional surveys are warranted in areas of Canada where the hemlock looper is present but rarely a problem, and where a high incidence of parasitism is found. Released and recovered hemlock looper larvae could be used to advantage in such surveys. A project to identify parasitoid species attacking the hemlock looper on Manitoulin Island in Ontario was initiated with CFS-Sault Ste. Marie in 1996. At Sault Ste Marie sites where 1000-2000 HL were released per tree between 2.5 and 4.5 % of the larvae were recovered. Parasitism was low: 1 species of tachinid and 2 species of Ichneumonid were collected. At Manitoulin sites where 5000 HL were released per tree less than 0.5% of thelarvae were recovered and parasitism consisted of 1 ichneumonid specimen. Plans for 1996 include repeated exposures of HL larvae (possibly including tethered larvae) near SSM every 2 weeks starting in late June until Mid August.

D. Gregarines

A protozoan parasite was recently discovered in the guts of hemlock looper larvae in the Maritimes and was identified as a eugregarine (*Leidyana* sp.) (Dr. Chris Lucarotti, CFS-Fredericton, personal communication). This protozoan may have a debilitating effect on the hemlock looper, substantially extending the larval period. Although direct mortality may be of some importance, the indirect effects of gregarines may be substantial because the extended larval period allows other mortality factors such as birds, predators, parasites and pathogens additional time to attack loopers. Surveys of hemlock looper populations in New Brunswick indicated that 50% of looper larvae were infected with gregarines in 1993 and in 1994, 80% of looper larvae were infected (Dr. Chris Lucarotti, CFS-Fredericton).

It has always been difficult to explain why looper outbreaks are most severe in Newfoundland and Anticosti Island. If this is due to lack of a biological mortality factor found in areas where the looper is present but rarely a significant threat, then the finding of any agent that is found in high incidence in such areas is of great interest. A total of 873 hemlock looper larvae were collected from 5 Newfoundland sites in 1995 and a similar number was collected in 1996 from the Hawkes Bay and Steady Brook (Marble Mountain) areas. None of these larvae contained gregarines (Dr. Chris Lucarotti, CFS-Fredericton) and thus it appears that eugregarines have potential as biological control agents in Newfoundland.

Pheromone-Mating Disruption

The hemlock looper pheromone is commercially available as a monitoring agent. If used as a mating disruptant, it is likely to be species-specific and have a benign, if any, effect on non-target organisms. A commercial partner is essential for commercialization of the pheromone as a mating disruptant.

Silviculture and Harvesting

Current research on the factors influencing the spatial dynamics of hemlock looper by A. Carroll (CFS-St. John's) and E. Bauce (U. Laval) will assist forest managers in developing silvicultural and harvesting plans.

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Update on Exotic Forest Pests and Plant Quarantine Surveys

Organizational changes

In March, the Canadian government announced the federal food inspection and quarantine system of Canada would be reorganized into the Canadian Food Inspection Agency (CFIA). This agency will include food inspection programs now in Agriculture, Health Canada and Fisheries and Oceans, under the Minister of Agriculture and Agrifood. The aim is to improve food safety, trade and commerce, and to reduce duplication of services. There will be about 4,500 people in the new agency.

All of animal and plant quarantine will go to the agency. Cost reduction, cost recovery and privatization, already in progress, will continue and probably increase. Most significantly for the group here today, forestry aspects of the Plant Protection program mandate will apparently be included in the new agency, even though there is no mention of anything other than food in the agency name. The name of the Chief Executive Officer has not been announced. Enabling legislation, setting out the responsibilities of the new agency, was tabled in parliament on September 19th. It is expected to begin operating in April 1997.

Asian Gypsy Moth (*Lymantria dispar* L.)

All males trapped in British Columbia this year are of North American biotype. The current Agriculture and Agrifood Canada policy is to survey and delimit prior to treatment. There is no evidence so far that immediate spraying around a single intereception is more effective in preventing an introduction than intensive delimiting trapping first. Introduction via ships has been minimised by the joint U.S./Canada AGM shipping policy. However, interceptions in British Columbia over the last two years suggest that other pathways may be involved. AAFC intends to cooperate with the USDA to prevent the introduction and establishment of AGM in North America.

Estimation of the prevalence of genetic markers in the Canadian gypsy moth population

The trapping design used in 1995 had a total of 18 trapping sites. One site not trapped because of technical difficulties was trapped in 1996, following the same protocol, and a site which had been trapped in 1995 was trapped again in 1996 for comparison with the missing site. About 12,000 moths were caught in 1995. A subsample of the moth catch (~1,800 specimens) were dissected: one half was frozen and the other half was processed for DNA. This DNA has been stored and can be used several times with different markers for polymerase chain reaction (PCR) testing. This study, along with other data, will help to establish the origin of a given gypsy moth, improving the present diagnostic test.

Dunnage

AAFC finalised a dunnage policy requiring port authorities to establish designated areas for storage of clean dunnage. Dunnage which has bark attached to it, insect damage or other symptoms must be disposed of or treated by deep burial or incineration.

In conjunction with this policy, and stimulated by a discovery of *Ips typographus* beetles in wooden pallets arriving in Hamilton last winter, an exotic bark beetle survey was undertaken at the major Canadian ports in 1996, using Lindgren funnel traps, with an attractant for *Ips* species and other bark beetles. One specimen of *Ips typographus* was trapped in Montreal in early May. Following a complete clean-up effort throughout the port, no junk wood remained. Two more beetles were trapped in other parts of the port later in May, and trapping was extended to areas with host material within 16 k of the port. About 55 sites were trapped, using 170 traps. Fortunately, no further beetles were found in this exercise. No other ports in Canada trapped *Ips typographus*.

Pine shoot beetle *Tomicus piniperda* (L.)

1996 results bring the total to sixteen infested counties in Ontario (see map). No other provinces of Canada have yet been found to be infested, despite repeated surveys.

Asian longhorn beetle (*Anoplophora glabripennis* Motschulsky)

This species, recently discovered in New York, has been intercepted in Canada in the past, a large number of beetles having been caught in B.C. in 1992.Plant Protection Division was informed that some fire wood from the infested area in New York had been trucked into Quebec. The material was inspected and no trace of beetles found.

As a follow-up to the earlier finds in B.C., a survey was carried out this fall at the original discovery site and around other areas where dunnage has been kept. No indications of establishment were found.

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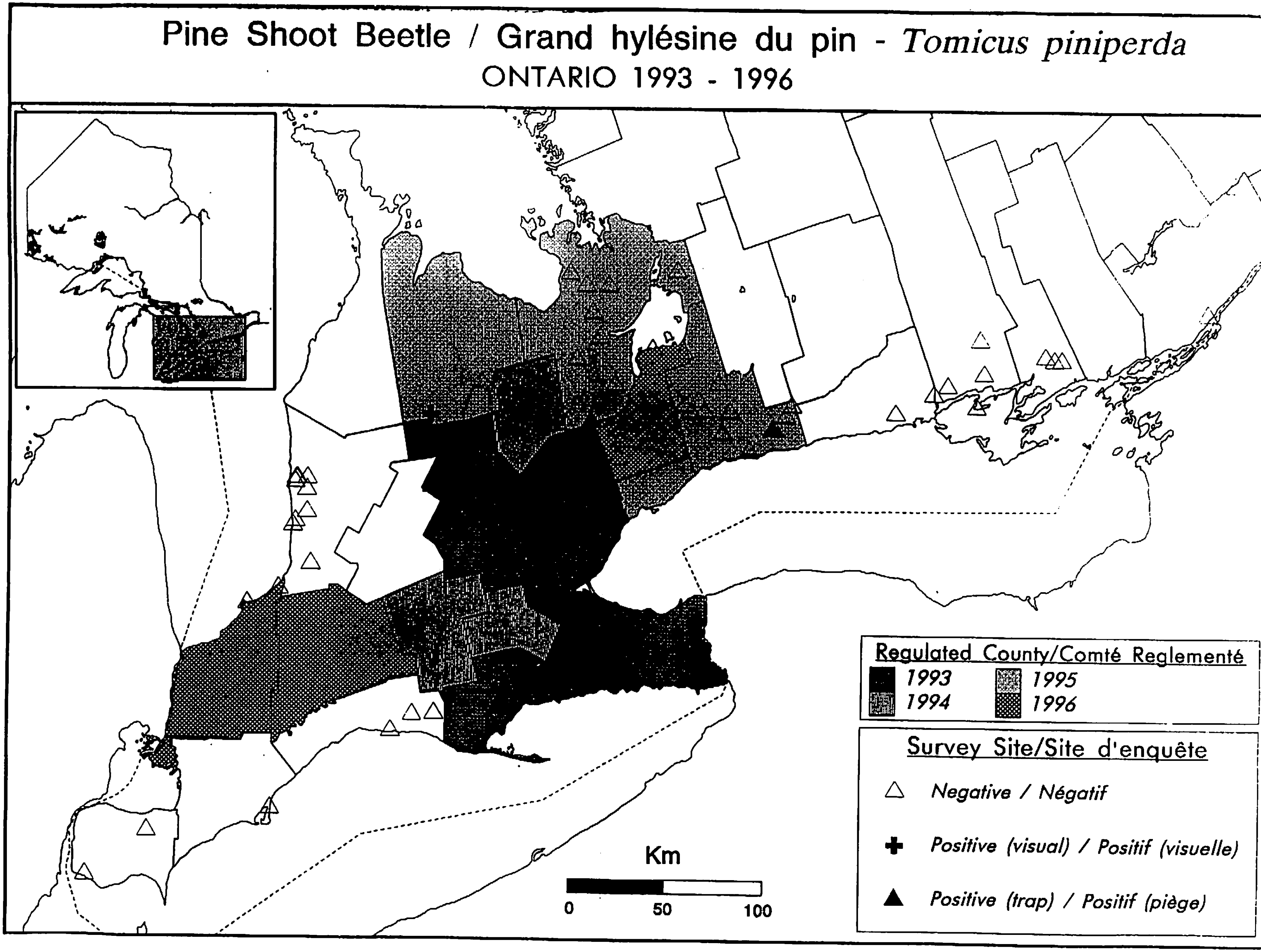
Pine Shoot Beetle / Grand hylésine du pin - Tomicus piniperda
ONTARIO 1993 - 1996
Regulated County/Comté Reglementé
1993
1994
1995
1996
Survey Site/Site d'enquête
Negative / Négatif
Positive (visual) / Positif (visuelle)
Positive (trap) / Positif (piège)
Km
0
50
100

Effects of Azadirachtin-Based Insecticides on the Egg Parasitoid, *Trichogramma minutum* Riley (Hymenoptera: Trichogrammatidae)

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The effects of azadirachtin formulations on the reproduction and survival of the egg parasitoid, *Trichogramma minutum* were examined in the laboratory to assess their compatibility in integrated pest management programs. A novel bioassay was developed for this purpose which could be used as a model ecotoxicological system to assess the potential effects of insecticides on a beneficial insect parasitoid. Radiation-killed eggs of the Mediterranean flour moth, *Anagasta kuehniella* (Zeller), that had been treated with azadirachtin-based insecticides, were presented to individual females of *T. minutum*. These eggs were then held until any parasitoids completed development and emerged from the eggs. Survival of the females 1 and 3 days after treatment, number of eggs parasitized, proportion of parasitized eggs from which adults emerged and sex ratios of emerging adults were determined. Azatin® EC(3% aza., AgriDyne Inc., Salt Lake City, USA), 'Neem EC' (experimental formulation, 4.6% aza., Phero Tech, Delta, BC, Canada) and 100% azadirachtin were tested at 50 g azadirachtin/ha (standard dosage) and 500 g azadirachtin/ha.

At 50 g/ha, no significant effects were observed with these treatments. At 500g/ha, female survival after one day was significantly reduced 64% by Azatin and 40% by Neem EC compared to controls. No reduction was evident with azadirachtin suggesting that other components of the formulations were responsible for the toxicity to females. Likewise, at 500g/ha, the number of eggs parasitized was reduced 89% by Azatin, 29% by Neem EC but not reduced by azadirachtin. These reductions in egg parasitism were probably indirectly due to the effects on females. At 500gha, parasitoid development success was reduced by all treatments including azadirachtin (Azatin - 79%, Neem EC - 45%, azadirachtin - 37%). Sex ratio of emerging adults was not affected. These results indicate that azadirachtin is compatible with *T. minutum* during egg parasitism at standard dosages.

Development of Neem Seed Extract for Forest Insect Pest Management in Canada

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Neem seed extract containing azadirachtin has great potential for managing several forest insect pests. In laboratory activity spectrum studies, neem was very potent to 12 species of lepidopteran and sawfly larvae and competitive with standard insecticides. Sawfly larvae are particularly susceptible (eg. LC50 - 0.04g azadirachtin/ha, introduced pine sawfly, *Diprion similis* (Hartig)(Hymenoptera, Diprionidae)).

Field trials were conducted with Neem EC (2% azadirachtin, Phero Tech, Delta, B.C., Canada) on the pine false webworm, *Acantholyda erythrocephala* (L.)(Hymenoptera, Pamphilidae) infesting red pine, *Pinus resinosa* Ait. At 50g azadirachtin/ha (ca. 0.02g./1.5-4m tree), mistblower (Solo® Port 423, 87.5L/ha) applications during egg hatch significantly reduced larval numbers and provided very good protection of 1-year old and current-year foliage (85-89% and 98-100% respectively) in both 1994 and 1995. In 1995, lower dosages of 12.5 and 25g/ha also provided similar foliage protection. An ultra-low-volume application of undiluted Neem EC at 2.5L/ha = 50g/ha with a Micron ULVA®+ sprayer provided 53% and 72% protection of old and new foliage respectively. At 10L/ha = 200 g/ha, excellent foliage protection (+90%) was achieved.

Mistblower trials have also been conducted on the introduced pine sawfly infesting 2-8 m. tall white pine *Pinus strobus* L. At 50g azadirachtin/ha, when larvae were mostly late instars, populations were reduced 62% by 14 days after treatment, and foliage consumption, as measured by frass output, was reduced 89%. Overall foliage protection was 73%. In 1995, population reductions were 41%(75% uncorrected), frass reductions were 99% and foliage protection was 65%.

Neem also provided protection from damage by white pine weevil, *Pissodes strobi* (Peck)(Coleoptera, Curculionidae) larvae which feed under the bark of conifer leaders. Backpack sprayer applications to jack pine, *Pinus banksiana* Lamb. or white pine leaders during the egg-hatching period provided 70-80% leader protection.

Red Maple Possesses Phytochemicals which Deter the Feeding of Forest Tent Caterpillar Larvae

Mamdouh Abou-Zaid, Blair Helson and J. Thor Arnason

Short-term, choice, feeding assays with trembling aspen leaf disks were employed to test the hypothesis that feeding deterrent compounds in red maple are responsible for the resistance of leaves of this tree to forest tent caterpillar larvae. Red maple leaf ethanolic extract applied to aspen leaf disks was significantly more deterrent than an ethanolic extract of sugar maple(which they consume). An ethanolic extract of trembling aspen (preferred host) actually stimulated feeding. The maple extracts were fractionated using a Buchner funnel packed with polyvinylpolypyrrolidone powder. Elution was carried out at a slow rate using water followed by aliquots of increasing concentrations (20, 50, 70, 100%) of ethanol. The fractions of the red maple extract were consistently more deterrent than the corresponding fractions from sugar maple at all concentrations tested (0.5-5.0%). The 20% and 50% EtOH fractions of red maple were most deterrent. Eighteen compounds have now been isolated and identified from the red maple extract. Three are new compounds. Of the 6 which have been bioassayed, gallic acid and particularly methylgallate possess antifeedant activity. These two compounds are present in the highest concentrations in the 2 most active red maple fractions. These results indicate that antifeedant compounds do play an important role in the resistance of red maple to forest tent caterpillar larvae.

Trichilia from Costa Rica: A potential source of botanical insecticides.

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Abstract:

Six species of *Trichilia* were collected from north west Costa Rica in July 1995. Crude methanol extracts were made and fed to *Spodoptera litura* neonate larvae. Growth rates were measured and compared to controls. The most active species collected was *T. americana*. Further work was carried out on this species and an EC_{50} of 15ppm was determined. Bioassay guided isolation of active compounds and their characterisation is in progress.

Tropical Timber Species as Sources of Botanical Insecticides

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Abstract:

Screening of wood extractives from tropical timber species and other trees against pestiferous lepidopterans such as the tobacco cutworm, *Spodoptera litura* and the variegated cutworm, *Peridroma saucia*, indicates the presence of insecticidal and growth inhibitory factors in certain genera. The mahogany family (Meliaceae) includes several important timber species in the genera *Swietenia, Khaya, Cedrela* and *Entandophramgma*, but also includes the Indian neem tree, *Azadirachta indica*, already well-known as a source of potent botanical insecticides. Strong bioactivity against insects has been observed in extracts from species of *Agalia, Trichilia* and *Chisocheton*. In most cases, limonoid triterpenes, characteristic secondary metabolites of the Meliaceae, are responsible for bioactivity, but in the case of *Aglaia*, the insecticidal principles are modified benzofurans. Extractives from several genera of the African walnut family (Olacadeae) have potent bioactivity as larval growth inhibitors, but this family has had sparse chemical characterization to date. Extractives from the Dipterocarpaceae, the most important family of timber species in tropical Asia, were essentially inactive in our screening program. However, bark, woodwaste and sawdust from certain commercially harvested timber species could be exploited for their biologically-active constituents.

NATURAL INSECT TOXINS FROM ENDOPHYTIC FUNGI: TOWARDS BIORATIONAL INSECT CONTROL

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Abstract

The spruce budworm, Choristoneura fumiferana, is Canada's most serious forest pest and, despite a variety of strategies aimed at controlling its depredations during the last quarter century, it remains a major economic insect problem.

Elucidation of the role of toxins produced by micro-organisms associated with host tree foliage will have an important bearing on our understanding of spruce budworm population dynamics. Furthermore, insect control by manipulation of the fungi and/or fungal metabolites which may be among the tree's natural defence systems is an attractive and exciting possibility.

Bioassay directed fractionation of cultures of endophytic fungi obtained from needles of balsam fir (Abies balsamea (L.) P. Mill), black spruce (Picea mariana, P. Mill, B.S.P.), white spruce (Picea glauca (Moench) Voss) and a leaf of wintergreen (Gaultheria procumbers L.) has led to the isolation and identification of several metabolites which are toxic to spruce budworm larvae and/or cells. The results indicate that woody plant endophytes promise to be a rich source of bioactive compounds with potential for exploitation as biorational insect control agents.

Botanicals from Neotropical Piperaceae and Meliaceae

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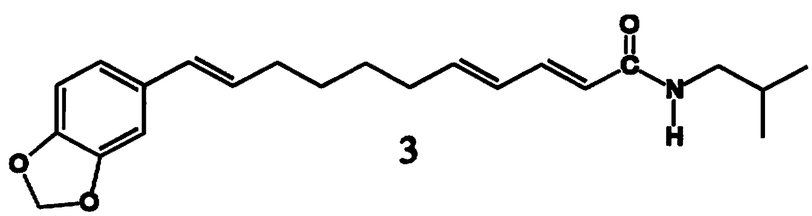
Phytochemicals with insecticidal properties have been isolated and studied from the neotropical Piperaceae, Meliaceae and related families. Investigation of 16 *Piper* spp. led to the isolation of active amiides, lignans and prenylated benzoic acid derivatives. Recent investigations of the Meliaceae and related families have led to the isolation of novel C,D spiro triterpenoids, and limonoids and steroids with antifeedant properties from the genus *Trichilia.* A botanical insecticide with commercial potential combining Meliaceae antifeedants and synergists from the Piperaceae is described.

Natural Products As Control Agents For Forest Insect Pests: Synthesis of Insecticidal Unsaturated Amide Alkaloids From Piper Species

George M. Strunz and **Heather Finlay**, *Natural Resources Canada, Canadian Forest Service-Atlantic*, and **Blair Helson**, *Natural Resources Canada, Canadian Forest Service-Ontario.*

Abstract

Piper spp., including *Piper nigrum* (black pepper) produce an array of unsaturated amide alkaloids, many of which exhibit pronounced bioactivity, e.g. insecticidal properties. We have devised new expedient synthetic approaches to these compounds, based on recently developed chemical methodology. The efficiency and brevity of the new strategy has allowed ready and rapid access to a dozen of these alkaloids, including pipercide **3**, piperolein A, **5** and **7**, an amide recently isolated from *P. sarmentosum.*



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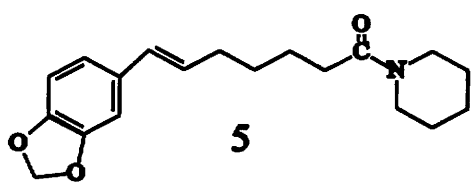

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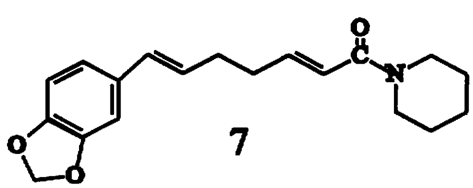

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Results of preliminary assays of the insecticidal activity of some of these compounds against important insect pest spp. are reported.

Chemistry of Phytotoxic Metabolites associated with Activity of Potential Mycoherbicides

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Abstract

We have investigated phytotoxic metabolites of two important potential mycoherbicides, *Bipolaris sorokiniana* and *Chondrostereum purpureum*..

We isolated the principal phytotoxic metabolites produced by cultures of *B. sorokiniana* and identified them as the known sesquiterpenes helminthosporal and prehelminthosporal. The phytotoxin bipolaroxin, a metabolite of *B. cynodontis*, was not produced by *B. sorokiniana*. We developed practical methodology for chemical synthesis of model compounds possessing the keto-hydroxyenal system, believed to be the array of functionality responsible for phytotoxicity of bipolaroxin. Some of the synthetic model compounds showed phytotoxicity in bioassays.

Ethyl acetate extracts of *C. purpureum* culture filtrates were reported by Ayer *et al.* in the 1980's to be phytotoxic, but the individual sesquiterpene metabolites that they identified from the fungus were not bioassayed. We reisolated several of the sterpurene-type sesquiterpenes studied by these researchers, and showed that sterpuric acid, sterepolide and dihydrosterepolide were toxic to cells of hybrid aspen at low concentrations. It can be concluded that sesquiterpene metabolites play a role, along with Miyairc's endo-polygalacturonase, in the pathogenicity of *C. pupuereum* to hardwood trees.

We have developed the most efficient laboratory synthesis to date of sterpurene (overall 33% yield). The route may be adapted for synthesis of some of the more highly oxygenated congeners of this metabolite.

Changes in juvenile hormone esterase activity and ecdysteroid titer in larvae of the spruce budworm, *Choristoneura fumiferana*, parasitized by the wasp *Tranosema rostrale*.

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Laurentian Forestry Centre, Canadian Forest Service-Quebec, Sainte-Foy (Qc), Canada - [1]Département de biologie, Université Laval, Sainte-Foy (Qc), Canada - [2]Department of Biology, Queen's University, Kingston (Ont.), Canada - [3]Department of Microbiology and Immunology, Dalhousie University, Halifax (N.S.), Canada.

Last-instar *Choristoneura fumiferana* larvae parasitized by *Tranosema rostrale* early in the stadium display retarded development and fail to initiate metamorphosis. Similarly, injection of the wasp's calyx fluid (CF) into healthy caterpillars induces a dose-dependent delay in pupation, which can be abolished by prior treatment of CF with UV and the DNA cross-linker psoralen. These results suggest that the wasp's polydnavirus is the factor responsible for the observed developmental disruptions.

In an effort to identify the physiological processes that are perturbed by *T. rostrale* CF, we examined the effects of parasitism and injection of CF on host plasma juvenile hormone esterase (JHE) activity and ecdysteroid titers in last-instar budworms. Under our experimental conditions, control larvae displayed only one peak of JHE activity (~ 30 nmol JH III/min/ml), which occurred on day 4 of the last stadium. In saline-injected animals, a similar peak was observed, but on day 5. In larvae parasitized or injected with CF (0.5 female equivalent) on day 1, levels of JHE activity were depressed during the entire stadium, with a somewhat greater reduction induced by CF injection (~ 3 nmol JH III/min/ml on day 4) than parasitism (~ 8 nmol JH III/min/ml on day 4). Similarly, parasitism and injection of CF both completely prevented the rise in hemolymph ecdysteroid titer observed in control and saline-injected larvae between day 3 and day 7 (rises from ~ 25 to 500-700 pg 20-hydroxyecdysone equivalents/μl hemolymph). Synthetic "Growth Blocking Peptide" (purified from *Pseudaletia separata* parasitized by *Cotesia kariyai*;1995, J. Insect Physiol. 41: 1) injected in healthy *C. fumiferana* larvae had a very limited effect on JHE activity.

Hormonal Regulation of Reproduction in *Choristoneura fumiferana* and *C. rosaceana*

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Reproduction and migration play important roles in the population dynamics of the eastern spruce budworm (SBW), *Choristoneura fumiferana*. We examined the role of juvenile hormone (JH) in the reproductive activities of both this species and the obliquebanded leafroller moth (OBL), *C. rosaceana*, which shares many life-history traits with *C. fumiferana* but which has not been observed to undertake migratory flights. In females of both species, corpora allata (CA) became activated near the end of the pupal stage. In SBW, a large increase in both JH I and JH II production was seen in the h following emergence, with the upward trend continuing until the 12th h of adult life. In 1-, 3-, and 5-day-old virgins, overall rates of JH biosynthesis remained high, but the proportion of JH I decreased while that of JH III increased. In OBL females, the trend was similar except that full activation of CA was not seen until day 1 and the proportion of JH I produced was generally much lower than in the SBW. In both species, the growth of basal oocytes paralleled the changes observed in JH production, suggesting a role for JH in ovarian growth. Decapitation of females at emergence reduced egg maturation in the next 48 h as compared to controls, whereas a topical application of the JH analogue methoprene enhanced it, in both species. Vitellogenin (Vg) was detectable in the hemolymph 2-3 days before emergence, before activation of the CA, suggesting that JH is not essential for Vg synthesis in these two species. Indeed, decapitation of females on the 5th day of the pupal stage did not prevent accumulation of Vg in the hemolymph. Mating on day 0 caused a decrease in Vg titers and an increase in egg production, most obvious on day 5 and seemingly more pronounced in *C. fumiferana*. However, mating had no significant effect on *in vitro* JH biosynthesis 1, 3, and 5 days after mating. Surprisingly, mating caused a transient but significant increase in JH esterase activity on day 1, in both species. These results raise interesting questions regarding whether or not JH titers increase after mating in these two tortricids.

A DSS for Budworm and Forest Management: Maximizing Protection Benefits and Forecasting Inventories

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Composition and age structure of much of the spruce-fir forest in eastern Canada is related more to past spruce budworm (*Choristoneura fumiferana*) outbreaks than to harvesting or wildfires. These outbreaks are a natural component of forest succession, but must be taken into account in forest management planning, if plans are to be accurate. Managers need tools to predict outbreak occurrence and effects on forest development, to ensure that expected timber supply/stand types will be present at the expected time of harvest/other usage, and to utilize silviculture and management planning to reduce the severity of future outbreaks.

We developed a budworm and forest management decision-support system under a 5 year multi-agency project supported by Canada's Green Plan. Our DSS design philosophy was to build individual tools targeted at specific forest management problems and to integrate these tools under an interactive graphical user interface and a GIS (currently implemented using Arc/Info). We will describe and demonstrate use of two components of this DSS, a Protection Planning System and a dynamic Inventory Projection System.

The Protection Planning System provides a systematic methodology for designing forest protection (insecticide use) under the threat of spruce budworm. It is based on quantifying the marginal timber supply benefits of protecting stands. The methodology comprises three steps: measure the impacts of defoliation, calculate the protection priority for each stand, and evaluate protection strategies. A defoliation-based stand growth model (STAMAN) and a timber supply model (FORMAN+1) are used to forecast forest development with and without defoliation. Protection priority (m^3/ha) is then calculated for each stand based on both direct (stand-level) and indirect (harvest queue disruption) marginal timber supply impacts associated with applying protection. This priority value is used as a mapping attribute to generate protection planning maps, and the user can digitize protection blocks into the DSS and quantify m^3/ha benefits.

The Inventory Projection System allows evaluation of effects of budworm outbreak and insecticide use scenarios on the forest inventory at user-specified times in the future. Stand dynamics are governed by volume yield curves and a set of rules which determine effects of two severities of budworm outbreak, protection, and successional changes. Display of current and projected stand attributes, attribute changes, different scenario results, and generation of thematic maps is under the user's control within a graphical user-interface. Common queries and map composites are prepackaged and selectable from a menu, and several forest performance indicators in the areas of landscape biodiversity, insecticide use, and timber supply perturbation are being developed. The idea here is to provide an efficient and effective way to visualize alternative future scenarios.

Abstract of poster presented at Forest Pest Management Forum, Ottawa, Nov. 18-22, 1996.

Defoliation and growth of balsam fir in mixed stands

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Changing stand composition by increasing the hardwood content has been suggested as a long term method for reducing the susceptibility and vulnerability of balsam fir (*Abies balsamea* (L.) Mill.) to spruce budworm (*Choristoneura fumiferana* (Clem.)). Central to this issue is the impact of hardwood on balsam fir defoliation caused by spruce budworm and the impact of defoliation on balsam fir volume growth.

Twenty-five mixed balsam fir - hardwood stands were selected in northern New Brunswick, with five stands in each of 20% hardwood classes (0-20, 21-40%, etc.). Defoliation each year from 1989 to 1993 was significantly ($p < 0.0001$) related to hardwood content, with r^2 ranging from 0.57 to 0.81. As hardwood content increased, defoliation of balsam fir decreased. From 1989 to 1992, the years of moderate-severe defoliation, balsam fir stands with <40% hardwoods sustained 58-71% defoliation on average, compared to 12-15% defoliation in stands with > 80% hardwood. A generalised model combining hardwood content and the estimated defoliation in pure softwood stands in a given year explained 77% of the variation in defoliation over stands and years.

Effects and mechanism of defoliation by spruce budworm on volume growth were also examined using one hundred dominant or codominant balsam fir trees which were harvested and analyzed for defoliation, tree dimensions, sapwood area, and volume increment. Average 1989-93 growth of trees with mean defoliation in 26-50, 51-75, and 76-100% classes was 39, 48, and 64% less, in comparison with those with 0-25% defoliation. A curvilinear regression model based on cumulative defoliation explained 64% of the variation in specific volume increment among 100 trees. Since the reduction of volume growth of balsam fir was not linearly related to defoliation, the relationship between volume growth and sapwood area was checked to examine the mechanism involved in the response of balsam fir to defoliation. Regression analyses showed that the relationship between volume growth and sapwood area was affected by defoliation. With low to moderate defoliation, the effect was only on the constants of the two defoliation class's regression lines. With higher defoliation, the constants and slopes of the regression lines were both changed by defoliation. This suggests that the defoliation might affect the relationship between leaf area and sapwood area, or the sapwood area adjustment, or photosynthate allocation pattern.

This study indicated that mixed balsam fir - hardwood stand management, with hardwood content > 40%, could substantially reduce defoliation during spruce budworm outbreaks and it can save the volume loss by defoliation. Further research could be done to reveal the mechanism involved in the lower defoliation in mixed stands, to examine the effects of defoliation on the relationship between leaf area and sapwood area, and to learn whether the photosynthate allocation patterns changes under severe defoliation.

Poster presented at Forest Pest Management Forum, Nov. 18-22, 1996, Ottawa.

Hazard Rating and Stand Vulnerability to Jack Pine Budworm Defoliation[1]

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Summary

A spatial hazard rating of forest stands for vulnerability to jack pine budworm (Choristoneura pinus pinus Freeman) damage is a component of the Jack Pine Budworm Decision Support System. Such a hazard rating system has been developed, but its evaluation compared with an actual outbreak had not been undertaken. Based on an outbreak in Saskatchewan, this study was designed to determine if a map produced from this system is associated with damaged stands and stand structure. Maps of hazard and defoliation damage represented by dead tree tops or top kill, were produced and overlaid with maps of stand structure that included drainage, species, age, height, and crown closure. Two statistical indicators of spatial association, Cramer's V, and Minnick's Coefficient of Areal Correspondence, were computed from contingency tables that contained point samples from map overlays between hazard and damage, and between hazard and stand attributes. The relationship between the hazard map and the map of defoliation damage was low. Several stands that rated high for hazard did not correspond to the natural structure of mature jack pine (Pinus banksiana Lamb.) stands, as determined from polygon overlays between stand age and stand height, and between crown closure and stand height. The transfer of a hazard rating system from one provincial jurisdiction to another may have had some influence due to differences between their respective stand inventory classification systems. The subjective rules used in the design of the hazard rating system, however, is more likely the major reason for the low correspondence between a hazard-rated stand and one that was moderately or severely damaged by defoliation. Future developments in hazard rating should be based on knowledge of relationships between stands that have sustained budworm damage and their structural characteristics. Geographic Information System Technology and spatial statistical tools are approaches that may help in defining these relationships. Once the hazard rating system has been refined, quantitative data on impact to stand volumes could be linked to hazard so that pest management options and their associated costs could be evaluated.

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[1] Poster Paper prepared for 1996 Pest Management Forum, November 20-21, 1996, Sault Ste. Marie, Ontario.

Genetic resistance to white pine weevil attack: a keystone for integrated pest management

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Dr. J.A. McLean and R. McIntosh UBC
Dr. J.H. Borden and Dr. E. Tomlin, Simon Fraser University
Dr. J. King, A. Yanchuk, G. Kiss and C. Ying. BC Ministry of Forests
Dr. Y. El-Kassaby and Ms. K. Lewis. Pacific Forest Products

Interior spruce family trials in British Columbia were surveyed for weevil resistance using an index which measured intensity of attack (number of attacks per tree), severity of each attack (how many internodes were destroyed) and tree tolerance to attack (i.e., if tree develops good form after an attack). The study demonstrated significant family variation in the attack index. Variation in resistance was related to ecoclimatic conditions of the place of origin of the parent trees. Analysis showed that parents from locations with high weevil hazard or high weevil populations yielded higher proportion of resistant trees. These sites are primarily low elevation, low latitude sites, especially on Moist-Warm habitats of the the Sub-Boreal-Spruce (SBS) biogeoclimatic zone. These results indicate an important role of tree phenology in the expression of resistance.

A study of the resin canal distribution on resistant and susceptible families at the Clearwater family trial, done in collaboration with SFU, extended the results obtained for Sitka spruce by Tomlin and Borden (1994): resistant families at Clearwater had significantly denser resin canal system in the bark than susceptible families. The study demonstrated significant family variation and potential for selection.

Another resistance mechanism was discovered. Dissection of interior and Sitka spruce leaders in which weevil attack had failed (eggs had been laid but no adult emergence occurred) demonstrated the existence of an induced defense reaction. The response was initiated shortly after feeding and oviposition in the attacked shoot and consisted of the cambium switching from producing normal tracheids and parenchyma ray cells to the production of epithelium which differentiated into traumatic resin canals, arranged in a ring fashion in the developing xylem. In sectioned leaders, these traumatic resin canals could be seen emptying their contents into feeding and oviposition cavities dug by the adults, and into the larval galleries. This defense reaction killed eggs and larvae. When the leader survived the attack, the cambium reverted to producing normal xylem tissue leaving one or more rings of traumatic resin canals embedded in the xylem annual ring. Artificial wounding experiments are underway both in the field and in the lab to quantify the prevalence of this response. Work in collaboration with UBC (Dr. J. Mclean and Rory McIntosh) at Kalamalka Forestry Centre, is determining details of the weevil attack and dispersal behaviour on resistant and susceptible trees and will determine the occurrence of the induced defense mechanism in relation to insect behaviour.

Movement of the White Pine Weevil *Pissodes strobi* (Peck.) in an Interior Spruce Plantation in Vernon B.C.

Rory McIntosh[1], John McLean[1], Rene Alfaro[2], Gyula Kiss[3].

The white pine weevil *Pissodes strobi* Peck. is a serious pest of regenerating Sitka *(Picea sitchensis)* and interior spruce *(P. glauca, P. engelmannii),* and their hybrid swarms *(P. glauca x engelmannii).* Trees are damaged or killed when larvae feed in the cambium of one year old leaders. Larvae mine down the axis of the tree into the two year old part of the stem and girdle the tree. Weevils can kill at least two and sometimes up to four years' growth. In severe infestations, losses due to reduced stand growth and defect can be as high as 40% of the stand volume.

Interior spruce are a valuable component of the Provincial wood supply. In 1993-94, 15.7 million m^3 of spruce was harvested in B.C. and 97 million interior and hybrid white spruce were planted. Many of the plantations established in the 1980's are now highly susceptible and at risk to infestation. However, no operational controls exist.

Currently, the best mitigative approach is through integrated pest management. Weevil habitat could be reduced by silvicultural manipulation coupled with the integration of genetically resistant stock. Resistant spruce genotypes provide an environmentally benign method to ensure future plantations will be better able to withstand weevil attack. Results of 10 years' research at the B.C.MoF. Kalamalka Research Station, in Vernon B.C., suggest that substantial genetic variation exists in weevil preference to different families of spruce. However, weevil-host interactions in plantations of interior spruce are poorly understood and as yet unexplored. Host-selection behaviour and host resistance mechanisms must be determined before an active breeding program to produce weevil-resistant trees can be fully developed.

The objective of this research was to determine how *P. strobi* move around in interior spruce. The following research questions were presented: 1) How much weevil movement is there within and between trees?; 2) How far do weevils move?; 3) How does weevil behaviour change throughout the year; and 4) Is there a peak period of dispersal ?

A 0.06 ha block of interior spruce, planted 10 years ago, then spaced to 1.25m., was used to develop and test hypotheses derived from these questions. Diurnal and seasonal field studies were conducted to monitor movement patterns in the plantation. Each tree was allocated an "address" using Cartesian coordinates. Within and between tree movement was measured using mark-release-recapture techniques. Movement was monitored using transect searches conducted in the plantation three times per week. At each search, all unmarked weevils were collected; their sex determined; marked on each elytron with different coloured liquid paper®; individually numbered; then returned to their original location. Different colours were used to differentiate between cohorts of parental and brood weevils in each year. The location and activity of all marked weevils was recorded.

Between 1994 and 1996, four diurnal studies were conducted to measure within tree movement and behaviour patterns over short periods of time. In each study, a block of eight trees (2 rows of 4 trees) were selected. All trees in the block were searched once an hour every hour over a time-span of 24 hours. Weevil location and activity at each search was recorded. Long-term seasonal movement was measured through regular transect searches and changes in weevil location over time were recorded. Movement data between March 1-October 31 were summarized to show seasonal movement patterns.

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The diurnal studies provided a "snap shot" of weevil behaviour at four different times of the year. Results show that patterns of behaviour differ throughout the season. In April, weevils were found predominantly on the stem. As temperatures increased in the spring they were observed to move to the terminal. By 14:00, 50% were found on the terminals. The study conducted in May showed a great deal of movement both within and between trees. Weevils were seen to congregate on the terminals between the hours of 6:00 and 15:00. This behaviour coincided with feeding, aggregation and oviposition activity. Weevils were distributed evenly between stem and laterals throughout the rest of the day. In July, when peak daily temperatures reached 35°C, weevils spent very little time on the terminals, just an hour or two in the early morning. Because of this transect searches during June and July were conducted at dawn when weevils were most exposed and thus visible on the leaders. At this time of year, weevils were recorded moving down to the protection of the forest floor (duff). Between 11:00 - 18:00 on average 70% of the weevils found were in the duff. In August, air temperatures were considerably cooler peaking at 25°C. Weevils at this time of year spend most of the time on and underneath lateral branches, moving to the terminals in the morning and evening.

The seasonal study showed that in the early Spring, activity increases as weevils move between host spruce trees testing them for suitability for brood production. Feeding, mating and oviposition behaviour increases. By mid-April, weevils aggregate on the apex of the previous years terminal shoot where they are potentially able move long distances by air. However on average weevils did not move much even during periods of peak activity. In summarizing 19 transect searches between March 1 to May 15, females (5.8m ± 2.58) moved on average more than males (5.38m ± 4.06). However, male movement was more variable.

It was concluded that the main mode of movement between trees was through crawling. The diurnal studies exposed a great deal of within tree movement throughout the season and that within-tree movement was highly variable over time. Over the season, weevils moved very little. Although a peak period of movement was detected in the spring during the period of aggregation and oviposition, weevils on average moved less than 14 m. among trees.

Key Words: Coleoptera: curculionidae, dispersal, diurnal, mark-recapture, *Picea engelmannii*, *P. glauca*, *Pissodes strobi*, tree improvement, weevil.

MORTALITY OF THE WHITE PINE WEEVIL AND PEST DAMAGE ASSOCIATED WITH SILVICULTURAL PRACTICES IN JACK PINE

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Several species of pines and spruce are infested by white pine weevils (Pissodes strobi) throughout North America. Although jack pine (Pinus banksiana) is one of the most important species in lumber and pulp production, very few studies have focused on the biology and infestation of the white pine weevil in jack pine plantations. During a four-year study, we quantified white pine weevil mortality caused by mammal, bird, and insect predation. Predation was examined under different stand conditions given by the type of reforestation (planted and seeded stands), depth of the duff, distance from woody debris, and presence of competing vegetation in jack pine stands in northern Ontario. Additionally, we quantified insect pest damage to jack pine seedlings and compared pest infestation between sites under different combinations of site productivity, harvesting technique, and site preparation.

Bird predation was quantified in planted and seeded stands by counting the number of emergence holes and pupal chambers in leaders that had been excavated by birds. To examine insect predation, leaders were screened to exclude insect predators during spring-summer. The point count technique was used to estimate abundance of birds. Exclusion and open (control) cages containing adult weevils were used to quantify mammalian predation during the winter. Surveys of pest damage were conducted in 7 two-year old jack pine plantations (Site Class 1 to 3). In each site, surveys were conducted in 12-15 plots with different combinations of harvesting technique/site preparation. Harvesting technique included: 1) full tree logging; and 2) tree length logging. Site preparation included: 1) scarification; 2) blading; 3) blading/compaction; and 4) no site preparation.

Results showed that: 1) bird (6.4% in planted and 8.9% in seeded stands) and insect (32.5% in planted and 56.5 in seeded stands, including larva competition) predators killed a similar proportion of larval and pupal weevils in planted and seeded stands; 2) the percentage of leaders killed by weevils in each stand was similar for both planted (12%) and seeded (14%) stands; 3) diversity and abundance of birds were similar in planted and seeded stands; 4) over a three-year period, winter mortality of adult weevils ranged from 83-88% with mammalian predation accounting for 5-13% of the total overwintering mortality; 5) more weevils died during the winter in a planted (92%) than in a seeded (76%) stand; 6) the distance from slash and presence of competing vegetation had no effect on the overwintering mortality of weevils; 7) the total number of weevils dying was inversely related to the depth of the duff; 8) percentage of seedlings damaged by pests ranged from 1.7-71.1%, where identified damage included webbing, hollow tips, chewing in needles and bark, nodules, and sucking; 9) more productive sites (Site Class 1) supported lower pest damage than less productive sites (Site Class 3); 10) harvesting technique (full-tree logging vs. tree length logging) had no effect on the percentage of seedlings damage by pests in a stand; 11) bladed and bladed/compacted plots experienced higher pest damage than scarified or non-prepared plots; 12) blading followed by compaction had no additional effect on pest damage.

Recommendations to forest managers include: 1) damage by the white pine weevil will not be affected by reforestation technique; 2) white pine weevil mortality may be increased by augmenting bird and insect predators; 3) the naturally high levels of overwintering mortality of adult weevils may be increased by reducing the depth of the duff layer, and possibly increasing habitat heterogeneity which will encourage mammalian predators; 4) jack pine seedlings planted in highly productive areas (Site Class 1) with little (scarification) or no site preparation will experience minimal damage by insect pests; 5) harvesting technique will not influence the levels of pest damage.

A Decision Support System for the Mountain Pine Beetle

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Background

The mountain pine beetle, *Dendroctonus ponderosae* Hopkins, is the most economically important forest insect pest in western North America. Every year it is responsible for the death of millions of mature pine trees (Wood and Van Sickle 1994). In British Columbia (BC), the major host of the insect is lodgepole pine, *Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm., which is the leading species in the province in terms of volume harvested (Anon. 1996).

The reduction in timber supply resulting from land use reallocation, long term harvesting, and losses to forest insects, disease, and fire, have made it increasingly important to maximize the recovery of wood volume from land designated for that use.

Forest management is becoming an increasingly complex business and the number of decisions that have to be made in the development of management plans has increased considerably in recent years. In BC, for example, the Forest Practices Code has introduced a multitude of new rules for dealing with environmental and other concerns in the development of management plans. It is not possible for a single person to put together these plans without input from experts in a number of disciplines.

Through years of research on the mountain pine beetle a considerable knowledge base has been developed on the biology, ecology, and management of this insect. A number of direct control and preventative management options are available for minimizing losses resulting from beetle epidemics. The mountain pine beetle decision support system (MPBDSS) project began as an effort to put together, in a user-friendly computer application, much of the knowledge that we have on this insect. This knowledge would then be readily available to forest managers who would use it to make better decisions in the development of management plans.

The System

The MPBDSS consists of a suite of programs any of which can be used to address a specific aspect of mountain pine beetle management. These programs can be grouped into three classes: database tools, knowledge tools, and user interface tools.

Database Tools: The database tools include: a) a beetle database, in which information about specific beetle infestations is stored including location, number of infested trees, survey information, treatment information etc. b) a forest inventory database with information about the forest resource including tree species composition, age, height, volume, etc. c) a geographic information system (GIS) for integration and analysis of spatial data on the beetle and forest resource and production of maps.

Knowledge Tools: Knowledge tools include: a) a risk rating system which integrates beetle and forest resource data to produce susceptibility and risk indices for mountain pine beetle at the stand level (Shore and Safranyik 1992) b) a management options expert system which is used to identify appropriate management strategies and tactics for minimizing losses to mountain pine beetle c) a mountain pine beetle infestation model which is used to predict the course of a mountain pine beetle epidemic and some of the impacts resulting from the infestation under different management scenarios.

User Interface Tools: Some user interface tools are provided including: a) a map viewer to allow the user to bring up and work with maps without having to possess or have a working knowledge of a full GIS b) a literature database which allows the user to search by a number of criteria and locate relevant references on the mountain pine beetle. Many of the individual system components have reporting capabilities incorporated in the software.

The system is nearing completion with an operational version due in 1997. Further detail on the

MPBDSS is available in Shore et al. (1996).

Literature Cited

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Wood, C.S. and G.A. Van Sickle. Forest insect and disease conditions British Columbia and Yukon - 1994. Natural Resources Canada, Can. For. Serv., Inf. Rep. BC-X-354. 39 p.

Spacing and Thinning Lodgepole Pine Stands to Reduce Susceptibility to the Mountain Pine Beetle.

A.Safranyik, T.L. Shore, R.A. Benton and D.A. Linton

Natural Resources Canada, Canadian Forest Service

Victoria BC V8Z 1M5

Spacing and fertilization experiments were established in mature lodgepole pine to assess the effects on tree mortality from the mountain pine beetle. The treatments included three levels of spacing (control (not spaced), 4x4m, and 5x5m) and two levels of fertilization (not fertilized, 500kg/ha of 30-0-0-10 NPKS fertilizer). Procedures of field establishment, experimental design and analysis, and preliminary results from the first three years of measurements are described. Dendroctonus valens and D. murrayanae commonly attacked trees that were damaged by logging or adjacent to skid trails but no mortality occurred directly from these attacks. Twenty-nine species of bark beetles emerged from stumps following thinning, or were captured in passive barrier traps. Mountain pine beetle has attacked only three trees to date, all in untreated plots. Wind speed and solar radiation increased as stand density decreased. Average daily temperature, however, was higher in the 4 x 4 m spacing than in the 5 x 5 m spacing, likely due to the cooling effect of vertical winds in the wider spacing.

Forest Pest Management Caucus

Minutes

Friday November 22, 1996
Conference Centre, Ottawa, Ontario

Chair - Richard Westwood

1. Status of PMRA Cost Recovery Initiative - L. Javor
   - discussed consultation sessions, involvement of stakeholders and program costs.
   - compared costs or registration to other countries and comparative recovery mechanisms.
   - next steps are to develop proposed fee structure base on stakeholder input, and establish an economic stakeholder committee.

2. Registration of Gypsy Moth Virus - W. Ormrod
   E. Caldwell updated the members on the registration of the Gypsy moth virus (Dispar virus). There is no intention of producing commercially by the CFS, but potential partners are being sought. Virus submissions for European Sawfly virus have been withdrawn due to the database not being current, especially in toxicology area. There will be a label amendment to the Douglas Fir Tussock virus.

3. Status of Minor Use Working Group - W. Ormrod
   W. Ormrod commented on the status of the minor use working group noting that the products up for review are dormant at this time.

4. Minor Use Program - E. Harvey
   E. Harvey questioned the status of the Minor Use Coordinator for Forestry and the minor use fund ($100,000 from CFS). W. Ormrod commented that all but $8,000 had been committed for other projects. E. Caldwell noted that if the funds were to continue that the funds would be through the Pest Management Network.

   The Members noted that the Caucus should write a letter to Gordon Miller to urge continuance the Minor Use fund program and to re-establish a minor use Coordinator, most likely through the CFS Pest Management network.

   ACTION: Chair to send letter to Canadian Forest Service emphasizing the need for the Minor Use fund program.

5. Draft Quarantine Polices for Gypsy Moth - M. Dawson
   M. Dawson presented information on the draft quarantine policies for Gypsy Moth and Pine Shoot Beetle. Copies were handed out and Caucus members with comments were asked to report them to M. Dawson directly.

6. Letter of Response to Plant Products Co. Ltd
Letter of response attached. This issue has been dealt with by the chair and no further action is required.

7. Proposal for Development of Integrated Pest Management Strategy for Spruce Budworm
N. Carter E. Caldwell, R. Westwood will form a working group to pursue the proposal. Attached is the proposal.

ACTION: N. Carter to chair working group and coordinate development of strategy by group members.

8. Caucus Business

Financial Report - R. Comeau
R. Comeau summarized the responses from the Caucus financial request letter response, and the status of the Caucus finances The financial statement is attached.

Appointment of New Chairperson
The members suggested that the present chairperson appoint a new chair.

ACTION: Acting Chair for this meeting (R. Westwood) to appraise current chair of caucus members suggestions for new chair.

The members recognized the work of the current Chair, Rod Carrow and expressed their appreciation.

9. Meeting adjourned

minutes recorded by:
R. Comeau, CIF/IFC

FOREST PEST MANAGEMENT FORUM

MEETING EVALUATION

Number of Respondents and Reliability of Data:

Provincial:	4
CFS:	9
Industry/Consultant:	1
Other:	1
Total	15

Although a sample of 15 represents a reasonably high 28% of total attendance of 54 (on Thursday, Nov. 21st), it remains a fairly small number and may be insufficient to represent the range of opinion of Forum attendees. Readers should bear this in mind when drawing conclusions from the data.

Two questions and an "Other Comments" item asked for narrative responses. The comments tend to be quite diverse, perhaps because of the small sample size. Since many of the comments are considered to be quite valuable, they have been included verbatim in Appendix 1.

Value of '96 Forum Program Elements

Each program element was rated individually where 1 is no value, 5 is very high value. Results are as follows:

Program Element	Provincial	CFS	Industry/Consultant /Other
Forest Pest Status	4	2.8	5
Operational Summaries	4.3	3.1	5
Experimental Trials	4	3.6	4
Scientific Accomplishments and Future Direction	3.3	4	3.5
Posters	3.3	4.1	2

There appears to be an obvious split between provincial and CFS participants in the relative importance placed on the first three items vs the last two; i.e., provincial attendees prefer '96 Forum program elements that were more forest management related and the CFS reps tend to favour those with a research focus. "Experimental Trials" was rated fairly high by both these groups and the difference between the two groups was smallest in this area suggesting both groups have a common interest in the practical results of work with new approaches.

Length of Forum

Respondents appear to favour a 2-3 day meeting with more leaning towards 2 days. This excludes time for the Forest Protection Technology and Forest Pest Management Caucus meetings.

Forum Location

Twelve out of 15 respondents including all provincial reps prefer continuing to hold the Forum in Ottawa.

Note

The Forum Steering Committee will review the findings of this evaluation in preparation for next year's meeting.

R. Smith
Dec. 11, 1996

Appendix 1

What changes in program would you like to see in future years?

Provincial

1. - less of a CFS show and tell style
   - presentations should focus on results, rather than justification of how money was spent or leveraged
   - if CFS wants an annual status meeting of its networks, then the CFS should have a separate meeting

2. - Day1 - pest status, operational summaries
   - Day2 - focus on one or two topics and have workshop type session
   - Day3 - have general papers on new/ongoing research of interest to the Forum

3. -hard copy of posters (at least summary/conclusions) available; abstracts probably not enough detail by themselves

4. - more non-BW topics - still dominates focus of CFS
   - more opportunity for provinces to describe what they do especially highlighting areas of overlap and if opportunities where CFS can fill gaps (BC primarily)
   - user feedback on CFS initiatives - are we using products, getting services?

CFS

1. - regional forest health monitoring (CFS) staff should be involved in Forest Pest Status Reports - surely there is FH info and data that could/should be reported
   - where is Saskatchewan? In absence of Saskatchewan, FH from Edmonton could have reported pest status

2. - special topics
   - network updates
   - research results...in a format that allows and fosters discussion
   - make effort to raise the profile of insects and diseases other than SBW

3. - featuring more projects/initiatives of industry and provincial governments

4. - cross-network presentations (i.e. PMM and LM)
   - presentation from external research collaborators

5. - synthesis of results to address protection issues
   - practical recommendations

6. - more tabled documentation - concentrate on problems e.g., operational treatments that should have worked but didn't for reasons that can be addressed, foreign introductions

- more working group meetings that have tangible results
- more client-driven sessions

7. - presentation from Biosystematics Research Institute

Industry/Consultant/Other

1. - ok as is for me

2. - more of a comment on the fact that I feel that the format and entire event was a vast improvement from the last few years. I found the vast majority of the program relevant

Do you have suggestions on how to provide more opportunity for discussion during the Forum? What topics might be addressed in this manner?

Provincial

1. - moderator should ensure presentations end in time for questions; the first time the moderator says there is no time for questions, the audience will stop asking them for any presentations that follow

2. - on Day2 workshop focussed session, am or pm on both the provincial operational approach and CFS research approach to specific problem, e.g., root diseases, management of plantations, pheremones, silvicultural IPM, etc.

3. - less time on "who" did what, more time on objectives, results, problems and future plans

4. - provincial.CFS relationships re. pest data collection - current agreements
   - good for provinces to see research results but if mostly CFS, not much point holding such a meeting

CFS

1. - symposium format?
   - topics: choose from areas that overlap networks

2. - feature fewer topics; some major accomplishments in networks dealing with pest management issues

3. - subject specific workshops (i.e., national inventory, x-network links)
   - preparing material to feed to NABFOR
   - socio-economics dimension of network research as well as the priority of such research

4. - change seating; have people face each other

5. - invite speakers to talk on specific themes, both insect and disease

6. - workshops: public workshops/open houses for contentious forestry concerns

7. - break groups on specific topics

Industry/Consultant/Other

1. - for me discussion mostly centred around technology committee where issues are quiet relative to amount of control work being low

Other Comments

Provincial

1. - Saskatchewan should have been represented, either by the province or local forest health network (i.e., James Brandt).
   - I suggest that instead of a CFS research meeting, the Forum should focus on pest management: provincial status and control, results of forest health surveys and results of related research

2. - continue to fund provincial reps' attendance

CFS

1. - assuming one day pest status, etc., Day2 and Day3 (if there is one) are for what? Has it been decided that it will be a CFS show and tell of scientific accomplishments and future directions? The provinces should be involved in some way - otherwise there will be even fewer questions and less discussion than there has been this year.

2. - organizers should critically assess who is gaining what from pest survey reports
   - encourage more input from disease researchers
   - think of the Forum as a research project or program - what deliverables do you offer Forum participants? We should go home excited, enlightened and inspired

3. - could/should be rotated to different regions because doing that would enable forest protection/management people in industry and provincial governments in these regions to attend in larger numbers

4. - would the Forum (or could the Forum) evolve to receive advice from clients, etc.

5. - the Forum should concentrate on identifying key pest problems leaving more time during the week for specific meetings, workshops, etc.
   - to save time: research and operational results can be tabled as handouts or posters

Industry/Consultant/Other

1. - arrange for special accommodation deals with local hotel(s)