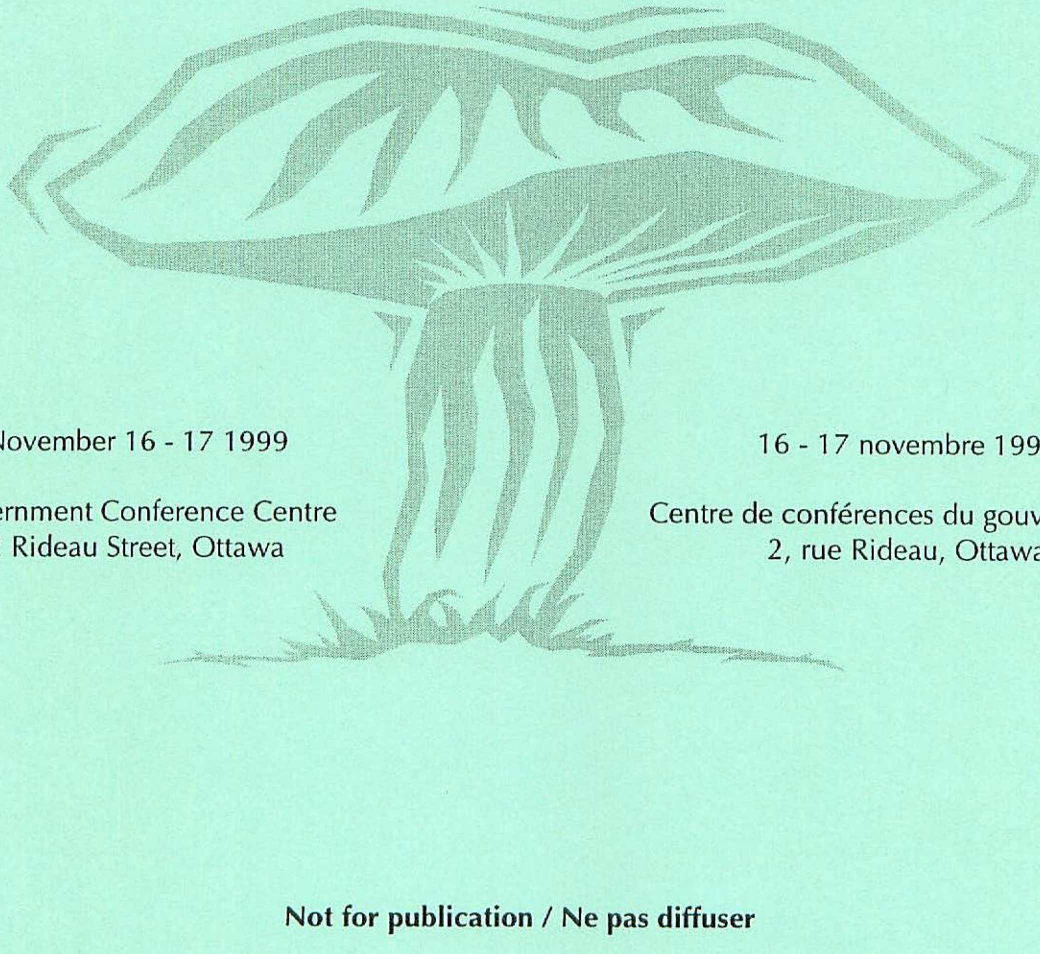
FOREST PEST MANAGEMENT

FORUM 99

SUR LA RÉPRESSION DES RAVAGEURS FORESTIERS



November 16 - 17 1999

Government Conference Centre
2 Rideau Street, Ottawa

16 - 17 novembre 1999

Centre de conférences du gouvernement
2, rue Rideau, Ottawa

Not for publication / Ne pas diffuser

Natural Resources Canada — Ressources naturelles Canada

Canadian Forest Service — Service canadien des forêts

Canada

1999 Forest Pest Management Forum
Government Conference Centre
Ottawa, Ontario

November 16 - 17, 1999

The Forest Pest Management Forum is annually sponsored by Natural Resources Canada, Canadian Forest Service, to provide a platform for representatives of various provincial and Federal governments to present, review and discuss current forest pest conditions in Canada and the United States. The threat to forest health in Canada and the implications on international trade imposed by invasive species was a major topic of this years forum.

Le Forum sur la répression des ravageurs forestiers est parrainé annuellement par le Service canadien des forêts, Ressources naturelles Canada. Il permet à des représentants de divers gouvernements provinciaux et du gouvernement fédéral de présenter et d'examiner la situation des principaux ravageurs forestiers au Canada et aux États-Unis. La menace posée par les espèces envahissantes pour les forêts canadiennes et les répercussions sur le commerce mondial a été au coeur des discussions de cette année.

Robert Sajan
Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts
Sault Ste. Marie, Ontario / Sault Ste. Marie (Ontario)
February 1999 / February 1999

Contents/Table des matières

1999 Forest Pest Management Forum
Forum 1999 sur la Répression des Ravageurs Forestiers
List of Participants / Liste des personnes présentes

Greg Adams J.D. Irving, Ltd
Sussex Tree Nursery
181 Aiton Road Sussex East, NB
E4G 2V5
Telephone: 506-432-2844
Fax: 506-432-2807
email: Adams.greg@jdirving.com

Mamdouh M. Abou-Zaid
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste. Marie, ON
P6A 5M7 Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: mabouzai@nrcan.gc.ca

Eirk Allen
Canadian Forest Service
Pacific ForestryCentre
Natural Resources Canada
506 West Burnside Road
Victoria, BC V8Z 1M5
Telephone: 250-363-0674
Fax: 250-363-0775
e-mail: Allan@pfc.forestry.ca

Peter Amirault
Forest Protection Ltd2502 Hwy102
Lincoln, NB
E3B 7E6
Telephone: 506-446-6930
Fax: 506-446-6934
e-mail fpl@nb.aibn.com

Joseph Anawati
Natural Resources Canada
Canadian Forest Service
580 Booth St.
Ottawa, ON
K1A 0E4
Telephone: 613-947-8996
Fax: 613-947-9090
e-mail: Janawati@NRCAN.gc.ca

Michel Auger
MRN - DCF
1283 Charest Ouest
Quebec City, QC
G1N 2C9
Telephone: 418-643-9679
Fax: 418:643-0381
e-mail: Michel.auger@mrn.gov.gc.ca

Dr. Ron Ayling
Aborvitae consultants
267 Spring St.
Almonte, ON
K0A 1A0
Telephone: 613-256-4617
Fax:
e-mail: ayling@magma.ca

Jean Beaulieu
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.PS.
Box 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-7616
Fax: 418-649-6956
e-mail: beaulieu@cfl.forestry.com

Guy Bird
Canadian Forest Service
Industry, Economics and Programs Branch
580 Booth St.
Ottawa, ON
K1A 0E4
Telephone: 613-947-9050
Fax: 613-947-9090
e-mail: gbird@nrcan.gc.ca

A. Temple Bowen, Jr.
Abbott Labs
140 Old Street Rd.
Peterborough, NH.
USA, 03458
Telephone: 603-924-1097
Fax: 603-924-1098
e-mail: at_bowen@conknet.com

Clément Bordeleau
MRN - DCF
1283 Charest Ouest
Quebec City, QC
G1N 2C9
Telephone: 418-643-9679
Fax: 418:643-0381
e-mail: Clement.Bordeleau@mrn.gov.gc.ca

Benoît Boulanger
AEF Global Inc.
855, rue Pépin
Sherbrooke, QC
J1L 2P8
Telehpone: 819-348-9461
Fax: 819-348-9466
e-mail: aefglobal@qc.aira.com

Paul Bolan
BioForest Technologies Inc.
105 Bruce St.
Sault Ste Marie, ON
P6A 2X6
Telephone: 705-942-5824
Fax:
e-mail: pbolan@soonet.com

Beuoit Boulanger
AEF Gobal
855 rue Pepin
Sherbrook, QC
Telephone: 819-347-9461
Fax: 819-348-9466
e-mail:

James Brandt
Natural Resources Canada
Canadian Forest Service
Northern Forestry Centre
5320 - 122 St.
Edmonton, AB
T6H 3S5
Telephone: 780-435-7326
Fax: 780-435-7359
e-mail: jbrandt@NRCAN.gc.ca

Keith Brown
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: kbrown@nrcan.gc.ca

Micheal R. Bridgen
SUNY College of Environmental. Science and Foresty
P.O. Box 48
Wanakena, NY
13695
Telephone: 315-848-2566
Fax: 315-848-3249
e-mail: bridgen@esf.edu

Steve Burke
Phero Tech Inc.
7572 Progress Way
Delta, BC
V4G 1E9
Telephone: 604-940-9944
Fax: 604-940-9433
e-mail: burkes@pherotech.com

Sandy Burt
Natural Resources Canada
1219 Queen St. E.
Sault ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: Sburt@NRCAN.gc.ca

Errol Caldwell
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: Ecaldwell@nrcan.gc.ca

Louis Caron
NORAC Concepts Inc
P.O. Box 62023
Orleans, ON
K1C 7H8
Telephone: 613-841-2907
Fax: 613-841-2908
e-mail: Lcaron@noracconcepts.com

Nelson Carter
Manager, Forest Pest Management
Dept. Natural Resources & Energy
P.O. Box 6000
Fredericton, NB
E3B 5H1
Telephone: 506-453-6689
Fax: 506-453-6689
e-mail: Necarter@gov.nb.ca

Terry Caunter
Health Canada
Pest Management Regulatory Agency
2250 Riverside Drive
Ottawa, ON
Telephone: 613-736-3779
Fax: 613-736-3770
e-mail: tcaunter@hc-sc.gc.ca

Thérèse Charbonneau
Natural Resources Canada
Canadian Forest Service
Science Branch
580 Booth St., 12D2
Ottawa, ON
K1A 0E4
Telephone: 613-947-8988
Fax: 613-947-9035
e-mail: Tcharbon@NRCAN.gc.ca

Dr. Pierre Charest
Natural Resources Canada
Canadian Forest Service
Science Branch
580 Booth St., 12D2
Ottawa, ON
K1A 0E4
Telephone: 613-947-8988
Fax: 613-947-9035
e-mail: pcharest@NRCAN.gc.ca

Hong Chen
Commodity Officer
Forestry Section, Canadian Food Inspection Agency
59 Camelo Drive
Nepean, ON
Telephone: 613-228-6696
Fax: 613-228-6602
e-mail: hchen@em.agr.ca

Russ Cozens
BC Forest Service
Forest Site Management Section
PO BOX 9513 Stn Prov Govt
Victoria, BC
V8W 9C2
Telephone: 250-387-8737
Fax: 250-387-2136
e-mail: Russ.Cozens@gems4.gov.bc.ca

Lesley Cree
Plant Health Risk Assessment Unit
Canadian Food Inspection Agency
3851 Fallowfield Road
Nepean, ON
K2H 8P9
Telephone: 613-228-6698
Fax: 613-228-6100
e-mail: creel@em.agr.ca

Hubert Crummey
Dept. of For. Resources and
Agri.. Foods
P.O. Box 2006
Fortis Tower
Cornerbrook, NS
Telephone: 709-637-2424
Fax:
e-mail: hcrummey@thezone.net

Marcel Dawson
Senior Commodity Officer
Forestry Section, Canadian Food
Inspection Agency
59 Camelo Drive
Nepean, ON
Telephone: 613-228-6696
Fax: 613-228-6602
e-mail: mdawson@em.agr.ca

David Davies
Forest Protection Limited
2502 Route 102 Hwy.
Lincoln, NB
E6C 2A7
Telephone: 506-446-6930
Fax: 506-446-6934
e-mail: daviesda@nbnet.nb.ca

Chuck Davis
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: cdavis@nrcan.gc.ca

Pierre DesRochers
Natural Resources Canada
Canadian Forest Service
1055 rue du P.E.PS.
C.P. 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-3922
Fax: 418-648-5849
e-mail: Desrochers@CFL.Forestry.ca

Linda DeVerno
NRCan - CFS
Science Branch
580 Booth St., 12D2
Ottawa, ON
K1A 0E4
Telephone: 613-947-4292
Fax: 613-947-9035
e-mail: ldeverno@NRCAN.gc.ca

Erhard Dobesberger
Survey Biologist
Canadian Food Inspection Agency
3851 Fallowfield Rd.
Nepean, ON
K2H 8P9
Telephone: 613-228-6698
Fax: 613-228-6662
e-mail: dobesbergerE@em.agr.ca

Jacques Dugal
1780 rue Semple
Quebec City, QC
G1N 4B8
Telephone: 418-681-3381
Fax: 418-681-0994
e-mail: j.dugal@sopfim.qc.ca

Louise Dumouchel
ACIA
3851 Fallowfield Rd
Nepean, ON
K2H 8P9
Telephone: 613-228-6698
Fax: 613-228-6100
e-mail: ldumouchel@em.agr.ca

Ron Favrin
Canadian Food Inspection Agency
3851 Fallowfield Rd
Nepean, ON
K2H 8P9
Telephone: 613-228-6698
Fax: 613-228-6662
e-mail: favrinr@em.agr.ca

Richard Fleming
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: rfleming@nrcan.gc.ca

Eric Georgeson
Nova Scotia Dept. Of Natural Resources
P.O. Box 130
Shubenacadie, NS
B0N 2H0
Telephone: 902-758-2232
Fax: 902-758-3210
e-mail: nsforprt@ns.sympatico.ca

David Gray
Natural Resources Canada
Canadian Forest Service
Atlantic Forestry Centre
P.O. Box 4000
Fredericton, NB
E3P 5P7
Telephone: 506-452-3462
Fax: 506-452-3078
e-mail: dgray@nrcan.gc.ca

H. Rae Grinnell
5432 West River Dr.
Manotick, ON
K4M 1G5
Telephone: 613-692-3484
Fax: 613-692-1244
e-mail:

Richard Groen
Abbott Labs
19 Wildan Dr.
Box 19
Freelton, ON
L0R 1K0
Telephone: 905-659-0886
Fax: 905-659-0885
e-mail: richard.groen@abbott.com

Brian Haddon
9 Dorey Court
Kanata, ON
K2L 2V5
Telephone:
Fax: 613-592-8101
e-mail: forchron@magma.ca

Richard Hamelin
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.PS.
Box 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-3693
Fax: 418-649-6956
e-mail: Rhamelin@nrcan.gc.ca

Dr. Yvan Hardy
Natural Resources Canada
Canadian Forest Service
580 Booth St.
Ottawa, ON
K1A 0E4
Telephone: 613-943-8990
Fax: 613-947-9090
e-mail: Yhardy@nrcan.gc.ca

Ken Harrison
Natural Resources Canada
Canadian Forest Service
Atlantic Forestry Centre
P.O. Box 4000
Fredericton, NB
E3P 5P7
Telephone: 506-452-3513
Fax: 506-452-3078
e-mail: kharrsio@NRCan.gc.ca

Irene Hay
NRCan - CFS
Science Branch
580 Booth St., 12D2
Ottawa, ON
K1A 0E4
Telephone: 613-996-0237
Fax: 613-947-9035
e-mail: ihay@NRCAN.gc.ca

Ole Hendrickson
Canadian Forest Service
580 Booth St., 12D2
Ottawa, ON
K1A 0E4
Telephone: 613-947-9026
Fax: 613-947-9090
e-mail: ohendric@nrcan.gc.ca

Anthony Hopkin
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: ahopkin@nrcan.gc.ca

S. Holmes
Natural Resources Canada
Canadian Forestry Service
P.O. Box 4000
Regent St.
Fredericton, NB
E3B 5P7
Telephone: 506-452-3574
Fax: 506-452-3828
e-mail: Stholmes@NRCAN.gc.ca

Gordon Howse
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: ghowse@nrcan.gc.ca

John Huber
Canadian Forest Service
ECORC, K.W. Neatby Building
Ottawa, ON
K2B 5G2
Telephone: 613-759-1840
Fax: 613-759-1927
e-mail: Huberjh@em.agr.ca

Lee Humble
NR Can - CFS
Pacific Forestry Centre
506 West Burnside Road
Victoria, BC
V8Z 1M5
Telephone: 250-363-0663
Fax: 250-363-0775
e-mail: Leland.humble@PFC.Forestry.ca

Dr. Jean E. Irvin
Director, Regulatory Affairs
AEF Global, Inc.
1462 Bryson Lane
Gloucester, ON
K1T 2T6
Telephone: 613-260-8072
Fax: 613-260-8073
e-mail: jirvin@sympatico.ca

Micheal Irvine
Ministry of Natural Resources
Forest Management Branch
Suite 400, 70 Foster Drive
Sault Ste Marie, ON
P6A 6V5
Telephone: 705-945-5724
Fax: 705-945-6667
e-mail: micheal.irvine@mnr.gov.on.ca

Keith Knowles
Manitoba Natural Resources
Box 70
200 SaultAux
Winnipeg, MB
Telephone: 204-945-7868
Fax: 204-948-2671
e-mail: Kknowles@nr.gov.mb.ca

Edward Kettela
Canadian Forest Service
Atlantic Region
P.O. Box 4000
Fredericton, NB
E3B 5P7
Telephone: 506-452-3214
Fax: 506-452-3828
e-mail: ekettela@nrcan.gc.ca

Dave Kennington
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: dkenning@nrcan.gc.ca

Dr. C.J. Lucarotti
Canadian Forest Service
Atlantic Region
P.O. Box 4000
Fredericton, NB
E3B 5P7
Telephone: 506-452-3538
Fax: 506-452-3525
e-mail: clucarot@nrcan.gc.ca

Gaston Laflame
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.PS.
Box 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-4149
Fax: 418-648-5849
e-mail: Glafamme@cfl.forestry.com

Harri Liljalehto
ONMR
300 Water St.
Peterborough, ON
K9J 8M5
Telephone: 705-755-1961
Fax:
e-mail: harri.liljalehto@mnr.gov.on.ca

Olav H. Loken
1170 Bonnie Cresent
Ottawa, ON
K2C 1Z5
Telephone: 613-225-4234
Fax: 613-225-4234
e-mail: oloken@sympatico.ca

Normand Lafrenière
Natural Resources Canada
Canadian Forest Service
1055 rue du P.E.PS.
C.P. 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-3922
Fax: 418-648-5849
e-mail: Nlafreniere@CFL.Forestry.ca

Andrew Lam
Canadian Food Inspection Agency
Plant Health and Protection Division
59 Camelot Dr.
Neapean, ON
K1A 0Y9
Telephone: 613-225-2342
Fax: 613-228-6606
e-mail: ablam@em.agr.ca

Linda MacDonald
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste. Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: lmacdona@nrcan.gc.ca

Wayne MacKay
Natural Resources Canada
Canadian Froest Service
P.O. Box 4000
Fredericton, NB
E3B 5P7
Telephone: 506-452-3004
Fax: 506-4523525
e-mail: wmackay@nrcan.gc.ca

Richard Martin
Health Canada - PMRA
2250 Riverside Drive
Ottawa, ON
K1A 0K9
Telephone: 613-736-3674
Fax: 613-736-3659
e-mail: richard_Martin@hc-sc.gc/ca

Larry Matwee
Manitoba Natural Resources
Box 27, GRP 8
R. R.#2
Dugald, MB
Telephone: 204-945-5006
Fax: 204-945-8385
e-mail: Lmatwee@nr.gov.mb.ca

Beth McEwen
City of Toronto
Parks and Recreation
100 Queen St. W.
21 E City Hall
Toronto, ON
Telephone: 416-392-1888
Fax: 416-392-6657
e-mail: bmcewen@city.toronto.ca

John McLaughlin
OMNR -OFRI
1235 Queen St. E.
Sault Ste. Marie, ON
P6A 2E5
Telehone: 705-946-2981
Fax: 705-946-2030
E-mail: John.McLaughlin@MNR.gov.on.ca

Murray McLaughlin
FORAGEN
134 Dimson Ave.
Guelph, ON
Telephone: 519-824-7923
Fax: 519-824-9146
e-mail: murraym@foragen.com

David A. McManama
Thermo Trilogy Corp
1703 DeLaney
Indianapolis, Indiana
46217
Telephone: 317-887-9797
Fax: 317-859-9400
e-mail: MacTrilogy@aol.com

Joe Meating
BioForest Technologies Inc.
105 Bruce St.
Sault Ste Marie, ON
P6A 2X6
Telephone: 705-942-5824
Fax:
e-mail: jmeating@soonet.ca

Bob Mickle
SERG.
12 Welsh Dr.
R.R. 3
Ayr, ON
N0B 1E0
Telephone: 519-632-5006
Fax: 519-632-5007
e-mail: Remspc@golelen.net

Ben Moody
Natural Resources Canada
Canadian Forest Service
Science Branch
580 Booth St.,
Ottawa, ON
K1A 0E4
Telephone: 613-947-9016
Fax: 613-947-9090
e-mail: bmoody@NRCAN.gc.ca

Denise Moranville
1780 rue Semple
Quebec City, QC
G1N 4B8
Telephone: 418-681-3381
Fax: 418-681-0994
e-mail: d.moranville@sopfim.qc.ca

Vince Nealis
Canadian Forest Service
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C.
V8Z 1M5
Telephone: 250-363-0663
Fax: 250-363-0775
e-mail: vnealis@pfc.forestry.ca

Stephen Nicholson
Sales Manager, Forestry
Abbott Laboratories
2704 Orser Road
Elginburg, ON
K0H 1M0
Telephone: 613-376-1070
Fax: 613-376-1069
e-mail: stephen.nicholson@abbott.com

Ian Nadar
Agfor & Associates
6519 Wellwood St.
Greely, ON
K4P 1G2
Telephone: 613-821-4868
Fax: 613- 821-2422
e-mail: agfor@ottawa.com

Hideji Ono
Alberta Environment, Land and Forest Service
10th Floor, 9920, 108 Street
Edmonton, AB
T5K 2M4
Telephone: 780-427-6807
Fax: 780-427-0292
e-mail: Hideji.Ono@gov.ab.ca

Bruce Pauli
Canadian Wildlife Service
100 blvd. Gamelin
Hull, QC
K1A 0H3
Telephone: 819-953-2634
Fax: 819-953-6612
e-mail: bruce.pauli@ec.gc.ca

Jacques Régnière
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.PS.
Box 3800
Sainte-Foy, QC
G1V 4C7
Telephone: 418-648-5257
Fax: 418-648-5849
e-mail: jregniere@cfl.forestry.com

Robert Sajan
Natural Resources Canada
Canadian Forest Service
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: bsajan@nrcan.gc.ca

Taylor Scarr
Provincial Entomologist
Ontario Ministry Of Natural Resources
Roberta Bondar Place
70 Foster Drive, Suite 400
Sault Ste Marie, ON
P6A 6V5
Telephone: 705-945-5723
Fax: 705-945-6667
e-mail: Taylor.Scarr@mnr.gov.ca

Paul Schorn
Dow Agro Sciences Canada
201, 1144-29 Avenue N.E.
Calgary, AB
T2E 7P1
Telephone: 403-735-8834
Fax: 403-735-8819
e-mail: pschorn@Dowagro.com

Wendy Sexsmith
Director
Pest Management Regulatory Agency
2250 Riverside Drive
Ottawa, ON
Telephone: 613-736-3660
Fax: 613-736-3659
e-mail: Wendy_Sexsmith@hc-sc-.gc.ca

Dr. Simon Shamoun
NRCan - CFS
Pacific Forestry Centre
506 West Burnside Road,
Victoria, BC
V8Z 1M5
Telephone: 250-363-0766
Fax: 250-363-0775
e-mail: Sshamoun@PFC.forestry.ca

Yudi Singh
Associate Director
Forestry Section, Canadian Food Inspection Agency
59 Camelo Drive
Nepean, ON
Telephone: 613-228-6696
Fax: 613-228-6602
e-mail: ysingh@em.agr.ca

Georgette Smith
Natural Resources Canada
Canadian Forest Service
Atlantic Forestry Centre
P.O. Box 4000
Fredericton, NB
E3P 5P7
Telephone: 506-452-3569
Fax: 506-452-3525
e-mail: gcsmith@NRCan.gc.ca

Guy K.M. Smith
Natural Resources Canada
Canadian Forest Service
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: gusmith@nrcan.gc.ca

Rod Smith
CFS - GLFC
1219 Queen St. E.
Sault Ste. Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: Rsmith@nrcan.gc.ca

Sandy Smith
University of Toronto
Toronto, On
M5S 1A1
Telephone: 416-978-5482
Fax: 416-978-3834
e-mail: s.smith@utoronto.ca

Tom Sterner
Natural Resources Canada
Canadian Forestry Service
P.O. Box 4000
Regent St.
Fredericton, NB
E3B 5P7
Telephone: 506-452-3574
Fax: 506-452-3828
e-mail: Tsterner@NRCAN.gc.ca

Greg Stubbings
Canadian Food Inspection Agency
Plant Health and Protection Division
59 Camelot Dr.
Neapean, ON
K1A 0Y9
Telephone: 613-225-2342
Fax: 613-228-6606
e-mail: gstubbings@em.agr.ca

Bob Taylor
Natural Resources Canada
Canadian Forest Service
580 Booth St.
Ottawa, ON
K1A 0E4
Telephone: 613-943-8990
Fax: 613-947-9090
e-mail: rotaylor@nrcan.gc.ca

Graham Thurston
Natural Resources Canada
Pest Control Development
P.O. Box 4000
Regent St.
Fredericton, NB
E3B 5P7
Telephone: 506-452-3574
Fax: 506-452-3828
e-mail: gthursto@nrcan.gc.ca

Borys M. Tkacz
Forest Pathologist
Forest Health Protection
USDA Forest Service
P.O. Box 96090
Washington, DC
20090-609
Telehpone: 202-205-1289
Fax: 202-205-1139
e-mail: btkacz/wo@fs.fed.us

Michel Tremblay
Rohm and Haas Canada
45-A Donovan Terrace
Moncton, NB
E1A 4P1
Telephone: 506-857-8741
Fax: 506-857-8980
e-mail: Michel-Tremblay@rohmhaas.com

K. van Frankenhuyzen
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste. Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: Fvanfran@nrcan.gc.ca

Gerrit van Raalte
Natural Resources Canada
Atlantic Forestry Centre
P.O. Box 4000
Fredericton, NB
E3B 5P7
Telephone: 506-452-3508
Fax: 506-452-3140
e-mail: gvanraal@nrcan.gc.ca

Guy Viel
AEF Global Inc.
855, rue Pépin
Sherbrooke, QC
J1L 2P8
Telehpone: 819-348-9461
Fax: 819-348-9466
e-mail: aefglobal@qc.aira.com

Dr. Doreen Watler
Canadian Food Inspection Agency
3851 Fallowfield Rd
Nepean, ON
K2H 8P9
Telephone: 613-228-6698
Fax: 613-228-6662
e-mail: watlerd@em.agr.ca

Mike Weber
Canadian Forest Service
Great Lakes Forestry Centre
1219 Queen St. E.
Sault Ste Marie, ON
P6A 5M7
Telephone: 705-949-9461
Fax: 705-759-5700
e-mail: mweber@nrcan.gc.ca

Dave Winston
Natural Resources Canada
Canadian Forest Service
580 Booth St.
Ottawa, ON
K1A 0E4
Telephone: 613-943-8990
Fax: 613-947-9090
e-mail: Dwinston@nrcan.gc.ca

Micheal Wood
Commodity Officer
Forestry Section, Canadian Food Inspection Agency
59 Camelo Drive
Nepean, ON
Telephone: 613-228-6696
Fax: 613-228-6602
e-mail: mwood@em.agr.ca

Program

1999 Forest Pest Management Forum and Associated Meetings

Sussex Room
Government Conference Centre
Ottawa, Ontario
November 15-17, 1999

Monday November 15

08:30-17:00 Meeting of the Forest Protection Technology Committee
Chair - Gordon Howse *Sussex Room*

19:00-21:00 Meeting of Spray Efficacy Research Group (SERG)
Chair - Bud Irving *Sussex Room*

Tuesday November 16

08:30	Opening Remarks	Dr. Yvan Hardy, Assistant Deputy Minister, Canadian Forest Service

Session I **Provincial and U.S. Pest Updates and Control Summaries**
Chair - Dave Winston

09:00	British Columbia Alberta Saskatchewan
10:00	Break, Posters
	Manitoba Ontario Quebec
11:30	Discussion Period
12:00	Lunch
13:00	New Brunswick Nova Scotia

Tuesday November 16 - continued

Session I	**Provincial and U.S. Pest Updates and Control Summaries** *Chair - Dave Winston*
13:00	Prince Edward Island Newfoundland United States
14:40	Discussion
15:00	Break, Posters
Session II	**Update: Regulatory Affairs and CFS Research Activities** *Chair - Nelson Cartier*
15:30	Canada Food Inspection Agency - *Greg Stubbings*
15:50	Pest management Regulatory Agency - *Wendy Sexsmith*
16:10	Canadian Forest Service - *Errol Caldwell*
16:30	Discussion Period
17:00-18:30	**Forum Marketplace** *Sussex Lounge* **A new networking and information exchange opportunity** Government and commercial exhibitors, posters on applied research and development Cash bar, hors d'oeuvres
17:30-19:00	Forum Steering Committee (closed) *Chair - Errol Caldwell*

Wednesday November 17

Session III	**Invasive species - threats to forest Health, Biodiversity, and International Trade** *Chair - Ton Sterner*
08:30	Introduction - *Tom Sterner*

Wednesday November 17 - continued

Session III	**Invasive species - threats to forest Health, Biodiversity, and International Trade** *Chair - Ton Sterner*
08:40	Evaluation of Interceptions in Dunnage *- Andrew Lam*
09:00	CFS Invasive Species Research - current status and needs *- Lee Humble*
09:20	Pine Shoot Beetle in Ontario *- Taylor Scarr*
09:40	Implications for Trade *- Guy Bird*
10:00	Coffee Break *Sussex Lounge*
10:30	Implications for biodiversity and biosystematics activities *- Ole Hendrickson*
10:50	Implications for CFS science program *- Gerrit van Raalte*
11:00	Discussion period
Session IV	**Applied Research, Emerging Technologies and Innovations** *Chair - Normand Lafrenière*
11:30	Development of bioherbicides for management of competing forest vegetation *- Simon Shamoun*
12:00	Lunch
13:00	Changing bark beetle fortunes and their natural enemies - perspectives from research on *Tomicus* and Ice-Storm damage. *- Sandy Smith*
13:30	Modelling gypsy moth seasonality on Vancouver Island *- Vince Nealis*
14:00	Biotechnological approaches in forest pathology research *- Richard Hamelin*
14:30	Spruce budworm outbreaks: a predictive system *- David Gray*

15:00 Coffee break

Wednesday November 17 - continued

Session IV Applied Research, Emerging Technologies and Innovations - continued

15:30 Balsam fir sawfly control with nuclear polyhedrosis virus
- Chris Lucarotti

16:00 Biocontrol approaches against insect pests in Eastern Canada
- Graham Thurston

Programme

Forum 1999 sur la répression des ravageurs forestiers

Salle Sussex
Centre de conférences du gouvernement
Ottawa (Ontario)
Du15 au 17 novembre 1999

Le lundi 15 novembre

8 h 30-17 h Réunion du Comité sur la technologie de protection des forêts
Président - Gordon Howse *Salle Sussex*

19 h-21 h Réunion du Groupe de recherche sur l'efficacité des pulvérisations (SERG)
Président - Bud Irving *Salle Sussex*

Le mardi 16 novembre

8 h 30 Mot de bienvenue — Dr. Yvan Hardy, Sous-ministre adjoint
Service canadien des forêts

Séance I **Mises à jour sur l'état des ravageurs et sommaires sur les méthodes de lutte (provinces et États-Unis)**
Président - Dave Winston *Salle Sussex*

9 h Colombie-Britannique
Alberta
Saskatchewan

10 h Pause

Manitoba
Ontario
Québec

11 h 30 Discussion

12 h Déjeuner

Le mardi 16 novembre

Séance I	**Mises à jour sur l'état des ravageurs et sommaires sur les méthodes de lutte (provinces et États-Unis)** *Président - Dave Winston* *Salle Sussex*
13 h	Nouveau-Brunswick Nouvelle-Écosse Île-du-Prince-Édouard Terre-Neuve États-Unis
14 h 40	Discussion
15 h	Pause
Séance II	**Mises à jour : Affaires réglementaries et activités de recherche du SCF** *Président - Nelson Carter* *Salle Sussex*
15 h 30	Agence canadien d'inspection des aliments - *Greg Stubbings*
15 h 50	Agence de réglementation de la lutte antiparasitaire - *Wendy Sexsmith*
16 h 10	Service canadien des forêts - *Errol Caldwell*
16 h 30	Discussion
17 h - 18 h 30	**Le Marché du Forum** *Salon Sussex* **Une nouvelle occasion d'établir des contacts et d'échanger de l'information** Exposants - gouvernement, et entreprises privées, affiches sur la recherche appliquée et le développement Bar payant, hors-d'oeuvre
17 h 30 - 19 h	Le Comité d'organisation du Forum se réunira à huis clos de *Président - Errol Caldwell*

Le mercredi 17 novembre

Séance III	**Espèces invasives - Menaces contre la santé des forêts, la biodiversité et le commerce international** *Président - Tom Sterner*
8 h 30	Introduction - *Tom Sterner*
8 h 40	Évaluation des interceptions faites dans le fardage *- Andrew Lam*
9 h	Recherche menée au SCF sur les espèces invasives - rapport d'étape et besoins *- Lee Humble*
9 h 20	Le Grand Hylésine des pins en Ontario *- Taylor Scarr*
9 h 40	Incidence sur les activités commericales *- Guy Bird*
10 h	Pause
10 h 30	Incidence sur la biodiversités de biosystématique *- Ole Hendrickson*
10h 50	Incidence sur le programme de sciences du SCF *- Gerrit van Raalte*
11h	Discussion
Séance IV	**Recherche appliquée, technologies nouvelles et innovations** *Président - Normand Lafrenière*
11 h 30	Mise au point de bioherbicides destinés à la luttle contre la végétation concurrente *- Simon Shamoun*
12 h	Déjeuner
13 h	Évolution de la situation du scolyte et de ses ennemis naturels - vues découlant d'une étude sur *Tomicus* et les dommages causés par la tempête de verglas *- Sandy Smith*

13 h 30	Modélisation des cycles saisonniers de la spongieuse sur l'île de Vancouver *- Vince Nealis*

Le mercredi 17 novembre

Séance IV	**Recherche appliquée, technologies nouvelles et innovations** *Président - Normand Lafrenière*
14 h	Approches biotechnologiques en matière de recherche sur la pathologie forestière *- Richard Hamelin*
14 h 30	Pullulations de la tordeuse des bourgeons de l'épinette: un modèle de prévision *- David Gray*
15 h	Pause
15 h 30	Lutte contre le diprion du sapin au moyen d'un virus de la polyédrose nucléaire *- Chris Lucarotti*
16 h	Approaches de lutte biologique contre les insectes ravageurs de l'est du Canada *- Graham Thurston*

Session I - Provincial and U.S. Control Summaries and Pest Updates
Chair: Dave Winston

Séance I - Mises à jour sur l'état des ravageurs et sommaires sur les méthodes de lutte (Provinces et États-Unis)
Président: Dave Winston

Important Forest Pest Conditions and Pest Management Operations in Alberta

H. Ono
Land and Forest Service, Alberta Environment

Summary

The spruce budworm, *Choristoneura fumiferana* (Clem.), currently is the major forest insect pest in Alberta. The budworm-defoliated area in 1999 was 191 657 ha, about 50% higher than the area defoliated in 1998. The pheromone trap catches of budworm moths indicate moderate to high risk of new budworm outbreaks in northern Alberta where current outbreaks are found. In the areas currently defoliated by the budworm, severity of defoliation is expected to be lower in 2000, except in isolated pockets.

Small patches of trees attacked by the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, were found in Willmore Wilderness Park and Banff National Park. Active mountain pine beetle infestations were also found along Palliser and Cross rivers in B.C., close to Alberta-B.C. border. Most of the plots with pheromone-baited trees in Willmore Wilderness Park had beetle hits. In 1999, beetle hits in pheromone-baited trees were lower in southern Alberta, compared to 1998.

Larch sawfly continued to defoliate tamarack in northwestern Alberta. Pine false webworm populations in Edmonton declined in 1999.

Aspen defoliator damage, notably by the forest tent caterpillar, *Malacosoma disstria* Hübner and Bruce spanworm, *Operophtera bruceata* (Hulst.), increased significantly during 1999. The gross area defoliated by the forest tent caterpillar was estimated to be 584 260 ha. Most of this defoliation was severe. The gross area of large aspen tortrix and Bruce spanworm defoliation in northwestern Alberta was 775 497 ha. In addition, Bruce spanworm defoliated large tracts of aspen stands in south and central parts of western Alberta.

For the first time in Alberta, black army cutworm, *Actebia fennica* Tauscher, defoliated newly planted cut-blocks scattered over a wide area in central Alberta. This outbreak followed a large-scale spring fire in this area. Moth catches in pheromone-baited traps set up in the infested-areas were relatively low; the scale and severity of this infestation are expected to decrease in 2000.

The first confirmed case of Dutch elm disease (DED) in Alberta was reported from Wainright. The smaller European elm bark beetle, a vector of DED, continued to be trapped at urban centres in the province. A computerised elm tree inventory of Alberta is being compiled by the Society to Prevent Dutch Elm Disease.

In 1999, Thuricide 48 LV® was aerially sprayed over 70 324 ha in northern Alberta to control spruce budworm infestations. Mimic 240LV® was sprayed over an additional 12 932 ha. All the sprayings were carried out by using fixed-wing spray aircraft equipped with Micronair AU4000® atomiser nozzles and Satloc Forestar® differential global positioning systems. Aerial sprayings in northwestern Alberta were hampered by unusually cold spring weather. In this area, light defoliation is expected in most of the sprayed plots in 2000. All the sprayed plots in northeastern Alberta are expected to have light defoliation in 2000.

Le point sur les principaux ravageurs forestiers et les campagnes de lutte entreprises en Alberta

H. Ono
Land and Forest Service, Alberta Environment

Sommaire

La tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.), est actuellement considérée comme le principal ravageur forestier en Alberta. La superficie défoliée par la tordeuse en 1999 s'est élevée à 191 657 ha, soit une augmentation de 50% par rapport à 1998. D'après le nombre de prises enregistrées aux pièges à phéromone, le risque que de nouvelles infestations se déclarent dans le nord de l'Alberta, où des infestations sévissent actuellement, est modéré à élevé. Dans les régions actuellement défoliées par la tordeuse, les infestations devraient diminuer d'intensité en 2000, sauf dans quelques enclaves isolées.

De petits îlots d'arbres attaqués par le dendroctone du pin ponderosa, *Dendroctonus ponderosae* Hopkins, ont été repérés dans le parc provincial sauvage Willmore et le parc national Banff. Des infestations actives ont également été signalées le long des rivières Palliser et Cross, en Colombie-Britannique, près de la frontière avec l'Alberta. Des prises ont été enregistrées dans la plupart des parcelles dans lesquelles des billons appâtés de phéromone avaient été installés. Par rapport à 1998, le nombre de prises dans les billons-appâts a diminué dans le sud de l'Alberta en 1999.

La tenthrède du mélèze a continué de défolier le mélèze dans le nord-ouest de l'Alberta. Les populations du pamphile introduit du pin ont décliné à Edmonton en 1999.

Les dommages infligés au peuplier faux-tremble par les défoliateurs, en particulier la livrée des forêts, *Malacosoma disstria* Hübner, et l'arpenteuse de Bruce, *Operophtera bruceata* (Hulst.), ont augmenté de façon significative en 1999. La superficie brute défoliée par la livrée des forêts a été estimée à 584 260 ha. La majeure partie de ce territoire a été gravement défoliée. La superficie brute défoliée par l'arpenteuse de Bruce dans le nord-ouest de l'Alberta a été estimée à 775 497 ha. L'arpenteuse de Bruce a en outre ravagé de vastes superficies de tremblaies dans le sud et le centre de la partie ouest de l'Alberta.

Pour la première fois en Alberta, la légionnaire noire, *Actebia fennica* Tauscher, a défolié des parcelles de coupe fraîchement reboisées sur un vaste territoire dans le centre de l'Alberta. Cette infestation s'est déclarée à la suite d'un important incendie qui a ravagé une bonne partie de la région au cours du printemps. Les nombres de prises enregistrées dans les pièges à phéromone déployés dans les secteurs infestés se sont révélés relativement faibles. On s'attend à ce que l'étendue et la gravité de cette infestation diminuent en 2000.

Le premier cas confirmé de maladie hollandaise de l'orme en Alberta a été signalé à Wainright. Des spécimens du petit scolyte européen de l'orme, vecteur de la maladie, ont encore été capturés cette année dans des pièges déployés dans des centres urbains de la province. La Society to Prevent Dutch Elm Disease a entrepris de compiler les résultats d'un inventaire informatisé des ormes de l'Alberta.

En 1999, des épandages aériens de Thuricide 48 LV® ont été effectués contre la tordeuse des bourgeons de l'épinette sur 70 324 ha dans le nord de l'Alberta. Une superficie additionnelle de

12 932 ha a également fait l'objet d'un traitement au Mimic 240 LV®. Tous les épandages ont été réalisés à l'aide d'un aéronef à voilure fixe équipé de buses Micronair AU4000 et d'un système Satloc Forestar® de positionnement par SPG en mode différentiel. Les températures anormalement froides qui ont sévi au cours du printemps ont retardé les traitements aériens dans le nord-ouest de l'Alberta. Dans cette région, on prévoit en 2000 des défoliations légères dans la plupart des parcelles traitées. Toutes les parcelles traitées dans le nord-est de l'Alberta devraient également subir des défoliations légères en 2000.

1999 Forest Pest Management Forum

Important Forest Pest Conditions and Pest Management Operations in Alberta

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

Contributors:
Land and Forest Service
S. Ranasinghe, E. Lee, D. Lux, M. Maximchuk,
S. Schwartz and M. Undershultz

J. Feddes-Calpas (Alberta Agriculture, Food and Rural Development)
C. Saunders (City of Edmonton), and T. Reichardt (City of Calgary)

November 1999
OTTAWA

1.0 INTRODUCTION

This report contains summaries of forest pest conditions (excluding weeds) and details of forest pest management operations carried out in Alberta during 1999. It covers the important forest pests that occurred in the "Green Area" as well as in the "White Area" of the province. The details of forest pest conditions (including details about noxious, and restricted weeds) and pest management operations will be published in the "1999 Annual Report on Forest Health in Alberta."

In Alberta, the "Green Area" is the forested area of the province (as opposed to the "White Area," which is the settled area). The Green Area is comprised of 17 *Forest Areas* organized into four *Forest Regions* (Figure 1). Prior to 1998 these *Forest Areas* were referred to as *Forest Districts*. The urban centres found within the "White Area" have their own agencies handling urban forest pest concerns.

This report contains information provided by a number of agencies (see listings on the title page). Mike Maximchuk, Forest Health Officer, carried out the aerial surveys in the Northwest Boreal (NWB) Region. Sarah Schwartz, Forest Health Officer, carried out the aerial surveys in the Northeast Boreal (NEB) Region with the help of Roger Brett, a Forest Health Network Technician attached to the Northern Forestry Centre (NoFC), Canadian Forest Service (CFS) in Edmonton. The Forest Health Officers, Daniel Lux (Park, Bow, Prairie (PBP) Region) and Erica Lee (Northern East Slopes (NES) Region) carried out the aerial surveys to detect mountain pine beetle infestations in southwestern Alberta including Jasper National Park and Banff National Park. Daishowa Marubeni International Ltd., Buchanan Lumber Ltd., Canfor (Hines Creek), Manning Diversified Forest Products and Millar Western Industries assisted in spruce budworm surveys. Weldwood of Canada Ltd. helped with mountain pine beetle surveys and sanitation projects in the NES Region. The province-wide gypsy moth survey was co-ordinated by Canadian Food Inspection Agency.

Figure 1. Forest Regions in Alberta

2.0 FOREST PEST CONDITIONS IN 1999 AND FORECASTS FOR 2000

2.1 Spruce Budworm, *Choristoneura fumiferana* (Clemens)

2.1.1 Budworm Defoliation in 1999

Aerial surveys were carried out in July to estimate the extent of budworm-defoliated area within the province. The procedures used for these surveys are described in the "Forest Health Aerial Survey Guide" (Ranasinghe and Kominek, 1999). The severity of spruce budworm defoliation was rated as moderate (36% to 70% defoliation) or severe (over 70% defoliation) because light defoliation (,35%) is normally not visible from the air.

The results of these aerial surveys are summarised in Table 1.

Table 1. Spruce budworm-defoliated area in Alberta, 1999.

Region	Forest Area	Defoliated Area (ha)			Remarks
		Moderate	Severe	Total	
Northwest Boreal	Upper Hay	7395	99468	106863	Net area
	MacKenzie	0	18043	18043	Net area
Northeast Boreal	South of lat. 57.6° [a]	11261	38502	49763	Net area
	North of lat. 57.6° [b]	7119	9869	16988	Gross area
TOTAL		25775	165882	191657	

[a] Athabasca and Waterways (part)
[b] Waterways (part)

In the NWB Region, the extent of the spruce budworm-defoliated area increased in 1999. Following aerial surveys, the extent of budworm defoliation in the Upper Hay and Mackenzie forest areas in this region was estimated at 124 906 ha. This is a 50% increase in the defoliated-area compared to the defoliated-area observed in 1998. Defoliation was severe in almost all (95%) of the affected stands. Some stands in the Upper Hay Forest Area, although sprayed with *Bacillus thuringiensis* var. *kurstaki* (Btk) in 1998, had moderate budworm defoliation in 1999. This is attributed to unusually high prespray population levels (up to 8455 budworms per 10 m^2 of foliage). These high population levels in 1998, in spite of over 90% budworm kill, left L_2 populations high enough to cause moderate defoliation in these stands in 1999. Spruce budworm defoliated some areas that have been sprayed in 1996, and in 1997. In addition, spruce budworm defoliated some new areas, as well (Figure 2).

In the southern section of the NEB Region (south of latitude 57. 6° N), the spruce budworm defoliated 49 763 ha, over 50% increase compared to 32 403 ha defoliated in 1998. Most of this defoliation was observed along the Athabasca and House river drainages southwest of Fort McMurray. As forecasted, severity of defoliation increased

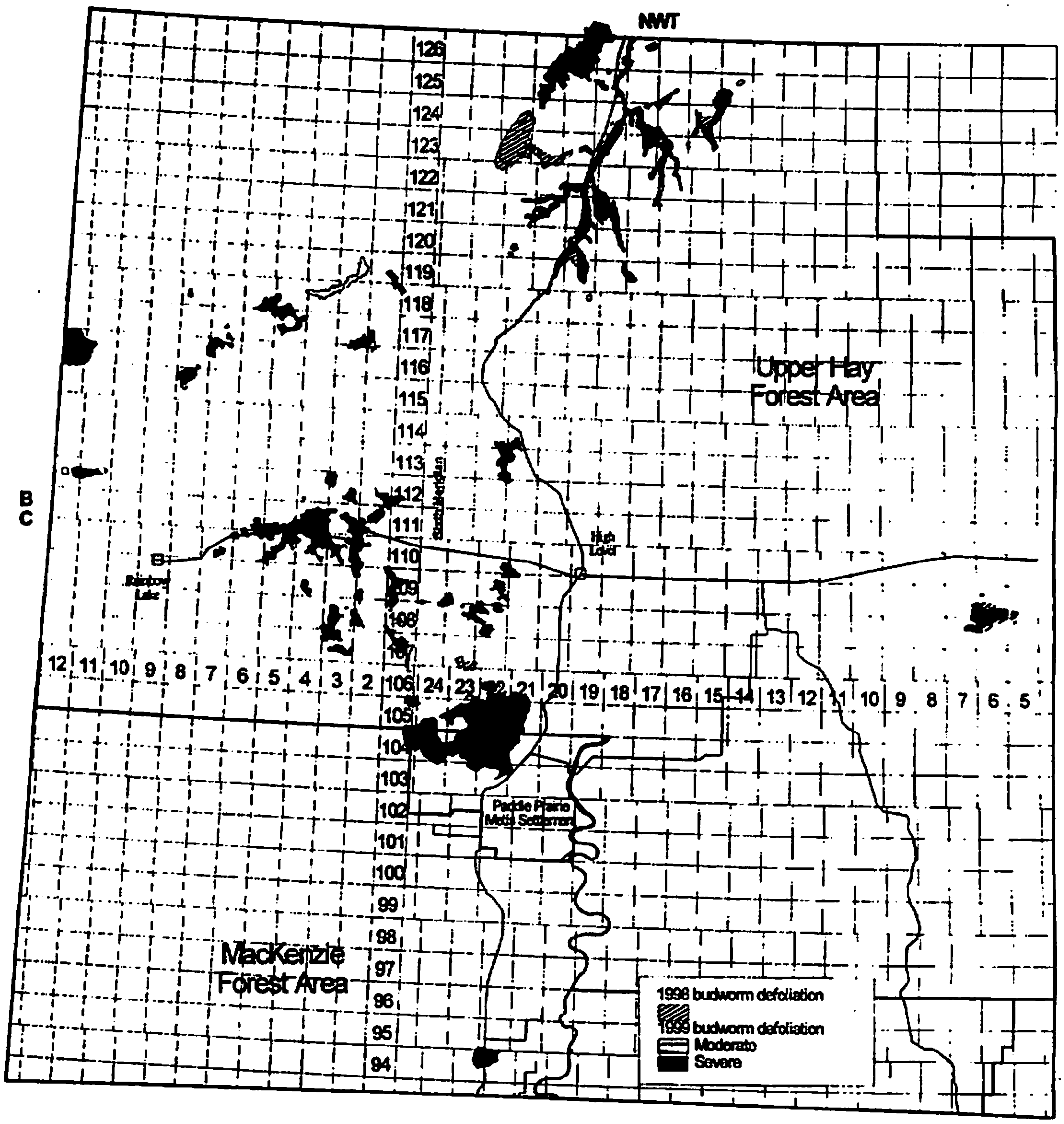


Figure 2. Spruce budworm defoliation in the Northwest Boreal Region of Alberta, 1999.

in this region resulting in moderate budworm defoliation on 11 261 ha and severe budworm defoliation on 38 502 ha. In the northern section of this region (north of latitude 57.6°), gross spruce budworm defoliation, i.e., total area including non-host stands over which defoliation was spread, was 16 988 ha. Most of this defoliation was observed along the Slave River bordering Wood Buffalo National Park. In this section, moderate budworm defoliation was found over 7119 ha and severe budworm defoliation was found over 9869 ha (Figure 3).

There was no spruce budworm defoliation in the NES and PBP regions.

2.1.2 Forecast for 2000 Based on Pheromone Trap Catches in 1999

Multi-Pher I® traps (Le Groupe Biocontrole, Quebec) baited with female budworm sex pheromone lures (Biolure®, Consep Membranes Inc., USA) were used to monitor spruce budworm populations in several forest stands located across the province. Although these stands had no signs of budworm defoliation, they were considered to have a high risk of being defoliated in the near future. The procedure for deploying these traps is described in the "Spruce Budworm Management Guide" (Ranasinghe and Kominek 1998).

One hundred and seventy-nine (179) monitoring plots were established across the province. The risk of a budworm outbreak in the PBP Region continues to be low as indicated by the relatively low trap catches. The budworm moth catches in the Foothills Forest Area (NES Region) were extremely low (< 8 moths per trap); however, this appears to be the two-year cycle budworm, *Choristoneura biennis* Free, because the trap catches have been alternating between high and low numbers during consecutive years. Higher trap catches are expected in 2000 in this forest area. In the Marten Hills Forest Area (NEB), risk of a budworm outbreak remained low. In the NEB Region, the risk of new budworm outbreaks ranged from low to high in the Athabasca Forest Area and moderate to high in the Waterways Forest Area.

Risk of new budworm outbreaks is low to moderate in the MacKenzie Forest Area (NWB) and low to high in the Upper Hay Forest Area (NWB) where current outbreaks are located. Risk of new spruce budworm outbreaks occurring in 2000 is low in the East Peace, Lakeshore, Smoky River and Wapiti forest areas in this region (Figure 4).

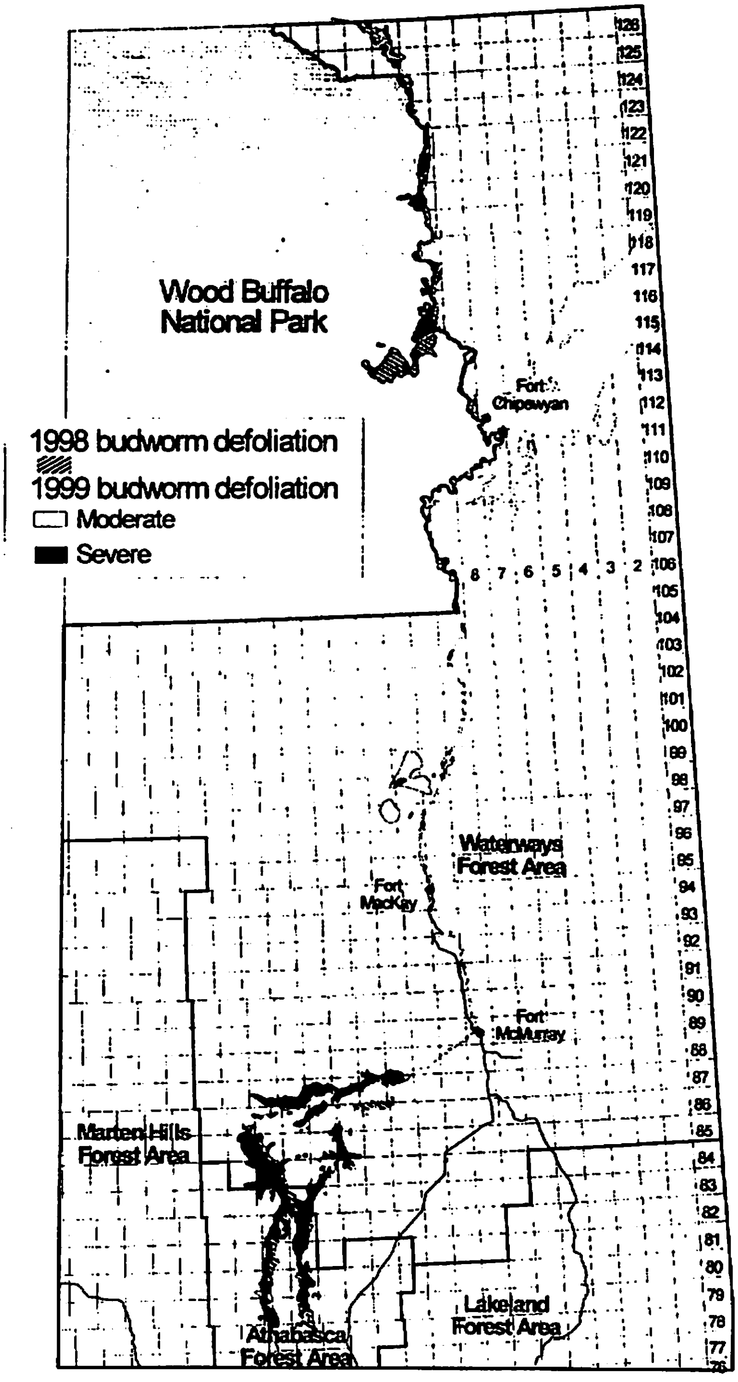


Figure 3. Spruce Budworm defoliation in the Northeast Boreal Reigon of Alberta, 1999.

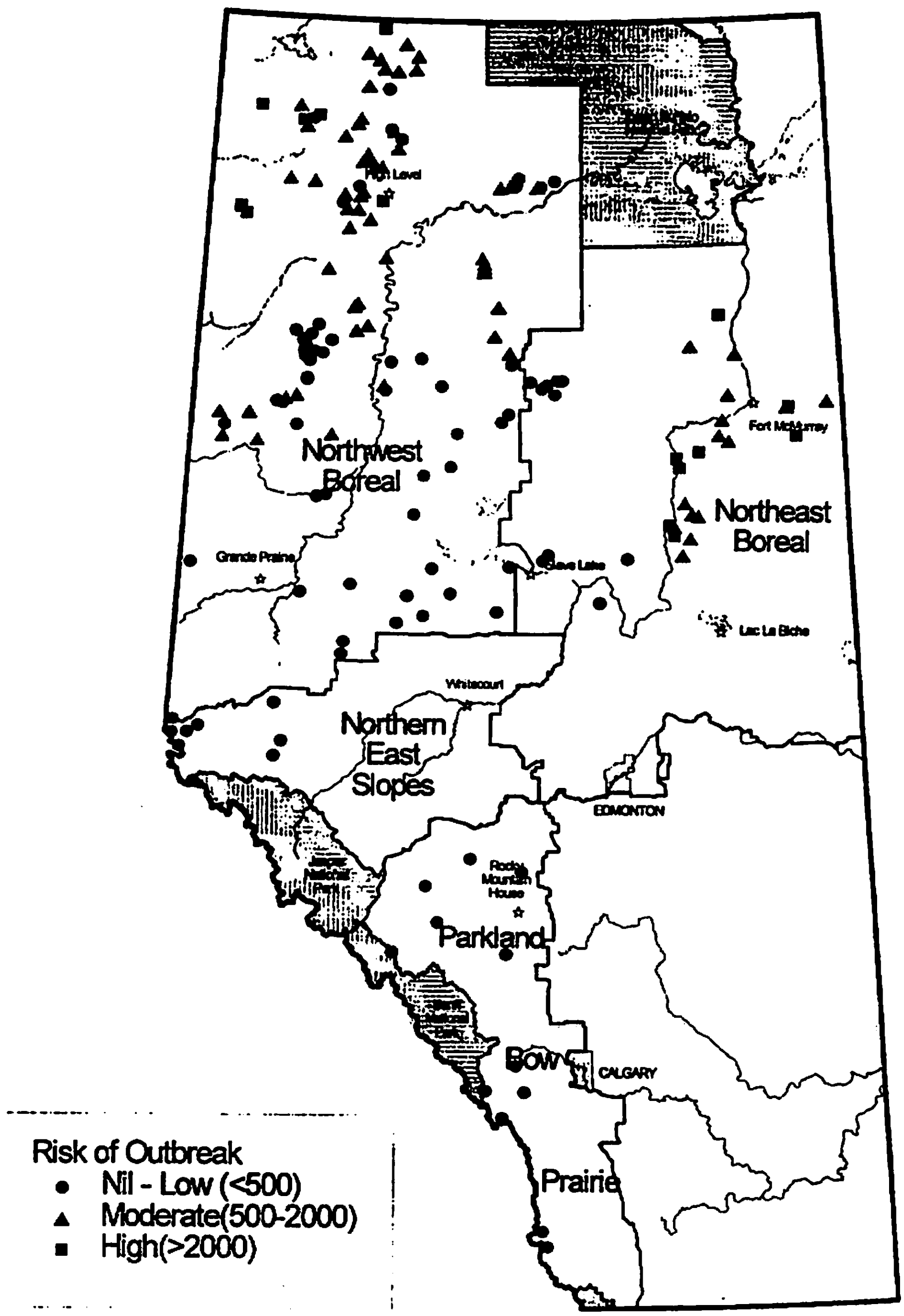


Figure 4. Spruce budworm moth catches in pheromone-baited traps in Alberta, 1999.

According to these survey results, no spruce budworm outbreaks are expected in the PBP regions in 2000. There is a low risk of a two-year cycle budworm outbreak in the Foothills Forest Area in the NES Region in 2000. Risk of new budworm outbreaks has increased in the Waterways Forest Area (NEB). Risk of new outbreaks continues to be high in the Upper Hay Forest Area of the NWB Region.

2.1.3 Forecast for 2000 Based on Second Instar Survey Results

Second-instar (L_2) surveys were carried out in forest stands that have been defoliated by the budworm during the current outbreak and in their vicinities. The results of these surveys were used to forecast the severity of defoliation expected in 2000. The survey procedures are described in the "Spruce Budworm Management Guide" (Ranasinghe and Kominek, 1998).

In the NWB Region, 214 plots were established; sixty-six plots were located in the stands sprayed with pesticides in 1999 for budworm control and the other 148 plots were located in the unsprayed stands. In 2000, in the MacKenzie Forest Area, larval counts in the plots (n=8) forecast severe defoliation in two plots, moderate defoliation in two plots and light defoliation in four plots. Overall, severity of budworm defoliation is expected to decrease in this forest area in 2000, except in Paddle Prairie Metis Settlement and Hawk Hills. In the Upper Hay Forest Area, larval counts in the **unsprayed** plots (n=139) forecast severe defoliation in 20% of the plots in 2000; moderate defoliation is expected in 28% of the plots and nil to light defoliation is expected in 52% of the plots. Out of the 66 **sprayed**-plots in this forest area, five are expected to have no defoliation and 53 are expected to have light defoliation in 2000. Seven of the remainder of sprayed- plots are forecasted to have moderate defoliation and the other sprayed-plot will have severe defoliation in 2000. The single plot located in the East Peace Forest Area is expected to have nil defoliation in 2000. Overall, the results of the survey forecast a decrease in severity of budworm defoliation in the NWB Region in 2000, although severe budworm defoliation is expected in isolated pockets (Figure 5).

In the NEB Region, 19 L_2 plots were established. In the Athabasca Forest Area, L_2 counts in three sprayed-plots forecast light defoliation in 2000; out of the six unsprayed plots, two are expected to have light defoliation and the other four plots are expected to have moderate defoliation in 2000. In the Waterways Forest Area, L_2 counts in the three sprayed-plots forecast light defoliation in 2000; out of the seven unsprayed plots, defoliation is expected to be light in three plots, moderate defoliation in two plots and severe defoliation in two plots in 2000. Overall, there will be a drop in severity of budworm defoliation in this region. Nil to light budworm defoliation is expected in the budworm-infested stands sprayed with Thuricide 48LV® in this region (Figure 6).

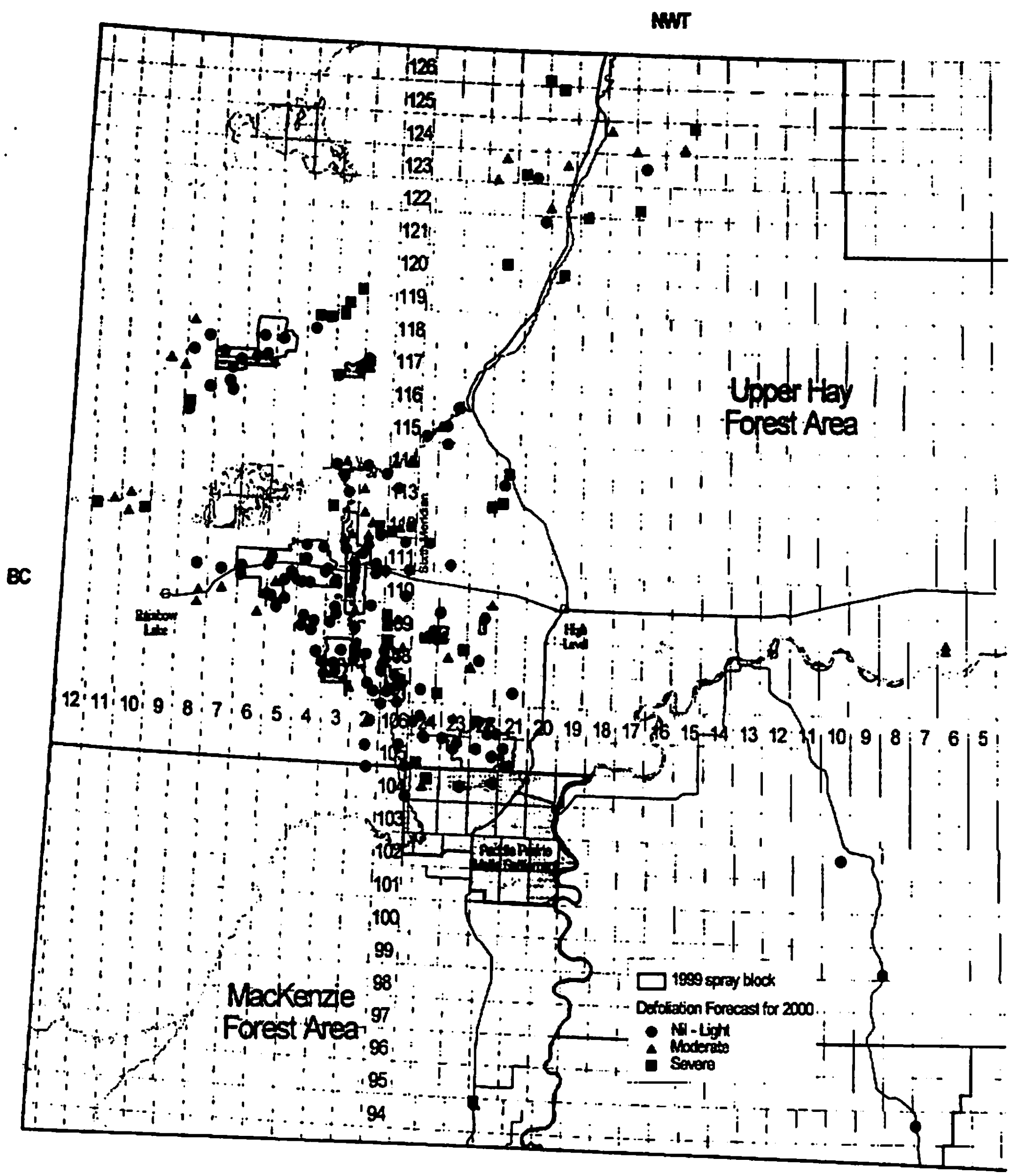


Figure 5. Spruce budworm defoliation forcast for 2000 based on 1999 second larval instar counts, Northwest Boreal Region, Alberta.

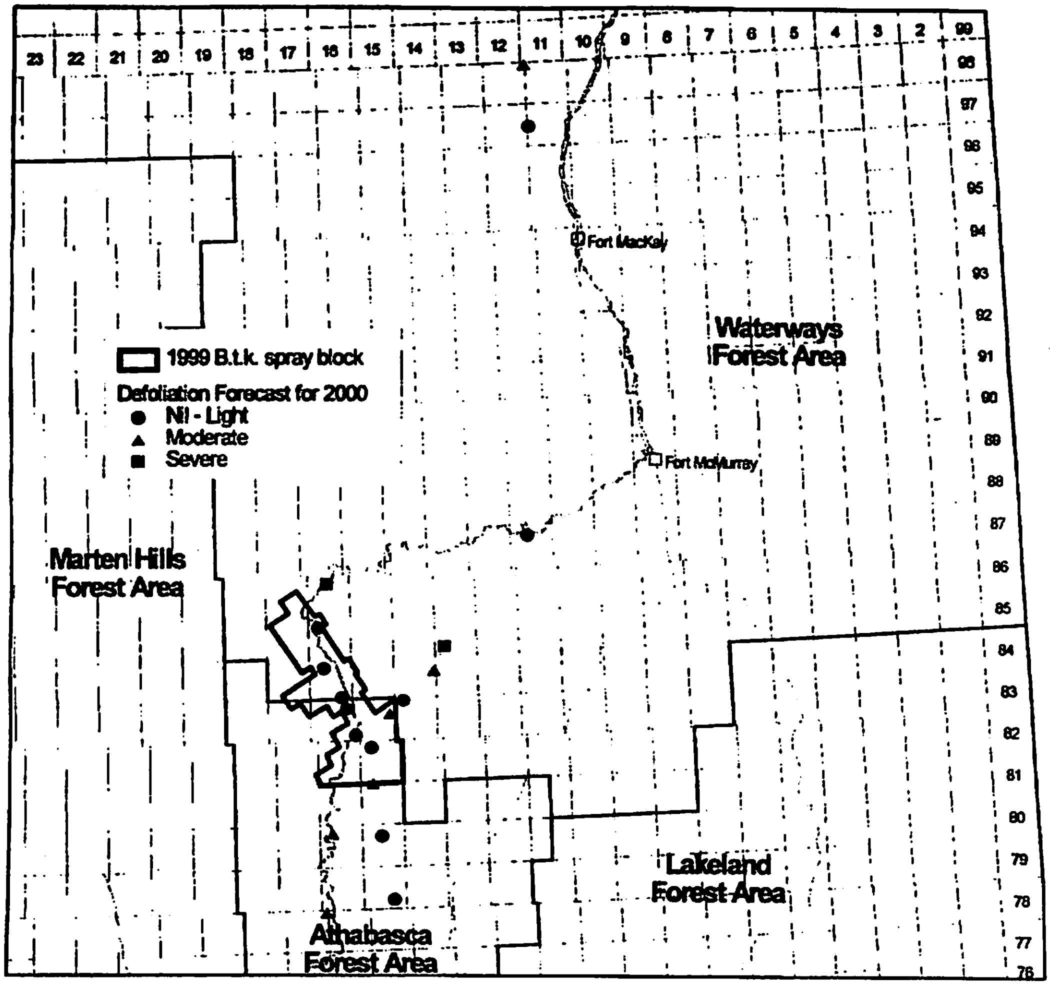


Figure 6. Spruce budworm defoliation forcast for 2000 based on 1999 second larval instar counts, Northeast Boreal Region, Alberta.

2.2Mountain Pine Beetle, *Dendroctonus ponderosae* Hopkins

2.2.1 Aerial Survey

In the spring and in the fall, the Green Area in southwestern Alberta was surveyed to detect mountain pine beetle (MPB) infestations. A fixed-wing aircraft was used for these surveys carried out by the Regional Forest Health Officers in NES and PBP regions. The surveys mainly covered the river valleys in the foothills bordering BC, and in Banff and Jasper national parks.

In the PBP Region, no mountain pine beetle infestations were detected within the Green Area. However, in Banff National Park few small "red patches," symptomatic of mountain pine beetle infestations, were found along the Healy and Brewster creek drainages. Altogether an estimated 75 trees are infested along the Brewster Creek. In the NES region, five small patches of beetle-infested trees were reported in Jackpine Pass in Willmore Wilderness Park (Figure 7). Trees with possible MPB attacks were observed down valley from Smokey Cabin and on Lake Twintree shore in Jasper National Park, close to Willmore Wilderness Park border (Leo Unger, pers. communication).

Active mountain pine beetle infestations are reported along Palliser and Cross rivers in B.C., close to Alberta-B.C. border. These infestations are located near Peter Lougheed Park in Alberta (BCFS staff in Invermere Forest District, pers. communication).

2.2.2 Survey with Pheromones

In southwestern Alberta, lodgepole pine stands with a high risk of becoming infested with mountain pine beetles were monitored for beetle activity. A two-component aggregation pheromone bait (Phero Tech Inc., B.C.) was used. The procedure for deploying these pheromone baits is described in "Mountain Pine Beetle Pheromone Monitoring Sampling Manual 1998" (Kominek, 1998).

Fifty-six plots were established in southern Alberta in 1998. The results of this survey are summarised in Figure 7.

In the PBP Region, 2 out of 21 plots in the Crowsnest Forest Area had beetle-hits. The number of beetle-hits ranged from one to three per tree, a decrease compared to the number of beetle-hits observed in 1998. None of these attacks was successful. In the Bow Forest Area, 4 out of 11 plots had beetle hits. The number of beetle-hits per tree ranged from 3 to 24 per tree; this is similar to the level of attack observed in 1998. None of the six plots located in the Clearwater Forest Area had any beetle-hits. Trees with successful beetle-hits in these Forest Areas will either be debarked or burned before the next spring.

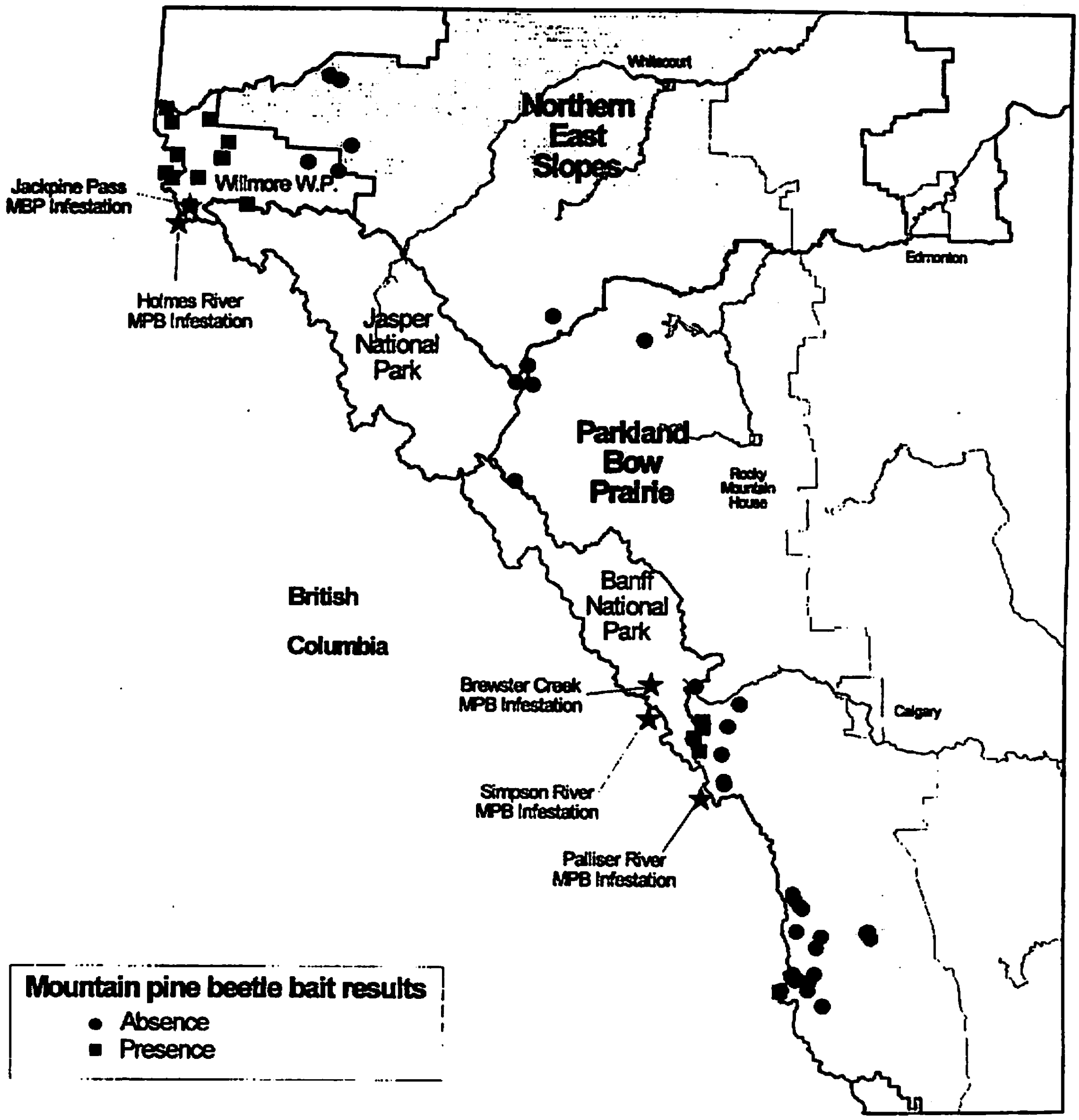


Figure 7. Mountain pine beetle infestations and beetle hits in pheromone-baited plots in Alberta, 1999.

In the NES Region, there were beetle-hits on trees in 11 out of 16 plots located close to the B.C. border, in Willmore Wilderness Park in the Foothills Forest Area. Twenty-eight beetle-attacked trees at these sites are scheduled to be cut and burned in the fall of 1999.
There were no beetle hits in the five plots located in the Yellowhead Forest Area of this region.

2.3 Larch Sawfly, *Pristiphora erichsonii* (Hartig)

The larch sawfly continued to defoliate tamarack, *Larix laricina*, in the Upper Hay Forest Area (NWB) Region. The area of defoliation was not estimated in 1999. This is the third consecutive year of larch sawfly defoliation observed in this area.

2.4 Pine False Webworm, *Acantholyda erythrocephala*

In 1999, pine false webworm populations in Edmonton declined compared to 1998. This reduction is likely due to the return of normal cold winter conditions after consecutive mild winters experienced in 1997 and 1998.

2.5Forest Tent Caterpillar, *Malacosoma disstria* Hübner

The forest tent caterpillar defoliation in northwestern Alberta increased significantly during 1999. In the NWB Region, the gross area with forest tent caterpillar defoliation was estimated to be 584 260 ha. Within this area, defoliation severity was rated as follows: severe over 489 700 ha, moderate over 93 431 ha and light over 1129 ha
(Figure 8).

In the NEB Region, the forest tent caterpillar remained endemic. Forest tent caterpillar defoliation in this region was confined to a small, lightly defoliated patch near Muriel Lake in the south-eastern corner.

2.6Other Aspen Defoliators

2.6.1 Satin Moth, *Leucoma salicis* (Linnaeus)

In Edmonton, 103 new satin moth infestations were detected in 1999. This is a slight decrease compared to 145 new infestations detected in the city in 1998. The satin moth primarily fed on ornamental poplar species. This pest, first detected in 1994 in northwest Edmonton, is now believed to be firmly established in Edmonton and surrounding communities.

In 1999, the Pest Management Regulatory Agency approved minor use of Ambush® 500 E.C. (permethrin) for satin moth control. This year, personnel from the City of Edmonton initiated field trials on use of Mimic® 240LV for satin moth control.

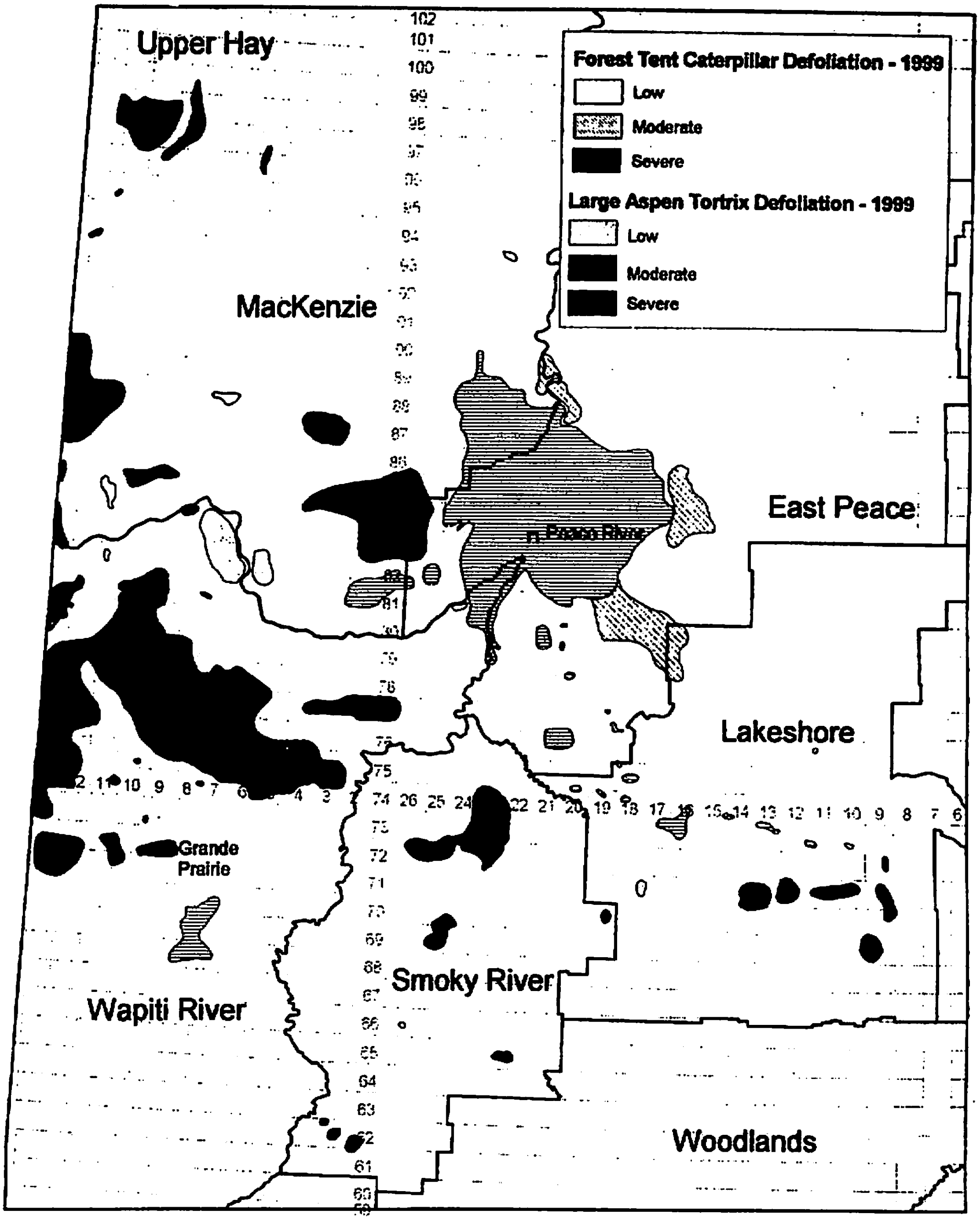


Figure 8. Defoliation caused by broadleaf-defoliators in the Northwest Boreal Region, Alberta, 1999.

A braconid parasitoid, *Cotesia melanoscela,* has been observed in many satin moth larvae in Edmonton. However, this parasitoid does not attack late instars of satin moth and suffers from a high degree of hyperparasitism.

In 1999, Land and Forest Service funded a research project by Dr. Gerhard Gries of Simon Fraser University to formulate satin moth pheromone for trapping purposes.

2.6.2 Large Aspen Tortrix, *Choristoneura conflictana* (Walker)

In 1999, for the third consecutive year, the large aspen tortrix continued to defoliate aspen stands in central and northwestern Alberta. In the NWB Region, the gross area defoliated by the large aspen tortrix and Bruce spanworm was estimated to be 775 497 ha (Figure 8). Most of this area had severe defoliation (542 909 ha); there was some moderate defoliation (192 880 ha) and little light defoliation (39 708 ha). In the NES Region, the large aspen tortrix defoliated an estimated 4700 ha near Whitecourt (Figure 9).

2.6.3 Bruce Spanworm, *Operophtera bruceata* (Hulst.)

Bruce spanworm defoliation in western Alberta expanded during 1999. It was widespread in the NWB Region (see above). In the NES Region, either moderate or severe Bruce spanworm defoliation was recorded over 64 000 ha. In the PBP Region, Bruce spanworm defoliation was widespread but was more pronounced in the Bow Forest area (Figure 9). The extent of the Bruce spanworm infestation in the PBP region was not estimated.

This year, several oviposition traps (Hébert and St-Antoine, 1999) were set up in the NES and PBP regions to collect egg masses of the Bruce spanworm. The egg mass counts will eventually be used to forecast the population trends of this pest.

2.7 Black Army Cutworm, (*Actebia fennica* Tauscher)

An outbreak of the black army cutworm was recorded for the first time in Alberta in the summer of 1999. This outbreak occurred in the NES Region following a large-scale fire that burned ca. 170 000 ha in May. The infestation was scattered throughout the burned area. However, the extent of black army cutworm-defoliated area was not estimated. The black army cutworm consumed the annual vegetation as well as the newly planted seedlings in many recently planted cut-blocks.

Unitraps® (Phero Tech Inc., B.C.) baited with black army cutworm pheromones were set up at 18 sites within the infestation. Three types of pheromone lures (Phero Tech Inc., B.C.) were tested at each site. The moths were trapped between the end of July and the first week of October. The moth counts were relatively low (range: 4 to 238 moths per trap) in the pheromone-baited traps set up in the infested areas. The black army cutworm damage is expected to be light in this area in 2000.

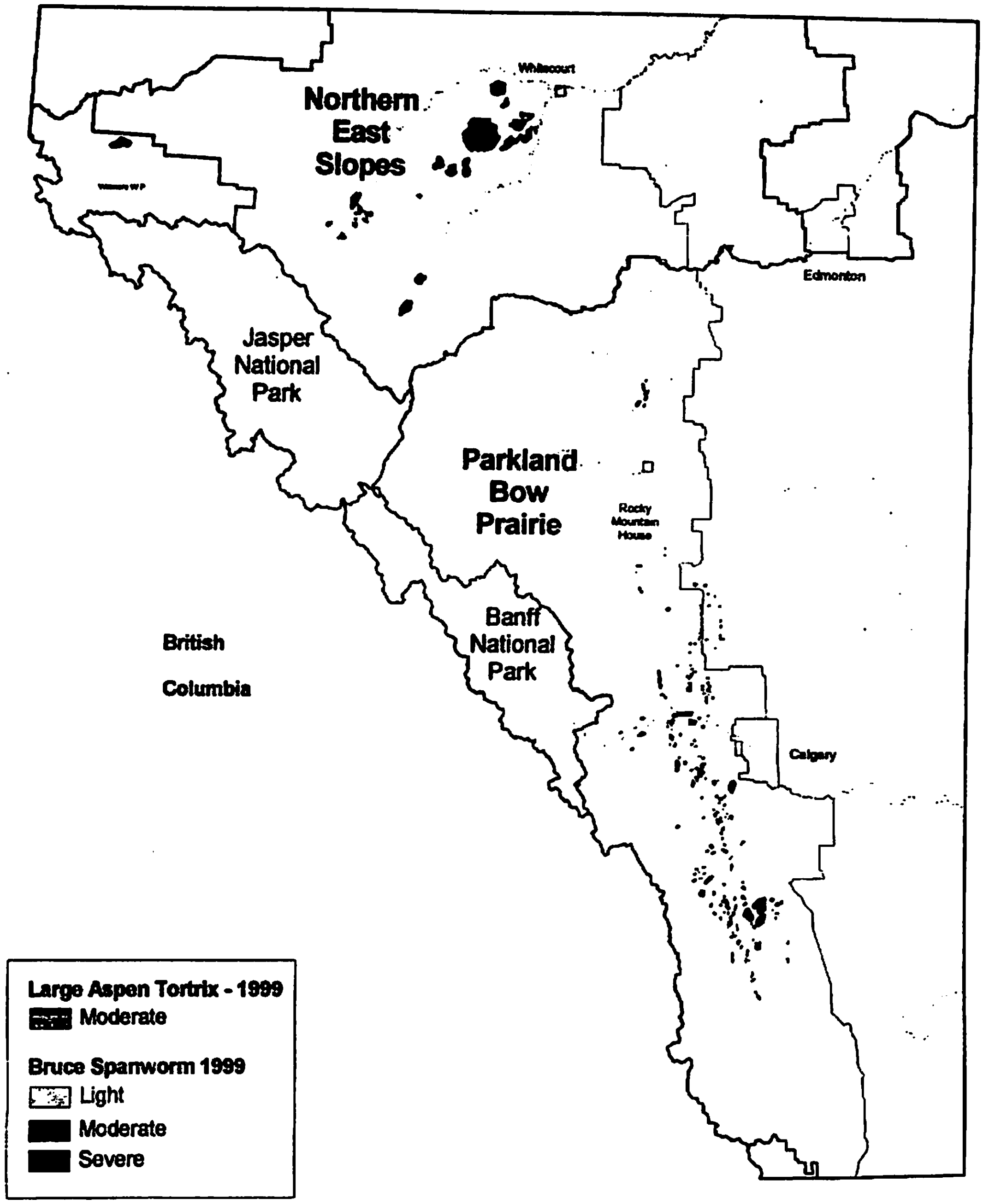


Figure 9. Defoliation caused by broadleaf-defoliators in the eastern slopes of Alberta, 1999.

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

Land and Forest Service (LFS) participated in the annual gypsy moth survey conducted by the Canadian Food Inspection Agency. No gypsy moths were detected in the 47 Disparlure-baited Delta traps set up by LFS. Altogether, 500 gypsy moth traps were set up across the province. So far in 1999, no gypsy moths have been trapped in Alberta (Hiro Koga, pers. comm.).

2.9 Birch leafminers, *Profenusa thomsoni* and *Fenusa pusilla*

An ichneumonid wasp, *Lathrolestes nigricollis*, a parasitoid of *F. pusilla* was introduced by the researchers in the City of Edmonton. This parasitoid spread rapidly providing effective biological control of this leafminer sp. Another introduced ichneumonid wasp, *L. luteolator*, is credited with controlling amber-marked birch leafminer outbreak in the city.

2.10Dutch Elm Disease (DED), *Ophiostoma ulmi* (Buis.) Nannf.

The first reported case of DED in Alberta has been confirmed from samples gathered in 1998 from an elm tree in Wainright. The pathogen was identified to be *Ophiostoma nova-ulmi* Brasier, the most virulent strain of the DED fungus. In 1999, thirty-five other suspected samples collected from different locations within the province were tested for the DED fungus; the test results were negative.

The smaller European elm bark beetle (SEEBB), *Scolytus multistriatus* (Marsham)- one of the vector species of DED - has been found in Alberta on a recurring basis. These beetles have been trapped every year from 1994 to 1999 in Calgary; from 1995 to 1999 in Edmonton; and, from 1998 to 1999 in St. Albert near Edmonton, and in Medicine Hat in southeastern Alberta. The number of SEEBB trapped in Edmonton and Calgary in 1999 was lower than the number trapped in 1998.

Previously, SEEBB has been trapped in Vauxhall, and High River in southern Alberta. The other vector of DED, to the native elm bark beetle, *Hylurgopinus rufipes* Eichh., has not been trapped to-date in Alberta.

In 1998, the Society to Prevent Dutch Elm Disease (STOPDED), a non-profit organisation established to protect and preserve Alberta's elm trees from DED, commenced working on a site-specific elm inventory for the province. This inventory contains the geographical distribution, tree condition and value of elms in Alberta. This computerized elm tree inventory now contains data on 219 934 elms growing in urban areas of Alberta and valued at $634 million.

Other Noteworthy Pests

Warren root collar weevil, *Hylobius warreni* Wood, caused significant young stand mortality in the PBP regions. These weevils attacked mature pine trees in the Bow Forest Area within this region.

Red belt was prevalent along the eastern slopes in the NES Region.

Elytroderma needle cast, *Elytroderma deformans* (Weir) Darker, was widespread within the NES Region, as well.

3.0 PEST MANAGEMENT OPERATIONS

3.1 Introduction

In 1999, Thuricide 48LV® (Thermo Trilogy Corporation, MD, USA) and Mimic 240 LV® (Rohm and Haas Canada Inc.) were aerially sprayed to manage the spruce budworm outbreaks in Alberta. The forest stands selected for spraying were expected to either be moderately or severely defoliated by the spruce budworm in 1999, i.e., have over 35% defoliation, as forecasted by the results of second-instar (L_2) surveys carried out in 1998. The objective of this spraying was to keep the infested trees alive by reducing the budworm populations to endemic levels, i.e., limit future defoliations to less than 35%.

The spruce budworm development and spruce bud growth in relation to degree-days were monitored leading up to spraying. This was carried out to determine the onset of spray-targeted stages (i.e., peaks of fifth-instar, and buds with needles flaring).

All the aerial sprayings were carried out by using fixed-wing spray aircraft fitted with Micronair AU4000® atomiser nozzles (Micronair Ltd., England) and SATLOC Forestar™ Differential Global Positioning Systems (Satloc Inc., USA). Spraying was carried out when weather conditions met the following parameters: winds <15 km/h; relative humidity >40%; and, no precipitation expected within six hours of spraying.

3.2 Northwest Boreal Region

A prespray sampling was carried out a few days before spraying to confirm the abundance of budworms in the stands slated for spraying. Forty-three sample plots were established as follows: twenty-three plots were located in the stands slated for Thuricide 48 LV spraying; nine check plots were located in comparable stands located near Thuricide-sprayed stands; seven plots were located in stands slated for Mimic 240 LV spraying; four check plots were located in comparable stands located near Mimic-sprayed stands. Out of the 43 plots, four plots (three check plots and one later sprayed with Thuricide once) had budworm populations that would have caused moderate defoliation, if left untreated; the other 39 plots had populations that would have caused severe defoliation.

In 1999, a total of 60 549 ha were sprayed for spruce budworm control in the NWB Region (Figure 10). Out of this area, 47 617 ha were sprayed with Thuricide and 12 932 ha were sprayed with Mimic. Thuricide was sprayed undiluted at the rate of 30 BIU/ha (2.36 L/ha) twice over 41 067 ha and once over an additional 6550 ha. Mimic was sprayed once at the rate of 70 g a.i/ha (i.e., 0.290 litres Mimic mixed with 1.710 litres of water per ha) over 12 932 ha.

Spruce budworms were spray-ready (peak of L_5) during the first week of June. However, because of unusually cold spring weather during early June, aerial spraying in the NWB

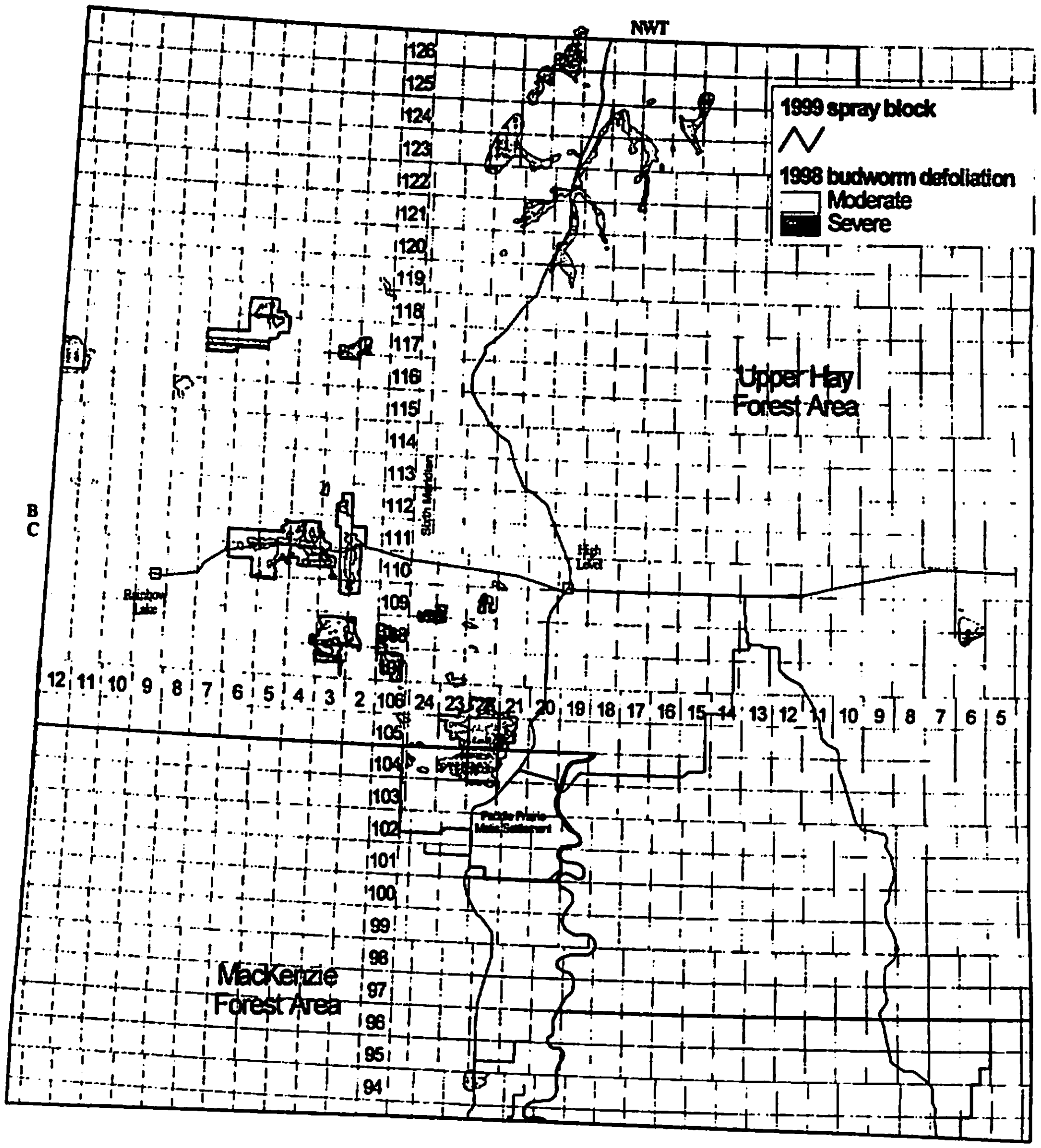


Figure 10. Aerial spray blocks in 1999, in relation to 1998 budworm defoliation in the Northwest Boreal Region in Alberta.

Region was postponed until mid-June. Between June 8 – 14, the minimum temperatures in the Mimic spray blocks ranged from zero to –4.0°C; minimum temperature in the Thuricide spray blocks ranged from zero to –1.0°C. These cold temperatures also slowed down spruce bud growth thus bringing asynchrony between spruce bud and budworm development.

In the fall, an L_2 survey was carried out to determine the effectiveness of aerial spraying in reducing the budworm populations. In the prespray plots sprayed with Mimic (n = 7), the mean L_2 populations were reduced to endemic levels that would only cause light defoliation in 2000. However, the check plots (n = 4) also had similar reduction in mean L_2 populations. This reduction of budworm population in the check plots may be attributed to unusually cold prespray temperatures recorded in the Mimic blocks.

Out of the three L_2 plots that were sprayed once with Thuricide, the plot that had moderate prespray counts had L_2 counts that forecasted nil defoliation in 2000. In comparison, the check plot also had L_2 counts that forecasted light defoliation in 2000. The other two L_2 plots that had high prespray counts had L_2 counts that forecasted light defoliation in 2000.

Twenty other prespray plots were sprayed twice with Thuricide. All of these plots had high prespray counts. The L_2 counts forecasted light defoliation in all of these plots in 2000. In comparison, L_2 counts forecasted severe defoliation in two of the check plots and light defoliation in the other six check plots in 2000.

Overall, nil to light defoliation is expected in most of the sprayed-areas in this region. The spray program has achieved its objective of reducing the budworm population to endemic levels. Unusually cold temperatures experienced in the spray blocks in the days before spraying appears to have had an impact on budworm mortality thus contributing to the results of this spray operation.

3.3 Northeast Boreal Region

In the NEB Region, 22 707 ha were sprayed with Thuricide 48LV to control the spruce budworm outbreak (Figure 11). Out of this area, 15 724 ha were sprayed once and 6983 ha were sprayed twice. Thuricide was sprayed at the rate of 2.36 L/ha (30 BIU/ha) in early June when budworms were at the peak of fifth-instar and spruce buds were open with needles flaring.

In the fall, an L_2 survey was carried out in the sprayed areas. In the Athabasca Forest Area, three L_2 plots were located in the areas sprayed once; all these plots are expected to have light defoliation in 2000. In comparison, two of the unsprayed check plots are expected to have light defoliation and another four are expected to have moderate defoliation in 2000. In the Waterways Forest Area, two L_2 plots were located in areas sprayed once; one L_2 plot was located in an area sprayed twice. All three of these plots are expected to have light defoliation in 2000. In comparison, out of the seven unsprayed check plots, five are expected to have light defoliation, one expected to have moderate defoliation and the other one is expected to have severe defoliation in 2000.

Overall, spruce budworm defoliation is expected to be light in the sprayed areas and light to severe in the unsprayed areas in this region.

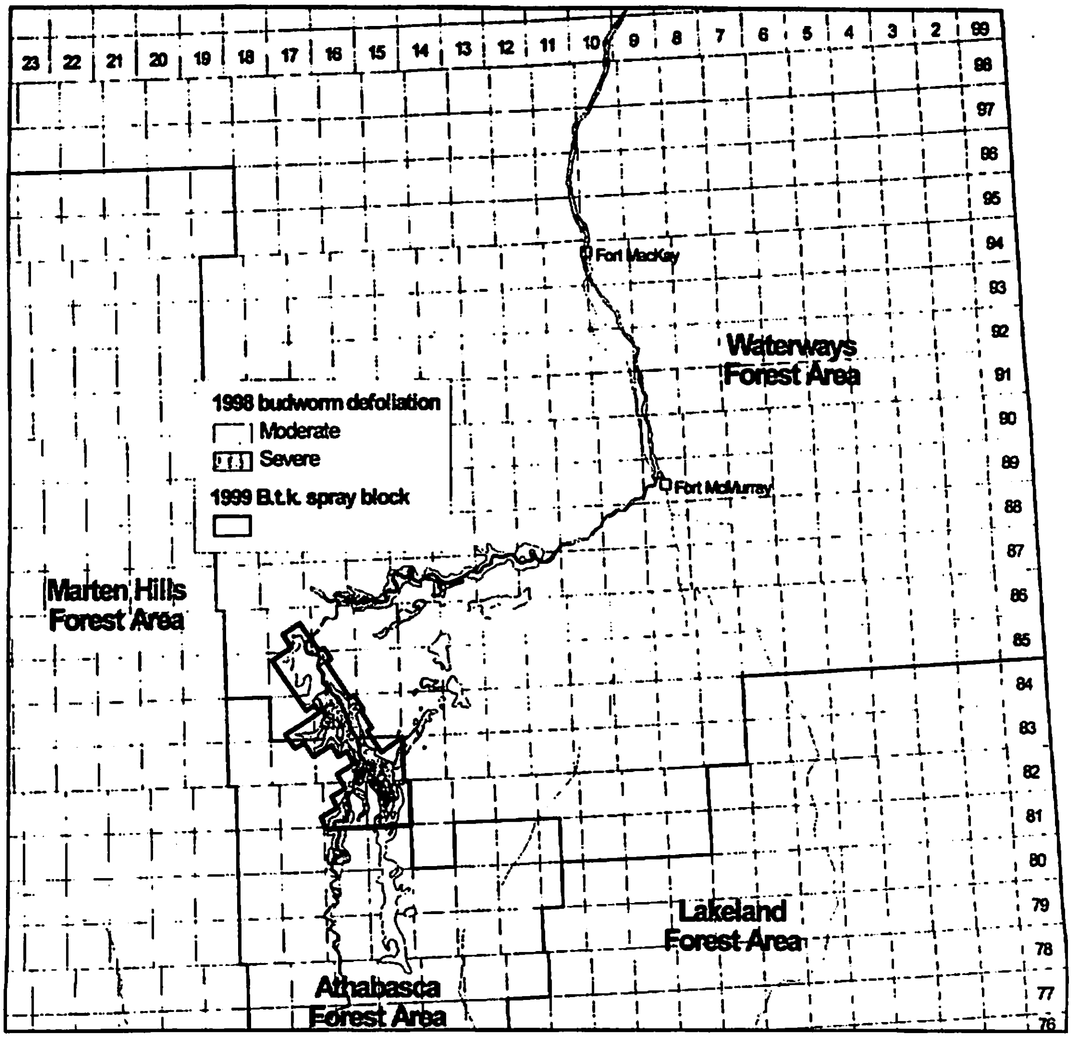


Figure 11. Aerial spray block in 1999, in relation to 1998 budworm defoliation in the Northeast Boreal Region in Alberta.

4.0 REFERENCES

Kominek, C. 1998. Mountain pine beetle pheromone monitoring sampling manual. Alberta Environmental Protection, Forest Health Branch. 26 p.

Ranasinghe, S.; Kominek, C. 1998. Spruce budworm management guide. Alberta Environmental Protection, Forest Health Branch.

Ranasinghe, S.; Kominek, C. 1999. Forest health aerial survey guide. Alberta Environment, Forest Health Branch.

Hébert, C.; St-Antoine, L. 1999. Oviposition trap to sample eggs of *Operophtera bruceata* (Lepidoptera: Geometridae) and other wingless geometrid moths. The Canadian Entomologist 131: 557-565.

Koga, H. Canadian Food Inspection Agency, personal communication.

The Eastern Spruce Budworm in Saskatchewan

D. Campbell, M. Campbell, R. Moore, and J. Thompson

J.H. Meating, P.M. Bolan, and M.W. Francis

Summary

The spruce budworm population and damage levels continued to increase in Saskatchewan in 1999. The total area of moderate to severe défoliation increased from 420,876 ha in 1998 to 506,749 in 1999. Populations increased in the Deschambault and Amisk lakes areas and decreased in the Hudson Bay area.

White spruce whole tree mortality occurred in small, scattered patches near Somme, south west of Hudson Bay and north west of La Ronge at Clam Lake.

Aerial spray operations were conducted across some 41,161 ha in 1999. Two applications of the biological insecticide *Bacillus thuringiensis* var. *kurstaki* (Btk.). were applied between June 1 and June 11. Operational objectives of foliage protection was achieved in the areas treated with Foray 48B and Foray 76B. Limited foliage protection was achieved in the block treated with Thuricide 48LV due to application delays.

Preliminary results indicate that spruce budworm populations will likely remain high in 2000 in many of the areas defoliated in 1999.

La tordeuse des bourgeons de l'épinette en Saskatchewan

D. Campbell, M. Campbell, R. Moore et J. Thompson

J.H. Meating, P.M. Bolan et M.W. Francis

Sommaire

Les effectifs de la tordeuse des bourgeons de l'épinette et la gravité des dommages infligés par ce ravageur ont continué d'augmenter en Saskatchewan en 1999. La superficie défoliée modérément à gravement est passée de 420 876 ha en 1998 à 506 749 ha en 1999. Les populations ont augmenté dans les secteurs des lacs Deschambault et Amisk, mais elles ont décliné dans la région de la baie d'Hudson.

Le ravageur a causé la mort d'épinettes blanches entières dans de petits îlots épars près de Somme, au sud-ouest de la baie d'Hudson et au nord-ouest de La Ronge au lac Clam.

Quelque 41 161 ha ont fait l'objet d'épandages aériens en 1999. Deux applications de l'insecticide biologique *Bacillus thuringiensis* var. *kurstaki* (Btk) ont été effectuées entre le 1er et le 11 juin. L'objectif des traitements opérationnels de 1999 consistait à protéger le feuillage des arbres hôtes. Cet objectif a été atteint dans les parcelles traitées au Foray 48B et au Foray 76B, mais les résultats ont été plus décevants dans la parcelle traitée au Thuricide 48 LV, divers facteurs ayant retardé les applications.

Les résultats préliminaires indiquent que les populations de la tordeuse des bourgeons de l'épinette demeureront probablement élevées en 2000 dans bon nombre des régions défoliées en 1999.

REPORT

1999 Forest Pest Management Forum

Ottawa, Ontario
November 16-18, 1999

The Eastern Spruce Budworm in Saskatchewan - 1999

Prepared for

Saskatchewan Environment and Resource Management
Forest Ecosystems Branch
Box 3003, McIntosh Mall
Prince Albert, SK
S6V 6G1

By

BioForest Technologies Inc.
105 Bruce Street
Sault Ste. Marie, ON
P6A 2X6

Phone 705-942-5824

The Eastern Spruce Budworm in Saskatchewan - 1999

D. Campbell, M. Campbell, R. Moore, and J. Thompson
Saskatchewan Environment and Resource Management
Prince Albert, Saskatchewan

J.H. Meating, P. M. Bolan, and M.W. Francis
BioForest Technologies Inc.
Sault Ste. Marie, Ontario

The eastern spruce budworm (*Choristoneura fumiferana* [Clem.]) outbreak that began in Saskatchewan in the early 1980's affected some 420,876 ha by 1998 (Figure 1). Moderate to severe defoliation was mapped across the province from the Manitoba border in the east to the Meadow Lake area in the west. Spruce budworm populations continued to increase in 1999. Aerial surveys conducted in July showed a total of 506,749 ha of moderate to severe defoliation, an increase of nearly 86,000 ha from 1998 (Figure 2). Most of the increase occurred in the Deschambault and Amisk lakes area in the northeastern portion of the outbreak. There was little change in the north central part of the province although the area affected decreased somewhat in Prince Albert National Park and in the area around Delaronde Lake. Budworm populations continued to decline in the Hudson Bay area.

Figure 1. Area of moderate to severe defoliation caused by the eastern spruce budworm in Saskatchewan, 1981 - 1999.

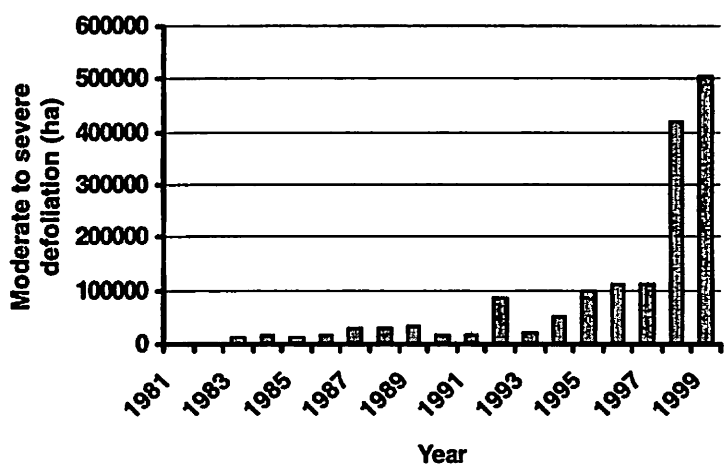
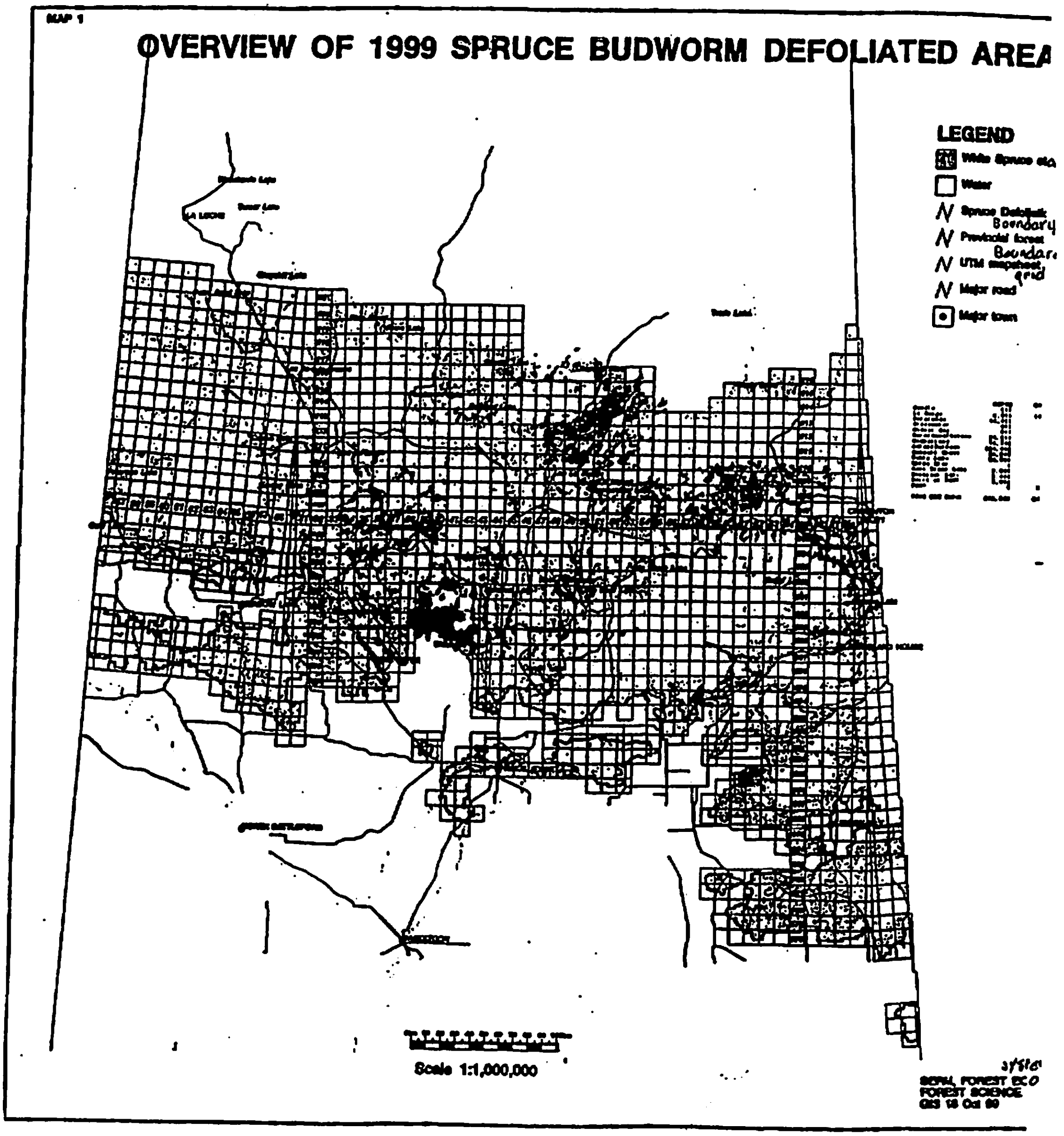


Figure 2. Area of moderate to severe defoliation caused by the eastern spruce budworm in Saskatchewan in 1999.

Figure 2. Area of moderate to severe defoliation caused by the eastern spruce budworm in Saskatchewan in 1999.



Understory white spruce mortality had been observed in immature stands in the Hudson Bay area as early as 1997. In 1999, aerial surveys detected patches of mature white spruce mortality in two areas; southwest of Hudson Bay near Somme, and northwest of La Ronge at Clam Lake. The areas were small and mortality was patchy. Spruce budworm populations were very high in many stands and the condition of many white spruce throughout the infestation deteriorated significantly in 1999. In many areas moderate to severe defoliation of upland black spruce was also common this year.

1999 Spruce Budworm Management Program

Results of the 1998 budworm L2 survey showed than some 79% of the 163 locations sampled had moderate or severe forecasts for 1999. This information was integrated with historical budworm defoliation patterns and harvest schedules to delineate stands eligible for the 1999 management program.

A total of 41,161 ha were included in the 1999 aerial spraying program. The program began on June 1 and was completed June 11. Most stands were treated twice with various formulations of the biological insecticide *Bacillus thuringiensis* var. *kurstaki* (Btk). The objective of the 1999 aerial spraying program was to protect white spruce foliage.

As in 1998, BioForest Technologies Inc. provided timing and assessment services to the operational program. BioForest Technologies staff also conducted the aerial defoliation and mortality surveys over some 17 million ha and collaborated with Saskatchewan Environment and Resource Management (SERM) and forest industry to design and conduct the spruce budworm pheromone, L2, and impact surveys.

Materials

Three Btk formulations were used in the 1999 operational spray program; Foray 48B, Foray 76B, and Thuricide 48LV. Most stands were treated with two applications of Btk but a few areas were treated with only a single application. A summary of the materials and areas treated in the 1999 operational spraying program in Saskatchewan is presented in Table 1.

There was also an experimental program in Saskatchewan in 1999 involving Btk formulations from Abbott Laboratories and AEF Global.

Aircraft

Five spray aircraft were used in the 1999 spruce budworm program. Battlefords Airspray and Wetaskiwin Aerial Applicators Ltd. supplied three AT 502 and two AT 402 aircraft. An additional AT 502 was made available for backup if needed. All spray aircraft were equipped with SATLOC GPS guidance systems and AU 4000 Micronaire atomizers. Two observer aircraft were used to monitor the program.

Table 1. Btk formulations used and areas treated in the 1999 Saskatchewan spruce budworm management program.

Btk Formulation	Location	Liters	Hectares
Foray 48B	Cumberland House	53,564	22,319
	La Ronge	13,009	5,421
	Big River	75,560	31,484
Total Foray 48B		142,133	59,224
Foray 76B	Big River	16,300	10,867
Thuricide 48LV	Big River	29,352	12,230

Weather

Weather data (daily maximum and minimum temperatures) was obtained from Atmospheric Environment Service, Environment Canada and monitored for the period April 1 to June 30 for three locations in the spray area. Degree-day estimates were used to schedule field surveys.

During the spray program, weather information (temperature, relative humidity, and wind speed and wind direction) was obtained from five automated weather stations within the treatment areas to provide real time weather conditions in local spray blocks.

Timing

Eight plots were established throughout the operational spray blocks to monitor insect and host development. Sampling began on May 18 and continued on a regular basis until completion of the program. The 1999 spruce budworm spray program began on June 1 in the eastern part of the infestation. The Host Index ranged between 3.9 in Cumberland Lake to 4.0 in Connell Creek. Larval indices ranged from 3.7 to 4.6. Blocks in the central and western portion of the spray program opened several days later on June 4 and 5 and the entire program was completed on June 11.

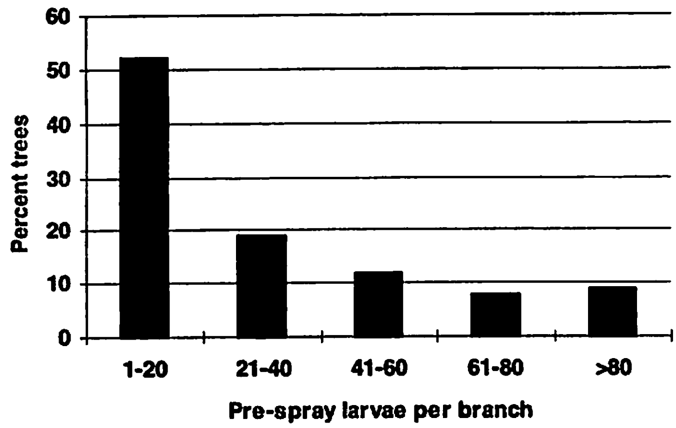
Spray Assessment

A total of 80 spray assessment plots (six white spruce per plot) were established in operational spray blocks in 1999. Pre-spray and post-spray samples were collected to determine spruce budworm population densities, budworm survival, and white spruce defoliation. An additional 27 assessment plots were sampled in untreated control areas to provide comparisons of budworm mortality and host defoliation with plots located in spray blocks.

Results

Budworm pre-spray populations averaged 35.8 (SD = 40.6) larvae per branch in the operational plots in 1999. Nearly fifty percent of the plots had average pre-spray populations greater than 20 larvae per branch and populations in some plots were exceptionally high (Figure 3). Surveys showed third and fourth instar population densities of more than two or three hundred larvae per 45 cm branch tip in some stands.

Figure 3. Frequency distribution of pre-spray spruce budworm larval populations in stands treated with Btk in Saskatchewan, 1999.



Post-spray surveys showed that white spruce defoliation in stands treated with two applications of Foray 48B (30BIU/2.4l/ha) was substantially lower than defoliation rates observed in the untreated control plots and was consistently lower at all pre-spray budworm densities (Figure 4). Operational treatments with Foray 76B showed similar results even in plots that received only a single application (Figure 5). Levels of foliage protection were generally better in the operational Foray 76B blocks than in the Foray 48B blocks, although the operational objective of foliage protection was achieved with both treatments.

Some 6,000 ha were treated with two applications of Thuricide 48LV (30BIU/2.4l/ha). Logistical problems during the operational program delayed the first Thuricide applications in the assessment blocks until the morning of June 10. The Larval Index at that time was 5.2 and pre-treatment defoliation in some plots averaged 32 percent. Budworm populations in both blocks were extremely high (Table 2). Because of the delays, the high budworm populations, and rapid budworm development, the second treatment was applied on June 11. Surveys in the two assessment blocks indicated that there was significant budworm mortality and some foliage protection attributable to the Thuricide 48LV treatments (Table 2).

Figure 4. Spruce budworm defoliation rates on white spruce treated with two applications of Foray 48B (30BIU/2.4l/ha) in Saskatchewan, 1999.

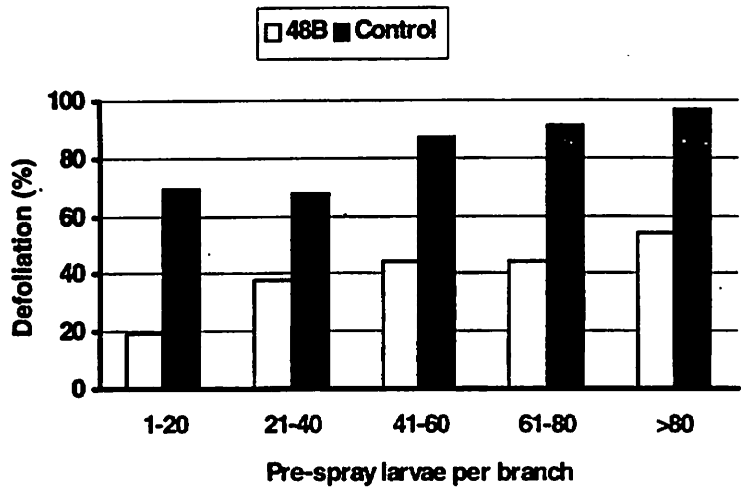
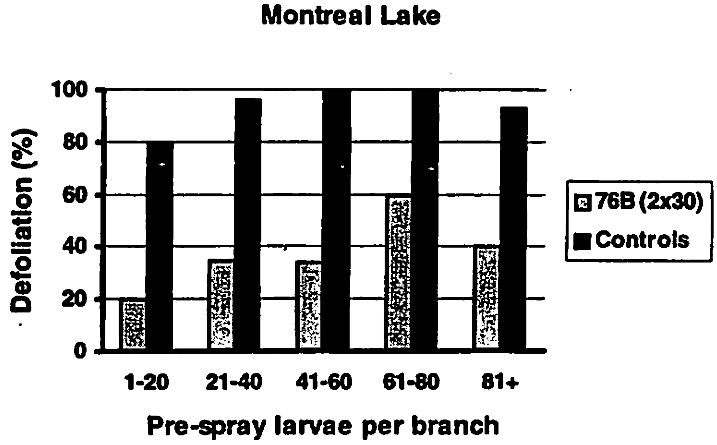
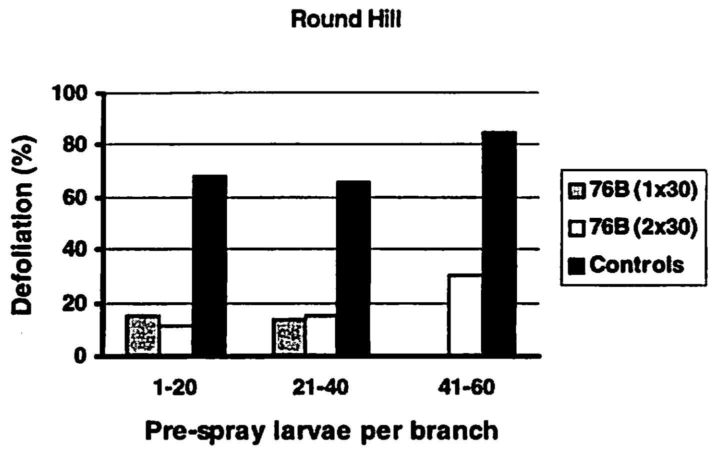


Table 2. Pre-spray spruce budworm populations, estimates of population reduction and white spruce defoliation in plots treated with two applications of Thuricide 48LV (30BIU/2.4l/ha) in Saskatchewan, 1999.

Block	Pre-spray budworm per branch	Population Reduction (%)	Adjusted Defoliation (%)
1	83.5	75	63
Controls	54.6		79
2	72.3	77	40
Controls	54.6		79

Figure 5. Spruce budworm defoliation on white spruce treated with one and two applications of Foray 76B (30BIU/1.5l/ha) in Saskatchewan, 1999 (the treatments at Montreal Lake were done back to back the same day).





Experimental Trials

BioForest Technologies Inc. designed and conducted experimental field trials in Saskatchewan in 1999 to test the efficacy of several Btk formulations. Two blocks were treated with the AEF Global Inc. formulation Bioprotec and three blocks were treated with single applications of Abbott Laboratory's Foray 76B and 96B.

Spruce Budworm Forecasts for 2000

Field crews conducted a budworm overwintering larval survey (L2) in September and October. Some 182 locations were sampled throughout Saskatchewan and foliage was processed at the BioForest Technologies L2 washing facility in Sault Ste. Marie, Ontario. Results of the survey were

not available for this report but preliminary figures indicate that budworm populations will likely remain high in many of the areas defoliated in 1999.

Remote Sensing and Spruce Budworm Detection Mapping

SERM and BioForest Technologies collaborated with Dr. Bradley Wilson from the University of Regina to design and conduct a study to assess the potential for using new Landsat-7 imagery to detect and map spruce budworm defoliation. Recently, there have been significant reductions in the cost of this imagery. This project will evaluate the new cost efficiencies of this method for damage mapping. A final report is expected in early 2000.

Spruce Budworm Impact Survey

SERM, BioForest Technologies Inc., and forest industry collaborated to design and establish a network of spruce budworm impact plots in Saskatchewan to assess the effects of the current budworm outbreak on the forest resource. The project was initiated in 1997, and to date some 71 intensive assessment plots have been established and surveyed. The network will be expanded in 2000 and will provide forest managers with an annual update on the status of the spruce and fir resource in Saskatchewan.

Spruce Budworm Decision Support System

SERM, BioForest Technologies Inc. and the Prince Albert Model Forest are collaborating to customize the Spruce Budworm Decision Support System developed by the Canadian Forest Service, Maritimes Region, to the Prince Albert Model Forest management unit. The processes developed for customizing the DSS to the Prince Albert Model Forest will be used as a template for expansion of the DSS to other management units in Saskatchewan.

FOREST PESTS IN MANITOBA – 1999

PREPARED FOR THE
1999
FOREST PEST MANAGEMENT FORUM
NOVEMBER 16-17, 1999

OTTAWA

Presented by:
K. Knowles
Forest Health and Ecology
Forestry Branch
Manitoba Conservation
200 Saulteaux Cres.
Winnipeg, Manitoba
R3J 3W3

Contributors:
Y. Beaubien
R. Eagle
R. Khan
K. Knowles
J. Leferink
L. Matwee
I. Pines
J. Skuba

Spruce Budworm Management

In 1999 the spruce budworm, *Choristoneura fumiferana*, infestation continued in Manitoba. Moderate to severe defoliation occurred in the Lake Winnipeg East area, Nopiming, Whiteshell and Hecla Island Provincial Parks, Grindstone Peninsula, Duck Mountain Provincial Forest and in northwestern Manitoba where the infestation continued its northward increase again this year. The Spruce Woods outbreak in southwestern Manitoba was similar in size to 1998. Digitizing and area determination of the infestation has not been completed at this time.

Based on the 1998 aerial defoliation survey and defoliation predictions derived from the 1998 egg mass surveys, an operational budworm suppression program was implemented in 1999 in the Pine Falls Paper Co. Forest Management License Area (FMLA) in eastern Manitoba, and in the Tolko Manitoba Inc. FMLA in northwestern Manitoba.

The biosynthetic insecticide, Mimic® 240 LV (tebufenozide) was aerially applied to 20,628 ha. The spray program was carried out in the Sandy River area, north of Lac du Bonnet and in the Lake Wanipigow area (7,094 ha) within the Pine Falls Paper Co. FMLA and in the Namew Lake area (13,534 ha) within the Tolko Manitoba Inc. FMLA. With the exception of some research spray blocks (1,572 ha) which received 105 or 140 grams active ingredient (a.i.) of Mimic per ha, all other spray blocks received a single application of 70 grams a.i. of Mimic per ha. The product was applied with water providing an application volume of 2.0 litres per ha (290 ml Mimic® and 1,710 ml water). The product was applied by a team of three Air Tractor 401B fixed-wing aircraft each equipped with eight AU 5000 Micronair rotary atomizer nozzles. The insecticide applications were carried out from May 28 to June 11, 1999.

The Pine Falls FMLA spray blocks were opened for spray operations on May 27, 1999. The Tolko FMLA spray blocks were opened June 5, 1999. Spray block openings coincided with host tree shoot tip development index 4.0 to 5.0 (Auger's Class) and peak 3^{rd} to 5^{th} instar larval development.

Each aerial spray aircraft was equipped with the Satloc Forestar real-time differential Global Positioning System (GPS) aerial navigation system. This system provided guidance over the treatment areas and allowed the aircraft to boom off (cease spraying) when flying over designated exclusion zones (buffer areas and non-target sites). Second-by-second GPS and spray application data from each spray aircraft was imported into the Pesticide Application Information System (developed by the Manitoba Conservation Department in conjunction with DataLink Space Mapping Space Technologies), where extensive quality analysis was performed on the contractor data. The use of this system facilitated a more efficient spray program as exclusion zones could be more readily predetermined and implemented during the application.

Pre and post spray surveys were carried out to determine the appropriateness of application timing and the success of the spray application in controlling spruce budworm larvae. When sampling, each plot site 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. The average pre spray budworm larval number per 45 cm spruce and balsam fir branch sample was 40 larvae in the Pine Falls FMLA and 52 larvae in the Tolko FMLA

The 1999 spray project was successful. Within the treatment blocks the population reduction was approximately 82% in the Pine Falls FMLA and 93% in the Tolko FMLA (Table 1). However, a delay in the application, due to unsettled weather conditions, plus high populations in the treatment blocks, resulted in defoliation being similar in the treated and untreated blocks (approximately 70%) within the Tolko FMLA (Table 2).

Table 1: Spruce Budworm - percent reduction in larval numbers

Location	Treatment	Area Treated	Pre Spray[1] Larvae	Post Spray[1] Larvae	Larval Mortality
Pine Falls FMLA	Mimic (70 gram a.i./ha)	7,094 ha	35	6	82%
Pine Falls FMLA	Untreated	N/A	47	17	41%
Tolko FMLA	Mimic (70 gram a.i./ha)	11,962 ha	44[2]	3	93%
Tolko FMLA	Untreated	N/A	31	7	76%

1. Number of larvae per 45-cm branch.
2. Does not include larval numbers for 105 & 140 gram a.i./ha treatment blocks (71 pre spray larvae/branch).

Egg mass surveys to predict 2000 defoliation and defoliation assessments were done during the month of August. Next year defoliation is predicted to be nil within the Pine Falls FMLA 1999 spray blocks and moderate within the Tolko FMLA 1999 spray blocks. Moderate and severe defoliation is predicted in the untreated blocks. Egg mass densities were significantly higher in the untreated than in the treated blocks in both FMLA's (Table 2).

Table 2: Spruce Budworm - 1999 defoliation and predictions for 2000

Location	Treatment	1999 Defoliation	Egg Masses per $10m^2$	2000 Prediction
Pine Falls FMLA	Mimic - 70 gram a.i./ha	42%	0	Nil
Pine Falls FMLA	Untreated	64%	168	Moderate
Tolko FMLA	Mimic - 70 gram a.i./ha	73%	44	Moderate
Tolko FMLA	Untreated	71%	227	Severe

Defoliation classes:

Light: Up to 35% defoliation of current shoots.
Based on <40 egg masses per 10 m^2 of branch area.

Moderate: 35% to 70% defoliation of current shoots.
Based on 40 to 185 egg masses per 10 m^2 of branch area.

Severe: Greater than 70% defoliation of current shoots and possible feeding on old foliage.
Based on >185 egg masses per 10 m^2 of branch area.

In addition to the spray and control block areas, egg mass surveys were carried out in Whiteshell Provincial Park, Pine Falls Paper Co. Ltd. FMLA, Nopiming Provincial Park, Duck Mountain and Spruce Woods Provincial Forests and in the Tolko Manitoba Inc. FMLA. Predictions for 2000 indicate a decline in the infestation in eastern Manitoba (Whiteshell, Nopiming, and Pine Falls FMLA). Within these areas defoliation is expected to be light next year with the exception of the Dorothy Lake and Manigotagan areas. In western Manitoba severe defoliation is predicted in Spruce Woods Provincial Forest and light defoliation (with the exception of the Laurie Lake area) is expected in Duck Mountain Provincial Forest. In northwestern Manitoba moderate and severe defoliation is predicted within the Tolko FMLA from Rocky Lake to Flin Flon and in the Sheridon area.

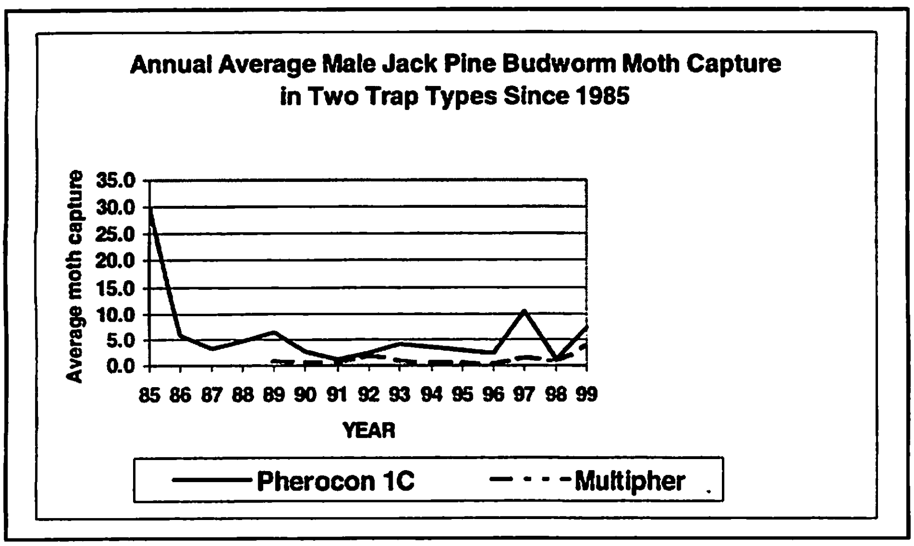
Spruce budworm pheromone traps were placed at 25 locations within the Pine Falls Paper Co. FMLA and at six locations in the Tolko Manitoba Inc. FMLA. Three Multi-Pher® insect traps containing spruce budworm pheromone (PVC lure containing 0.3% by weight of a 95:5 blend of (E)- and (Z)-11-tetradecenal) were placed 40 m apart at each plot location in either a straight or triangular configuration. Within the Pine Falls Paper Co. FMLA moth captures decreased at 75% of the sample locations. The overall increase in moth captures was 11% higher than in 1998. In the Tolko Manitoba Inc. moth captures increased at all repeat plot locations and were 40% higher than in 1998.

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. In 1999, the number of male moth captures increased across the province. Only three northerly sites had the same moth captures as last year.

Figure 1:



Branch assessment for shoot defoliation and egg masses have been completed. Pollen cone bud counts are progressing. So far, light defoliation was recorded on sampled branches from Shilo, Nopiming, St. Martins, and Moose Lake. No egg masses have been found.

Forest Tent Caterpillar

Moderate to severe defoliation by forest tent caterpillar (*Malacosoma disstria*) has occurred in northern Manitoba over the last three years, particularly in The Pas, Flin Flon and Sheridon areas. In 1999 the outbreak was widespread, but not quite as severe as in the past two years.

Over the past few years some isolated areas of forest tent caterpillar defoliation have been reported and/or mapped in southern Manitoba. These localized outbreaks have tended to subside after one or two years without enlarging and reaching epidemic proportions. In 1999 the size and frequency of these outbreaks increased particularly in the eastern (from Winnipeg to the Ontario/Manitoba boundary) and Interlake areas. The current distribution of these outbreaks suggests that southern Manitoba may be on the verge of a widespread infestation. The last major infestation in southern Manitoba occurred more than 20 years ago. At its peak in 1977, that infestation covered an area of 119,000 km^2.

In 1999 a fall egg band survey was carried out to predict forest tent caterpillar defoliation in 2000. Generally light defoliation is expected in western Manitoba in the areas of Rossburn, Roblin, Benito, Duck Mountain Provincial Park, Red Deer River and Assessippi Provincial Park. Light defoliation is expected in northwestern Manitoba in The Pas, Clearwater Lake, Cranberry Portage, Grass River Provincial Park and Flin Flon areas. In the Manitoba Interlake area generally moderate defoliation is expected, with the exception of Hecla Island Provincial Park and Grindstone Provincial Recreation Area, where severe defoliation is predicted. Severe defoliation is predicted in southeast Manitoba from Winnipeg to the Manitoba/Ontario boundary. Moderate and severe defoliation is predicted for much of Whiteshell Provincial Park and moderate defoliation is expected in the Lake Winnipeg East region (Pine Falls Paper Forest Management License Area and Nopiming Provincial Park).

Dutch Elm Disease Management 1999/2000

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

The annual DED surveillance program ran for approximately three months during the summer of 1999. This survey program encompassed 38 cost-sharing communities as well as 14 buffer zone municipalities around selected towns and cities. Within all cost-sharing communities, the Province of Manitoba is responsible for the survey and marking of diseased and hazard elm trees i.e. decadent to the point that they are capable of supporting elm bark beetle breeding activity. The Province of Manitoba is also responsible for removal of infected and hazard elms from all cost sharing communities except those of Brandon and Swan River. The Province of Manitoba and the cost-sharing communities cost-share DED management aspects such as sanitation pruning, basal spraying with chlorpyrifos, replacement planting, site specific inventory, general tree care and education and training courses approved by the Province. The City of Winnipeg, which has no cost sharing agreement with the Province, operates its own Dutch elm disease program with the assistance of a $700,000 grant from the Department of Urban Affairs.

The range of Dutch elm disease extends across southern and central regions of the province from the

Manitoba-Ontario border into Saskatchewan and northward to the Saskatchewan River. The disease extends throughout the entire range of American elm in Manitoba.

The Province of Manitoba is in the second year of a buffer zone expansion program around the City of Winnipeg. During the 1999 Provincial summer survey, 8,071 elms were marked for removal within this buffer area. There were also 4,027 elms marked in and around the 38 cost-sharing communities, bringing the total number of elms marked during the Provincial summer survey to 12,098. In addition, 145 firewood piles were identified for removal throughout the survey area. In the City of Winnipeg, 6,779 elms were slated for removal, of which 4,668 were diagnosed as having DED and the remainder classified as hazards. In addition, the City of Winnipeg issued 235 firewood notices. The City of Dauphin, in conjunction with Manitoba Conservation (formerly Manitoba Natural Resources) Forestry Branch and Manitoba Education and Training, initiated a cleanup of dead and dying elm trees along the Vermilion River within the City of Dauphin. This program removed approximately 4,500 elms during the winter of 1998/1999. This program is planned to continue during the winter of 1999/2000. Other major urban centres with disease include Morden, Neepawa, Portage la Prairie, Selkirk, Steinbach, Swan River and Winkler.

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. In the western and northwestern portions of the province the Swan, Red Deer, Carrot and Saskatchewan Rivers plus numerous smaller rivers are heavily infested.

From April 1, 1998 to March 31, 1999 Provincial DED sanitation crews removed 16,376 trees; the Cities of Winnipeg and Brandon removed 6,678 and 326 elms in 1998,respectively; and the City of Dauphin removed 4,500 elms during the 1998/1999 winter works program.

The major vector of Dutch elm Disease in Manitoba is the native elm bark beetle (*Hylurgopinus rufipes*). The more aggressive smaller European elm bark beetle (*Scolytus multistriatus*) has been found in small numbers in the City of Winnipeg, since 1975. In its semiannual survey, the City of Winnipeg found three European elm bark beetles in 1999. Eight pheromone trap locations were established across southern Manitoba, from 1982-1995, to monitor the population and distribution of *S. multistriatus*. Two specimens were captured in rural Manitoba in 1989.

Aspen Decay Survey

In recent years trembling aspen has gained in importance as a commercial species in Manitoba. 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, 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 FMU's 10, 11 and 13 in western Manitoba. During the 1998 and 1999 field season the survey has continued in FMU's 14.

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 *(Hypoxylon mammatum)* and the incidence of butt rot and poplar wood borer *(Saperda calcaratta)* attack were assessed. The results by FMU are as follows:

Table 3: Volume Loss to Advanced Decay

Maturity Class	Western FMU 10	Western FMU 11	Western FMU 13	Southeast FMU 20	Southeast FMU 23
Immature (30 to 49 years)	2%	1%	2%	1%	4%
Mature (50 to 70 years)	5%	2%	7%	4%	4%
Overmature (71+ years)	4%	10%	7%	7%	12%

Table 4: Incidence of Poplar Woodborer

Maturity Class	Western FMU 10	Western FMU 11	Western FMU 13	Southeast FMU 20	Southeast FMU 23
Immature (30 to 49 years)	14%	15%	7%	38%	36%
Mature (50 to 70 years)	12%	27%	29%	38%	55%
Overmature (71+ years)	19%	46%	27%	44%	63%

Table 5: Incidence of Butt Rot

Maturity Class	Western FMU 10	Western FMU 11	Western FMU 13	Southeast FMU 20	Southeast FMU 23
Immature (30 to 49 years)	37%	19%	36%	24%	37%
Mature (50 to 70 years)	58%	33%	44%	44%	49%
Overmature (71+ years)	69%	57%	51%	54%	65%

Table 6: Volume Loss to Hypoxylon Canker

Western FMU 10	Western FMU 11	Western FMU 13	Southeast FMU 20	Southeast FMU 23
2%	2%	4%	7%	10%

With the exception of FMU 10 (4% loss) volume loss to advanced decay in the overmature class ranged from 7% to 12%. The results for this maturity class in FMU 10 are suspect due to the small sample size. It was difficult to increase the sample size in this category as it only occupied 2% of the forested land base within the FMU.

The results give some indication that the incidence and volume loss to Hypoxylon canker and the incidence of poplar woodborer attack tends to be greater in the southeastern than the western portion of the Province.

Regeneration Performance Assessment - Pest Impact Plot Survey

From 1986 to 1988, the Silviculture Section of the Manitoba Forestry Branch located Regeneration Performance Assessment (RPA) plots in recently established plantations of the four 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 periodically assess the seedlings for pest damage and occurrence and relate this incidence to tree growth and vigour. The seedlings are assessed every three years until age 21.

In 1999, the fourth pest assessment was conducted on the 1987 permanent silvicultural RPA plots. These included 27 plantations or 249 plots with white spruce, black spruce, jack pine or red pine. Data entry and analysis is ongoing. The majority of trees were recorded as healthy and competition and weevil damage was noted in a few areas.

Pine Stem Canker

Stem cankers on both red and jack pine have been monitored in Sandilands Provincial Forest since 1990. The cankers are caused by *Sphaeropsis pinea* and/or *Ceratocystis minor.* Two 30m x 30m plots were established 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. Assessments done in 1999 indicated that the severity of stem cankering and tree mortality had essentially remained the same or decreased slightly since 1996 in both the red and jack pine plantations. It is suspected that these fungi have behaved opportunistically, infecting trees following a period of drought stress that occurred through much of the 1980's and ended in 1991. With the return of normal moisture conditions in recent years, both species of pine on these sites have been more resistant to infection.

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%. Since 1992 only one tree out of the total 840 has died due to Armillaria root disease. It is suspected that a reduction of inoculum (due to the decomposition of infested stumps and roots from the previous stand) in the soil, plus the ability of trees with larger root systems to survive infection, has resulted in the low mortality rates in recent years.

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). Annual mortality was generally in the 1% to 2% range up to and including 1996. However, over the last three year period annual mortality has been consistently below 1%.

White Pine Weevil

Three of seven Tree Improvement family test plantations which had high populations of white pine weevil in 1998 were sprayed with methoxychlor in the spring of 1999 to minimize environmental variation. Follow-up observations indicated the number of damaged terminals decreased considerably in all three sites.

Vegetation Management

The long term effect of aerial herbicide application on competition and conifer species can be monitored through the establishment of vegetation plots within treated and untreated areas of plantations. Plots are instituted prior to treatment and measured for trees, shrubs, herbs and available browse to ungulates. Changes in vegetation and tree measurements are conducted at one, three, and five years after treatment.

In 1999, a first-year assessment was conducted in the 1998 glyphosate-treated white spruce plantation in the Central Region. Third-year assessments were conducted in the 1996 herbicide-treated white spruce plantation in the Central Region and two jack pine plantations in the Eastern Region. Measurements were conducted on all tagged conifer trees, surviving hardwoods and shrubs. Density and diversity counts were also recorded. Data entry and analysis is ongoing.

In 1999 herbicide applications were carried out by Pine Falls Paper Co. Ltd., Tolko Manitoba Inc. and Manitoba Conservation. A total of 1231.4 ha were treated in 1999 (Table 7)

Table 7: Summary of 1999 Herbicide application in Manitoba

User	Purpose	Method	Active Ingredient	Product	Rate l/ha	Area treated (ha)
Manitoba Conservation	Site Prep.	Ground - Bracke	Glyphosate	Vision	3	86.3
Manitoba Conservation	Site Prep.	Ground - Bracke	Glyphosate	Vision	3.8	128
Manitoba Conservation	Site Prep.	Ground - Bracke	Hexazinone	Velpar	16	21.5
Manitoba Conservation	Release	Back-pack	Triclopyr	Release	5	60
Pine Falls Paper Co.	Release	Back-pack	Glyphosate	Vision	5	110
Pine Falls Paper Co.	Site Prep.	Ground - Cluster Nozzle	Glyphosate	Vision	2.5	210
Tolko Manitoba Inc.	Release	Aerial - fixed wing	Glyphosate	Vision	5	615.6
Total						1231.4

1999 Integrated Forest Renewal Program Pest Survey

In a relatively short time, as old growth forests are harvested, the amount of predominantly man-made forests (naturally regenerated and plantations) will increase substantially in the Province of Manitoba. Understanding the new challenges, particularly forest pest problems that are associated with renewed forests, is imperative to ensuring Ecosystem integrity and a sustainable wood supply. Providing an adequate level of assessment and evaluations of emerging technologies in the field of forestry is essential. The greatest economic savings in terms of preventing long term losses 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.

Identification of major pests at all stages of forest growth is important to minimize pest impacts. Pest control measures and long term pest management strategies prevent major losses to the provincial wood supply and contribute to a sustainable forest ecosystem.

The monitoring of major forest pests is the responsibility of the Province of Manitoba. The forest industry is requesting improved forest pest management services. Integration of forest health survey methodologies into three existing operational forest surveys over the past three years has helped to meet this mandate. The three surveys are:

A) Pre-Harvest Ecological Assessment (carried out on stands at least two years prior to harvesting)

B) Forest Regeneration Surveys (carried out on all sites depleted seven years earlier)

C) Free to Grow Surveys (carried out on sites depleted 14 years earlier)

Once all three surveys are running at full capacity, there will be well over 30,000 ha surveyed annually. The collection of forest health data includes areas managed by the forest industry. (Forest Management License Areas - Pine Falls Paper Company (PFPC), Tolko Manitoba Inc. (Tolko), and Louisana-Pacific (L-P) as well as forest lands directly managed by the Province of Manitoba. Survey staff are intensively trained in the identification of damaging forest pests and are provided with forest health codes and colour pictorial guides. A list of forest health criteria has been developed to allow prompt sorting of surveyed stands so that a more intensive forest health assessment can be completed by Forest Health and Ecology staff in the same field season.

Forest health follow up assessments and pest specific surveys to evaluate potential losses provide an overall Stand Pest Hazard Rating:

Low = pest awareness
Moderate = exercise caution when doing stand tending; monitor for decline and adjust year of harvest if required
Severe = expected volume will be significantly reduced by rotation age

The collection of forest health data in these surveys continues to prove very beneficial at locating stands with forest health concerns. Detailed pest management decisions are being developed with local forest managers for stands identified as having significant forest health concerns through all three surveys. Data is provided annually and will be eventually available on the Forestry Branch tracking system which is Geographic Information System (GIS) based, serving to link head office and forest company/regional offices. Tracking of areas prior to harvest (Pre-harvest survey), through to the renewal stage and onward is essential in an integrated management approach. This information becomes a historical record providing forest managers with a visual tool to aid in future decision making. It also provides the Forest Resource Management Section with pest impact information to improve accuracy of wood supply data.

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.

Preharvest Survey

The collection of forest health data in Preharvest Surveys continued for the second year for all three Manitoba forest companies (Pine Falls Paper Company, Tolko Manitoba and Louisana-Pacific). Four new health codes were added in 1999 (Brown Cubical Rot, White Pocket Rot, Yellow Stringy Rot, and Poplar Borer *Saperda calcerata).* Advanced decay was broken down into three broad categories: brown cubical rot, white pocket rot, and yellow stringy rot to encourage and simplify the collection of root and stem decay data when survey staff encountered root disease centres.

Based on the data collected in the companies' initial preharvest survey, a total of 41 stands (3,538 ha) were selected, using screening criteria, for a more intensive follow up health assessment. The most significant or primary pest was given an overall Stand Hazard Rating (L-Low, M-Moderate, S-Severe) as shown in Table 8 for 1998 and 1999.

Other noteworthy pests included: stem canker (fire scarring at the base of the stem) often associated with brown cubical rot in both black spruce and jack pine; stem canker (unidentified) on black spruce; and spruce budworm, *Choristoneura fumiferana*, on black spruce when growing with balsam fir and white spruce in PFPC stands. Stem and root decay in conifers was very common.

Pest Specific Surveys

Root and butt decay was frequently encountered during routine Preharvest Surveys. To demonstrate the volume loss due to root disease centers, an intensive ground survey was conducted in the north Interlake (just south of Long Point). The total surveyed area was 120 hectares. Root disease centers (> 10 metres in diameter) were mapped and measured along parallel lines spaced 50 meters apart. GPS readings were taken at the center of each pocket encountered on the line. At each pocket, evidence of yellow stringy rot, white pocket rot, brown cubical rot and /or Armillaria (mycelial fans) was recorded.

Total area of the disease pockets mapped was 6.72 ha. Of this total area various combinations of the root/butt rot diseases were found: brown cubical rot occurring alone consisted of 4.37 ha; a combination of yellow stringy rot and brown cubical rot occurred on 1.06 ha; yellow string rot and armillaria occurred on 0.44 ha; white pocket rot alone occurred on 0.43 ha; and a combination of all 3 types of decay occurred on 0.42 ha.

The 120 ha area surveyed was made up of numerous stand types. One stand, in particular was significantly impacted by the root diseases. It occupied 29.8 ha, or 25% of the total area surveyed but had 4.52 hectares (67%) of infected area. This stand consisted of 40% jack pine, 20% black spruce and 20% trembling aspen. Fire scarring at the base of conifers was a common entry point for brown cubical rot.

Table 8. Preharvest Survey Health Follow up Results

Pest (Primary)	Company	Overall Stand Hazard Rating # Ha & Host Affected					Total # Affected	
		L	L-M	M	M-S	S	Ha	Stands
Dwarf Mistletoe		224	67	283	45		619	9
		JP	JP	JP	JP			
Arceuthobium americanum & A. pusillum	PFPC	33					33	1
		BS						
Budworm Choristoneura fumiferana	PFPC			57		169	226	4
				BF		BF/WS		
Root and Stem Decay (*Armillaria sp.*, White pocket rot, Yellow Stringy Rot, Brown Subical	Tolko	447	186	120	50	120	923	12
		JP/B	JP/BS	JP/BS	BS	JP/BS		
	PFPC	566	544	64			1184	7
		JP	JP	JP				
Stem Canker	Tolko	93					93	1
		JP						
Rot)	PFPC	211					211	1
		JP						
Hypoxylon Canker *H. mammatum*	PFPC		52				52	1
			TA					
Hardwood Stem Decay	L-P			34	84		118	4
				TA	TA			
Western Gall Rust *Endocronartium harknessii*	L-P		79				79	1
			JP					

STATUS OF IMPORTANT FOREST PESTS IN ONTARIO IN 1999.

G.M. Howse[1] and T. Scarr[2]

[1] Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario

[2] Ontario Ministry of Natural Resources, Forest Management Branch, Sault Ste. Marie, Ontario

OVERVIEW

The 1999 field season, as planned, was similar to the 1998 field season in terms of activities and personnel. Activities involved monitoring forest health plots, establishing new national forest health assessment plots, introduced pests and major forest disturbances. Also, as in 1998, a team of twelve Forest Health Technicians (six-Canadian Forest Service (CFS) and six-Ontario Ministry of Natural Resources (OMNR)) were deployed throughout Ontario. The six OMNR staff are located in Fort Frances, Nipigon, Hearst, Chapleau, Kemptville and Aylmer; the six CFS staff are based in Sioux Lookout, Thunder Bay, Sault Ste. Marie, Sudbury, Angus and Minden. This report is a summary of information collected by the 12 Forest Health Technicians and reflects monitoring, aerial surveys and other activities from late May to mid-September.

Warmer than normal temperatures and higher than normal precipitation prevailed during the spring and early summer resulting in advanced insect and foliage development but not as advanced as 1998.

Based on aerial surveys, forest tent caterpillar (*Malacosoma disstria* Hbn.), gypsy moth (*Lymantria dispar* [L.]) and large aspen tortrix (*Choristoneura conflictana* [Wlk.]) infestations increased in 1999 whereas spruce budworm (*Choristoneura fumiferana* Clem.) declined.

ACTIVITÉ DES PRINCIPAUX RAVAGEURS FORESTIERS EN ONTARIO

G.M. Howse[1] et T. Scarr[2]

[1] Ressources naturelles Canada, Service canadien des forêts, Centre de foresterie des Grands Lacs, Sault Ste. Marie (Ontario)

[2] Ministère des Richesses naturelles de l'Ontario, Direction de la gestion forestière, Sault Ste. Marie (Ontario)

Sommaire

Comme prévu, la campagne de lutte entreprise en 1999 contre les ravageurs forestiers ressemblait à celle de l'année précédente pour ce qui est des activités menées à bien et du personnel affecté à leur réalisation. Les activités consistaient à surveiller le réseau de parcelles indicatrices de l'état de santé des forêts, à aménager de nouvelles parcelles aux fins de l'évaluation de l'état des forêts et à suivre l'activité des ravageurs introduits et des principales perturbations en milieu forestier. Comme en 1998, une équipe composée de 12 techniciens forestiers (six du Service canadien des forêts et six du ministère des Richesses naturelles de l'Ontario) a été déployée à l'échelle de la province. Les six membres du MRNO ont mené à bien leurs activités à Fort Frances, Nipigon, Hearst, Chapleau, Kentville et Aylmer, et leurs collègues du SCF, à Sioux Lookout, Thunder Bay, Sault Ste. Marie, Sudbury, Angus et Minden. Le présent rapport résume les données recueillies par ces 12 techniciens forestiers et rend compte des activités de surveillance et de lutte aérienne et des autres initiatives qui se sont déroulées de la fin-mai à la mi-septembre.

Le printemps et le début de l'été ont été anormalement chauds et ponctués de précipitations anormalement abondantes. Le développement des insectes et du feuillage s'en est trouvé accéléré, quoique pas d'une façon aussi marquée qu'en 1998.

D'après les relevés aériens, les infestations par la livrée des forêts (*Malacosoma disstria* Hbn.), la spongieuse (*Lymantria dispar* [L.]) et la tordeuse du tremble (*Choristoneura conflictana* [Wlk.]) se sont intensifiées en 1999, tandis que celles causées par la tordeuse des bourgeons de l'épinette (*Choristoneura fumiferana* Clem.) ont décliné.

STATUS OF IMPORTANT FOREST PESTS IN ONTARIO IN 1999

by

G.M. Howse[1] and T. Scarr[2]

Report prepared for the annual Forest Pest Management Forum, Ottawa, November 16-17, 1999.

[1] Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario

[2] Ontario Ministry of Natural Resources, Forest Management Branch, Sault Ste. Marie, Ontario

FOREST INSECTS

Eastern Spruce Budworm, *Choristoneura fumiferana* Clem.

The extent of moderate-to-severe defoliation caused by spruce budworm decreased in 1999 to 81 204 ha, compared to 141 287 ha in 1998 (Table 1, Fig. 1). This is the lowest area of spruce budworm defoliation mapped in Ontario since 1967.

The only defoliation mapped in northwestern Ontario totalled 513 ha on Big Island, Lake of the Woods, Kenora District.

In Northeastern Ontario, the infestation near the village of Warren on Highway 17 which straddles the Sudbury - North Bay District boundary declined to approximately 70 600 ha in 1999 compared to about 83 500 ha in 1998. A pocket of defoliation totalling about 1 249 ha occurred in the same location as 1998, south of Gore Bay west of Lake Kagawong, Manitoulin Island, Sudbury District. Ten hectares of moderate defoliation was mapped in Kirkwood Township, Sault Ste. Marie District. A total of 741 ha of light defoliation was mapped in Rogers Township, Hearst District.

Table 1: Gross area of moderate-to-severe defoliation caused by the eastern spruce budworm in Ontario, 1996 - 1999.

Region District	Area (ha)			
	1996	1997	1998	1999
Northwest				
Dryden	4 695	0	0	0
Fort Frances	42 004	26 765	22 721	0
Kenora	12 725	11 032	6 289	513
Nipigon	60 164	15 507	0	0
Red Lake	3 964	4 018	0	0
Sioux Lookout	6 138	16	0	0
Thunder Bay	117 971	3 420	0	0
	248 661	60 758	29 010	513
Northeast				
Chapleau	31 433	0	0	0
Hearst	3 334	3 520	1 900	0
North Bay	26 116	33 758	47 661	44 345
Sault Ste. Marie	3 194	0	0	10
Sudbury	22 501	26 306	36 584	27 522
Wawa	81 136	0	0	0
	167 714	63 584	86 145	71 877
South Central				
Aurora	0	8	36	0
Aylmer	0	0	4	0
Bancroft	0	0	131	0
Guelph	0	0	9	0
Kemptville	4 880	6 870	15 755	4 524
Midhurst	0	0	27	0
Parry Sound	438	0	0	0
Pembroke	13 060	3 447	9 781	4 290
Peterborough	178	384	389	0
	19 556	10 709	26 132	8 814
TOTAL	435 931	135 051	141 287	81 204

In southern Ontario, populations collapsed everywhere except in eastern Ontario in the Pembroke and Kemptville districts. Even here, the area of moderate-to-severe defoliation declined to 4 524 ha and 4 290 ha in Kemptville and Pembroke districts in 1999 compared to 15 755 ha and 9 781 ha respectively in 1998. Defoliation persisted in the Renfrew, Arnprior and Almonte areas, west of Ottawa and in Larose Forest to the east of Ottawa. In many instances, large white spruce trees were infested, many in plantations.

Spruce budworm caused tree mortality increased by only 508 ha in 1999 to a total of 8 469 423 ha (Fig. 2) compared to 8 468 915 ha in 1998. The new tree mortality was mapped in North Bay District.

Gypsy Moth, *Lymantria dispar* (L.)

Moderate-to-severe defoliation caused by gypsy moth increased to 15 399 ha in 1999 compared to 3 060 in 1998 (Table 2, Fig. 3). The increases in defoliation for the past two years may be the start of a new outbreak in Ontario.

Defoliation was mapped in Aylmer, Guelph, Kemptville, Peterborough and North Bay districts. In Aylmer District, defoliation occurred primarily in woodlots southeast of Windsor in Colchester North and South townships; from Walpole Island to Sarnia, east of the St. Clair River in Moore, Sombra, Dawn and Enniskellen townships; near the town of Thamesville in Camden, Zone, Orford and Howard townships; Fanshawe Conservation Area, north of the City of London and Backus Woods, South Walsingham Township.

In Guelph District (formerly Cambridge District), a new infestation was mapped in the south-west corner of the district, west of the town of Exeter where trembling aspen and white birch were affected in Hay and Stephen townships. New infestations occurred in the eastern part of the district. Much of the oak forest on Six Nations Indian Reserve, southwest of Brantford was completely defoliated. Further to the east, new infestations were found in the following townships; Seneca, North Cayuga, Canborough, Caistor, Gainsborough, Humberstone, Crowland, Willoughby and Niagara.

A 10 ha pocket of defoliation in 1998 in the Ganaraska Forest, Hope Township, Peterborough District expanded to 366 ha in 1999. There were changes in the infestations at Charleston Lake and Charleston Lake Provincial Park, northeast of Gananoque, Kemptville District. The net effect was an increase to 1 660 ha in 1999 compared to 1 388 ha in 1998. Some 290 ha of defoliation was mapped at Lake Nipissing, North Bay District.

A pheromone trapping program was conducted in northern Ontario parks and campgrounds. A total of 60 locations were trapped in 1999 (Fig. 4). Results were similar to previous years in that moths were caught in multiple numbers in North Bay, Sudbury, Sault Ste. Marie, Wawa and Timmins districts. A single moth was caught in Kap-Kig-Iwan Provincial

Park, Kirkland Lake District and in the Dawson Trail Campground, Quetico Provincial Park, Fort Frances District.

Table 2: Gross area of moderate-to-severe defoliation caused by the gypsy moth in Ontario, 1996 - 1999.

Region District	Area (ha)			
	1996	1997	1998	1999
Northeast				
North Bay	0	0	0	290
Sault Ste. Marie	87	0	0	0
Sudbury	6 208	0	0	0
	6 295	0	0	290
South Central				
Aylmer	919	5	1 548	2 933
Guelph	0	0	112	10 150
Kemptville	0	20	1 388	1 660
Pembroke	0	0	2	0
Peterborough	0	0	10	366
	919	25	3 060	15 109
TOTAL	7 214	25	3 060	15 399

Forest Tent Caterpillar, *Malacosoma disstria* Hbn.

The forest tent caterpillar outbreak increased from 2 986 118 ha of defoliation in 1998 to 3 653 583 ha in 1999 (Table 3, Fig. 5), an increase of only 667 465 ha; however, there were major regional changes. The outbreak in the Northeast region declined overall by almost 700,000 ha with declines in Chapleau, Cochrane and Hearst districts whereas increases occurred in the Kirkland Lake and Timmins districts. Overall, in the Northwest Region, there was an increase of 1 362 901 ha with new infestations or increased infestations in every district with the exception of Nipigon. Forest tent caterpillar larvae were observed frequently in districts such as Sault Ste. Marie, Parry Sound and Midhurst with light defoliation observed through the central portion of Parry Sound District from Georgian Bay east to Highway 11.

Pine False Webworm, *Acantholyda erythrocephala* (L.)

The area of moderate-to-severe defoliation caused by pine false webworm declined for the second consecutive year to 1 457 ha in 1999 compared to 2 948 ha in 1998 (Fig. 6). A total area of 997 ha of defoliation was mapped in the Midhurst District where most of the damage occurred to red, white and Scots pine plantations near Craighurst in Oro Township. Defoliation was also observed in adjacent Flos and Vespra townships and further west in the district in Holland, Sullivan, Bentinck, Brant, Mono and Tecumseth townships.

Infestations in the Ganaraska Forest ,west of Rice Lake, in Hope and Cavan townships, Peterborough District and Newcastle Township, Aurora District declined to 432 ha in 1999 compared to 683 ha in 1998. Most of the defoliation occurred to mature white pine and tree mortality is expected. Defoliation was also noted at Balsam Lake Provincial Park, Bexley Township, Peterborough District and Carlow Township, Bancroft District.

In Pembroke District, severe defoliation was noted in red and Scots pine plantations in Alice, Stafford, Ross, Horton, Raglan, Algona, and Wilberforce townships. A jack pine plantation in Huntley Township, Kemptville District was defoliated. Heavily damaged pines were observed in the area of Sault Ste. Marie.

Table 3: Gross area of moderate-to-severe defoliation caused by the forest tent caterpillar in Ontario, 1996 - 1999.

Region District	Area (ha)			
	1996	1997	1998	1999
Northwest				
Dryden	0	9 639	68 911	661 302
Fort Frances	0	0	0	93 339
Kenora	0	273	20 548	189 795
Red Lake	0	987	18 749	171 569
Sioux Lookout	8	0	8 181	122 727
Thunder Bay	0	0	1 834	242 392
	8	10 899	118 223	1 481 124
Northeast				
Chapleau	2 953	0	13 985	0
Cochrane	512 022	1 102 202	1 636 972	1 218 759
Hearst	255 094	432 841	890 109	451 163
Kirkland Lake	1 881	42 683	88 913	224 997
Timmins	80 693	190 388	237 916	277 540
Wawa	0	1 288	0	0
	852 643	1 769 402	2 867 895	2 172 459
South Central				
Kemptville	1 626	0	0	0
	1 626	0	0	0
TOTAL	854 269	1 780 301	2 986 118	3 653 583

Oak Leaf Shredder, *Acleris semipurpurana* (Kft.)

Overall, defoliation caused by oak leaf shredder declined in 1999 to 1 580 ha compared to 2 078 ha in 1998 (Fig. 7). There were 450 ha of defoliation in Midhurst District with pockets of defoliation near Midland in Tiny Township and west of the city of Barrie in Vespra Township. Some 1 130 ha of defoliation occurred near Six Mile Lake Provincial Park and Beausoleil Island in Baxter Township, Parry Sound District. Defoliation by oak leaf shredder totalling 1 400 ha in 1998 in Aylmer and Cambridge district would probably have occurred again in 1999 but was masked by feeding of gypsy moth and an oak leafminer, *Japanogromyza viridula*.

Large Aspen Tortrix, *Choristoneura conflictana* (Wlk.)

The extent of large aspen tortrix defoliation increased in 1999 to a total of 531 761 ha compared to 197 736 ha in 1998 (Table 4, Fig. 8). Most of the defoliation occurred around Lake Nipigon in Nipigon and Thunder Bay districts. One large infestation extended from the town of Nipigon to the City of Thunder Bay along the north shore of Lake Superior.

Numerous small pockets of defoliation totalling 13 953 ha occurred in Kirkland Lake, North Bay, Timmins and Sudbury districts. Most of the defoliation in northeastern Ontario occurred in the town of Englehart area to Lake Temagami area. There were also pockets of defoliation north of Sudbury, near Gogama and on Manitoulin Island. Small pockets of moderate defoliation were observed throughout much of the area infested in 1998 in the City of Sault Ste. Marie and vicinity. Tortrix larval populations were common around Barrie and in Brant Township, Midhurst District. A small pocket of severe defoliation was detected in Monteagle Township, Bancroft District and moderate defoliation (small pocket) occurred in Westmeath township, Pembroke District.

Bruce Spanworm, *Operophtera bruceata* (Hulst)

Moderate-to-severe defoliation caused by Bruce spanworm in 1999 was mapped on St. Joseph Island, east of the City of Sault Ste. Marie, Sault Ste. Marie District. There were five areas of defoliation in Jocelyn and Hilton townships that totalled 3 251 ha, an increase over 1998. However, populations that caused defoliation north and northwest of Sault Ste. Marie in 1998 declined in 1999. Overall, in 1998 there were 4 581 ha of defoliation compared to 3 251 ha in 1999.

Pine Shoot Beetle, *Tomicus piniperda,* (L)

This regulated, introduced insect was found in the two remaining southwestern Ontario counties, Essex and Kent previously considered uninfested, in 1999 (Fig. 9). The incidence of new infestations and damage, particularly to Scots pine seems to be on the increase.

Special surveys were conducted in August, 1999 in the Wawa, Sault Ste. Marie, Sudbury and North Bay districts involving personnel from the Canadian Forest Service, Ontario Ministry of Natural Resources, and Canadian Food Inspection Agency. One hundred and forty five potentially susceptible locations were checked for presence of the beetle. The beetle or signs of its presence were not found. Surveys in Parry Sound District also found no signs of the beetle.

Table 4: Gross area of moderate-to-severe defoliation caused by the large aspen tortrix in Ontario, 1996 - 1999.

Region District	Area (ha)			
	1996	1997	1998	1999
Northwest				
Nipigon	32 824	92 519	80 968	208618
Sioux Lookout	0	0	0	72
Thunder Bay	17 637	67 595	114 130	309 118
	50 461	160 114	195 098	517 808
Northeast				
Kirkland Lake	0	0	0	2 612
North Bay	0	0	0	7 228
Sault Ste. Marie	0	0	2 638	0
Sudbury	0	0	0	3 162
Timmins	0	0	0	951
	0	0	2 638	13 953
TOTAL	50 461	160 114	197 736	531 761

ABIOTIC

Blowdown

High winds on or about July 4, 1999 caused 121 873 ha of blowdown (Fig. 10) in the following districts in Ontario: near Atikokan and in Quetico Provincial Park, Fort Frances District - 26 402 ha; Dryden District - 1 215 ha; Thunder Bay District - 28 100 ha; central Chapleau District - 43 333 ha; central Wawa District - 9 361 ha; central Timmins District - 8 913 ha; Kirkland Lake District - 1 253 ha; North Bay District - 362 ha; Hearst District - 234 ha; Pembroke District - 2 505 ha; and Bancroft District - 195 ha.

Wind velocities of up to 90 km/hr were recorded in Thunder Bay District and as high as 128 km/hr at the Chapleau fire centre. Digital map coverage for Thunder Bay District was provided courtesy of Greenmantle Inc. of Thunder Bay.

Damaged Red Cedar

Eastern red cedar was affected within an area of 26 470 ha in south central Peterborough District from Trenton to Kingston, Price Edward County and Amherst Island by a combination of juniper tip blight, *Kabatina juniperi* R. Schneid. & Arx; cedar leaf miner, *Argyresthia* sp.; cedar-apple rust, *Gymnosporangium juniperi-virginianae* Schwein. and winter drying. This is the second year that red cedar has been affected and wide spread twig and branch mortality has occurred.

Snow Damage

An early season snowstorm in late October 1998 damaged some 33 312 ha of immature jack pine regeneration from a 1980 fire in the central part of Thunder Bay District. The damaged area is located between Hollinshead and Obonga lakes and between secondary roads 811 to the west and 511 on the east.

Aspen Decline

Trembling aspen stands in Thunder Bay (45 162 ha) and Nipigon (61 352 ha) districts, totalling 106 514 ha (Fig. 11), were aerially mapped as defoliated. The crowns appeared very thin in stands of all ages. Ground checks, including felling trees, found stunted foliage and up to 50% growth reduction for the past two years. It is believed that a combination of drought, insect defoliation, poor sites and clonal differences among stands are contributing factors.

OTHER PESTS AND ABIOTIC FACTORS

A number of other pests and abiotic factors were encountered while monitoring forest health plots or were observed during travel or checking major forest disturbances. They included the following:

Cedar leafminers, *Argyresthia aureoargentella* Brower, *A. thuiella* (Packard), *Coleotechnites thujaella* (Kft.) caused severe leafmining to eastern white cedar in Kemptville, Pembroke, Peterborough, Bancroft and Fort Frances districts. Severe damage is occurring in the Pembroke District in the Round, Golden and Clear lakes area where winter drying and drought in previous years had stressed the cedar trees. Severe damage was noted in Monteagle Township, Bancroft District and Charleston Lake, Rear and Front of Leeds and Landsdowne townships, Peterborough District. Ten locations of severe damage were mapped in Fort Frances District.

Large populations of pine engraver beetle, *Ips pini* (Say), have infested red pine, Scots pine and spruce in the area of the 1998 ice storm damage. Living trees are not being damaged but many injured or bent over trees are being attacked.

In general, larch casebearer, *Coleophora laricella* (Hbn.) populations declined in 1999 in southern and northeastern Ontario. However, eastern larch beetle, *Dendroctonus simplex* LeC., is attacking larch trees in stands that have been severely defoliated by larch casebearer for two or three years. In particular, dead and dying larch trees have been noted in the Minden area and elsewhere in the Bancroft and Peterborough districts with a recent history of larch casebearer, in parts of 18 townships that extend for the full length of the centre of Parry Sound District and Garden River First Nation, east of the City of Sault Ste. Marie, Sault Ste. Marie District.

In general, there was widespread increase in the frequence of attack by Dutch elm disease, *Ophiostoma ulmi* (Buisman) Nahnf. in southern Ontario, in particular Aylmer, Guelph, Bancroft, Peterborough, Pembroke and Kemptville districts.

Whole tree mortality of Norway spruce was a widespread occurrence throughout Guelph District in areas that experienced the greatest drought in 1998. By early May windrows of Norway spruce turned red and dropped all foliage. No evidence of root rot or insect (bark beetle) activity was found.

Beech bark disease, *Nectria coccinea* var. *faginata* Lohman, Watson and Ayers was confirmed for the first time for Ontario at six locations; two locations in Erin Township, Guelph District; Murray, Cramahe and Brighton townships, Peterborough District and Rear of Leeds and Landsdown Township, Kemptville District. This finding may confirm that the disease has been present in Ontario for a number of years.

Introduced pine sawfly, *Diprion similis* (Hartig), occurred at outbreak levels in 1993 and 1994 along the Georgian Bay shoreline from Carling Township, north of the town of Parry Sound to Freeman Township, south of Parry Sound, a distance of approximately 60 kilometres. Numbers of sawfly larvae increased this year and white pine trees on some islands were moderately-to-severely defoliated. An aerial survey in early October, 1999 detected some 10 pockets of defoliation totalling 12 ha on several islands near the village of Dillon in Carling Township.

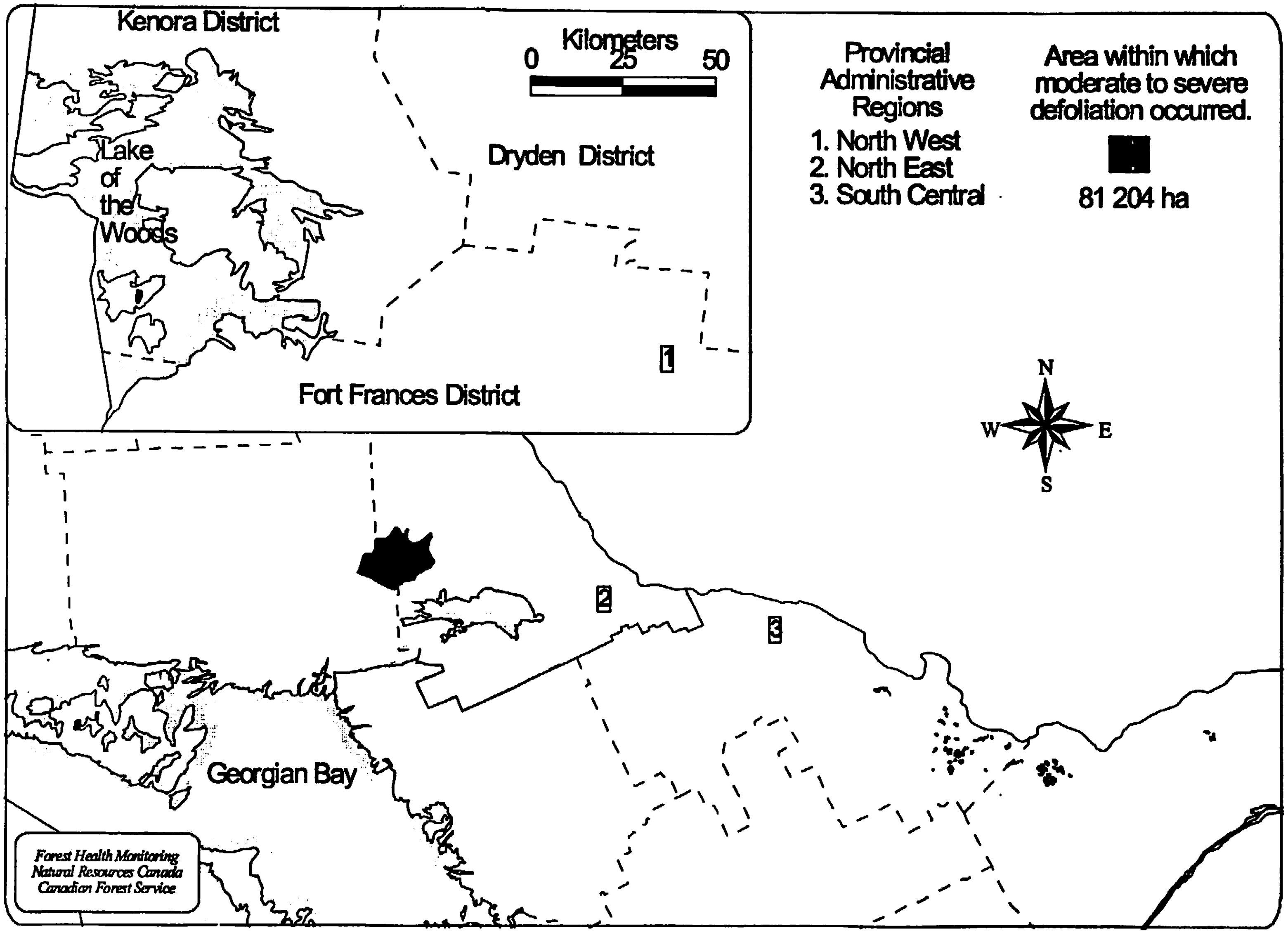


Figure 1. Spruce Budworm (*Choristoneura fumiferana* [Clem.]) defoliation in 1999.

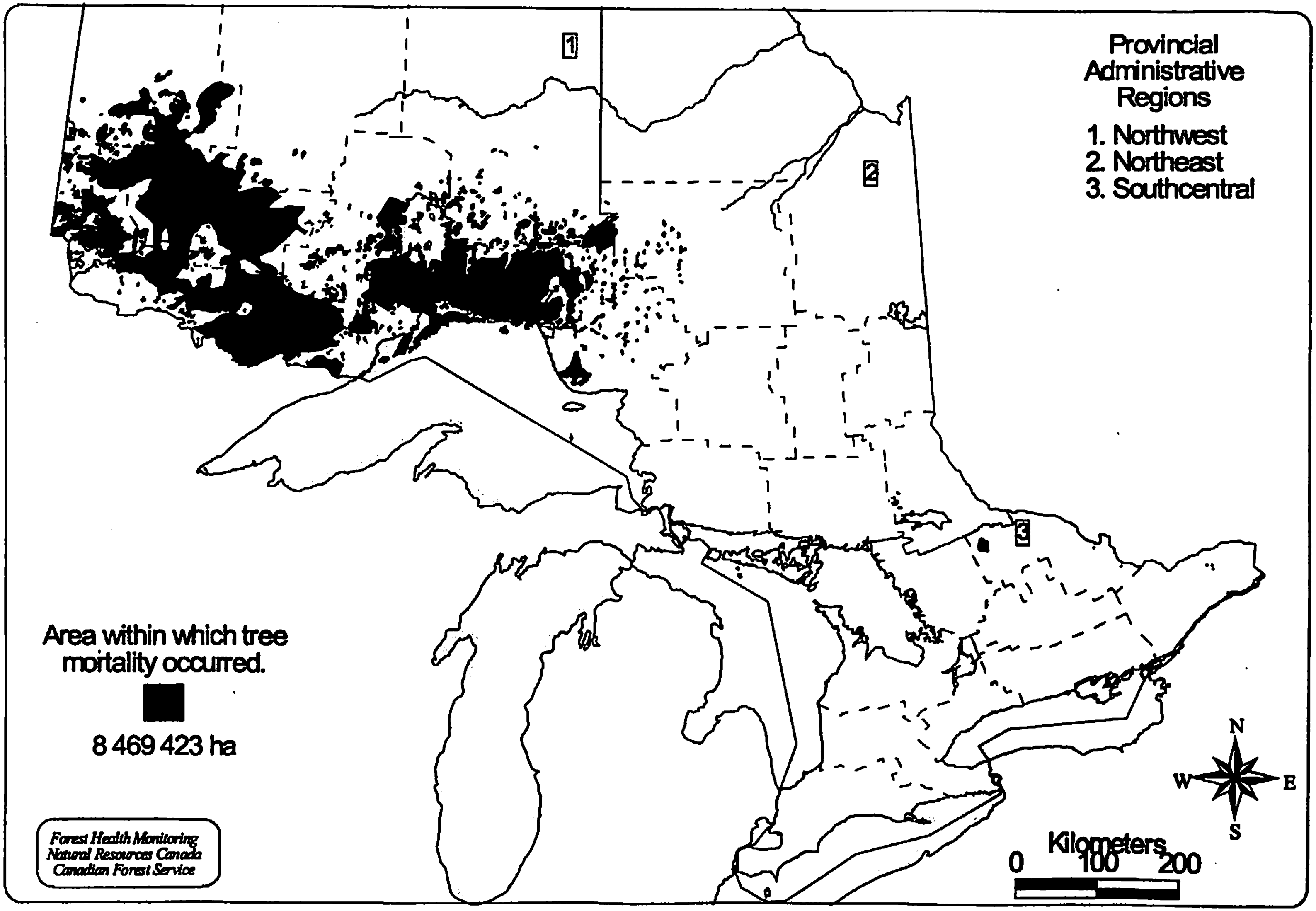


Figure 2. Eastern Spruce Budworm caused tree mortality in 1999.

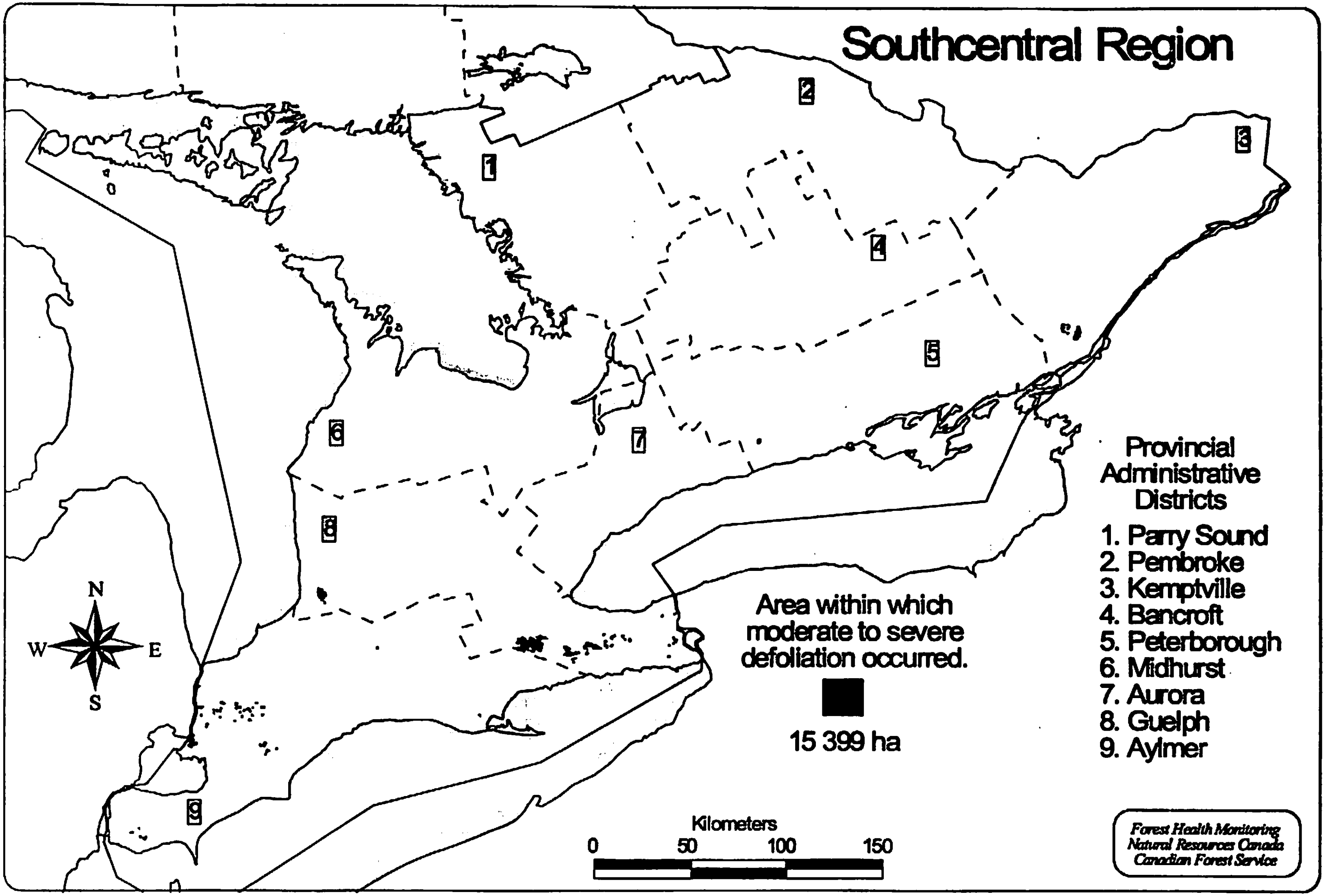


Figure 3. Gypsy Moth (*Lymantria dispar* L.) defoliation in 1999.

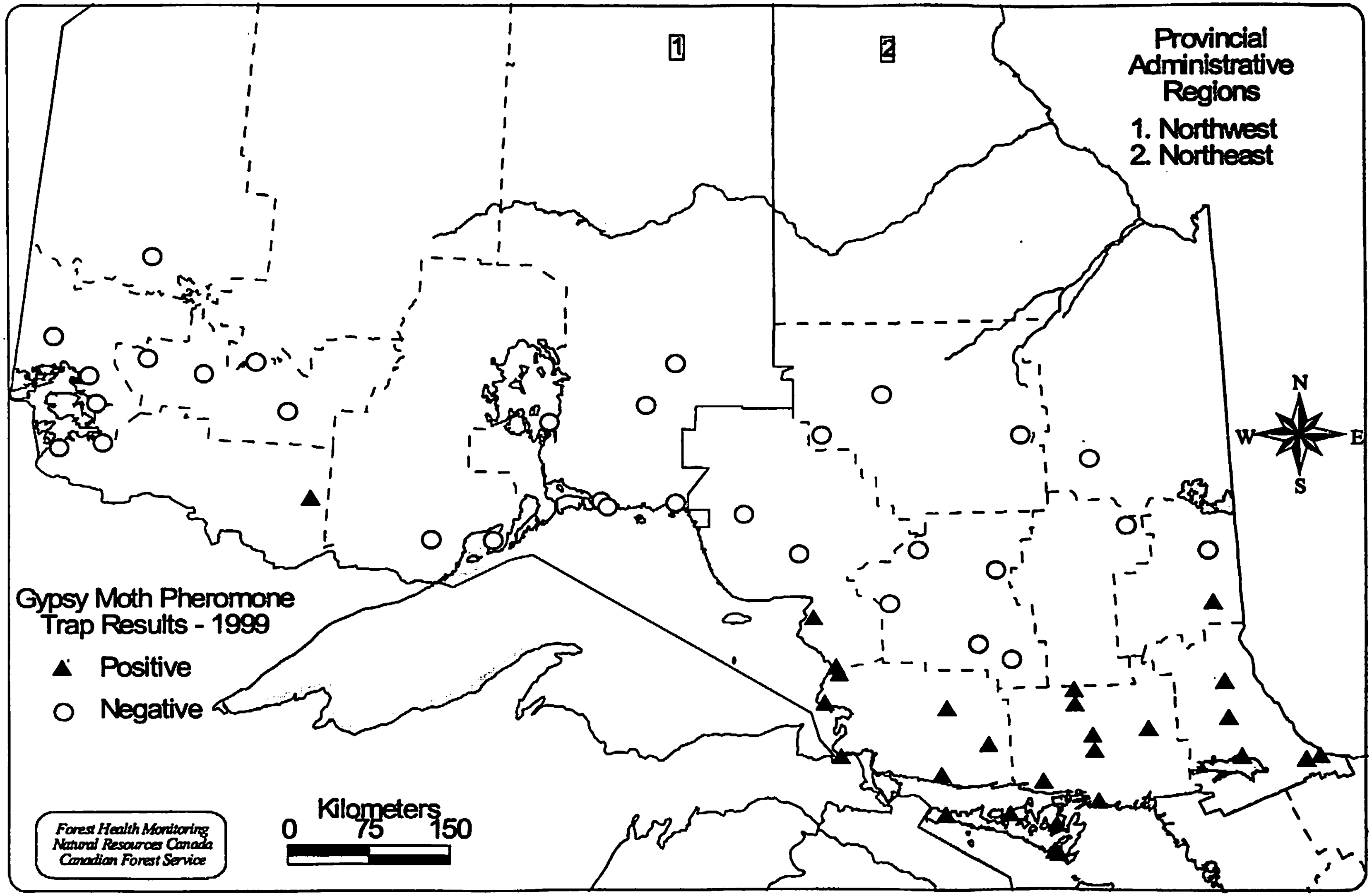


Figure 4. Results of the 1999 Gypsy Moth pheromone trapping program.

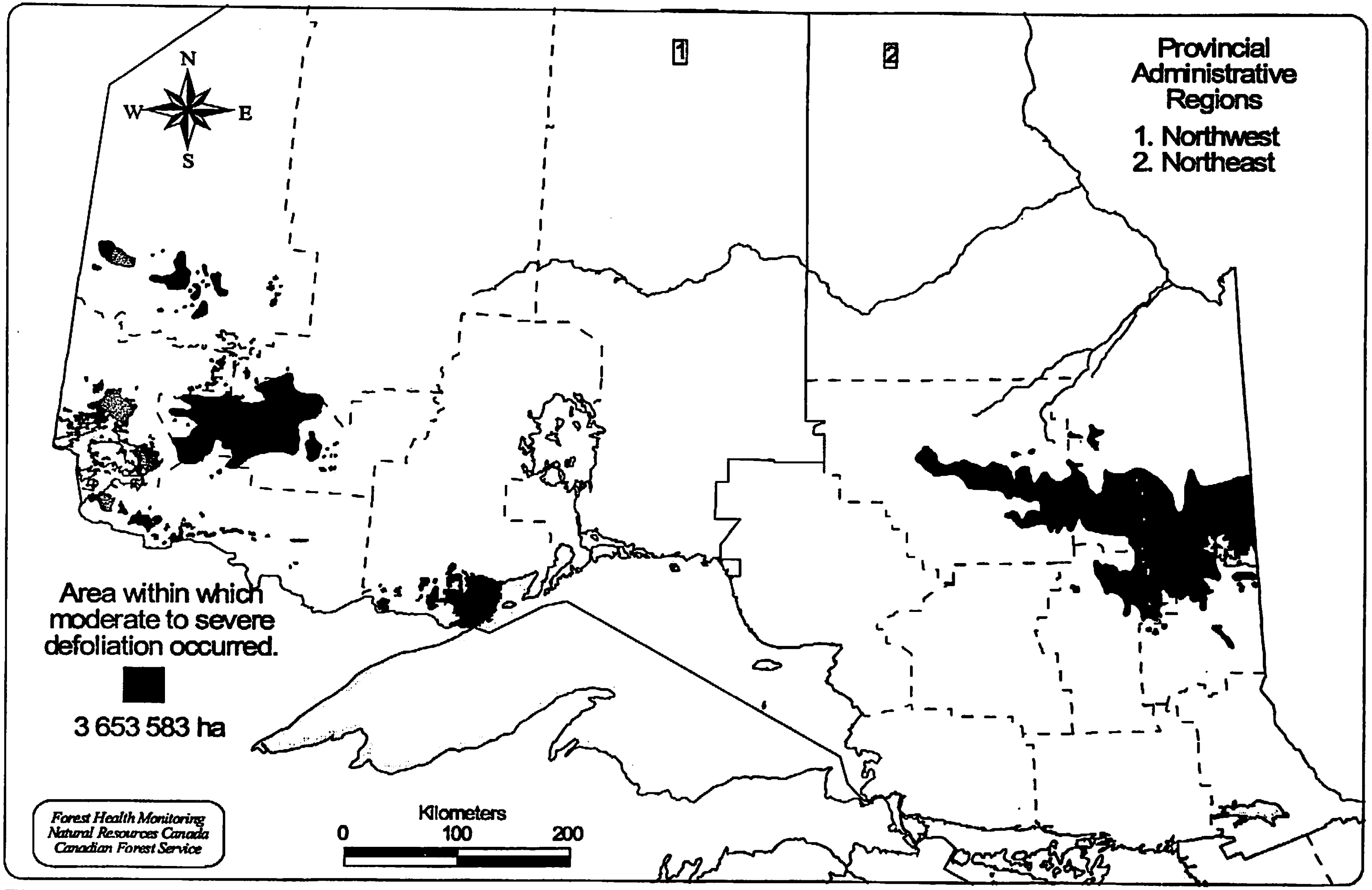


Figure 5. Forest Tent Caterpillar (*Malacosoma disstria* Hbn.) defoliation in 1999.

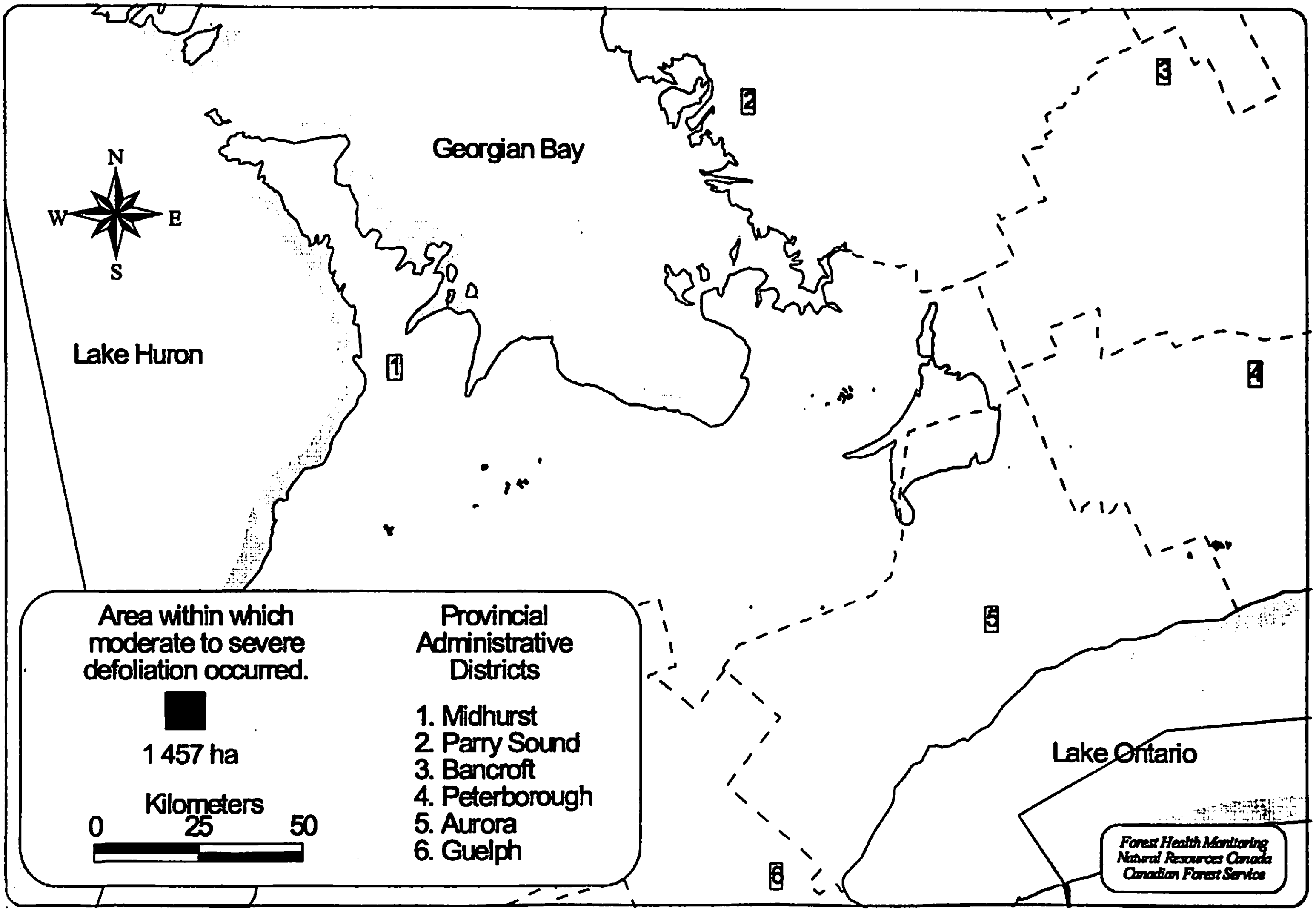


Figure 6. Pine False Webworm (*Acantholyda erythrocephala* L.) defoliation in 1999.

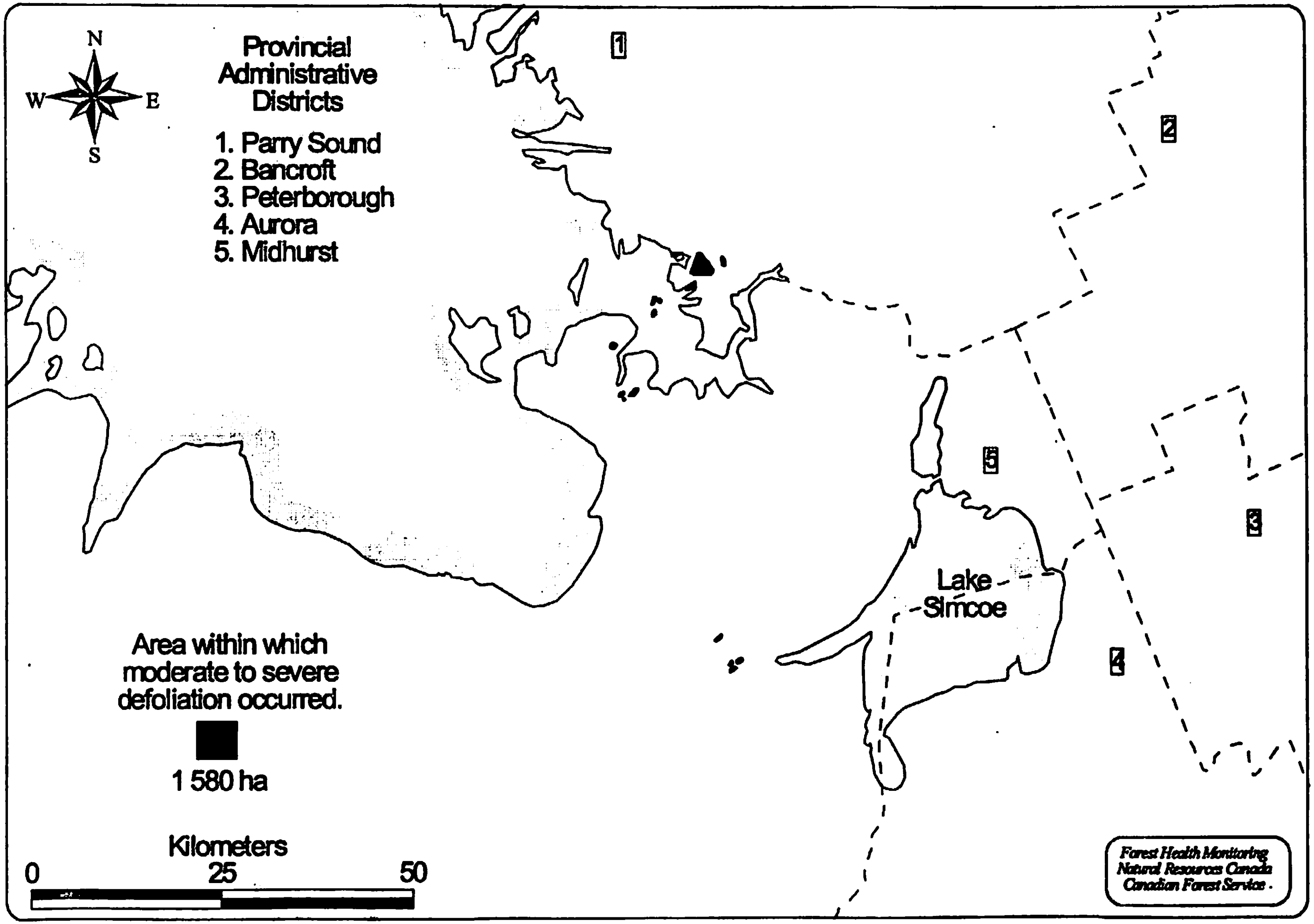


Figure 7. Oak leaf shredder (*Acleris semipurpurana* Kft.) defoliation in 1999.

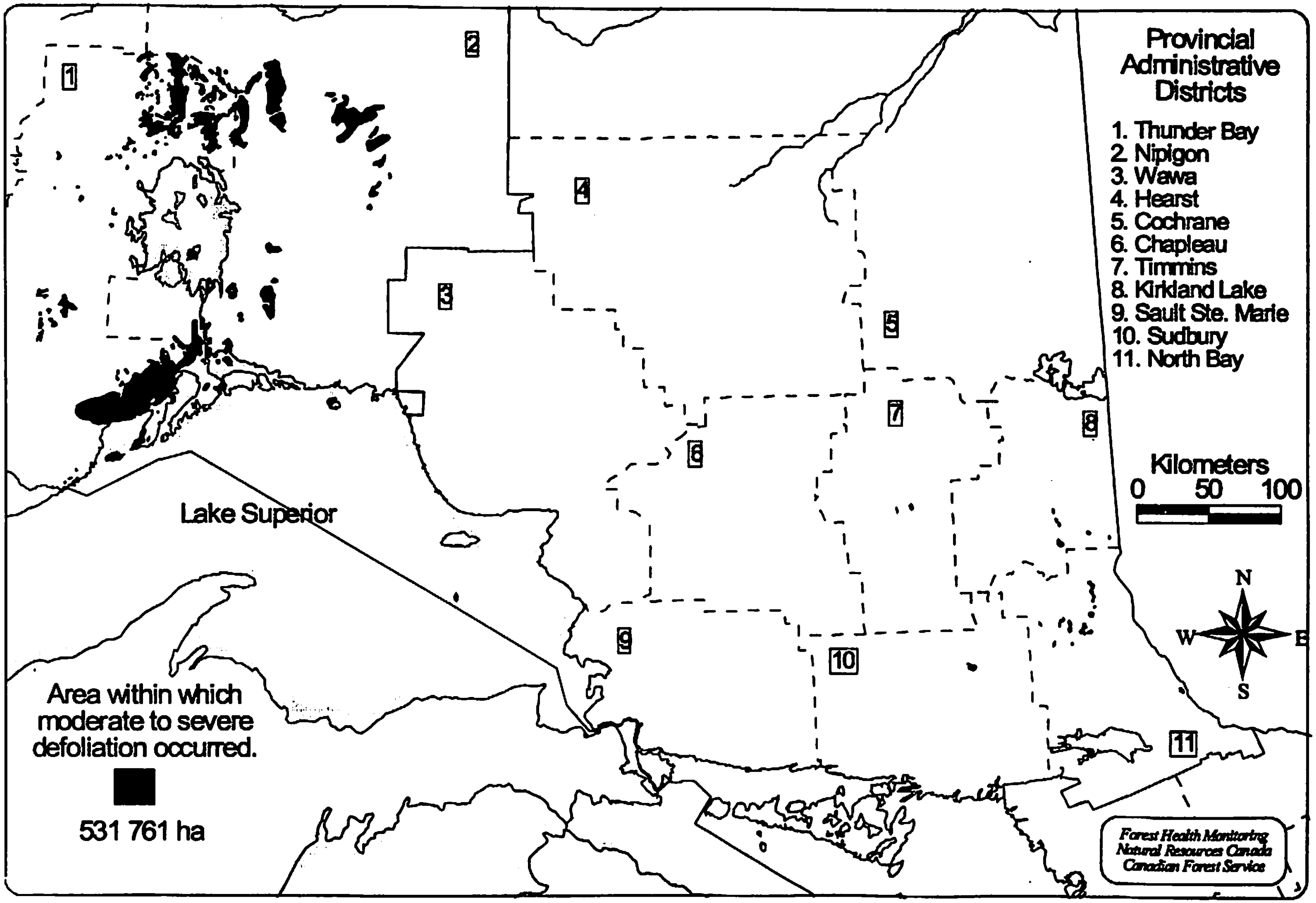


Figure 8. Large aspen tortrix (*Choristoneura conflictana* Wlk.) defoliation in 1999.

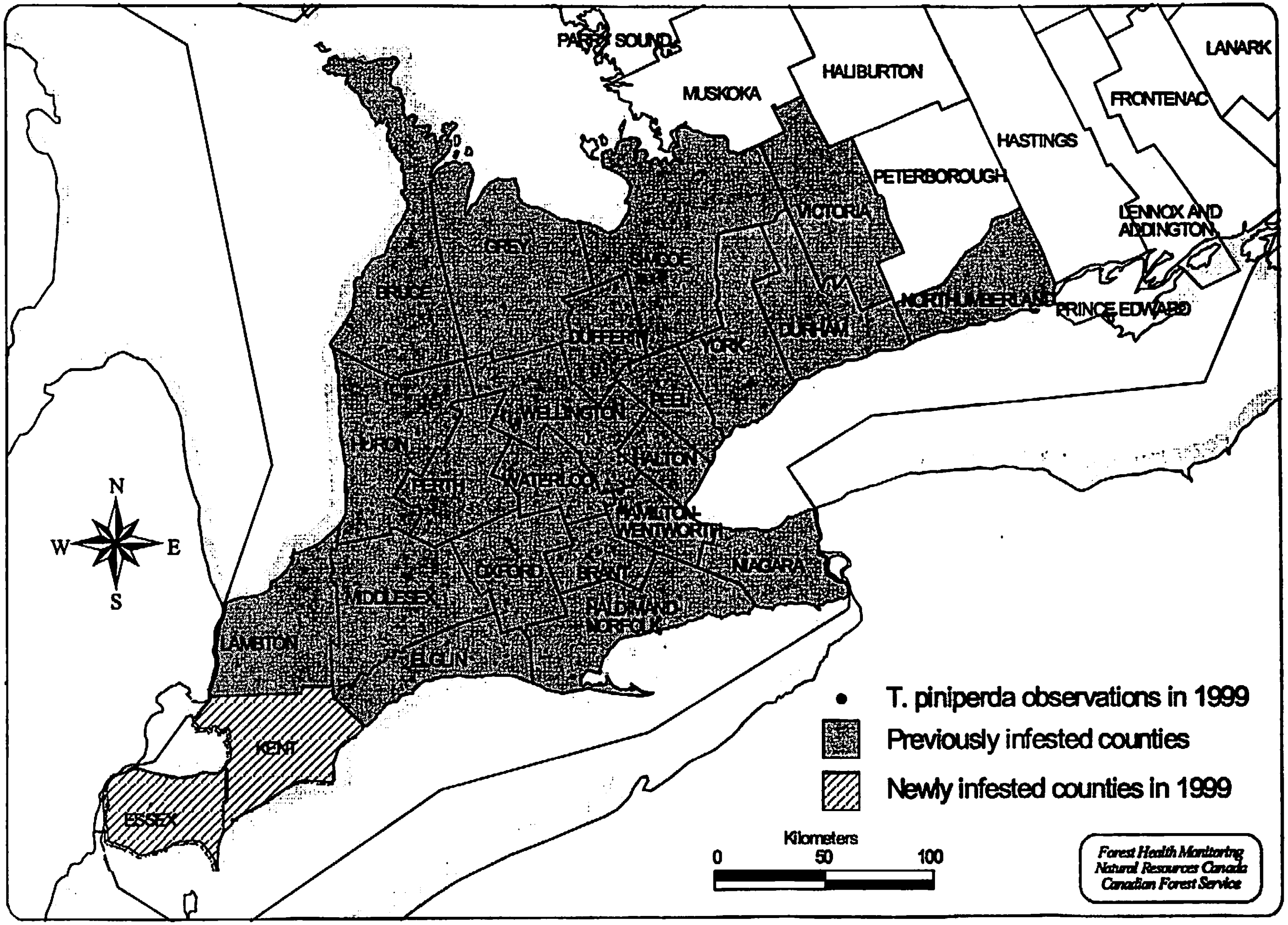


Figure 9. Locations of known damage by the pine shoot beetle (*Tomicus piniperda* [L.]) and infested couties in 1999.

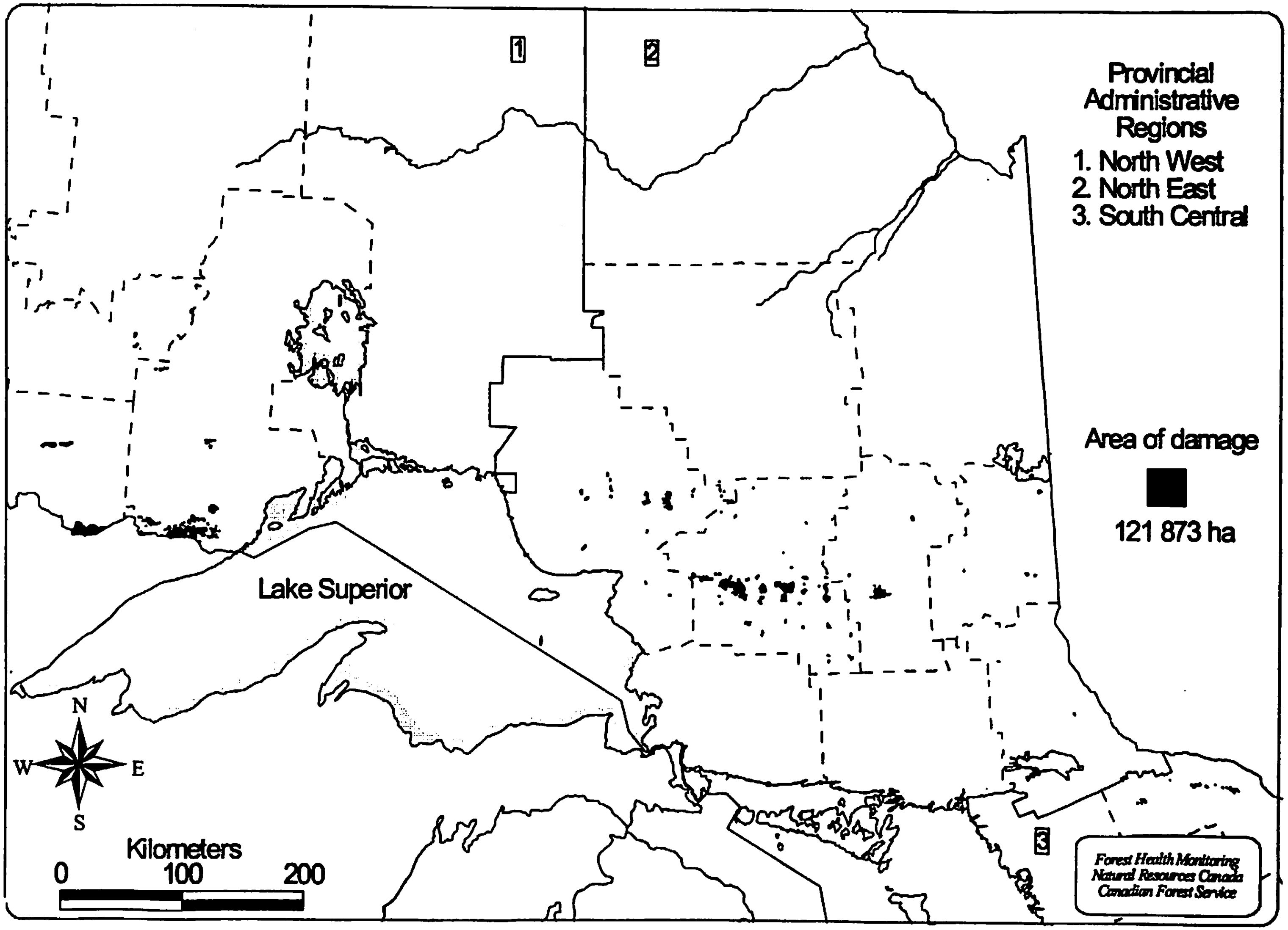


Figure 10. Blowdown damage in 1999.

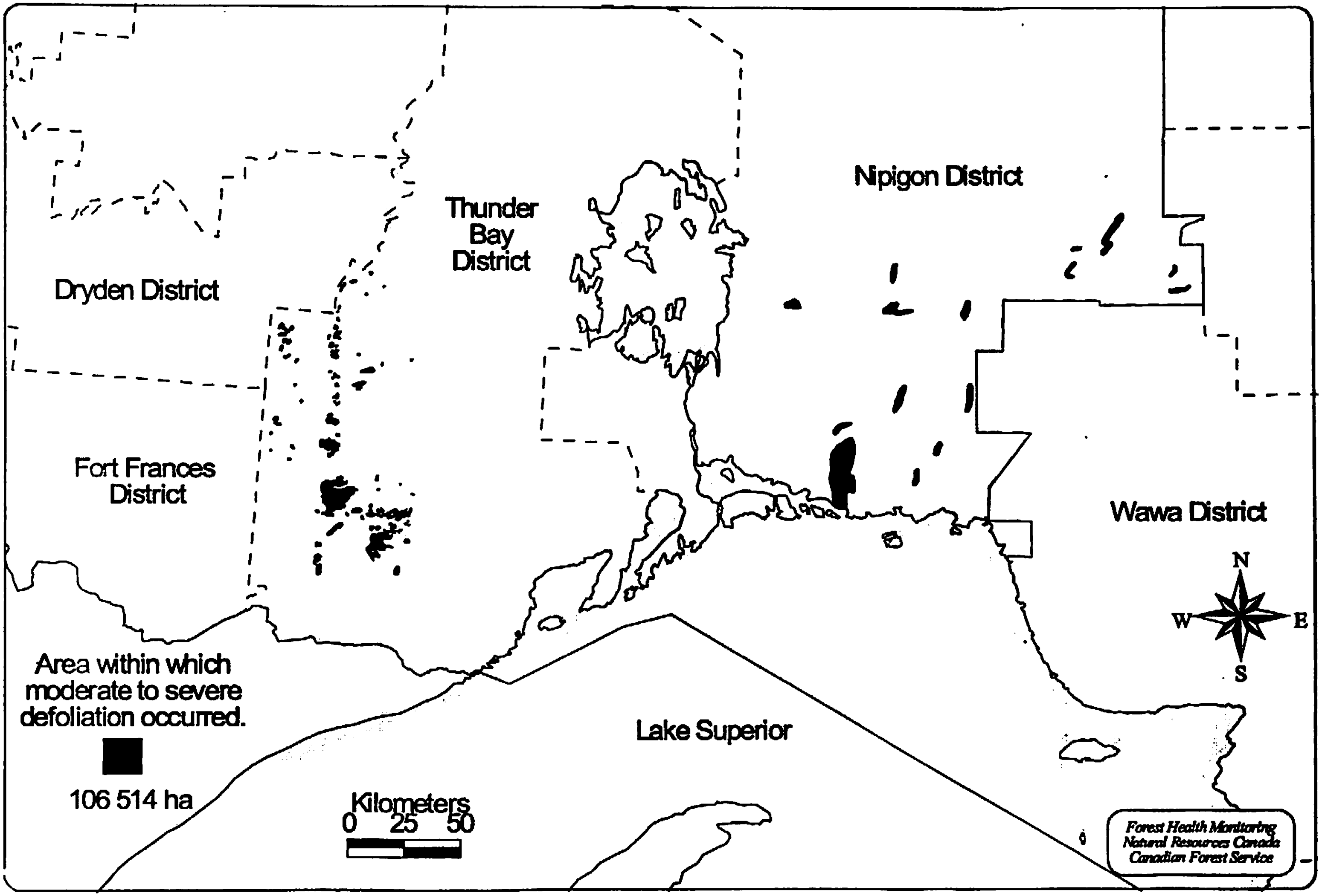


Figure 11. Aspen decline in 1999.

(Survey of Forest Insects and Diseases in Quebec in 1999)

Clément Bordeleau

Sommaire du Relevé des Insectes et des Maladies des Arbres au Québec en 1997

Quebec ministry of natural resources, forest conservation branch

In 1999, the principal insects defoliating evergreen forests were the spruce budworm and the hemlock looper, which caused considerably more damage than in 1998. In deciduous forests the main problem was the tent caterpillar, while at plantations the pine shoot beetle became a major concern. In the summer, there was also severe damage due to severe wind storms.

Here are the year's highlights:

- continued spread of the spruce budworm infestation in the Outaouais region, and expansion of the local infestations identified in 1998 in the regions of Central Quebec, the St Maurice Valley, the Eastern Townships, and Saguenay - Lac-Saint-Jean;
- spectacular increase in hemlock looper populations in the North Shore region;
- jack pine budworm populations endemic;
- regression of larch casebearer in most regions of Quebec;
- significant increase in tent caterpillar populations in the Abitibi - Témiscamingue region;
- gypsy moth endemic throughout nearly its entire range in the province;
- regression of the large aspen tortrix in the Eastern Townships and St Maurice Valley;
- damage cause by windfall in southern Quebec;
- detection of pine shoot beetle at plantations in southern Quebec;
- increased damage caused by white pine blister rust at plantations in the Central Quebec, Eastern Townships, Lanaudière and Laurentides regions.

Sommaire du Relevé des Insectes et des Maladies des Arbres au Québec en 1997

Clément Bordeleau

Quebec ministry of natural resources, forest conservation branch

RÉSUMÉ

La tordeuse des bourgeons de l'épinette et l'arpenteuse de la pruche ont été, en 1999, les principaux insectes défoliateurs des résineux. Les dégâts qu'ils ont causés ont connu une progression marquée par rapport à l'année dernière. Dans les forêts feuillues, la livrée des forêts a été le problème entomologique le plus important alors que dans les plantations, le grand hylésine des pins est devenu une préoccupation majeure. Quelques tempêtes de vents violents ont également entraîné de graves dommages à l'été 1999.

Les principaux faits marquants ont été :

- la progression continue de l'infestation de la tordeuse des bourgeons de l'épinette dans la région de l'Outaouais ainsi que l'expansion des infestations locales relevées l'an dernier dans les régions du Centre-du-Québec, de la Mauricie, de l'Estrie et du Saguenay–Lac-Saint-Jean ;
- la progression spectaculaire de l'infestation de l'arpenteuse de la pruche dans la région de la Côte-Nord ;
- l'état endémique des populations de la tordeuse du pin gris ;
- la régression des populations du porte-case du mélèze dans la plupart des régions du Québec ;
- l'augmentation importante des populations de la livrée des forêts dans la région de l'Abitibi-Témiscamingue ;
- le niveau endémique des populations de la spongieuse dans la majorité de l'aire de distribution de l'insecte au Québec ;
- la régression des populations de la tordeuse du tremble dans les régions de l'Estrie et de la Mauricie ;
- les dégâts causés par les chablis dans le sud du Québec ;
- la détection du grand hylésine des pins dans les plantations du sud du Québec ;
- l'aggravation des dommages causés par la rouille vésiculeuse du pin blanc dans les plantations du Centre-du-Québec, de l'Estrie, de Lanaudière et des Laurentides.

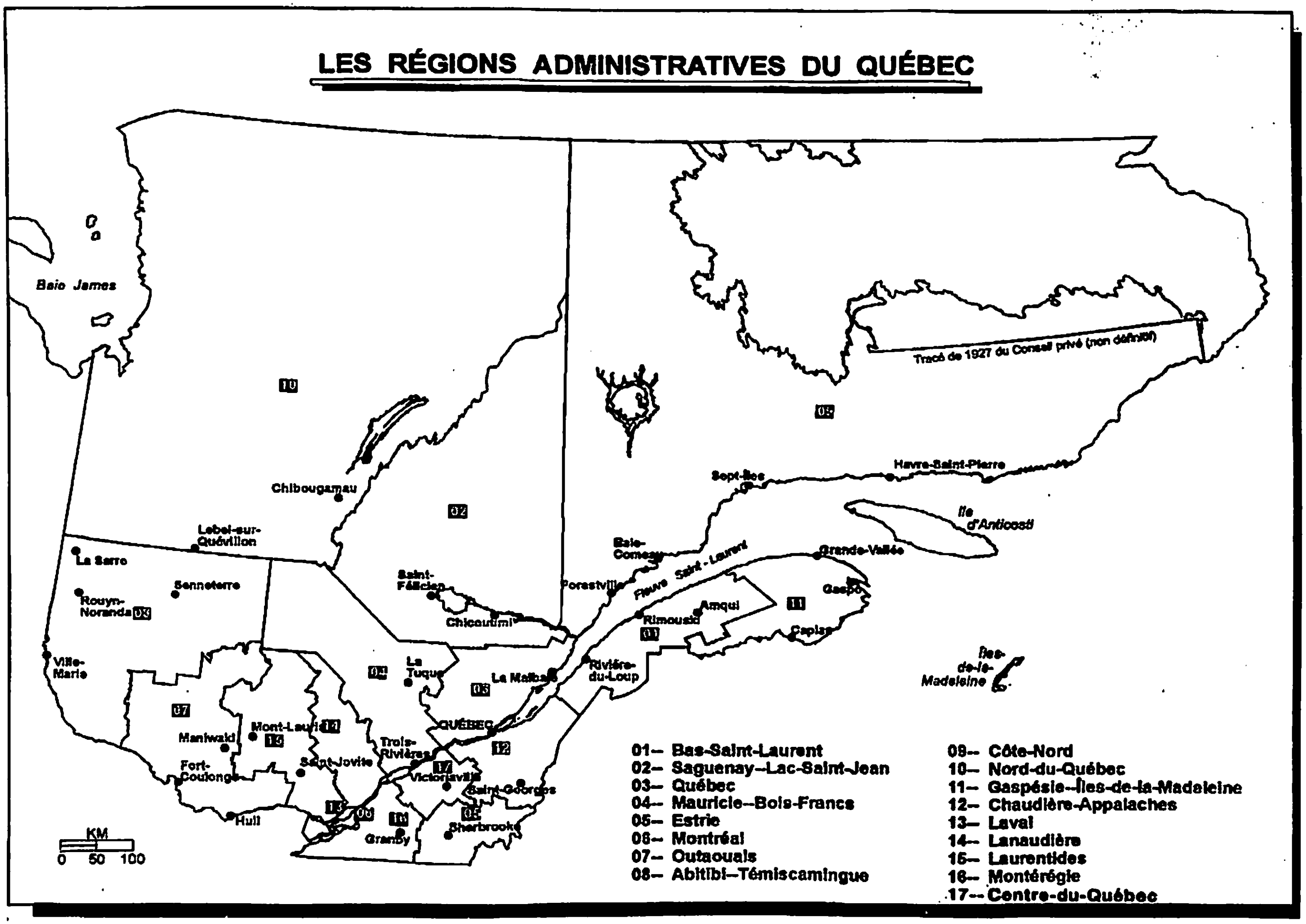
SOMMAIRE DU RELEVÉ DES INSECTES ET DES MALADIES DES ARBRES AU QUÉBEC EN 1999

PAR
CLÉMENT BORDELEAU

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 16 au 17 novembre 1999

Carte 1 - Régions administratives du Québec



PROGRAMME DE SURVEILLANCE DANS LES FORÊTS NATURELLES

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

INFESTATION

L'infestation de la tordeuse des bourgeons de l'épinette a connu une progression notable en 1999. Les superficies affectées par l'insecte couvrent près de 23 000 ha, soit un peu plus du double de celles de l'année dernière (Tableau 1, Carte 2). Les dégâts se sont avérés modérés ou graves sur près de 89 % de la superficie défoliée. L'accroissement des aires infestées est majoritairement attribuable à l'expansion de l'épidémie à l'intérieur du périmètre de la zone infestée en 1998 dans la région de l'Outaouais. Les foyers recensés dans les autres régions du Québec n'ont par contre que légèrement progressé par rapport à l'an dernier.

Tableau 1 - Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette au Québec en 1999

Régions administratives	Niveaux de défoliation			Total
	Léger	Modéré	Grave	
Saguenay-Lac-Saint-Jean	223 (70)[1]	0 (0)	42 (0)	265 (70)
Centre-du-Québec	33 (0)	16 (11)	197 (122)	246 (133)
Mauricie	42 (37[2])	140 (0)	45 (0)	227 (37)
Estrie	0 (7)	0 (0)	27 (10)	27 (17)
Outaouais	2 334 (1 128)	3 682 (2 238)	16 185 (7 116)	22 201 (10 482)
Total	**2 632** (1 242)	**3 838** (2 249)	**16 496** (7 248)	**22 966** (10 739)

( )[1] = Superficies affectées en 1998
[2] = Dégâts très faibles

En Outaouais, les défoliations sont demeurées majoritairement concentrées au sud de la région, soit à l'intérieur d'un secteur délimité par les municipalités de Fort-Coulonge, Maniwaki et Buckingham. L'infestation n'a que légèrement progressé au nord et à l'est de la zone infestée en 1998. Les dégâts ont été plus étendus et plus intenses dans le bassin de la rivière Gatineau (lacs Sainte-Marie, Kazabazua, Venosta, Martindale), sur l'Île-du-Grand-Calumet ainsi qu'aux environs des localités de

Schwartz et Ladysmith. Les infestations relevées dans les régions du Centre-du-Québec (sanctuaire de Drummondville), de la Mauricie (parc national de la Mauricie, Saint-Rock-de-Mékinac), de l'Estrie (Compton) et du Saguenay–Lac-Saint-Jean (Jonquière) sont demeurées locales, même si les superficies infestées se sont accrues par rapport à 1998.

PRÉVISIONS

L'inventaire des larves en hibernation (L2) a été réalisé dans quelque 425 sites répartis dans toute la province. Les résultats partiels indiquent que l'épidémie demeurera majoritairement confinée à l'intérieur de la zone d'infestation de la région de l'Outaouais, soit à l'intérieur du périmètre délimité par les municipalités de Fort-Coulonge, Maniwaki et Buckingham (Cartes 3 et 4). Bien que le niveau des populations prévu y soit à la baisse comparativement à 1999, des dégâts importants sont encore anticipés dans plusieurs secteurs, dont ceux localisés le long de la rivière Gatineau et au nord-ouest du parc de la Gatineau. Les foyers localisés dans les régions de l'Estrie, de la Mauricie, du Centre-du-Québec et du Saguenay–Lac-Saint-Jean seront affectés gravement l'an prochain. Aucune expansion majeure de ces infestations locales n'est cependant prévue pour 2000. Dans toutes les autres régions du Québec, le niveau des populations de la tordeuse demeure très faible.

ARPENTEUSE DE LA PRUCHE
Lambdina fiscellaria (Guen.)

INFESTATION

L'infestation de l'arpenteuse de la pruche détectée l'année dernière dans la région de la Côte-Nord a connu une progression spectaculaire en 1999. Par contre, le seul foyer encore actif en 1998 sur l'île d'Anticosti s'est complètement résorbé cette année. Dans les autres régions du Québec, les populations de l'insecte sont demeurées à l'état endémique.

Les aires affectées par l'arpenteuse sur la Basse Côte-Nord couvrent plus de 472 000 hectares, soit une superficie près de 18 fois plus étendue qu'en 1998 (Tableau 2). Des défoliations ont été relevées de la rivière Matamec jusqu'à Saint-Augustin (Carte 5). L'invasion la plus destructrice rapportée antérieurement sur la rive nord du Saint-Laurent avait sévi entre 1927 et 1930 ; les superficies endommagées par l'insecte avaient alors été estimées à 38 300 hectares. Les aires infestées se situaient dans la partie sud des bassins des rivières Manicouagan, Godbout et de la Trinité.

Tableau 2 - Superficies (ha) affectées par l'arpenteuse de la pruche au Québec en 1999

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Grave	
Côte-Nord	2 170 (2 600)[1]	18 775 (6 006)	451 194 (18 344)	472 139 (26 950)

( )[1] = Superficies affectées en 1998

Les dommages s'avèrent graves sur l'ensemble des territoires infestés en 1999. L'arpenteuse a causé la destruction totale du feuillage dans la majorité des sapinières touchées, et ce, même dans les zones qui subissaient une première année d'attaque. La présence de mortalité de sapins dans les peuplements gravement défoliés a été relevée sur quelque 302 000 hectares.

L'expansion de l'épidémie s'est principalement produite à l'est de la rivière Natashquan ; une vaste zone s'étendant du lac Musquaro au lac Robertson a gravement été endommagée par l'arpenteuse. Plusieurs autres foyers de pullulation de l'insecte ont également été relevés à l'est de ce territoire, soit majoritairement dans les bassins des rivières Saint-Augustin nord-ouest et Saint-Augustin. D'autres progressions importantes de l'infestation ont été enregistrées entre les bassins des rivières Natashquan et Aguanish, ceux des rivières Nabisipi et Washishou, ainsi que ceux des rivières Mingan, Saint-Jean et Magpie. Finalement, quelques nouveaux petits foyers sont apparus entre les rivières Matamec et Sheldrake.

PRÉVISIONS

Un relevé des œufs a été effectué à l'automne par le ministère des Ressources naturelles du Québec (MRNQ) et par la Société de protection des forêts contre les insectes et les maladies (SOPFIM). Une centaine de sites ont été échantillonnés par le MRNQ dans l'est du Québec, alors que la SOPFIM a concentré ses efforts d'échantillonnage dans les secteurs infestés où la ressource ligneuse a été allouée ou pourrait être allouée à différents utilisateurs. Un plan d'intervention sera préparé, si nécessaire, afin de limiter les dégâts en 2000. Le MRNQ examine également la possibilité de mettre en place un programme de récupération des bois affectés.

PORTE-CASE DU MÉLÈZE
Coleophora laricella (Hbn.)

La présence du porte-case du mélèze a été signalée encore cette année dans la majorité des régions du Québec. Le niveau des populations a généralement baissé par rapport à 1998, sauf dans les régions de la Mauricie et de Québec où les dommages se sont maintenus ou ont augmenté.

Les infestations ont complètement chuté en 1999 dans les régions de l'Abitibi-Témiscamingue et du Bas-Saint-Laurent. Dans les régions de l'Outaouais, des Laurentides, de Chaudière-Appalaches, du Saguenay–Lac-Saint-Jean et de la Gaspésie–Îles-de-la-Madeleine, le porte-case est toujours présent mais la gravité des dégâts s'est fortement atténuée. Des défoliations graves ont encore été relevées localement dans les régions de la Mauricie et de Québec alors que l'on observait, pour une première année, des dégâts dans les régions de la Montérégie et de l'Estrie.

TORDEUSE DU PIN GRIS
Choristoneura pinus pinus Free.

Les populations de la tordeuse du pin gris sont restées à l'état endémique dans la totalité des foyers d'infestations qui avaient été rapportés au cours des dernières années dans la région de l'Outaouais. Ce défoliateur a complètement disparu du dernier foyer qui était localisé dans la municipalité de Kazabazua. Un relevé des larves en hibernation a été réalisé dans 19 sites du réseau de surveillance installé dans l'ouest de la province. Les résultats indiquent que les populations de la tordeuse du pin gris continueront à se maintenir à un niveau endémique en 2000.

TORDEUSE DU MÉLÈZE
Zeiraphera improbana (Wlk.)

Des dégâts importants ont été causés cette année par la tordeuse du mélèze dans les régions de la Côte-Nord et de la Gaspésie–Îles-de-la-Madeleine.

Sur la Côte-Nord, des défoliations modérées à graves ont été observées entre les Escoumains et Sainte-Anne-de-Portneuf, entre les rivières Moisie et Matamec, entre Longue-Pointe-de-Mingan et Rivière-au-Tonnerre ainsi que sur l'île d'Anticosti. Des défoliations légères à graves ont été relevées dans toute la région de la Gaspésie–Îles-de-la-Madeleine, mais les peuplements affectés couvrent généralement moins de 5 hectares. Les dommages ont été particulièrement graves au sud du parc de la Gaspésie et de Murdockville ainsi qu'à l'extrémité est de la péninsule gaspésienne.

LIVRÉE DES FORÊTS
Malacosoma disstria Hbn.

INFESTATION

L'infestation relevée en 1999 dans la région de l'Abitibi-Témiscamingue a couvert 169 000 hectares (Tableau 3, Carte 6). Le peuplier faux-tremble a subi des défoliations variant principalement de légères à modérées. L'épidémie a surtout affecté quatre grands secteurs qui s'étendent d'Amos à Saint-Dominique-du-Rosaire, de Barraute jusqu'au nord du lac Quévillon, autour du lac Abitibi et au sud-ouest de Rouyn-Noranda. La présence de l'insecte a également été relevée en quelques endroits autour du lac Saint-Jean et dans la région de l'Outaouais, sans toutefois causer de défoliations notables.

Tableau 3 – Superficies (ha) affectées par la livrée des forêts en Abitibi-Témiscamingue, en 1999

Région administrative	Niveaux de défoliation			Total
	Léger	Modéré	Grave	
Abitibi-Témiscamingue	74 702	85 293	9 263	169 258

PRÉVISIONS

Les résultats partiels du relevé des œufs qui a été effectué indiquent que les dégâts seront beaucoup plus intenses dans l'ouest de la province en 2000.

SPONGIEUSE
Lymantria dispar (L.)

Cette année encore, les populations de la spongieuse sont généralement demeurées à un niveau endémique dans l'ensemble de l'aire de distribution québécoise de cet insecte. Ce défoliateur a été détecté plus fréquemment en Montérégie et dans l'Outaouais, mais les dégâts sont demeurés peu importants. Ils ont été généralement légers dans l'ensemble des aires où l'insecte a été détecté. Des défoliations graves n'ont été relevées que dans deux localités situées dans la région des Laurentides.

ARPENTEUSE DE BRUCE
Operophtera bruceata Hulst
ARPENTEUSE D'AUTOMNE
Alsophila pometaria Harr.

Les dégâts causés par ces défoliateurs hâtifs des érablières ont été plus sporadiques cette année qu'en 1998. Ils ont généralement été circonscrits aux foyers d'infestation recensés au cours des dernières années.

Les populations de l'arpenteuse de Bruce ont presque complètement disparu dans l'ensemble de la province. De faibles dégâts n'ont été rapportés que dans cinq sites de la région du Bas-Saint-Laurent. Une baisse généralisée des populations de l'arpenteuse d'automne a également été observée dans la plupart des régions en 1999. L'insecte a encore causé localement des défoliations légères à modérées dans la région de l'Outaouais.

TORDEUSE DU TREMBLE
Choristoneura conflictana (Wlk.)

Les populations de la tordeuse du tremble ont régressé dans la majorité des foyers recensés l'année dernière. Les dégâts sont généralement limités à de petites superficies. Des défoliations ont toutefois été relevées pour une quatrième année consécutive dans la région de l'Estrie, alors que de nouveaux foyers étaient détectés dans la région de l'Outaouais. Les infestations localisées dans les régions de la Mauricie ont chuté cette année. Un petit foyer d'infestation grave a finalement été relevé dans la région des Laurentides.

Dans la région de l'Estrie, seulement quelques îlots d'une superficie de 1 à 5 hectares, dans les secteurs de Barnston, Woburn et Sherbrooke, ont subi des défoliations variant de légères à modérées. Dans celle de l'Outaouais, des dégâts variant de légers à graves ont été relevés aux environs de Val-des-Bois, Notre-Dame-de-la-Salette, Thorne-Centre, du lac Murray et de Gracefield.

PORTE-CASE DU BOULEAU
Coleophora serratella (L.)

La régression des populations du porte-case du bouleau, qui avait été observée au cours des deux dernières années dans le centre et dans l'est de la province, s'est poursuivie en 1999. Celles-ci ont continué de se résorber dans l'ensemble des régions affectées, soit en Mauricie, au Saguenay–Lac-Saint-Jean, sur la Côte-Nord, dans le Bas-Saint-Laurent et dans la Gaspésie–Îles-de-la-Madeleine.

Dans la région du Saguenay–Lac-Saint-Jean, des dégâts ont toutefois été observés dans les bassins des rivières Mistassini et Mistassibi (légers à modérés) ainsi que près de Dolbeau et du lac Gray (modérés à graves). Les défoliations se sont atténuées dans le bassin de la rivière Saguenay; quelques îlots de dégâts légers ont été relevés au lac Huard, à Rivière-Éternité et à Saint-Félix-d'Otis.

DÉGÂTS CLIMATIQUES

Quelques tempêtes de vents violents se sont abattues sur le sud du Québec au cours de l'été. Au début juin, plusieurs petits chablis furent signalés dans les régions du Bas-Saint-Laurent et des Laurentides. En début juillet, les régions de l'Estrie, des Laurentides et de la Montérégie ont également été balayées par de forts vents. Les pires dommages ont été observés dans un triangle d'une cinquantaine d'hectares délimité par le lac Nominingue et les municipalités de l'Ascension et de l'Annonciation dans la région des Laurentides. Un territoire couvrant un peu plus d'une quarantaine d'hectares (cantons Arundel et Harrington) a également été fortement endommagé dans cette dernière région. Deux tornades ont aussi frappé la région de l'Outaouais en juillet. Quatre zones (lacs Subb, Galarneau, Forant et Malone) d'une superficie d'environ 150 hectares ont été très endommagées alors que sur l'Île-aux-Alumettes, les arbres furent déracinés sur une distance d'au moins 20 kilomètres, près de Desjardinsville.

Le printemps hâtif et sec a favorisé le développement précoce du feuillage de certaines essences comme les peupliers. Une chute considérable de la température survenue à la mi-mai a entraîné la gelure du feuillage. Les peupliers faux-tremble des régions du Bas-Saint-Laurent, de la Gaspésie–Îles-de-la-Madeleine et de la Côte-Nord ont été particulièrement affectés.

PROGRAMME DE SURVEILLANCE DANS LES PLANTATIONS

GRAND HYLÉSINE DES PINS
Tomicus piniperda (L.)

Le grand hylésine des pins a été signalé pour la première fois au Québec en 1998 dans les localités de Saint-Malo et de La Patrie, en Estrie. Cette année, on a exercé une surveillance accrue dans les régions qui bordent la frontière américaine et dans la plupart des localités où des usines importent du pin des États-Unis. Pour mener à bien ce programme de détection, réalisé en collaboration avec l'Agence canadienne d'inspection des aliments, on a installé près de 200 pièges attractifs sur l'ensemble du territoire « à risque ». Les pièges ont été judicieusement répartis dans les plantations de pins, les cours à bois des usines de transformation et les différents points d'entrée du bois importé. On a ainsi capturé des hylésines dans une cinquantaine de sites localisés dans 27 municipalités réparties dans huit municipalités régionales de comté (MRC) du sud du Québec, soit depuis la MRC du Granit jusqu'à celle de Brome-Missisquoi (Carte 7). Des dommages n'ont été perceptibles que dans un site, soit une plantation mixte dans laquelle on retrouve du pin sylvestre, du pin rouge et du pin blanc. Le pin sylvestre est âgé d'un peu plus d'une quarantaine d'années et il a été fortement endommagé par le verglas de 1998. Un dispositif a été installé dans cette plantation afin de suivre l'impact du grand hylésine.

CHARANÇON DU PIN BLANC
Pissodes strobi (Peck)

Les données actuelles ne laissent pas entrevoir de changements importants quant au nombre de plantations qui pourraient être atteintes par le charançon du pin blanc en 1999. Certaines indications nous laissent cependant appréhender une légère augmentation des dommages dans les plantations d'épinettes de Norvège établies dans l'est du Québec.

DIPRION DE LECONTE
Neodiprion lecontei (Fitch)

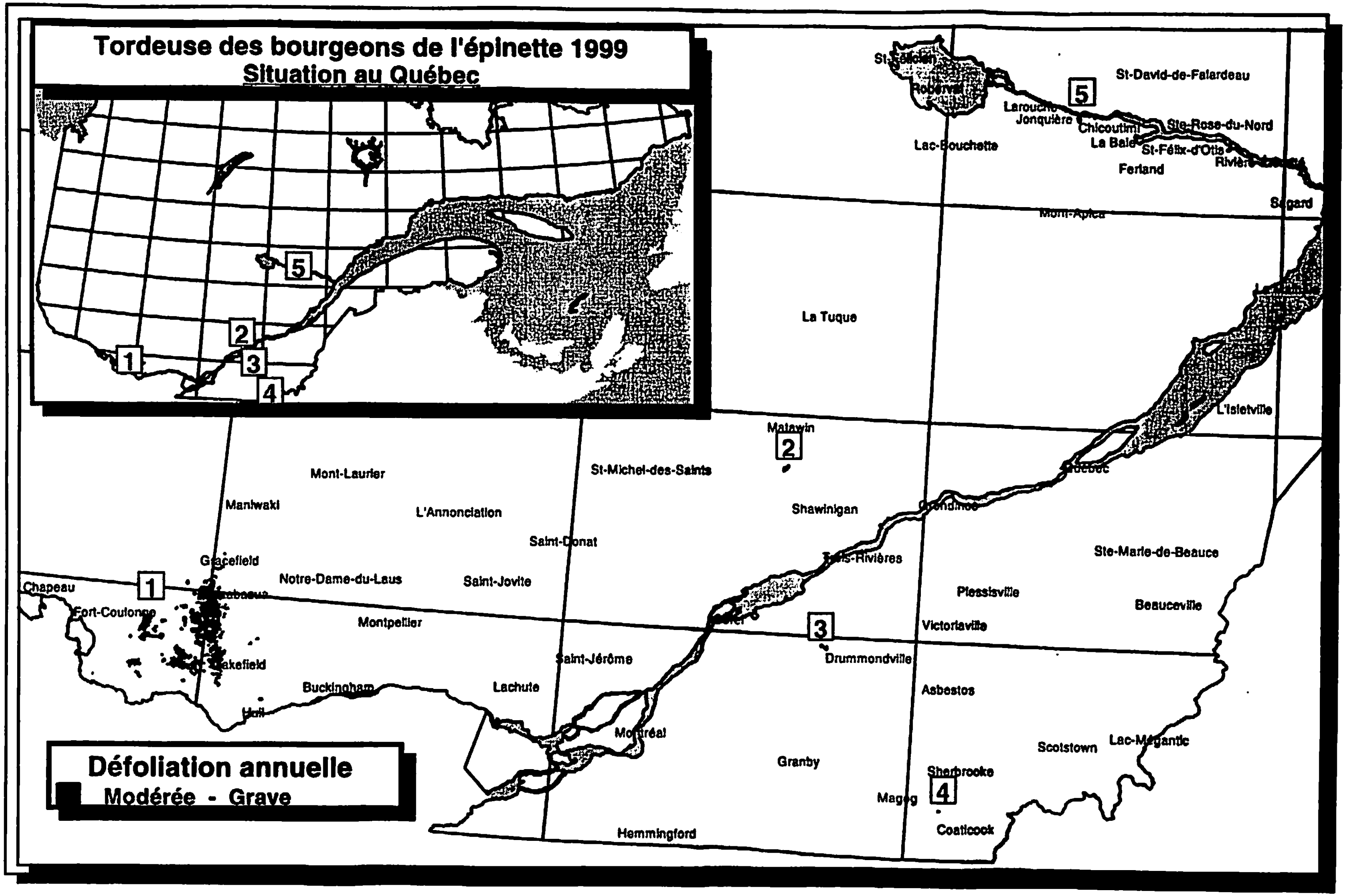
En 1999, on a relevé le diprion de LeConte dans un plus grand nombre de plantations de pins rouges des régions de l'Estrie et du Centre-du-Québec comparativement à 1998. Toutefois, les dommages causés par l'insecte ont généralement été faibles. À proximité de Drummondville, on a traité une plantation gravement atteinte à l'aide du virus de la polyédrose nucléaire (Lecontvirus^MD^).

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

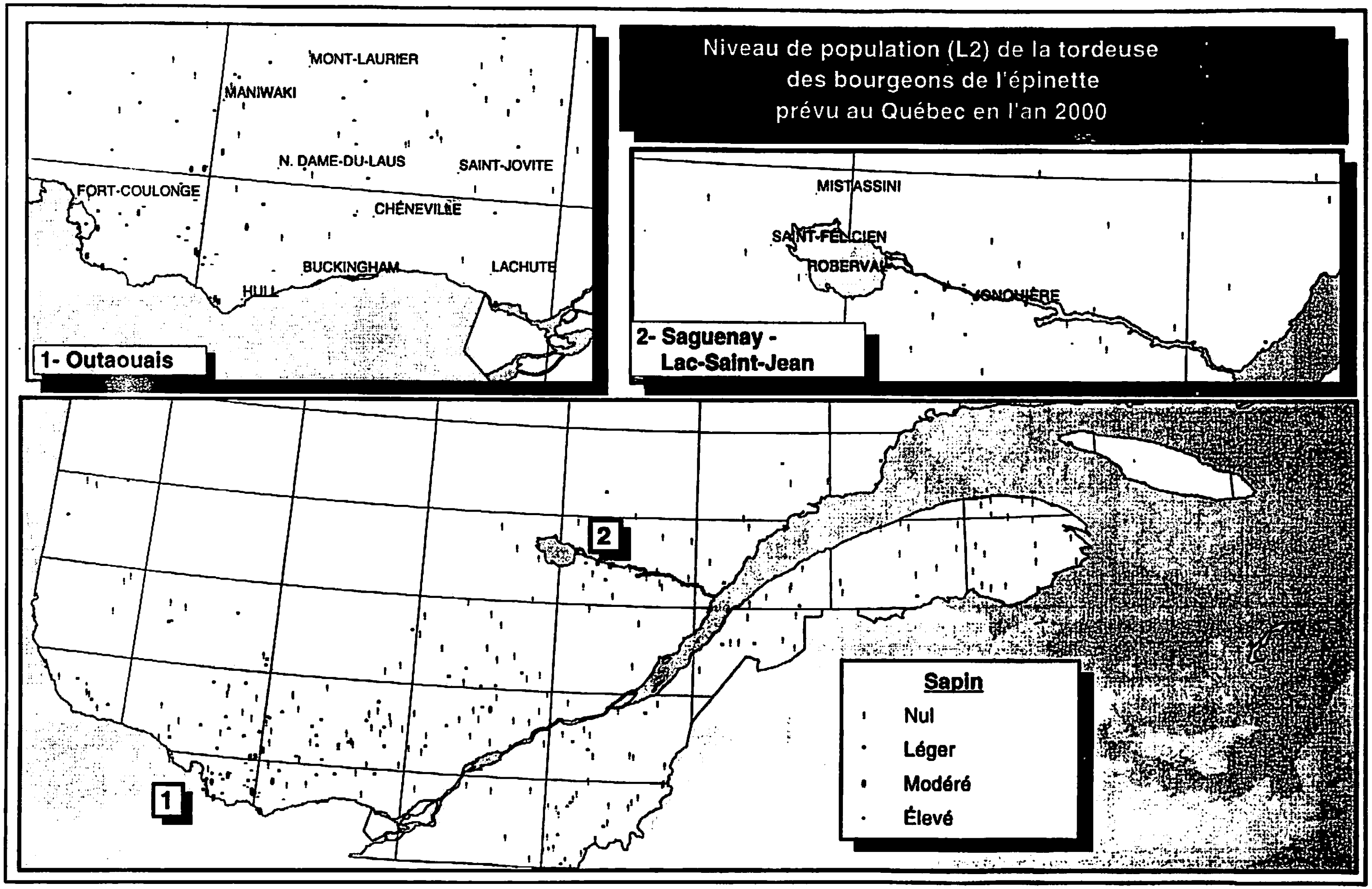
Les données recueillies jusqu'à la mi-août indiquent que les dommages causés par la tenthrède à tête jaune ont été négligeables dans la majorité des régions. Quelques petits foyers d'infestation ont persisté dans les régions de Chaudière-Appalaches, du Bas-Saint-Laurent et de la Gaspésie–Îles-de-la-Madeleine, alors que quelques nouvelles infestations étaient décelées dans les régions des Laurentides et du Saguenay–Lac-Saint-Jean.

ROUILLE VÉSICULEUSE DU PIN BLANC
Cronartium ribicola J.C. Fish

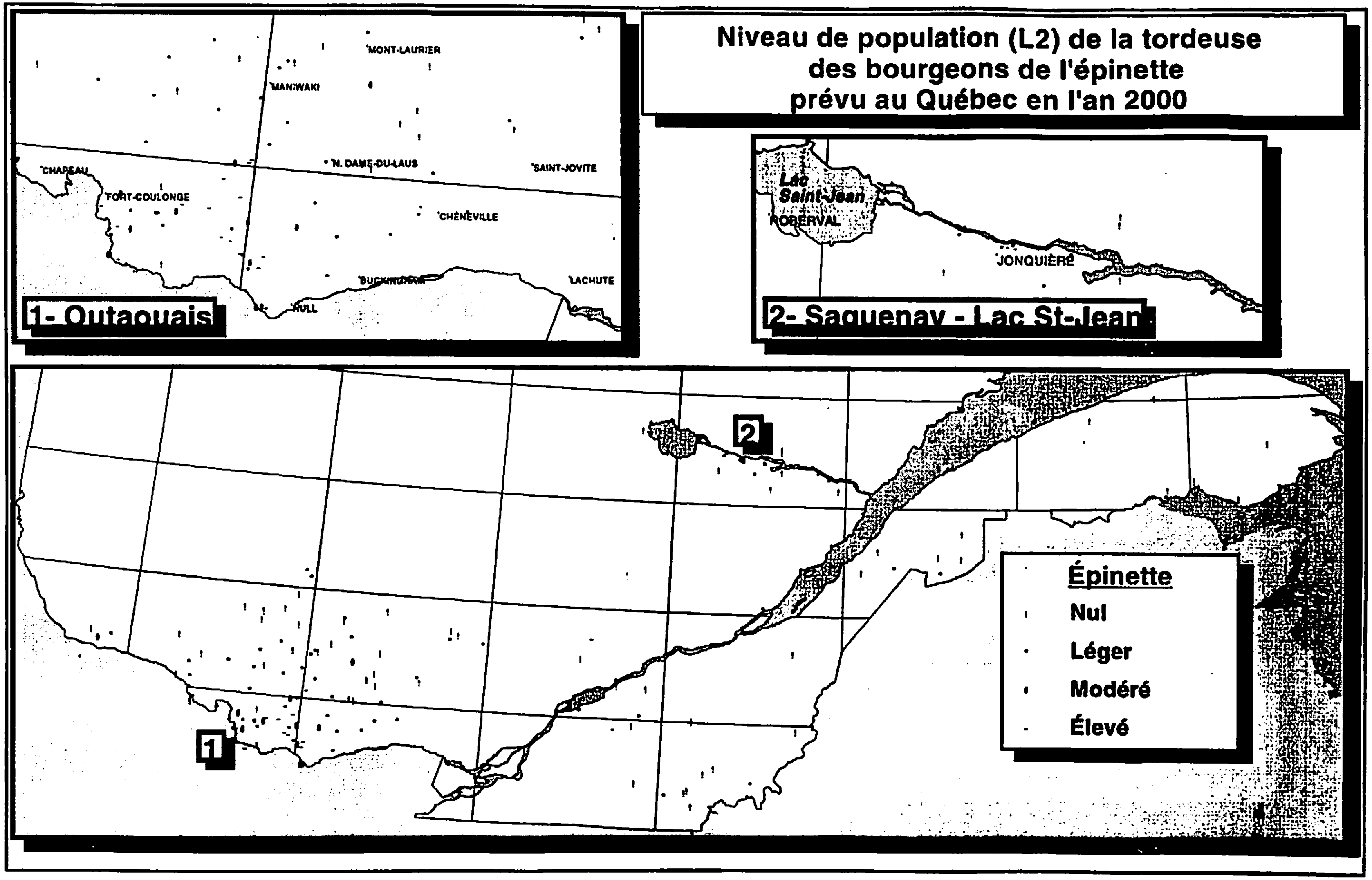
Cette année encore, un peu plus de 80 % des plantations sont atteintes par la rouille vésiculeuse du pin blanc, à l'échelle du Québec. On signale que les dommages s'aggravent dans plusieurs plantations. Dans les régions les plus touchées, c'est-à-dire celles du Centre-du-Québec, de l'Estrie, de Lanaudière et des Laurentides, le nombre de plantations modérément ou gravement atteintes a plus que doublé depuis l'an dernier.


Tordeuse des bourgeons de l'épinette 1999
Situation au Québec
Défoliation annuelle
Modérée - Grave
St-David-de-Falardeau
Ste-Rose-du-Nord
Jonquière
Chicoutimi
La Baie
St-Félix-d'Otis
Lac-Bouchette
Ferland
La Tuque
L'Isletville
Matawin
Mont-Laurier
St-Michel-des-Saints
Maniwaki
L'Annonciation
Shawinigan
Ste-Marie-de-Beauce
Notre-Dame-du-Laus
Saint-Jovite
Chapeau
Plessisville
Beauceville
Montpellier
Victoriaville
Drummondville
Lachute
Asbestos
Buckingham
Scotstown
Granby
Sherbrooke
Coaticook
Hemmingford

Carte 2

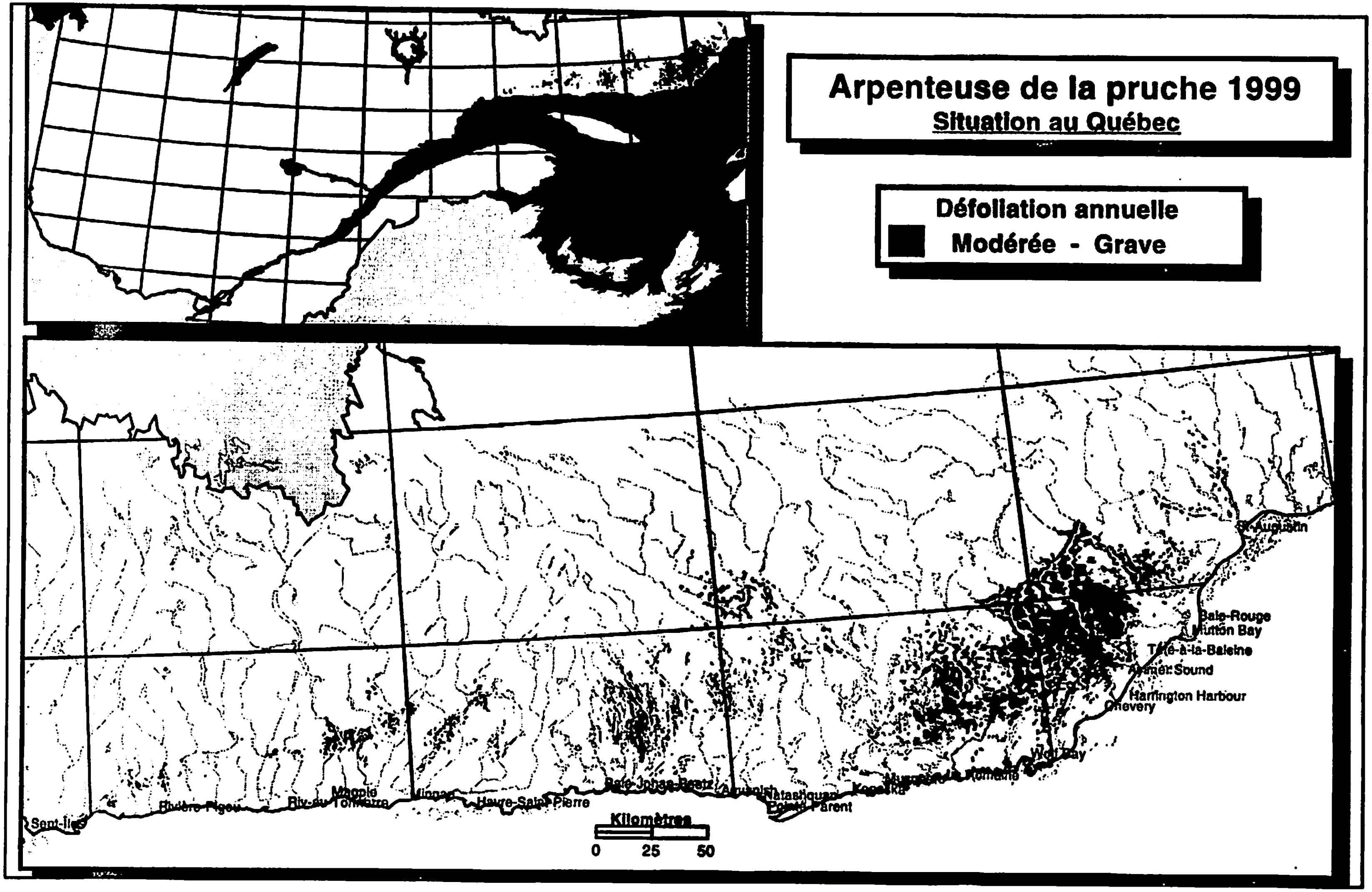

Niveau de population (L2) de la tordeuse
des bourgeons de l'épinette
prévu au Québec en l'an 2000
MONT-LAURIER
MANIWAKI
N. DAME-DU-LAUS
SAINT-JOVITE
FORT-COULONGE
CHÉNEVILLE
BUCKINGHAM
LACHUTE
HULL
1- Outaouais
MISTASSINI
SAINT-FÉLICIEN
ROBERVAL
JONQUIÈRE
2- Saguenay -
Lac-Saint-Jean
2
1
Sapin
Nul
Léger
Modéré
Élevé

Carte 3



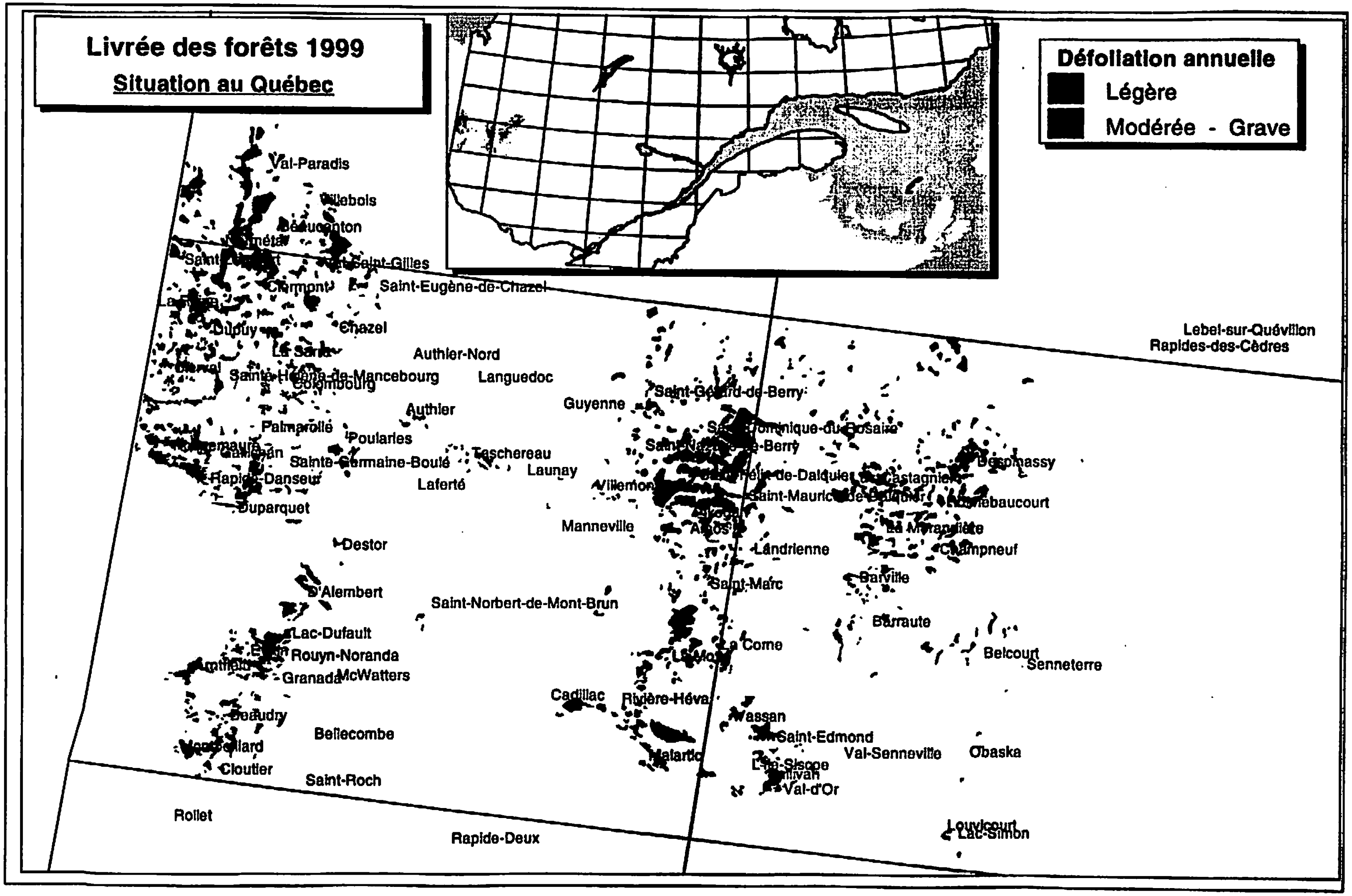
Niveau de population (L2) de la tordeuse
des bourgeons de l'épinette
prévu au Québec en l'an 2000
1- Outaouais
MONT-LAURIER
MANIWAKI
CHAPEAU
FORT-COULONGE
N. DAME-DU-LAUS
SAINT-JOVITE
CHÉNÉVILLE
BUCKINGHAM
LACHUTE
HULL
2- Saguenay - Lac St-Jean
Lac Saint-Jean
ROBERVAL
JONQUIÈRE
2
1
Épinette
Nul
Léger
Modéré
Élevé

Carte 4

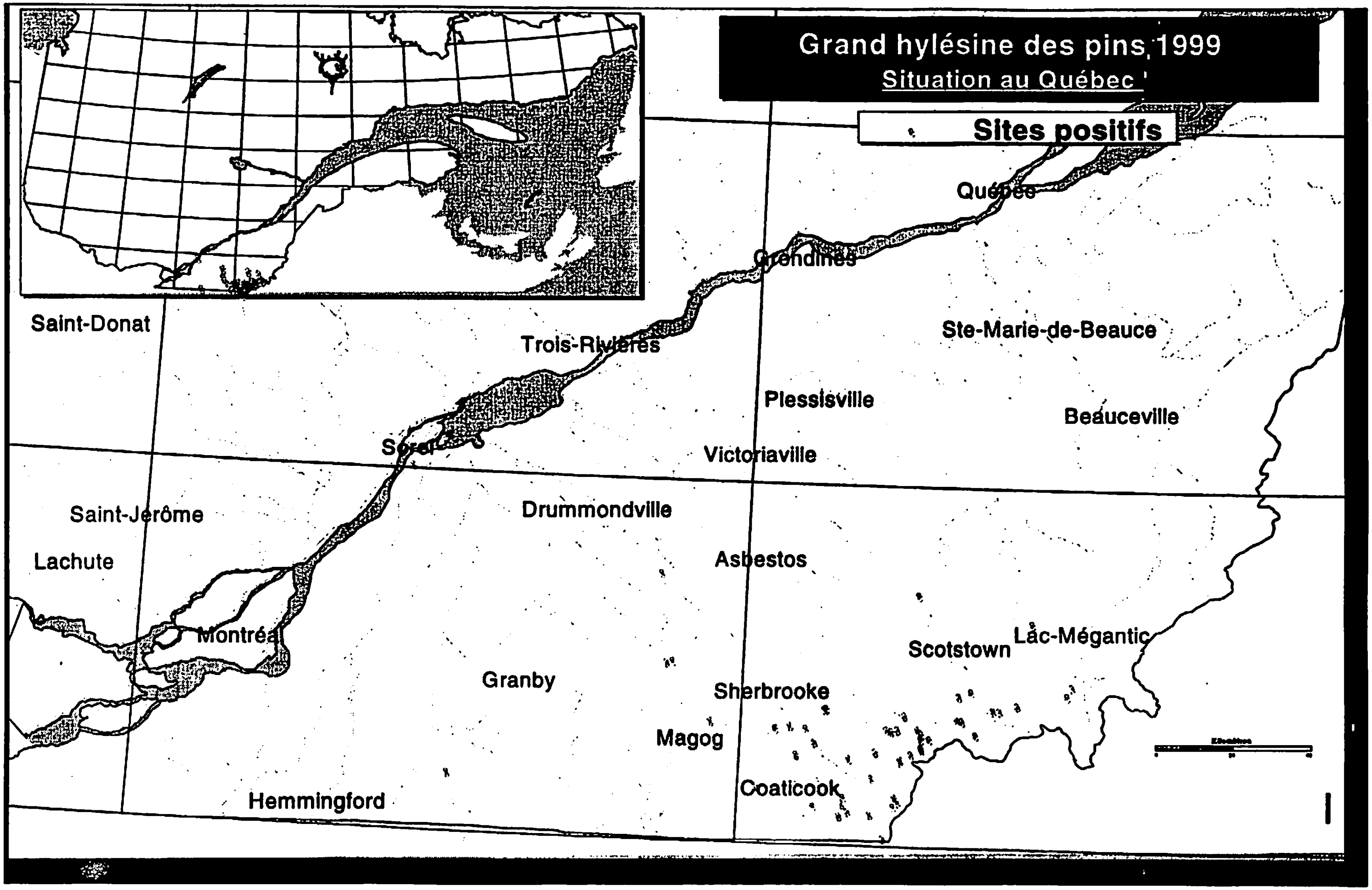


Arpenteuse de la pruche 1999
Situation au Québec
Défoliation annuelle
Modérée - Grave
Baie-Rouge
Mutton Bay
Tête-à-la-Baleine
Harrington Harbour
Chevery
Havre-Saint-Pierre
Natashquan
Kegaska
Kilomètres
0
25
50

Carte 5


Livrée des forêts 1999
Situation au Québec
Défoliation annuelle
Légère
Modérée - Grave
Val-Paradis
Saint-Eugène-de-Chazel
Chazel
Authier-Nord
Languedoc
Authier
Poularies
Guyenne
Taschereau
Launay
Laferté
Duparquet
Destor
Manneville
Landrienne
Champneuf
Saint-Norbert-de-Mont-Brun
D'Alembert
Lac-Dufault
Rouyn-Noranda
McWatters
Bellecombe
Saint-Roch
Cloutier
Rollet
Rapide-Deux
Cadillac
Saint-Edmond
Val-Senneville
Obaska
Val-d'Or
Barraute
Belcourt
Senneterre
Lebel-sur-Quévillon
Rapides-des-Cèdres

Carte 6


Grand hylésine des pins 1999
Situation au Québec
Sites positifs
Québec
Grondines
Saint-Donat
Trois-Rivières
Ste-Marie-de-Beauce
Plessisville
Beauceville
Sorel
Victoriaville
Saint-Jérôme
Drummondville
Lachute
Asbestos
Montréal
Scotstown
Lac-Mégantic
Granby
Sherbrooke
Magog
Coaticook
Hemmingford

Carte 7

Forest Pest Conditions in New Brunswick in 1999

N. Carter, D. O'Brien, D. Lavigne and L. Hartling
Department of Natural Resources and Energy
Forest Pest Management Section
P.O. Box 6000
Fredericton, N.B. E3B 5H1

OVERVIEW

The majority of New Brunswick's forests are experiencing a period of relative freedom from major insect or disease attack. Operational protection programs have not been required since 1995 - the end of the spruce budworm outbreak that caused great concern and aerial control programs for four decades. By comparison, current pests are virtually insignificant, though they have local importance. Besides general defoliation of hardwoods, larch and cedar stands have been gradually reduced in vigour by various pests including: larch casebearer, larch sawfly, larch beetle, and cedar (arborvitae) leaf miners.

Surveys of plantations continue to confirm excellent health except for occasional yellowheaded spruce sawfly attack (which has declined significantly in the last two years), and possible increasing incidence of white pine weevil (especially on Norway spruce). Surveillance is continued to ensure pests of significance are detected as early as possible.

The most significant changes are related to two introduced pests. Two new sites have been confirmed to have the European Race of Scleroderris Canker of Pines. Both are within a few kilometres of the 'original' positive site in northwestern New Brunswick. Additionally, one new site (Grays Mills) has been confirmed to be positive for European Gypsy Moth in Kingston Parish, King's County, outside the currently regulated parishes. There was no change in the status of Butternut Canker, a new disease that was confirmed present in the Province by the Canadian Forestry Service for the first time in 1997.

Forest Pest Conditions in New Brunswick in 1999

(Prepared for the Annual Forest Pest Management Forum held in Ottawa, Nov.16-18, 1999)

N. Carter, D. O'Brien, D. Lavigne and L. Hartling
Department of Natural Resources and Energy
Forest Pest Management Section
P.O. Box 6000
Fredericton, N.B. E3B 5H1

PESTS OF SOFTWOODS:

Spruce Budworm: The last area of defoliation by spruce budworm (4000 ha) in New Brunswick was detected in 1995. The last operational control programs were conducted in 1993 on Crown land, and in 1995 by J.D. Irving Limited on their freehold lands. No defoliation was forecast for 1999 and none was detected.

Populations of spruce budworm remain at endemic levels around the Province and no defoliation is forecast for 2000 and no control is needed

Pheromone Survey: In 1999, an operational pheromone monitoring survey was again conducted (by DNRE) consisting of the uniform distribution of 157 Delta pheromone traps around the Province. All but two traps were recovered. Compared with results from the past two years (Table 1), there was a 'very slight' increase in the number of positive traps and overall mean trap catch ***but the magnitude of the differences are much too minor to be interpreted as a meaningful biological increase in populations.***

J.D. Irving Limited placed out traps on their Black Brook, Deersdale and Sussex freehold limits. Overall, their trap catches were similar to the Provincial survey, though slightly higher in Black Brook (mean = 12 moths/trap). Traps at Deersdale and Sussex had mean catches of 0.9 and 1.0 moths/trap, respectively.

Table 1. Number of spruce budworm male moths caught in DNRE's operational pheromone trap survey in New Brunswick from 1996 to 1999.

Number of moths/trap	Year			
	1996	**1997**	**1998**	**1999**
Nil	53%	73%	67%	59%
1-10	41%	27%	33%	41%
>10	6%	0%	0%	<1%
Maximum catch	**54**	**6**	**10**	**12**
Number of traps	99	148	148	155

L2 Survey: **An overwintering L2 survey was also conducted, with modifications to the usual operational methods though geographic distribution around the Province was maintained. Since 1986, the number of operational survey plots has gradually been reduced from over 1500 to only 75 (i.e. at half the current pheromone trap locations). At 50 plots, the usual method of sampling 3 trees/plot was maintained. At the remaining 25 plots, 30 trees/plot were sampled to increase the chances of detecting rising populations earlier than might be detected in the regular survey and to analyze along with moth counts from pheromone traps.**

Table 2. Number of overwintering spruce budworm larvae detected in DNRE's operational L2 survey from 1996 to 1999.

	Year			
	1996	1997	1998	1999
Number of plots	503	317	75	75
Number of branches	1509	951	900	900
Number of L2	8	2	4	0

J.D. Irving Limited also sampled 30 plots (3 trees/plot) on their freehold limits at Deersdale. From the overall total of 990 branches thus collected, not a single larvae was found thereby confirming very low populations as in the past several years and re-affirming results of the pheromone survey.

Jack Pine Budworm: Defoliation by this insect has not been detected since 1983. Nonetheless, annual monitoring has been conducted because of the importance of jack pine, in natural stands and plantations, to the Provincial wood supply

Populations of jack pine budworm remain at endemic levels around the Province. No defoliation is forecast for 2000, and no control is needed.

Pheromone Survey: Various levels of pheromone trapping have been done (previously most was done courtesy of the former Forest Insect and Disease Survey of the Canadian Forestry Service). In each of the past three years, however, DNRE has placed out traps. There were no moths caught in 1997, and the highest trap catch in 1998 was 8 moths. In 1999, slightly more traps had moths and the highest number in one trap was 41 moths (Table 3).

Table 3. Number of jack pine budworm male moths caught in DNRE's operational pheromone traps in New Brunswick from 1997 to 1999.

Year	Number of moths/trap				
	0	1 – 10	11 – 20	21 – 40	>40
1997	46	0	0	0	0
1998	30	22	0	0	0
1999	23	23	4	0	1*

L2 Survey: A visit was made to the site with 41* moths to look for signs of defoliation and to collect branches to process for possible detection of overwintering larvae. There was no evidence of feeding damage, and no larvae were found on the 9 branches (75-cm long) that were collected and processed for L2.

Hemlock Looper: The only reported outbreak of hemlock looper in New Brunswick occurred from 1989 - 1993. Controls were applied in 1990, 1991 and 1993. No defoliation was forecast for 1999 and none was detected.

Based on previous experience, pheromone trap catches are not expected to represent populations capable of causing any significant defoliation in 2000, and no control is needed.

Pheromone Survey: A pheromone trapping survey (by DNRE) was conducted around the Province and consisted of placing out 105 Multipher traps, of which 98 were retrieved. The overall mean Provincial trap catch was 120 moths/trap, which was virtually the same as last year (123 moths/trap), but slightly lower than the mean in 1997 (160 moths/trap). A visual examination of the data suggests a similar situation as last year with the 'highest' counts generally in the northwestern parts of the Province.

J.D. Irving Limited also placed out pheromone traps on their freehold limits in the Black Brook, Deersdale, and Sussex areas. Results were similar to DNRE's operational survey (i.e. mean trap catches were 45, 114 and 123, respectively).

Whitemarked Tussock Moth: The last outbreak of whitemarked tussock moth occurred in the 1970s in both New Brunswick and Nova Scotia. In 1975, the area defoliated in New Brunswick was 25 000 ha, and in 1976 it was 202 400 ha. Thus, the population explosion of this insect in Nova Scotia in 1997 coupled with their forecast for 1998 caused great interest in New Brunswick. Although no egg masses were detected in New Brunswick in the fall/winter of 1997/98, it was decided that survey efforts would be made to look for whitemarked tussock moth in 1998. Also, due to concerns expressed by the Province's forest industry, information sessions were held with them, private woodlot owners and Regional department staff. In 1999, concerns continued though ground and aerial surveys did not detect any significant evidence of whitemarked tussock moth.

Based on observations in 1999, there appears to be no threat of whitemarked tussock moth damage in 2000, and no control is needed.

Pheromone Survey: A pheromone trapping survey was conducted by DNRE, consisting of placing out 59 traps in the southeast (mostly) and other selected locations around the Province. Of the 57 traps that were retrieved, only 2 were positive (one had 1 moth, and one had 2 moths). Last year, 5 (of 59) traps were positive having 1-4 moths/trap. This is the second year we used this particular pheromone.

{Of interest, these traps again caught moths of the closely related **rusty tussock moth** much the same as last year. Rusty tussock moths were caught in 20 traps this year with a range of 1-11 moths/trap. In 1998, moths were caught in 19 traps, and the range was 1- 9 moths/trap}.

Egg-mass Survey: During the fall, 142 locations were surveyed and only 1 whitemarked tussock moth egg mass was found.

<u>Yellowheaded Spruce Sawfly</u>: Populations of yellowheaded spruce sawfly have returned to endemic levels in the southeast as only 1 plantation again had signs of light attack this year (down from 8 with light attack last year). At one time, as many as 37 black spruce plantations in the area had active sawfly populations in them. Some tree mortality is evident.

In 1998 in the north-central area, there were 43 black spruce plantations affected including 35 with light damage, 5 with moderate damage, and 3 with severe damage in them. In 1999, there was an overall improvement as 29 had no apparent current-year defoliation; 10 had light feeding; and only 4 had some moderate feeding. Six new areas are suspect, and verification is pending at this time.

<u>Cedar (Arborvitae) Leafminers</u>: Damage from this group of four closely related leafmining insects has gradually increased over the past few years, but was especially noticeable during aerial reconnaissance in the spring. Although detectable throughout the Province, the areas most heavily affected occur in the southwest, especially in Charlotte, Sunbury and York Counties. A special aerial survey of these areas detected moderate to extreme damage (including some tree mortality) over a total area of 38 600 ha. The least affected area appeared to be in the northwestern part of the Province.

<u>Larch Pests</u>: Damage by larch casebearer, larch sawfly, and larch bark beetle was extensive and noticed throughout the Province during ground and aerial surveys. Refoliation of some stands became evident later in the summer. Due to the general unhealthy state of larch throughout the Province, this year's attack most likely will increase the chances for continued attack by larch beetle and further contribute to decline in stand health. Unhealthy larch stands are especially noticeable throughout southern regions.

Balsam Fir Sawfly: Various life stages and light to moderate defoliation were detected at six small locations east of Saint John in the southern part of the Province.

European Larch Canker: This disease has been present in the Province since 1978. In 1997, the CFS found one new site positive for European larch canker just outside the existing quarantine zone established some years ago by the Canadian Food Inspection Agency (CFIA). 'Introduced' pests initially fall under the jurisdiction of the CFIA under the Federal Plant Protection Act. In 1998 and 1999, surveys done by the CFS did not detect any new sites positive for European larch canker outside the regulated area in New Brunswick.

White Pine Blister Rust: Concerns raised by one of the Licensees over pest damage on white pine resulted in visits to several of their plantations and natural areas managed for this species. Evidence of white pine blister rust was common on over-story natural trees and symptoms were also detected on some of the planted stock. Observations confirmed the nursery stock was not the cause of the damage. The mite *Trisetacus alborum* was also present on needles of many planted trees and natural regeneration.

Scleroderris Canker – European Race: In 1998, the CFS had confirmed that only one site was positive for the European Race of Scleroderris canker of pine in the Province (northwestern New Brunswick). That conclusion was based on re-analyses of cultures that had been taken some years ago. In 1999, they again took samples from that site and two other plantations within a few kilometres. The 'original' site was again confirmed positive for the presence of the European race. And, samples from Scots pine at the second site were also confirmed to be European Race. Likewise, the third site also proved to be positive, but there it was found on red pine. This is the first significant change for this disease within the Province, since the improved method of distinguishing between the North American race and the European race has been used.

PESTS OF HARDWOODS:

Satin Moth: Defoliation by satin moth was first detected in 1996 at the end of the recent outbreak of forest tent caterpillar (1991 - 1996). At that time, defoliation was particularly noticeable in the south-central and southeastern areas of the Province, but could not be separated from the damage being caused by forest tent caterpillar. Damage intensified in these areas in 1997. In 1998, an aerial survey detected defoliation over approximately 33 800 ha, mostly in the same general areas attacked the previous year, though populations appeared to be subsiding. In 1999, defoliation was again detected – this time distributed mostly over wide areas in northern New Brunswick (totaling about 18 074 ha).

One area in the southwest had dead poplar evident over 4 400 ha, most likely the result of repeated defoliation by satin moth and possible earlier weakening by forest tent caterpillar, coupled with drought for long periods in the past two summers.

Forest Tent Caterpillar: A small area (250 ha) was defoliated by forest tent caterpillar near Bathurst in northern New Brunswick. The last large outbreak of this insect lasted six years from 1991 – 1996, and the previous one also lasted six years (from 1979 – 1984).

Birch Sawfly: This insect caused complete defoliation of yellow birch over an area of 2 700 ha in Madawaska County in northern New Brunswick.

Willow Flea Beetle: Damage to balsam poplar was extensive throughout the Province.

Gypsy Moth: No defoliation by gypsy moth was forecast for 1999 and none was detected. In fact, since its presence was re-discovered in 1981 (after an absence of some 40 years), the only defoliation ever reported, except for feeding on individual trees, was 4 ha of second-growth poplar in 1987. Activities conducted in 1999 consisted of : pheromone trapping, life-stage/egg-mass surveys, and the third year of a parasitoid release.

Pheromone Survey: Delta pheromone traps were generally placed outside the regulated areas known to have established populations of gypsy moth. A total of 345 traps were deployed by : DNRE (105), CFS/Parks Canada (41), and the Canadian Food and Inspection Agency (199). A total of 332 traps were retrieved (Table 4), of which 183 (55.1%) were negative, 128 (38.6%) had 1-10 moths/trap, 18 (5.4%) had 11-20 moths/trap, and only 3 (1.0%) had >20 moths/trap (maximum = 24). The 'higher' number of moths (i.e. 6-10/trap) caught in the traps placed out by the CFIA (Table 4) is due to the fact that many of those traps were placed within and close to known infested areas where the same trend of higher counts is frequently reported. Traps placed by DNRE and CFS were generally very far removed from known infested areas.

Life-stage/Egg-mass Survey: During the life-stage/egg-mass survey, 179 sites were examined using a 'timed-search' method. Of these, 117 were negative, 54 had new egg masses, and 8 had old egg masses or other life stages present (other than male moths). Only 1 new positive site was found outside the currently regulated parishes within the Province. This was located at Grays Mills in Kingston Parish (Kings County).

Table 4. Results of gypsy moth monitoring survey using pheromone traps in 1999.

<u>Agency</u>	Number of Traps		<u>Number of male moths/trap*</u>					Total male moths	Male moths/ trap
	Placed	Missing	0	1-5	6-10	11-20	>20		
CFIA	199	9	74	68	28	18	2	703	3.70
			38.9	*35.8*	*14.7*	*9.5*	*1.0*		
CFS-Atlantic/ Parks Canada	41	1	28	12	0	0	0	23	0.58
			70.0	*30.0*	*0.0*	*0.0*	*0.0*		
NBDNRE	105	3	81	18	2	0	1	74	0.73
			79.4	*17.6*	*2.0*	*0.0*	*1.0*		
All agencies combined	345	13	183	98	30	18	3	800	2.41
			55.1	*29.5*	*9.0*	*5.4*	*1.0*		

*** Percentages in Italics.**

Population changes have also been monitored at 75 sites surveyed annually since 1995. The number of new egg masses/person hour searching decreased from 1995 until 1998, but increased in 1999 (Table 5). These numbers are still far below levels that would cause any significant defoliation, except to individual trees. These 75 sites are found in five counties, in four of which the number of positive sites increased from the previous year. These areas will again be surveyed in 2000 to see whether another increase occurs.

Table 5. Number of new egg masses/person-hour (NEM/PH) searching at 75 sites visited each year from 1995 to 1999.

Year	1995	1996	1997	1998	1999
NEM/PH	40.1	9.7	3.5	2.9	8.6

Parasitoid Release Trial: Ceranthia samarensis (Villeneuve) is a parasitoid that attacks low-level populations of gypsy moth in Europe, and was introduced into Ontario several years ago. In 1997 in New Brunswick, a small-scale open release of c.130 gravid females (courtesy CFS-Laurentian) was made, but no evidence of successful attack was found. In 1998, the release of a greater number of parasitoids was anticipated, but due to a rearing problem, only 58 gravid female adults became available (again courtesy CFS-Laurentian). These were divided and released in 3 (8'x8'x8') cages, each built around a small red oak tree on which c.600 gypsy moth larvae had been 'seeded'. Larval collections (n=1613) and subsequent rearing recovered 76 *Ceranthia* puparia, of which 73 were subsequently buried in a special container on site where the trial had been conducted. Follow-up work in 1999 consisted of examining overwinter survival, possible successful mating, and attack of sentinel gypsy moth larvae again placed on the oak tree in the cage where the puparia had been buried.

In the spring of 1999, several gypsy moth egg masses were collected from the vicinity and allowed to hatch under normal field conditions. The parasitoid attacks second and third instar larvae; and active larval feeding on the foliage is a cue that aids in bringing the gravid females to their hosts. Larvae were initially placed on artificial diet and then transferred to the oak tree around which the cage had been built. The protective mesh that covered the small box in which the puparia had been buried was removed and emergence monitored on a daily basis.

A total of 10 adult *Ceranthia* flies were confirmed to emerge over the period May 10^{th}–27^{th}. Two weeks after the last adult emerged, it was decided to collect all the gypsy moth larvae from the tree and return them to the laboratory to see whether any parasitoid larvae might emerge and form puparia. A total of 1250 gypsy moth larvae were collected. From these, 3 parasitoid larvae emerged and formed puparia. All other gypsy moth larvae were retained in alcohol and subsequently dissected under a microscope. This process revealed 2 other gypsy moth larvae with *Ceranthia* larvae still in them. Although meager in numbers, the trial demonstrated that: (i) *Ceranthia* puparia did successfully overwinter and emerge in New Brunswick, (ii) did successfully mate, and (iii) did successfully parasitize gypsy moth larvae.

The original objective of this work was to hopefully establish this parasitoid in the Province to add to those other natural bio-control factors already acting to keep gypsy moth populations from irrupting to outbreak levels. Recent information indicates that perhaps the Canadian Forest Service will greatly reduce their efforts, or will no longer participate in international programs to obtain parasitoids from Europe. Thanks to D. W. Quednau (CFS-Laurentian), we have obtained the remaining 1200 puparia from CFS Laurentian for work in 2000. The future of our project might be short lived unless a source of many more *Ceranthia* can be found.

Poplar Twig Blight: This disease was seen extensively in the Tetagouche River area in northern New Brunswick and completely defoliated poplar stands over 22 320 ha. Refoliation was evident within 2-4 weeks, though leaves were smaller and fewer in numbers, possibly leaving them in a weakened state for next year.

Butternut Canker: In 1999, surveys conducted by the Canadian Forest Service did not detect any new sites positive for butternut canker in New Brunswick. This disease was first confirmed present in the Province by the CFS in 1997 at 5 locations, viz. 1 located about 12-km north of Woodstock, and 4 sites located close together about 12-km beyond that near Stickney (Carleton County), in the western part of the Province about 20-km north of Woodstock. These sites are about 25-35 km east of Houlton, Me. where the disease has previously been found by Maine authorities.

Forest Pests Update for Prince Edward Island

Summary

A hot, dry growing season, with above normal spring temperatures and below normal precipitation added to the stress of Island forests.

The eastern larch bark beetle, *Dendroctonus simplex* LeC., was widespread in Prince and Queens Counties causing moderate to severe defoliation in larch stands. Current harvesting of larch stands is unable to keep up with he whole tree mortality caused by this insect. The balsam woolly adelgid, *Adelges piceae* (Ratz.), is the unconfirmed cause of balsam fir mortality in Kings and Queens Counties.

The pheromone trapping program conducted in 1999 included eastern spruce budworm, gypsy moth and exotic bark beetles.

Le point sur les principaux ravageurs forestiers dans l'Île du Prince-Édouard

Sommaire

Les conditions anormalement chaudes et sèches qui ont été enregistrées au cours du printemps et de la saison de croissance ont contribué à alourdir les pressions qui agissent sur les forêts de l'île.

Le dendroctone du mélèze, *Dendroctonus simplex* LeC., était répandu dans les comtés de Prince et de Queens et y a causé des défoliations modérées à graves dans les peuplements de mélèze. Au rythme où se poursuit actuellement l'exploitation par arbres entiers, on ne parvient pas à récupérer tous les arbres tués par le ravageur. Le puceron lanigère du sapin, *Adelges piceae* (Ratz.), est la cause non confirmée de la mort de sapins baumiers dans les comtés de Kings et de Queens.

Les campagnes de piégeage (phéromone) lancées en 1999 visaient la tordeuse des bourgeons de l'épinette, la spongieuse et les scolytes exotiques.

Forest Pests Update
Prince Edward Island 1999

A hot, dry growing season contributed to an increase in forest insect pests on Prince Edward Island. An early spring with temperatures above normal created an environment favourable to many forest pests. A precipitation deficit in May and June further stressed Island forests, weakening their ability to withstand insect attack.

Table 1 - Weather Data for Charlottetown - May/June 1999

May			
Mean Temperature	12.4°C	Precipitation	26.0 mm
*Normal Temperature	8.84°C	Precipitation	96.8 mm
June			
Mean Temperature	17.3°C	Precipitation	32.7 mm
*Normal Temperature	14.4°C	Precipitation	91.1 mm

* Environment Canada 30 year average

The warmer growing season combined with lower than normal rainfall lowered humidity levels. This resulted in a reduction in the rate of spread of tree diseases and the occurrence of new infections such as Sirococcus Shoot Blight and European Larch Canker.

The long drought period during the growing season slowed reforestation efforts in 1999; planting was shut down in June due to lack of soil moisture. Planting was resumed in mid-August when soil moisture levels were adequate to maintain seedling health.

FOREST PEST HIGHLIGHTS

Conifer Species

Spruce Budworm - Pheromone trapping was carried out across the province with no notable catches of Spruce Budworm and no defoliation observed. Several traps did catch Hemlock Looper moths but these were taken in too early to determine any population trends.

Eastern Larch Bark Beetle - Widespread in Prince and Queens Counties causing moderate to severe damage in pole to mature timber. The insect is moving east and has caused low to moderate damage in Kings County at present. Present harvesting of infested Larch stands is unable to keep up with mortality caused by this insect. Some individual tree mortality in larch plantations was also observed in Cardigan, Richmond and Days Corner.

Spruce Bark Beetle - Three small pockets of Spruce Bark Beetle were observed in Queens County; Uigg, Iona and Strathgartney. These were small infestations with less than 50 trees in each area affected.

Yellow Headed Spruce Sawfly - Found in all three counties. Primarily a problem pest in Black Spruce plantations established on abandoned agricultural land. There was an increase observed in the amount of Black Spruce plantations being defoliated by this insect in 1999. Both plantations and tree seed orchards were moderately infested in Upton Road, Hazelbrook, Indian River, Farmington, Richmond and St. Chrysostome.

White Pine Weevil - Low to moderate damage to White Pine and Norway Spruce plantations across the province. This insect also attacked White Spruce, Black Spruce, Red Spruce and Scots Pine plantations in Queens and Prince Counties. The past two years have seen an increase in the amount of damage caused by White Pine Weevil in young plantations on PEI.

European Pine Shoot Moth - Found across the province in low to moderate levels. Red pine plantations which have been infested for several years have poor stem form and may result in fewer crop trees at harvest. Austrian Pine shelter belts are also being hit by the insect.

Balsam Woolly Adelgid - Although unconfirmed, it is believed to be responsible for individual tree mortality of Balsam Fir in Queens and Kings Counties. Balsam Fir stands in Brookvale Demonstration Woodlot, 48 Road, Tracadie Cross and Clearsprings have been affected. Additional sampling will be carried out in 2000 to determine the cause of this mortality.

Eastern Spruce Gall Adelgid - White Spruce plantations and to a lesser extent, Norway Spruce have some degree of damage in the low to moderate category.

White Pine Blister Rust - Confirmed in a young plantation in Prince County (Burton) but is found across the province. The Burton plantation has approximately 20% of the trees infected, but damage is considered low.

Sirococcus Shoot Blight - Found in all three counties. The disease has caused mortality in Kings and Queens Counties in Red Pine plantations circa 1950's origin. There were no new records of Sirococcus in 1999; infected stands looked much better this year than last due to dry weather limiting the spread of the disease.

Balsam Twig Aphid - Found in Balsam Fir plantations in Queens and Kings Counties. Damage caused is low to moderate category. This insect is of primary concern to Christmas tree growers.

<u>Deciduous Species</u>

Dutch Elm Disease - The disease is found in all three counties. There was only one new location identified in 1999. The city of Summerside removed several infected trees and continues to monitor other Elm within city limits.

Bronze Birch Borer - Found in both Kings and Queens Counties. This insect has killed and weakened White Birch trees throughout Charlottetown and its surrounding municipalities. The insect is also responsible for killing White Birch in the Montague area.

White Birch Leaf Miner - Widespread throughout the province infecting White Birch and to a lesser extent Grey and Yellow Birch. Damage is in the low to moderate category depending on tree size.

Birch Sawfly - Found in Queens County primarily in open grown ornamental trees; damage would be low.

Alder Leaf Beetle - Widespread throughout the province. Several years of defoliation has caused mortality in older stands causing moderate to severe damage.

PHEROMONE TRAPPING 1999

Spruce Budworm: 20 traps across PEI - PEI Forestry Division

Exotic Bark Beetle Trapping: Camp Tamawaby -Two Lingdren funnell traps (Exotic Beetle Lures) to determine population status of Exotic Beetles captured in 1998 Trypodendron domesticum (Linn.) native to western and central Europe - PEI Forestry Division.

Gypsy Moth: Pheromone Trapping - nine daily monitoring traps (two Kings County, five Queens County, two Prince County)
Results all negative except one trap which caught four male moths. Egg mass searches to be carried out this fall.

The 1999 Forest Insect Status and Control Activity in Newfoundland

H. Crummey

Summary

Three on-going insect infestations are of concern in Newfoundland: hemlock looper, *Lambdina fiscellaria fiscellaria* (Guenée), balsam fir sawfly, *Neodiprion abietis* complex, and the yellowheaded spruce sawfly, *Pikonema alaskensis* (Rohwer). In 1998 some 41,500 ha were forecasted to be infested by the hemlock looper. An aerial spray operation was conducted in 1999 to combat this looper across 9,800 ha of infested forest using *Bacillus thuringiensis* var. *kurstaki* (Btk.) (Foray 76B). The balsam fir sawfly was forecasted to infest approximately 20,200 ha and in an effort to control the population of this sawfly an aerial spray operation was conducted over 1,300 ha of forested land using the chemical insecticide Dylox 420. The yellowheaded spruce sawfly was also forecasted to infest some 1,200 ha in 1999. An experimental ground sprayed trial, using two application rates of NEEM (extract from the Asian Neem tree), were applied on a total of 60 ha.

Le point sur les ravageurs forestiers et les campagnes de lutte entreprises à Terre-Neuve en 1999

H. Crummey

Sommaire

Trois ravageurs constituent actuellement des sources de préoccupations importantes à Terre-Neuve : l'arpenteuse de la pruche, *Lambdina fiscellaria* (Guenée), le diprion du sapin, complexe *Neodiprion abietis*, et la tenthrède à tête jaune de l'épinette, *Pikonema alaskensis* (Rohwer). On prévoyait que quelque 41 500 ha seraient infestés par l'arpenteuse de la pruche en 1998. En 1999, dans le cadre de la campagne de lutte lancée contre ce ravageur, 9 800 ha de forêt infestée ont fait l'objet d'un traitement aérien au *Bacillus thuringiensis* var. *kurstaki* (Btk) (Foray 76B). On s'attendait également à ce que le diprion du sapin infeste environ 20 200 ha. Dans le but de réprimer les populations de ce ravageur, un épandage aérien de l'insecticide chimique Dylox 420 a été effectué sur quelque 1 300 ha de forêt infestée. Quant à la tenthrède à tête jaune de l'épinette, on prévoyait qu'elle infesterait 1 200 ha en 1999. Dans le cadre d'un essai expérimental, deux doses de NEEM (extrait de NEEM, essence asiatique) ont été appliquées au sol sur 60 ha.

The 1999 Forest Insect Status and Control Activity in Newfoundland

(Prepared by H. Crummey, Newfoundland Forest Service for
Forest Pest Management Forum - Ottawa, Nov. 1999)

Insect Status:

Three on-going insect infestations are of concern in insular Newfoundland (NF): hemlock looper, balsam fir sawfly and yellowheaded spruce sawfly. The hemlock looper infestation is situated mainly in northern NF(on the Northern Peninsula); the balsam fir sawfly mainly in western NF (southwest of Corner Brook), but also in southern NF (Bay d'Espoir) and southeastern NF (Burin Peninsula); and the yellowheaded spruce sawfly mainly in central NF (off the Bay d'Espoir Highway). Both sawfly pests are of particular concern to the Forest Service and to industry in that they are affecting areas which have undergone intensive silviculture treatment and have been established at considerable cost to maintain sustainable forestry. Control programs were carried out in 1998 and again in 1999.

Hemlock looper

The hemlock looper infestation continued on the Northern Peninsula. Isolated pockets of infestation were also detected in 1998 on the Avalon Peninsula, in particular near Paddys Pond. In 1998, a total of about 13,000 hectares (ha) were defoliated with 6,300 ha in the moderate and severe categories. The main areas defoliated on the Northern Peninsula were south of Western Blue Pond, east and southeast of Eastern Blue Pond, from River of Ponds north to Barr'd Harbour, northeast of Hawkes Bay, around Leg Pond – Castors River and east of Reefs Harbour. A control program using a single application of B.t.k. was carried out on approximately 7,200 ha in 1998.

The defoliation forecast for 1999 indicated a total of 41,500 ha were expected to be affected on the Northern Peninsula from River of Ponds - Eastern Blue Pond northward to Hawkes Bay – Leg Pond – Plum Point vicinity. It was anticipated that some increase in the infestation would occur in the northern part of the infestation. Scattered pockets of infestation were also expected elsewhere on the Northern Peninsula and on the Avalon Peninsula.

A control program using B.t.k. (Foray 76B) was carried out in 1999 in the Hawkes Bay area and northward, using two single-engine Dromader M-18 aircraft. A total of 9,800 ha were treated with 6,500 ha receiving two applications. The season was early this year (2-3 weeks ahead of normal) which meant the insect was early and defoliation became evident prior to treatment. Weather delays of 7 days and 6 days also hampered control activity. At this time assessments of the program are still being conducted and the annual defoliation survey is about to commence shortly.

Balsam fir sawfly

The major balsam fir sawfly infestation on-going in western Newfoundland continued. High populations and damage occurred in much of the area originally forecast, particularly the approximately 10,000 ha of valuable balsam fir pre-commercially thinned stands located from Stephenville Crossing - Barachois Brook, northeastward to south of Pinchgut Lake. Two other

pockets of infestation also continued, one on the Burin Peninsula near St. Lawrence and one in Bay d'Espoir. In 1998, a total of approximately 24,000 ha were defoliated in the moderate and severe categories with approximately 16,000 ha, 6,000 ha and 2,000 ha in western NF, Bay d'Espoir, and on the Burin Peninsula respectively. Of particular concern is the loss of tree growth associated with defoliation by this insect in the areas affected and the longer term implications for areas already damaged and those at risk.

In 1998, approximately 3, 200 ha were treated in western Newfoundland with one application of the chemical insecticide Dylox 420 (trichlorfon) at 750 grams(g) of active ingredient (a.i.) per hectare. Dylox received 'Emergency Use' registration from Health Canada - Pest Management Regulatory Agency (PMRA) in 1998 to allow treatment to control this sawfly. Of significance in the 1998 program were the 200 metre buffer zone requirements around designated water bodies, which greatly restricted treatment of infested areas.

In addition, in1998, an experimental program was carried out cooperatively between the Department of Forest Resources & Agrifoods, forest industry and the Canadian Forest Service to test a number of rates of Dylox to better determine the least amount of insecticide required to achieve acceptable levels of tree protection. Dylox rates of 250 g a.i., 500 g a.i. and 750 g a.i. were applied in one application to three blocks (combined total of approximately 370 ha in western Newfoundland). Although treatment was late, both the 250 g and 500 g gave good results.

The 1999 moderate and severe defoliation forecast was for 20,200 ha to be affected in western NF, and the infestations in Bay d'Espoir and the Burin Peninsula to be at the same level as in 1998. A control program was initiated with the proposed rate of Dylox being significantly reduced (i.e. 250 g - 500 g) compared to 1998 (750 g). It was reasoned that this rate reduction would mitigate potential negative environmental impacts and therefore allow treatment of more of the infested area. However, for the 1999 season only, a Temporary Registration (not an URMULE) was granted by PMRA, but with greater restrictions and conditions than required in 1998. In addition, the Operator's Licence issued by the provincial Department of Environment & Labour further stipulated 200 m buffer zones on <u>all water bodies</u> including those <u>visible from the air</u> during pre-spray flights. The 200 m buffer was granted for helicopter application only, not fixed-wing aircraft. The net result was that only 1,300 ha of the infested area could be treated operationally using two helicopters. As indicated for the hemlock looper, the season was earlier that expected and defoliation was visible prior to treatment. Delays were also encountered due to permitting complications and monitoring requirements outlined below. Assessments are continuing on the results of the program.

In addition to the operational spray, PMRA required experimental trials to determine the efficacy of even further reduced rates of Dylox. The CFS tested both 125 g and 250 g to compare with the operational rate of 375 g.

<u>Alternative control options:</u>

The CFS, cooperatively with NFS and forest industry, conducted aerial trials using both the biological insecticide, B.t.i. (used in aquatic systems for biting fly control) and a naturally occurring NF balsam fir sawfly virus isolated from the infested areas. This isolate was exposed to additional sawfly larvae and additional dead insects collected to increase the amount of virus available. The insect material was ground up and sprayed out over a test area to determine efficacy. The CFS also conducted a number of lab bioassays on NEEM, B.t.i. and Dylox.

Research Initiative on Sawfly:

A research initiative, started in 1997 continued in 1998 and 1999. Initially, this work was conducted by the Canadian Forest Service - Atlantic Region, with the forest industry (Abitibi Consolidated and Corner Brook Pulp & Paper) and the Newfoundland Forest Service as partners. The project was to look at the balsam fir sawfly in particular (but also the yellowheaded spruce sawfly) to determine what naturally occurring control agents, including virus and parasites, are present and their influence on the current outbreak(s); the influence of thinned or planted stands on the present outbreak(s) compared with unthinned or natural regeneration, particularly for the balsam fir sawfly; the overall tree impacts of these infestations and what the longer term trends will be with respect to tree recovery and continued increment growth. In 1999, this work continued, but under an NSERC (National Science and Engineering Research Council) grant with the University of New Brunswick along with the existing partners.

Yellowheaded spruce sawfly

An on-going infestation of yellowheaded spruce sawfly, mainly in black spruce plantations in central Newfoundland, located in the Frozen Ocean Lake - Crowe Lake - Rolling Pond - Miguels Lake areas, continued to cause damage to affected stands. In 1998, scattered pockets were also detected, with a new infestation near Brians Pond on the Northern Peninsula and one near Conne Pond in Bay d'Espoir. Approximately 1,200 ha of spruce plantations were affected to some degree in central NF in 1997. In 1998, defoliation in central plantations, estimated from ground surveys, was approximately 400 ha with the majority being light. There were also areas of moderate and severe defoliation, particularly in stands untreated in the control program.

In 1998, a total of approximately 845 ha, consisting of twenty-five (25) blocks, were treated using a helicopter, with the chemical insecticide Dylox (trichlorfon) in central Newfoundland. Treatment consisted of one application of Dylox at 750 g a.i. per hectare. Dylox is registered for control of this insect. Of significance with this program, as with the balsam fir sawfly program, were the 200 metre buffer zone requirements around all specified water bodies which limited treatment of infested areas.

It was anticipated that the level of infestation in 1999 would be about the same. Areas treated in 1998 were not expected to be infested to the same extent in 1999. Additional areas of defoliation in southern NF and on the Northern Peninsula were expected to continue. A control program of up to a maximum of 1000 ha was expected.

In 1999, ground application (not aerial) of Dylox was considered due to the location and accessibility of much of the infestation and to maximize areas treated as a result of decreased buffer zones with ground application. An URMULE was granted by PMRA for ground application of Dylox (with a 75 m aquatic buffer zone) to control this insect. However, it was decided that Dylox would not be used, only NEEM (extract from the asian NEEM tree) would be applied by ground in an experimental trial. Both 25 g and 50 g were tested on a total of 60 ha treated. The experiment was coordinated and assessed by CFS. The NEEM arrived very late and was applied to the late instars, less than ideal. Data analyses are on-going at this time.

Dylox Environmental Monitoring Requirements:

Monitoring was required in 1998 for the Dylox programs, consisting of: water samples and benthic invertebrate studies; fish impacts (brain cholinesterase levels); bird impacts (brain cholinesterase levels) on three species of song birds; residue levels in liver and muscle tissue of rabbits (snowshoe hare); terrestrial invertebrate (insect) impacts; and water samples collected from cabin areas adjacent to treatment blocks. Based on the results of these studies, additional studies were required in 1999 and stipulated both by PMRA and provincial Environment. These were: aquatic impacts, both a follow-up to the two systems (stream & pond/per system) studied in 1998 and more systems (three) consisting of treated blocks and untreated areas. The 1999 monitoring was to be more intensive, and longer time-related sampling was required to increase the database. Based on concerns and perception with respect to "cabin" water and potable community water supply(ies), a more extensive study along with more time-interval sampling was required for this aspect in 1999. The aquatic work was contracted to Jacques Whitford Environmental. In addition, there was a requirement to broaden the monitoring scope of terrestrial insect impacts, i.e. a variety of sampling methodologies and more habitat locations (vegetation, ground, air, etc.) to determine what impacts were occurring. Time-line sampling was more extensive in 1999. This work was carried out by CFS. Results will be available once analyses are completed.

Additional monitoring:

Of note is the fact that although aquatic monitoring was required by Health Canada-PMRA and provincial Environment and to be carried out by an independent, qualified and reputable company with the terms, modifications, etc. dictated by these regulatory bodies, Environment Canada also has teams out sampling the same aquatic systems for compliance and enforcement purposes.

Forest Health Conditions in the United States

Borys M. Tkacz, Forest Pathologist
Forest Health Protection
United States Department of Agriculture

Presenation Outline:

Forest Ecosystem Health Concerns

- Forest wildfire threat
- Invasion of non-native invasive organisms
- Wildland/urban interface
- Loss of biodiversity
- Air pollution
- Degraded riparian areas
- Changed ecological conditions

Forest Health Risk Mapping

Layers

- Risk from insect and disease mortality
- Fire
- Threatened and endangered species
- Wildland/urban interface

Forest Insect and Disease Risk Map

- Identified 58 million acres considered to be at risk for 25% or more tree mortality over the next 15 years.
- Two-thirds of expected damage caused by:
  - Gypsy moth (East)
  - Root diseases (West)
  - Southern pine beetle (East)
  - Bark beetles (West)

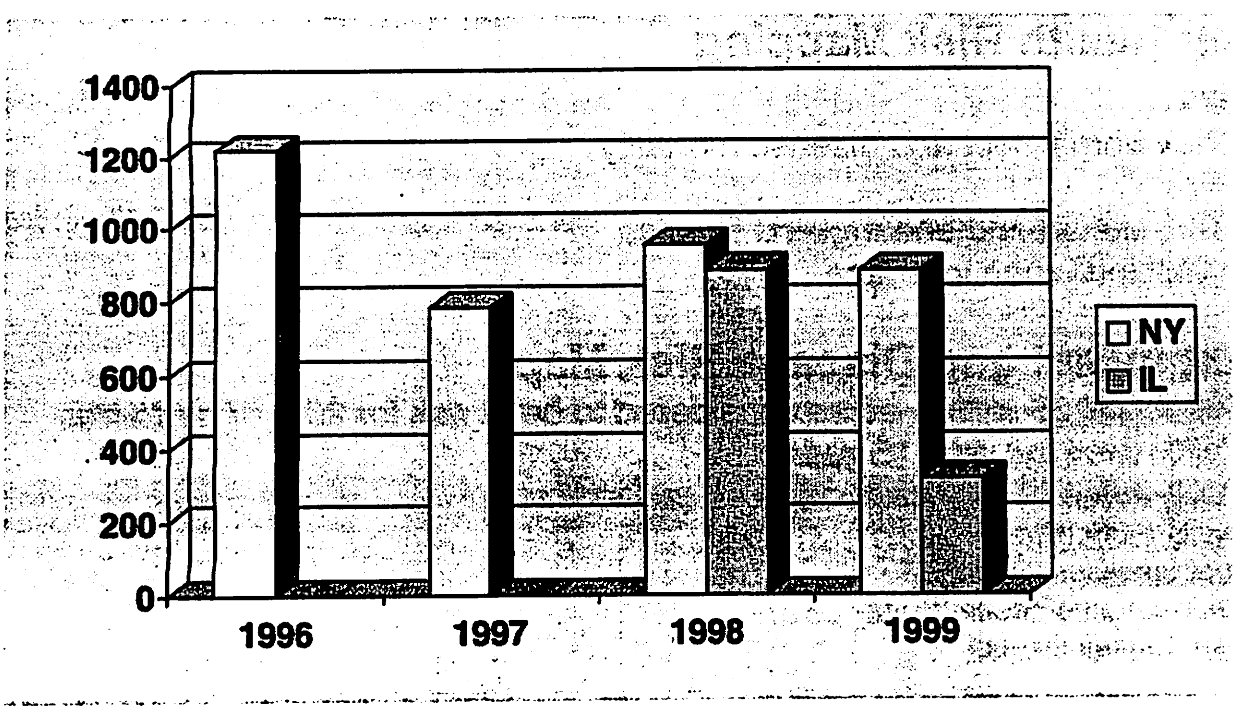
Non-native Invasive Insects
1999 Highlights

Asian Longhorned Beetle (ALB)

(Anoplophora glabripennis)

- New infestations found in Chicago and Manhattan.
  - A few blocks from Central Park in Manhattan;
  - A new location in Queens;
  - Lincoln Park, Chicago;
  - Near O'Hare Airport;
  - In Islip, NY.

Number of ALB-Infested Trees Removed in New York and Illinois



Japanese Cedar Longhorned Beetle

(Callidiellum rufipenne)

- Has been confirmed in 10 towns in 3 counties in Connecticut based on trap and visual surveys.
- Also confirmed at two locations in New York on cedar plant stakes.
- Connecticut has permanent state quarantine in effect.

Longhorned Beetles in Bonsai

(Anoplophora chinensis, A. malasiaca)

- Animal and Plant Health Inspection Service has found citrus longhorned beetle (*A.chinensis*) on crepe myrtle bonsai in Georgia.
- White spotted cirtrus longhorned beetle (A. malasiaca) was found on trident maple bonsai in Wisconsin.
- Larvae found on dwarfed wisteria plants in Florida.

Asian Gypsy Moth

(Lymantria dispar)

- DNA analysis confirmed that male moth trapped in Seattle, WA is of the Asian strain

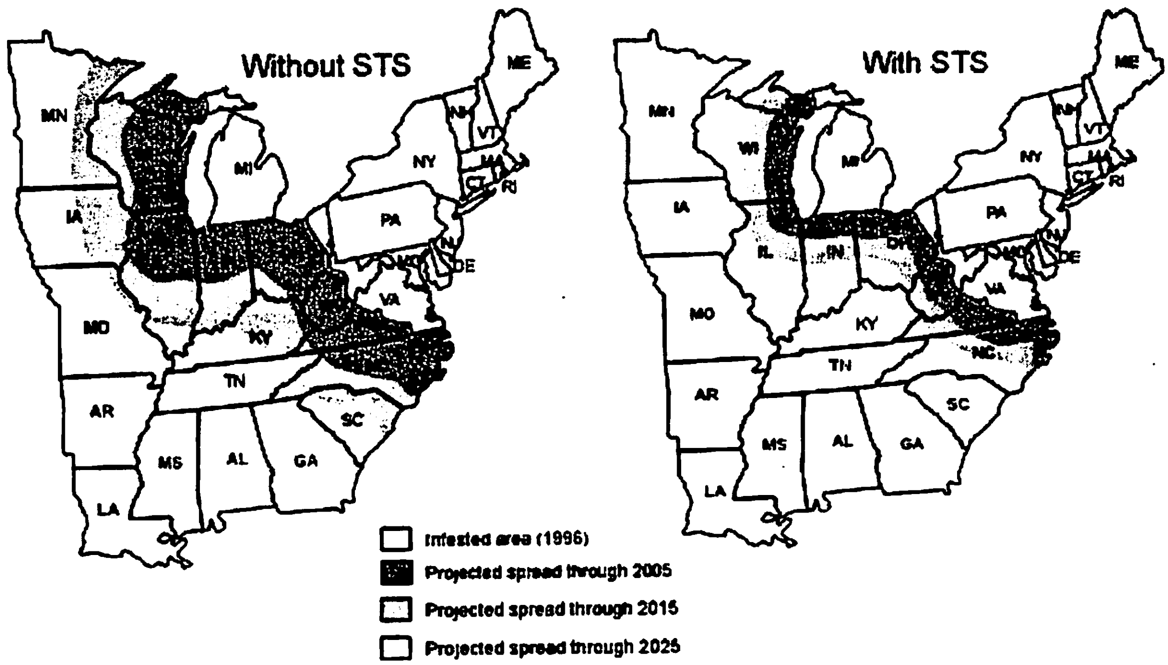
Gypsy Moth (GM)

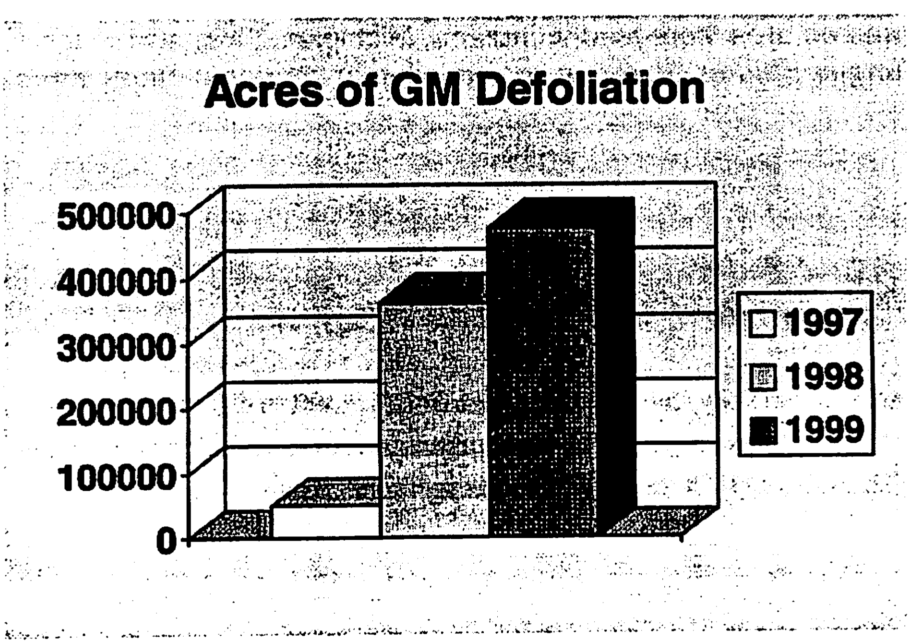
(Lymantria dispar)

- Defoliation increased for a second year in a row.
- Generally infested area increased in Indiana, Michigan, Ohio, and Virginia.
- Biocontrol fungus *Entomophaga maimaiga* failed to appear in many areas.

Gypsy Moth Slow the Spread Project

- Decrease new territory invaded each year from 15,600 to 6,000 sq mi.
- Protect forests, forest-based industries, urban and rural parks, private property.
- Avoid $22 million/yr in damage and management costs.


Without STS
With STS
MN
IA
MO
AR
LA
MS
AL
GA
SC
TN
KY
VA
PA
NY
MI
WI
IL
IN
OH
NC
ME
NH
VT
MA
CT
RI
NJ
DE
MD
Infested area (1996)
Projected spread through 2005
Projected spread through 2015
Projected spread through 2025

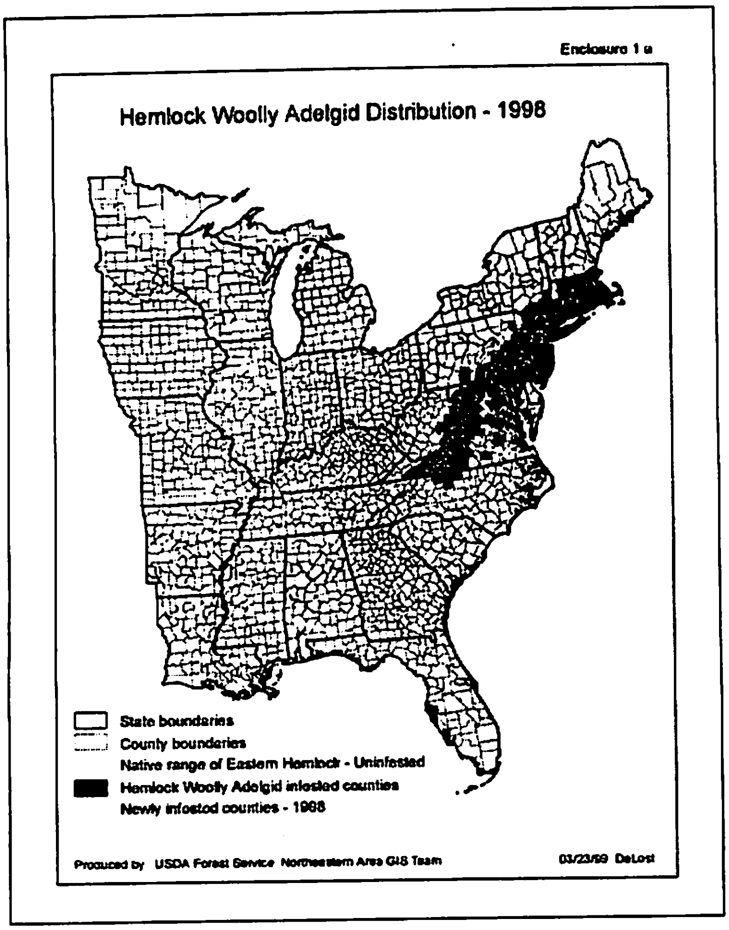

Acres of GM Defoliation
500000
400000
300000
200000
100000
0
1997
1998
1999

Hemlock Woolly Adelgid

(Adelges tsugae)

- Continued to expand its range north and south

- Mass release of Japanese coccinellid predators *(Pseudoscymnus tsugae)* in CT, MD, MA, NC, NJ, NY, RI, VA, WV.



Pine Shoot Beetle

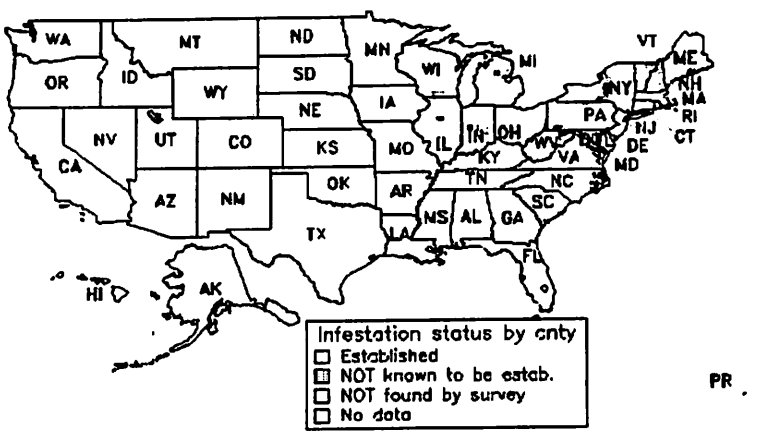
(Tomicus piniperda)

- Continued to expand its range into new counties:
  - IN: Hamilton, Henry, Marion, Montgomery, Rush;
  - MI: Arenac, Cheboygan, Iosco, Roscommon;
  - NH: Coos;
  - NY: Broome, Chenango, Jefferson, Lewis, Madison, Oneida, Tioga;
  - PA: Bedford, Fayette;
  - VT: Essex, Orleans;
  - WV: Marshall, Tucker;
  - WI: Green, Rock .

1999 Reported Surveys of Pine Shoot Beetle, Tomicus piniperdc

1999-11-02 Data retrieved from National Agricultural Pest Information System

CLICK in legend box
for additional explanation.



The Center for Environmental and Regulatory Information Systems does not certify to the accuracy or completeness of this map.

Pink Hibiscus Mealybug

(Maconellicoccus hirsutus)

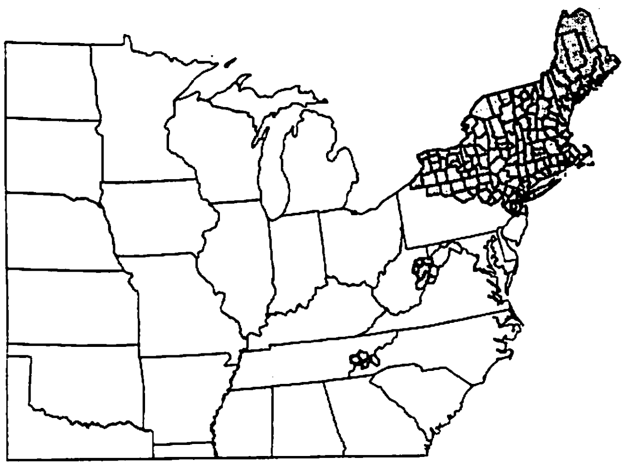
- Attacks over 200 plant species.
- Has caused extensive damage on Caribbean islands.
- In 1998 found in Puerto Rico.
- In 1999 found in California near U.S.-Mexico border.

Non-native Invasive Pathogens
1999 Highlights

Beech Bark Disease

(Cryptococcus occidentalis
+ Nectria coccinea var. faginata)

- Beech mortality continues to increase in affected areas of the Northeast, North Carolina, Tennessee, and West Virginia.



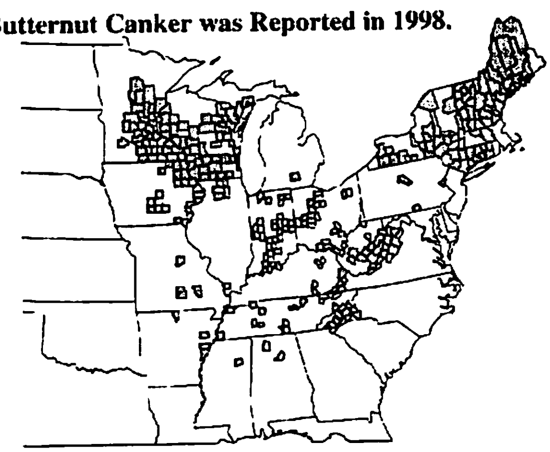
Eastern Counties Where Beech Bark Disease was Reported in 1998.

Butternut Canker

(Sirococcus clavigignenti-juglandacearum)

- Disease is now found throughout most of the range of butternut in the U.S.
- Disease is a serious threat to survival of species.
- Resistance breeding is underway.

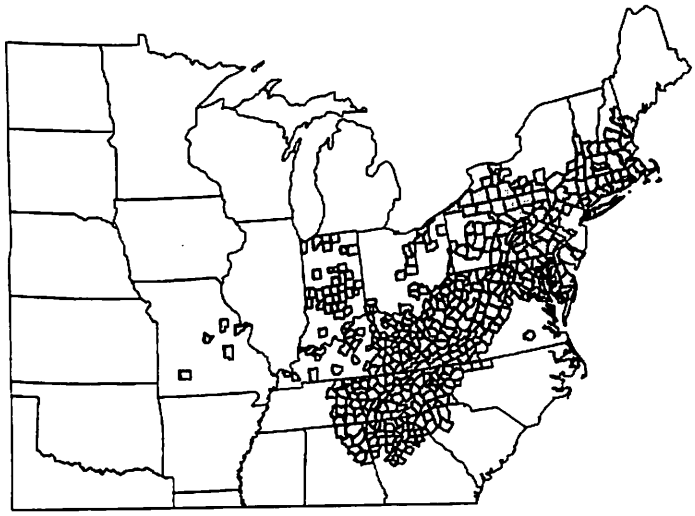
Eastern Counties Where Butternut Canker was Reported in 1998.



Dogwood Anthracnose

(Discula destructiva)

- In Southeastern states, most of the dogwood above 3,000 ft. elev. have died.



Eastern Counties Where Dogwood Anthracnose was Reported in 1998.

Pitch Canker of Monterey Pine

(Fusarium circinatum)

- Found for the first time in Solano County, CA at a Christmas tree farm.
- This location is hotter and drier than any other known infested site.

Port-Orford-Cedar Root Disease

(Phytophthora lateralis)

- An interagency Conservation Strategy is being developed for Port-Orford-Cedar.

-Identify levels of risk at various scales.
-Utilize all management techniques available.
-Public education.
-Research

Native Insects & Pathogens
1999 Highlights

Douglas-fir Beetle

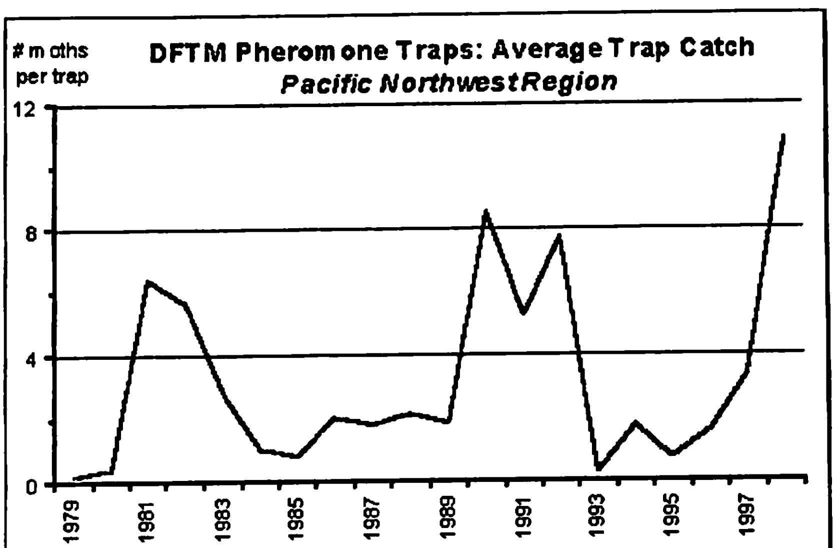
(Dendroctonus pseudotsugae)

- Populations reached epidemic proportions in northern Idaho near Coeur D'Alene.
- Increasing populations on Yakima Indian Nation Lands and surrounding areas in Washington.

Douglas-fir Tussock Moth

(Orgyia pseudotsugata)

- Defoliation of 2,000 ac in California – Sequoia NF and Sequoia Kings Canyon N.P.
- Defoliation of 2,000 ac in eastern Oregon.
- Large-scale outbreaks anticipated next year in Oregon.



Mountain Pine Beetle

(Dendroctonus ponderosae)

- Reached epidemic proportions along the Front Range in Colorado and the Black Hills of South Dakota

Southern Pine Beetle

(Dendroctonus frontalis)

•Activity generally low across the southern U.S. in 1999.
•However, in Alabama, outbreaks were widespread and severe

Spruce Beetle

(Dendroctonus rufipennis)

- Infestation in Alaska continued to decline.
- Epidemic is developing in Colorado following blowdown in 1997.
- Blowdown in northern Minnesota may lead to increased populations.

Western Spruce Budworm

(Choristoneura occidentalis)

- Defoliation appears to be increasing in northern Arizona, northern New Mexico, southern Utah, Washington, and on Yakima Indian Nation lands.

Oak Decline

- A severe episode of oak decline is occuring in the mountains of Arkansas.
- Complex of causes includes: acute drought, red oak borer, 2-lined chestnut borer, armillaria root rot, defoliators, hypoxylon canker.

Forest Health Monitoring(FHM)

Objectives:

- Establish a monitoring system throughout the forests of the United States to determine detrimental changes or improvements that occur over time.

- Provide baseline and health trend information that is statistically precise and accurate.
- Report annually on status and changes to forest health.

FHM Components

- Detection Monitoring
- Evaluation Monitoring
- Intensive Site Ecosystem Monitoring

Detection Monitoring
FHM Indicators

- Tree Growth
- Tree Regeneration
- Tree Crown Condition
- Tree Damage
- Tree Mortality
- Lichen Communities
- Ozone Bioindicator Plants
- Soil Morphology and Chemistry
- Vegetation Structure
- Plant Diversity

Forest Health Monitoring
Key Points 1999

- Detection Monitoring Plot portion of FHM is being fully integrated with the Forest Inventory and Analysis (FIA) program.
- The FHM program has been expanded to include 33 states covering 74% of the forested land in the contiguous United States.
- FHM/FIA will be one of the principal data sources for reporting on Montreal Process Criteria and Indicators for sustainable forest management and the Environmental Report Card.

Session II - Update: Regulatory Affairs and CFS Research Activities
Chair: Nelson Carter

Séance II - Mises à jour: Affaires réglementaries et activités de recherche du SCF
Président: Nelson Carter

PMRA Program Update/Biopesticides

Forest Pest Management Forum
November 16, 1999

Wendy Sexsmith
Director
Alternative Strategies and Regulatory Affairs
Pest Management Regulatory Agency
Ottawa, Ontario
Wendy_Sexsmith@hc-sc.gc.ca

Health Canada
Pest Management Regulatory Agency

Santé Canada
Agence de réglementation de la lutte antiparasitaire

INTRODUCTION

"BIOPESTICIDES"

- Microbials
- Pheromones
- Macrobials

IMPROVED ACCESS TO BIOPESTICIDES

GOAL

- Remove regulatory barriers
- Maintain health and environmental protection
- Simultaneous access
- Sustainable pest management and risk reduction **Mechanism in North America**
- North American Free Trade Agreement on Pesticide

Risk Reduction Subcommittee
USA/Canada/Mexico

WHAT IS HARMONIZATION?

- Common approaches to doing business that allow a submission prepared for one jurisdiction to be accepted for review in another jurisdiction

- Does not mean identical

COMPONENTS OF HARMONIZATION

- Data Requirements
- Study Protocols
- Formats
- Electronic Standard
- Risk Assessment Techniques

RESEARCH PERMITS - NOT HARMONIZED

PRE-SUBMISSION CONSULTATION - HARMONIZED APPROACH

- data requirements
- waivers

TIERED DATA REQUIREMENTS - HARMONIZED EXCEPT FOR EFFICACY

- characterization
- health
- environment
- efficacy

MICROBIALS

DATA REQUIREMENTS
TAILORED TO UNIQUE ASPECTS:

- Biological properties
- Host range
- Infectivity
- Ability to persist, multiply and disseminate

GENETICALLY MODIFIED:
REGULATED AS SUBSET OF MICROBIALS

PHEROMONES

RESEARCH PERMITS, NOTIFICATIONS - NOT

COMPLETELY HARMONIZED

PRE-SUBMISSION CONSULTATION - HARMONIZED APPROACH

- data requirements
- waivers

TIERED DATA REQUIREMENTS - HARMONIZED EXCEPT FOR EFFICACY

- chemistry
- based on Tier 1 human and environmental tox results
- reduced for Straight-Chained Lepidopteran Pheromones

PHEROMONES

REGISTRATION NOT REQUIRED

- Used in fixed-location lures for monitoring pests

REGISTRATION REQUIRED

- Used in dispensers placed in large numbers for pest control
- Broadcast or sprayed

DATA REQUIREMENTS TAILORED TO UNIQUE ASPECTS:

- Non-toxic: modify behaviour of target
- Target specific
- Use concentrations close to naturally occurring levels
- Dissipate rapidly

Macrobials

- In Canada falls under PCPA definition of pest control product
- Not currently regulated as pesticides
- In US, would be regulated by USDA/APHIS

DATA REQUIREMENTS AND HARMONIZATION

Joint Reviews / Microbials and Pheromones

- NAFTA Commitment
- 12 month performance standard
- Announcement June 1997
- Revised Procedures published August 1999
- One product registered (pheromone)
- Six new microbial actives proposed

DATA REQUIREMENTS AND HARMONIZATION

Minor Use

- User Requested Minor Use Registration (URMUR) Directive - August 1999

- Allows the use of reviews from OECD countries such as US for minor uses in Canada

IR-4 Biopesticides

  - linkage with IR-4 Biopesticides program

HARMONIZATION - PROCESS

Organization for Economic Cooperation and Development, Working Group on Pesticides (OECD)

Compare Data Requirements in Guidelines

Dossier Review

- Evaluator Meeting to Compare Practices, requirements

OECD Workshop

- develop Common Core Data Requirements

HARMONIZATION - STATUS/OECD

MICROBIALS

- Evaluator meeting - Aug 1998 (US, Canada, Sweden, Netherlands)
- EU workshop - Oct 1998 (+ US, Canada, Switzerland)
- OECD Pesticides Forum - June 1999
  - compare EU with US/Canada requirements
  - Canada to draft OECD Guideline document

HARMONIZATION - STATUS/OECD

PHEROMONES

- Evaluator meeting - March 1998
- Canada hosting OECD workshop - Sept 1999
- Reach concensus on data requirements

HARMONIZATION - STATUS/OECD

Macrobials

- Exploring international possibilities - February 1999
- Follow up meeting - October 1999

FUTURE WORK

- Test guidelines
- Risk assessment
- Dossier / monograph

SUMMARY

- Committed to facilitate access
- Remove regulatory barriers
  - Data requirements
  - Harmonization
  - NAFTA
  - OECD
- Sustainable pest management and risk reduction

PEST MANAGEMENT REGULATORY AGENCY

FURTHER INFORMATION

PMRA Web site:

http://www.hc-sc.gc.ca/pmra-arla/indexe.html

EPA Web site: http://www.epa.gov

OECD Pesticide Programme Web Site:

http://www.oecd.org/ehs/pesticid.htm

Information Service:
1-800-267-6315 or 613-736-3799 (Canada)

CFS Pest Research Update

Errol Caldwell

Program Director
Natural Resources Canada
Canadian Forest Service

CFS Pest Research Update

Forest Pest Management Forum

Nov. 16, 1999

Summary

- Recent changes due to priority setting
- Current or upcoming initiatives
- Current activities and accomplishments

Recent Changes to the PMM Network

- Transfer of Pest Management Biotechnology program to the Forest Biotechnology Network (formerly TBAG)
- Name change to Integrated Pest Management
- Responsibility for overall accounting, coordination of CFS Network contributions to IPM
- Emphasis on controls for pests of commercial fibre
- Reduced priorities for classical biocontrol, mycoherbicides, seed and cone pests
- Reorganized to 2 programs

IPM Network Programs

- Pest Management Methods
  - Development and testing of environmentally acceptable pest control products as a component of IPM for forest insect pests, tree pathogens and competing vegetation of economic importance for commercial forest fibre production
- Environmental Assessment
  - Ensure that forest pest control strategies are efficient, effective and environmentally acceptable to clients, regulators and other stakeholders

Pest Management Methods Development Program

- Development of biological control products
  - Mycoherbicides e.g. Ecoclear, fusarium, snowmold
  - B.t. control products, ADAM kit, b.t. efficacy model
  - Insect viruses e.g. T3NPV, Bfsf, Wmtm
  - Entomopathogenic fungi e.g. E. maimaiga
  - Microbial competitors of forest pathogens for Wpbr, mistletoe, annosus root rot
  - Insect parasitoids e.g. ceranthia, Pfww, Wpw
  - Mass production technologies for biocontrol agents
  - Mode of action research, b.t. toxin database

Pest Management Methods Development Program
(continued)

- Development of natural control products
  - pheromones for mating disruption and monitoring e.g. Epsm registration under NAFTA, Psb research in Chile
  - lab and field testing of botanicals and other natural products for insect control e.g. neem vs. Pfww, seed & cone insects, tree injector, maple extracts, spinosad efficacy

Environmental Assessment Program

- Determine the environmental impacts of pest control tools and strategies
  - Fate and non-target impacts of forest pest control products e.g. neem
  - Guidelines, data and methods in support of regulatory decisions for forest pest control products e.g. recombinants
- Regulatory support and practical information for pest management operational needs
  - Operational strategies for improved efficacy of pest control alternatives e.g. b.t.,triclopyr & glyphosate, field tests for bfsf, sbw, wmtm, yhss, wsbw, dftm etc.
  - Strategies for operational adoption of IPM, sbw DSS

Interaction with Other Networks

- Forest Ecosystem Processes - pest ecology & population dynamics, e.g. Sbw early intervention
- Forestry Practices - silvicultural approaches to IPM
- Forest Biotechnology - control product biotechnology or pest resistant trees
- Landscape Management - IPM DSS's and knowledge synthesis
- Climate Change - effect of global change on pest distributions
- Forest Health and Biodiversity Networks - info on forest health in relation to native and exotic pests and impacts
- Fire - interaction between fire and pest occurrences
- Socioeconomics - economics and social implications of pest options

IPMN Key Emerging Issues

- Reduced pest research funding (A-base), but increase in external and B-base support
- Increasing pest populations
- Reduced commercial forest land base
- Commercial support for forest pest control product development
- Regulatory requirements/constraints e.g. GLP,
- Exotic pest threats
- Increased attention to toxics
- need to rebuild client linkages

Future Directions and Opportunities

- Exotics
- Research Funding in support of intensive forest management
- Trend to more direct support via Forest Industry
- Biotechnology support
- Environmental and toxics research support
- Emphasis will be on focussed, B-base funding and partnerships
- Need for synthesis and ready access to existing knowledge

Session III - Invasive species - threats to Forest Health, Biodiversity, and International Trade
Chair: Tom Sterner

Séance III - Espèces invasives - Menaces contre la santé des forêts, la biodiversité et le commerce international
Président: Tom Sterner

CFS Invasive Species Research: Challenges and Opportunities

L.M. Humble, E. Allen and G. Smith

With the discovery of invasive species such as *Tomicus piniperda* in the eastern US and Canada and *Anoplophora glabripennis* in the eastern US, foresters have become increasingly aware of the threat posed to forest ecosystems by the establishment of non-indigenous introductions. Invasive species can cause direct economic losses through impacts on forest productivity (tree mortality or growth loss) or wood quality (degrade the value of wood products). Indirectly, they can result in economic losses to the forest sector through the imposition of international trade restrictions and loss of markets. CFS has initiated a number of studies addressing issues related to the introduction of exotic species of concern to forestry. The objectives of this research are: to determine which species are entering the country; to determine the mode of introduction; to determine if introduced species are being redistributed; and to determine what threat they pose to Canada's forests and forest economies . The ultimate goal is to reduce the risk to our forests from non-indigenous introductions.

We provide a brief review of current CFS activities related to the introduction of non-indigenous bark and wood boring insects in Canada. A large number of historical and current pest problems (both insect and disease) in Canadian forests result from accidental introductions of invasive species. The more significant of these pests and their historical impacts are reviewed in the recently published CFS Science Program Context Paper, "Alien Forest Pests".

Research was recently undertaken at CFS-Pacific to identify the species of woodborers associated with solid wood packaging and to quantify their abundance. The incidence of bark and woodborers in wooden wire rope spools originating from Asia and in dunnage supporting granite block shipments from Europe were determined. In addition, wood packaging intercepted by the CFIA during port inspections was held under quarantine containment for adult emergence to allow reliable determination of the species entering Canada.

While *Anoplophora glabripennis* was not detected in these studies, 12 other exotic species were recovered. Nine of the species reared from wood packaging originating in Asia were long-horned woodborers (Cerambycidae), with four species, *Arhopalus unicolor, Hesperophanes* [=*Trichoferus*] *campestris, Megopis sinica, Monochamus alternatus*, being recovered from multiple shipments, and an additional two species (*Ceresium flavipes, Xylotrechus magnicollis*) being present as multiple individuals within single shipments. Exotic species of Anobiidae (*Ernobius* and *Ptilineurus* spp.) and Siricidae (*Tremex abie* and *Tremex* sp. prob. *fuscicornis*) were also intercepted. Containment rearing of spruce bolts used as dunnage in shipments of stone from northern Europe yielded more than 2500 individuals (40+ species) including potentially serious pests such as *Ips typographus*, *Polygraphus poligraphus* and *Tetropium fuscum*. These rearings demonstrate the diversity of exotic species arriving in Canada in solid wood packaging.

Non-indigenous woodborers have become established in forest ecosystems in the past and will likely continue to establish as a consequence of the use of solid wood packaging. With the exception of some of the Scolytidae from northern Europe (e.g. *Ips typographus* and *Pityogenes chalcographus*) for which pheromone based lures are available, reliable survey and detection tools are not available for any of the aforementioned species. Existing detection systems may be applicable in some instances as at least two of the woodborers have been recovered in ethanol baited multiple funnel traps or UV light traps. During 1999, *Tetropium fuscum* was discovered to be present in forests adjacent to a container port in Halifax through laboratory rearing of dead and dying red spruce (*Picea rubens*) conducted by CFS-Atlantic, yet the species was not detected in trapping programs conducted at the same location. The ease of transport of containerized goods and associated wood-packaging allows the introduction of such pests into forests anywhere in the country. The detection of non-indigenous establishments associated with such shipments and determination of their impacts is a major research challenge. Research trials of detection tools for non-indigenous introductions are currently being conducted at the CFS-Atlantic, Great Lakes and Pacific research centres.

In 1995, a research program to determine if non-indigenous bark and wood borers were establishing in forest ecosystems was initiated at CFS-Pacific. At the same time collaborative research was conducted with the CFIA in association with CFS-Pacific and Atlantic to determine if introductions were occurring in and around import facilities. Five species of introduced ambrosia beetles and one species of long-horned woodborer have been discovered in British Columbia since implementation of these detection surveys. To date, more than 160,000 specimens comprising 60+ species of Scolytidae have been recovered in southwestern BC through the combined effort of the CFS and CFIA. Seventy-five percent of all specimens captured are contained in only 6 species. Surprisingly, while the two most abundant species are native ambrosia beetles, the next four most abundant species were introduced species (two of which were not known to occur in North America prior to 1995). Indeed, 41% of all species for which more than 100 individuals were trapped (17 species) were non-indigenous and only two of those had previously been recorded. At least two of the recent introductions discovered in British Columbia, *Trypodendron domesticum* and *Xyleborinus alni*, have been independently discovered in eastern North America.

At some of the 86 locations examined in the collaborative research noted above, established non-indigenous Scolytidae were found to be numerically more abundant than native species in the trap captures. This pattern was also apparent in the relative abundance of bark and ambrosia beetles reared from naturally attacked native tree species in British Columbia. At one location, fewer than 3% of all individuals emerging from 3 naturally attacked native tree species were found to be native Scolytidae. It is not known if these introductions are impacting either native tree or ambrosia beetle species.

Recent introductions of on-indigenous bark and wood-borers have been discovered in the forests of both eastern and western Canada. The potential pest status of most of these recent discoveries is not known. Interceptions associated with wood packaging demonstrate that species continue to arrive. Detection methodologies have not been developed for most of the species intercepted, thus it is difficult to determine which are establishing and could pose threats to forest ecosystems. Research opportunities exist in the development of detection tools for these and other invasive species of concern. As well, research is needed to define the ecological and economic impacts of recent and historically introduced species.

Damage to native pines in Ontario by pine shoot beetle

Taylor Scarr

Forest Health and Silviculture Section, Forest Management Branch, Ontario Ministry of Natural Resources, 70 Foster Drive, Suite 400, Sault Ste. Marie, Ontario, Canada, P6A 6V5

Gord Howse

Canadian Forest Service, Natural Resources Canada, Great Lakes Forestry Centre, 1219 Queen Street East, Sault Ste. Marie, Ontario, Canada, P6A 5M7

Presented at the Forest Pest Management Forum 99, November 16-17, 1999, Ottawa, Ontario, Canada

Introduction

Pine shoot beetle (*Tomicus piniperda* (L.)) was first discovered in Ontario in 1992. Subsequent surveys have found it in 26 counties or regional municipalities in southwestern Ontario. The current distribution is bounded by the infested counties of Northumberland to the east, and Victoria and Simcoe counties to the north.

Until 1998, all reports indicated the insect was benign. No high populations were detected, and damage to live trees was limited to minor shoot attack. The Canadian Food Inspection Agency (CFIA) undertook no management activities. The CFIA did impose a quarantine restricting imports of pine roundwood, Christmas trees, and unprocessed bark from infested counties in the U.S., and domestic quarantine affecting shipments out of infested counties in Ontario. Surveys were limited, consisting mostly Lindgren funnel traps baited with generic alpha-pinene lures, placed in counties adjacent to those already known to be infested. If a single beetle was found in a county, that county was deemed infested and under quarantine. The traps were then moved to the next county.

Pine shoot beetle in Ontario, 1998

This view of this insect changed in 1998. During joint surveys conducted under a Memorandum of Understanding between the Ontario Ministry of Natural Resources (OMNR) and the Canadian Forest Service (CFS), this insect was found to be in high populations in several locations in southwestern Ontario. It was found to be attacking both Scot's pine, and native pines: red, white, and jack pine. Tree mortality was evident, as was extensive shoot attack. Stands of pines were turning red from the damaged shoots, and as trees died. These stands became visible during aerial surveys. Several of the stands with the highest populations were in counties outside the quarantine area, and not known to be infested.

In many cases, sources of brood material were quite evident, such as piles of pine logs adjacent to standing pine trees, or leveling of a Christmas tree plantation next to a remaining plantation. In other sites, no obvious source could be detected. In some of these sites, the Scot's pine seemed relatively healthy prior to shoot attack. In other cases, the trees appeared to be under stress from Diplodia tip blight or drought.

Eight stands were studied in more detail in 1998. One stand of pure Scot's pine showed over 80% mortality due to pine shoot beetle (after all other sources such as root rot were eliminated). Mortality varied in the remaining seven stands, ranging from 0% in a pure white pine stand, to 28% in Scot's pine stands or stands of Scot's pine mixed with other pines. Counts of dropped shoots on the ground ranged from 38 shoots/10m^2 to 118 shoots/10m^2.

Age of shoot attack varied by host species. The original Pest Risk Assessment done by the CFIA for pine shoot beetle indicated the beetle's preference for larger diameter shoots may make jack pine less susceptible to attack than Scot's pine. The insect, though, simply attacked older shoots further back on the branch. On jack pine, 72% of the attacks were on shoots two or three years old, whereas on Scot's pine, only 50% of the shoots attacked were two or three years old. Thus a single beetle attacking a jack pine can do greater damage by taking out a shoot with two or three years of shoot growth, compared to a beetle attacking Scot's pine and killing only one year's growth.

Pine shoot beetle in Ontario, 1999

There was no appreciable expansion of the area of severe pine shoot beetle damage in 1999. Trapping surveys by the CFS-OMNR Forest Health Monitoring program found the beetle in three additional counties: Essex, Kent, and Victoria. A formal, extensive survey was conducted by the CFIA, CFS, and OMNR from Dubreuiville (to the east of Lake Superior), to Sault Ste. Marie, St. Joseph Island, Thessalon, Espanola, Nairn Center; Sudbury, and Sturgeon Falls. The focus was on Scots' pine plantations, Christmas tree farms, and pines near mill sites. No pine shoot beetle damage was found during this visual survey, although several suspect shoots damaged by native insects were detected.

Surveys conducted by the CFS-MNR Forest Health Monitoring program looked for pine shoot beetle in the districts of Muskoka and Parry Sound, and eastern Ontario. No pine shoot beetles were found. Likewise, an on-going study into the response of red pine insects to the 1998 ice storm in eastern Ontario did not find any pine shoot beetles.

Five additional stands were added to the investigation into the severe infestations in southwestern Ontario. The data are currently being collected.

OMNR also initiated a study in 1999 with the CFS on the factors affecting the pine shoot beetle dynamics in the areas of severe infestation. A new, possibly enhanced lure for funnel traps is being evaluated as part of this study.

Conclusion

The view of this insect changed in 1998 when high populations were detected and implicated in causing mortality to native pine species. No doubt there is more going on in southwestern Ontario than just pine shoot beetle. Nonetheless, its high populations, and its ability to kill trees, indicate it could be a serious threat to North American pines.

It remains to be seen whether the presence of Scot's pine is critical for the beetle to reach damaging populations. If Scot's pine is critical, the insect will have little impact on ecosystems. Trade impacts, though, could still be important.

If Scot's pine is not critical, then the insect could be devastating for pine forestry.

Management activities, such as harvesting, spacing or thinning, or block cuts, as well as natural forces such as blowdown, fire, or other insects, could create brood material for the beetle. These contributing factors would then have to be addressed to mitigate the effects of the beetle.

Much more study is needed to assess the infestations in southwestern Ontario. Management recommendations can then be developed, and regulations revised appropriately.

Implications for Trade

Guy Bird

Canadian Forest Service
Industry, Economics and Program Branch

Trade & Bugs-the Link

- **IT'S ALL ABOUT PROTECTION**

- **ITS ALL ABOUT THE DELICATE BALANCE**

Trade & Bugs-the Link

PROTECTION

(what's at stake)

- ***PROTECT THE FORESTS***
- ***PROTECT OUR ECONOMY***
- ***PROTECT OUR TRADE***

PROTECTING THE FOREST

Canada's forests- 10 percent of the world's

Total	*417.6 million ha*
Commercial	*234.5 million ha*
Managed	*119.0 million ha*
Harvest	*1.0 million ha*

All values- biodiversity, habitat, recreation, conservation, fibre supply

PROTECTING THE ECONOMY

FOREST SECTOR CONTRIBUTION

- 877,000 jobs (1 in 16)
- Shipments $68.2 Billion (56% exported)
- $11 billion plus in wages & salaries

PROTECTING THE TRADE

- 2 of every 5 Cadn jobs export dependent
- Total Cadn exports $318.5 Billion
- Forest product exports $39.8 B (12.5%)
- Wood product exports $14.8 Billion
- Canada accounts for just under 20% of the world's trade in forest products

PROTECTING THE TRADE

- **Canadian Imports**

1998- $298.5 Billion   1995- $225.50b298

- **From the USA**

1998- $203.5b (68.1%) 1995- $150.6b (66.8%)

- **From Asia**

1998- $38.2 b (12.8%) 1995- $29.8b (13.2%)

- **From China**

1998-$7.6b (2.6%)   1995- $4.6b (2.0%)

Trade & Bugs-the Link

The Delicate Balance

- ***PROTECT THE FORESTS***
- ***PROTECT OUR TRADE***
- ***MEET OUR INTERNATIONAL OBLIGATIONS***

Trade & Bugs-the Link

The Golden Rule

Do unto others as you would have them do unto you

in plant health

Don't do unto others as you don't want them to do unto you

Trade & Bugs-the Link

STRIKING A BALANCE BETWEEN

- protecting the forest
- facilitating trade

or

- protecting the forest
- protecting the market

WE HAVE SEEN THEM ALL

Trade & Bugs-the Link

The Famous ALHB

- US takes action - restrictions on packaging (appears justified)
- the source seems evident- implications far reaching
- affects range of products

Trade & Bugs-the Link

PACKAGING /DUNNAGE A special case

- **A high risk pathway**
- **Hard to quantify risk and detect**
- **We don't normally ship packaging**
- **We ship buttons, bulldozers, toys, shoes or machinery maybe wood products but not only wood products.**

Trade & Bugs-the Link

One Year Later

- Chinese regulations against USA*
- Same product (packaging)
- Covers a pest they already have (pwn)

- Forest health or something else?

*Footnote- China not member of WTO- no recourse

Trade & Bugs-the Link

*Another Footnote:

- Canada an export dependent country but a modest economic power
- We need a strong rules based trading system- we wouldn't win a trade war
- We need that WTO SPS code

Trade & Bugs-the Link

The EU Plant Health Regs (PWN)

- Long-standing issue
- Cost Cadn producers not less than $400 million annually
- No amount of Science and information has convinced EU to change rules
- SPS Code might help - but a long process no guarantees- market damage done

Trade & Bugs-the Link

WE NEED SCIENCE

- TO PROTECT OUR FORESTS
- TO ENSURE OUR MARKET ACCESS
- TO ENSURE OUR REGULATIONS PASS THE TEST

Alien forest pests: biodiversity and biosystematics issues

Ole Hendrickson
Canadian Forest Service
Science Branch, Ottawa

Alien forest pests: general concerns

- Aliens lack natural enemies and can cause vastly more damage than natives
- Host tree has no evolutionary history with pest - may have minimal defenses or may over-react (e.g., a rapid inducible resistance) and in the process kill itself
- Coupled with native pests and normal, abiotic stresses and strains, aliens may overshoot tree's resilient capacity

Outline for this talk

- Case studies of alien fungal pathogens
- Review of Niemela and Mattson (1996), "Invasion of North American forests by European phytophagous insects"
- General conclusions: impacts for biodiversity and biosystematics
- Action at international level under Convention on Biological Diversity

History of beech bark disease

- Beech scale introduced to Nova Scotia around 1890
- Spread westward and southward through forests of Canada and the United States.
- Present in Ontario, northeastern Ohio
- Recently discovered in the Great Smoky Mountain National Park along the Tennessee-North Carolina border

Beech trees + C. *fagisuga* + *Nectria* spp. = Beech bark disease

- Exotic beech scale insect, *Cryptococcus fagisuga* Lind., attacks beech bark
- Scale attack makes beech susceptible to killing attacks by fungi of genus *Nectria*
  - The principal fungus, *Nectria coccinea* var. *faginata* Lohm. and Watson, was probably introduced also
  - The native pathogen, *Nectria galligena* Bres., also attacks and kills bark predisposed by scale

Interactions with other species

- No invertebrate parasites of beech scale
- Ladybird beetle *Chilocorus stigma* Say is most common predator, responds to high scale densities, but tends to disperse and fails to feed on all life stages of scale
- Scale colonies often develop initially under patches of epiphytic mosses and lichens
- Trees with upper branch surfaces covered by mosaics of dense, smooth crustose lichens often remarkably disease-free

Beech bark disease - Phase 1

- Scale populations build rapidly to high levels, may kill outer bark cells and cause fissuring; insect alone rarely damages the cambium
- Infection of bark by one or both *Nectria* pathogens soon follows infestation.
- Bark exudation ("tarry spots"), which can result from many other causes as well, is often the first sign that bark has been killed by *Nectria*.
- Massive invasion by the pathogens of scale-infested trees usually ensues; often, more than 50 percent of the beech trees > 25 cm dbh are killed

Beech bark disease: Phase 2

- Opening-up of stands by mortality or salvage of diseased trees can lead to dense sprout and seedling-origin stands, overly rich in beech and impoverished in associated species
- Aggregations of cankers develop over time, and trees become increasingly defective, but are seldom girdled and killed quickly as in phase 1
- Severely affected trees lose vigor, grow slowly, are replaced by less severely diseased and resistant beech trees and trees of other species

Three North American tragedies: Chestnut blight, butternut canker and Dutch elm disease

- American chestnut eliminated from eastern forests as a dominant species by chestnut blight (*Cryphonectria parasitica* (Murr.) Barr)
- Butternut is being extirpated, as butternut canker (*Sirococcus clavigigenti-juglandacearum* Nair, Kostichka & Kuntz) spreads to northern areas
- Urban and forest American elm populations decimated by Dutch elm disease (*Ophiostoma ulmi* (Buis.) Narruf. and *O. nova-ulmi*).

History of Dutch elm disease

- Disease first entered the US on shipments of unpeeled veneer logs from Europe.
- Dying American elms were first observed in Cleveland, Ohio in May 1930
- Pathogen first isolated in Canada in 1944, linked to shipment of elm crates from France in ~ 1940
- Disease now has spread throughout most of North America
- All three native elm species at risk

Rapid spread of butternut canker

- Fungus first appeared in North America approximately 40-50 years ago
- Thought to be an introduced pathogen owing to its sudden appearance
- Believed to have been first established in southeast US
- Recently detected in New Brunswick

Threat of butternut extinction

- US Forest Service estimates that 77 % of the butternuts in the Southeast are dead
- Surviving trees heavily infected, not reproducing
- Unlike chestnuts, butternuts do not sprout after stem death
- Fungal spores carried on the fruit husks
- When a population becomes infected, that particular gene pool has the potential to be permanently lost.

Little is known about the causal agent of butternut canker

- *Sirococcus clavigignenti- juglandacearum* is a member of the "Fungi Imperfecti": sexual stage remains unknown
- Lack of knowledge about its physiology and genetics hinders the development of a comprehensive strategy for saving butternut
- Survival of large butternut trees in localities where most trees have been destroyed suggests genetic resistance may be present.

Loss of chestnut as a dominant species

- An exotic fungal root rot disease, *Phytophthora cinnamomi* Rands, infested southern populations as early as 1824
- Thought to have caused mortality of chestnut primarily in low, moist areas
- Chestnut blight was introduced in late 1800s, spread rapidly through range (~ 40 km/year)
- Chestnut continues to sprout from roots
- Placed on COSEWIC list in 1987

More chestnut blight history

- *Cryphonectria parasitica* first recorded 1904 in New York City
- Japanese chestnut trees (*Castanea crenata* Siebold & Zucc.) had been imported since 1870s, were widely distributed, sold by mail order
- Chinese chestnut trees (*Castanea mollissima* Blume), first imported in 1900, were another source of blight in southern US
- Led to passage of US Plant Quarantine Act in 1912

Uncertain future for chestnut

- Blight-resistant chestnut likely in near future, but *Phytophthora cinnamomi* will restrict planting
- Chestnut faces another exotic pest, chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu): infestations first reported in 1974 in southern US, spreading northward
- Larvae feed upon bud and flower tissue forming a characteristic gall and producing a toxin that can kill the infested branch.
- Severe infestations can cause tree mortality

Effects of loss of chestnut

- American chestnut was once the dominant hardwood species in eastern North America
- Produced large crops of nuts eaten by wildlife and humans
- Oaks, hickories, and other trees that have replaced the chestnut have less food value

Negative synergies among aliens?

- Both gypsy moth (*Lymantria dispar* L.) and chestnut blight were introduced to North America in late 1800s
- Oak species replaced chestnut following rapid spread of chestnut blight
- This created more extensive oak forests susceptible to gypsy moth

"Insect trade imbalance" between Europe and North America

- About 300 of the ~ 400 established alien insect species in North America are from Europe; only 34 have made reverse journey
- Not caused by different total numbers of species, unlikely to reflect trade volumes
- Could reflect greater ecological opportunities here, or greater competitive ability of European species

Ecological Opportunities

- More potential host tree species in North America, with less fragmented distribution
- European insects able to colonize new tree species congeneric with their original host
- European "weeds" established here (e.g., Scots pine harbors *Tomicus piniperda* L.)
- Higher insect species loading in Europe
- Hard to break into smaller, isolated forest pockets in Europe

Competitive ability

- Higher selection pressure in Europe for ability to disperse and invade disturbed habitats (biota more severely impacted by glaciation)
- Polyploidy and parthenogensis (e.g., adelgids, sawflies, scolytids, scales)
- High to low latitude transfers and diapause
- Early spring emergence (e.g., *T. piniperda*, *L. dispar*)
- Evidence for displacement of native species (e.g., European sawfly leafminers on *Betula*)

Problematic invasive forest plants

Latin name	English name	Nature of problem
Centaurea diffusa Lam.	Diffuse knapweed	Conifer survival & growth, interior BC
Cytisus scoparius (L.) Link	Scotch broom	Endangered Garry oak ecosystems, Douglas-fir regeneration, Vancouver Island, BC
Morus alba L.	White mulberry	Hybridizes with endangered red mulberry
Rhamnus cathartica L.	European buckthorn	Highly invasive in forest edges, floodplains, ON, QC, Maritimes

Impacts of alien pests on biodiversity

- Loss of genetic variation in host species (possibly leading to extinction)
- Secondary effects on other species owing to loss of habitat provided by host species
- Displacement of native flora and fauna
- Altered ecosystem succession
- Loss of productivity and resilience, impacts on ecosystem services

Implications for biosystematics

- Multi-agency approaches
- Maintain reference collections and diagnostics expertise for plants, insects, fungi
- Guidelines for depositing voucher specimens

Convention on Biological Diversity

- Substantive treatment of alien species at fourth meeting of Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA)
- Draft guiding principles will be considered at fifth SBSTTA meeting, and these may be recommended for adoption at policy level
- Outline for case-studies has also been prepared

Draft guiding principles

- General (precautionary approach, priority to prevention, state responsibility, research and monitoring, education and awareness)
- Prevention (quarantine, information exchange, capacity building and cooperation)
- Introduction (prior assessment if deliberate, provisions for unintentional introductions)
- Mitigation of impacts (eradication if feasible, otherwise containment, control of damage)

Implications for CFS Science Program

Gerrit van Raalte

Regional Director General
Atlantic Forestry Centre
Fredericton, NB

CFS ROLE IN EXOTIC FOREST PESTS

EXOTICS (alien, introduced, invasive, non-indigenous)

- Significant present and potential impact
  - »global trade
  - »forest health
  - »biodiversity

CFIA AND CFS

- Complementary Roles
- MOU - July 1998

CFIA

- Mandate for quarantine regulation

  Plant Protection Act

- Detection/control/information

CFS

- Research/technical advice
- Source of expertise
  - » identification
  - » monitoring/dss
  - » risks and impacts
- Links between CFIA - provinces/ industry

CURRENT CFS S&T EFFORT

- Limited taxonomic/diagnostic capability
  - CFS establishments
  - Ottawa
- Limited research - examples
  - pine shoot beetle - GLFC
  - dss for gypsy moth spray - PFC
  - exotics in dunnage - PFC
  - DNA identification techniques - AFC, LFC

CURRENT CFS S&T EFFORT (continued)

- Collaboration in surveys
- Exotic pest advisories
- Collaboration in risk assessments
- Participation in provincial advisory councils

CURRENT INITIATIVES

- Federal Biosystematics Partnership
  - 5 NR S&T departments
  - Museum of Nature
- NAFC Insect and Disease Study Group
  - Sub-committee - CFIA chairs; 3 countries
  - Review current/required exotic pest research needs

CURRENT INITIATIVES (continued)

- CFS scientists task group
  - Examine current CFS exotics research
  - Prioritize objectives
  - Define realistic deliverables
  - Develop 5-year National/Cohesive Plan
  - Identify critical gaps

FUTURE

CFS considering entering interdepartmental discussions leading to a strong collaborative partnership on the exotic pests issue.

Session IV - Applied Research, Emerging Technologies and Innovations
Chair: Normand Lafrenière

Séance IV - Recherche appliquée, technologies nouvelles et innovations
Président: Normand Lafrenière

Development of bioherbicides for management of competing forest vegetation in conifer regeneration sites.

Simon F. Shamoun, Ph.D
Research Scientist- Biological Control of Forest Diseases and Weeds

Abstract

The discovery and development of fungal pathogens as potential biological control agents (mycoherbicides) to suppress competing forest vegetation (forest weeds) is receiving increased attention in the management of conifer regeneration sites in North America. . Biological control agents need to be sufficiently virulent to mitigate the aggressiveness of competing vegetation, while allowing crop trees to compete successfully to the free-to-grow stage. To manage hardwood weeds in conifer regeneration sites and utility rights-of-way, an experiment was conducted to test the efficacy of the wound pathogen *Chondrostereum purpureum* (Pers.:Fr.) Pouzar as compared to the herbicide Vision®. Results indicate that *C. purpureum* is as effective as Vision® for control of red alder. In another pathosystem, weedy *Rubus* spp. are being targeted due to their capacity to rapidly invade conifer regeneration sites and ecologically sensitive riparian zones, effectively reducing the growth and survival of young planted and naturally regenerating conifer seedlings. A potential candidate, *Fusarium avenaceum* (Fr.) Sacc. was selected and applied inundatively on target weeds under greenhouse conditions. Test plants receiving formulated *F. avenaceum* combined with 0.4% Silwet L-77® induced significant foliar necrosis. These two pathosystems are presented as examples for an applied biocontrol strategy for vegetation management in forestry and will be discussed in detail.

Keywords: mycoherbicides, *Chondrostereum purpureum*, *Fusarium*, competing forest vegetation, hardwood weeds, *Rubus*, dwarf mistletoes.

Mise au point de bioherbicides pour la lutte contre la végétation forestière concurrente dans les peuplements de conifères en régénération

Simon F. Shamoun, Ph.D.
Scientifique chercheur - Lutte biologique contre les maladies des arbres forestiers et les plantes nuisibles

Résumé

La découverte et la mise au point de champignons phytopathogènes comme agents potentiels de lutte biologique (mycoherbicides) contre la végétation forestière concurrente suscitent de plus en plus d'intérêt en Amérique du Nord pour la gestion des peuplements de conifères en régénération. Les agents de lutte biologique doivent être suffisamment virulents pour contrer la nature agressive de la végétation concurrente tout en permettant aux arbres d'avenir de résister à la compétition exercée par les mauvaises herbes jusqu'à ce qu'ils atteignent le stade de croissance libre. Pour lutter contre les feuillus indésirables dans les peuplements de conifères en régénération et les emprises de services publics, nous avons réalisé une expérience afin de comparer le potentiel de l'agent pathogène de blessure *Chondrostereum purpureum* (Pers:Fr.) Pouzar à celui de l'herbicide Vision®. Cette expérience a révélé que le *C. purpureum* est aussi efficace que l'herbicide Vision® contre l'aulne rouge. Dans un autre pathosystème, diverses espèces nuisibles de *Rubus* retiennent notre attention du fait qu'elles peuvent envahir rapidement les peuplements de conifères en régénération et les zones riveraines écologiquement sensibles et compromettre la croissance et la survie des semis de conifères tant plantés qu'issus de la régénération naturelle. Un champignon candidat, le *Fusarium avenaceum* (Fr.) Sacc., a été choisi et appliqué en serre de façon massive sur des mauvaises herbes. Une nécrose foliaire prononcée a été observée chez les mauvaises herbes qui avaient reçu une formulation de *F. avenaceum* combinée à du Silwet L-77® à 0,4 %. Nous présentons et décrivons en détail ces deux pathosystèmes afin d'illustrer une stratégie de lutte biologique appliquée contre la végétation forestière concurrente.

Mots-clés : mycoherbicides, *Chondrostereum purpureum*, *Fusarium*, végétation forestière concurrente, feuillus indésirables, *Rubus*, faux-guis.

Development of bioherbicides for management of competing forest vegetation in conifer regeneration sites.

Simon F. Shamoun, Ph.D
Research Scientist- Biological Control of Forest Diseases and Weeds

Development of alternatives to existing forest vegetation methods, such as chemical herbicide application and manual brushing, has become important in forest management plans due to economic constraints and increasing public concern over pesticide use. With rising demands for forest products, there is a need for intensification of forest management to raise productivity. Interference by non-commercial or competing vegetation (forest weeds) will continue to be a serious problem in management of young conifer plantations. Control of competing vegetation can take many forms, including removal by mechanical or manual brushing and chemical herbicides (Wall *et al.* 1992). These methods have distinct disadvantages such as environmental concern, non-target effects, and cost-effectiveness. This has necessitated a more intensive search for alternative management strategies for invasive forest weeds that are cost effective, efficacious, environmentally safe and sustainable (Jobidon 1991, Watson and Wall 1995). The idea of using plant pathogens for management of weeds is not new. However, the concept of the development of a bioherbicide technology as a specialized field of study is very young. The use of a biological control strategy in natural ecosystems entails the enhancement of naturally occurring plant pathogens, thus quickening the decline of competing vegetation through the manipulation of these pathogens. The expected result should be an increase in early conifer growth rate and a shorter rotation age of commercially valuable crop trees (Wall and Hasan 1996).

As in other ecosystems, three major biological control strategies are being used with respect to management of competing forest vegetation: classical, inundative (bioherbicde or mycoherbicide), and augmentative (silvicultural manipulation). The classical biocontrol strategy has been used to control exotic forest weeds. The inundative strategy using indigenous plant pathogens is one of the more promising approaches for management of native forest weeds. The augmentative strategy of forest stands has been promoted by sound research based on knowledge of the biology of plant pathogens, autecology of the target weeds and the ecology of forest ecosystems (Wall 1984, Wall *et al.* 1992). Markin and Gardner (1993) and Wall and Hasan (1996) and have reviewed in detail numerous examples of forest weed biocontrol initiatives worldwide.

A focussed program on development of biological control agents for forest weeds was established at the Canadian Forestry Service-Pacific Forestry Centre (CFS-PFC) in 1986 (Dorworth 1990). Among the target weeds considered were *Acer macrophyllum* Pursh, *Alnus rubra* Bong., *Calamagrostis canadensis* (Michx.) Beauv., *Epilobium angustifolium* L., *Gaultheria shallon* Pursh, *Populus tremuloides* Michx., and *Rubus* spp., including wild red raspberry [*Rubus strigosus* Michx. = *R. idaeus* var. *strigosus* (Michx.) Focke], thimbleberry (*R. parviflorus* Nutt.), and salmonberry (*R. spectabilis* Pursh). Plant pathogens from these weeds have been isolated, identified and tested for their potential use as biological control agents (Dorworth 1990, Wall and Shamoun 1990, Oleskevich *et al.* 1998). To date, researchers at CFS-PFC have successfully secured four U.S. patents on different biological control pathosystems, including biological control of *C. canadensis* with *Colletotrichum* sp. and *Fusarium* sp. (Winder 1995), control of *A. rubra* with *Nectria ditissima* Tul.

(Dorworth 1994), biological control of weed trees with *C. purpureum* (Wall *et al.* 1996) and biological control of weedy *Rubus* spp. with *Fusarium avenaceum* (Shamoun and Oleskevich 1999).

The use of *Chondrostereum purpureum* has been tested on hardwood weed species and efforts are directed towards commercialization of the mycoherbicide "ECOclear™", according to an agreement between CFS-PFC and MycoLogic Inc., University of Victoria, British Columbia (BC), Canada. Recently, a promising biological control agent *Fusarium avenaceum*, for weedy *Rubus* spp. and *C. canadensis* has been tested, and further research is underway for its development as a bioherbicide (Oleskevich *et al.*, 1998, Winder 1999). A combined action of *F. avenaceum* and rhizobacteria has been proposed as a potential biocontrol strategy for *C. canadensis* (Winder and Macey 1998). Research efforts are underway to elucidate the interaction of various endophytic fungi with *Alnus* spp. and *Rubus* spp., and to assess their potential use as mycoherbicides (Sieber *et al.* 1991, Shamoun and Sieber 1993, Shamoun and Sieber 1999). In addition to native competing forest vegetation, there is a group of parasitic plants such as dwarf mistletoes (*Arceuthobium* spp.), which have lost their ability to manufacture carbohydrates through photosynthesis and adapted to a parasitic mode of existence are often lumped with forest weeds groups. In areas under retention silviculture (partial harvesting systems), commercially valuable conifer species heavily infected by mistletoe show reduced vigor and height and diameter growth. At CFS-PFC, a new research project on biological control of dwarf mistletoes was initiated as a result of forest industry clients demand. To date, several fungal parasites associated with dwarf mistletoes, shows potential promise as biological control agents, such as *Colletotrichum gloeosporioides*, *Nectria neomacrospora*, and *Cylindrocarpon gillii*, and *Caliciopsis arceuthobii* (Shamoun 1998, Shamoun and DeWald 1999).

The objective of this article is to illustrate two case studies: 1) *C. purpureum* as a potential biological control for *A. rubra* in conifer regeneration and utility rights-of-way sites, and 2) *F. avenaceum* as a potential control agent for invasive *Rubus* spp. in conifer regeneration and riparian sites.

Pathosystem I: *Chondrostereum purpureum* - *Alnus rubra*

Traditionally, periodic manual brushing of competing tree species or spraying with chemical herbicides in conifer regeneration sites and within rights-of-way (ROW) has been used. These approaches have serious disadvantages, including high labour requirements, resprouting from cut stumps, and concerns over soil and water contamination. Recently, biological control of invasive hardwood trees using the fungus *C. purpureum* to suppress regrowth has been suggested (Scheepens and Hoogerbrugge 1989, Wall 1994, Shamoun *et al.* 1996, Dumas *et al.* 1997). This strategy could considerably increase intervals between repeat cutting operations in conifer regeneration sites and ROW, particularly if sufficient effectiveness is attained and automation of simultaneous brushing and stump treatment operations was developed. A biological control strategy using *C. purpureum* would have a low likelihood of soil or water contamination and minimal risk to non-target plant species (de Jong *et al.* 1996, Ramsfield *et al.* 1996, Shamoun and Wall 1996).

A research program was established to develop and register *C. purpureum* as the first mycoherbicide for use in Canadian forests as an essential component of an integrated forest vegetation management in conifer reforestation sites and utility ROW (Shamoun and Hintz 1998a).

Pathosystem II: *Fusarium avenaceum* - *Rubus* spp.

Biological control strategies that utilize microbial control organisms or their secondary metabolites are receiving greater consideration for use within conifer regeneration sites. A research project focusing on the biological control of *Rubus* spp. using indigenous fungi has been established. Three *Rubus* spp., wild raspberry, thimbleberry and salmonberry are being targeted due to their capacity to rapidly invade reforestation sites, effectively reducing the growth and survival of many conifer species in Canada and the northern United States (Oleskevich *et al.* 1996). The study has thus far assessed fungi associated with *Rubus* stem and leaf diseases and selected a candidate pathogen, *F. avenaceum*. The biological control strategy utilizes inundative levels of fungal inoculum applied as a foliar spray to incite leaf damage and to temporarily suppress *Rubus* growth. Inoculum production methods, amendment of inocula with adjuvants, and co-application with low doses of glyphosate have been investigated to increase fungal pathogenicity (Abbas *et al.* 1995, Oleskevich *et al.* 1998).

Materials and Methods

Pathosystem I: *Chondrostereum purpureum* - *Alnus rubra*

The site for this field experiment was established under a utility ROW near Duncan, BC (48°49'N, 123°50'W) encompassing healthy red alder (*A. rubra*) of 5-10 cm diameter, in September 1994. Within a randomized block design containing 30 plots, six treatments were compared: two fungal formulations (*C. purpureum* isolates PFC 2139, PFC 2140), a control formulation treatment, two chemical treatments (12% Vision® spray and a carbopaste formulation of Vision®), and manual cutting (slash). Alder trees were cut with a brushing chain saw and the appropriate treatment was applied manually to the cut wood surface. *Chondrostereum purpureum* was grown on nutrient base, formulated, and dried in the laboratory, and subsequently resuspended and applied as a paste to cut stumps (Wall *et al.* 1996). During the following two growing seasons, data collected included occurrence of resprouting from stumps, the number of living sprouts per stump, and stump mortality based on the presence and absence of living sprouts. The presence of fruiting bodies of *C. purpureum* and other basidiomycetes on treated stumps was assessed 18 mo post-treatment.

Pathosystem II: *Fusarium avenaceum* - *Rubus* spp.

F. avenaceum was collected and purified from diseased foliage and stems of wild raspberry from central (49° to 54° latitude) and coastal British Columbia, between May to September, 1990-1994. *F. avenaceum* caused foliar damage in pathogenicity tests on detached *Rubus* leaves.The optimum temperature for *F. avenaceum* growth and germination was determined through testing. As well, agar, liquid, and grain media were evaluated for their ability to promote *F. avenaceum* growth and sporulation.

Inundative applications of conidial inoculum were made to *Rubus* plants in shadehouse trials. Plants were rated for up to 3 wk after inoculation and compared to control plants, and experiments were repeated. In efforts to enhance pathogenicity, amendments to *F. avenaceum* inoculum included nutrients (sucrose, neopeptone, malt, sodium alginate), humectants (starch, psyllium hydrophilic muciloid), dispersants (Tween 80, wetting agents), stickers/surfactants (Silwet L-77®- Loveland Industries, Greeley, CO, USA), and formulation into an invert emulsion. The strategy of combining

F. avenaceum with low doses of glyphosate (RoundUp® - Monsanto Canada, Sardis, BC, Canada) to increase host susceptibility was assayed, after determining the effect of the herbicide on fungal growth and germination. The presence of phytotoxins produced by *F. avenaceum* grown in a rice medium was also investigated (Oleskevich *et al.* 1998).

Results and Discussion

Pathosystem I: *Chondrostereum purpureum* - *Alnus rubra*

Resprouting of cut alder stumps occurred throughout the six treatments by spring 1995, reaching a maximum height of 50 cm among resprouts within the slash treatment. Resprout mortality occurred on many stumps by mid-summer, resulting in 65-100% mortality (Table 1). Alder stumps treated with *C. purpureum* and with herbicides showed significantly less living sprouts than other treatments, with a mean of less than 1 living resprout per stump. Analysis of first year data by planned contrasts revealed that *C. purpureum* and herbicide treatments resulted in similar levels of stump mortality and resprouting of alder, and were statistically different from the formulation control and slash treatments. Both fungal treatments gave similar results. At 2 yr post-treatment (1996), > 95% stump mortality was recorded on stumps treated with fungal and herbicide treatments, with PFC 2139 and Vision® reaching 100% mortality. In comparison with 1995, all treatment plots had less resprouting and higher stump mortality. Analysis of 1996 data the trend showed a trend similar to 1995, that the overall *C. purpureum* treatments were not significantly different from herbicides but were different from the formulation controls and slash treatment.

Fruiting bodies of *C. purpureum* were observed about 18 mo after *C. purpureum* inoculation of red alder stumps. The peak of *C. purpureum* fruiting bodies was found in spring 1996, on 66% and 84% of the stumps treated with PFC 2139 and PFC 2140 respectively, on about 19% of stumps treated with herbicides, and on 43% of stumps which had received the formulation control and slash treatment (Table 2). Fruiting bodies of *Trametes (Coriolus) versicolor* (L.:Fr.) Pil. and *Schizophyllum commune* Fr. and other basidiomycetes were observed on many stumps in all treatment plots.

Results of these tests, and similar large scale field trials conducted in the conifer reforestation sites of BC interior (Harper *et al.* 1998), Ontario (Dumas *et al.* 1997) and in the Netherlands (de Jong *et al.* 1990), indicate that *C. purpureum* is quite effective as a biological control agent of stump sprouting of alder, aspen and American black cherry, respectively.

Pathosystem II: *Fusarium avenaceum* - *Rubus* spp.

Fusarium avenaceum, maximum colony growth and spore germination was observed between 10-30°C and 15-25°C, respectively, A formulation of *F. avenaceum* was developed by growing the fungus on rice grain (Abbas *et al.* 1995), and subsequent inoculum combined with an organosilicone surfactant at a concentration 0.4% Silwet L-77®, enhanced greater foliar damage than other formulations (data not shown). Extensive foliar necrosis occurred with this formulation within 24-48 h on wild *R. strigosus* and *R. parviflorus*, resulting in large areas of necrotic leaf tissue, leaf curl and death. *Rubus strigosus* was the most susceptible to the formulated spray, followed by *R. parviflorus* and *R. spectabilis*, respectively. Analysis of variance showed significant differences between *F. avenaceum* and Silwet L-77® treatment and all other treatments for *R. strigosus* ($F=61.39, P<0.001$), *R. parviflorus* ($F=38.43, P<0.001$) and *R. spectabilis* plants ($F=12.39, P<0.001$) (Table 3). All treated *Rubus* spp. flushed new leaves by 3 weeks, and the new foliage and stems were free of damage symptoms. A preliminary host- range study showed no effects on major conifer species when sprayed with *F. avenaceum* and Silwet L-77®. . The incorporation of low- doses of glyphosate was not further pursued, as the combined action of *F. avenaceum* with glyphosate did not exceed that of glyphosate alone (data not shown). Phytotoxin extraction and analysis of *F. avenaceum*- infested rice filtrates revealed a single toxin, moniliformin at levels of 3 300 p.p.m. (Oleskevich et al. 1998). The enhancement of foliar necrosis by the combined action of *F. avenaceum* and Silwet L-77® may have been achieved by stomatal egress and through the maximum uptake of *Rubus* plants of the phytotoxin, moniliformin (Stevens 1993, Shamoun and Oleskevich 1999). Similar results were demonstrated on *Ascochyta pteridis* Bers. for biocontrol of bracken [*Pteridium aquilinium* (L.) Kuhn.] (Womack and Burge 1983), and most recently, by using *F. avenaceum* for biocontrol of *C. canadensis* (Winder 1999). The biorational strategy for management of weedy *Rubus* spp. and other agricultural weeds is a promising approach (Abbas *et al.* 1991, Jobidon 1991). Ongoing research is underway to screen other phytotoxins associated with *F. avenaceum* isolates collected from *Rubus* spp. by using biochemical and tissue culture techniques (Hollmann *et al.* 1999). Based on the research results by Oleskevich *et al.* (1998) and Shamoun and Oleskevich (1999), ongoing research activities are being focused on using biorational applications of the formulated *F. avenaceum* on invasive weedy *Rubus* spp. in conifer and riparian regeneration sites. .

Conclusions and general prospects

Biological control strategy for management of competing vegetation is poised to become an essential component of forest management practices. Plant pathogenic fungi are presently considered the most promising biological control agents. Research and development on this subject was a result of public pressure and demand for alternative management strategies that are cost-effective, environmentally safe and sustainable (Wagner 1993).

Recent advances in formulation technology, phytopathology, molecular biology and silviculture have accelerated the commercialization and production of three biological control products for management of invasive and competing forest vegetation in South Africa, The Netherlands and Canada, respectively (STUMPOUT®, BioChon®, and ECOclear™) (Morris *et al.* 1998, Ravensberg 1998, Shamoun and Hintz, 1998a, 1998b). Traditionally, classical biological control approach has been used for control of introduced weeds. Development of bioherbicide/mycoherbicide is more promising strategy for management of indigenous forest weeds. The augmentative biological control has special relevance for forestry and therefore could be termed as "silvicultural manipulation" strategy which can be promoted by sound research programs based on ecology of forest ecosystems, biology of plant pathogens and autecology of target weeds. Biological control agents will likely provide alternatives to some chemical herbicides and other unpractical vegetation management tools. The enhancement of the effectiveness and safe use of biological control agents can be achieved by integrating them with manual brushing practices, such as application of ECOclear™ or STUMPOUT® on cut stump of hardwood weeds, or combining foliar pathogens such as *Fusarium avenaceum* with adjuvants/surfactants or low-doses of registered herbicides for foliar applications onto target weeds.

The main concern to both regulatory authorities and to the public in general, in using fungal pathogens for control of forest weeds, is their potential threat to non-target plants. This is especially relevant to classical biological control strategy, where exotic pathogens are introduced into new ecosystems. In contrast, risk analysis of indigenous fungal pathogens used as mycoherbicides (e.g. *C. purpureum*) is extremely low, according to the investigations by de Jong *et al.* (1990). Recently, results based on advanced epidemiological modeling systems and molecular analyses and monitoring (e.g. PCR-DNA technology: RAPD, RFLPs, rDNA and mtDNA) studies, have revealed the safe use of native fungal pathogens (de Jong *et al.* 1996, Becker *et al.* 1999, Gosselin *et al.* 1999, Ramsfield *et al.* 1996 Ramsfield *et al.* 1999). In contrast, most of the plant pathogens that have caused serious losses to forest tree species in the new world were introduced accidentally in forest products and nursery stocks, such as Dutch elm disease, chestnut blight, and white pine blister rust disease (Manion, 1981), and not through using native plant pathogens via planned biological control programs (Cook *et al.* 1996). The potential use of biotechnological techniques to enhance the efficacy of biological control agents is very promising strategy for development of bioherbicides (Watson and Wall 1995). From a practical, sociological, economical and ecological viewpoint, bioherbicide technology should be viewed as an essential component of an integrated forest vegetation management that will be employed in combination with manual brushing, mechanical removal, adjuvants/surfactants, plant growth regulators, and reduced doses of chemical herbicides. Current research on forest weed biocontrol should yield several improvements in forest management, including new commercial products and more widely acceptable approaches to forest management.

References

Abbas, H.K., C.D. Boyette, R.E. Hoagland, and R.F. Vesonder. 1991. Bioherbicidal potential of Fusarium moniliforme and its phytotoxin, fumonisin. Weed Sci. 39: 673-677.

Abbas, H.K., C.D. Boyette, and R.E. Hoagland. 1995. Phytotoxicity of *Fusarium*, other fungal isolates, and of the phytotoxins fumonisin, fusaric acid, and moniliformin to jimsonweed. Phytoprotection 76:17-25.

Becker, E.M., L.A. Ball, and W.E. Hintz. 1999. PCR-based genetic markers for detection and infection frequency analysis of the biocontrol fungus *Chondrostereum purpureum* on sitka alder and trembling aspen. Biol. Contr. 15: 71-80.

Cook, R. J., W. L. Bruckart, J.R. Coulson, M.S. Goettel, R.A. Humber, R. A. Lumsden, R.D. Maddox, J.V. McManus, M.L. Moose, L. Meyer, P.C. Quimby, J.P. Stack and J.L. Vaughn. 1996. Safety of microorganisms intended for pest and plant disease control: a framework for scientific evaluation. Biol. Contr. 7: 333-351.

de Jong, M.D., P.C. Scheepens, and J.C. Zadocks.1990. Risk analysis for biological control: A Dutch case study in biocontrol of *Prunus serotina* by the fungus *Chondrostereum purpureum*. Plant Dis. 74: 189- 194.

de Jong, M.D., E.Sela, S.F. Shamoun, and R.E. Wall. 1996 Natural occurrence of *Chondrostereum purpureum* in relation to its use as a biological control agent in Canadian forests. Biol. Contr. 6: 347-352.

Dorworth, C.E. 1990. Mycoherbicides for forest weed biocontrol- the PFC enhancement process, pp.: 116-119 In: Bassett et al. (eds.), Alternatives to chemical control of weeds, Proc. Int. conf. At the Forest Research Inst., Rotorua, New Zealand, FRI Bull. 155.

Dorworth, C.E. 1994. Method for controlling red alderusing *Nectria ditissima* ATCC 74260. U.S. Patent No. 5,340,578.

Dumas, M.T., J.E. Wood, E.G. Mitchell and N.W. Boyonoski. 1997. Control of stump sprouting of *Populus tremuloides* and *P. grankikentata* by inoculation with *Chondrostereum purpureum*. Biol. Contr. 10: 37-41.

Gosselin, L., R. Jobidon, and L. Bernier. 1999. Genetic variability and structure of Canadian populations of *Chondrostereum purpureum*, a potential biophytocide. Molec. Ecology 8: 113-122.

Harper, G.J., P.G. Comeau, W.E. Hintz, R.E. Wall, R. Prasad, and E. M.Becker. 1998. Second-season efficacy results of *Chondrostereum purpureum* applications on aspen and sitka alder in British Columbia. Pp.:121-123, In: Wagner, R.G. and D.G. Thompson (Compilers). Third Int. conf. On Forest Vegetation Management: Popular summaries, Ont. Min. of Nat. Resour., Ont. For. Res. Inst., For. Res. Info. Paper No. 141.

Hollmann, P.J., S.F. Shamoun and S.P. Lee. 1999. Establishment and characterization of weedy *Rubus* tissue cultures for *in vitro* bioassays of *Fusarium avenaceum* phytotoxins. Phytopathology 89 (6): S 34 (Abstract).

Jobidon, R. 1991. Some future directions for biologically based vegetation control in forestry research. For. Chronicle 67: 514-519.

Manion, P. D. 1981. Tree Disease concepts. Prentice- Hall, Inc., Englewood Cliffs, New Jersey, 389 pp.

Markin, G.P. and D.E. Gardner. 1993. Status of biological control in vegetation management in forestry. Can. J. For. Res. 23: 2023-2031.

Morris, M.J., A. R. Wood and A. Den Breeyen. 1998. Development and registration of a fungal inoculant to prevent re-growth of cut wattle tree stumps in South Africa, and a brief overview of other bioherbicide projects currently in progress. P. 15, In: IV International Bioherbicides Workshop- Programme and Abstracts. August 06-07, 1998, University of Strathclyde, Glasgow, Scotland. (Abstract)

Oleskevich, C., S.F. Shamoun, and Z.K. Punja. 1996. The biology of Canadian weeds. No. 105. *Rubus strigosus* Michx., *R. parviflorus* Nutt., *R. spectabilis* Pursh. Can. J. Plant Sci. 76:187-201.

Oleskevich, C., S.F. Shamoun, R.F. Vesonder and Z.K. Punja. 1998. Evaluation of *Fusarium avenaceum* and other fungi for potential as biological control agents of invasive *Rubus* species in British Columbia. Can. J. Plant Pathol. 20:12-18.

Ramsfield, T.D., E.M. Becker, S.M. Rathlef, Y. Tang, T.C. Vrain, S.F. Shamoun, and W. E. Hintz. 1996. Geographic variation of *Chondrostereum purpureum* detected by polymorphisms in the ribosomal DNA. Can. J. Bot. 74:1919-1929.

Ramsfield, T.D., S. F. Shamoun, Z.K. Punja and W.E. Hintz. 1999. Variation in the mitochondrial DNA of the potential biological control agent *Chondrostereum purpureum*. Can. J. Bot. (In press).

Ravensberg, W.J. 1998. BioChon® effective biological and environmentally friendly product. Koppert Biological Systems (The Netherlands) Pest leaflet, 2 pp.

Scheepens, P.C. and A. Hoogerbrugge. 1989. Control of *Prunus serotina* in forests with the endemic fungus *Chondrostereum purpureum*, pp. 545-551. *In* E.S. Delfosse [ed.], Proceedings, 8th International Symposium on Biological Control of Weeds, 6-11 March, 1988, Rome Italy.

Shamoun, S.F. and T.N. Sieber. 1993. Isozyme and protein patterns of endophytic and disease syndrome associated isolates of *Melanconium apiocarpum* and *M. marginale*. Mycotaxon 49: 151-166.

Shamoun, S.F. and R.E. Wall. 1996. Characterization of Canadian isolates of *Chondrostereum purpureum* by protein content, API ZYM and isozyme analyses. Europ. J. For. Pathol. 26:333-342.

Shamoun, S.F., Ramsfield, T.D., G. Shrimpton and W.E. Hintz. 1996. Development of *Chondrostereum purpureum* as a mycoherbicide for red alder (*Alnus rubra*) in utility rights-of-way.. Page 19, *In* Comeau, P. and G. Harper (Eds.), Proceedings, Expert Committee on Weeds National Meeting, December 09-12, 1996., BC Min. of Forests, Res. Branch, Victoria, BC.

Shamoun, S.F. 1998. Development of biological control strategy for management of dwarf mistletoes. In: (R. Sturrock, compiler). Proceedings of the 45th Western International Forest Disease Work Conference (WIFDWC), pp. 36-42. Prince George, B.C. , September, 1997.

Shamoun, S.F. and L. DeWald.1999. Control of dwarf mistletoes by biological, chemical and genetic control methods. In: (Giels *et al.* Eds.)- Mistletoes of North American Conifers (In press).

Shamoun, S.F. and W.E. Hintz. 1998a. Development and registration of *Chondrostereum purpureum* as a mycoherbicide for hardwood weeds in conifer reforestation sites and utility rights-of-way. Page 14, *In* IV Int. Bioherbicide workshop programme and Abstracts. August 06-07, 1998, University of Strathclyde, Glasgow, Scotland.

Shamoun, S.F. and W.E. Hintz. 1998b. Development of *Chondrostereum purpureum* as a biological control agent for red alder in utility rights-of-way. Pages: 308-310, *In* Wagner, R.G. and D.G. Thompson (Compilers). Third Int. Conf. on Forest Vegetation Management. Popular summaries, Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Info. Paper No. 141.

Shamoun, S.F. and C. Oleskevich. 1999. *Fusarium avenaceum* and its use as biological control agent for *Rubus* species. U.S. Patent Application No. 09/086,346 (In press).

Shamoun, S.F. and T.N. Sieber. 1999. Colonization of leaves and twigs of *Rubus parviflorus* and *Rubus spectabilis* by endophytic fungi in a reforestation site in British Columbia. Mycol. Res. (In press).

Sieber, T.N., Siber-Canavesi, F.and C.E. Dorworth. 1991. Endophytic fungi of red alder (*Alnus rubra*) leaves and twigs in British Columbia. Can. J. Bot. 69: 407-411.

Stevens, P.J.G. 1993. Organosilicone surfactants as adjuvants for agrochemicals. Pestic. Sci. 38:103- 122.

Wagner, R.G. 1993. Research directions to advance forest vegetation management in North America. Can. J. For. Res. 23: 2317-2327.

Wall, R.E. 1984. The role of disease in removal of weed species from developing forest stands. PP. 673-676. *In* Delfosse, E. (Ed.). Proceedings VI Int. Sympos. Biol. Contr. Of weeds, 19-25 august, Vancouver, BC, Canada.

Wall, R.E. and S.F. Shamoun. 1990. Experiments on vegetation control with native pathogenic fungi in the southern interior of British Columbia. Can. For. Serv. And BC Min. of Forests, Forest Resources Development Agreement Rep. 134, Victoria, BC, 18 pp.

Wall, R.E. 1990. Biological control of red alder using stem treatments with the fungus *Chondrostereum purpureum*. Can. J. For. Res. 24:1527-1530.

Wall, R.E., R. Prasad, and S.F. Shamoun. 1992. The development and potential role of mycoherbicides for forestry. For. Chronicle 68:736- 741.

Wall, R.E. and S. Hasan. 1996. Management of plant pathogens for vegetation management control in forestry. PP. 1-19, *In* Raychaudhuri, S.P. and K. Maramorosch (Eds.). Forest Trees and Palms -Diseases and control., Oxford and IBH Publishing Co., PVT, Ltd. New Delhi, India.

Wall, R.E., R.Prasad and E. Sela. 1996. Biological control for weed trees. U.S. Patent No. 5,587,158.

Watson, A.K., and R.E. Wall. 1995. Mycoherbicides: their role in vegetation management in Canadian forests. *In* Recent progress in forest biotechnology in Canada, pp. 74-82. P.J. Charest and L.C. Duchesne, eds. Canadian Forest Service Information Report PI-X-120, Victoria, British Columbia.

Winder, R.S. 1995. Mycoherbicide and method for controlling *Calamagrostis canadensis.* U.S. Patent No. 5,472,690.

Winder, R.S. and D.E. Macey. 1998. Biological control of grasses in reforestation areas: problems and prospects.. Pages 360-362. *In* Wagner, R.G. and D.G. Thompson (Compilers). Third Int. Conf. on For. Vegetation Management: Popular summaries, Ont. Min. Nat. Resour., Ont. For. Res. Inst., For. Res. Info. Paper no. 141.

Winder, R.S. 1999. Evaluation of Colletotrichum sp. and Fusarium spp. as potential biological control agents for marsh reed grass (Calamagrostis canadensis). Can. J. Plant Pathol. 21: 8-15.

Womack, J.G. and M.N. Burge. 1993. Mycoherbicide formulation and the potential for bracken control. Pestic. Sci. 37:337- 341.

Table 1. Mortality and number of living sprouts on cut stumps of red alder treated with *Chondrostereum purpureum* or chemical herbicides.

Treatment	1995		1996	
	Mortality (%)	Living sprouts (no. per stump)	Mortality (%)	Living sprouts (no. per stump)
Slash control	65.00b	4.45a	86.00ab	1.18a
Formulation control	70.00b	3.49ab	72.00 b	0.37b
PFC 2140	83.00ab	0.95bc	96.00a	0.02b
PFC 2139	92.00a	0.45c	100.00a	0.00b
Vision® (spray)	97.00a	0.35c	99.00a	0.01b
Vision® (Carbopaste)	100.00a	0.01c	100.00a	0.00b

Treatments with the same letter are not significantly different ($P \leq 0.05$; Duncan's multiple range test).

Table 2. Occurrence (percentage) of fruiting bodies of basidiomycetes on red alder stumps.

Treatment	*Chondrostereum purpureum*	*Schizophyllum commune*	*Coriolus versicolor*	Others
Slash control	42bc	19a	28a	37a
Formulation control	43bc	17a	13ab	21b
PFC 2140	84a	15a	9b	11b
PFC 2139	66ab	13a	18ab	19b
Vision® (spray)	15c	3a	6b	11b
Vision® (Carbopaste)	23c	13a	4b	8b

Treatments with the same letter are not significantly different ($P \leq 0.05$; Duncan's multiple range test).

Table 3. Foliar necrosis of *Rubus* plants resulting from inundative applications of *Fusarium avenaceum* inoculum, originating from infested rice cultures, and combined with an organosilicone surfactant (Silwet L-77®), means + SEM.

Treatment	Foliar injury*		
	Rubus strigosus	*Rubus parviflorus*	*Rubus spectabilis*
control-water	0.44 + 0.18d	0.20 + 0.13c	0.20 + 0.13b
surfactant (Silwet L-77®)	1.89 + 0.26b	2.17 + 0.31b	0.67 + 0.21b
F. avenaceum	1.33 + 0.17c	1.38 + 0.38b	0.75 + 0.25b
F. avenaceum + (Silwet L-77®)	3.89 + 0.11a	3.31 + 0.18a	2.00 + 0.26a

*Foliar injury rating index with <2 = slight injury, 2-3.5 = moderate injury, and >3.5 = severe injury. Within a column, values followed by the same letter are not significantly different (P = 0.05; Student-Newman-Keuls test).

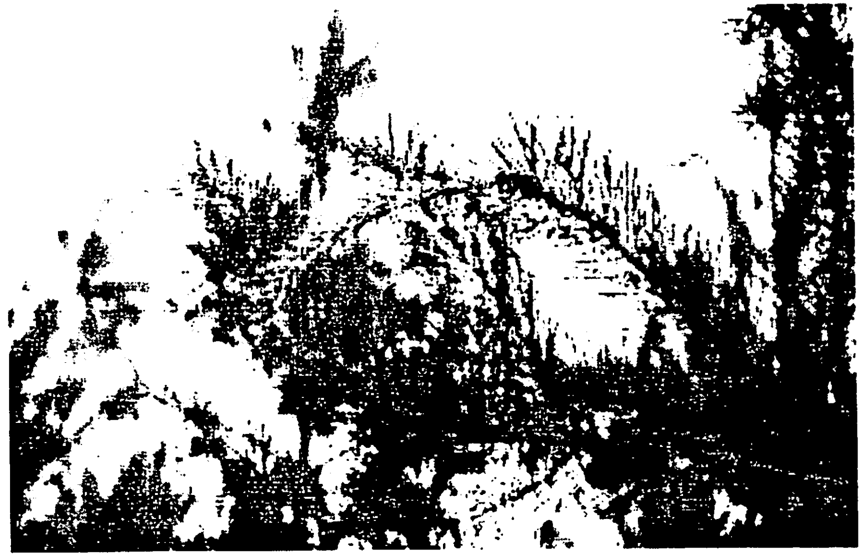
Changing Bark Beetle Fortunes & Their Natural Enemies

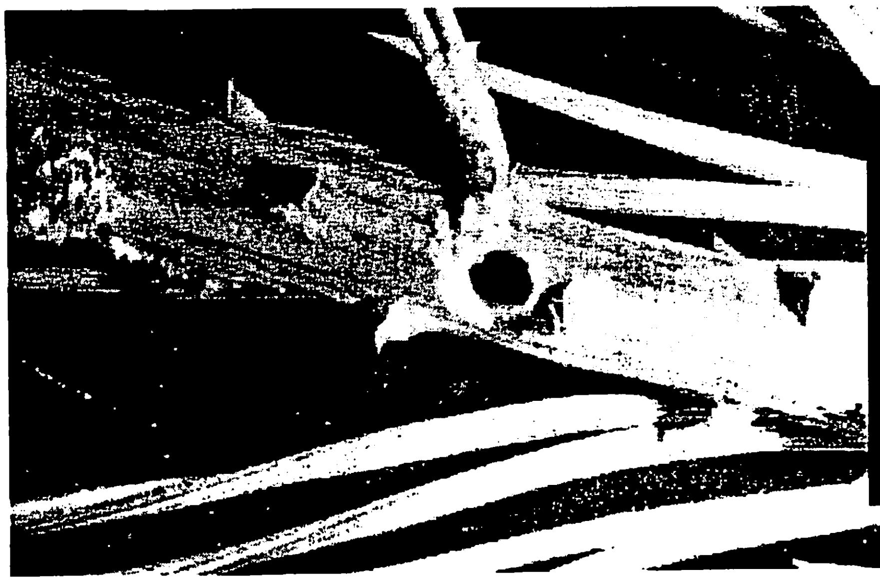
Perspectives from Research on *Tomicus* and Ice-Storm Damage

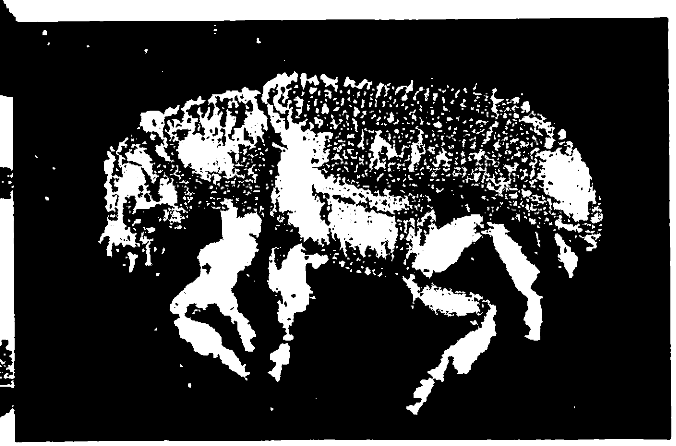
Pine Shoot Beetle

Tomicus piniperda

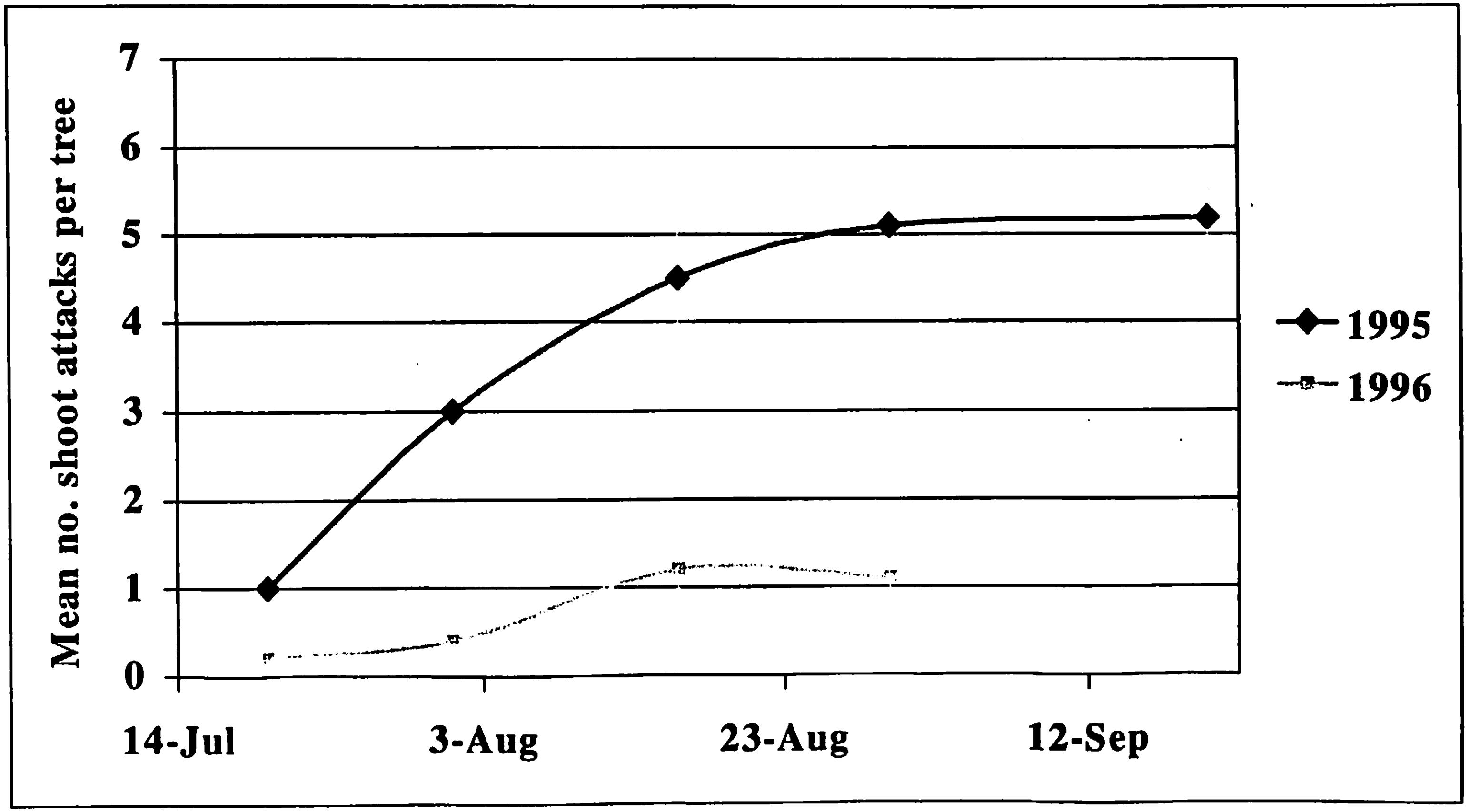
Summer/fall shoot-feeding



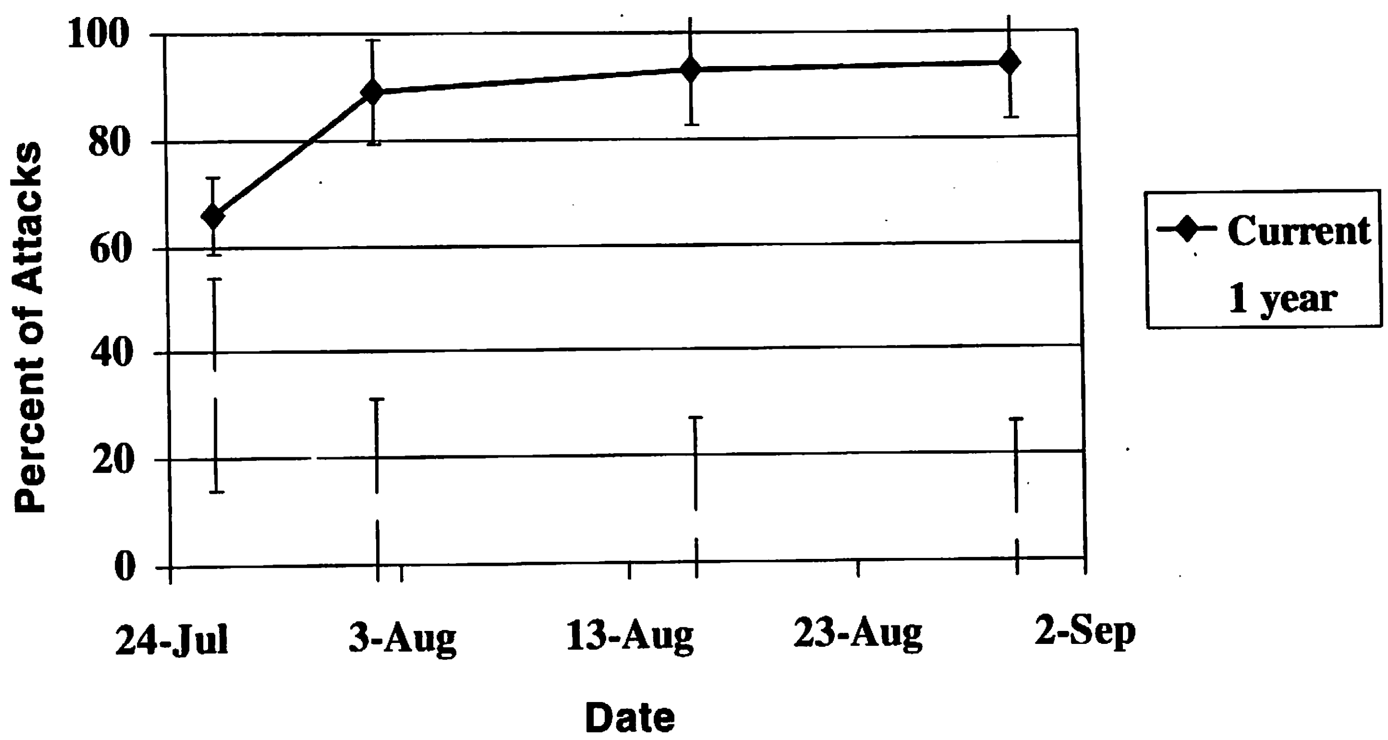




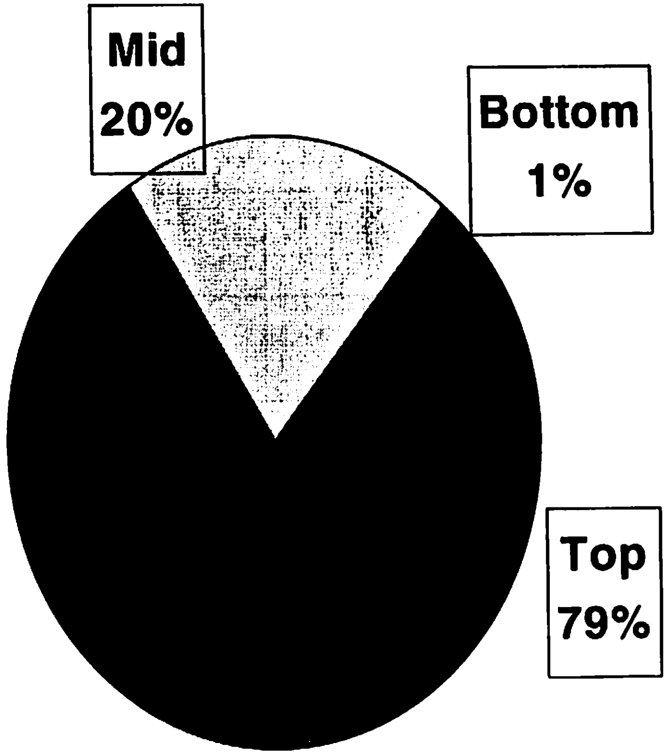
Shoot Feeding 1995 and 1996



Age of Attacked Shoots

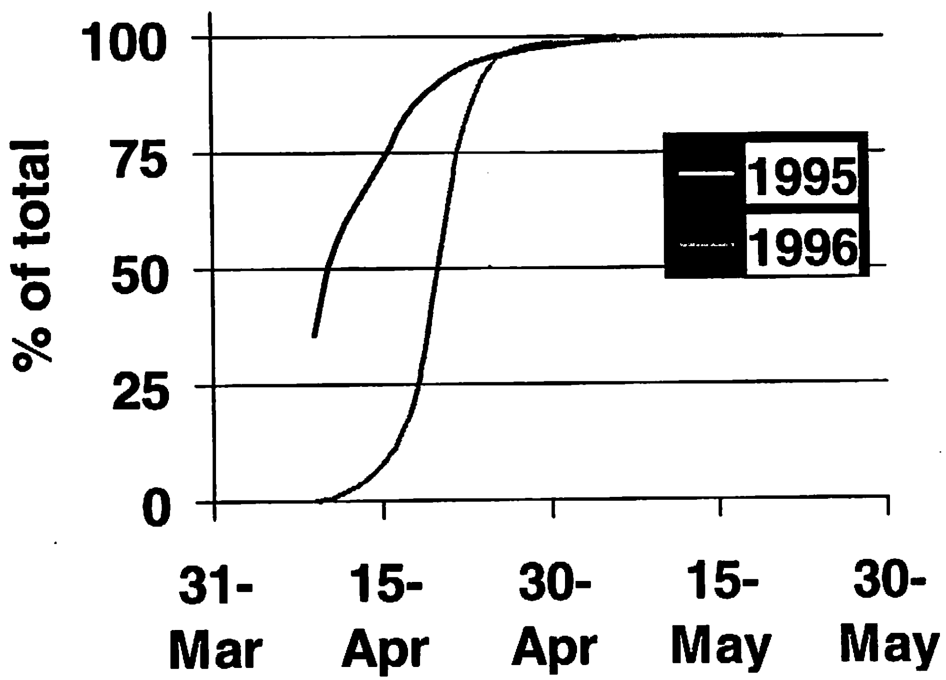


Location of Shoot Attacks in Tree Crowns

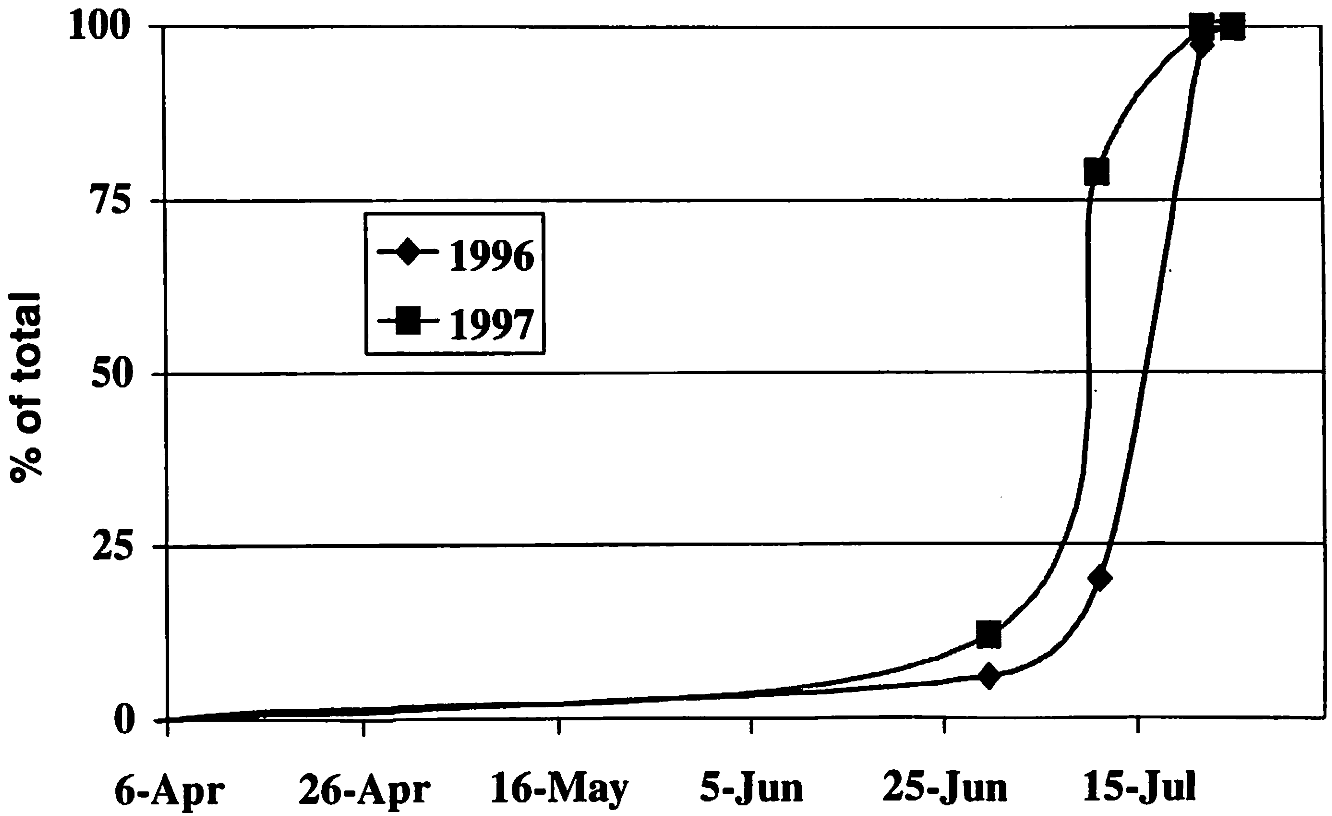


(n=222 shoots)

Colonization – Parental generation



Emergence - New generation

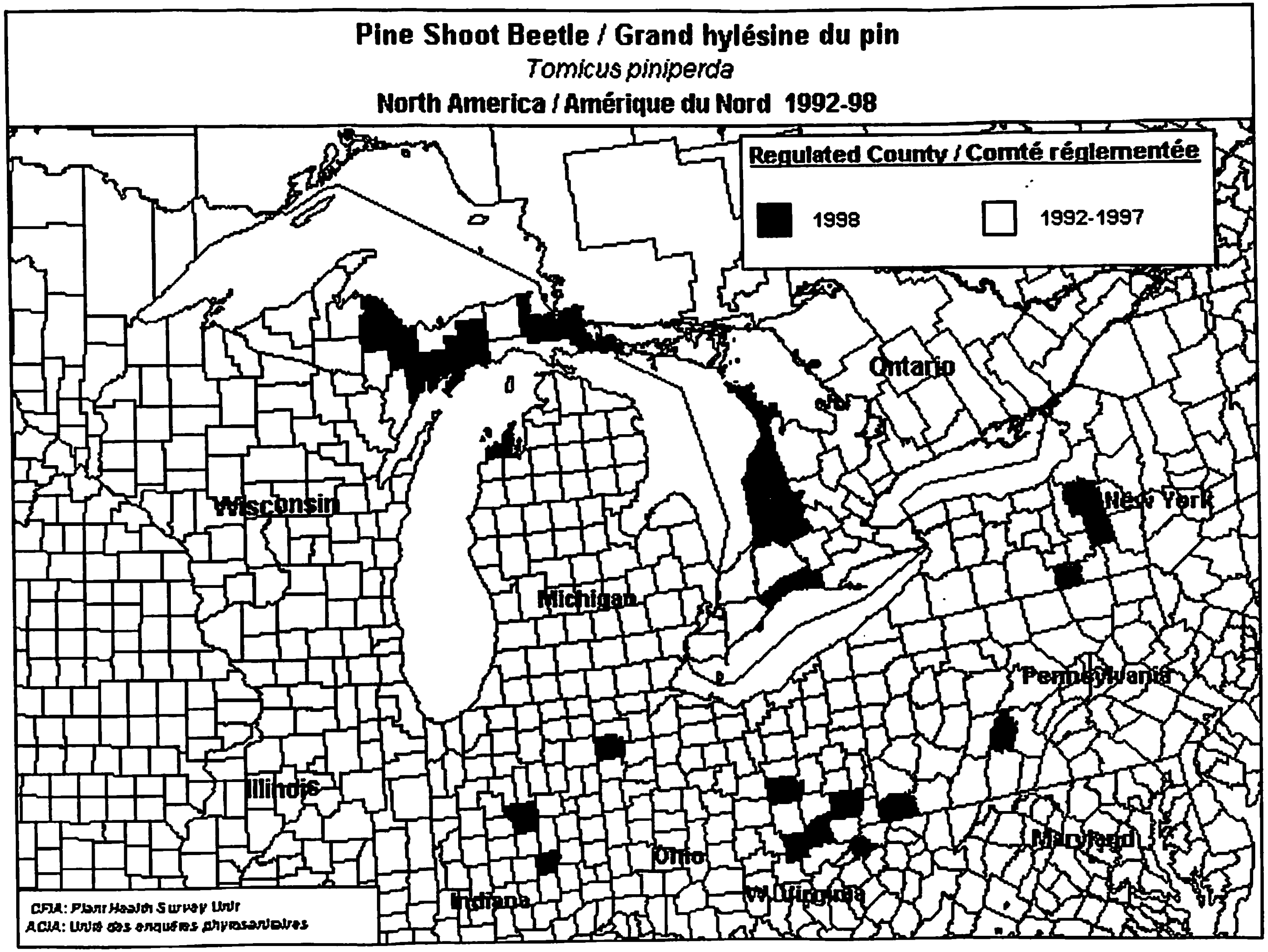


Other Associated Species

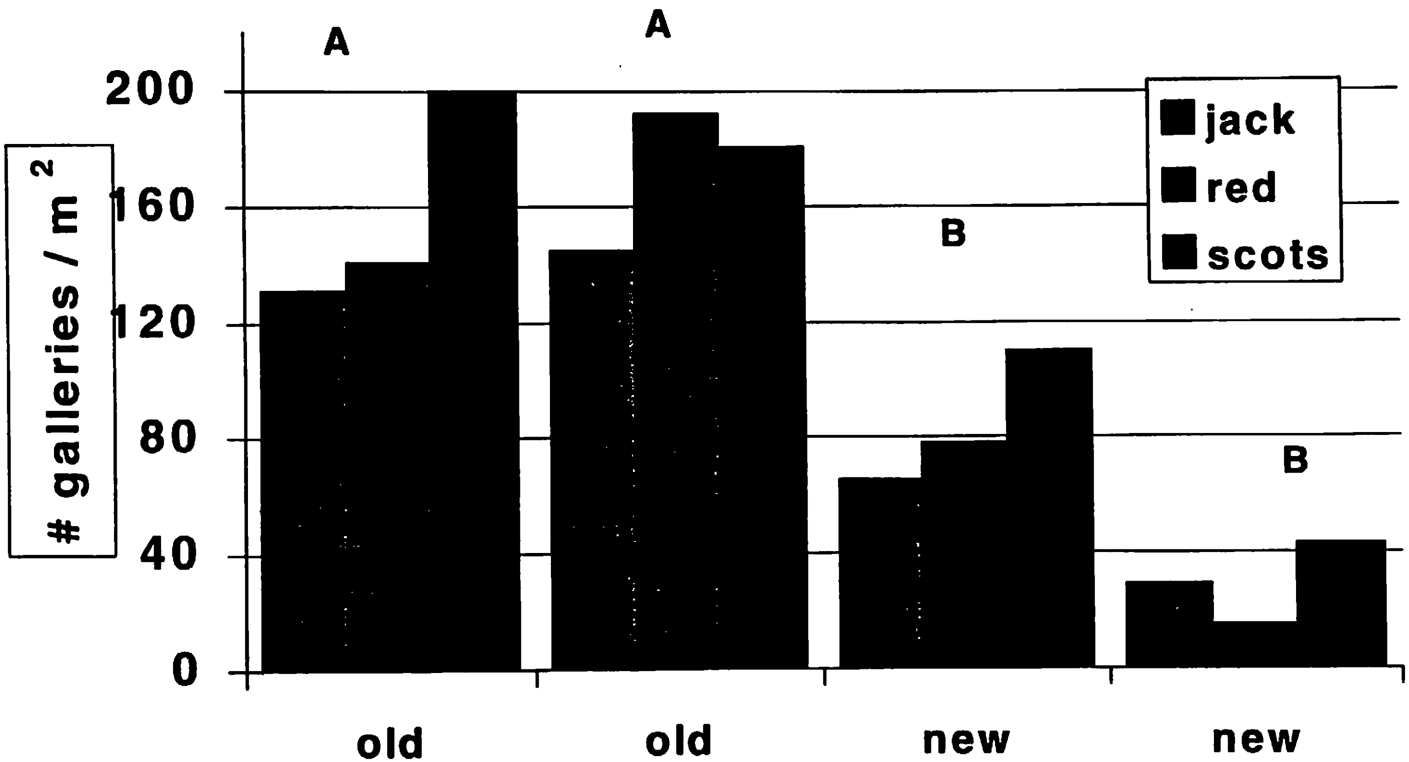
- *Ips pini, Pissodes approximatus, Hylastes opacus* (introduced)

- A few cerambycid larvae

- Varies greatly between sites and years
  - Oldest Site: Little except *Tomicus* since 1994
  - Newer sites, more of the above 3 spp.
  - No clear trend between high/low sites


Pine Shoot Beetle / Grand hylésine du pin
Tomicus piniperda
North America / Amérique du Nord 1992-98
Regulated County / Comté réglementée
1998
1992-1997
Ontario
Wisconsin
Michigan
New York
Pennsylvania
Illinois
Ohio
Indiana
Maryland
W Virginia
CFIA: Plant Health Survey Unit
ACIA: Unité des enquêtes phytosanitaires

Gallery Density – New vs Old Sites



* Significant difference between sites (p=0.001), but not between pine spp. (p=0.353)

Dinotiscus sp.

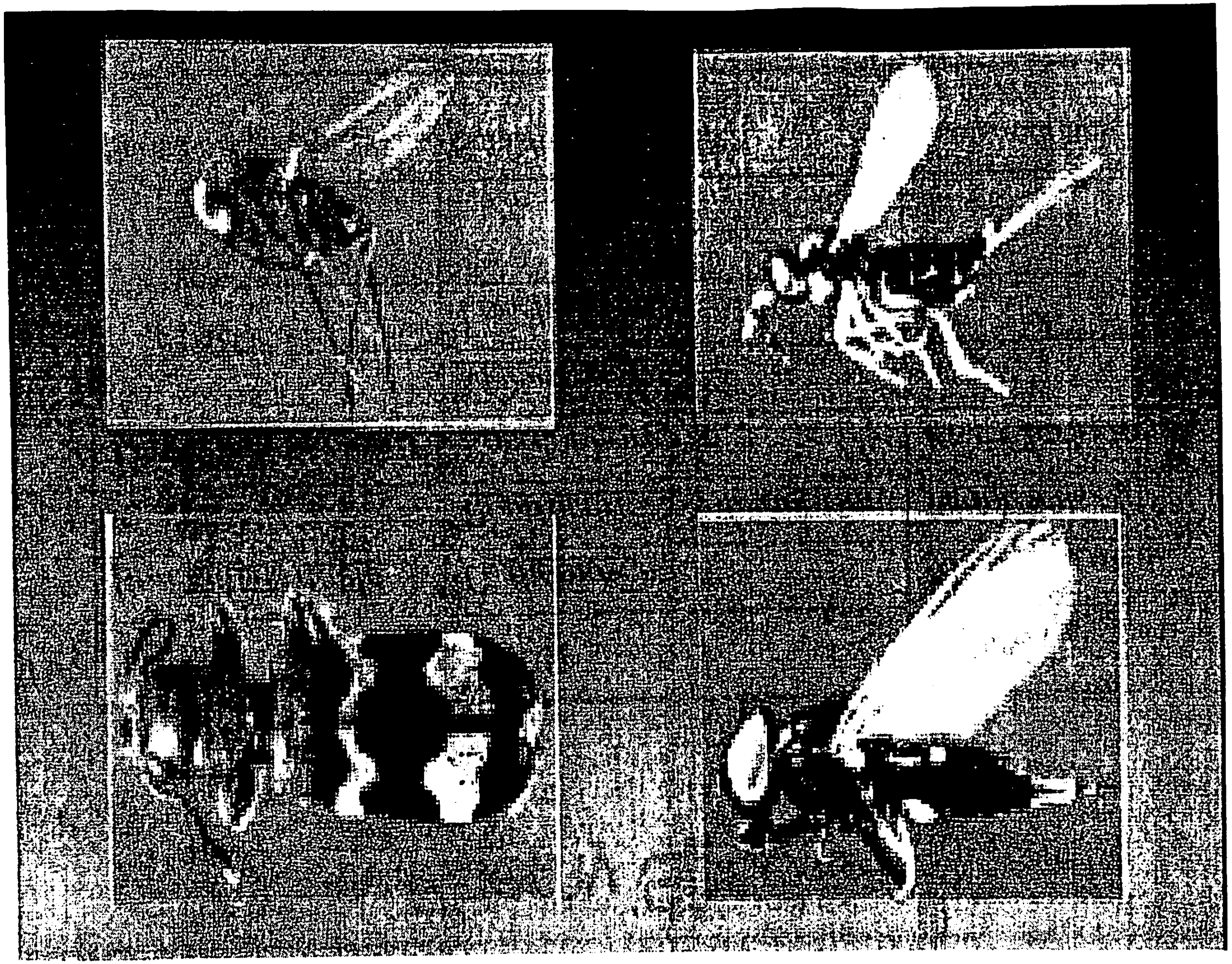
Rhopalicus sp.

Total % Parasitism – New *vs* Old

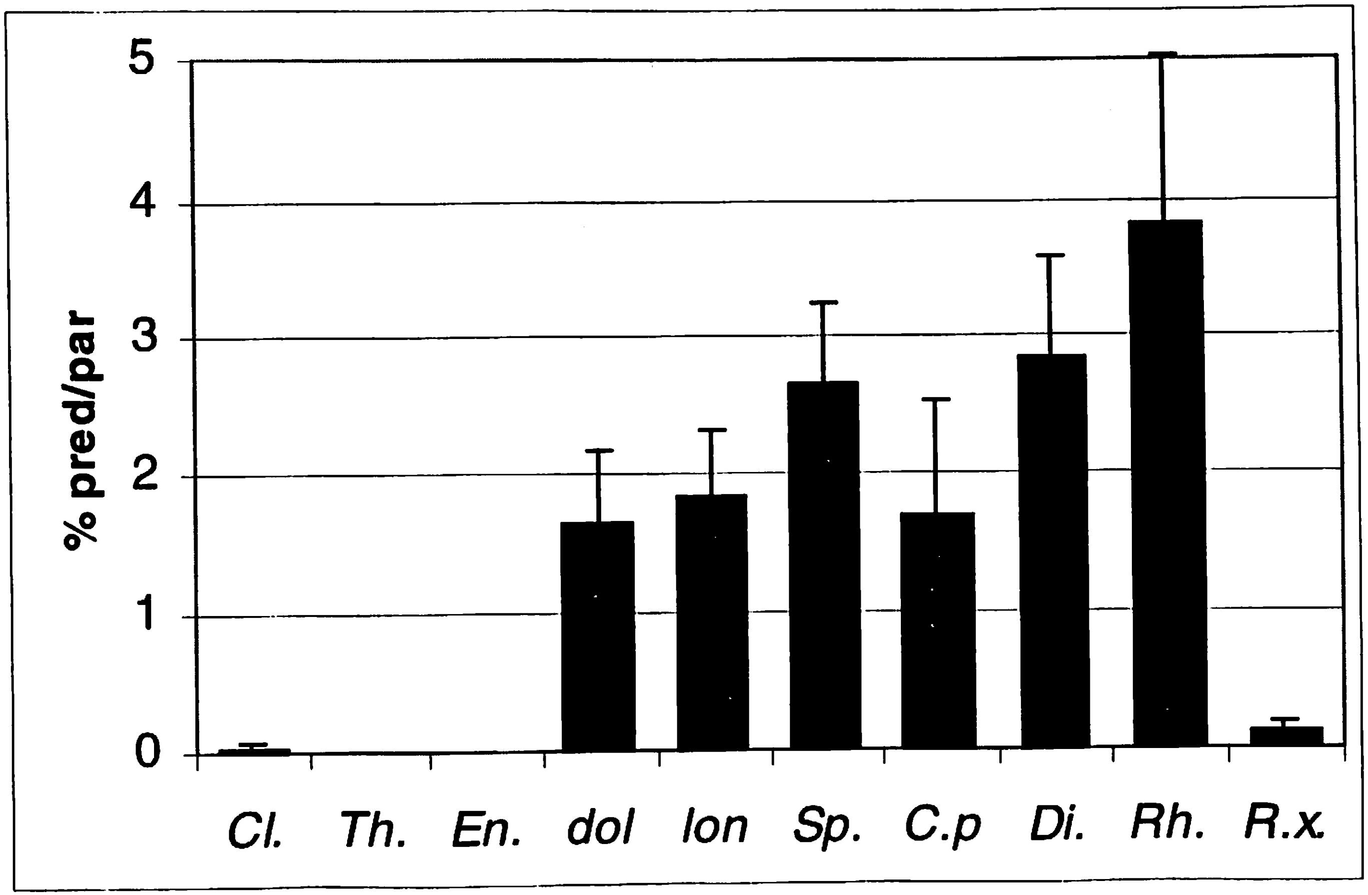
* Significant difference between pine spp. (p=0.001), but not between sites. (p=0.159)

New Enemy Species

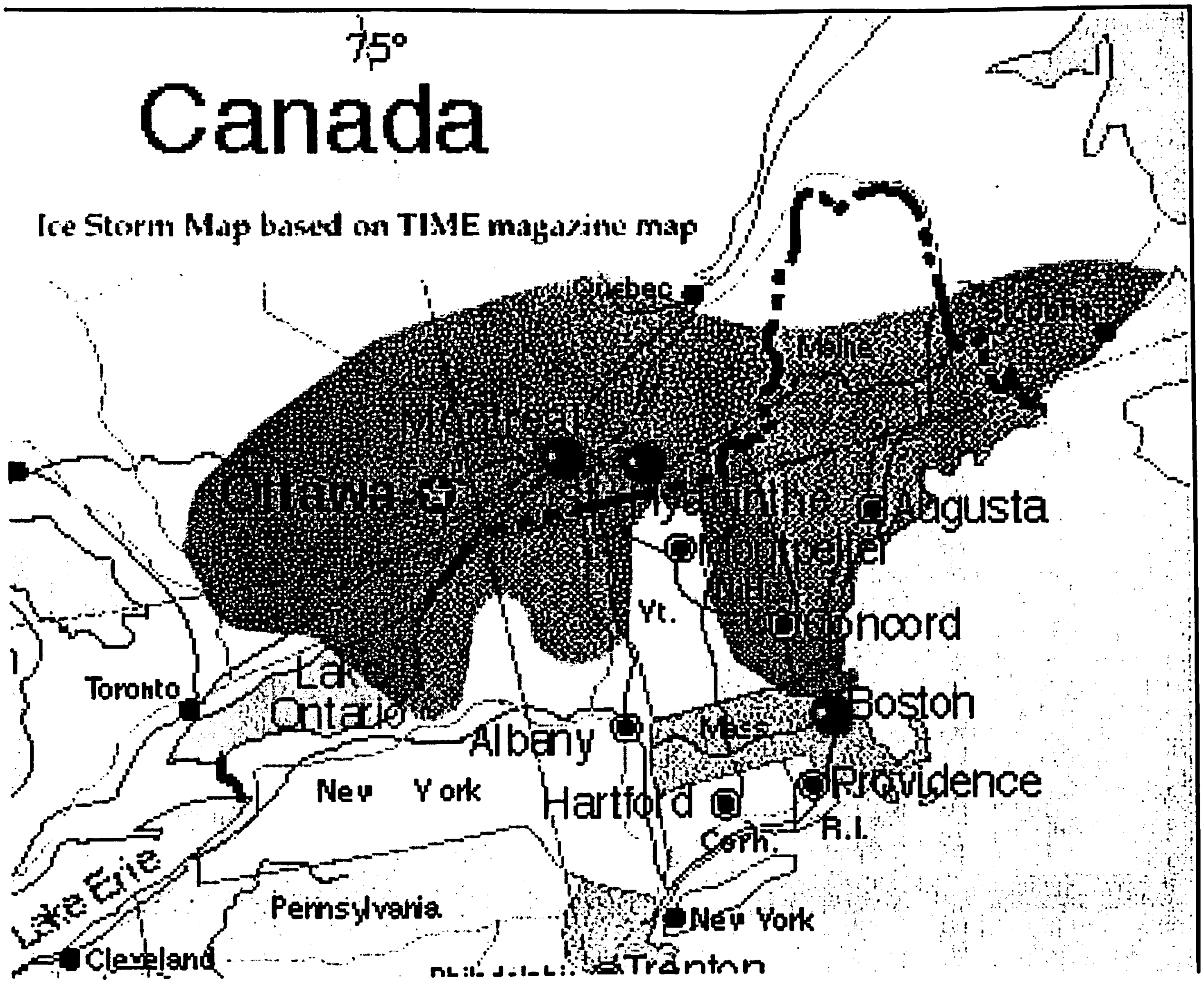
1996	1997	1998	1999
	Rhopalicus tutela	*D. thompsonii*	*Rh. pulchripennis*
		Roptrocerus xylophagorum	*Dinotiscus. sp?*
	Dinotiscus eupterus	*Ropalophorus sp.*	*Few Clerid larvae*
		Medetera sp.	
		Lonchaea sp.	
Scots pine	Scots/red/jack/pine	Scots/red/jack pine	Scots/red/jack pine



Natural Enemy Complex

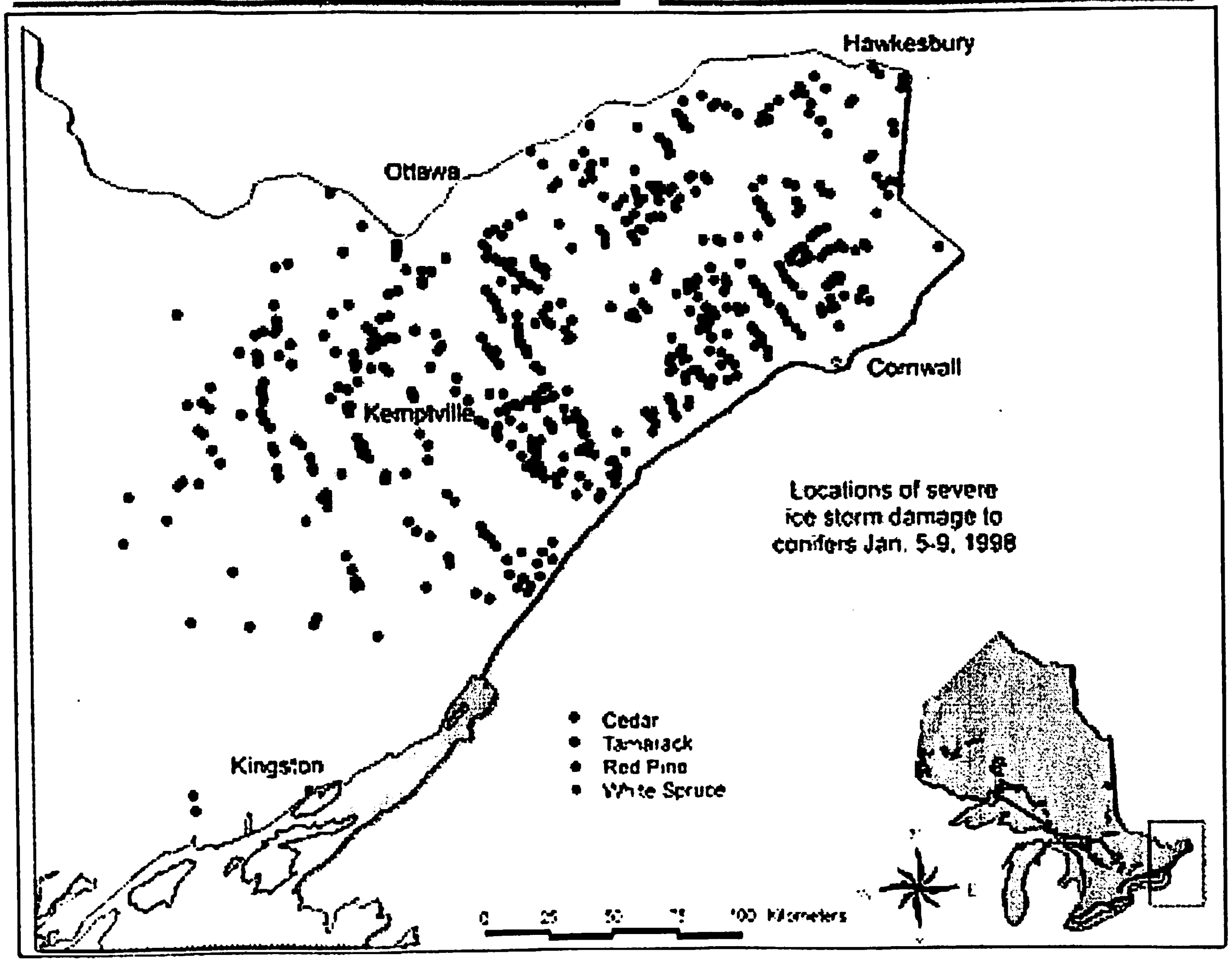


Ice Storm of 1998


75°
Canada
Ice Storm Map based on TIME magazine map
Quebec
Ottawa
Augusta
Vt.
Concord
Toronto
Boston
Albany
New York
Hartford
Providence
R.I.
Lake Erie
Pennsylvania
New York
Cleveland

Forest Management Branch - OMNR - Sault Ste. Marie

Forest Health Monitoring - CFS - Sault Ste. Marie

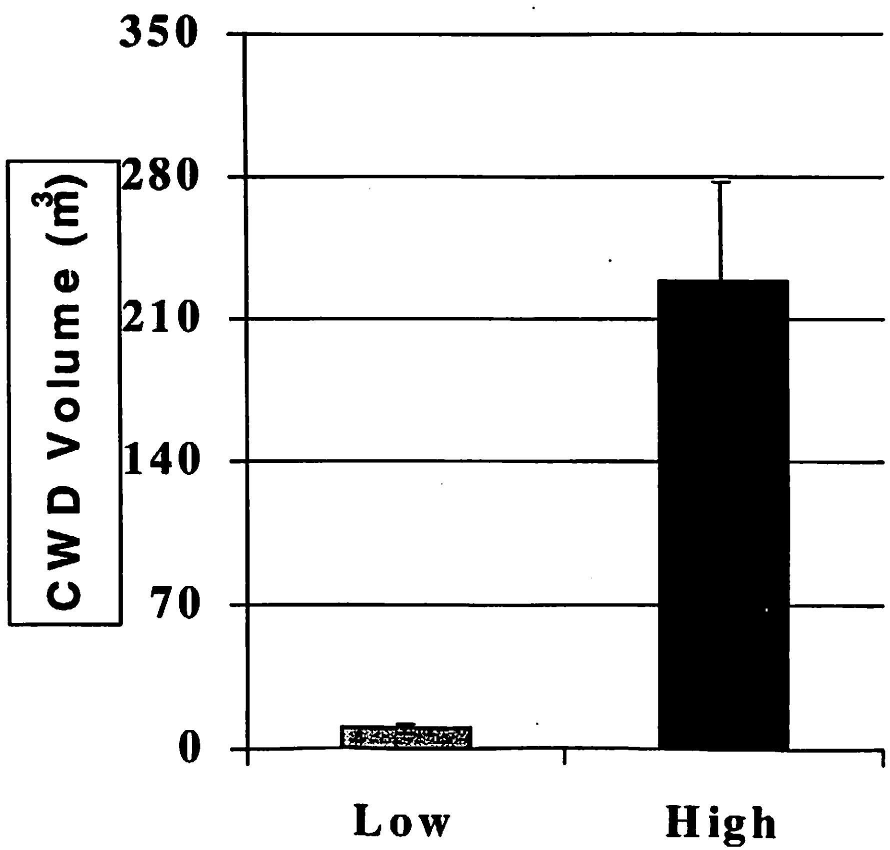


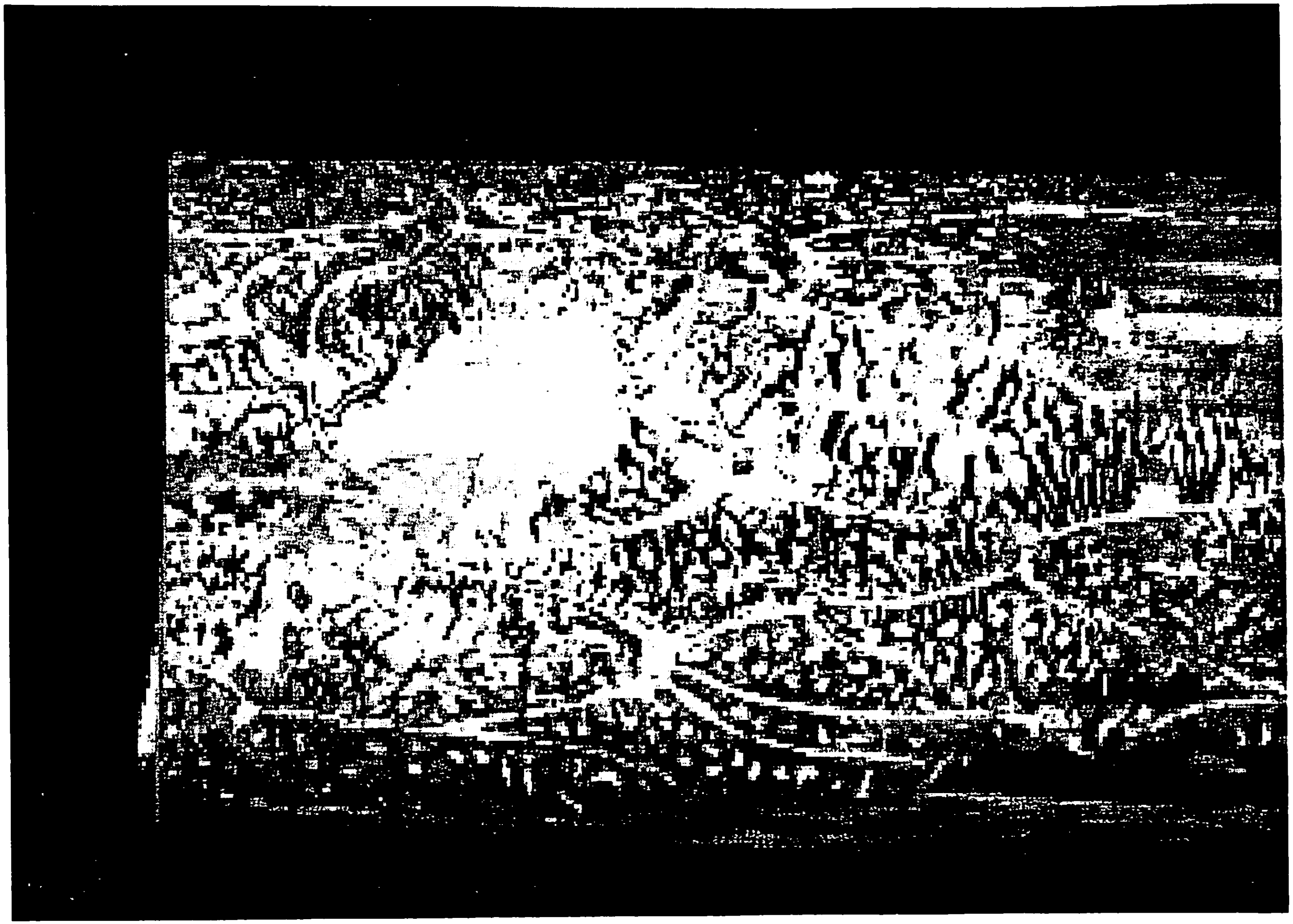
Low Debris Volume

High Debris Volume

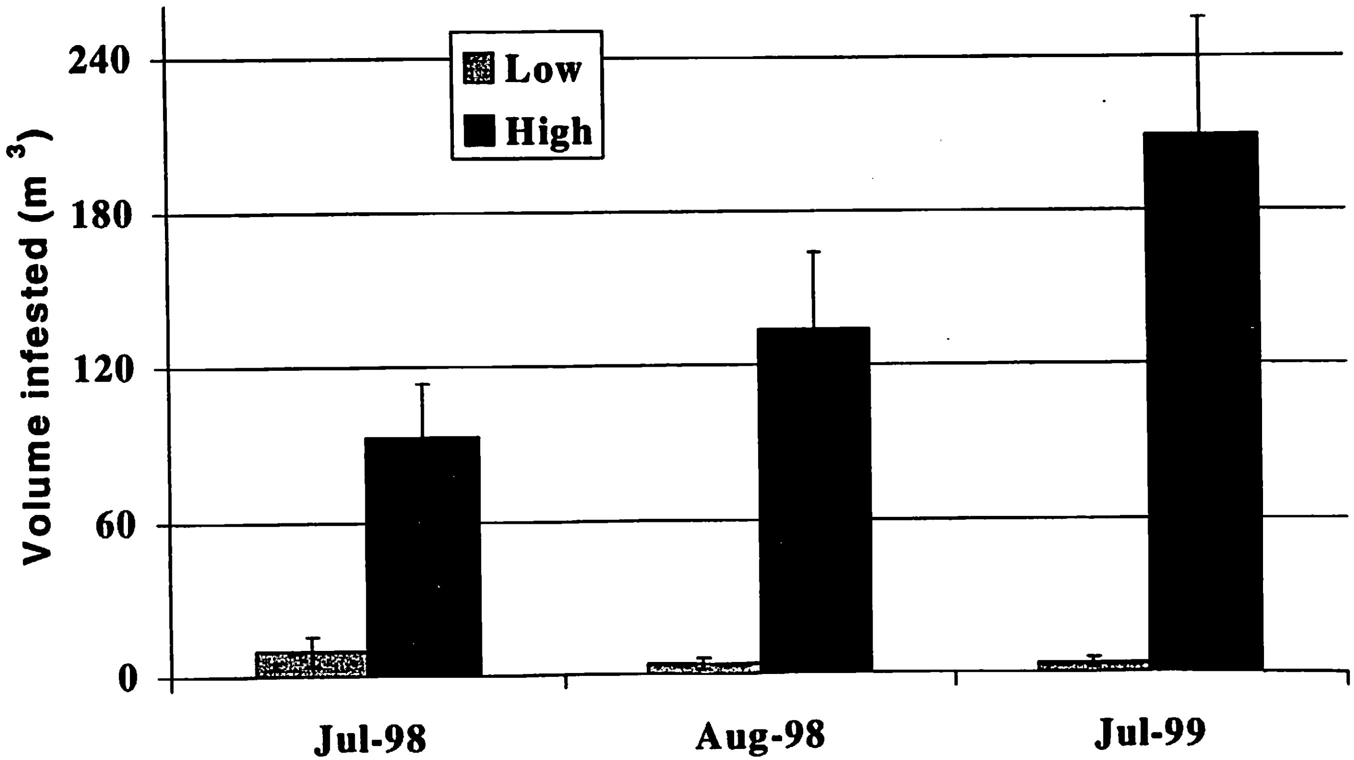
Volume of Coarse Woody Debris

- Snags, snapped tops, uprooted, blowndown and bent trees
- p=0.01 (Kruskal-Wallis)

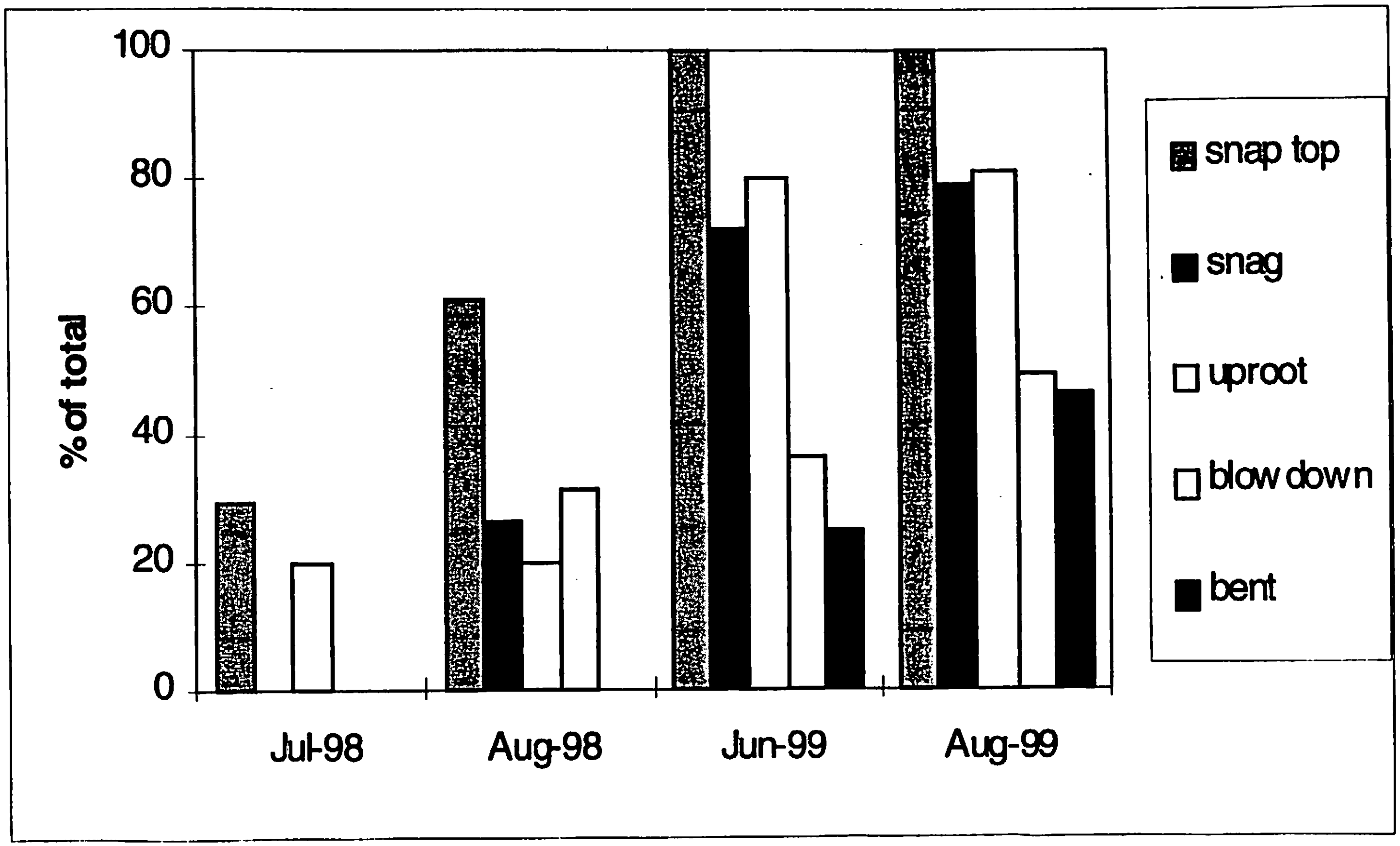




Volume of *Ips* Infestation



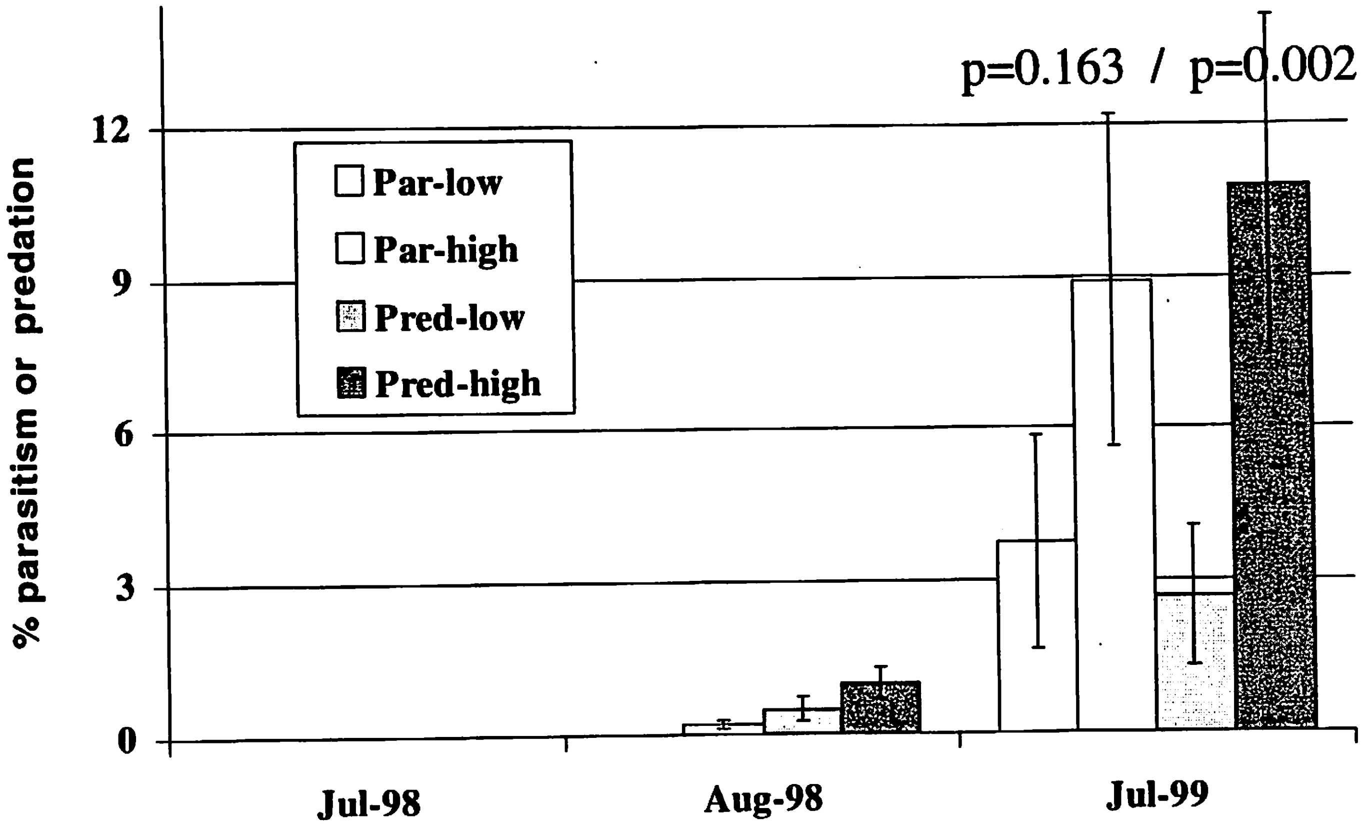
Location of Infestation



Species Found

LOW	HIGH
Ips pini	*I. pini*
Pissodes approximatus	*P. approximatus*
Few cerambycids	*Monochamus scutellatus*
	M. notatus
	M. titillator
	Acanthocinus pusillus
	Astylopsis sexguttata

Parasitism or Predation Levels



I. pini Natural Enemy Complex

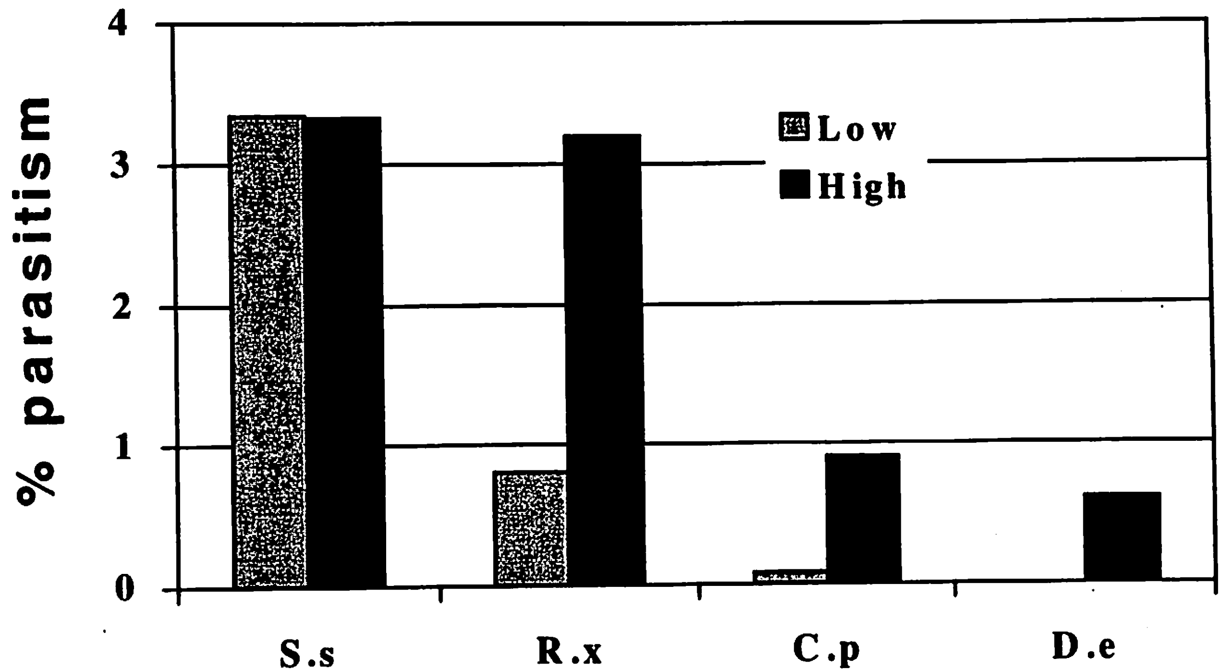
Parasitoids

- Pteromalids:
  - *Roptrocerus xylophagorum*
  - *Dinotiscus eupterus*
- Braconids:
  - *Spathius sp.*
  - *Coeloides pissodes*

Predators

- Dolicopodids:
  - *Medetera spp*.
- Lonchaeids:
  - *Lonchaea sp.*
- Clerids:
  - *Thanasimus dubius*
  - *Enoclerus sp.*

Parasitoid Species



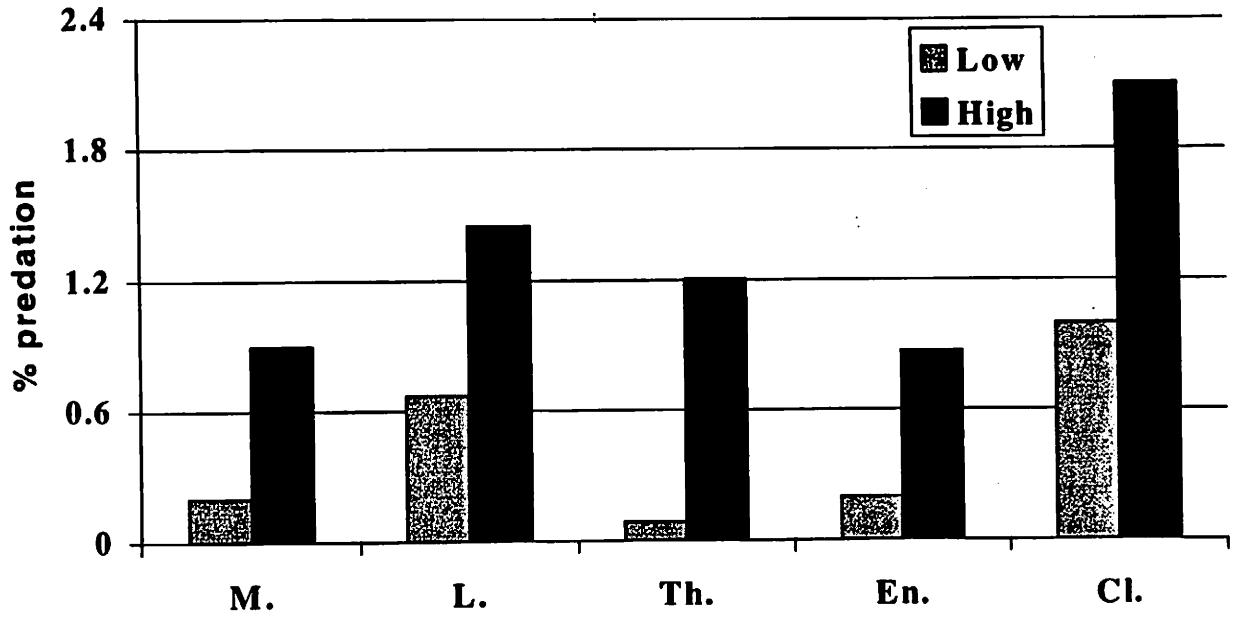
S.s = *Spathius sp.*

R.x = *Roptrocerus xylophagorum*

C.p = *Coeloides pissodes*

D.e = *Dinotiscus eupterus*

Predator Species



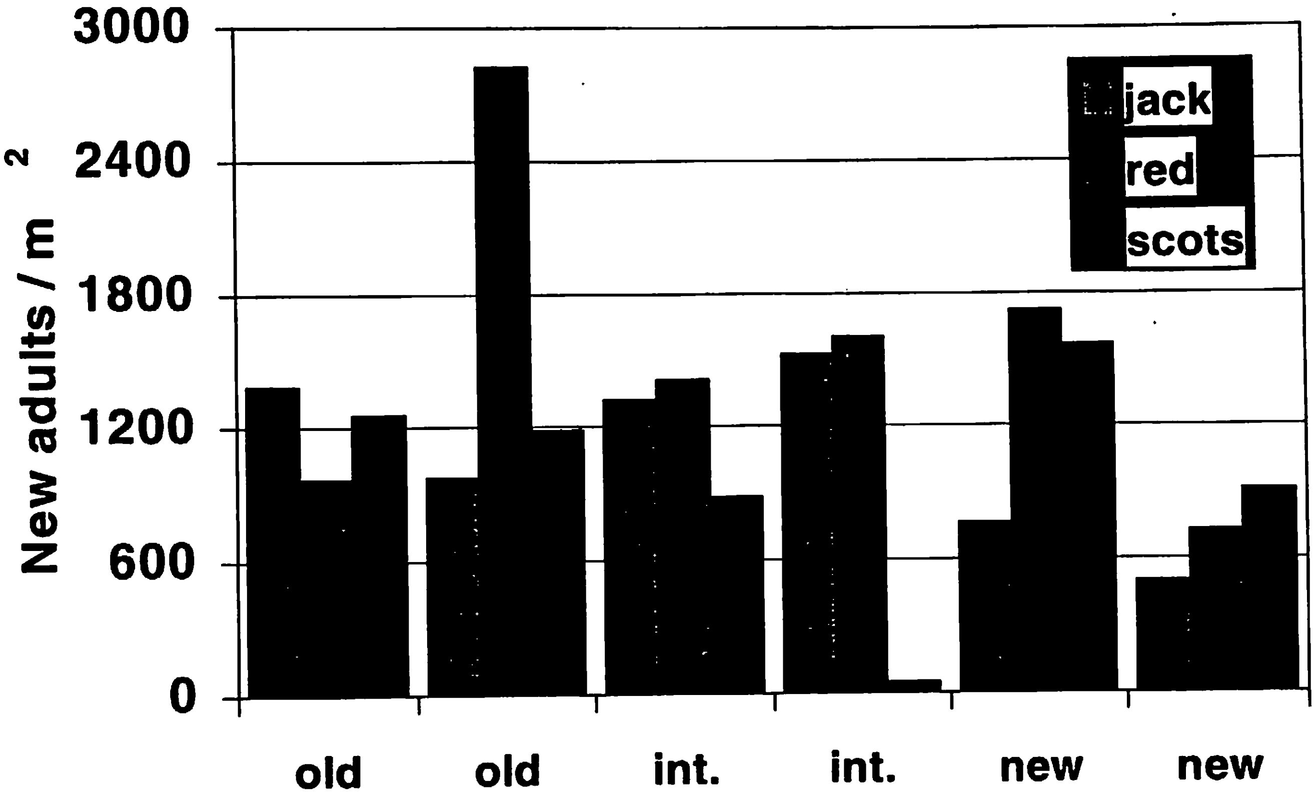
M. = *Medetera spp.* L. = *Lonchaea sp.*

Th. = *Thanasimus dubius* En. = *Enoclerus sp.* Cl. = Clerid larvae

Conclusions

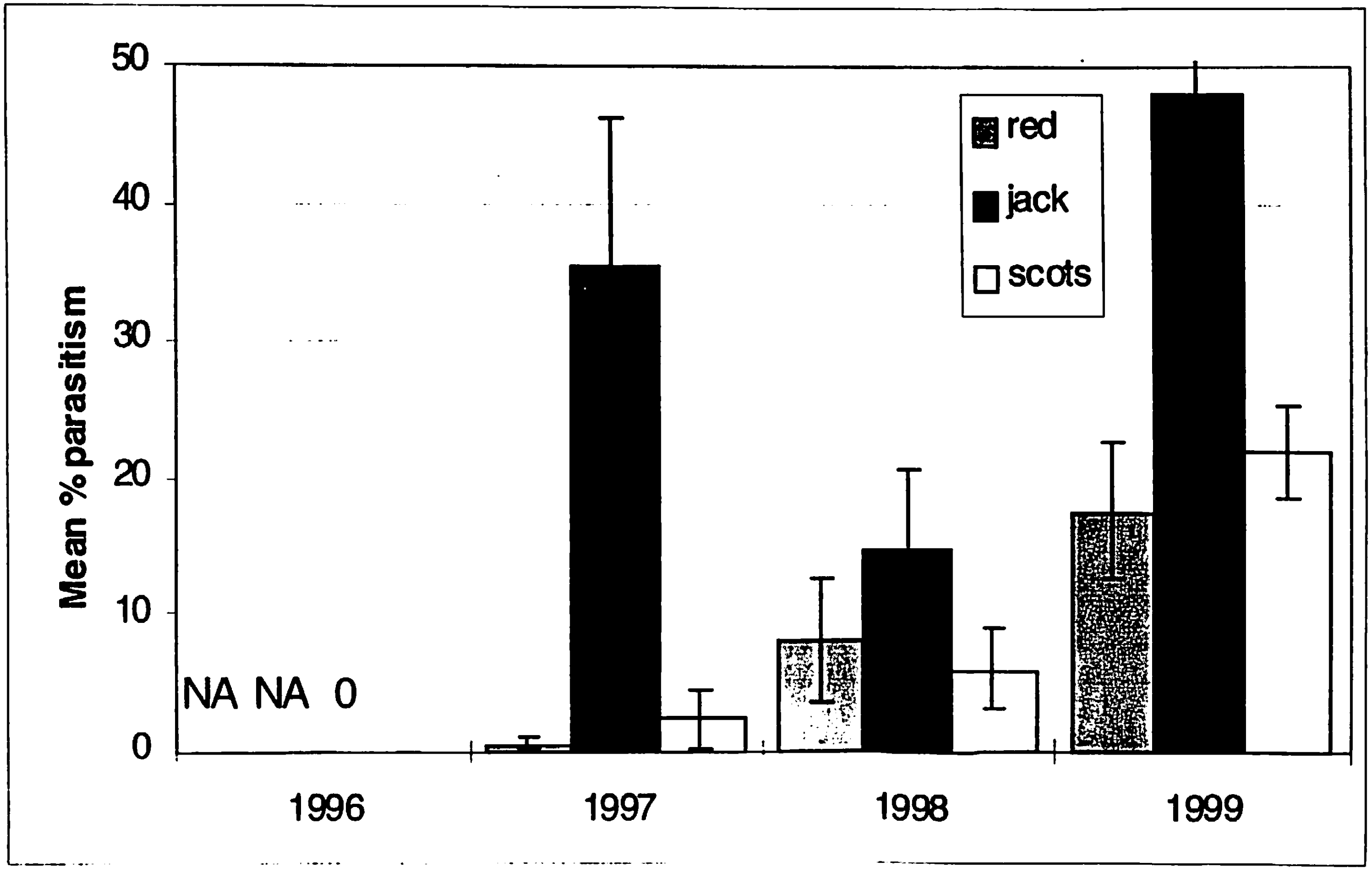
- Higher profile for bark beetles in the east
- Changes in native beetles and their natural enemy complexes
- Gaps in natural enemy complex

Production – New vs. old sites

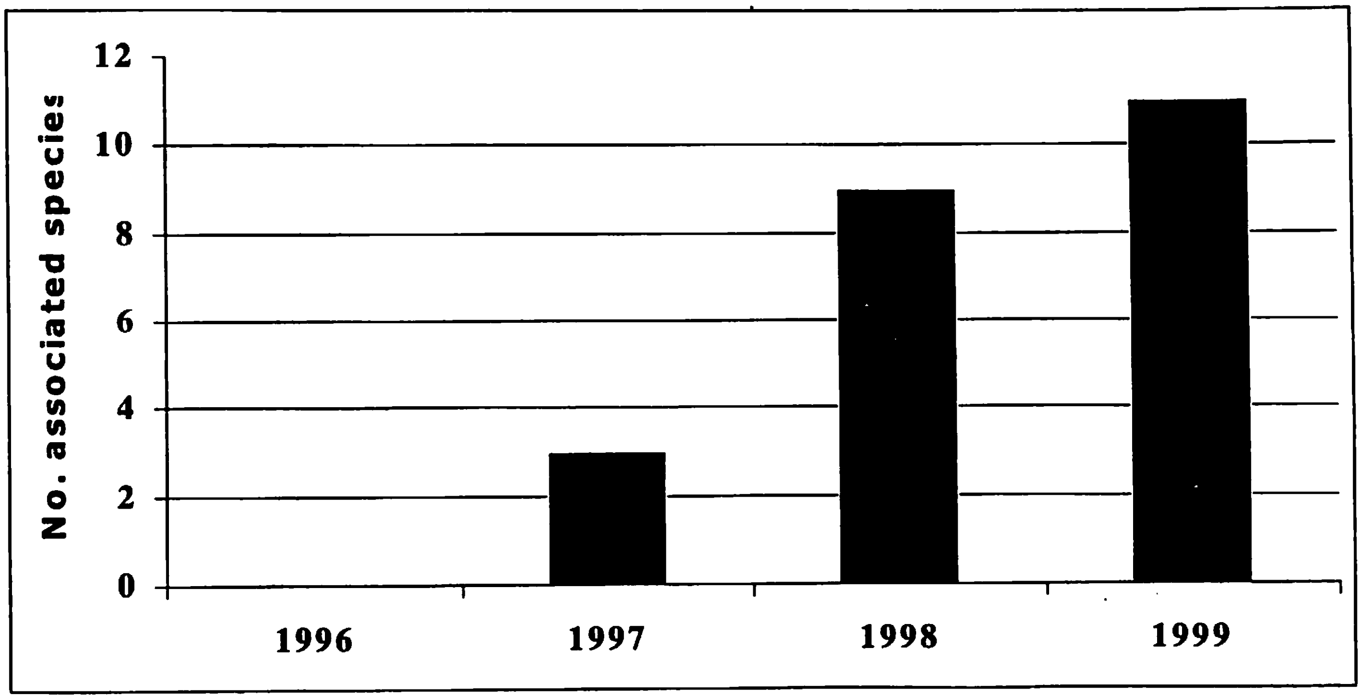


*** no significant difference between pine spp. (p=0.058) or between sites. (p=0.163)

% Parasitism over Time



No. Natural Enemy Species



Scots pine

1 site   1 site

Scots / red / jack pine

6 sites

Modeling Seasonal Development of Gypsy Moth for Decision-Support of an Eradication Program in British Columbia

Vince Nealis[1], Jacques Régnière[2], and David Gray[3]

Natural Resources Canada-Canadian Forest Service

[1]Pacific Forestry Centre, 506 W. Burnside Rd., Victoria, British Columbia, V8Z 1M5

[2]Laurentian Forestry Centre, PO Box 3800, Ste-Foy, Québec, G1V 4C7

[3]Atlantic Forestry Centre, PO Box 4000, Fredericton, New Brunswick, E3B 5P7

Abstract

Observations of field-caged egg masses of the European gypsy moth [*Lymantria dispar* (L.)] on Vancouver Island, British Columbia, indicate that overwinter survival of this exotic insect is very high in this area and that the emergence of larvae in the spring occurs over a period of 4 to 5 weeks. These observations were used to validate a process-oriented phenology model which was, in turn, used to time pesticide applications during the 1999 eradication program against the gypsy moth. Based on a digital elevation model and climate normals, the phenology model was used to examine heterogeneity of seasonal development within the eradication zone and to identify areas where successful completion of the insect's life history might be unlikely because of climate.

Modélisation du développement saisonnier de la spongieuse comme outil d'aide à la décision aux fins de la lutte contre ce ravageur en Colombie-Britannique

Vince Nealis[1], Jacques Régnière[2] et David Gray[3]

Ressources naturelles Canada, Service canadien des forêts

[1] Centre de foresterie du Pacifique, 506, West Burnside Road, Victoria (C.-B.) V8Z 1M5

[2] Centre de foresterie des Laurentides, C.P. 3800, Ste-Foy (Qc) G1V 4C7

[3] Centre de foresterie de l'Atlantique, C.P. 4000, Fredericton (N.-B.) E3B 5P7

Résumé

Des observations en cage de masses d'oeufs de la spongieuse européenne [*Lymantria dispar* (L.)] dans l'île de Vancouver (Colombie-Britannique) ont révélé que le taux de survie hivernale de ce ravageur exotique est très élevé dans la région et que l'éclosion des oeufs au printemps s'étale sur une période de 4 à 5 semaines. Nous nous sommes fondés sur ces observations pour valider un modèle phénologique orientés sur les processus utilisé en 1999 pour établir le calendrier des applications de pesticide dans le cadre du programme d'éradication de la spongieuse. Nous avons utilisé ce modèle phénologique fondé sur un modèle altimétrique numérisé et les normales climatologiques pour examiner le caractère hétérogène du développement saisonnier du ravageur dans la zone d'éradication et cerner les secteurs où ce dernier a peu de chance de boucler son cycle vital en raison de conditions climatiques défavorables.

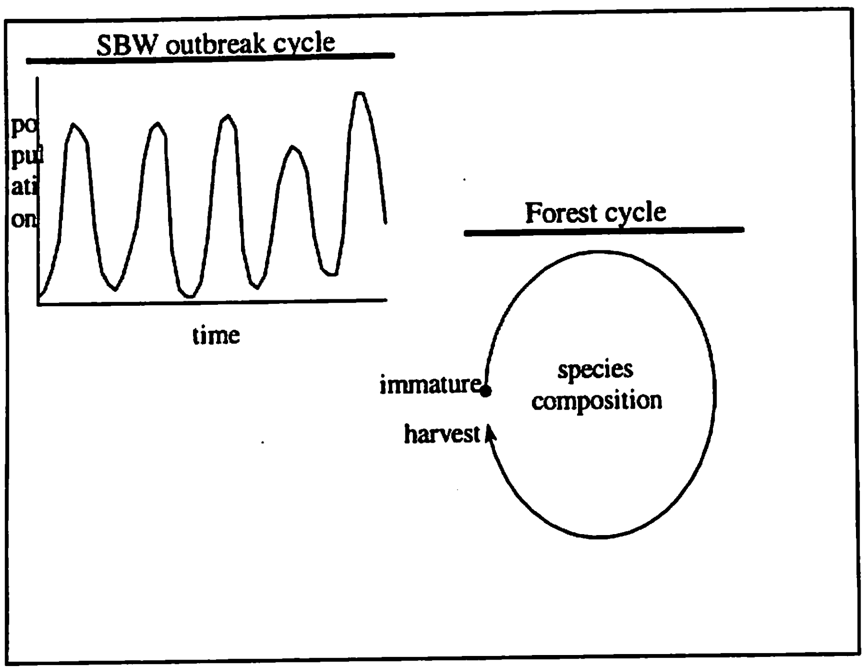
Spruce budworm outbreaks: a predictive system.

David Gray[1,2]
and
Bruno Boulet[3], Jacques Régnière[1], Rémi St. Amant[1], and Pierre Duval[1]

Estimated losses to the forest resources of Québec during the last spruce budworm outbreak (1965 - 1996) total:

- $14 bil.; or
- the equivalent of 10 years of harvesting; or
- enough wood to build 3.5 mil. homes and produce 50 mil. tonnes of newsprint.

Losses within individual forest stands is dependent on the interaction between the cyclic nature of SBW outbreaks and the cyclic nature of stand composition (Fig. 1). DEFOLIO was



[1] Canadian Forest Service,
Laurentian Forestry Centre
[2] Current address:
Canadian Forest Service,
Atlantic Forestry Centre

[3] Ressources naturelles Québec

developed to assist forest resource managers by making spatially explicit predictions of the occurrence and duration of the next SBW outbreak in Québec. DEFOLIO is fully bilingual and is available without charge at the following addresses:
http://www.cfl.forestry.ca/Publications/Note7/Note7_ang.html or
http://www.cfl.forestry.ca/Publications/Note7/Note7_fr.html

Using a multivariate technique known as direct gradient analysis it was shown that approximately 60% of the observed spatial variability in outbreak characteristics (timing, duration, intensity, etc.) can be explained by environmental variables. The existence of strong relationships between environmental conditions and outbreak characteristics lends confidence to the predictions produced by DEFOLIO.

These techniques are being tested in other regions of Canada where SBW is also an important forest defoliator.

Balsam Fir Sawfly Nuclear Polyhedrosis Virus

C. Lucarotti[1], B. Morin[1], P. Leblanc[2], E. Kettela[1], S. Holmes[1], G. Thurston[1], S. Li[3] and G. Holloway[4]

[1]Canadian Forest Service - Atlantic, P.O. Box 4000, Fredericton, NB, E3B 5P7
[2]Forest Protection Limited, 2502 Route 102 Hwy., Lincoln, NB, E3B 7E6,
[3]Canadian Forest Service - Atlantic, P. O. Box 960, Corner Brook, NF, A2H 6J3,
[4]Newfoundland Forest Resources and Agri-food, P. O. Box 2006, Corner Brook, NF, A2H 6J8.

Population crashes due to nuclear polyhedrosis virus (NPV) epidemics occur in many species of sawflies (Hymenoptera: Diprionidae). NPVs are transmitted through ingestion by a suitable host. NPV infection is density-dependent and sawflies are particularly susceptible to the communication of disease as most are communal and feed openly on foliage. Polyhedral inclusion bodies (PIBs) dissolve in the guts of larvae, releasing the virions to infect the midgut epithelial cells. Sawfly NPVs only infect the midgut epithelium so that, following a single replicative cycle, infected cells, containing PIBs, are sloughed off into the frass and out of the body where they can infect other insects. Death normally occurs within one to two weeks but, during that time, the host is producing infective units of the disease. Attempts to use NPVs to suppress sawfly populations have usually met with success.

In August 1997, we collected balsam fir sawfly (BFS - *Neodiprion abietis*) larvae from two plots near Corner Brook, Newfoundland. These insects were reared in our laboratory in Fredericton, New Brunswick and larvae that died in rearing were examined for the presence of the BFS NPV (NaNPV). This virus was found in a number of larvae and was isolated. NaNPV was also isolated from BFS larvae from Liscombe Point, Nova Scotia in summer 1997. In February through May 1998, BFS eggs collected in Nova Scotia, were brought into the laboratory where larvae were reared on balsam fir foliage and were infected with NaNPV in order to increase our stocks of NaNPV from Nova Scotia. Virus amplification of Newfoundland NaNPVwas carried out at the Pasedena Field Station in July and August 1998. Additional amplification of both vral strains were completed during the winter and spring of 1998-99.

In Newfoundland, the Newfoundland strain of NaNPV was mixed in approximately 100 L of 25% molasses with 3% sticker. It was applied at 2000 h on July 12, 1999, to an area of 1.2 ha, just south of Big Gull Pond, at a rate of 2.8×10^{11} PIBs/ha, using a Bell helicopter equipped with Micronair® AU 5000 nozzles. The larval index was 3.25 and the weather conditions for the spray were clear, calm and warm. Collections of larvae began at the first sign of larval mortality on July 17 and continued for the next 10 days. Dead larvae were placed into 50-mL centrifuge tubes and frozen. Significant amounts of virus have been isolated from this material. Preliminary checks of the data indicate that larval mortality due to applied virus was very high.

In Nova Scotia, the Nova Scotia strain of the virus was applied to 3 ha of a thinned balsam fir stand at the rate of 1×10^{10} PIBs/ha in a molasses-sticker mix using a truck mounted mistblower. The application was late with a larval index of 3.67. Onset of mortality in the field was delayed beyond what was expected, probably due to the larval size. Nevertheless, larval survival percentage in the virus block was 26.3% less than in the control block. Larvae collected from the block have yielded considerable amounts of virus.

Research support: Abitibi Consolidated, Canadian Forest Service, Corner Brook Pulp and Paper, Governments of Newfoundland and Nova Scotia, Natural Sciences and Engineering Research Council.

Biological Control of Forest Insects in Eastern Canada CFS - AFC Research Activities 1999

Graham S. Thurston

Introduction

Two areas of intense work this past summer for us at the CFS - Atlantic lab were in product efficacy testing and in looking more closely at the use of naturally-occurring pathogens for the control of forest defoliators. We are currently faced with several somewhat intractable problems for which solutions need to be found. Probably the most urgent one is the balsam fir sawfly, for which no registered product is available in Canada at the moment. In order to combat the defoliation caused by this insect, Newfoundland has obtained an Emergency Registration for the organophosphate insecticide trichlorfon in 1998 and Temporary Registration in 1999. This is only a stop-gap measure and can not expect to go on for much longer. As you may know, the pressure against the use of chemicals for controlling forest insects is mounting and the search for more benign management options is going on apace.

I will report briefly here on work with several non-chemical control products and three sawfly species. Sawflies, being Hymenoptera, do not lend themselves to control by Btk or Mimic, both of which are lepidopteran-specific, and therefore management of sawfly problems in forestry is at the moment problematic.

Field trials were also conducted against the eastern spruce budworm, *Choristoneura fumiferana*. However, to keep this report down in size, all I will say about those trials is that the *Bacillus thuringiensis kurstaki*-based products Bioprotec (AEF Global), Thuricide (Thermo Trilogy) and Foray (Abbott) all proved to be efficacious at a range of potencies. Further information can be obtained by contacting the author or colleagues at CFS-Fredericton.

The Products

The botanical insecticide neem has been shown to be effective against several forest insects. A few years ago it was shown that neem is effective against balsam fir sawfly, but what has been missing is an indication of the lowest rate of application that could be used effectively. This is important because neem products are at present very expensive, at around $100 per 50 g a.i. Neem may be expensive, but the cost of not using an expensive option, when it is the only option out there, may be much higher. Neem, as the product Neemix 4.5 from Thermo Trilogy Corp., was tested for efficacy against balsam fir sawfly, pine false webworm, and yellowheaded spruce sawfly at rates from 20 to 50 g a.i./ha.

In the search for options for controlling sawfly species, we conducted some preliminary lab and field trials which suggested that the *israelensis* strain of Bt (Bti) may have some activity against sawfly larvae. Based on these results we set out to assess Vectobac 1200L (Abbott) under field conditions against both balsam fir sawfly and yellowheaded spruce sawfly.

Recently, we have isolated a naturally-occurring virus from balsam fir sawfly populations in Newfoundland and Nova Scotia. Chris Lucarotti has just reported on the results of the work we did on it this year. To me, this is the most promising option for the long term management of outbreaks of balsam fir sawfly. Other control options will probably be needed for some areas but if we can come up with a simple, cheap, effective method of producing the virus and distributing it where needed, the pressure this insect puts on the wood supply can be dramatically reduced.

The Insects

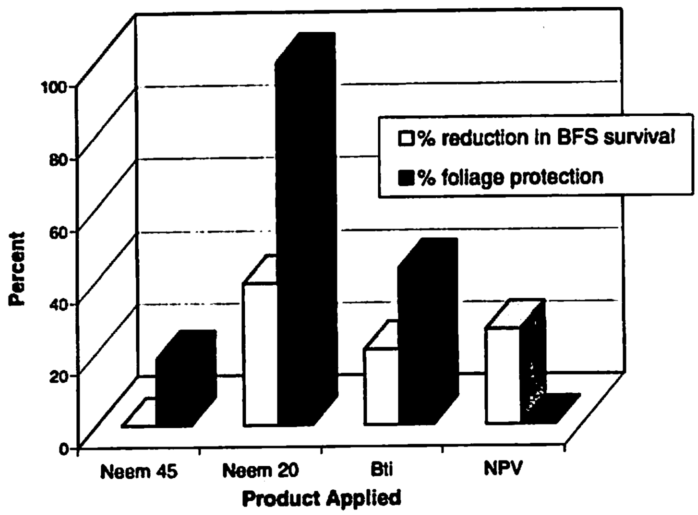
1) Balsam Fir Sawfly

The balsam fir sawfly, *Neodiprion abietis*, is at present a serious problem in balsam fir stands in eastern Newfoundland and Cape Breton Island, Nova Scotia, where it is responsible for defoliation to over 60,000 ha of trees. This insect historically has increased in numbers locally but then the populations have collapsed without causing undue concern. Recently, however, the outbreaks appear to be persisting and the insect is causing extensive defoliation and concomitant growth reduction and tree mortality. The areas presently affected in NF and NS are important because they are slated to be harvested during the predicted wood supply shortage coming within 20 years and any loss could affect the annual allowable cut from those areas.

In the summer of 1999, two separate programmes were carried out, one in Nova Scotia by Thurston and one in Newfoundland by Lucarotti and Kettela. Virus work was carried out in both provinces and has been reported on by Dr. Chris Lucarotti. The Nova Scotia study was conducted in the highlands of Cape Breton Island in thinned stands of balsam fir. Product applications were made with a truck-mounted mistblower (Rotomist) in a volume of 200 litres per hectare. Products tested were: Neemix 4.5 at 20 and 45 g a.i./ha, Vectobac (Bti) at 72 BIU/ha, and virus at 1×10^{10} PIBs/ha. The programme was initiated late due to insect development being advanced by 2 to 3 weeks in the highlands. At the time the pretreatment samples were taken the larval index was 3.7, when an index of close to 2.0 at time of spray is ideal. This late start resulted in more feeding damage and less product efficacy. Moreover, trials with larger larvae generally result in higher control 'mortality' than trials with younger larvae. This is due to the larger larvae dropping off the branches more easily while the samples are being taken, larvae moving into pupation sites off the branches, and higher incidence of parasite and predator attack on larger larvae. Because of the natural large population reduction effects caused by the applied products may have been somewhat obscured.

The results (Figure 1) indicate that, while the products were applied late, some were still effective. The low rate of neem was particularly effective, giving good foliage protection and reducing larval survival. The discrepancy between the low and high rates of neem is explained by a 32mm rainfall 24 hours after the application to the high rate block, whereas no rain followed the low rate of application. This indicates the need for proper formulation of the Neemix product before it can be used routinely in forestry applications. The results with Bti were quite variable and firm conclusions can not be drawn. However, the data and a survey of the spray block suggest that the Bti was having some effect (dead and deformed larvae were found in the Bti block but not in the untreated control block). Viruses are normally most effective when used against young larvae; in this study a virus was used against late instars. The longer time required to kill the larger larvae, combined with the increased consumption of those larvae, resulted in no foliage protection being detected. However, the goal of the virus trial was not foliage protection but was establishment of the virus, followed by initiation of an epizootic. Whether this goal was attained will be determined in the summer of 2000.

Figure 1. Efficacy of products against balsam fir sawfly larvae, as measured by reduction in survival and degree of foliage protection.



Most immediately promising is the use of Neemix 4.5 for BFS control and foliage protection. A much lower rate than has been used previously is possible, however determination of the lowest possible rate has not yet been made. It appears that 20 g a.i./ha, with ground-based spray equipment, is sufficient for management of this insect. Whether this same rate of application will be as efficacious under lower volume aerial applications remains to be determined.

2) Yellowheaded Spruce Sawfly

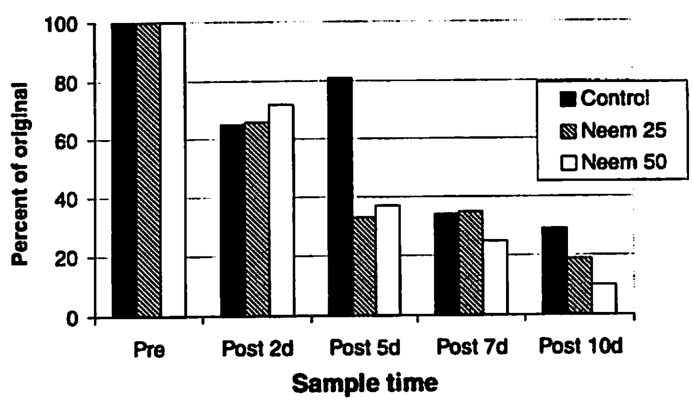
The yellowheaded spruce sawfly, *Pikonema alaskensis*, is an ongoing problem in black and Norway spruce plantations in New Brunswick, Nova Scotia, and Newfoundland. It is also a concern in areas of Ontario and Quebec. This insect is a problem primarily in young plantations of spruce. Outbreaks tend to be initially spotty and isolated but can later coalesce and cause widespread defoliation, tree deformation, and mortality. At present, trichlorfon is the only product available for aerial application and there is a demand for more benign alternatives. Two programs with the yellowheaded spruce sawfly were carried out in the summer of 1999, one in Newfoundland with Neemix 4.5, and one in New Brunswick with Vectobac 1200L, a Bti-based product.

2 (a) YHSS - Newfoundland (neem)

The Newfoundland programme was conducted in infested black spruce plantations in central Newfoundland. The product, Neemix 4.5, was applied at the rates of 25 and 50 g a.i./ha using a large mistblower mounted on a C-4 skidder. Application was late (due to the product not being shipped in time) and was made when the larvae were quite large (larval index of 3.9 to 4.6). This resulted in a possible reduced efficacy and less meaningful post-treatment assessments, due to the larvae ceasing feeding and dropping from the trees to pupate.

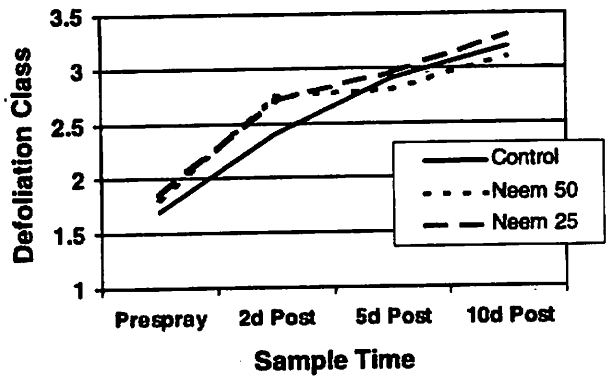
The numbers of larvae found on the untreated control sample branches dropped significantly within a few days of the pretreatment sample being taken, with only 34% of the original larvae remaining 7 days post-treatment (Figure 2). This makes it difficult to determine the full extent of the efficacy of Neemix against this insect. However, the large drop in numbers in both treated sites relative to the control site by 5 days post-treatment indicates that neem was having an affect on the larval numbers by this time. Had the programme been initiated earlier in the insect development cycle, the differences observed 5 days post-treatment would probably also have been visible at the later sampling periods.

Figure 2. Reduction in larval YHSS numbers in treated and untreated blocks after application of Neemix 4.5.



The data recorded for defoliation throughout the programme did not give a clear indication of foliage protection by Neemix 4.5. This is primarily due to the late start to the programme, considerable defoliation already having occurred. Photographic assessment indicated that the defoliation ranking increased throughout the course of the sample period in all blocks, with little difference between the blocks (see Figure 3).

Figure 3. Defoliation, in 20% defoliation classes, of sample branches (arithmetically standardized to uniform initial larval density)



Empirical observation indicated that those larvae remaining alive in the neem-treated blocks at the post-treatment sample times were considerably less healthy and mobile than those in the untreated control block. This indicates some sub-lethal effect on YHSS, which may have expressed itself as a reduction in larval numbers had the neem application been made at an earlier larval instar.

The late application of neem that occurred in this experimental trial unfortunately resulted in reduced efficacy and partially obscured results. Nevertheless, it is clear that Neemix 4.5 at 25 g a.i./ha causes significant reduction in larval numbers of yellowheaded spruce sawfly. The reduction in larval numbers seen at 50 g a.i./ha is no different than that seen at 25 g, indicating that the lower rate of application is suitable for this insect pest.

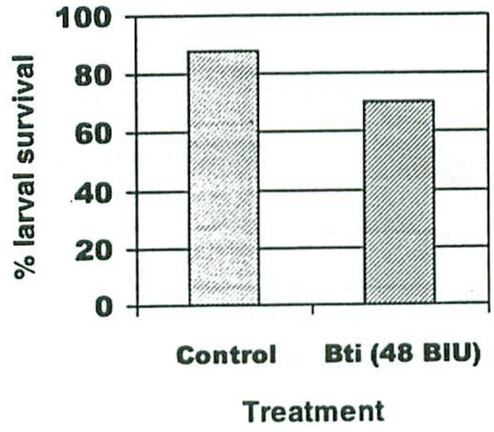
2 (b) YHSS - New Brunswick (*Bti*)

An area of YHSS infestation in young black spruce plantations in northern New Brunswick was used for testing the efficacy of Vectobac 1200L. The product was applied at the rate of 48 BIU/ha from the air using a Cessna 188 AgTruck fitted with Micronaire AU4000 atomizers and digital GPS guidance and spray control hardware.

Sampling consisted of non-destructive assessment of larval numbers and defoliation percentage on tagged branches of sample trees. Samples were taken at intervals before and after product application.

In general, the results suggest little effect by Bti on larval YHSS, although there may have been some impact. The data presented in Figure 4 is only a portion of that collected in this experiment but is representative of the effect of Bti.

Figure 4. Yellowheaded spruce sawfly larval survival rates in Vectobac-treated and untreated plots 8 days post treatment.



The results of this trial with *Bacillus thuringiensis israelensis* do not support the use of Bti for control of YHSS. However, because some effect was seen with both species of sawflies used (BFS and YHSS), it does suggest that there may be a Bt with greater activity against foliage-feeding hymenopterans. Because of the current difficulty in controlling sawflies, a search for such a bacterium may be warranted.

3) Pine False Webworm

The pine false webworm, *Acantholyda erythrocephala*, is a sawfly species causing serious damage to valuable stands of red pine in southern Ontario. Neemix 4.5, a neem-based insecticide, was applied by air to red pine stands in Simcoe Co., Ontario. The spray equipment was a Cessna 188 AgTruck equipped with AU4000 Micronaire atomizers and digital GPS guidance and spray control systems. Neemix 4.5 was applied, diluted in water, at the rates of 25 and 50 g a.i./ha, with the treatment occurring at the end of the PFW egg hatching period on 7 June 1999. Each treatment block was 16 ha in size and located in the Craighurst Tract, Simcoe Co., ON, in a stand of 36-year old red pine. Within each experimental block, 20 sample trees were selected on a transect running perpendicular to the direction of flight lines.

Assessment

Prior to spray and 2, 4, 7 and 9 days post treatment, two midcrown branch tips (50 cm) were clipped using pole pruners. The larvae were removed from these branches and the numbers living and dead recorded. At 4 d, 7 d and 9 d post treatment, defoliation assessments were made on each sample tree, in addition to the larval counts. Prior to this year's feeding, the defoliation in each block was negligible. Daily frass collections were also made in all blocks, using frass collection trays placed beneath sample trees.

Results

Larval count and defoliation data are summarized below. The percent of recovered larvae that were dead increased dramatically in both treated blocks by Day 7 post treatment. The reason for the initial relatively high percent mortality in Block B is unclear, but no signs of disease were present in these larvae.

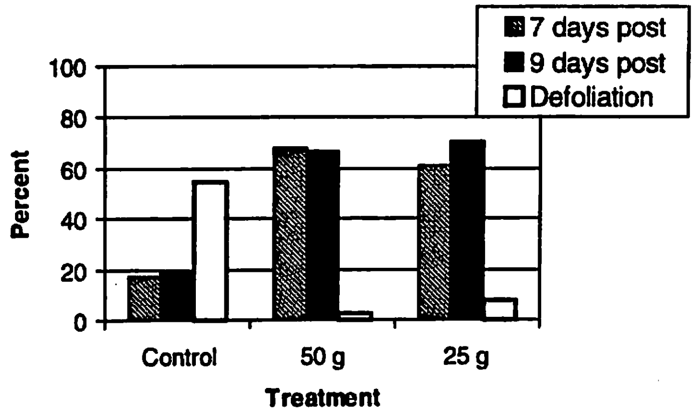
Table 1. Summary of pine false webworm larval numbers and percent dead in experimental blocks (n=20 trees).

Sample	Control* (Untreated)		Block A (50 g/ha)		Block B (25 g/ha)	
	Living Larvae per Branch	% dead	Living Larvae per Branch	% dead	Living Larvae per Branch	% dead
Pre Spray	32.1 (8.3)	-	55.7 (8.4)	-	18.1 (3.8)	-
2d	21.0 (5.6)	11.9 (5.7)	57.6 (8.0)	7.5 (2.3)	20.4 (4.0)	35.8 (7.1)
4d	19.8 (3.8)	12.0 (3.3)	79.7 (12.4)	17.4 (2.3)	32.0 (5.1)	34.7 (4.4)
7d	14.3 (3.5)	16.9 (7.5)	31.2 (7.6)	68.0 (5.9)	12.4 (3.1)	61.0 (6.7)
9d	23.1 (4.8)	19.9 (4.2)	13.9 (3.0)	67.1 (5.6)	7.9 (1.8)	70.4 (6.4)

* numbers in parentheses are SEM

End-of-season defoliation was dramatically reduced in both spray blocks, as compared to the untreated control block (Table 2, Figure 5). This foliage protection is encouraging for the future use of Neemix for pine false webworm control.

Figure 5. Defoliation percent (at end of season) and percent dead pine false webworm larvae recovered in treated and untreated blocks.



The daily frass collection data (data not shown) did not give a clear picture of the efficacy of Neemix 4.5. However, the final collection date (June 27), which included frass collected during the previous 10 days, suggested that a dramatic reduction in frass production occurred in the treatment blocks as compared with the untreated control block. Especially with trees the size of the red pine in this study, frass collection is an inexact measure of efficacy, and refinements in the collection technique are possibly needed. Nevertheless, it can give a good indication of the non-lethal effects of insect control products such as neem.

Table 2. End-of-season defoliation estimates of red pine trees in pine false webworm experimental blocks (n=20 trees).

Treatment	Percent defoliation at end of season			
	Upper Crown	Mid Crown	Lower Crown	Whole Tree
Block A (50 g/ha)	1.3	2.1	5.6	2.7
Block B (25 g/ha)	3.5	6.5	12.6	7.6
Control	6.7	26.5	67.5	40.0

Conclusions

The results clearly indicate that Neemix 4.5 is effective at reducing pine false webworm larval numbers and providing foliage protection on red pine. Application of Neemix at either rate to early instar larvae provided almost complete foliage protection. We suggest that the low rate of application (25 g a.i./ha) is sufficient for effective control of this insect pest, if it is applied to early larval instars.

General Conclusions

Sawflies are difficult problems for forest managers, and will probably remain so for the immediate future. While there has been good progress on the collection of efficacy data of alternative (non chemical) control products, with neem-based pesticides leading the way, the regulatory status of these materials is such that they can not yet be used in Canada on an operational basis. It is hoped that this situation changes in the near future.

The bacterial insecticide Bti did not prove to be very effective in field trials against sawfly species. The degree of control achieved was not sufficient to warrant use of the tested products in further field trials. However, the fact that some effects were noted is encouraging and should serve to spur on the search for a sawfly-active strain of *Bacillus thuringiensis*.

Poster Session Abstracts
Présentations par affiches (Résumés)

Beech Bark Disease In Ontario

C.N. Davis, R. Sajan and [1]A.A. Hopkin.
Canadian Forest Service, 1219 Queen Ste. E. P.O. Box 490 Sault Ste. Marie, ON. P6A 6A9
[1]email AHOPKIN@NRCAN.GC.CA

Beech bark disease is responsible for causing serious levels of damage and mortality to beech trees(*Fagus grandifolia*) in North America. The disease can be caused by at least two fungi, *Nectria coccinea* var. *faginata*, and *Nectria galligena*. These fungi attack and kill the bark of beech previously infested by the beech scale insect *Cryptococcus fagisuga*. The insect, and probably *N. coccinea* var. *faginata*, were accidentally introduced from Europe to Nova Scotia around 1890. The disease became established in beech stands throughout the Maritime provinces, and in 1965 was confirmed in Quebec. Since the late 1960's, surveys have detected heavy infestations of beech scale in beech stands in southern Ontario. However, the disease was not previously confirmed from Ontario, although reports suggest that it has been present in the province for some 15 years. In 1999, ten positive locations were identified and confirmed in southern Ontario (Fig. 1). The first location was in Hastings County, northwest of the city of Trenton. In Ontario, the disease is presently in its early stages, and does not show the classic symptoms, such as multiple cankers, typically identified with beech bark disease in more established areas. Mortality is present, but not yet at high levels in mature beech.

La maladie corticale du hêtre en Ontario

C.N. Davis, R. Sajan et [1]A.A Hopkin
Service canadien des forêts, 1219 Queen Street East, P.O. Box 490, Sault Ste. Marie (Ont.)
P6A 6A9
[1] Courriel : ahopkin@nrcan.gc.ca

La maladie corticale du hêtre est à l'origine de dommages considérables et d'une mortalité importante chez le hêtre (*Fagus grandifolia*) en Amérique du Nord. La maladie est causée par au moins deux champignons, à savoir le *Nectria coccinea* var. *faginata* et le *N. galligena*. Ces champignons attaquent et détruisent l'écorce des hêtres préalablement infestés par la cochenille du hêtre, *Cryptococcus fagisuga*. Cet insecte, et probablement le champignon *N. coccinea* var. *faginata*, ont été introduits accidentellement d'Europe en Nouvelle-Écosse vers 1890. La maladie s'est installée dans les hêtraies des provinces Maritimes, et sa présence au Québec a été confirmée en 1965. Les relevés effectués depuis la fin des années 1960 ont révélé la présence d'infestations graves par la cochenille dans des hêtraies du sud de l'Ontario. Toutefois, la présence de la maladie n'a jamais été confirmée en Ontario, même si de nombreux rapports donnent à entendre qu'elle y sévit depuis une quinzaine d'années. En 1999, la présence de la maladie a été détectée et confirmée en dix endroits du sud de l'Ontario (fig. 1). Le premier cas confirmé a été signalé dans le comté de Hastings, au nord-ouest de Trenton. En Ontario, la maladie en est encore à son stade initial, et les symptômes normalement observés dans les régions où la maladie est bien établie (p. ex. formation de chancres multiples) ne se sont pas encore manifestés. La mortalité est présente, mais les taux ne sont pas encore élevés parmi les hêtres parvenus à maturité.

Distribution of Butternut Canker (*Sirococcus clavigignenti-juglandacearum*) in Eastern Canada

[1]A. Hopkin, [2]L. Innes, E. [3]Hurley, [3]K. Harrison, and [1]C.N. Davis

[1]Canadian Forest Service, Sault Ste. Marie, ON. Email AHOPKIN@NRCAN.GC.CA
[2]Ministère des ressources naturelle, Quebec, QC.
[3]Canadian Forest Service, Fredericton, N.B.

Butternut (*Juglans cinerea*) in Canada and the United States is being endangered by butternut canker disease. The disease is caused by the fungus *Sirococcus clavigignenti-juglandacearum.* which causes branch and stem cankers that often result in mortality or severe damage to the tree. It is not known how long this disease has existed in North American, or whether it is native or introduced. The disease was first reported from Wisconsin in 1967, and in Canada, butternut canker was first collected from Quebec in 1990, and then in Ontario in 1991. However, it is known from aging of the cankers, that the disease has been present in Ontario for at least 20 years. In 1997, the disease appeared in New Brunswick. Butternut canker is currently known to exist throughout the range of butternut in Ontario and Quebec, with limited distribution, at present, in New Brunswick. In Quebec the disease has also been isolated from black walnut (*Juglans nigra*) in nurseries. Damage black walnut is limited to small cankers, however the disease is also present on the fruits of this tree species as well as those of butternut, and can be carried with them.

Distribution du chancre du noyer cendré (*Sirococcus clavigignenti-juglandacearum*) dans l'est du Canada

[1] A. Hopkin, [2] L. Innes, [3] E. Hurley, [3] K. Harrison et [1] C.N. Davis

[1] Service canadien des forêts, Sault Ste. Marie (Ont.). Courriel : ahopkin@nrcan.gc.ca
[2] Ministère des Ressources naturelles, Québec (Qc).
[3] Service canadien des forêts, Fredericton (N.-B.)

Au Canada et aux États-Unis, le noyer cendré (*Juglans cinerea*) est menacé par le chancre du noyer cendré. La maladie est causée par le champignon *Sirococcus clavigignenti-juglandacearum*. Ce dernier entraîne la formation de chancres sur les branches et les tiges et cause souvent la mort de l'arbre ou provoque de graves dommages. On ignore depuis combien de temps la maladie sévit en Amérique du Nord et si elle y est indigène ou introduite. Le premier cas a été signalé au Wisconsin en 1967. Au Canada, sa présence a été détectée pour la première fois au Québec en 1990, puis en Ontario, en 1991. Toutefois, l'âge des chancres indique que la maladie sévit en Ontario depuis au moins 20 ans. En 1997, la maladie a fait son apparition au Nouveau-Brunswick. L'aire de répartition du chancre du noyer cendré recoupe actuellement celle de son hôte en Ontario et au Québec et, pour l'instant, la chevauche partiellement au Nouveau-Brunswick. Au Québec, l'agent pathogène a également été isolé chez des noyers noirs (*Juglans nigra*) cultivés en pépinière. Bien que les dommages observés chez les noyers noirs se limitaient à des chancres de petite taille, l'agent pathogène est également présent sur les fruits des deux espèces de noyer et peut être propagé par ces derniers.

Monitoring Tree Health In Ontario After The Ice Storm

[1]Anthony AA. Hopkin, [1]Gordon M. Howse and [2]Tim Williams

[1]Canadian Forest Service, Sault Ste. Marie, ON. Canada, P6A 5M7, ahopkin@nrcan.gc.ca
[2]Ontario Ministry of Natural Resources, 659 Exeter Rd. London, ON. N6E 1L3

In January of 1998, a major ice storm effected north eastern North America. In Canada, damage occurred from eastern Ontario through to western New Brunswick. The most significant damage was reported in western Quebec and eastern Ontario. After the storm a joint federal provincial program was established to assess damage and monitor the recovery of eastern Ontario forests. This included aerial surveys of the damaged area and plot-based assessments of damage and recovery. In Ontario, more than 604,000 ha of forest were mapped as damaged. Pre-existing plot locations were utilized for ground assessments, as these provided information on stand conditions prior to the storm. In total 26 plots from the CFS forest health monitoring system and 48 plots from the OMNR growth and yield program were utilized for initial assessments of damage. Hardwood tree species showed significantly more damage than conifers, although the levels were variable between and within stands. Tree species showing the greatest damage were basswood, beech, soft maple and white birch; those showing the least damage were hard maple, oak, ash and hickory species. Plots were also used to monitor tree recovery. Crown condition and tree vigor were measured during the 1998 growing season, using North American Maple Project (NAMP) methodology. Trees are also assessed for the presence of stem damage (frost cracks, sun scald, wounding), decays and wood-boring insects. Decays are considered to be a serious long-term problem to the ice damaged forests.

Surveillance de la santé des arbres en Ontario après la tempête de verglas

[1] Anthony A.A. Hopkin, [1] Gordon M. Howse et [2] Tim Williams

[1] Service canadien des forêts, Sault Ste. Marie (Ont.), Canada, P6A 5M7 , ahopkin@nrcan.gc.ca
[2] Ministère des Richesses naturelles de l'Ontario, 659 Exeter Rd., London (Ont.) N6E 1L3

En janvier 1998, une importante tempête de verglas a frappé le nord-est de l'Amérique du Nord, provoquant au Canada des dommages depuis l'est de l'Ontario jusqu'à l'ouest du Nouveau-Brunswick. Les dommages les plus importants ont été signalés dans l'ouest du Québec et l'est de l'Ontario. Après la tempête, le gouvernement fédéral et l'Ontario ont mis sur pied un programme conjoint en vue d'évaluer l'ampleur des dommages et de suivre le rétablissement des forêts de l'est de l'Ontario, notamment au moyen de relevés aériens dans les secteurs ravagés et d'évaluations des dommages et du rétablissement à partir de parcelles d'observation. En Ontario, plus de 604 000 ha de forêt ont été considérés comme ravagés. On a utilisé des parcelles déjà établies pour les évaluations au sol, car on possédait déjà des données sur l'état avant la tempête des peuplements qui y étaient établis. Au total, 26 parcelles faisant partie du réseau de surveillance de l'état des forêts du SCF et 48 parcelles du programme de suivi de la croissance et du rendement des peuplements du MRNO ont été utilisées aux fins des évaluations initiales. De façon générale, les feuillus ont été plus lourdement touchés que les conifères, mais l'ampleur des dommages variait d'un peuplement à l'autre et à même à l'intérieur de chaque peuplement. Les dommages les plus considérables ont été notés chez tilleul, le hêtre à grandes feuilles, l'érable argenté et le bouleau à papier. À l'opposé, les essences qui ont le mieux résisté au verglas étaient l'érable à sucre, le chêne, le frêne et le caryer. Les mêmes parcelles ont été utilisées pour le suivi du rétablissement des peuplements dévastés. L'état du houppier et la vigueur de l'arbre ont été mesurés durant la saison de croissance 1998, selon la méthodologie du North American Maple Project (NAMP). Une attention particulière a également été accordée aux dommages de la tige (gélivures, échaudage, blessures), aux caries et aux dégâts causés par les insectes. Les caries sont considérées comme un important problème à long terme dans les forêts ravagées par le verglas.

Competitve Binding between Cry1A and Cry9Ca delta-endotoxins to Spruce Budworm Brush-border Membrane Vesicles

Anthony S.D. Pang, J.Lawrence Gringorten and Kees van Frankenhuyzen

GLFC, Canadian Forest Service, 1219 Queen Street East, Sault Ste. Marie, Ontario P6A 5M7

Spruce budworm, *Choristoneura fumiferana* Clemens, is a serious lepidopteran pest of Canadian forests. Aerial spraying of *Bacillus thuringiensis* (*Bt*) subsp. *kurstaki* HD-1 has been the method used to control it. Concern over the development of resistance to *Bt* delta-endotoxins in some agricultural pests has prompted the search for combinations of toxins that will maintain effective control of spruce budworm while minimizing selective pressure for resistance development. To achieve this, other *Bt* toxins need to be identified that are active against spruce budworm but do not compete with HD-1 toxins for the same midgut receptors. Here we report the results of a competitive binding study between two HD-1 toxins, Cry1Aa and Cry1Ab, and a toxin produced by a novel Bt isolate classified as Cry9Ca. This toxin protein was previously found to be even more active against spruce budworm than Cry1A toxins. The experiments were performed on brush-border membrane vesicles (BBMVs) from budworm midguts.

Both Cry1Aa and Cry1Ab displayed a stronger affinity toward spruce budworm BBMVs than Cry9Ca and could displace the latter. Cross-immunoelectrophoresis indicated that the two Cry1A toxins bind to three different BBMV moieties whereas Cry9Ca only binds to one. From the displacement data it is concluded that the Cry1A toxins and Cry9Ca compete for the same binding site on the BBMVs. Bioassays against spruce budworm of mixtures of Cry1A and Cry9Ca have so far revealed no evidence of either synergism or antagonism between the two classes of toxins. It is concluded that while a combination of Cry1A and Cry9Ca will have no negative interactive effect on toxicity to spruce budworm, it offers no advantage from the point of view of resistance management of this insect.

Liaison compétitive entre les delta-endotoxines Cry1A et Cry9Ca au niveau des vésicules de la bordure en brosse de la tordeuse des bourgeons de l'épinette

Anthony S.D. Pang, J. Lawrence Gringorten et Kees van Frankenhuyzen

CFGL, Service canadien des forêts, 1219 Queen Street East, Sault Ste. Marie (Ont.) P6A 5M7

La tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* Clemens, est un important ravageur forestier au Canada. Pour réprimer les populations de ce lépidoptère, on a recours à des épandages aériens de *Bacillus thuringiensis* (Bt) var. *kurstaki* HD-1. Les craintes suscitées par l'apparition d'une résistance aux delta-endotoxines du Bt chez certains ravageurs agricoles ont incité les chercheurs à tenter de trouver des combinaisons de toxines permettant de réprimer efficacement les populations de la tordeuse tout en réduisant au maximum les pressions sélectives favorisant l'apparition d'une telle résistance. À cette fin, il faut identifier d'autres toxines du Bt qui agissent contre la tordeuse sans entrer en compétition avec les toxines HD-1 pour les mêmes récepteurs au niveau de l'intestin moyen. Nous décrivons ici les résultats d'une étude de la liaison compétitive entre deux toxines HD-1, soit Cry1Aa et Cry1Ab, et la toxine Cry9Ca, produite par un nouvel isolat de Bt. Cette protéine toxique s'est révélée encore plus active que les toxines Cry1A contre la tordeuse des bourgeons de l'épinette. Les expériences dont il est ici question ont été réalisées au niveau des vésicules de la bordure en brosse de l'intestin moyen du ravageur.

Tant la Cry1Aa que la Cry1Ab présentent une plus grande affinité pour les vésicules de la bordure en brosse de la tordeuse que la toxine Cry9Ca et pourraient déplacer cette dernière. Une analyse par immuno-électrophorèse croisée a révélé que les deux toxines Cry1A se lient à trois groupes fonctionnels distincts, alors que la toxine Cry9Ca se lie à un seul groupe. Ces résultats donnent à croire que les toxines Cry1A et Cry9Ca se livrent une compétition pour le même site de liaison au niveau de la bordure en brosse. Les essais biologiques utilisant des mélanges de Cry1A et de Cry9Ca contre la tordeuse n'ont pas révélé la présence d'un synergisme ou d'un antagonisme entre ces deux classes de toxines. En conséquence, même si l'utilisation conjointe des toxines Cry1A et Cry9Ca ne compromet pas la toxicité du Bt pour la tordeuse des bourgeons de l'épinette, elle n'offre aucun avantage pour ce qui est de prévenir l'apparition d'une résistance au Bt chez ce ravageur.

Would Combining Cry1A and Cry9Ca δ-Endotoxins of *Bt* be Useful for Controlling Spruce Budworm?

Anthony S.D. Pang, J. Lawrence Gringorten, and Kees van Frankenhuyzen

Canadian Forest Service, 1219 Queen Street East, P.O. Box 490, Sault Ste. Marie, Ontario P6A 5M7, Canada

Abstract

Commercial bioinsecticides used to control spruce budworm, *Choristoneura fumiferana* Clemens, utilize the HD-1 strain of *Bacillus thuringiensis* subsp. *kurstaki*. Because of its high potency, HD-1 is considered a good source for the production of genetically modified trees with one of its toxin genes. However, growing concern over the risk of resistance development posed by transgenic trees has necessitated the continued screening of other *Bt* strains for an additional gene that could be cloned into trees along with the gene from HD-1 to reduce the risk of resistance. Toward that end, other *Bt* toxins need to be identified that are active against budworm but do not compete with HD-1 toxins for the same midgut receptors. Here we report the results of a competitive binding study between two endotoxin proteins produced by HD-1, Cry1Aa and Cry1Ab, and a toxin produced by a novel *Bt* isolate classified as Cry9Ca. The latter was previously found to be even more active against spruce budworm than the Cry1A toxins.

The experiments were performed on brush-border membrane vesicles from budworm midguts and indicated that the Cry1A toxins and Cry9Ca, in fact, compete for the same binding site. Bioassays against spruce budworm of mixtures of Cry1A (1Aa or 1Ab) and Cry9Ca revealed no evidence of either synergism or antagonism. It is concluded that while a combination of a Cry1A protein and Cry9Ca will have no negative interactive effect on toxicity to spruce budworm, mixtures of the two or their alternate use in spray programs or the creation of transgenic trees to express both toxins offers no advantage from the point of view of resistance management of this insect.

Les delta-endotoxines Cry1A et Cry9Ca peuvent-elles être utilisées conjointement à profit pour lutter contre la tordeuse des bourgeons de l'épinette?

Anthony S.D. Pang, J. Laurence Gringorten et Kees van Frankenhuyzen

CFGL, Service canadien des forêts, 1219 Queen Street East, P.O. Box 490, Sault Ste. Marie (Ont.) Canada P6A 5M7

Résumé

Les bioinsecticides commerciaux utilisés contre la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clemens), contiennent la souche HD-1du *Bacillus thuringiensis* ssp. *kurstaki.* En raison de sa toxicité élevée, cette souche est considérée comme une bonne source pour la production d'arbres modifiés génétiquement possédant l'un des gènes codant la synthèse de la toxine. Toutefois, en raison des préoccupations croissantes liées à l'apparition d'une résistance suscitées par les arbres transgéniques, les scientifiques ont entrepris d'analyser d'autres souches de Bt en vue de trouver un gène supplémentaire susceptible d'être introduit chez les arbres par clonage en même temps que le gène de la souche HD-1, de manière à réduire le risque de résistance. À cette fin, il faut identifier d'autres toxines du Bt qui agissent contre la tordeuse sans entrer en compétition avec les toxines HD-1 pour les mêmes récepteurs au niveau de l'intestin moyen. Nous décrivons ici les résultats d'une étude de la liaison compétitive entre deux toxines HD-1, soit Cry1Aa et Cry1Ab, et la toxine Cry9Ca, produite par un nouvel isolat de Bt. Cette protéine toxique s'est révélée encore plus active que les toxines Cry1A contre la tordeuse des bourgeons de l'épinette.

Les expériences dont il est ici question ont été réalisées au niveau des vésicules de la bordure en brosse de l'intestin moyen du ravageur. Ces expériences ont révélé que les toxines Cry1A et Cry9Ca se livrent une compétition pour le même site de liaison. Les essais biologiques utilisant des mélanges de Cry1A (1Aa ou 1Ab) et de Cry9Ca contre la tordeuse n'ont pas révélé la présence d'un synergisme ou d'un antagonisme entre ces deux classes de toxines. En conséquence, même si l'utilisation conjointe des toxines Cry1A et Cry9Ca ne compromet pas la toxicité du Bt pour la tordeuse des bourgeons de l'épinette, cette stratégie, tout comme l'utilisation séquentielle des deux toxines dans le cadre de programmes de pulvérisation ou la création d'arbres transgéniques exprimant les deux toxines, n'offre aucun avantage pour ce qui est de prévenir l'apparition d'une résistance au Bt chez ce ravageur.