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Report of the Fourteenth Annual Forest Pest Control Forum Government Conference Centre Ottawa, Ontario November 18-20, 1986

Rapport du quatorzième colloque annuel sur la répression des ravageurs forestiers Centre de conférences du Gouvernement Ottawa (Ontario) Du 18 au 20 novembre 1986

Canadian Forestry Service
Ottawa, Ontario
January, 1987

Service canadien des forêts
Ottawa (Ontario)
Janvier 1987

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

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

B.H. Moody
Canadian Forestry Service / Service canadien des forêts
Ottawa, Ontario / Ottawa (Ontario)
January, 1987 / Janvier 1987

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

Maine Forest Service
H. Trial, Augusta

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

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

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

New Brunswick Department of the Environment
Wendy Sexsmith, Fredericton

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

Ontario Ministry of Natural Resources
B. McGauley, Maple
J. Churches, Maple
Ian Smigielski, Tweed
Mark Brinson, Tweed
Amy Luciani, Tweed

Department of Natural Resources Manitoba
G. Munro, Winnipeg

Saskatchewan Department of Parks and Renewable Resources
M. Pandila

Alberta Forest Service
R. Miyagawa

Research and Productivity Council
Charles J. Wiesner

Forest Protection Limited
Craig Howard, Fredericton

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

Department of National Defense Headquarters
Rick Walter, Ottawa

Environment Canada

Environmental Protection Service
P.A. Jones, Ottawa

Canadian Wildlife Service
K. Freemark, Ottawa
N. Garrity, Fredericton

Agriculture Canada
D. Laidlaw, Plant Health Division, Ottawa
D. Walter, Plant Health Division, Ottawa
R. Bast-Tjeede, Plant Health Division, Ottawa
H. Krehm, Plant Health Division, Ottawa
Al Schmidt, Plant Health Division, Ottawa
Jim Kelleher, Biocontrol Unit, Ottawa
A. MacDonald, Pesticides Directorate, Ottawa

Canadian Forestry Service
G.A. Van Sickle, Victoria
H. Cerezke, Edmonton
L. Magasi, Fredericton
P.C. Nigam, Fredericton
D. Eidt, Fredericton
D.G. Embree, Fredericton
E.G. Kettela, Fredericton
A. Raske, St. John's
G. Carew, St. John's
A. Juneau, Ste. Foy
D. Lachance, Ste. Foy
J. Robert, Ste. Foy
G.M. Howse, Sault Ste. Marie
A. Retnakaran, Sault Ste. Marie
K. Frankenhuyzen, Sault Ste. Marie
D. Kreutzweiser, Sault Ste. Marie
S. Smith, Sault Ste. Marie
B.V. Helson, Sault Ste. Marie
N. Payne, Sault Ste. Marie
J.H. Meating, Sault Ste. Marie
T.J. Ennis, Sault Ste. Marie
E.T. Caldwell, Sault Ste. Marie (chairperson)

J.C. Mercier, Ottawa
J.A. Armstrong, Ottawa (chairperson)
E.S. Kondo, Ottawa (chairperson)
E.J. Mullins, Ottawa
R.G. Taylor, Ottawa (secretary)

T.J. Ennis	CFS-Sault Ste. Marie
E.T.N. Caldwell	CFS-Sault Ste. Marie
A.G. Raske	CFS-St. John's NFLD
E. Kettela	CFS-Fredericton, N.B.
A. Juneau	CFS-Ste. Foy, P.Q.
J. Meating	CFS-Sault Ste. Marie
G.A. Van Sickle	CFS-Victoria, B.C.
H. Cerezke	CFS-Edmonton, Alberta
G.M. Howse	CFS-Sault Ste. Marie
L.P. Magasi	CFS-Fredericton, N.B.
A. Funk	CFS-Victoria, B.C.
D.C. Eidt	CFS-Fredericton, N.B.
D.G. Embree	CFS-Fredericton, N.B.
A. Retnakaran	CFS-Sault Ste. Marie
Blair Helson	CFS-Sault Ste. Marie
Dave Kreutzweiser	CFS-Sault Ste. Marie
Nick Payne	CFS-Sault Ste. Marie
G. Carew	CFS-St. John's NFLD
P.C. Nigam	CFS-Fredericton, N.B.
Kees van Frankenhuyzen	CFS-Sault Ste. Marie
D. Lachance	CFS-Ste. Foy, P.Q.
J. Robert	CFS-Ste. Foy, P.Q.
S. Smith	CFS-Sault Ste. Marie
R.G. Taylor	CFS-HQ
E.S. Kondo	CFS-HQ
J. C. Mercier	CFS-HQ
Jack Armstrong	CFS-HQ
E.J. Mullins	CFS-HQ

NOTICE OF MEETING

The Fifteenth Annual Forest Pest Control Forum

will be held in

Sussex Room, 1st Floor

Government Conference Centre

2 Rideau St., Ottawa

November 17, 18, 19, 1987

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

Avis de réunion

Le quinzième colloque annuel

sur la répression des ravageurs forestiers

aura lieu dans le

Salon Sussex, 1er étage

Centre de conférences du Gouvernement

2, rue Rideau, Ottawa

du 17, 18, 19 novembre 1987

(de 8:30 h à 16:00 h)

FOURTEENTH ANNUAL FOREST PEST CONTROL FORUM
SUSSEX ROOM, 1ST FLOOR
2 RIDEAU STREET, OTTAWA

NOVEMBER 18-20, 1986
8:30 AM - 5:00 PM

AGENDA

1. Welcome and Introductory Remarks — J.C. Mercier (Nov 19)

2. General Forest Pests Status and Control

2.1	Introductory Remarks -		G.M. Howse (Chairman)
Insects			
2.2	Mountain Pine Beetle	B.C. Alberta	A. Van Sickle R. Miyagawa H. Cerezke
2.3	Jack Pine Budworm	Manitoba Saskatchewan Ontario	G. Munro, H. Cerezke M. Pandila B. McGauley G. Howse J. Meating
2.4	Gypsy Moth	Ontario B.C. N.B. U.S.	B. McGauley J. Meating G.A. Van Sickle L.P. Magasi P. Orr
2.6	Hemlock Looper	Newfoundland	H. Crummey A. Raske
2.7	Others		
	Hylobius Blackheaded Budworm		L.P. Magasi G.A. Van Sickle
Diseases			
2.8	Scleroderris	Ontario Quebec Newfoundland	G.M. Howse D. Lachance G. Carew
2.9	Pinewood Nematode		FIDS Heads
2.10	Others		
	DED Mistletoe		 G. Munro

	Dwarf Mistletoe	M. Pandila
	European Larch Canker	L.P. Magasi

3. **PESTICIDE REVIEW**

3.1	Introductory Remarks	E.T. Caldwell (chairman)
3.2	Registration Update	W.D. Stewart
3.3	CPPA Forest Protection Program	J.P. Martel
3.4	Overview of FPMI Programs	T.J. Ennis
3.5	Pest Prediction and New Product Testing	B. Helson
3.6	Zeiraphera Update-Biology Control	J. Turgeon E. Kettela
	IGR Research Against Zeiraphera	A. Retnakaran
3.7	Permethrin Drift Study	N. Payne
3.8	Dimilin Impact Study	D. Kreutzweiser
3.9	Experimental Spray Against Hemlock Looper	A. Retnakaran A. Raske
3.10	B.t. Research	K. van Frankenhuyzen
3.11	Field Evaluation of Bioassay Techniques for B.t.	C.H. Wiesner
3.12	Trichogramma Experiments in Ontario	S. Smith
3.13	Spruce Budworm Behaviour and Their Vulnerability to Fenitrothion Spray Operations in Balsam Fir and Red Spruce in New Brunswick.	P.C. Nigam
3.14	Work on Environmental Impacts of Spruce Budworm Control Practices at CFS-Maritimes	D.C. Eidt
3.15	Preliminary Results of Field Trials	D.C. Eidt E.G. Kettela
3.16	Entomophilic Nematodes for Forest Insect Control	D.C. Eidt

4.8 British Columbia — G.A. Van Sickle

Outbreak Status 1986
Prospects 1987

Committee for Review and Improvement of Survey Assessment Techniques (November 17) — E.G. Kettela (Chairman)

Workshops November 20

1) Zeiraphera Research Needs — J. Turgeon

2) Control of Gypsy moth with B.t.-Can we do better? — K. van Frankenhuyzen

Report of the Forum Mandate Review committee — B. McGauley

Opening Remarks of the
Fourteenth Annual Forest Pest Control Forum
November 18-20, 1986
Sussex Room, 1st Floor
Government Conference Centre, 2 Rideau St.

The attendees of the forum were honoured this year by the presence of Mr. Jean Claude Mercier, Associate Deputy Minister of the Canadian Forestry Service. This was the first time since his appointment that Mr. Mercier had the opportunity to attend the forum. However, he is no stranger to the many members of the Pest Control Forum as he was the Assistant Deputy Minister of the Quebec Department of Energy and Resources and a member of the Eastern Spruce Budworm Council.

Mr. Mercier took the opportunity to interact with the members of the forum both during the formal meeting and at coffee break. Topics of interest were of course major pest problems and the decline of the spruce budworm in eastern Canada; however, other points of discussion also arose. Mr. Mercier expressed his concern about weeds as a forest pest and discussed the significance of the Doern Wilson Report. He discussed the National Forest Awareness Campaign designed to sharpen the public's awareness of the forest sector and increase public support. On an organizational level Mr. Mercier talked about the CFS-Agriculture Canada relationship and expressed pleasure at our autonomy.

After the discussion Mr. Mercier took the opportunity to listen to several presentations.

Mr. Mercier expressed his interest and support for the forum and requested that he be kept informed of its activities.

Allocution d'ouverture du quatorzième colloque sur la répression des ravageurs forestiers
Du 18 au 20 novembre 1986
Sussex Room, 1er étage
Centre de conférences du Gouvernement
2, rue Rideau

Les participants du colloque de cette année ont été honorés de la présence de M. Jean Claude Mercier, sous-ministre associé du Service canadien des forêts. C'était la première fois depuis sa nomination que M. Mercier avait l'occasion d'assister au colloque. Il n'était cependant pas vraiment un inconnu pour de nombreux membres du colloque sur la répression des ravageurs forestiers puisqu'il a occupé le poste de sous-ministre adjoint au ministère de l'Énergie et des Ressources du Québec et qu'il a été membre du Conseil de la tordeuse des bourgeons de l'épinette.

M. Mercier a profité de l'occasion pour dialoguer avec les membres du forum tant aux ateliers que pendant les pauses. Les principaux sujets abordés ont bien sûr été les principaux ravageurs forestiers et le déclin de la tordeuse des bourgeons de l'épinette dans l'est du Canada, mais d'autres sujets ont également été soulevés. M. Mercier a exprimé son inquiétude sur la question des mauvaises herbes considérées comme ravageurs des forêts et a discuté de la pertinence du rapport Doern Wilson. Il en a également profité pour parler de la campagne nationale de sensibilisation aux forêts qui vise à attirer l'attention du public sur le secteur forestier et à augmenter son appui. Sur le plan administratif, M. Mercier a discuté du rapport entre le SCF et Agriculture Canada et s'est déclaré satisfait de notre autonomie.

Après les débats, M. Mercier a assisté à plusieurs présentations.

M. Mercier a exprimé son intérêt et son appui pour le colloque et a demandé d'être tenu au courant de ses activités.

PACIFIC REGION - 1986

STATUS OF IMPORTANT FOREST PESTS

AND EXPERIMENTAL CONTROL PROJECTS

Prepared for the

Fourteenth Annual Pest Control Forum

November 18-20, 1986

Ottawa

Presented by:

G.A. Van Sickle
Pacific Forestry Centre
Victoria, B.C.

Contributors:

M. Hulme
L. Safranyik
J. Sutherland
C. Wood

SUMMARY OF IMPORTANT PESTS

The following have been selected as the pests most likely to be of interest to participants. Equally significant in terms of losses are several forest diseases such as root rots, dwarf mistletoes, stem decays, rusts and cankers, however, as these are perennial once established and fluctuate little from year to year, annual surveys are not practical or necessary. Furthermore, controls for such diseases are more practical as preventative treatments, combined with stand management practices during the harvest-regeneration phase or juvenile stand tending. Other impacts not included are nursery and regeneration losses; quarantine matters; aesthetics; increased fire hazards; earlier losses from white pine blister rust and balsam woolly aphid which, for now, restricts the management of these valuable tree species. For more detailed information of these and other pests active in the Pacific Region in 1986, the reader is referred to "Forest Pest Conditions in British Columbia and Yukon" published annually by P.F.C.

Mountain Pine Beetle

For the second consecutive year, the area and volume of lodgepole pine and some western white pine killed by mountain pine beetle in British Columbia declined. Nonetheless, the beetle continues to be the most damaging forest insect in the province with more than 8 200 active infestations covering more than 88 000 ha from the International border near Montana to northeast of Prince Rupert near the Alaskan border. This area exceeds that burned by forest fires in British Columbia in 1986 (15 500 ha) more than fivefold. Additionally, mature lodgepole pine killed by the beetle in 1984 and earlier are a legacy over more than 180 000 ha in the Cariboo Region and 37 000 ha in the Kamloops Region.

The most significant decline occurred in the Cariboo Region, where below normal temperatures in late 1984 and again in 1985 virtually eliminated beetle populations in mature pine. However, in other regions recent faders were mapped during the aerial surveys and infestations remain active over 47 000 ha in the Kamloops Region, up 3% from 1985; over 27 000 ha in the Nelson Region up nearly twofold from 1985, about 8 400 ha in the Prince Rupert Region, 1 200 ha in the Prince George Region and 4 200 ha in the Vancouver Region, mostly similar to 1985.

Secondary beetles including *Ips* spp., *Dendroctonus murrayanae* and *Trypodendron* spp. were very common in the northwestern part of the Cariboo Region, in adjacent areas of the Prince George Region and in localized areas of the Nelson Region. A scolytid, *Hylurgops* sp. was very numerous in the root collars of mature pine in pockets southwest of Prince George.

Infestations along the B.C.-Alberta border and in Glacier and Yoho National Parks declined generally but increased in Kootenay National Park. The declines were attributable to climatic impact in higher elevation stands, declining availability of suitable host and to cooperative control operations. A continuing interagency control program near the eastern entrance to Manning Provincial Park has been successful. However, northeast of the control area about 8% of the lodgepole pine (240 trees) in a cruise strip in Copper Creek along the park boundary were killed by 1985 beetle attack, about the same as the previous year. All the 1986 attacked trees were baited or near pheromone-baited trees and were treated with MSMA.

In Mt. Robson Provincial Park, west of Jasper National Park about 259 beetle-attacked trees were felled and burned during the 1985-86 winter. At least 30 recently killed trees were seen in late 1986 in groups of 1-6 trees over about 100 ha east of Mt. Robson Centre. An initial ground survey found only two trees attacked in 1986, and poor brood production. Additional co-operative surveys are in progress this week before decisions on control actions are made.

Variation of current attack among stands and regions was great. In 52 cruise strips in or adjacent to recently infested stands, the average current attack was 12% and ranged from 4% in the Kamloops Region to about 28% in the western part of the Prince Rupert Region. This compares to an average of 17% (range 0-57%) in 1985. The only evidence of current attack in the Cariboo Region was in the Quesnel TSA and was associated with pheromone trapping programs in areas scheduled for harvesting in the near future. In adjacent areas of the Prince George Region, the incidence of current attack was similar. Levels in the Nelson Region were also slightly lower. Only in the western part of the Prince Rupert Region was current attack at or slightly more than 1985 levels.

Salvage of beetle-killed and susceptible timber continues at double the Annual Allowable Cut (A.A.C.) in some Timber Supply Areas (TSA). A possible reduction in the AAC in the near future has been indicated.

Spruce Beetle

The area and volume of mature white and Engelmann spruce killed by spruce beetle in British Columbia declined for the fourth consecutive year. Most of the 3 800 ha of recent beetle-infested stand mapped was in the Kamloops and Prince Rupert regions. Localized populations and tree mortality, mostly at endemic levels, occurred in all other regions. Several factors contributed to the decline; mainly salvage and sanitation operations, and to a lesser degree host depletion and below normal temperatures in late 1984 and 1985. Brood mortality in parts of the Prince Rupert Region averaged 70% (range 40-95%).

In the northern part of the Prince Rupert Region, 20 lightly infested mature spruce were found in pockets along 9 km of the Haines Road north of the Alaska-B.C. border. In 1983 about 300 beetle-infested trees near this new road construction were removed or felled and peeled.

A potential increasing population at the south end of Glacier National Park in and adjacent to recent salvage and harvesting operations was treated by cutting the logs into short lengths to increase drying.

Budworms

Western budworm populations increased significantly and defoliated more than 413 000 ha of immature and mature Douglas-fir in four forest regions. This is nearly double the area defoliated in 1985 and is concentrated in the Kamloops Region. Of the total, 80% of the defoliated area was classified as light, 18% moderate and 2% severe.

Areas of expansion included the eastern part of the Cariboo Region, the North Thompson River Valley and the Okanagan Valley. Defoliation also occurred in adjacent parts of the Nelson Region and for the first time since 1981, in the Vancouver Region. In higher elevation stands of the southern part of the Cariboo Region populations declined by about 25%. This decline was attributed to colder than normal temperatures and slow bud development in late spring, resulting in mortality of early larval stages.

Parasitism of early and some late instar larvae occurred at all but two of 41 sites sampled mostly in the Kamloops Region, but averaged only 8% (range 0-50%). This is down 3% from 1985, and too low to effectively reduce populations. Numbers of eggs in and adjacent to 54 infested stands in 4 regions forecast severe defoliation in 72% of the sites for 1987, moderate in 13% and light in the remainder.

Understory tree mortality and height growth loss is evident, but variable in some stands defoliated for 5 to 8 consecutive years. The number of permanent study plots to assess long term impact of defoliation was increased to 86.

The effectiveness of an experimental 200 ha interagency aerial spray control trial (using Bt) in Paul Lake Provincial Park near Kamloops was affected by late application and rainfall. Larval mortality averaged 44%.

As forecast, the extent and intensity of defoliation of alpine fir and spruce forests by two-year cycle budworms increased to moderate and severe over 60 000 ha in the Cariboo and Prince George regions. This was a tenfold increase from 1985 and up from 2 000 ha in 1984, the last year of feeding by mature larvae. Low endemic populations occurred in isolated higher elevation fir-spruce stands in the Nelson Region and, for the first time in recent years, near Kamloops. In previously infested stands in the Prince Rupert Region, populations remained at very low levels. Based on the increased number of egg masses in and adjacent to 13 infested stands in three regions, two-year cycle early instar larvae in 1987 buds are expected to be numerous. They should not, however, cause significant discoloration or defoliation until they mature in 1988.

Significantly increased populations of one-year cycle eastern spruce budworm moderately defoliated the 1986 needles on mainly valley bottom balsam fir and white spruce over 94 700 ha northeast of Fort Nelson to the borders of the Yukuon and Northwest Territories, and west of Fort Nelson to the Coal River Valley, a thirteenfold increase from 1984. infestations have occurred periodically in the Fort Nelson area since 1957. The last occurred in the mid--1970's when 27% of the trees examined in the Liard and Smith River valleys had an average of 1.2 m of top-kill.

Blackheaded Budworm

Blackheaded budworm populations defoliated mature and some immature western hemlock over 56 000 ha on the Queen Charlotte Islands and near Kitimat. Of this, 57% was classified moderate defoliation, 31% light and 12% severe. High numbers of hemlock sawfly were also common in many of these stands. This is the second year of defoliation in these areas and an increase from 30 800 ha in 1985.

Populations in the Cariboo, Kamloops and Nelson regions and the lower mainland part of the Vancouver Region collapsed after two successive years of light and moderate defoliation. The collapse in Interior stands, from 12 500 ha in 1985, was attributed in part to cool moist weather in late spring.

To date, tree mortality in second growth stands averaged about 12% over 3 000 ha on the Queen Charlotte Islands and severe top-kill averaging 8 m is present on 75% of the remainder. About half of the semimature hemlock had 4 m long top-kill. In the moderately and severely defoliated mature stands, about 80% of the trees averaged 3 m top-kill.

Egg samples from 33 sites mainly on the Queen Charlotte Islands forecast severe defoliation at only 1 site, moderate at 7 and trace or light at the remainder. Primarily light defoliation is predicted for the South Moresby Island area, including Lyell Island, southern Graham Island, Masset Inlet and in the Kitimat area. Stands moderately to severely defoliated during the past two years should generally have only trace to light defoliation in 1987. Heavier defoliation is indicated for northern Moresby Island and Louise Island. Larval parasitism in three areas in the currently active infestation averaged 16% (range 2-23%); not high enough to significantly reduce the population.

Douglas-fir Tussock Moth

There was no evidence of this important defoliator of Douglas-fir stands. This follows a major population collapse in 1984 after a 3-year outbreak had covered 23 500 ha mainly in the Kamloops Region. Larvae were not collected in any previously defoliated stands. Conspicuous mortality of previously defoliated Douglas-fir was evident over 5 100 ha in 1986, the same area defined by aerial surveys in 1984.

Seventy-five adult male moths were trapped in 25 of 114 pheromone-baited sticky traps in 9 of 19 previously active tussock moth areas, mainly in the Kamloops Region. This was up slightly from 4 moths at the 19 locations in 1985, but indicates only very low endemic populations in 1987.

Larch Defoliators

Defoliation of western larch in southeastern British Columbia by larch casebearer declined in intensity for the second consecutive year, being generally light with only isolated pockets of severely defoliated immature trees. Trace or light defoliation occurred at only 16 of the 27 long term study sites. Scattered roadside larch were severely defoliated in the West Kootenay. In adjacent parts of the Kamloops Region isolated stands were only very lightly defoliated.

More than 5 200 adult parasites, *Chrysocharis laricinellae*, were released in four infested stands in a biological control program continued by FIDS since 1966. Larval sampling to forecast 1987 populations and parasite levels is in progress with results expected in December.

Male adult casebearers were monitored with pheromone-baited traps at 15 parasite release sites and 7 sites beyond the known limits of casebearer populations. The number of adults were only slightly higher than last year at two release sites and low elsewhere. A slight expansion beyond the known limits of the casebearer was apparent in the West Kootenay, but not in the East Kootenay east of Elko nor in the western part of the host range in the north Okanagan Valley.

After four consecutive years of defoliation of western larch, mainly in the western part of the host range in the Nelson and Kamloops regions, larch budmoth populations collapsed. Below normal temperatures in May 1986 contributed in part to the mortality of overwintering early instar larvae where 1985 populations had defoliated larch over 14 800 ha. Pheromone baits attracted 1 to 277 male adults at previously defoliated sites, but there had not been evidence of larvae.

Cone and Seed Pests

Cone crops were heavy in north coastal areas, but generally light and spotty elsewhere, similar to 1985. Cone and seed pests were also variable in 39 province-wide cone bearing stands. Major pests included Douglas-fir seed chalcid which infested up to 45% of the cones in parts of the Nelson Region and in four coastal seed orchards. A spruce cone maggot infested up to 75% of the white and Engelmann spruce cones in six interior stands and Sitka spruce in a seed orchard on Vancouver Island. Also, 78% of the cones in 18 natural Sitka spruce stands in the western part of the Prince Rupert Region were infested by the maggot. Western hemlock cones in five north coastal areas were healthy as were yellow cedar cones from Rennel Sound on the Queen Charlotte Islands.

Twelve coastal and three interior seed orchards were surveyed in 1986. Cooley spruce gall aphid severely infested Douglas-fir in nine coastal orchards. Balsam woolly aphid infested twigs on about 5% of the amabilis fir in three orchards on Vancouver Island, all within the known infestation zone. Swiss needle cast was less severe and extensive than in 1985 but infected 10 and 50% of the Douglas-fir in two coastal orchards. Spruce gall aphid was common on up to half the spruce in four coastal orchards where it had occurred to varying degrees for several years. White and Engelmann spruce in two orchards near Kamloops were again lightly infested by western spruce budworm, which has been epidemic in adjacent Douglas-fir stands. Stem rusts persist and pine needle diseases infected about 10% of the needles in provenance trials south of Prince George.

Black Army Cutworm

Cutworms killed up to 10% of the newly planted conifer seedlings in parts of at least 13 recently planted sites in the interior part of the Prince Rupert Region, where larvae have been common for the last five years. Most lodgepole pine seedlings and some spruce in 3 of 4 sites over 20 ha in the Prince George Region were moderately or severely defoliated for the third consecutive year. Populations were common in the eastern part of the Cariboo Region but damage, mainly to ground cover, was very light. There was no evidence of populations in the Kamloops Region nor in the Nelson Region where extensive areas, mostly dry sites, burned in 1985.

Parasites and virus have contributed to reducing cutworm populations with up to 48% parasitism of early and mid-instar larvae from the Cariboo, Prince George and Prince Rupert regions. Pupal parasitism was 29% in the Prince George Region.

Sticky traps baited with experimental pheromones attracted up to 30 male adults per trap at 73 sites in four regions, indicating continuing populations in 1987. Cutworms pose a continuing threat to some 1987 spring planting areas in Prince Rupert and Prince George regions and in parts of the Cariboo and Kamloops region where slash burning increased significantly in 1986.

High numbers of a variegated cutworm, *Peridroma saucia*, were found for the first time in a newly planted site in the eastern part of the Cariboo Region. A small number of spruce seedlings and most ground cover over part of the plantation were severely defoliated. Mortality of overwintering pupae of this primarily agricultural and forest nursery pest is expected to be high.

Pinewood Nematode

Unidentified nematodes were extracted from 29 of 181 branch and stem samples from symptomatic dying trees and from 4 of 55 adult Monochamus woodborers collected in British Columbia in 1986. Identification is pending. Samples were from lodgepole, western white, white bark and ponderosa pine wood chips and adults of Buprestidae and Cerambycidae. Surveys in B.C. during the preceding three years found only bacterial or other insect associated nematodes, which are commonly found across Canada including: *Aphelenchoides* sp., *Cryptaphelenchus* sp., *Deladenus* sp. and *Acrobeles* sp.

Gypsy Moth

In the continuing cooperative trapping program, 24 adult male gypsy moths were trapped in 19 sticky traps in 8 areas this year in British Columbia. This compares with 14 moths in 13 traps in 3 areas in 1985. The new catches were at Kelowna (7), Clinton (2), south of Kamloops (1), Chilliwack (8), Vancouver (1), Point Roberts (1), Belmont Park near CFB Esquimalt (3) and Goldstream Provincial Park (1) near Victoria. About 7 000 traps were monitored throughout the province in the twelfth year of the cooperative program with Agriculture Canada, Plant Health, the B.C. Forest Service and CFS-FIDS. Of 268 traps set out by CFS-FIDS in 233 forested recreation areas in National and Provincial parks and some commercial sites, one at Kelowna attracted one moth.

Experimental Control Projects

Bark Beetles

Most control actions against bark beetles involve rescheduling of harvest, salvage, single tree cut and burn, trap tree programs, pheromone baiting, hazard rating systems and additional access road construction.

No further field evaluation of pine oil to prevent mountain pine beetle attack (see 1983-1985 Pest Control Forum reports) has been conducted during 1986. In earlier field trials, both the eastern and western forms of pine oil were highly effective in preventing attacks when beetle populations were low but generally ineffective when beetle populations were high.

A "tree monkey", a self-climbing debarking and delimbing machine, is being developed for treatment of mountain pine beetle broods in single trees and small groups of infested trees. A prototype, developed under contract with Windsor Machines Ltd. of Vancouver, B.C., has been field-tested and needs further development.

Field work on a joint Canada-U.S.A. study to evaluate the reliability of existing systems for predicting hazard of infestation by mountain pine beetle has been completed. Data from 150 stands has now been gathered. Also, data from a four year study of mountain pine beetle dispersal are being analyzed.

Winter Moth

Defoliation of deciduous trees and shrubs in the Greater Victoria area by significantly reduced winter moth populations, was very light and scattered for the second consecutive year. Parasitism (Cyzenis albicanus and Agrypon flaveolatum) is being evaluated. Initial assessments indicate a greatly reduced incidence of Cyzenis compared to 1985 when overall parasitism averaged 42% (range 9-68%) at 33 sites.

Spruce Weevil

Field sampling indicates that insects associated with Pissodes strobi in leaders of Picea sitchensis can have a considerable impact on weevil populations in the leaders. As a first step in increasing the number of P. strobi associates, methods have been tested for separating the asociates from P. strobi in the leaders. So far two methods have proved successful. (1) Pissodes strobi is not as cold hardy as its associates. Thus, if leaders are frozen in defined temperatures/time regimes, all P. strobi are killed and the associates are not harmed. (2) Leaders can be stored in containers covered by screen of defined dimensions that will confine all the P. strobi while allowing all species of associates to escape.

The present operational method of attempted control of P. strobi is to clip and destroy attacked leaders, but this also destroys all insect associates. These can now be retrieved by either of the methods outlined above. The choice of method will depend on resources available and judgment of acceptable risks. Exploiting the relative lack of cold-hardiness of P. strobi requires suitable freezing equipment, but all P. strobi are killed. Confining leaders in screened containers requires simple equipment but P. strobi can escape if container or screen is defective.

Regeneration Pests

Known to be seed-borne on container-grown spruce, Sirococcus strobilinus is mainly controlled with post emergent fungicides which are both time consuming and costly. Thus, the possibility of eliminating this pathogen from seeds by heat treating seeds in water was investigated.

Based on two initial experiments which determined the thermal death points of spruce seed and S. strobilinus to be 49°C and 47°C, respectively, a third experiment was undertaken to assess the survival and general performance of heat treated spruce seeds in containers.

In a factorial design experiment, three spruce seedlots known to carry S. strobilinus were water-treated at three temperatures (20, 47 and 49°C) and four times (0, 30, 60 and 90 minutes). Following treatment, seeds were double sown into a standard container nursery growing medium in type 211 styroblocks arranged in a randomized complete block design in a greenhouse. Germinants were counted on a regular basis over a period of 34 days and the incidence of S. strobilinus closely monitored and recorded. Root dry weights and shoot heights were also recorded from a random sampling of seedlings at the end of the experiment.

A preliminary assessment of the data reveals that:

1) S. strobilinus was recovered only from controls and seeds treated at 20°C (for all times).

2) In general, germination rates and percentage germination values decreased with increasing time and temperature.

Statistical analyses of all experimental data are currently underway.

Small scale trials of diatomaceous earth with pyrethrins, dimethoate and permethrin were conducted against the western conifer seed bug (Leptoglossus occidentalis) in the laboratory. All produced 100% mortality. In the field on bagged branches containing insects, permethrin and dimethoate again produced 100% mortality but diatomaceous earth caused no mortality. The poor results with the earth was due to excess moisture (rain and dew) which caused the diatomaceous particles to bloat and lose their edges.

Pinewood Nematode

Taxonomic descriptions show the pinewood nematode (PWN), Bursaphelenchus xylophilus, having a rounded tail while a closely related species, B. mucronatus has a pointed tail. Some populations of Bursaphelenchus found in Canada appear to have an intermediate tail shape and Dr. R. Anderson (Agriculture Canada, Ottawa) designated nematodes from trees or wood chips as either an 'r'- (tip of tail round) or 'm'-form (tip of tail slightly pointed). To determine the significance of tail shape when identifying B. xylophilus and B. mucronatus, Dr. J. Webster and students at Simon Fraser University are using DNA hybridization techniques to see if 'r'- and 'm'-forms of nematodes are different species or if the 'm'-form nematodes are related to B. mucronatus. This research, funded by the Canadian Forestry Service (C.F.S.), has shown that although minor differences exist, both 'm'- and 'r'-form nematodes are the same, i.e. both are B. xylophilus, and that B. mucronatus is distinctly different from either 'm'- or 'r'-form B. xylophilus. Blind testing is in progress, then the technology and probes will be transferred so that the findings can be used to identify PWN's from across Canada.

Based upon a request from Scandinavia officials, CFS Headquarters had Dr. Jack Sutherland (Pacific Forestry Centre, Victoria) inoculate 10 to 20, 1-year-old Scots pine from Sweden with two Canadian isolates of PWN. For comparison, a known pathogenic isolate of PWN from Missouri was included in the trial. Inoculum levels were 100 PWN/seedling; control seedlings received sterile water. Twenty percent of the seedlings inoculated with PWN from Clinton, B.C. and from Missouri were dead 42-46 days after inoculation. Trees inoculated with a Quebec isolate of PWN and the controls remained healthy. Large numbers of PWN were recovered from both the shoots and roots of killed seedlings.

File: 235-40

Date: November 14, 1986

B.C. FOREST SERVICE - PEST CONTROL ACTIVITY

Entomology:

Bark beetles remain a widespread problem in five of the six Forest Regions of the Province. The primary problem is the mountain pine beetle, Dendroctonus ponderosae; spruce beetle, D. rufipennis, infestations have declined in most areas. Current status of these pests is given by the Forest Insect and Disease Survey unit of the Canadian Forestry Service.

1986/87 represents the third year of a projected five year program designed to reduce the rate of spread of bark beetle infestations. Approximately $8.2 million was allocated this year to continue activities as described in past reports to this Forum. Preliminary results indicate that this program has been successful in limiting expansion in many areas. A complete evaluation will be conducted upon completion of the program.

Western spruce budworm, Choristoneura occidentalis, has continued to expand, primarily in the Kamloops Forest Region. In 1986, a small scale trial using B.t. at a rate of 30 BIU per hectare over approximately 200 hectares, was made. Due to the advanced development of the budworm and difficulties with weather conditions, control effectiveness was likely less than optimal; however, this exercise was effective from a staff training standpoint.

Surveys indicate that continued severe defoliation can be expected in 1987 over a large area of the Kamloops Forest Region. Planning is currently underway to assess the need for control activity in 1987. Widespread treatment is not being considered; however, high value stands where significant damage is expected are being evaluated for pesticide application. Such stands include: areas where intensive silviculture operations such as thinning have been carried out; stands managed for selective logging; parks; and others. Potential losses are being determined in cooperation with CFS damage appraisal personnel. This information will be used to assess the need for protective treatments. If treatments are deemed desirable, these areas will be protected until the infestation subsides. Only a small portion of affected stands will be treated.

Blackheaded budworm, Acleris gloverana, continues to infest large areas of primarily hemlock stands on the Queen Charlotte Islands. No treatment is being considered at this time. Damage appraisal plots are being established throughout the affected areas to provide more precise estimates of loses due to this insect.

Gypsy moth, lymantria dispar, continues to be of concern to the Forest Service. Although eradication remains the responsibility of Agriculture Canada, the B. C. Forest Service is continuing and expanding it's cooperation role in the Province-wide pheromone trapping survey program. Over 1,500 traps were placed by Forest Service staff in recreation sites and forested areas. This program is expected to continue in future years.

Peter M. Hall
Forest Entomologist
Pest Management
Forest Protection Branch

!PH/mje 4344j!

FOREST DISEASES IN BRITISH COLUMBIA

by J. Muir
B.C. Forest Service
Protection Branch
Victoria, B.C.

Pinewood nematode developed as a major concern in 1985-1986 and continues as a potentially very serious threat to our annual 10 billion dollar forest product exports from B.C. We have supported a vigorous program by Agriculture Canada, Plant Health and the Canadian Forestry Service to deal with the nematode. Surveys of wood chips at mills in B.C., in co-operation with Plant Health, have revealed several occurrences of the nematode. We need to develop a more precise method to determine the occurrence of the nematode, perhaps by trapping the sawyer beetle vector.

Our regional forest pathologists and other staff at Vancouver, Kamloops, Nelson, Williams Lake, Prince George and Prince Rupert Forest Regions are developing and implementing training programs, and establishing field trials and demonstrations to control various pathogens. Dwarf mistletoes and root diseases continue to be the major concerns. Other diseases of young trees, especially in plantations are important, including white pine blister rust, and programs and procedures are being developed for these too.

With provincial funds allocated for pest control under the Forest Resources Development Agreement, we have undertaken several projects, including:

- pest damage surveys of young plantation trees in Prince George and Prince Rupert Forest Regions.
- assessment of deteriorating subalpine fir stands.
- development of root disease survey and sampling methods for southern interior forests.
- stem analysis of infected trees to determine growth losses caused by lodgepole pine dwarf mistletoe.
- permanent sample plots for thinning trials in stands with leader weevil (Pissodes strobi), dwarf mistletoes and root diseases.
- sampling for residual roots in areas de-stumped for root diseases.
- white pine blister rust tree selection.

- development of a pest management information system.

- control of porcupine damage to young trees.

These FRDA projects should yield valuable results and give us a good basis for a provincial forest disease control program.

ALBERTA FOREST SERVICE

1986 FOREST INSECT AND DISEASE REPORT

R. Miyagawa

(A) Mountain Pine Beetle Program

Survey and Control Program

The 1985 fall survey program indicated that the number of larva which were expected to overwinter for the 1986 population had diminished considerably from the previous year. The 1986 spring survey indicated that there was further population reduction due to low survival rates of the overwintering larva. Thus the number of trees treated during the past summer declined drastically as shown in the following table:

Number of Trees Treated

Development Years	Lodgepole Pine	Limber Pine
1984-85	4,493	15,657
1985-86	271	1,033

Survey of the beetle salvage area has indicated that the beetle population in this area has also drastically declined. Very few newly faded trees were found during the spring and summer. Even in the area east of Waterton National Park where very little salvaging has occurred, newly infested trees were difficult to find.

1986 MPB Pheromone Baiting Program

Five hundred trees were pheromone baited during the past summer. Further decline in the beetle population is indicated by the number of successfully attacked baited trees. This is shown in the following table:

Area	Total No. Baited trees	Total No. of Attacked Trees	
		Successful	Unsuccessful/Light Attack
Crowsnest	544	23	51
Kananaskis	56	19	9

Very few trees adjacent to the trap were successfully attacked. The majority of the successfully attacked trees were hit from the base of the tree to approximately six feet above the base. Thus, only twelve to fifteen of the attacked trees will require felling and burning, while the others may not.

Future of the MPB Program

The major objective of the mountain pine beetle program has been achieved since the infestation movement did not go beyond the northern control boundary in the Crowsnest area. The beetles although present in the Kananaskis area did not develop into a major infestation. Thus, as of the fifteenth of November, the project will be considered officially completed. A monitoring program will be maintained as part of the overall annual forest insect and disease survey. At the same time any newly infested trees will be located and treated accordingly.

(B) Spruce Budworm

Only endemic populations of the spruce budworms were discovered through the continuous monitoring program of the forests under the management of the Alberta Forest Service. An extensive budworm trapping program was initiated to provide data on budworm populations throughout these forested areas.

Budworm populations have persisted in the farm shelterbelt areas, the parkland area of the province and in the city of Edmonton. Spraying programs have been initiated in some of these areas.

(C) Jack Pine Budworm

The jack pine budworm population has not changed from the previous year. Jack pine stands located approximately eighty kilometers north of Edmonton continue to be the only major infested stand in Alberta. No apparent spread or increase in population has been indicated from the past years survey. There is a continuing interest in the use of pheromone to monitor this population.

(D) Spruce Beetle

Spruce beetle problems have declined during the past two years. No new major infestation has been located by the continuous monitoring program initiated throughout the areas of previous infestation and in high hazard rated stands. Large areas of infested stands have been logged during the past two years and a control burn program was completed in one of these logged areas.

Dr. Herb Cerezke of the Canadian Forestry Service in co-operation with the Drs. Hal Wieser and Elizabeth Dixon of the University of Calgary have been conducting experiments in pheromone baiting for spruce beetle. Results indicate that pheromones may be useful for beetle population monitoring program.

(E) Forest Tent Caterpillar

The Forest Tent Caterpillar population in forested areas declined considerably. Two areas, one in Whitecourt Forest and the other in Slave Lake Forest, were judged to have moderate to severe defoliation.

Defoliation by tent caterpillar has been quite severe in some of the parkland areas especially in areas close to the Alberta-Saskatchewan boundary.

(F) Dwarf Mistletoe

The Bow/Crow Forest continued their mistletoe survey program, and data from these surveys have been used to change cutting priority areas. All districts are expected to have a complete zoning of their forests for mistletoe infestations.

(G) Poplar Diseases

A special survey was conducted by the Bow/Crow Forest in the Kananaskis Recreation area to pinpoint diseased and dying poplar as well as other species of trees in campsites. Trees endangering the safety of the campsites were marked to be removed.

FOREST PESTS IN MANITOBA, 1986

Jack Pine Budworm

Spruce Budworm

White Pine Weevil

Dutch Elm Disease

Dwarf Mistletoe

Armillaria Root Rot

by

K. Knowles, T. Boyce, Y. Beaubien

Presented to the 14th Annual National Pest Forum

by

Geoff Munro

Jack Pine Budworm

1986 - Status Report

There was a noticeable decline in the jack pine budworm infestation in 1986. A major collapse occurred in the Northern and Interlake regions. Localized infestations persisted in the Western and Southeastern regions. Widespread severe defoliation continued for a second year East of Lake Winnipeg into Ontario.

Based on the 1985 egg mass survey, a spray program for 34,000 hectares was initiated. Low pre-spray larval populations caused cancellation of 7,500 hectares at Sipiwesk, William Lake, Moose Lake, Wanless and Cowan. Application of *Bacillus thuringiensis* at 20 B.I.U. per hectare was completed as follows:

	Hectares Treated	Larval Reduction
Sandilands		
Cat Hills	409	83%
Vasser	3,268	41%
Woodridge	14,694	69%
Fireguard Block	1,170	83%
Dawson Cabin	342	80%
Belair		
Murray Hill	1,123	99%
Jackfish Lake	1,656	82%
Belair	392	47%
Traverse Bay	651	92%
Cowan		
Cowan	2,286	48%
Kississing		
Jenny Lake	364	61%
Naesap Lake	177	61%

Pheromone traps were placed in the field at 12 locations throughout the province. Male moth captures declined drastically from 1985 at all but 2 locations. Results are as follows:

Location	1985 Moth Capture	1986 Moth Capture
~~Moose Lake~~	95	4
St. Martins	960	129
Sandilands	512	60
Porcupine Mr.	378	22
Wallace Lake	458	107
Belair	94	108
Spruce Woods	1080	504
Flin Flon	111	7
Simonhouse	84	12
Thompson	69	6
Lynn Lake	225	1
Whiteshell	107	122

Egg mass surveys to predict 1987 defoliation were carried out in all spray block locations. Results from all areas indicate nil or light defoliation for next year.

Spruce Budworm

1986 - Status Report

Infestations in Whiteshell Provincial Park and southern Interlake Region continued for the 11th consecutive year. The Lake Winnipeg East infestation (now in its 5th year) persisted at severe levels. Considerable balsam fir mortality has occurred in the infestation areas.

Spray operations with *Bacillus thuringiensis* (20 B.I.U. per hectare) were carried out in two high use recreation areas. Spray efficacy was less than desirable at both locations. Results were as follows:

Location	Hectares Treated	Larval Reduction
Hecla Island (treatment area)	375	37%
Untreated Plots	-	18%
Tulabi Falls(treatment area)	230	62%
Untreated Plots	-	45%

The results of the egg mass survey indicate a decline in the Interlake infestation. All sample locations are predicting light defoliation for 1987. Results from the Whiteshell and Lake Winnipeg East samples predict moderate and severe defoliation again in 1987.

WHITE PINE WEEVIL - 1986

White pine weevil, *Pissodes strobi*, has become a chronic problem in approximately 1100 hectares of white spruce plantations located in the Interlake Region of Manitoba. Although sanitation pruning was carried out on 185 hectares in 1984 and 1985 the infestation entered its fifth consecutive year expanding into surrounding areas. The entire plantation area was surveyed this summer to determine weevil distribution. Sanitation pruning was carried out on 200 hectares based on survey results.

The removal of competing poplar within the white spruce rows over the past five years may have contributed to the increase in weevil numbers. Silvicultural prescriptions may require modification in white spruce plantations as the weevil is a sun loving insect preferring open growing trees.

DUTCH ELM DISEASE IN MANITOBA
1986 - STATUS REPORT

During the 1986 summer surveillance season, approximately 13,000 elms were examined in and around urban and rural municipalities. Of these, 2,948 were confirmed to have Dutch Elm Disease and 9,879 were classified as hazards, many of these probably dead as a result of D.E.D. Because of the large number of elms infected in wild stands throughout southern Manitoba, particularly in eastern and central regions, control efforts were again concentrated on elms in and around cost-sharing communities. Trees in the wild were largely ignored due to the impracticality of controlling the disease in those areas.

The number of municipalities with D.E.D. increased from 72 to 77 this year. This includes major urban centres like Winnipeg, Brandon, Portage la Prairie, Carman and Selkirk as well as major parks such as the North West Angle Provincial Forest, Spruce Woods and Whiteshell Provincial Parks and the Riding Mountain National Park. D.E.D. was observed for the first time this year in the Rural Municipalities of Ellice, Archie, Miniota, Wallace, Woodward and Edward. Increases in the number of diseased and dead trees were observed around Bissett, Nopiming Provincial Park, along the Netley Creek watershed North of Teulon and along the Northeast shoreline of Lake Manitoba.

Although D.E.D. continues to increase in the wild stands, diseased elms in urban centres with control programs were comparably low. Less than 1% of Winnipeg's elms were diseased, and in Brandon, less than 2% of the elms were infected. Again, most of these trees are found in the wild stands along the river-banks where control measures are less effective. The City of Winnipeg reported 3,218 samples taken this year of which 2,219 were confirmed D.E.D. and an additional 5,464 were marked as Hazards.

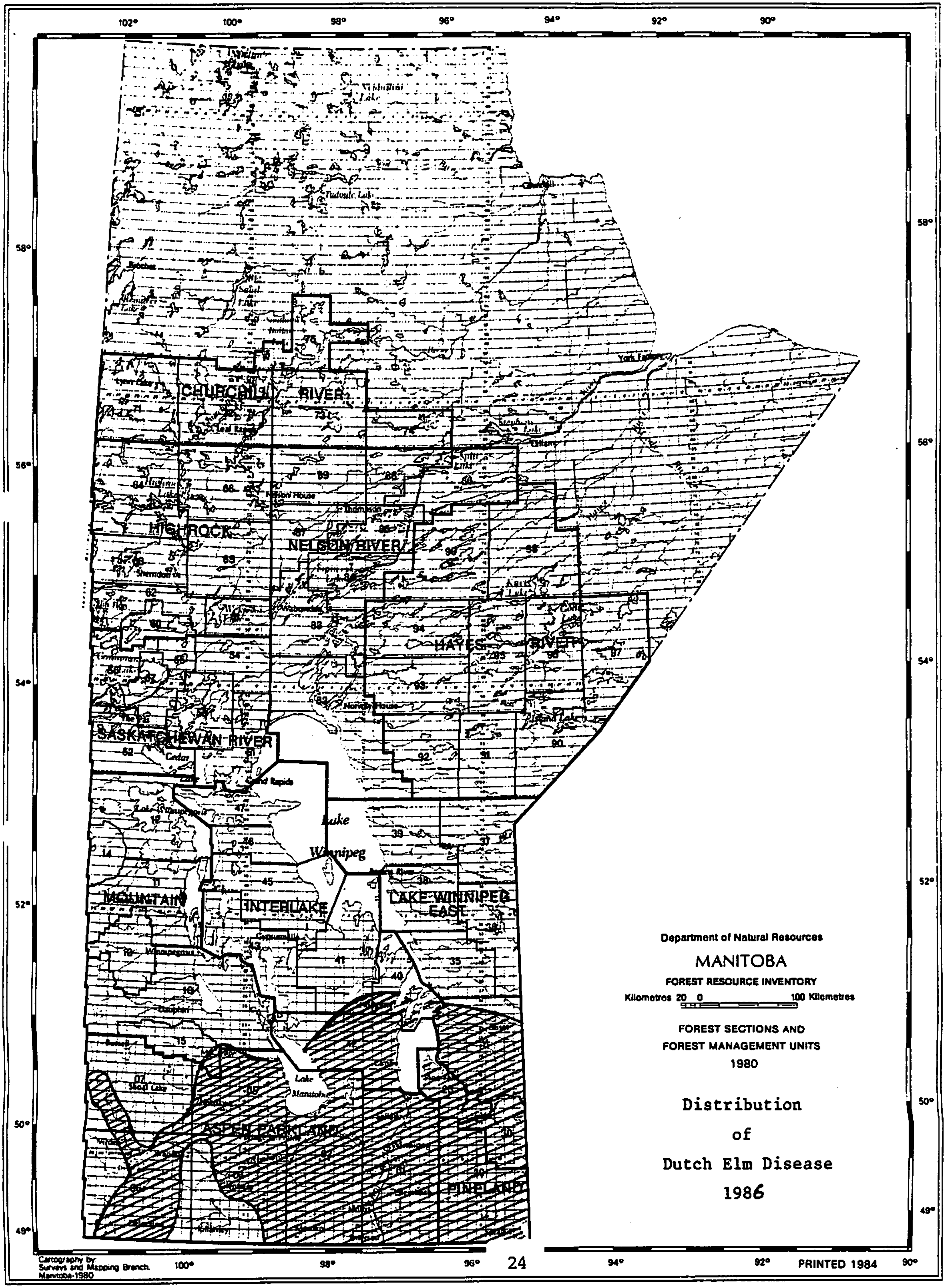
The disease has continued to increase along most of southern Manitoba's rivers. Large increases in disease have occurred on the Red and Assiniboine rivers around Winnipeg, along the Assiniboine to Portage la Prairie and Brandon and west of Brandon as far as the St. Lazare area. The Whitemud River around Westbourne has shown a considerable increase in disease, as well as the east escarpment of Riding Mountain National Park. The smaller river and creek systems in south central Manitoba also experienced more pockets of infection, thus endangering the farm shelterbelts in the areas around Winkler, Altona, Morden, and Carman.

The Souris River southwest of Brandon was surveyed by air and reported to be extensively infected right into the United States and back into Saskatchewan. However, the natural elm population drops off just a few miles into Saskatchewan.

The community of Minnedosa which had one diseased tree in 1979 experienced one tree with D.E.D. this year. Neepawa which had three diseased trees in 1984 remained disease free again this year. However, other communities such as Winkler, Morden, Ste. Anne and Souris experienced a considerable increase this year as compared to last. Some communities such as Carman, Deloraine, Stonewall, Gimli, Morris and Altona have shown favourable results from sanitation practices which have included pruning and basal spraying.

The first diseased tree in rural Manitoba this year was observed in St. Jean on May 28 and in the Winnipeg area about June 14. Again, because of generally cool spring weather conditions and substantial infestation of cankerworms external symptoms were delayed and sampling of diseased trees in any great numbers did not get started until the end of June. Most sampling was done in July and the first week in August.

From April 1st to October 31st, 1986, the Provincial Dutch Elm Disease Sanitation crew removed 3,292 elm trees. In addition, approximately 2,200 decadent elms were removed in Beaudry Provincial Park west of Winnipeg and the Brandon buffer zone during the winter works projects which ran from December 1985 to April 1986.



CHURCHILL RIVER
HIGHROCK
NELSON RIVER
HAYES RIVER
SASKATCHEWAN RIVER
MOUNTAIN
INTERLAKE
LAKE WINNIPEG EAST
ASPEN PARKLAND
PINELAND
Lake Winnipeg
Lake Manitoba
Grand Rapids
Nelson House
Norway House
York Factory
Department of Natural Resources
MANITOBA
FOREST RESOURCE INVENTORY
Kilometres 20 0 100 Kilometres
FOREST SECTIONS AND
FOREST MANAGEMENT UNITS
1980
Distribution
of
Dutch Elm Disease
1986
Cartography by:
Surveys and Mapping Branch.
Manitoba-1980
PRINTED 1984

DWARF MISTLETOE

1986 - STATUS REPORT

In Manitoba dwarf mistletoe causes extensive damage reducing both the quantity and quality of merchantable timber. Two species occur in the province; *Arceuthobium americanum*, attacking jack pine, and *A. pusillum*, attacking white and black spruce. Over the past three years surveys, research and sanitation for this disease has been carried out under the Canada-Manitoba Forest Renewal Agreement.

In 1986 operational surveys were carried out in the Interlake, Western and Eastern regions to locate areas for harvesting and sanitation. Survey work also resulted in data collection for the ongoing research projects.

Two research projects funded by the Agreement are being delivered by the University of Manitoba Botany Department. A Ph.D. study, to further research the biology of *A. americanum* on jack pine under Manitoba conditions, is being carried out by J. Gilbert. This research should indicate vulnerable stages in the parasite's life cycle which can be taken advantage of in developing management plans. The other project carried out by T. Meyer is for the development of a loss simulator model. Taking into consideration stand volume, age, tree mortality, site conditions and the rate of dwarf mistletoe spread, the model will determine the cost-effectiveness of control and the most economically feasible time to harvest.

Sanitation treatments carried out for dwarf mistletoe consisted of post-logging treatments (removal of residual infections prior to reforestation), fuelwood production in heavily diseased unmerchantable stands, creation of disease free buffer zones (15 metres wide) to protect uninfected juvenile stands, and thinning and pruning of juvenile stands to reduce the disease to tolerable levels.

ARMILLARIA ROOT ROT

1986 - STATUS REPORT

Armillaria root rot continues to be a problem in red pine plantations at a few locations in Eastern and Southeastern Manitoba. The disease has been found in plantations ranging in age from 5 to 50 years of age. In the younger plantations (5 to 15 years) the decaying roots and stumps from the previous generations of trees (jack pine in all cases) appears to be the food base facilitating the build up of the fungus in the soil. The older plantations (35 to 50 years) have experienced the removal of suppressed red pine or residual jack pine in recent years. This activity again, is believed to have supplied the food base as disease incidence occurs in the immediate vicinity of the removed trees. Infected trees have suffered substantial growth reduction and mortality. With considerable thinning now being carried out in red pine plantations, there is a concern this activity may trigger outbreaks of Armillaria.

An impact study initiated in 1983 has monitored active infection centres in 10, 12 and 13 year old plantations in Belair Provincial Forest. Within the five study plots, mortality due to Armillaria was 33.6%, 32.7%, 16.3%, 13.7%, and 17.2% at the end of the 1986 field season. Over the 1986 field season the percent increase in mortality was 1.8%, 1.8%, 2.0%, 0.8%, and 0%. The commulative increase in mortality over the 3 year period has been 9.7%, 11.5%, 7.2%, 3.8%, and 4.0%. The disease although still active in these localities appears to be spreading at a slower rate.

The Control of Forest Insects in Ontario - 1986

B.H. McGauley and S.A. Nicholson

Ministry of Natural Resources
Pest Control Section

In 1986, the Ontario Ministry of Natural Resources conducted protection spraying on 735,759 hectares of forested land including parks, wildlife habitat, plantations and seed production areas against the spruce budworm, jack pine budworm and the gypsy moth (Figure 1). This was the largest program ever undertaken in the history of forest insect control in Ontario.

Twenty-four open houses were conducted in an effort to inform forest users and the public about the need for forest protection and the appropriateness of chemical and biological insecticides. In addition, four media briefing sessions involving the Minister were held which demonstrated the Ministry's dedication to this program. The government decision of February 12 to use only biological insecticide in 1986 resulted in the use of approximately 1.5 million litres of the Bacillus thuringiensis (B.t.) products Dipel 132 and Thuricide 48 LV (Table 1).

Spruce budworm spraying was conducted on 150,633 hectares in the Northwestern, North Central, Northern and Northeastern Regions. Some 482,032 ha. of jack pine forest were sprayed in the Northwestern, North Central, Northern and Northeastern Regions for jack pine budworm. Spraying for the gypsy moth occurred on 45,677 ha. of Crown land and 57,417 ha. of private land in the Eastern Region.

Both fixed wing and helicopter spraycraft were used along with a fleet of navigational aeroplanes. Aircraft were secured from across Canada and the U.S. The total cost of the program approached 30 million dollars.

A full description of the program for each insect pest is provided in the following account.

JACK PINE BUDWORM

The jack pine budworm has been present in Ontario for many years but control action has not generally been taken. In 1984, the Canadian Forestry Service reported some 1.15 million hectares of moderate-to-severe defoliation. The area increased to 3.66 million hectares in 1985.

The Ministry of Natural Resources established Working Committees to assess the areas and values at risk. Portions of all Northern Regions satisfied the criteria used to select stands as candidates for a proposed spray program, including high value parks, plantations, wildlife areas and commercial forests, with a minimum 50% jack pine composition and greater than 41 years of age. A total of 482,032 ha. of jack pine forests were sprayed for protection against the budworm.

In January, district open houses and/or media briefing sessions were conducted to explain the proposed program to the public in Fort Frances, Dryden, Atikokan, Sioux Lookout, Red Lake, Kenora, Thunder Bay, Sault Ste. Marie, Sudbury, Espanola, Elliot Lake, Gogama and Chapleau. The open houses provided an opportunity for forestry staff to present information about the insecticides B.t. and fenitrothion, the proposed spray blocks and areas proposed for treatment by salvage or accelerated cutting. People attending the open houses were encouraged to submit written comments about the protection spraying program.

Airstrips were constructed/upgraded in the Districts of Blind River, Gogama, Espanola, Chapleau, Sudbury, Fort Frances, Kenora and Red Lake.

Thuricide 48LV and Dipel 132 were sprayed neat from June 6 to June 25 at a rate of 20 BIU/1.57 L/ha. Micronair rotary atomizers were used on the spraycraft and Cessnas were used as pointer aircraft.

SPRUCE BUDWORM

The spruce budworm in Ontario caused moderate-to-severe defoliation on some 8.7 million hectares in 1984 and this increased to 12.3 million hectares in 1985. Committees were established to assess the values at risk and determine the need for aerial insecticide applications. The Districts of Ignace, Sioux Lookout, Thunder Bay, Nipigon, Terrace Bay, Geraldton, Hearst and Wawa determined that significant values were at risk and therefore proposed spraying projects.

Throughout January 1986, public open houses and/or media briefings to outline proposed programs, were held in the communities of Sioux Lookout, Ignace, Thunder Bay, Nipigon, Geraldton, Terrace Bay, Hearst, Wawa and White River. The proposals outlined candidate areas for protection with the insecticides B.t. and aminocarb (Matacil) and those areas scheduled for salvage and accelerated harvest. Revisions in the Provincial insect control policy enabled the inclusion of many candidate areas for protection. An increased public awareness of the importance of insect pests coupled with the policy revisions resulted in a spruce budworm protection program of 150,633 hectares.

Most of the spruce budworm spraying was conducted using Thuricide 48LV with some Dipel 132 being used in Wawa District. Spraying was conducted between May 30 and June 17. B.t. was sprayed neat at 20 BIU/1.57L/ha. using rotary atomizers with a few stands in the Thunder Bay District receiving the higher rate of 30 BIU/2.34L/ha. Airstrips were located in the Districts of Nipigon, Hearst, Wawa and Thunder Bay. Spraying in Geraldton, Terrace Bay and parts of Thunder Bay was conducted with a small fleet of helicopters equipped with rotary atomizers. There were technical/formulation problems encountered in some spruce budworm spraying locations and discussions with the suppliers are ongoing.

GYPSY MOTH

The gypsy moth spread significantly in 1984 with 80,000 hectares receiving moderate-to-severe defoliation. However, by 1985, the area of moderate-to-severe defoliation had dramatically increased to 246,000 ha. throughout Eastern Ontario. Forecasts for 1986 suggested a potential for continued dramatic increases in defoliation. This coupled with the recent infestation history caused considerable forestry and public concern and prompted increased protection activity. Agreements were established with 5 Counties in Eastern Ontario to coordinate a private land protection program.

Throughout January 1986, open houses and/or media briefing sessions were held at Sharbot Lake, Tweed, Dacre, Brockville and Ottawa. The insecticides B.t. and carbaryl were proposed at the open houses with carbaryl being restricted to remote areas outside of the main body of moderate-to-severe defoliation.

The spray program was conducted out of five airstrips located at Black River, Irvine Lake, Trenton, Westport and Gananoque. The spraying of 103,094 hectares of commercial forests, public and private woodlots, cottage properties, wildlife habitat and park lands began on May 21 and was completed by June 11. All of the areas received a double application of Dipel 132 with the areas originally proposed for carbaryl receiving a third spray. The B.t. (40%) was mixed with water (60%) and sprayed at 30 BIU/6L/ha. using rotary atomizers. Nearly half of the aircraft assembled for the entire Ontario program were used in the gypsy moth program.

In general, the 1986 protection program was completed satisfactorily. There were 163 aircraft involved in the program including fixed wing piston and turbo Thrushes, Pawnees, Ag-Cats, Ag-Trucks and Dromadier M18s and helicopters such as the Jet Ranger, Bell 212 and Sikorsky S55. There were some minor incidents such as forced landings but no serious injuries occurred during the entire program.

A week of unseasonably warm weather during late May increased the rate of insect and host development for both spruce and jack pine budworms. Virtually all spray blocks were opened at the same time, instead of in the usual staggered pattern. Insect development in northern blocks was generally ahead of more southerly blocks. This resulted in some frantic activity to ensure airstrip and mixing-loading readiness. Subsequent rainy weather slowed insect development to near normal timing, but also hindered spray operations. All proposed spray blocks were treated before budworm began to pupate.

In addition to the operational spray program, a number of trials were conducted including:

1) testing of the NRD strain of B.t. for gypsy moth control;

2) Dipel 132 sprayed neat at 30 BIU/2.34L/ha. for gypsy moth control;

3) an aqueous formulation of Dipel for jack pine budworm control; and

4) a Thuricide 48LV formulated to reduce the corrosion tendencies this product has in spray equipment.

The results of the operational and test spray program will be detailed in a Canadian Forestry Service report but were generally good for gypsy moth and most jack pine budworm programs and variable in the spruce budworm projects.

Forest protection plans are currently being developed for 1987.

Defoliation for the three major insects has dropped to 8.9 million, 1.7 million and 167.8 thousand hectares for spruce budworm, jack pine budworm and gypsy moth respectively. We anticipate a maximum program in 1987 of 250,000 hectares; 50,000 jack pine budworm in Northwestern Region, 100,000 spruce budworm in North Central Region and up to 100,000 gypsy moth in Eastern Ontario, again including Crown and private land.

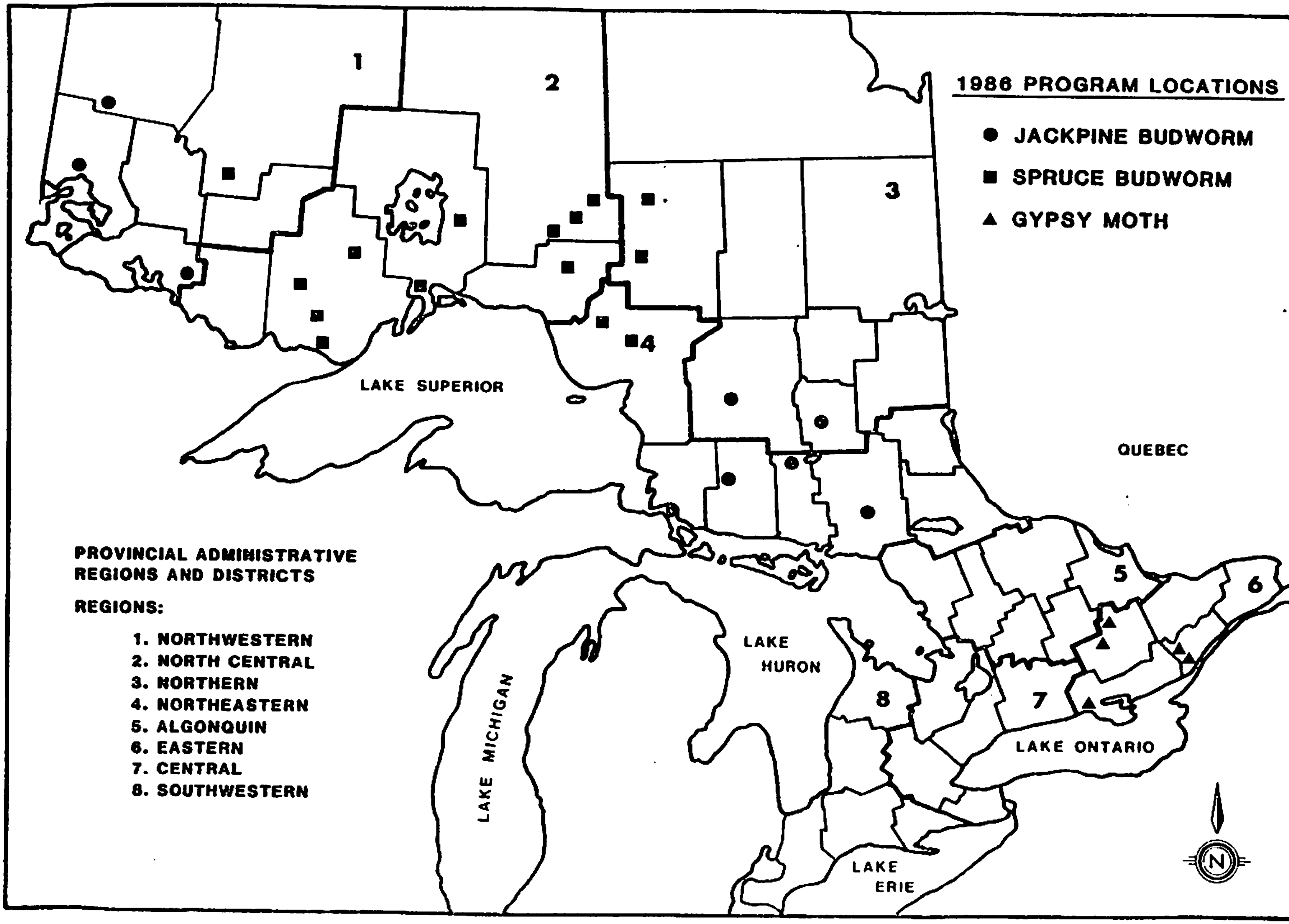


FIGURE 1 LOCATIONS OF 1986 AERIAL INSECTICIDE APPLICATIONS. OMNR, PEST CONTROL SECTION

TABLE 1. 1986 FOREST INSECT SPRAYING PROGRAM

REGION/ DISTRICT	PEST	HA. TREATED	INSECTICIDE USED	NUMBER OF APPLICATIONS	RATE(S) PER HA.	COMMENTS
NW REGION	Jack Pine Budworm	210,104	Dipel 132	1	20 BIU/1.57 L	commercial forests
Kenora						provincial parks
Ignace	Jack Pine Budworm	5,472	Thuricide 48LV	1	20 BIU/1.57 L	plantations
Sioux Lookout						
Red Lake						
Fort Frances	Spruce Budworm	168	Dipel 132	1	20 BIU/1.57 L	
Dryden						
NC REGION	Jack Pine Budworm	31,793	Thuricide 48LV	1	20 BIU/1.57 L	commercial forests
Thunder Bay						parks
Atikokan	Spruce Budworm	80,447	Thuricide 48LV	1	20 BIU/1.57 L	spruce plantations
Geraldton						
Nipigon						
Terrace Bay	Spruce Budworm	17,417	Thuricide 48LV	1	30 BIU/2.34 L	
	Spruce Budworm	878	Thuricide 48LV	2	30 BIU/2.34 L	
NE REGION	Jack Pine Budworm	86,238	Dipel 132	1	20 BIU/1.57 L	commercial forests
Sudbury						provincial parks
Wawa	Jack Pine Budworm	69,089	Thuricide 48LV	1	20 BIU/1.57 L	
Blind River						
Espanola						
	Spruce Budworm	10,568	Dipel 132	1	20 BIU/1.57 L	
	Spruce Budworm	3,898	Thuricide 48LV	1	20 BIU/1.57 L	

1986 FOREST INSECT SPRAYING PROGRAM - continued

REGION/ DISTRICT	PEST	HA. TREATED	INSECTICIDE USED	NUMBER OF APPLICATIONS	RATE(S) PER HA.	COMMENTS
N REGION	Jack Pine Budworm	84,808	Dipel 132	1	30 BIU/6.0 L	commercial forests parks plantations
Chapleau Gogama Hearst	Spruce Budworm	36,618	Thuricide 48LV	1	30 BIU/6.0 L	
E. REGION						
Carleton Place Tweed Napanee Brockville	Gypsy Moth	93,008	Dipel 132	2	30 BIU/6.0 L	Crown land (45,677 ha) private land (57,417 ha)
ALGONQUIN REGION	Gypsy Moth	10,086	Dipel 132	3	30 BIU/6.0 L	
Pembroke						

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Canadian Forestry Service - Maritimes

TECHNICAL NOTE

SOME OF THE MAJOR PESTS IN THE FORESTS OF NOVA SCOTIA IN 1986

Insect and disease pests of forest trees can destroy wood already in the forest, reduce the amount of growth or affect the aesthetic appearance of the trees. A great number of pests are active in the Province each year, some general in distribution, others very much localized, some persist for a number of years, others flare up then disappear, some get a foot-hold and spread through the susceptible forest type, others can be checked and kept in place. All have some effect on the forest.

In 1986, over 200 species of insects and diseases were recorded in Nova Scotia. A few of the major pests or those with the potential to become major pests are briefly discussed below, with the exception of spruce budworm and the seedling-debarking weevil that are discussed elsewhere.

GYPSY MOTH, the most destructive hardwood defoliator in in North America, was first discovered in Nova Scotia in 1981. Since then it has been found at 22 locations in 8 counties in the western part of the Province. In most of these areas the insect is currently present at very low numbers. However, in some places like Shelburne or New Minas there is a definite population build-up. Although for now, gypsy moth may be considered an insect of inhabited areas (an urban pest?), it is likely to spread, if not controlled, and could become a major forest pest especially in western Nova Scotia where oak, one of its favorite food sources, is of economic importance. The presence of gypsy moth could also have detrimental consequences to the Christmas tree export industry.

- NURSERIES
- PLANTATIONS
- SILVICULTURE
- UTILIZATION
- ECONOMICS
- TREE IMPROVEMENT
- **INSECTS AND DISEASES**

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PINEWOOD NEMATODE is an organism of great current concern because of implications of its presence to international trade. The nematode, introduced into trees by insect vectors, multiplies fast and kills trees in certain parts of the world. Surveys, involving over 150 areas in the Maritimes, identified three pine trees containing pinewood nematodes, all in New Brunswick. In addition, the so-called 'm' form, an affiliate of uncertain connection was found in three fir and spruce trees in Nova Scotia. Nematodes in all six trees were present in very low numbers and it is doubtful that they were the cause of death. There is no evidence to justify the pinewood nematode in the Maritimes as an organism of biological importance but the consequences of its presence may be economically significant.

SIROCOCCUS SHOOT BLIGHT is a disease of conifers, mostly of red pine. On most of the continent it is of no great consequence. However, in the Maritimes region of Canada, and especially in parts of Nova Scotia, the disease is considered one of the major impediments to the success of red pine plantation programs. The disease occurs both in plantations and in natural stands, repeated attacks cause shoot-, then branch-mortality and eventually kill trees as much as 15 m in height. Close to 40% of the stands are infected in the Province, more than 25% of the trees are affected and about 9% of the trees are dead (based on a survey in 1983). Sirococcus shoot blight is present throughout Nova Scotia but is most common and damaging west of the Colchester-Pictou and Halifax-Guysborough county lines. Plantations in many areas, such as Rushy Lake, Stanley Management Area, Chignecto Game Sanctuary are in seriously deteriorating condition. The disease is found more and more frequently in the eastern part of the Province and its control should be given serious consideration.

SPRUCE BEETLE, which killed about half of the merchantable white spruce on Cape Breton Island and caused widespread tree mortality in pockets on the mainland in the early 1980-s, has been on the decline in the last three years in most areas. Although the number of newly infested trees was down in many areas in 1986, most notably on Cape Breton Island, a slight increase was observed at some locations, such as in parts of Pictou and Antigonish counties.

EASTERN LARCH BEETLE, following widespread infestations of the larch sawfly in the 1970-s, killed off over 60% of the merchantable larch by 1981. Populations have been drastically reduced since then and although the insect is widely spread throughout the Province very few newly infested trees were observed in 1986. It appears that with the removal of much of the most susceptible tree sizes this beetle will not be a serious tree killer in the next few years.

EUROPEAN LARCH CANKER, a disease known to occur in North America only on mainland Nova Scotia and in southeastern New Brunswick, in Canada, in addition to a narrow coastal zone in Maine, causes cankers on branches or stems of trees resulting in branch mortality or death of small trees. The fungus infects a wide variety of larch species and can quickly spread through young stands (as much as 81% increase in incidence observed in just three years). To contain the disease, quarantine regulations have been put into effect by the Plant Health Division of Agriculture Canada, effective July 1, 1986. As the result of these regulations, the movement of certain larch material is restricted from mainland Nova Scotia and the southern part of New Brunswick. Also, certain restrictions now exist regarding the movement of some material within the quarantine area.

DUTCH ELM DISEASE has been known in the Province since 1969 but in most areas, except Cumberland-Colchester counties, was affecting less than 10% of the elm population as recently as 1982. Since then the disease has both spread and intensified greatly and now covers much of Nova Scotia and is killing trees in large numbers. In 1986, a multi-governmental control program resulted in close to 600 samples, most of them positive, and extended the known distribution of the disease, having been confirmed in 20 communities for the first time, in Colchester, Antigonish, Inverness and Victoria counties. The outlook is generally bleak but with concentrated control effort the elm can be saved.

Nova Scotia has many other important forest pests. Some of those, not discussed either because they are currently at an ebb of their cyclic fluctuation or because they are of localized importance, include: whitemarked tussock moth, European pine shoot moth, balsam gall midge, balsam twig aphid, balsam woolly adelgid, larch casebearer, various needle rusts of conifers, ash rust, maple leafroller, oak leaf-roller, oak leaf shredder, fall cankerworm, and others.

-L.P. Magasi
Forest Insect and Disease Survey

October 24, 1986

INSECT CONTROL PROGRAM IN NEWFOUNDLAND IN 1986

H. Crummey

(Prepared for 1986 Annual Pest Control Forum, Ottawa - November 18-19, 1986)

SPRUCE BUDWORM

The C.F.S. forecast for 1986 indicated that no moderate and severe defoliation and only four (4) isolated areas of light defoliation were expected on about 7 460 ha in central and western Newfoundland. Based on this forecast, no control program or environmental monitoring studies were proposed. The aerial defoliation survey, carried out in late summer by C.F.S. personnel, indicated a total of 4 036 ha defoliated with 2 202 ha in the severe category and the remainder in the light. Although the severe defoliation was not in the forecast, the actual damage caused was not significant in size.

At this time, there is no 1987 forecast available as surveys and processing are still ongoing; however, it is not anticipated that there will be a control program for spruce budworm in 1987.

HEMLOCK LOOPER

This insect was of major concern in 1986. The total forecast, based on the 1985 C.F.S. egg survey, was 912 000 ha of which 219 000 ha were in moderate and severe category and distributed in mainly western but with some in central and eastern Newfoundland. The remaining 692 000 ha were in the light forecast and 165 000 ha of this contained looper egg numbers not sufficient to cause noticeable damage.

Based on these figures, the Department of Forest Resources and Lands, in conjunction with the two (2) paper companies, proposed a control program on high priority stands in the moderate and severe forecast areas and on silviculturally important areas in the light forecast. Initially twenty-seven (27) blocks totalling some 84 055 ha were identified for treatment (Table 1, Figure 1). Based on pre-spray population surveys, it was necessary to extend three (3) blocks totalling some 8 772 ha. Some block adjustments and realignment as well as deletions resulted in twenty-five (25) blocks totalling 84 448 ha being treated (Table 1, Figure 1). Of this, one block (B. 107) of 3 830 ha was sprayed for Environmental Monitoring. The chemical insecticide, fenitrothion (Folithion), was used on approximately 94% (79 028 ha) of this area and B.t. (Dipel 132) was used on 5 420 ha. Fenitrothion was applied in an oil-based formulation as two (2) applications (minimum of five (5) days apart) of 210 g ai/1.5 L/ha. Only 282 ha did not receive the second application. B.t. was applied undiluted as one application of 30 BIU/2.36 L/ha.

Spray aircraft were supplied by Conifair Aviation of St. Jean, Quebec and consisted of one (1) four-engine Douglas DC-4 and one (1) team of four (4) 600 h.p. Grumman AgCats (owned by Beaver Air Spray - St. Mathias, Quebec). The DC-4 was equipped with boom and nozzle spray apparatus and with Litton LTN 51 Inertial Navigation System. The DC-4 sprayed chemical only. Aerial supervision was provided by a DFRL spotter in a twin-engine Piper Aerostar supplied by Conifair. The AgCats were equipped with six (6) Mini-Micronairs (AU 5000). Navigation was provided by a helicopter and supervision by a DFRL spotter in a twin-engine Cessna 337. AgCats sprayed both chemical and B.t. Of the total 84 448 ha, the DC-4 sprayed approximately 80%.

DC-4 operations were carried out mainly from Stephenville Airport in Western Newfoundland because of the location of the larger blocks but Gander Airport was also used. The AgCats used both Stephenville and Gander plus a dirt strip at Barachois in southwestern Newfoundland.

The first areas were opened for treatment on June 28. The DC-4 operation began on June 28 and ended on August 3. Spraying took place on nineteen (19) of thirty-seven (37) days (51%). The AgCats were ready for spraying on June 30; however, because of adverse weather, operations did not commence until July 3 and ended on August 3. Spraying took place on sixteen (16) of thirty-five (35) days (46%). The DC-4 operation was twice grounded for four (4) days and twice for three (3) days while the AgCat operation was, on different occasions, grounded by adverse weather for six (6), four (4) and three (3) consecutive days.

Pre-spray larval population levels were variable within blocks again this year as they were in 1985. Sampling methodology consisted of beating larvae from three (3) trees per plot. A six (6) foot by eight (8) foot beating sheet was used and the total larvae from the three (3) trees were tabulated. Counts varied considerably within and between blocks. The overall range was from as low as six (6) up to 9 024 for three (3) trees. Numbers up in the thousands would and did cause very significant defoliation.

Because of the very mobile and variable nature of the looper, it is very difficult to statistically analyze operational plot data and compare with check (unsprayed) areas. In many cases adequate check areas were not available to give a reasonable comparison. In these cases only an indication can be given based on actual uncorrected data. However, plot data were analyzed by treatment and compared with check data where available.

As was the case in 1985, a number of blocks, especially those with high to extreme larval numbers, had defoliation visible from the air prior to treatment. This was inevitable.

Uncorrected larval mortality ranged from 0 to 100% with no consistency based on larval numbers or insecticide. However, 48% of sprayed plots had greater than 90% uncorrected mortality and 36% had greater than 96% uncorrected mortality compared with no check plots having greater than 90% natural mortality.

Defoliation estimates were variable ranging from light in many sprayed plots to severe in plots with extreme larval counts even though there was high larval mortality. This was due to a significant amount of defoliation occurring by early hatching larvae prior to total hatching and prior to insecticide treatment. In general, foliage protection was achieved on most sprayed areas. This was confirmed by aerial reconnaissance of sprayed blocks and by mapping of defoliation by Department of Forest Resources and Lands personnel. Table 2 indicates, that of the chemical blocks, 13% of the total area had moderate to severe defoliation, 3% had light and 84% had no visible defoliation while 24% of the total area of B.t. blocks had severe defoliation and 76% had no visible defoliation. Although acceptable, B.t. did not appear to be as effective as chemical in contributing to foliage protection. Also, significant areas of severe defoliation were evident adjacent to but outside of treated areas.

An Island-wide defoliation survey, carried out by the Canadian Forestry Service, indicated that in 1986 the looper caused moderate and severe defoliation on approximately 215 000 ha mainly in western and southwestern Newfoundland. Light defoliation occurred on an additional 117 000 ha.

As part of the Provincial licence to carry out the operational program, environmental monitoring was again required. Two (2) studies similar to those in 1985 were required - the impact of fenitrothion on songbirds and the impact on pollinators. As part of these studies, residue samples were also collected. These studies were contracted out to a consulting firm. The analyses of data is still ongoing but preliminary reports are expected by the end of November.

In addition to the operational program, the C.F.S., in cooperation with the Department of Forest Resources and Lands, carried out an experimental spray program to field test the efficacy of Dimilin, an insect growth regulator, and fenitrothion flowable as well as fenitrothion technical. A similar experiment was carried out in 1985. Final results for 1986 are not yet available. However, four (4) blocks were treated with one (1) of the operational AgCats. Fenitrothion technical and fenitrothion flowable were sprayed on one (1) - 30 ha block each and Dimilin was sprayed on two (2) - 51 ha blocks at two (2) different rates.

The 1987 looper forecast is not available. C.F.S. crews have just recently completed field work and samples are being processed. It is expected the forecast will be available by early January. It is anticipated that a spray program of 150 000 - 200 000 ha would be likely. Approval in principal has already been received from Government to conduct a program in 1987.

TABLE 1

1986 HEMLOCK LOOPER SPRAY BLOCKS

BLOCK #	LOCATION	ORIGINAL AREA	REVISED AREA
Chemical(a)			
101	Bald Mountain	2 965	2 980
102*	Rainy Brook	1 330	1 350
103	Langdons Pond	6 755	6 745
104	Serpentine Lake + Ext.	4 880	5 861
105*	Big Gull Pond	18 870	18 850
105*(Ext.)		-	2 200
106	Puddle Pond	11 680	11 675
107(c)	Harpoon Brook	6 615	3 830
108	Caledonia Brook	5 030	5 050
109	Little River	1 370	Deleted
110*	Weirs Pond	2 230	2 230
111	Ocean Pond	5 235	5 180
112**	Portland Creek	-	3 195
	(DC-4 TOTAL)	(66 960)	
201	Codroy Pond	450	381
202	Crabbes River South	685	685
203	Crabbes River North	1 270	1 270
204	Hungry Grove Pond	615	615
205	Robinsons River	1 330	1 375
206	Spruce Brook	695	695
206(Ext.)		-	1 190
207	Big Cooks Pond	1 100	1 100
209*	Clode Sound	840	661
210	Rocky Pond	655	665
211	Beaver Pond	1 065	1 065
212	Big Pond	180	180
213**	Portland Creek	2 260	-
214**	Brian's Pond	530	-
	CHEMICAL TOTAL	78 635	79 028
B.t.(b)			
301	Island Pond	990	990
302	Eastern Lake	1 240	1 240
303	Gander Bay	3 190	3 190
	B.t. TOTAL	5 420	5 420
	AgCat TOTAL	(17 095)	
	GRAND TOTAL	84 055	84 448

(a) Fenitrothion - 210 g ai/1.5L/ha
(b) Dipel 132 - 30 BIU/2.36 L/ha (undiluted)
(c) Block 107 was deleted from operational spraying but was treated for Environmental purposes only.
* Both types of aircraft used.
** Blocks 213 and 214 were combined to form Block 112.

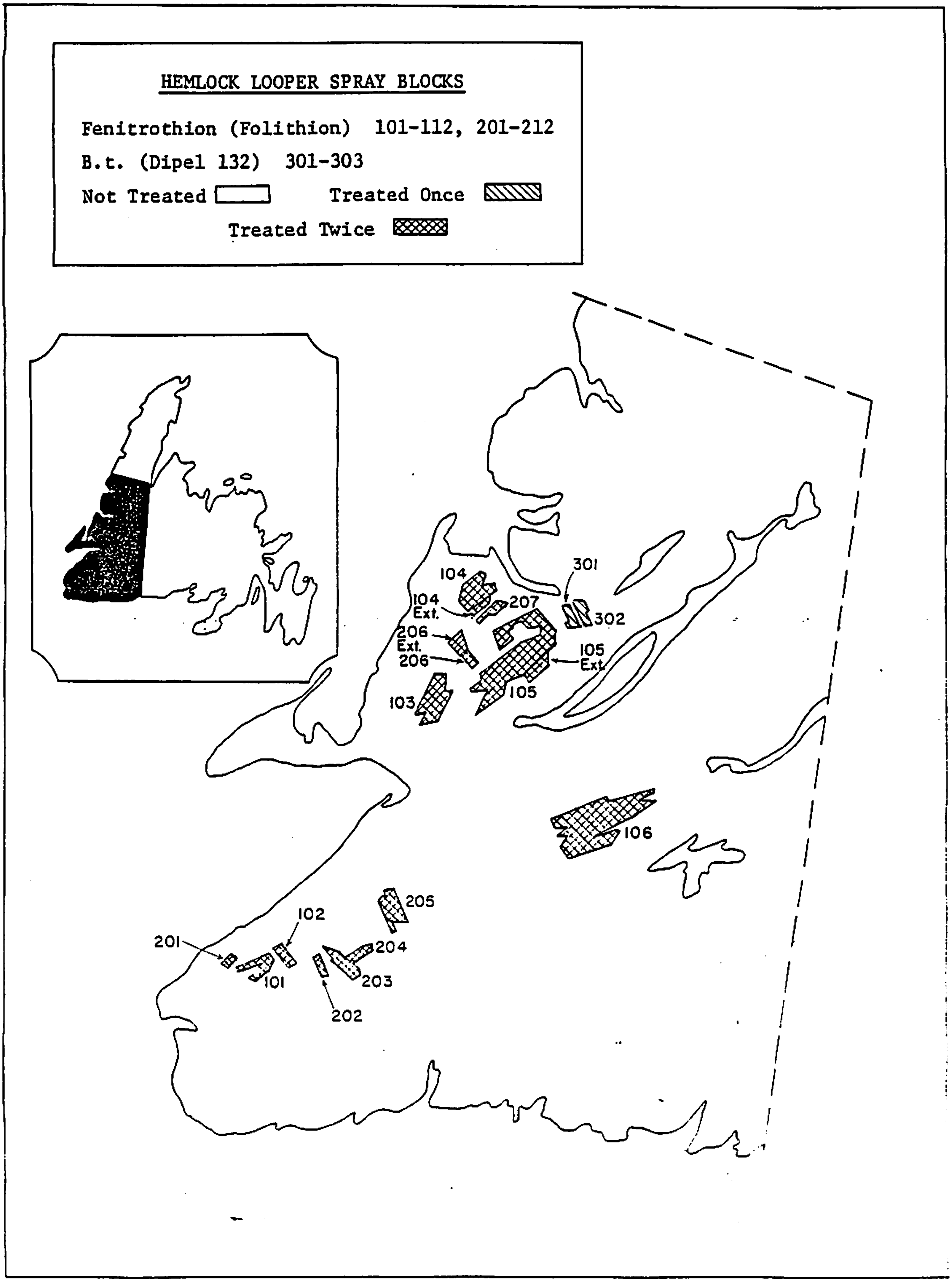

FIGURE 1. 1986 PROPOSED HEMLOCK LOOPER SPRAY AREAS

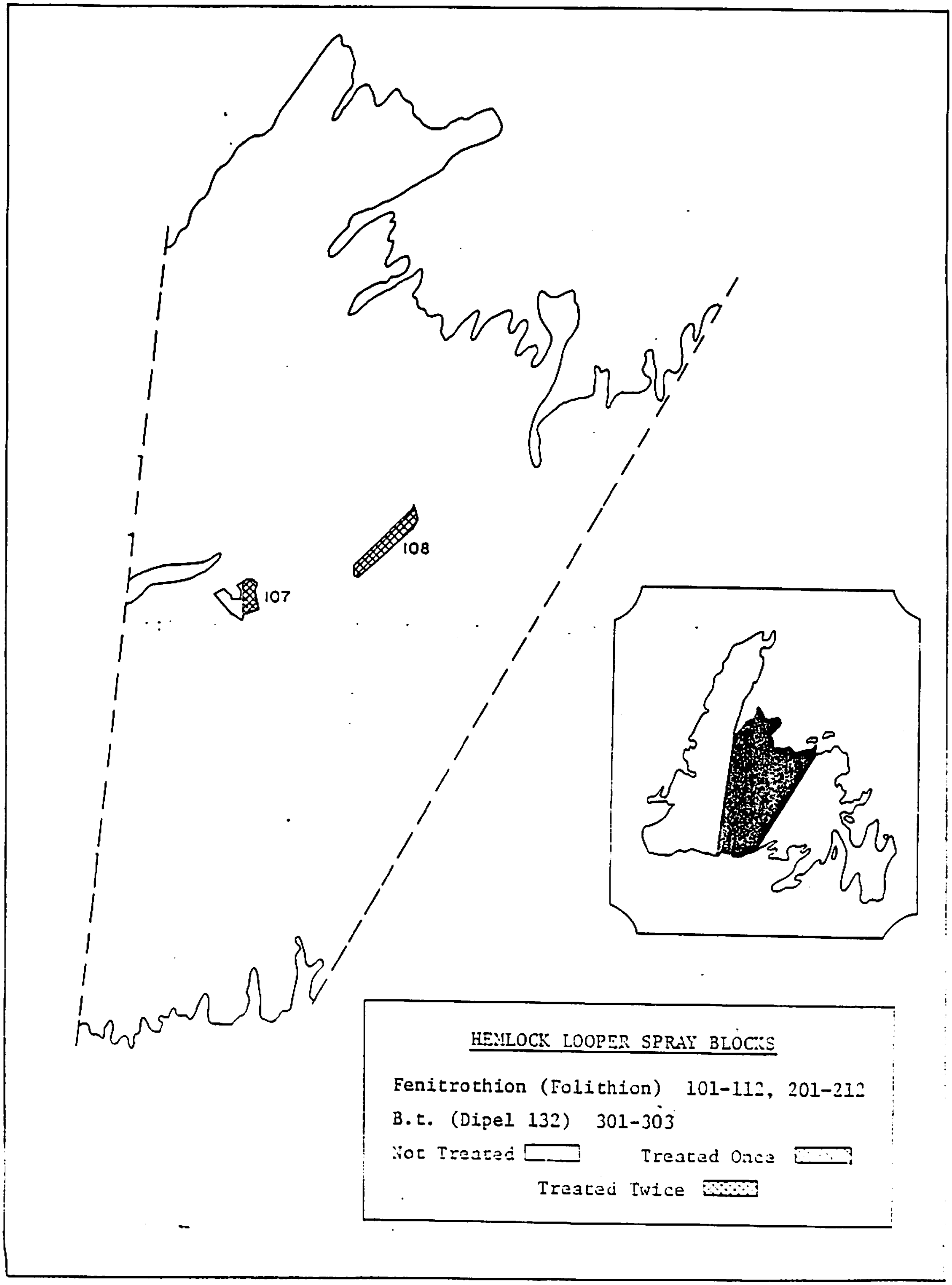

FIGURE 1. 1986 PROPOSED HEMLOCK LOOPER SPRAY AREAS (CONT'D.)

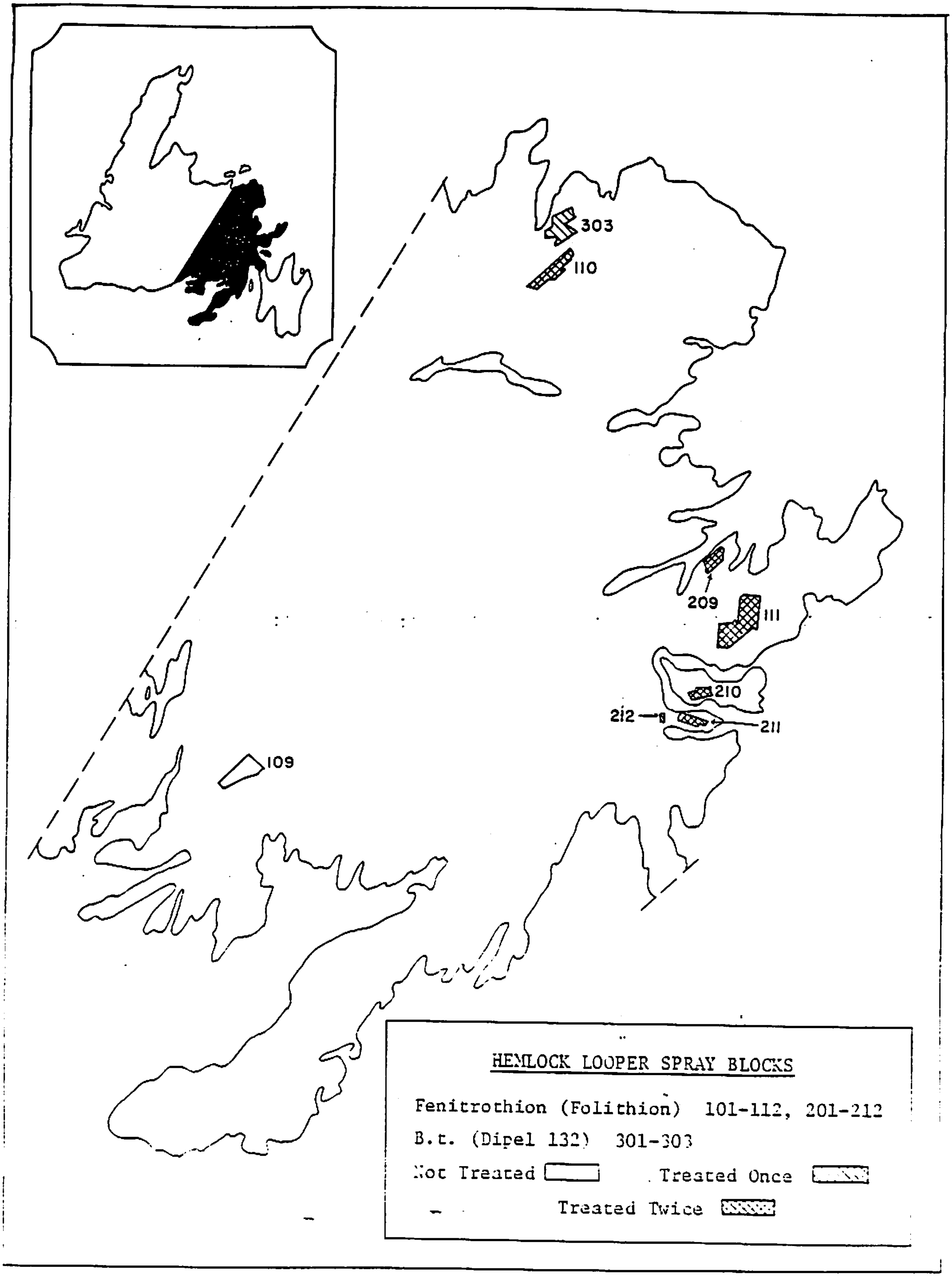

FIGURE 1. 1986 PROPOSED HEMLOCK LOOPER SPRAY AREAS (CONT'D.)

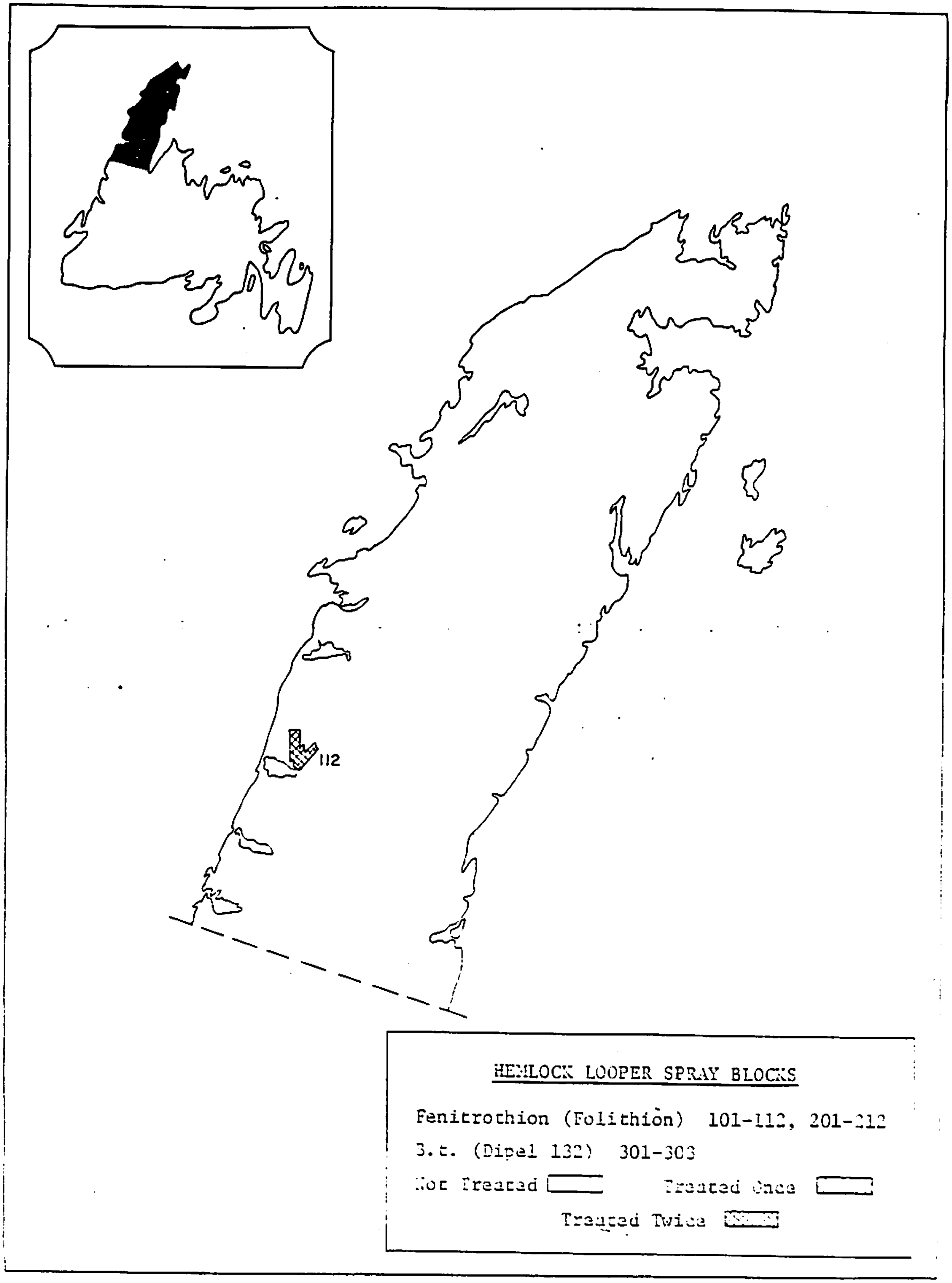

FIGURE 1. 1986 PROPOSED HEMLOCK LOOPER SPRAY AREAS (CONT'D.)

TABLE 2

AREA OF 1986 DEFOLIATION (HA)

BLOCK #	NIL		LIGHT		MODERATE		SEVERE		TOTAL
Chemical	HA	%	HA	%	HA	%	HA	%	
101	2 968	100	-	0	-	0	12	<1	2 980
102	1 350	100	-	0	-	0	-	0	1 350
103	6 575	97	-	0	-	0	170	3	6 745
104	5 219	89	-	0	573	10	69	1	5 861
105	19 630	93	-	0	-	0	1 420	7	21 050
106	8 672	74	202	2	310	3	2 491	21	11 675
107	Sprayed for Environmental Monitoring Only								
108	4 884	97	-	0	166	3	-	0	5 050
110	Results not yet available.								
111	3 093	60	17	33	134	3	230	4	5 180
112	2 354	74	-	0	829	26	12	<1	3 195
201	448	100	-	0	-	0	2	<1	450
202	18	3	-	0	187	27	480	70	685
203	1 128	89	-	0	-	0	142	11	1 270
204	537	87	-	0	-	0	78	13	615
205	273	20	-	0	-	0	1 102	80	1 375
206	1 787	95	-	0	-	0	98	5	1 885
207	1 089	99	-	0	-	0	11	1	1 100
209	680	81	-	0	-	0	160	19	840
210	655	100	-	0	-	0	-	0	655
211	264	25	222	21	-	0	581	54	1 065
212	79	44	6	3	95	18	-	0	180
Total	61 715	84	2 153	3	2 294	3	7 058	10	73 206
B.t.									
301	492	50	-	0	-	0	498	50	990
302	1 212	98	-	0	-	0	28	2	1 240
303	Results not yet available.								
Total	1 704	76					526	24	2 230

* Based on Department of Forest Resources and Lands Assessment

JACK PINE BUDWORM IN ONTARIO[1]

- Outbreak Status 1986
- Forecasts 1987
- Results of Spraying Operations, 1986

by

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[1] Report prepared for the Annual Pest Control Forum, Ottawa, November 18-19, 1986.

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

OUTBREAK STATUS 1986

The jack pine budworm situation in Ontario changed considerably in 1986. The overall area of moderate-to-severe defoliation was 1,728, 825 ha, a decrease of 53% from the 3,660,069 ha recorded in 1985 (Table 1 and Figure 1).

In the Northwestern Region, the area of moderate-to-severe defoliation increased by about 76,000 ha, some of which was located in the large infestation that straddled the four corners of the Fort Frances, Dryden, Ignace and Atikokan districts. In the Sioux Lookout District, approximately 90,000 ha of new moderate-to-severe defoliation were mapped in the Wendigo Lake area. The bulk of the defoliation, over 800,000 ha, persists in the Red Lake District, with the main infestation stretching from the Red Lake-Balmertown area north to Deer Lake and west to the Manitoba border. Although infestations in the Kenora District declined by 56,800 ha, approximately 315,000 ha recurred in scattered pockets throughout the district.

Infestations in the North Central Region virtually collapsed in 1986. The only moderate-to-severe defoliation remaining consists of about 31,000 ha in the northwest corner of the Atitokan District, which was part of the infestation described above.

There was a substantial decline in the Northern and Northeastern regions as well. The area of moderate-to-severe defoliation totalled 135,196 ha in 1986, in comparison with 1,842,811 ha in 1985, a reduction of 93%. Populations completely collapsed in the Sault Ste. Marie, Temagami and Kirkland Lake districts where no defoliation was recorded. The largest infestations remaining (70,107 ha) is located on the Chapleau-Blind River district boundary. The remainder consists of scattered pockets located in the Chapleau and Gogama districts of the Northern Region and the Blind River, Espanola, Sudbury and North Bay districts of the Northeastern Region.

Infestations in the Parry Sound District of the Algonquin Region were reduced from about 54,000 ha in 1985 to approximately 8,100 ha this year. Infestations in this area consisted of scattered pockets along the Georgian Bay Coast between Ojibway Island and the Sudbury District boundary.

Forecasts 1987

Jack pine budworm egg-mass sampling was carried out in 389 locations across the province in 1986. An analysis of the results, including 44 samples from sprayed areas, shows an overall decline of 54% in egg-mass densities (Table 2).

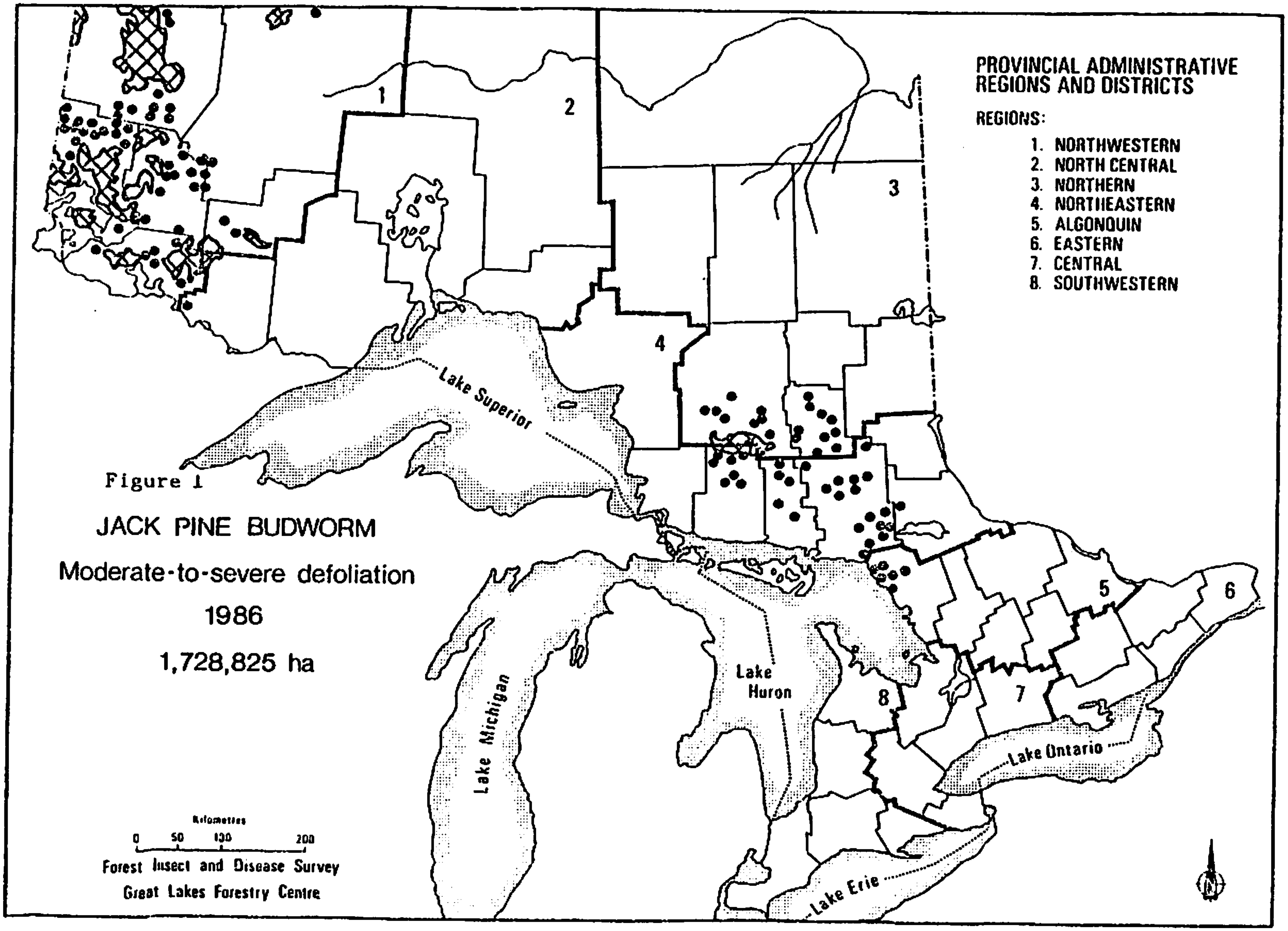

Figure 1

JACK PINE BUDWORM

Moderate-to-severe defoliation

1986

1,728,825 ha

Table 1. Gross area (ha) of current moderate-to-severe defoliation by the jack pine budworm from 1984 to 1986

Region	District	Area of moderate-to-severe defoliation 1984	1985	1986
Northwestern	Red Lake	139,334	1,027,202	877,521
	Fort Frances	14,044	44,652	99,391
	Ignace	0	15,973	37,435
	Kenora	0	372,242	315,731
	Sioux Lookout	0	1,646	90,408
	Dryden	0	16,103	133,653
		153,378	1,477,818	1,554,139
North Central	Atikokan	335,770	278,623	31,391
	Thunder Bay	34,798	6,783	0
		370,568	285,406	31,391
Northeastern	Sault Ste. Marie	746	14,262	0
	Blind River	118,021	256,351	24,741
	Espanola	233,027	217,665	1,212
	Sudbury	76,896	385,762	30,129
	Temagami	530	6,224	0
	North Bay	0	6,792	545
		429,220	887,056	56,627
Northern	Chapleau	95,598	546,198	60,929
	Gogama	49,102	334,815	17,640
	Kirkland Lake	26,895	74,742	0
		171,595	955,755	78,569
Algonquin	Parry Sound	25,397	54,034	8,099
TOTAL		1,150,158	3,660,069	1,728,825

In northwestern Ontario, results were varied. In the Fort Frances, Red Lake and Sioux Lookout districts declines in egg-mass densities of 44%, 48% and 22%, respectively, will probably result in a significant reduction in the extent and severity of defoliation in 1987 and indeed a widespread collapse of infestations is possible. In Dryden, Ignace and Kenora districts egg-counts increased by 60%, 52% and 27%, respectively. In spite of this, however, it is expected that increased pressure from parasites, reduced jack pine flowering and other natural control factors will reduce defoliation to light and occasionally moderate levels. Most of this defoliation will occur in previously infested areas in the Kenora and Western Dryden districts, between Manitou Sound and McLarty Township in the western Fort Frances District and in the area of the junction of the Fort Frances, Atikokan, Dryden and Ignace districts. New pockets of moderate-to-severe defoliation may develop along the Dryden/Fort Frances border in the vicinity of Manitou Lake. No significant defoliation is expected in the North Central Region with the exception of the northwest corner of Atikokan District where a small area of light or moderate defoliation may occur.

In northeastern and southern Ontario, populations collapsed in 1986 and with further reductions in egg-mass counts ranging from 67 to 90%, defoliation will be insignificant in 1987.

Table 2. Comparison of jack pine budworm egg-mass densities in Ontario in 1985 and 1986 (based on six 61 cm jack pine branch tips at each location

OMNR Region	No. of locations sampled in 1986	No. of locations common to both year	Average no. of egg-masses		
			1985	1986	% change
Northwestern	171	88 (7)*	5.1	4.2	-17
North Central	28	23 (4)*	5.7	2.2	-62
Northeastern	82	63 (20)*	3.3	0.3	-90
Northern	89	48 (13)*	4.5	0.5	-89
Southern Ontario**	19	16	0.6	0.2	-67
	389	238 (44)*	4.3	2.0	-54

* Number of 1986 spray locations included in total

** Southern Ontario includes the Algonquin and Central Regions.

RESULTS OF SPRAYING OPERATIONS

In 1986, the Ontario Ministry of Natural Resources aerially sprayed some 482,032 ha of jack pine forest in four regions of the province to protect trees from the jack pine budworm (Table 3). Operationally, two formulations of *Bacillus thuringiensis* (*B.t.*) were used in this year's program. Dipel 132 (Abbott Laboratories) and Thuricide 48LV (Sandoz) were applied at a rate of 20 BIU/1.6 l/ha from both fixed-wing aircraft and helicopter. All blocks received a single application. A small experimental program was carried out in Sudbury District involving single applications of Dipel ABG-61 (Abbott Laboratories) and Foray 48B (Microbial Resources).

Northeastern Ontario: The 1986 jack pine budworm aerial spraying program in northeastern Ontario involved five districts - Chapleau, Gogama, Sudbury, Espanola and Blind River - in two OMNR regions - the Northern and Northeastern. A total of 240,135 ha were treated with either Dipel 132 or Thuricide 48LV.

Abnormally warm temperatures (30° C +) during the last week of May and the first week of June accelerated insect and host development in the northeast. Spray blocks were opened on June 8, nine days earlier than in 1985, and spraying began on the morning of June 9. Spraying was completed 27 days later on June 25. A summary of larval development at eight locations in northeastern Ontario is presented in Table 4.

Egg-mass surveys conducted by the CFS in the Northern and Northeastern regions in 1985 indicated that a substantial decline in numbers had occurred. Consequently, forecasts for 1986 called for "a reduction in the extent of moderate-to-severe defoliation as well as in the level of defoliation" in the northeast. Indeed, a population collapse over extensive areas was deemed possible in 1986. An extensive L_2 survey conducted during the winter (1985-86) generally confirmed forecasts based on egg-mass counts. This resulted in the cancellation of several proposed spray blocks in Sault Ste. Marie, Chapleau and Temagami districts. Several more blocks in Gogama and Espanola districts were dropped from the program when early larval surveys conducted in May and June revealed low budworm populations.

A total of 240 plots (10 trees per plot) were established in some 45 spray blocks to assess the effectiveness of the 1986 programs. Results are presented by OMNR district in Tables 5 to 9. Pre-spray larval populations were generally low throughout the region and declined to zero or near zero levels in the post-spray surveys. Consequently, defoliation levels were generally light in both spray and check plots.

Northwestern Ontario: The 1986 jack pine budworm aerial spraying program in northwestern Ontario involved five districts - Red Lake, Kenora, Dryden, Fort Frances and Atikokan - in two OMNR regions - the Northwestern and North Central. A total of 241,897 ha were treated with either Dipel 132 or Thuricide 48LV.

As in northeastern Ontario, unusually warm weather in late May and early June tended to accelerate insect and host development. Spray blocks in southern Red Lake and Kenora districts were opened June 4 and Atikokan and Fort Frances districts on June 6. The remaining blocks in northern Red Lake District were opened June 9 and all spraying was completed by June 22. A summary of larval development in northwestern Ontario in 1986 is presented in Table 10.

Some 75 plots (10 trees per plot) were established in 15 spray blocks to assess the efficacy of the 1986 aerial spraying program in northwestern Ontario. Unlike the program in the northeast, access to many of the blocks treated in northwestern Ontario was extremely difficult, often requiring the use of helicopters. Results of the assessment surveys are found in Table 11. Pre-spray larval populations, while quite variable, were generally lower than anticipated. Individual tree defoliation levels were extremely variable within some plots, often ranging from 5 to 90%. The highest defoliation rates were usually associated with the presence of staminate flowers. Table 12 compares average pre-spray larval densities and defoliation rates on trees with and without staminate flowers in northwestern Ontario in 1986. Overall, only 10% of treated trees had defoliation levels of more than 50% compared to nearly one-third of the untreated trees.

Table 3. Jack pine budworm: Area (ha) treated by OMNR region and materials used in the 1986 aerial spraying program.

OMNR Region	Area treated (ha)	Materials used
Northwestern	210,104	Dipel 132, Thuricide 48LV
North Central	37,793	Dipel 132
Northern	84,808	Dipel 132
Northeastern	155,327	Dipel 132, Thuricide 48LV
TOTAL	482,032	

Table 4. Jack pine budworm: Summary of larval development on jack pine in northeastern Ontario in 1986.

Location	Date	Larval Instar (%)					
		2	3	4	5	6	7
Blind River District							
Sagard Twp	May 26	76	19	5			
	June 2		59	41			
	June 6		13	74	13		
	June 11		3	58	30	9	
	June 18		9	52	35	4	
	June 23		5	13	45	32	5
	June 27			2	15	48	35
Lane Twp	May 26	81	17	2			
	June 4		68	28	4		
	June 7		4	94	2		
	June 12		2	56	34	8	
	June 20		6	20	54	16	4
	June 27				28	52	20
Sudbury District							
Cox Twp	May 27	33	67				
	June 1	2	51	47			
	June 3	2	36	62			
	June 7		16	82	2		
	June 19			8	52	38	2
	June 24			2	25	17	56
Hart Twp	May 31	68	28	4			
	June 5	2	58	36	4		
	June 19			24	48	28	
	June 24			2	42	36	20
	June 26			4	16	44	36
Chapleau District							
Nimitz Twp	May 27	90	10				
	June 2	9	74	15	2		
	June 5		19	71	10		
	June 13			67	20	13	
	June 19		6	12	56	24	2
	June 24			3	57	31	9
	June 26			2	20	68	10
Carew Twp	May 27	43	54	3			
	June 3	4	54	38	4		
	June 10		4	76	16	4	
	June 19		2	22	57	19	
	June 24			6	51	39	4
	June 26				24	64	12

(cont'd)

Table 4. Jack pine budworm: Summary of larval development on jack pine in northeastern Ontario in 1986 (concl.)

Location	Date	Larval Instar (%)					
		2	3	4	5	6	7
Gogama District							
Noble Twp	May 28	98	2				
	May 31		64	36			
	June 9		4	86	10		
	June 16			60	30	10	
	June 23			14	50	28	8
	July 2			4	20	29	47
Paudash Twp	May 27	89	11				
	May 31	2	84	14			
	June 3	2	65	31	2		
	June 9	2	4	80	10	4	
	June 16		8	64	24	4	
	June 23		2	28	51	19	
	July 1			22	8	38	32

Table 5. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in Chapleau District, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Block C - 1/2	4.6	0.1	70	11
Checks	4.5	0.3		10
Block C - 6	2.3	0.1	0	15
Checks	2.4	0		3
Block C -13/16/17	1.1	0	0	4
Checks	1.0	0		2
Block C - 19	1.5	0	0	1
Checks	1.4	0		1
Block C - 27	2.0	0	0	11
Checks	1.9	0		4
Block C - 28	2.7	0	0	16
Checks	2.8	0		5
Block C - 32/33	3.6	0.1	0	2
Checks	3.5	0.1		14
Block C - 35	5.7	0.1	50	12
Checks	5.9	0.2		16

Table 6. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in Gogama District, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Block G - 12	2.3	0	0	0
Checks	2.4	0		3
Block G - 38	1.5	0	0	0
Checks	1.5	0		2
Block G - 45	2.1	0	0	0
Checks	2.1	0		4
Block G - 48	0.9	0	0	0
Checks	0.8	0		4
Block G - 50	1.2	0	0	0
Checks	1.3	0		1
Block G - 114	2.5	0	0	0
Checks	2.4	0		3
Block G - 117	3.4	0	100	3
Checks	3.4	0.1		9

Table 7. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of *B.t.* in Sudbury District, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Block S - 20	3.7	0	100	14
Checks	3.8	0.1		12
Block S - 23	3.7	0	0	5
Checks	3.0	0		10
Block S - 56	0.8	0	0	2
Checks	0.7	0		4
Block S - 106	0.4	0	0	6
Checks	0.5	0		3
[a]Block S - 112 south	1.8	0	0	8
Checks	2.1	0		7
Block S - 112 north	3.7	0	100	11
Checks	3.7	0.1		14
Block S - 113	1.1	0	0	9
Checks	1.2	0		5
Block S - 114	6.1	0	0	9
Checks	5.9	0		16
Block S - 117	0.6	0	0	6
Checks	0.6	0		1
Block 3S- 122	7.3	0.4	0	45
Checks	7.0	0.2		20
[b]Block S - 129	1.3	0	0	7
Checks	1.2	0		5

[a] Treated with Foray 48 B at 20 BIU/1.6 l/ha

[b] Treated with Dipel.

Table 8. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in Espanola District, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Block E - 7	0.3	0	0	0
Checks	0.3	0		1
Block E-8	1.4	0	0	0
Checks	1.3	0		1
Block E - 13	0.1	0	0	0
Checks	0.2	0		1
Block E - 17	0.5	0	0	0
Checks	0.4	0		1
Block E - 18	0.9	0	0	0
Checks	0.8	0		2
Block E - 23	0.1	0	0	0
Checks	0.2	0		1
Block E - 31	0.4	0	0	1
Checks	0.3	0		1
Block E - 35	0.7	0	0	0
Checks	0.7	0		3
Block E - 36	5.6	0	100	7
Checks	5.4	0.3		12

Table 9. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in Blind River District, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Block B-C-1	3.8	0	100	7
Checks	3.9	0.1		11
Block B9/48/49	3.4	0	100	4
Checks	3.3	0.1		9
Block B - 14	6.7	0.2	0	28
Checks	6.6	0.1		16
Block B - 47	4.7	0	100	2
Checks	4.5	0.3		10

Table 10. Jack pine budworm: Summary of larval development on jack pine in northwestern Ontario in 1986

Location	Date	Larval Instar (%)					
		2	3	4	5	6	7
<u>Atikokan District</u>							
Kirk Lake	May 25	100					
	May 29	4	92	4			
	June 1		14	83	3		
	June 5		4	80	14	2	
	June 13		2	28	44	26	
	June 24			9	5	23	63
Crook Lake	May 25	100					
	May 28	11	89				
	May 31	2	36	62			
	June 5	2	28	66	4		
	June 13			28	70	2	
	June 18		4	8	42	42	4
<u>Kenora District</u>							
Redditt Twp	May 23	100					
	May 27	33	67				
	May 30	2	34	64			
	June 2		16	84			
	June 4		26	68	6		
	June 10		6	18	72	6	
	June 16			2	44	52	2
	June 25				2	24	74
<u>Red Lake District</u>							
Hegson Twp	May 30		78	22			
	June 8		10	82	6	2	
	June 17		4	14	60	22	
	June 26			10	14	38	38

Table 11. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in northwestern Ontario, 1986.

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Atikokan North	2.4	0.1	91	14
Checks	2.7	1.0		35
Atikokan South	1.5	0	100	8
Checks	1.5	0.9		34
Red Lake - 13	1.2	0.1	91	12
Checks	1.3	1.0		26
Red Lake - 14	1.0	0	100	11
Checks	1.3	1.0		26
Red Lake - 28	6.2	0.2	92	15
Checks	6.3	2.3		55
Red Lake - 38	1.8	0	100	6
Checks	1.6	0.1		21
Red Lake - 39	2.7	0	100	13
Checks	2.5	1.3		27
Red Lake - 40	3.2	0.2	88	40
Checks	3.8	1.7		30
Red Lake - 42	3.0	0	100	6
Checks	3.2	1.7		31
Red Lake - 47	0.5	0	100	7
Checks	0.9	0.3		22
Red Lake - 48	8.7	0.4	90	58
Checks	8.7	4.2		51
Red Lake - 51	6.3	0.3	93	19
Checks	6.4	4.1		53
Kenora - 77	0.1	0	100	5
Checks	0.6	0.5		24

(cont'd)

Table 11. Jack pine budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Dipel 132 at 20 BIU/1.6 l/ha in northwestern Ontario, 1986 (concl.)

Location	Pre-spray larvae per 60 cm tip	Surviving pupae per 60 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Kenora - 101	2.2	0.1	50	6
Checks	2.2	0.2		18
Kenora - 103	0.9	0.2	70	19
Checks	1.3	1.0		26
Sioux Lookout				
Goodie Lake	2.2	0.2	0	16
Checks	2.2	0.2		18

NOTE: Blocks treated with Thuricide 48LV were not assessed because of poor accessibility.

Table 12. Jack pine budworm: Pre-spray larval densities and defoliation rates on trees with and without male staminate flowers in northwestern Ontario, 1986.

	Flowers present	Flowers absent
* Trees (%)	41	59
Larvae per 60 cm tip	11.1	2.0
Average defoliation (%)	48	30

* A total of 350 trees were sampled throughout the region.

JACK PINE BUDWORM INFESTATION IN SASKATCHEWAN

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INTRODUCTION:

Jack Pine Budworm has long been a relatively serious insect problem of jack pine plantations and natural stands in Saskatchewan's commercial forest zone. Moderate to severe infestations have occurred periodically in Saskatchewan. These infestations have been cyclic in nature lasting usually for four to six years before suddenly collapsing. Significant amount of jack pine mortality, top kill and general stand decadence are the results of these infestations.

PREVIOUS INFESTATIONS:

The first recorded outbreak was observed in 1939 in the Fort a la Corne Provincial Forest, about 50 km. east of Prince Albert. Following several years of moderate to severe injury, the outbreak terminated in 1945.

Two major outbreaks have occurred since the 1939 infestation causing relatively moderate to minor damage, i.e. defoliation and top kill. One occurred from 1963-1967 in the Nisbet, Pines, Canwood and Fort a la Corne areas and the other lasted from 1977-80 in the Nisbet and in the Torch River Provincial Forest, north of Nipawin.

CURRENT STATUS:

The current outbreak of Jack Pine Budworm infestation started in 1984 in several locales near Nipawin and Hudson Bay covering an area of about 26,800 ha. In 1985 the infestation increased dramatically covering almost the entire eastern portion of Saskatchewan's Commercial Forest Zone from Manitoba-Saskatchewan border and caused moderate to severe defoliation over 130,000 ha. New area also included the Torch River Provincial Forest north of Nipawin, Fort a la Corne, and Nisbet Provincial Forests near Prince Albert.

This year, from surveys it appears that this outbreak shows signs of collapse in Hudson Bay, along Saskatchewan-Manitoba border, Nipawin and in Torch River Forest, but has increased in size and intensity in Fort a la Corne and in Nisbet Forest near Prince Albert.

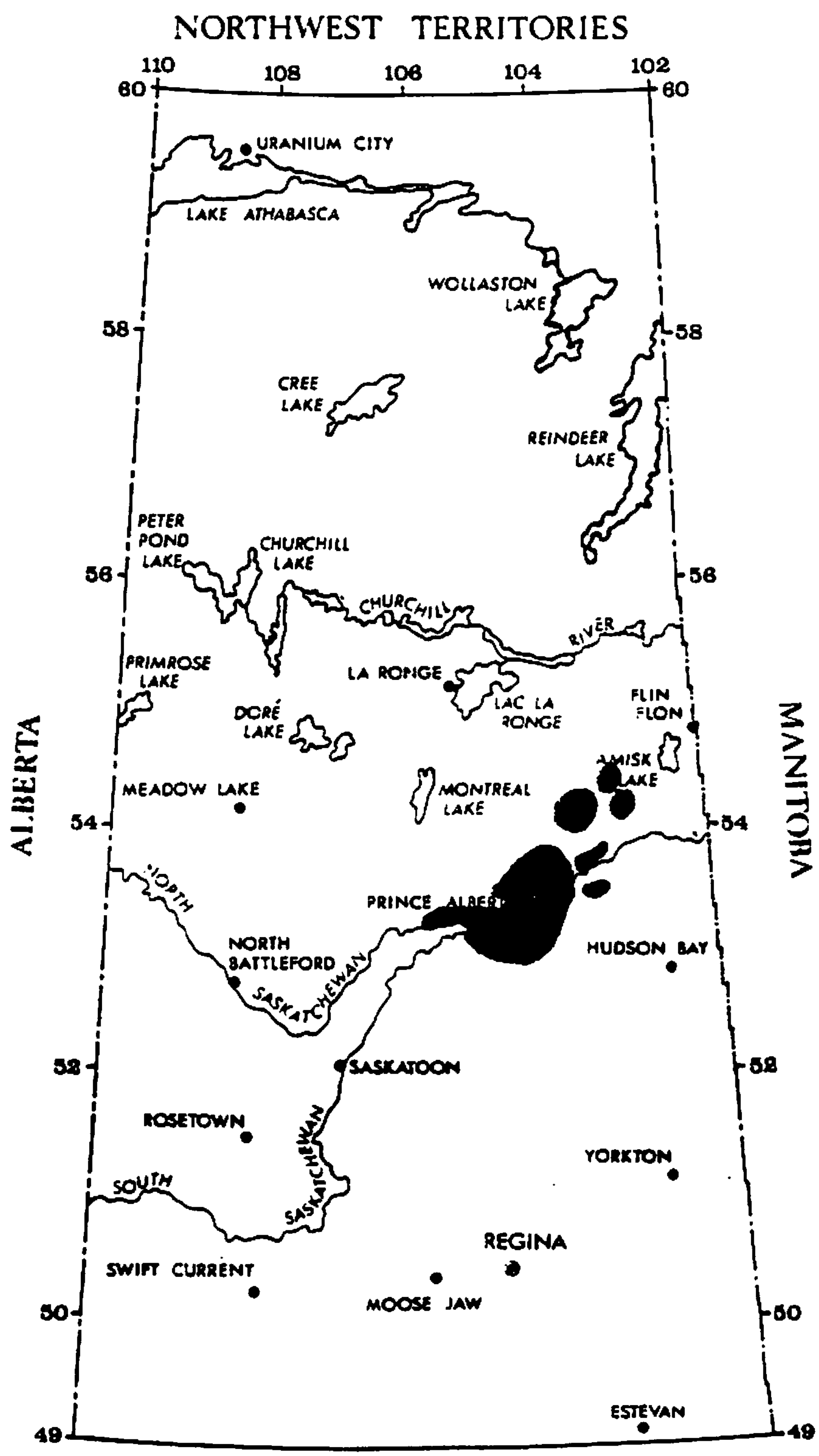
CONTROL STRATEGY:

- Harvesting plans have been developed in severely infected areas in Torch River Forest and in Prince Albert Pulp Co.'s management areas near Nipawin Provincial Park.

- Pheromones are being tested by CFS in various locations in the forest to help in monitoring population trend.

- Under Canada-Saskatchewan agreement, CFS and SPRR have initiated a study on the impact of Jack Pine Budworm infestation in the forest.

- The results of egg mass survey by CFS were not yet available for prediction of 1987 trend in the population.



SASKATCHEWAN

JACK PINE BUDWORM INFESTATION
IN SASKATCHEWAN - 1986

GYPSY MOTH IN ONTARIO, 1986[1]

- Outbreak Status 1986

- Forecasts 1987

- Results of Spraying Operations, 1986

by

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[1] Report prepared for the Annual Pest Control Forum, Ottawa, November 18-20, 1986.

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

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

OUTBREAK STATUS 1986

After five years of expanding infestations, the gypsy moth outbreak in eastern Ontario declined in 1986 (Table 1). Over all, moderate-to-severe defoliation of hardwood forest totalled 167,776 ha in 1986 in comparison with 246,342 ha in 1985 (Fig. 1). This represents a decrease of 32%.

The bulk of the decline occurred in the older infested areas in the Kaladar-Tweed area of the central Tweed District. In this area the infestation broke up into a number of scattered pockets, and moderate-to-severe defoliation in the Tweed District was reduced from 172,232 ha in 1985 to 73,525 ha this year. Table 2 lists the area of defoliation by OMNR district and Table 3 summarizes defoliation by county. In spite of the decline, the periphery of the infestation continued to expand, with substantial increases in the amount of moderate-to-severe defoliation recorded in the Carleton Place and Brockville districts of the Eastern Region. Smaller increases were recorded in the Pembroke District of the Algonquin Region and the Lindsay District of the Central Region, where moderate-to-severe defoliation was first recorded in 1985.

In the Carleton Place district, most of the expansion occurred in the Christie Lake-Silver Lake area of South Sherbrooke Township, along with a number of pockets in Lavant Township. Infestations in the Brockville District expanded in the Jones Falls-Chaffeys Locks area of South Crosby Township, in the Crosby Lake-Westport area of North Crosby Township, in the Marble Rock area and on the north and south sides of Charleston Lake. New infestations were recorded on the west side of the Napanee District in Cramahe Township, one of which extended some distance into adjacent Haldimand Township of the Lindsay District, Central Region. Infestations in the Lindsay District consisted of 402 ha of moderate-to-severe defoliation in Haldimand Township as described above, and 15 ha in Belmont Township, with a slight extension into adjacent Methuen Township, Bancroft District. In Bancroft District the area infested consisted of 164 ha of moderate-to-severe defoliation in small pockets in Belmont Township, down from the 240 ha recorded in the same area last year. Infestations which in 1985 encompassed 90 ha in Lyndoch, Griffiths, Brougham, Blithfield, and McNab townships, Pembroke District, expanded to about 221 ha this year.

Elsewhere in the Algonquin Region, small numbers of larvae were found in many widely scattered areas in the Pembroke District, in Airy Township, Algonquin Park District and in Burleigh, Faraday, Dungannon and Bangor townships, Bancroft District. Small numbers of larvae were also collected from nine townships throughout the Lindsay District, including Emily, Darlington and Serpent Mounds Provincial Parks.

In the Central Region a single collection of three caterpillars was made at Bronte Creek Provincial Park, Cambridge District, and low numbers of larvae persisted in the Silver Bay area of Humberstone Township and the Crystal Beach area of Bertie Township, Niagara District.

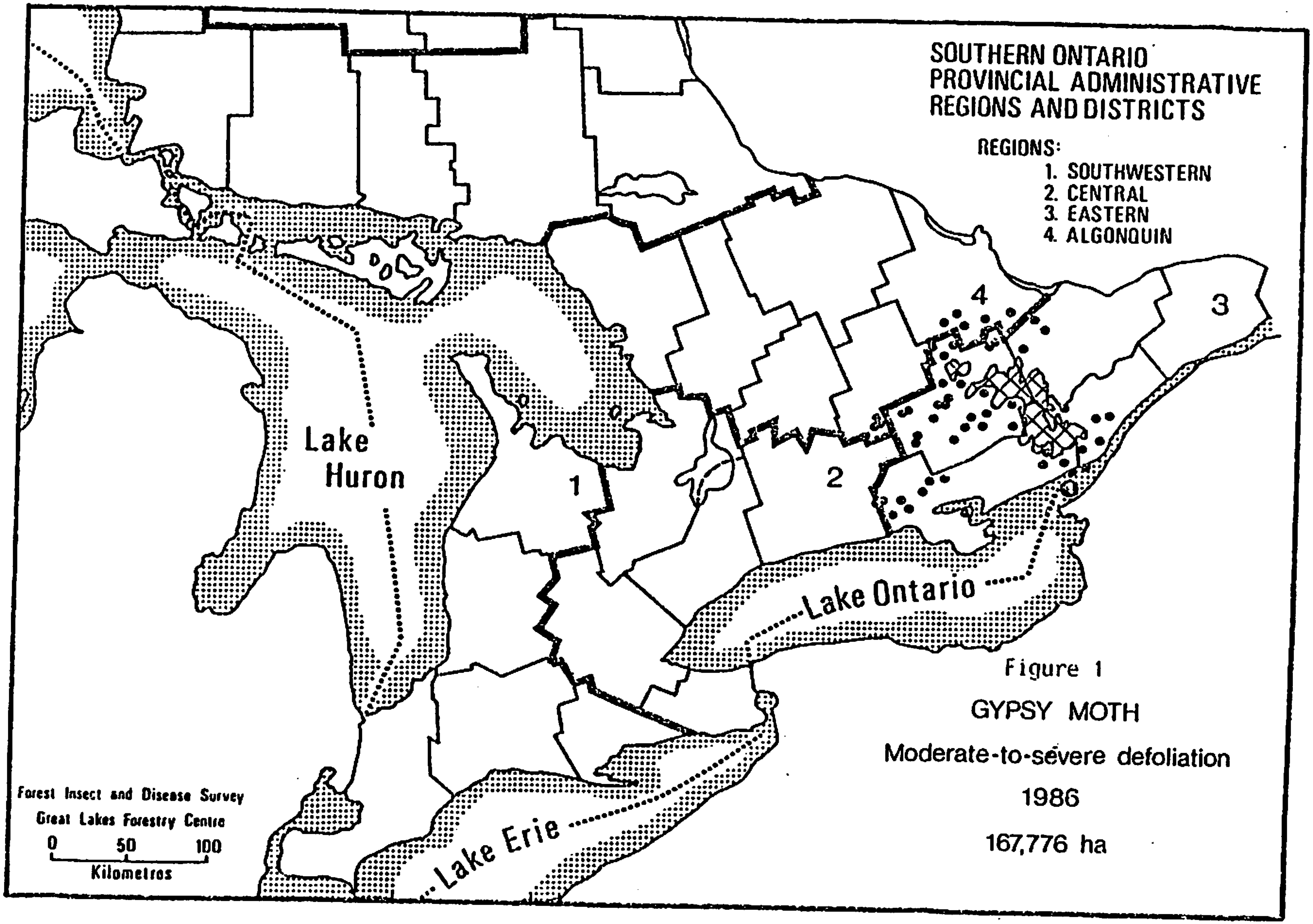

Figure 1
GYPSY MOTH
Moderate-to-severe defoliation
1986
167,776 ha

Table 1. Gypsy moth defoliation in the Eastern Region, 1981-1986

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

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

Region	District	1985	1986
Eastern	Tweed	172,232	73,525
	Napanee	58,326	57,780
	Carleton Place	4,197	13,386
	Brockville	11,232	22,283
Algonquin	Pembroke	90	221
	Bancroft	240	164
Central	Lindsay	25	417
TOTAL		246,342	167,776

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

County	1986
Northumberland	1,430
Peterborough	179
Hastings	11,668
Lennox and Addington	8,627
Prince Edward	540
Frontenac	109,442
Leeds	22,283
Lanark	13,356
Renfrew	221
Ottawa-Carleton	30
	167,776

In the Southwestern Region, OMNR staff reported low numbers of larvae and egg-masses in the 40-ha woodlot in Charlotteville Township, Simcoe District. Small numbers of larvae were also collected in St. Williams tree nursery in South Walsingham Township. A small number of egg-masses was reported south of Sarnia in Moore Township, Chatham District, by personnel of the Plant Protection Division of Agriculture Canada, however, followup larval surveys failed to disclose any insects.

Larval Trapping

For the fourth consecutive year the FIDS Unit and the OMNR Park Branch carried out a larval trapping program in 61 locations, mainly provincial parks and campgrounds in southern Ontario (Fig. 2). The trapping program is based on the gypsy moth larval habit of descending the trees to hide during the day. A strip of burlap is tied around the tree trunk with the top half folded over the bottom half. Descending larvae hide under the overhanging burlap where they are easily captured. FIDS rangers installed traps at each park where they were monitored constantly by the rangers and parks personnel. Suspect larvae were sent to the Sault Ste. Marie laboratory for positive identification. Of the 12 parks trapped in the Eastern Region, larvae were captured in 10 (Table 4). These results were not unexpected as all these locations were within the area considered to be generally infested by the pest.

However, larvae were trapped in seven parks outside of the Eastern Region. These included two locations in the Algonquin Region (Pembroke and Bancroft districts) and five locations in the Central Region (one each in Huronia and Cambridge districts and three in Lindsay District).

Pheromone Trapping

The adult pheromone trapping program was again carried out at the same parks in southern Ontario where larval trapping took place as well as in a number of other locations (Fig. 3). Two pheromone traps were installed at each park and, wherever possible, one trap was located at the entrance area and the other in a camping area. Additional traps were installed in highly suspect locations. Positive identification of captured moths was made at the Sault Ste. Marie laboratory. Moths were captured at 63 of 64 parks compared with 51 of 67 parks trapped in 1985 (Table 4). In addition to moths being caught in more locations in 1986 than previously, the average number of moths trapped in southern Ontario parks this year was 65% higher, i.e. 15.3 moths/trap compared to 9.3 moths/trap in 1985. Year-to-year changes are quite striking in districts such as Bracebridge which went from 0 moths/trap in 1985 to 9 moths/trap in 1986, Parry Sound from .4/trap to 11.8, Huronia from .9 to 14.7 and Owen Sound from 1.1 to 4.8.

A pheromone trapping program was also conducted in northern Ontario similar to that employed in southern Ontario. Two traps were located in each provincial park or private campground and ten traps

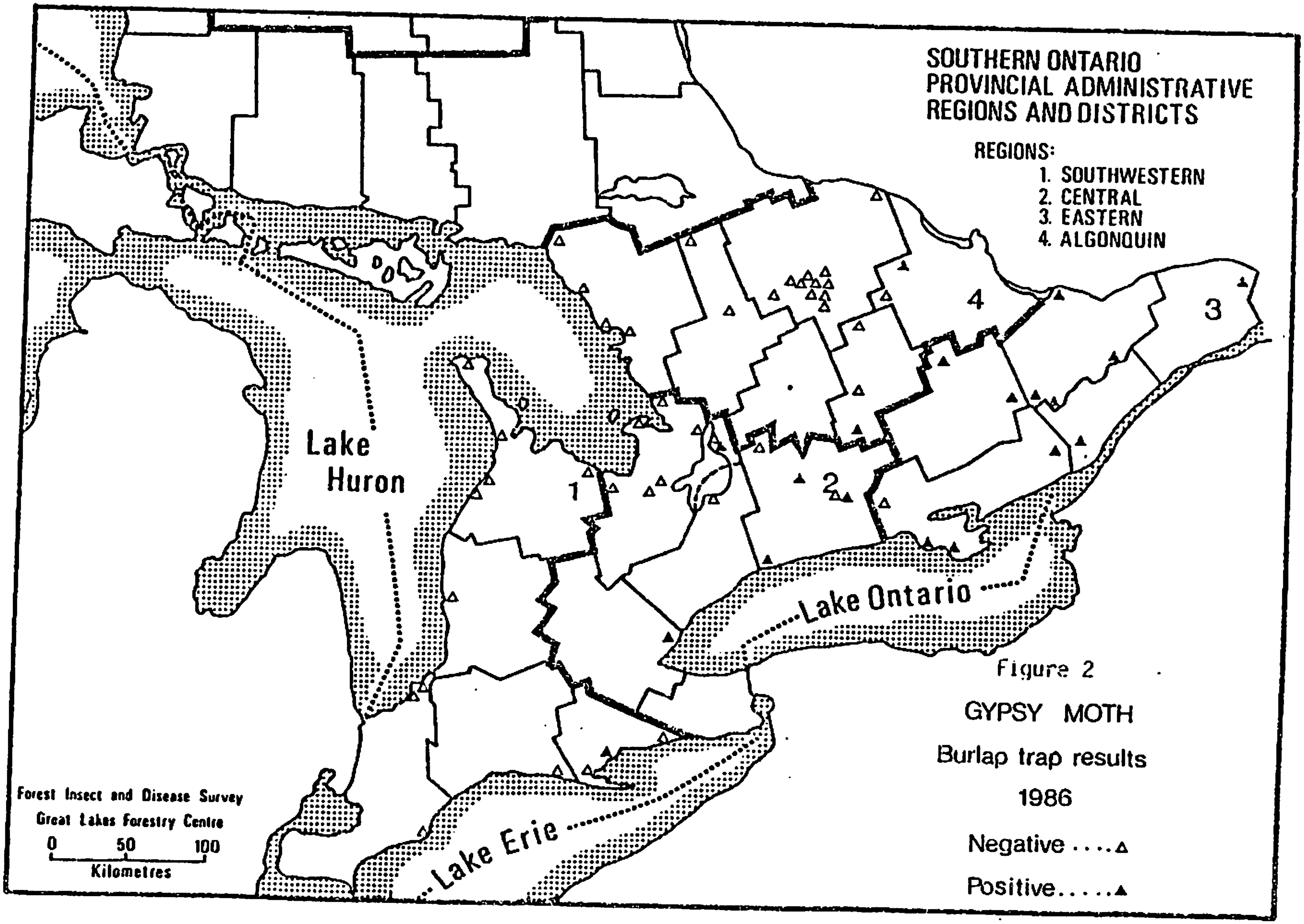

Figure 2
GYPSY MOTH
Burlap trap results
1986

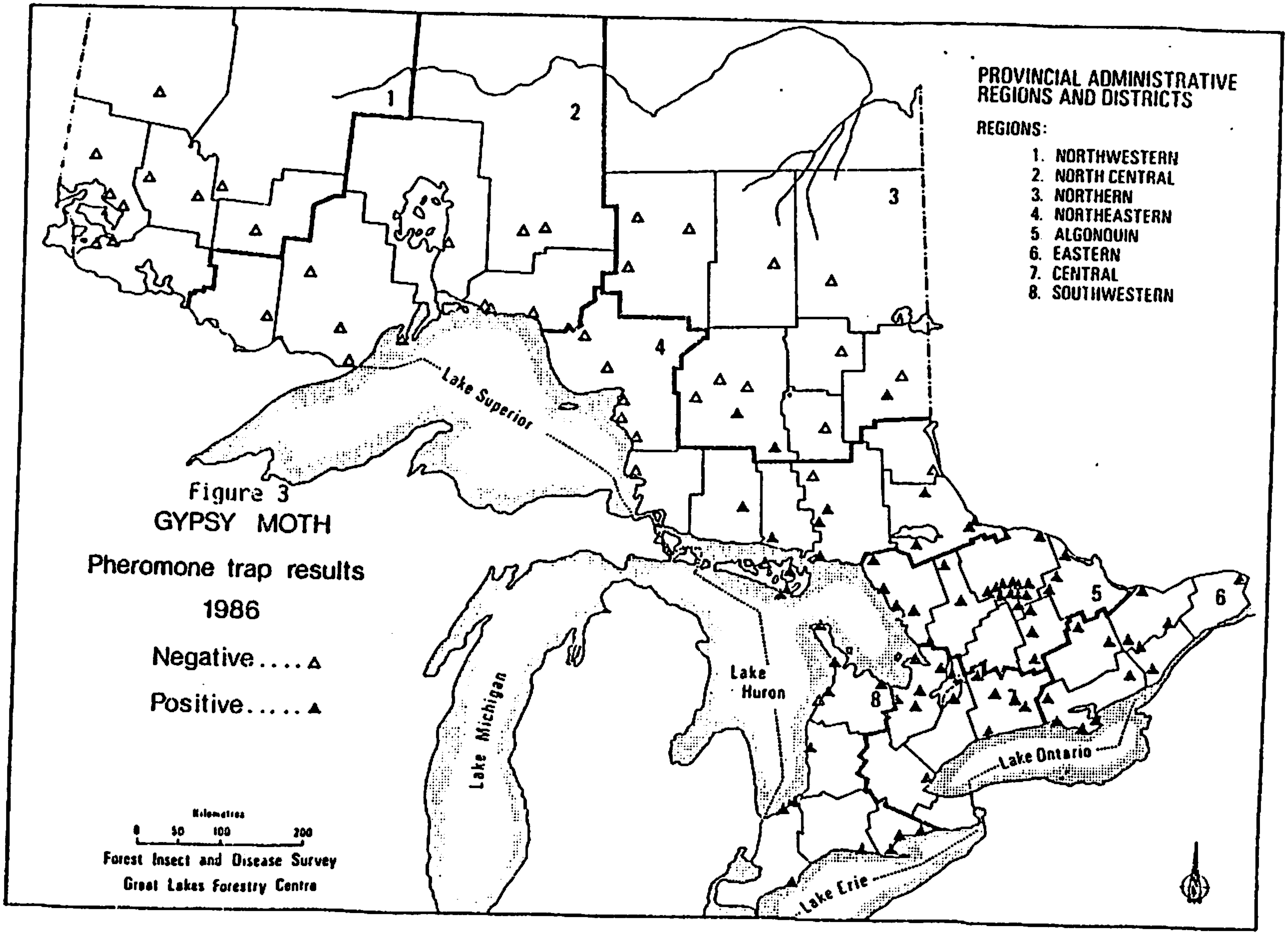

Figure 3
GYPSY MOTH
Pheromone trap results
1986

were deployed in areas where gypsy moth was trapped in 1985. Suspect moths in traps were identified by the Great Lakes Forestry Centre. Of the 56 locations trapped in northern Ontario in 1986, male moths were found in 15, all in northeastern Ontario, a three-fold increase over the 5 locations that produced adults in 1985. Male moths were trapped in all four parks in North Bay District, in three of four parks in Sudbury District, in four of five locations in Espanola District and single moths were trapped in Mississagi Provincial Park in Blind River District, in one location in Kirkland Lake District and in two locations in Chapleau District. Moths have been trapped at one location, Red Lodge, Bidwell Township, Manitoulin Island, Espanola District, for three consecutive years (1984, 1985, 1986) and at three locations for two years (1985 and 1986). The latter are Mississagi Provincial Park, Blind River District, South Bay Resort, Manitoulin Island, Espanola District and Antoine Provincial Park, North Bay District.

Forecasts, 1987

Egg-mass surveys indicate that the potential for infestation in 1987 is reduced considerably when compared to 1985 egg-mass densities. In many situations egg-mass counts have declined by 90% or more and new infestations are not likely to occur except along the eastern edge of the 1986 infestation area.

Results of Spraying Operations

In 1986, the Ontario Ministry of Natural Resources carried out the largest aerial spraying program ever conducted in Canada against the gypsy moth. A total of 103,094 ha, including 45,677 ha of crown land and 57,417 ha of private land, were treated with double or triple applications of the bacterial insecticide *Bacillus thuringiensis* (*B.t.*) Seven districts (Lindsay, Napanee, Tweed, Brockville, Carleton Place, Pembroke and Bancroft) in the Eastern, Algonquin and Central regions participated in the 1986 program which began the third week of May. Dipel 132 was applied by fixed-wing and rotary-wing aircraft at a rate of 30 BIU/6.01/ha. A small experimental program was conducted involving double applications of the nuclear polyhedrosis virus and the *B.t.* formulation SAN-415. The virus was produced by Dr. J.C. Cunningham of the Forest Pest Management Institute and the *B.t.* by Sandoz Agro Canada Inc.

Survival of overwintering gypsy moth egg-masses has been found to be extremely variable in Ontario. In some years a high proportion of egg-masses may be killed by a combination of cold winter temperatures and a lack of snow cover. In early April 1986, gypsy moth egg-masses were collected from six locations within the area proposed for spraying. The egg-masses were placed in individual containers and reared in the quarantine facilities at the Great Lakes Forestry Centre. The proportion of egg-masses producing larvae and the proportion of larvae produced per egg-mass was determined and is summarized in Table 4. The data in this table indicate a generally high rate of hatch from egg-masses collected at both levels - ground and above ground - but the proportion of larvae produced per egg mass

Table 4. Gypsy moth: Summary of overwintering egg survival in eastern Ontario, 1985-86.

Location	Ground			Bole		
	% Egg-masses hatched	% Eggs per mass hatched	Larvae per egg-mass ($\bar{x}$)	% Egg-masses hatched	% Eggs per mass hatched	Larvae per egg-mass ($\bar{x}$)
Frontenac Prov. Pk	100	98	245	60	31	96
White Lake	100	94	267	84	38	86
Burnstown	100	97	265	96	81	248
Griffith	100	93	197	92	38	86
Charleston	96	93	229	100	79	196
Stirling	100	96	278	100	93	284
Overall	99	95	247	89	61	166

was more variable and somewhat lower in egg masses collected above ground level. In fact, when compared to previous years (Table 5) the average number of larvae produced per egg-mass in 1986 was lower than any previous year. This may, in part, account for the lower than expected defoliation levels observed in much of eastern Ontario this year.

As a result of unusually warm, spring temperatures (Fig. 4) gypsy moth egg-masses began hatching approximately two weeks earlier than normal in mid-to-late April. Egg hatch was complete in most locations by early-to-mid May. A summary of larval development for six locations is presented in Table 6. Spraying began in the southern spray blocks on May 21 when most larvae were in the first three instars and was completed by June 12.

The effectiveness of the 1986 gypsy moth aerial spraying program was assessed by comparing changes in egg-mass density and defoliation rates in plots established in sprayed and unsprayed (check) areas. Results of these surveys for both the operational and experimental programs are presented in Tables 7 to 10.

Plots established for the 1985 gypsy moth egg-mass survey and new plots established in April 1986 were used to assess changes in egg-mass density. Each plot was 10 m x 10 m (.01 ha) in size. A total of 70 plots were surveyed in spray areas with another 14 checks. The results, as presented in Table 7, indicate a significant decline in egg counts from 1985 to 1986 in all areas except Silver Lake and Charleston Lake provincial parks. Because the decrease in the 1986 egg counts is similar in both the spray and check plots the efficacy of the *B.t.* aerial spraying program is difficult to assess in terms of population reduction.

Defoliation surveys were conducted in the same plots used to assess changes in egg-mass density. A single branch (45 cm) was cut from each of ten trees in each plot and the defoliation estimated. Red and white oak were preferred for sampling, but others such as sugar maple, red maple, ironwood, white ash, bitternut hickory and basswood were also examined. Defoliation summaries for red and white oak and sugar maple are presented in Table 8. While differences between sprayed and unsprayed plots are not dramatic, rates in the treated plots are generally lower than those in the checks.

Results of the experimental trials are presented in Tables 9 and 10 and are very similar to those observed in the operational spray areas.

Overall, the *B.t.* aerial spraying program conducted in eastern Ontario in 1986, seems to have been effective in reducing defoliation rates. But, because of the significant decline in egg-mass densities throughout the region, the impact of the spray program in terms of egg-mass reduction can not be determined.

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Table 5. Gypsy moth: Average number of larvae produced per egg-mass from 1983-1986 in eastern Ontario.

Year	Average larvae per egg-mass Ground	Bole
1983	274	223
1984	339	176
1985	375	276
1986	247	166

Figure 4. Gypsy moth: Heat accumulation rates at the Kingston and Ottawa airports in 1986.

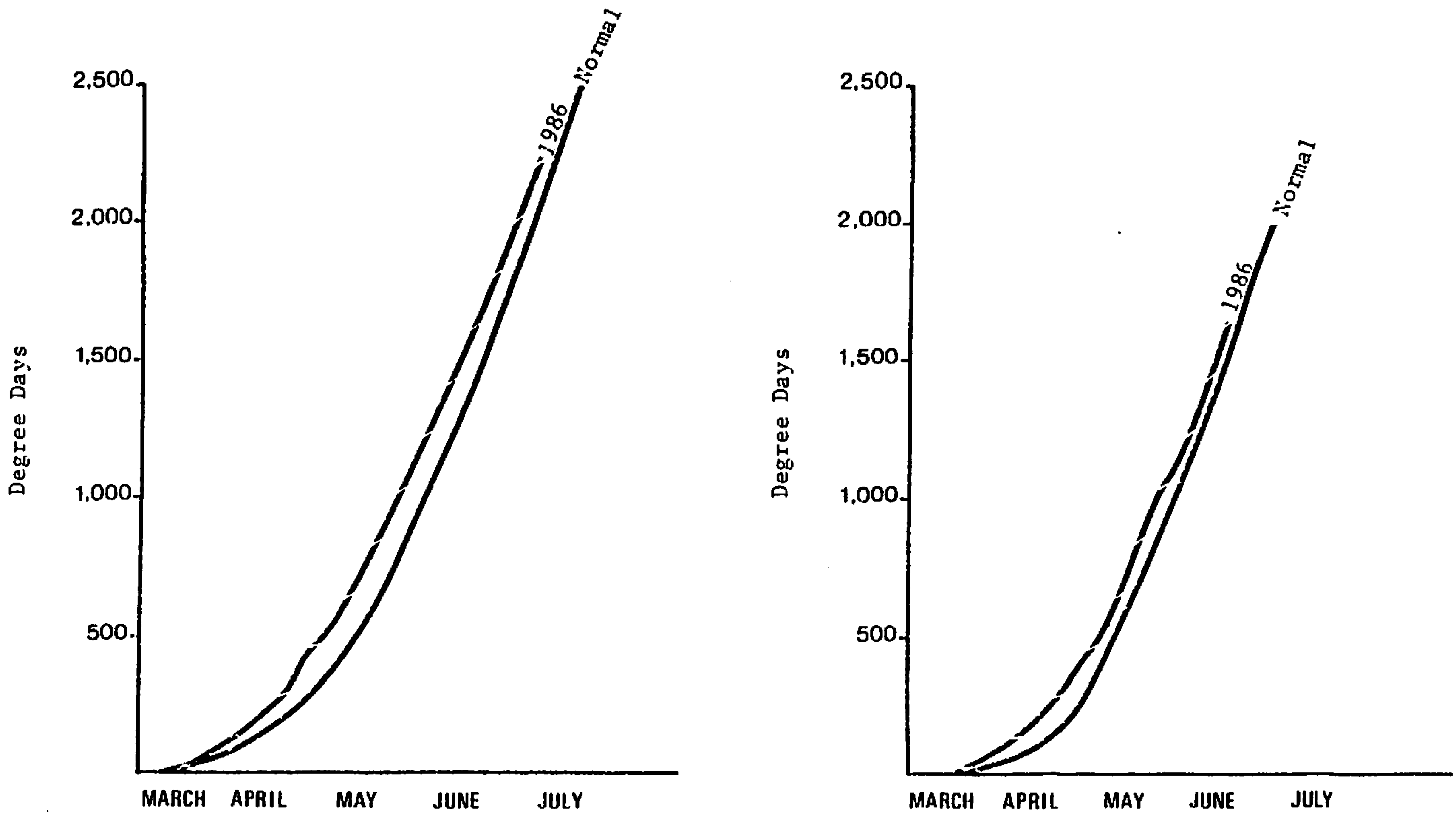


Table 6. Gypsy moth: Summary of larval development in eastern Ontario, 1986.

Location	Date	Larval Instar (%) I	II	III	IV	V	VI
Bon Echo Provincial Park	May 12	100					
	16	18	82				
	20	4	60	36			
	29		6	32	60	2	
	June 6			10	42	42	6
	16			2	18	32	48
	26				6	12	82
Black Lake	May 11	100					
	16	49	49	2			
	20	18	49	33			
	26	10	25	60	5		
	30		4	13	70	13	
	June 6			18	44	36	2
	13			4	36	34	26
	20				20	18	62
	24					8	92
Frontenac Provincial Park	May 11	100					
	15	48	48	4			
	20		38	62			
	26		36	50	14		
	June 17				38	17	45
Griffith Twp	May 12	100					
	15	41	59				
	21	22	40	38			
	26	8	46	42	4		
	June 10		2	32	46	18	2
Sydney Twp	May 9	100					
	13	88	12				
	16	10	82	8			
	23		16	66	18		
	29		4	38	56	2	
Clarendon Twp	May 14	100					
	19	34	52	14			
	22	20	38	42			
	June 2		2	16	74	8	
	9			18	44	38	
	17			2	32	46	20
	25				8	26	66

Table 7. Gypsy moth: Changes in egg-mass densities in plots treated with double or triple applications of Dipel 132 at 30 BIU/6.0 l/ha in eastern Ontario, 1986.

Location	No. plots	Average number of egg-masses per plot (.01 ha)		% Change
		1985	1986	
Tweed District				
Sharbot Lake Prov. Pk	15	23.5	12.7	-46
Bon Echo Prov. Pk	3	2.0	0.7	-67
Kennebee Twp	3	37.3	3.0	-92
Elzevir Twp	6	68.5	0.7	-99
Second Depot Lk	2	33.0	1.0	-97
Wagarville	2	17.0	1.0	-94
Carleton Place District				
Silver Lake Prov. Pk	3	0.7	1.0	+33
Murphy's Point Prov. Pk	3	3.3	0	-100
Lavant Station	6	14.7	0.2	-99
Napanee District				
Frontenac Prov. Pk	6	28.5	21.3	-25
Stirling	3	12.7	1.7	-87
Brockville District				
Charleston Lake Prov. Pk	3	0.3	3.3	+900
Pembroke District				
Griffith	15	115.8	8.8	-92
Check Plots				
Tamworth	3	117.7	13.7	-88
Kennebec Twp	1	107.0	5.0	-95
Olden Twp	2	23.5	0	-100
Coxvale	2	46.5	9.5	-80
Oro Twp	2	23.0	2.5	-89
Kaladar	4	52.0	10.3	-80

Table 8. Gypsy moth: Defoliation on white oak (wO), red oak (rO) and sugar maple (sM) aerially treated with double or triple applications of Dipel 132 at 30 BIU/6.0 l/ha in eastern Ontario, 1986.

District and Location	No. Plots	Average defoliation (%)		
		wO	rO	sM
Tweed District				
Sharbot Lake Prov. Pk	6	17	27	18
Bon Echo Prov. Pk	3	-	19	9
Kennebec Twp	3	-	19	7
Elzevir Twp	6	21	25	16
Second Depot Lake	2	40	21	-
Wagerville	2	41	27	22
Napanee District				
Frontenac Prov. Pk	7	26	38	15
Stirling	3	17	30	-
Brockville District				
Charleston Lake Prov. Pk	3	20	28	8
Carleton Place District				
Silver Lake Prov. Pk	4	13	-	11
Murphy's Point Prov. Pk	3	-	14	14
Lavant Station	6	-	25	12
Pembroke District				
Griffith 1	5	-	27	-
2	5	-	15	-
3	5	-	50	-
Check Plots				
Kennebec	1	-	18	-
Tamworth	3	60	-	-
Kaladar	4	22	25	-
Olden	2	-	50	9
Coxvale	2	-	40	-
Oro	2	40	50	12

Table 9. Gypsy moth experimental trials: Changes in egg-mass densities.

Treatment	No. plots	Average number of eggs per plot (.01 ha) 1985	1986	% Change
*NPVirus (2.7 x 10^{11} PIB/9.4 l/ha)	5	32.4	15.6	-52
*NPVirus (2.2 x 10^{12} PIB/9.4 l/ha)	5	15.4	0.2	-99
**B.t.* SAN-415 (30 BIU/6.0 l/ha)	3	24.7	16.3	-33

* Two applications.

Table 10. Gypsy moth experimental trials: Defoliation on white oak (wO), red oak (rO) and sugar maple (sM) aerially sprayed in eastern Ontario, 1986.

Treatment	No. plots	Average defoliation (%) wO	rO	sM
*NPVirus (2.7 x 10^{11} PIB/9.4 l/ha)	5	-	39	13
*NPVirus (2.2 x 10^{12} PIB/9.4 l/ha)	5	19	22	12
**B.t.* SAN-415 (30 BIU.6.0 l/ha)	3	32	37	16

* Two applications.

GYPSY MOTH DEFOLIATION AND SUPPRESSION IN THE NORTHEASTERN UNITED STATES 1986 - 1987

Peter W. Orr

In 1986, gypsy moth defoliation occurred on 976,528 ha throughout the northeastern United States, up from 691,622 ha in 1985 (Figure 1). Significant increases in defoliation were reported in Connecticut, Maine, Michigan, New York, Pennsylvania, Rhode Island, Virginia, and West Virginia (Figure 2). Populations remain vigorous along the advancing front of defoliation in western Pennsylvania, Maryland, Virginia, and West Virginia. In central Michigan defoliation increased to 24,836 ha, triple the defoliation reported in 1985. Preliminary egg mass surveys indicate that populations are likely to be heavy in most areas in 1987.

In 1986, cooperative State/Federal gypsy moth suppression projects were conducted in Delaware, Maryland, Massachusetts, Michigan, New Jersey, Pennsylvania, Rhode Island, Virginia, and West Virginia. A total of 233,982 ha was treated with chemical or biological insecticides (Figure 3). About 61 percent of the treatments involved the application of the insect growth regulator dimilin and 38 percent involved application of *Bacillus thuringiensis* (*B.t.*).

During the last three years, the use of *B.t.* has declined and the use of dimilin has increased for gypsy moth suppression (Figure 3). The primary reason for the decline in use of *B.t.* seems to center on poor population reduction. When *B.t.* is applied to very high gypsy moth populations, in excess of 12,355 egg masses/ha, enough larvae survive the treatments to produce populations which will require retreatment of the same areas the following year. This is often the case even when *B.t.* is applied twice.

In contrast, applications of dimilin resulted in good population reduction in areas of very high egg mass density. Retreatment of the same areas is seldom required the following year. In 1987, where State agencies have a policy to offer only *B.t.* in their State suppression programs some towns or communities may drop out of the State program. Most of these towns will fund their own suppression projects in which a chemical insecticide will be used.

Plans are underway for cooperative State/Federal suppression projects on about 323,756 ha of State and Private lands during the spring of 1987 in Delaware, Maryland, Massachusetts, Michigan, New Jersey, Pennsylvania, Rhode Island, Virginia, and West Virginia (Table 1). A federal suppression project involving about 17,807 ha is proposed on the Allegheny National Forest in Pennsylvania.

Presented at the Fourteenth Annual Forest Pest Control Forum, Ottawa, Ontario by Peter W. Orr, Assistant Director, USDA Forest Service, Northeastern Area, State and Private Forestry, Broomall, Pennsylvania.

TABLE 1.--Proposed 1987 Cooperative Gypsy Moth Suppression Projects

State	Acres	Hectares	Insecticide
Delaware	50,000	20,235	*B.t.*, Dimilin
Maryland	115,000	46,540	*B.t.*, Dimilin
Massachusetts	15,000	6,070	*B.t.*, Dimilin
Michigan	65,000	26,305	*B.t.*
New Jersey	92,200	37,313	*B.t.*, Dimilin
Pennsylvania	300,000	121,408	*B.t.*, Dimilin
Rhode Island	70,000	28,328	*B.t.*
West Virginia	100,000	40,470	*B.t.*, Dimilin
Total	807,200	326,669	

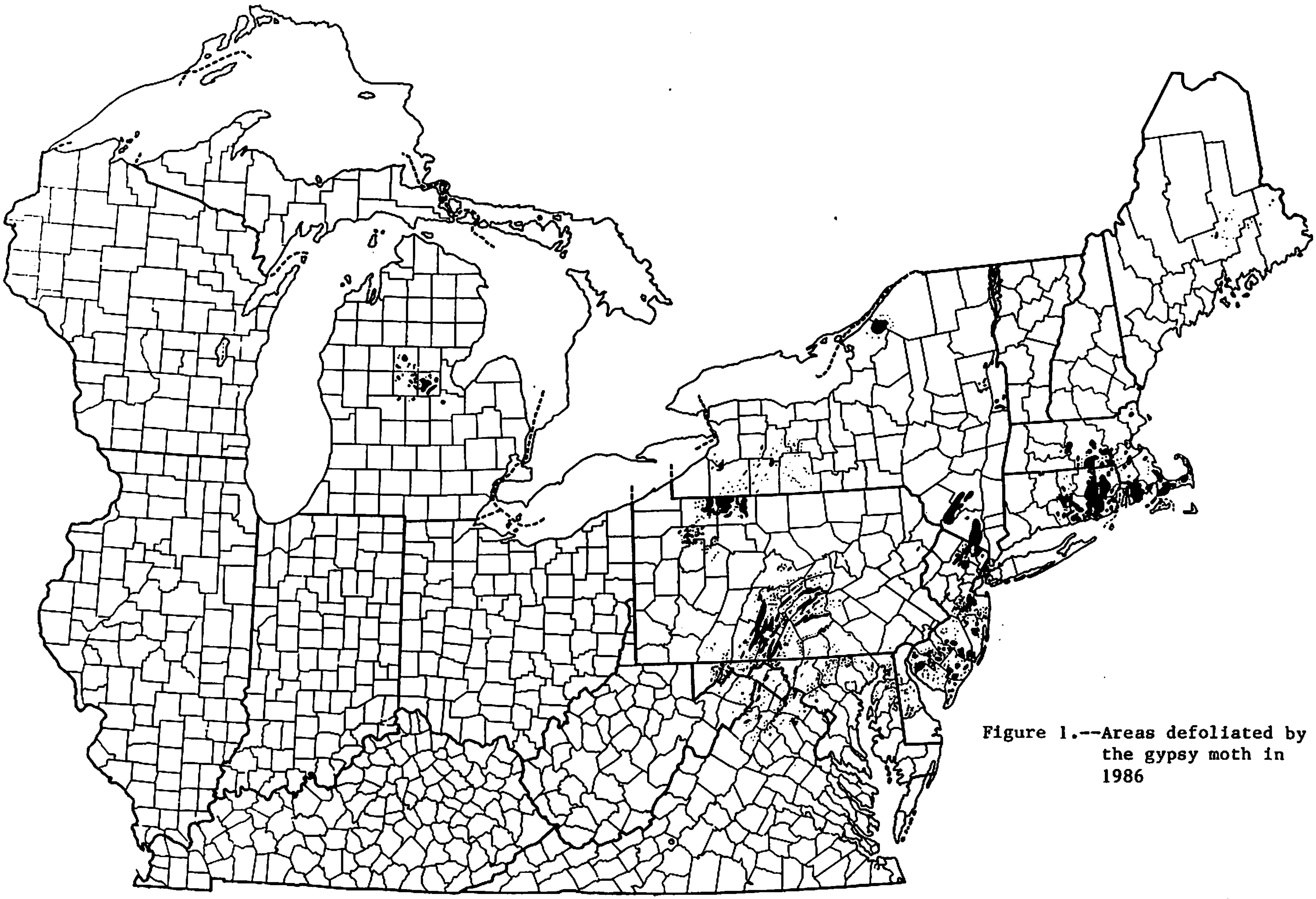
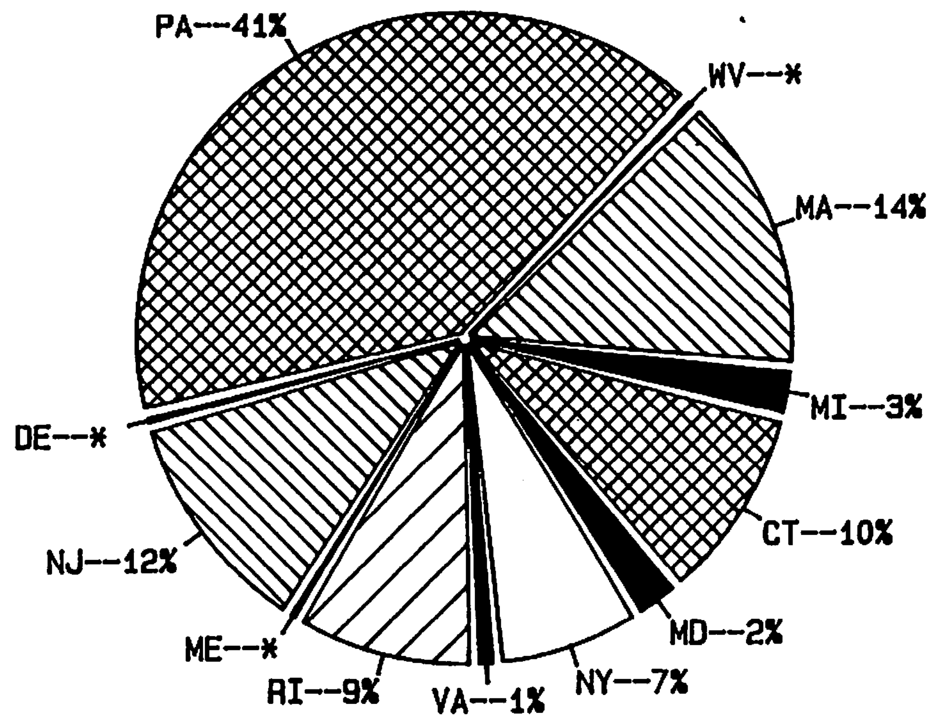


Figure 1.--Areas defoliated by the gypsy moth in 1986

Prepared by the USDA Forest Service, Forest Pest Management, Morgantown, WV.

Figure 2.--Gypsy moth defoliation by state (total = 2.4 million acres) 1986



Percent of Total Acres
Defoliated by State

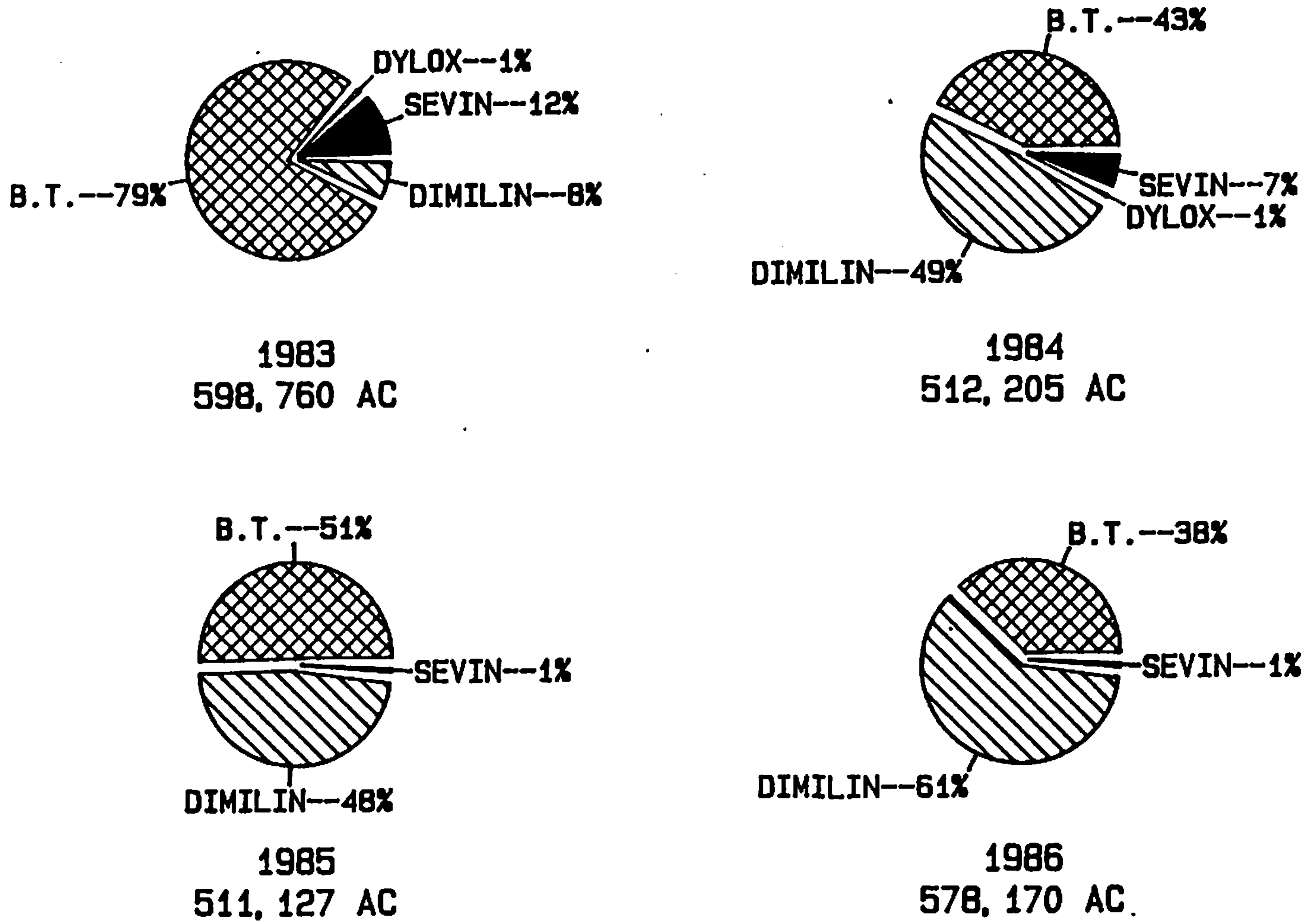
	Acres
DE	3,118
WV	8,250
ME	11,572
VA	27,259
MD	58,190
MI	61,370
NY	175,365
RI	219,150
CT	237,237
NJ	280,290
MA	343,091
PA	987,819

Moderate to heavy defoliation.

* DE, ME, and WV combined have less than 1%.

Prepared by USDA Forest Service,
Forest Pest Management, Morgantown, WV

Figure 3.--Insecticide use in cooperative State/Federal gypsy moth suppression projects 1983 - 1986



Treated acres in DE, MD, MA, MI, NJ, PA, RI,
VA, and WV.
prepared by USDA Forest Serv., Forest Pest Mgt.

THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1986

Hudak, J., K.P. Lim and L.J. Clarke

REPORT PREPARED FOR THE FOURTEENTH ANNUAL FOREST PEST CONTROL FORUM
OTTAWA, 18-20 NOVEMBER 1986

NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
ST. JOHN'S, NEWFOUNDLAND
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THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1986

by

Hudak, J., K.P. Lim and L.J. Clarke

Larval Development and Defoliation - The weather in the early part of the season had higher than normal precipitation and less sunshine. There was a late snowfall and two nights of frost in early June but temperatures averaged above normal for the month. Hatching and early larval development was about two weeks ahead of normal. July had less sunshine and was colder and wetter than average. August was sunny and warm for most of the month with above normal temperatures. The weather during adult emergence, mating, egg laying and dispersal was colder and wetter than average.

The egg survey conducted in the fall of 1985 indicated that the area of moderate and severe defoliation by the hemlock looper in 1986 would reach about 219 000 ha distributed in four major areas in western Newfoundland and in several smaller areas in central and eastern parts of the Island. Light defoliation was also expected to occur on about 693 000 ha throughout the Island but this area contained about 165 000 ha where looper numbers were thought to be marginal to cause any noticeable defoliation.

The larval and aerial defoliation surveys showed that moderate and severe defoliation occurred on about 215 000 ha (Table 1). Severe reddening of balsam fir foliage was evident near Codroy Pond, in the headwater areas of the major rivers of southwestern Newfoundland, from Georges Lake to Corner Brook including the Cooks Brook area, from Cormacks Lake to Red Indian Lake, and near Hawkes Bay in western Newfoundland. Severe defoliation also occurred in Terra Nova National Park, near Triton Brook and Lake St. John, and on parts of the Avalon Peninsula (Fig. 1). Light defoliation was recorded on about 117 000 ha in 1986. Looper larval numbers were too low to cause noticeable defoliation in many stands forecast for light defoliation in 1986. However, these areas are of prime concern because of the possible expansion of the outbreak in 1987.

Control Programs - The Department of Forest Resources and Lands conducted an operational control program against the looper and treated about 81 000 ha with Fenitrothion and about 5 000 ha with *Bacillus thuringiensis*.

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

Biological Mortality Factors

In 1986, samples of hemlock looper were collected from five sample areas. The major larval parasite was an ichneumonid species. The major pupal parasite was a tachinid species. About 0.4% of hemlock looper samples were parasitized.

Fungal pathogens caused about 4.5% mortality of the reared larval samples. The major fungal pathogen was *Entomophaga aulicae*. Other fungal pathogens detected were *Paecidomyces farinosus* and *Verticillium lecanii*. Both *P. farinosus* and *V. lecanii* are new host records. About 0.5% of larval samples were infected by an undescribed microsporidian.

Damage Assessments - The majority of the severe defoliation occurred in western Newfoundland in predominantly mature and overmature stands, but some semi-mature stands were also severely damaged. Tree mortality may reach 80% in some stands within the next 2 years. The Department of Forest Resources and Lands will assess the damage at the inventory level.

Forecast of Hemlock Looper Outbreak for 1986 - The egg survey commenced in mid-October and branches were collected from 850 sample points throughout the Island. The forecast will be provided after the processing of the branch samples have been completed.

Table 1. Areas (ha) of defoliation caused by the hemlock looper in productive forests of Newfoundland in 1986.

Management Unit No.	Defoliation Class[1] Light	Moderate	Severe	Total
1	7 019	714	12 923	20 656
2	5 519	884	5 316	11 719
4	218	-	5 703	5 921
5	1 439	34	1 841	3 314
6	415	68	989	1 472
7	190	181	88	459
10	-	-	68	68
11	34	102	144	280
12	2 832	156	5 980	8 968
13	1 722	1 408	33 181	36 311
14	7 703	714	72 786	81 203
15	46 455	4 079	43 213	93 747
16	156	54	252	462
17	37 400	2 250	15 294	54 944
18	2 429	-	-	2 429
Sub-total	113 531	10 644	197 778	321 953
TNNP	423	82	2 920	3 425
GMNP	2 651	592	3 457	6 700
Grand Total	116 605	11 318	204 155	332 078

[1]Light - 1-25%.
Moderate - 26-75%.
Severe - 76-100%.

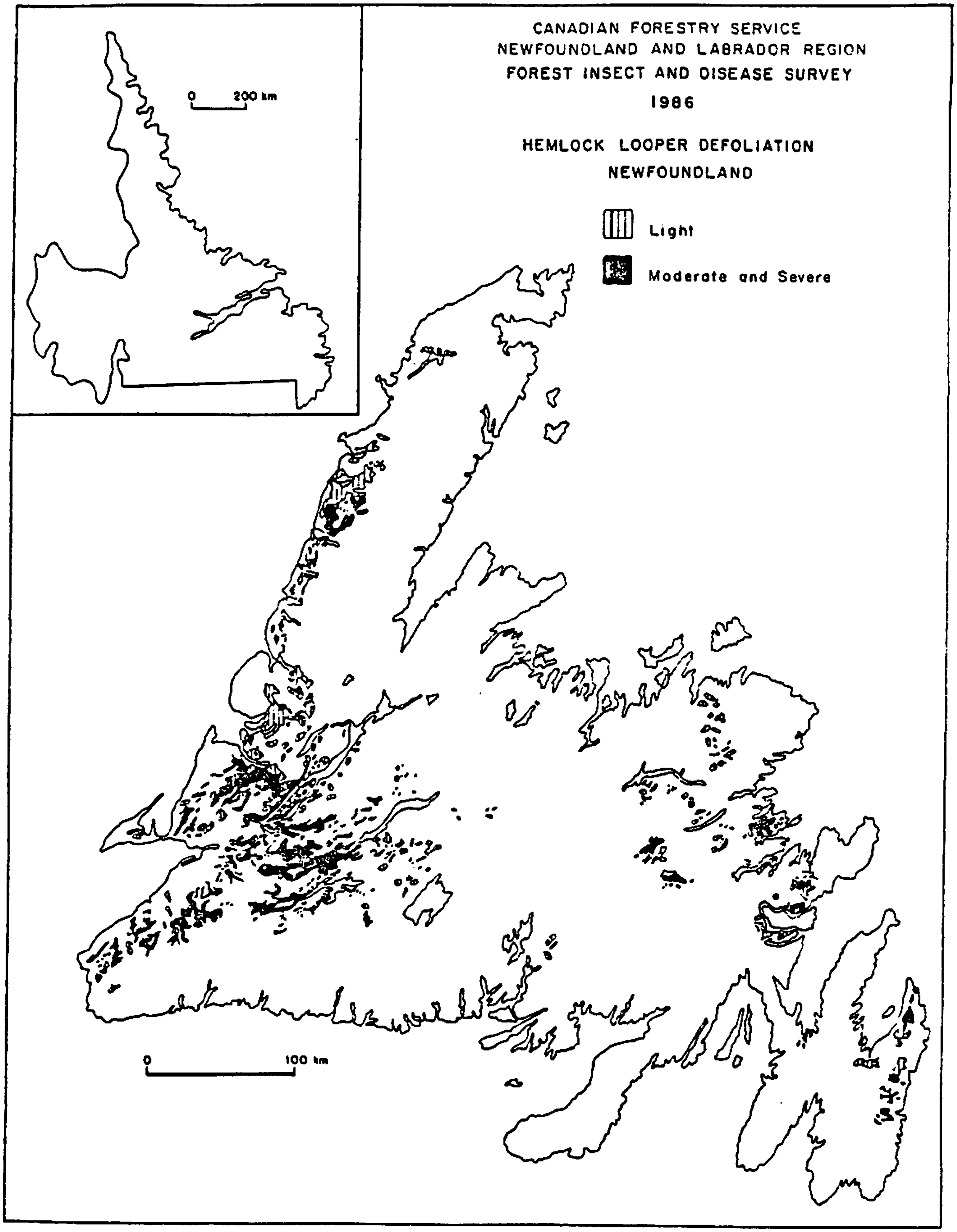

Figure 1. Areas of defoliation caused by the hemlock looper in productive forests of Newfoundland in 1986.

Statement for the 14th Annual Forest Pest Control Forum, November, 1986

SEEDLING DEBARKING WEEVIL IN THE MARITIMES: ASSESSMENT AND CONTROL

B.A. Pendrel, L.P. Magasi, CFS-Maritimes

INTRODUCTION

The seedling debarking weevil, Hylobius congener, is a pest of newly established plantations in that it only affects young seedlings. The essential reason why it is a pest now when prior to about 1982 it was almost unheard of, is because of the increasingly popular practice of "hot" planting. This refers to reforesting an area within a year of its being harvested. To give an idea of the scale of the problem, some 1985 data follow.

Table 1. 1985 HYLOBIUS CONGENER DAMAGE ASSESSMENT - SELECTED SAMPLES

LOCATION	FINAL ASSESSMENT ATTACKED	KILLED	HOST SPECIES
Lorne, Pictou Co.	22%	10%	Spruce
Elgin-c, Pictou Co.	77%	70%	White spruce
Elgin-e, Pictou Co.	38%	11%	White spruce
Donny Brk. Rd., Antig. Co.	3%	0%	Black spruce
Donny Brk. Rd., Antig. Co.	31%	14%	Black spruce
Southampton, Cumb. Co.	23%	5%	Red pine
Lower Maccan, Cumb. Co.	19%	7%	Red pine
McAdam, New Brunswick	16%	13%	White spruce

As a result of this damage many plantations have had to be fill planted or completely replanted. All softwood species are subject to damage, from larch and spruce, to pines.

Weevils are attracted in large numbers to a cut-over. Up until a few years ago cut-overs were either left unplanted, or it often took years before they were planted. By this time the weevils had completed their life cycle and the adults produced had dispersed to other sites which were releasing the appropriate olfactory message. Our more recent practice of planting very soon after the harvest has been a great silvicultural improvement generally but it has put the seedlings in direct contact with the weevils in the site.

SOLUTIONS

Obviously one way around this problem is to postpone planting by 2 or 3 years, and this is still a realistic solution, however, given the advantages of early planting, we would like to find another way around this seedling debarking weevil problem. Our first priority is to generate a Hazard Rating. We have identified a number of components of hazard and collected much quantitative information, the analysis of which is just underway.

Some of the essential components are:

1. Damage is greater where there is a deep layer of moss or other organic litter. This is because the weevil requires a moist environment within centimeters of its food source if it is to exploit that food source. Highly scarified areas with exposed mineral soil or dry sites with poor bryophyte development and small amounts of litter usually have little damage.
2. Areas treated silviculturally with a complete burn suffer little damage, as would follow from above.
3. Damage is greater where there are few naturally occurring seedlings of either hardwoods or softwood or even shrubs and herbs on the plantation site.
   As the weevils are polyphagous (they eat everything), the more plant material that is growing alongside the planted seedlings the less likely it is that the seedlings themselves will be damaged.
4. Small sites are at greater risk than large cutovers as weevils invading a site will be more concentrated. More insects per m2 translate into more damage.
5. Weevil numbers and thus damage will be greatest where there have been a series of cut-overs on succeeding years in the same general area, allowing a population build-up.

This understanding of the problem, when quantified to some extent will allow us to evaluate the potential of a site to suffer damage and will suggest a means of avoiding such damage.

Some of the control work underway to date has been:

(1) Chemical - working with the Scott Paper Company out of their Springhill Nursery we tested three chemicals, Furadan (carbofuran), Lorsban (chlorpyrifos) and Diazinon applying them in a nursery setting to simplify the application procedures and to substantially alleviate environmental concerns. Treated seedlings were planted in regularly scheduled sites in an appropriate scientific design. While we could demonstrate that treatments could kill weevils, significant damage still occurred. This was not really surprising as the target pest is active from early spring until fall for two full seasons. Further, immigration into the site may take place over much of the field season. More work is planned for 1987. FPMI is currently screening pesticides for future trials.

(2) Biological - Nematode investigation through Jean Finney of Memorial University. Lab screening program only.

(3) Pheromone chemistry/behavior. On the recommendation of the NSFRAC a one-year research contract was awarded to the Research and Productivity Council for 1986-1987 to develop a trap bait and monitoring system. A sensitive and accurate monitoring system

is essential for any control operation and the possibility exists, to adjust this technology to actual control of the pest. The ability to monitor is also important in rating the hazard of a site.

Good progress has been made by RPC on the development of a weevil trap through RPC's electro-antennagram studies of weevil responses to various tree-host volatiles and the production of a proto-type trap.

(4) Physical Barriers - Swedish development of the plant stocking.
- 1986 trials successful, about 99% of seedlings undamaged.
- double planting times and will add a cost of $0.06 per tree.

(5) Site Preparation: Another area of control under investigation is site preparation. While it may be our site preparation methods which have partly lead us into this problem, they may provide a solution in some instances. We're investigating site preparation initially, through a survey of existing damage in light of site preparation techniques. It is possible that we may initiate some trials in 1987.

THE STATUS OF SCLERODERRIS CANKER IN NEWFOUNDLAND IN 1986

Hudak, J. and G.C. Carew

REPORT PREPARED FOR THE FOURTEENTH ANNUAL FOREST PEST CONTROL FORUM, OTTAWA, 18-20 NOVEMBER 1986.

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THE STATUS OF SCLERODERRIS CANKER IN NEWFOUNDLAND IN 1986

by

Hudak, J. and G.C. Carew

Scleroderris canker was first recorded in Newfoundland in 1979 on five ornamental Austrian pine trees near St. John's. In 1980 and 1981 several new infections were found on ornamental pines throughout the city. In cooperation with Agriculture Canada, these trees were pruned or cut and burnt in an effort to eradicate the disease. An Island-wide intensive survey did not detect the disease outside of the St. John's area and the Provincial Department of Forest Resources and Lands established a quarantine area in 1980 (Fig. 1). A severe outbreak of the disease occurred in 1981 in a 2 ha experimental red pine plantation near Torbay in the vicinity of St. John's. Disease development was extremely rapid and nearly all trees, about 6000, in the plantation showed severe reddening throughout their crowns. All trees were cut and burnt in the fall of 1981 in an effort to eradicate the disease. Regular inspection of the area since 1981 showed no infection of any other adjacent tree species which include planted Sitka spruce, Norway spruce, and natural regeneration of black spruce and balsam fir. In 1982 the disease was found on ornamental Scots pine, Jack pine and red pine on the Salmonier Line, about 30 km west of St. John's. This was the first record of the disease outside the quarantine area. The trees were cut and burnt. The disease recurred on other trees in 1984 and these were cut and burnt. Subsequent inspections showed no new infections in the area.

A branch sample taken in late 1985 from a Sitka spruce grown in an experimental plantation near Roddickton was confirmed in early 1986 to be damaged by Scleroderris canker. In 1969 and 1970 eight other plantations were also established throughout the Island using the same stock of seedlings imported from New Brunswick (Fig. 1). The examination of these plantations in 1986 showed various amounts of old mortality, recent branch dieback and topkill. The development of these symptoms appeared to be very gradual. Branch samples were taken from these plantations for cultural identification of the disease and subsequent determination of its race.

Cultures obtained from the Sitka spruce plantation near Roddickton and all other previous Scleroderris isolates in Newfounldand were serologically diagnosed as the European race. Culturing of samples from the other eight Sitka spruce plantations are in progress. Following the results of the culturing, the damaged trees will be pruned or cut and burnt.

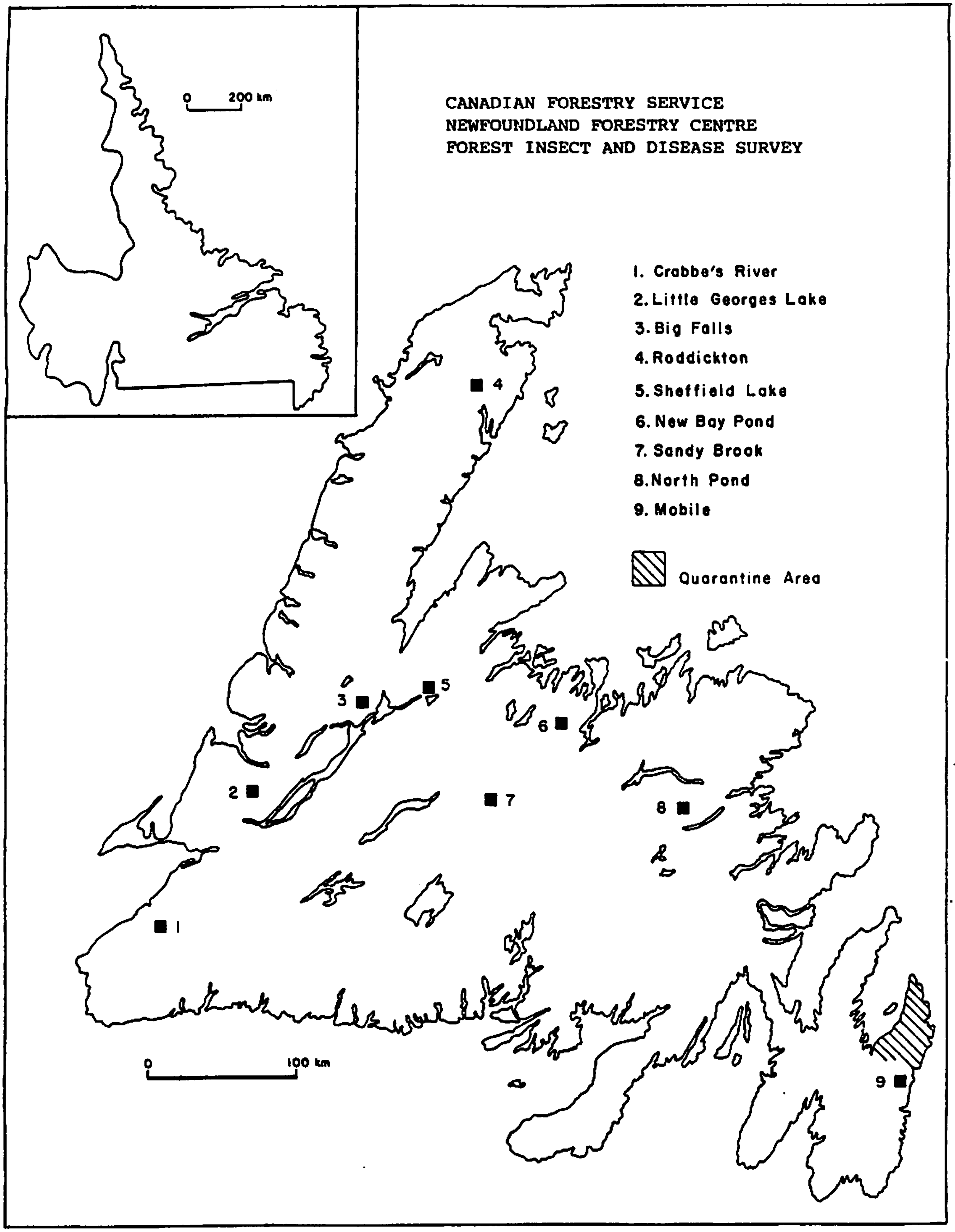

Figure 1. Locations of Scleroderris canker quarantine area and the Sitka spruce experimental plantations.

Forestry Forum Report November 18 -19, 1986.

1. Pesticides Directorate: New address as of December 15, 1985.
SBI Building, 2nd Floor
Billings Bridge Plaza
2323 Riverside Drive
Ottawa, Ontario K1A0C6
613-993-4544

2. Management Change: Wayne Ormrod = new DG
Janet Taylor = Director of Product Management
Frank Cedar = Director of Information Secretariate
Jean Hollebone = Director of Policy & Planning

3. Call Line: 1-800-267-6315, 3 persons, operational from May to present
- 3271 calls to end of October
- 3% were from forestry sector
- approximately 10-12% of calls could be classed in the forest/tree/environmental category depending on pest/use season.

4. New Registrations/Uses: In a letter of February 10, 1986, the major registrants of BT products were contacted and invited to add 'Aerial Application Urban Areas' to their labels as a restricted use.
At the same time, full registration of Jackpine Budworm use at 30 BIU's/ha was approved/offered.
Companies were also invited to update/expand their product labels to include additional pests (previously registered), specific use areas, and equipment, rates and directions for ground application.

- Temp Registration of BT for Eastern Hemlock Looper @ 2.41/ha was renewed on two Abbott products (Dipel 88 & 132).

- The US TM Biocontrol-1 product for Douglas Fir Tussock Moth was given temporary registration for 1986 #19293.

- Sevin XLR Plus #17027 was registered for Gypsy Moth control.

5. Guidelines: - Guidelines for the Registration of Microbial/Biological Pesticides was finally translated and has been released as an R-Memo (R-1-229). Comments are requested by January 30, 1987. This is a first draft.

- Environmental Chemistry and Fate Guidelines which were released as R-1-222 are being revised and should be available by the end of February 1987.

6. Pesticide Information: Negotiations are continuing in order to have pesticide information available through the CISTI (Canada Institute of Scientific and Technological Information) system It is hoped that the MOU will be finalized in 1987. This would make available information re: product name, registrant, product classification, guarantee, active ingredients, pests and sites (but not site/pest info).

W.E. Stewart,
Evaluation Officer
Pesticides Directorate
November 18, 1986.

Guidelines for the Registration
of Naturally Occurring Microbial/
Biological Pesticides in Canada

Guide d'homologation
des pesticides microbiens naturels et
biologiques au Canada

S.W.Ormrod
Pesticides Directorate

GUIDELINES FOR REGISTRATION

OF

NATURALLY OCCURRING MICROBIAL/BIOLOGICAL

PESTICIDES IN CANADA

S.W. ORMROD

TABLE OF CONTENTS

Part 1. INTRODUCTION:

1.0 General:

Guidelines for the type of data required for the registration of microbial pesticides in Canada are presented here. The guidelines apply to all microbial pest control agents used as pesticides, including bacteria, fungi, viruses and protozoans that are naturally occurring as well as those that are strain-improved and their (by)products or metabolites from the manufacturing process unless separated. These guidelines do not apply to biochemical* pest control agents nor to genetically engineered or modified organisms. These latter groups will be addressed in a separate memorandum.

The guidelines have been prepared taking into consideration those of the Environmental Protection Agency (EPA), the United Kingdom (UK), and the World Health Organization (WHO). The guidelines mentioned above are referenced in Appendix I. Although the Canadian requirements are similar to those of the EPA, some additional requirements are included that pertain specifically to Canadian conditions. For example, field studies and efficacy done in Canada relative to desired Canadian use patterns are mandatory.

Because of the many variables involved for each microbial, these guidelines are not meant to be inflexible but to identify the basic types of data that are necessary for the evaluation of living and complex biological organisms. Each submission will be considered on an individual basis since specific requirements may vary. The specific test requirements and protocols are likely to change as more research is conducted and the corresponding knowledge and understanding of biological organisms increases.

In general, reference can be made to EPA Guidelines for guidance in experimental design. References to some of the standard scientifically recognized protocols for tests are presented in Appendix I. As mentioned above, flexibility with respect to individual protocols is desirable because of changing technology and individual variations regarding test requirements of various organisms. Therefore, it is recommended that individual study protocols be submitted by the registrant for comments and discussion before actual testing is undertaken.

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*Biochemical Agents: are naturally occurring chemicals (or identical synthetic chemicals) that are isolated or derived from natural biological sources - e.g., pheromones, plant growth regulators, insect growth regulators.

It is important to note that the numbering system and organization of these guidelines follows the system established by the Pesticides Directorate for pesticides as presented in Trade Memoranda T-1-237-240. Not all (numerical) sections of the established pesticide guidelines are applicable to the biologicals; therefore, some (numerical) sections have been omitted.

The tests required to evaluate the safety and impact of a microorganism to humans, the environment and non-target organisms are arranged in a multi-level, tier system. For many organisms and uses, if initial testing of the agent at Tier 1 shows no evidence of hazard(s), further testing is not necessary. However, if any individual positive results are found within Tier 1, the appropriate follow-up tests from Tier 2 will be required, with the possibility of progression to an additional higher Tier. A single positive result does not indicate the need for all the advanced tier tests, but only progression to the appropriate tests in those tiers.

Microbials intended for use on food crops will automatically be subject to more complex test requirements.*

Results from laboratory and field studies will be evaluated by the Pesticide Directorate and our advisors in the Environmental Health Directorate, Food Directorate, Environmental Protection Service, Canadian Wildlife Service, and Fisheries and Oceans Canada, to determine if further tests are necessary based on assessment of use pattern and fate. By following these guidelines, data provided should be sufficient to allow this evaluation. Evaluation will follow the philosophy stated by OECD in discussing this aspect: "Scientific judgment rather than rigid criteria should be exercised in accepting or rejecting (certain) test results."

1.1 Microbial Control Agent Criteria:

The following criteria should be met by any candidate for a microbial control agent:

- selectivity for the specific pest organism
- absence of any adverse effect on man
- absence of any adverse effect on domestic animals, fish, wildlife and non-target insects or desirable plants.

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* Consult with Food Directorate, Health and Welfare Canada.

- limitation of influence, e.g., never completely eliminating a target plant or animal species.
- absence of any detrimental effects on water quality
- lack of accumulation in non-target organisms
- ease of production
- ease of dissemination
- self-maintaining when established
- effectiveness under the environmental conditions of the intended use locations
- simplicity of assay for its presence in small amounts, both quantitatively and qualitatively

Part 2: (CHEMISTRY) REQUIREMENTS FOR SAMPLES, SPECIFICATIONS AND ANALYTICAL METHODOLOGY

2.0 Samples:

Pursuant to Section 11 of the Pest Control Products Regulations, samples of the technical grade of the active ingredient (purest form) and formulated product, may be requested of registrants. Refer to T-1-238 for details of samples sizes, etc.

Specifications:

2.1 Basic Manufacturer's Name and Address
2.2 Date of Specifications
2.3 Trade Name
2.4 Common, Alternative and Superceded Names
2.11 Name and Address of Manufacturing Plant

2.12 Manufacturing Methods:

A complete description of the manufacturing process is required with starting and intermediate materials (if any) and the steps taken to assure the integrity of these materials, and to limit any-extraneous contamination, both chemical and biological. A process flow diagram, quantities or ratios, temperatures, pH, etc., may be required to gain a deeper understanding of the process.

Detailed description of the process used to establish the identity and purity of the culture from which the active ingredient is produced, the method of manufacture, and techniques used to assure uniform or standardized product.

2.13 Specifications on Technical Grade of Active Ingredient (AI) (Purest Form):

- Taxonomic position, serotype composition and strain (bacteria, fungi, protozoans)
- Natural occurrence and geographic distribution of the microbial agent.
- Any relationship to a known human, mammalian or plant pathogen.
- Biological properties of the active ingredient with respect to target species, pest host range, life cycle, and mode of action (in the target species), temperature growth dependence, susceptibility to antibiotics.
- Description of any unusual morphological, biochemical or resistance characteristic of the organism if different from the classic description of the organism.
- Any potential hazard (e.g., infectivity, toxins or metabolic (by) products) to man, the environment or non-target species.
- Certification of Ingredient Limits: The confidence limits of potency as well as the guaranteed amount of active ingredient in the product should be expressed in recognized terms such as international units of potency per milligram, % of weight, units of viability or replication, or other expression of biological activity.

2.14 Quality Control Method:

Information should be provided on time and frequency of sampling. A series of typical results should be submitted plus current methods used for quality control. The integrity of the active ingredient as determined by the most specific and sensitive chemical or serological test must be demonstrated. If the test is not a recognized standard test, a detailed description of the test and information regarding specificity, interfering substances, accuracy, and sensitivity must be provided.

2.15 Analytical Data and Methodology:

A detailed methodology for the analysis of samples is required. For example, a quantitative serological test of the microbial agent would be submitted in place of the standard "chemical analysis".

A. Technical Material:

Precise test procedures and criteria for identification (morphological, biochemical, analytical [physical, chemical], serological or other means) of the active ingredient(s) and of all impurities which exceed 0.1% by weight must be provided.

Impurities or Extraneous Materials:

Details of procedures used to assure the exclusion of impurities (e.g., bacterial and fungal toxins, allergens, and other metabolic products, mutant strains, microbial contaminants especially potentially infective or antagonistic forms, by-products from chemical reactions in the manufacturing process, fermentation residues of the growth of bacteria or fungi, extraneous host residues for viruses produced in cell cultures, whole animals, or other living forms, residues of contaminants remaining following purification or extraction processes, and impurities in chemicals used in the manufacturing process) must be presented. If purity cannot be achieved, then the means of controlling the contaminants to some acceptable limit must be detailed.

If substances known to be hazardous to humans or other non-target mammalian species are known or suspected to be present at some stage of the manufacturing process, they must be identified chemically or biologically. Assurances (by assay) must be submitted to show that the substances do not occur in the final product.

B. Formulated Products:

Product Identity: The percentage composition of each ingredient in the formulated product, including purpose and identity is required. The basic manufacturer's name and address must be indicated for each ingredient in the formulation.

2.16 Summary of Physical and Chemical Properties (Technical):

Colour
Physical State
Odour
Density, bulk denisty or Specific Gravity
Stability
Storage Stability
Viscosity
Miscibility
Corrosion Character
(Oxidizing or reducing action)

Part 3 TOXICOLOGY

Tier 1 testing requirements are summarized in Table 1. A general progression through Tier 2 and 3 testing requirements based on individual positive results from Tier 1 are being drafted and will be presented in the near future.

3.0 General:

Preliminary data are a necessary prerequisite before Tier 1 testing is undertaken. This includes the accurate identification and characterization of the agent as well as the characterization and identification of any toxins or metabolic (by)products.

Maintenance of the identity and purity of the seed stock from which the technical grade of the active ingredient is required. State-of-the-art quality control testing is necessary to ensure the maintenance of pure cultures, and to guard against contamination with other microorganisms, or the formation of a mutant. Each lot of product must be tested to assure its accurate identification and to show that it corresponds to the seed stock. The most valid and precise technique available for identification of the strain and species should be employed. The final technical grade and formulated product must be in the same form as that which was safety tested.

Table 1 is a summary of tests proposed for individual organisms at Tier 1 level. No specific protocols have been included. It is recommended that registrants consult with the Pesticides Directorate and Health and Welfare before tests are carried out to ensure that the most precise, valid and currently acceptable "state-of-the-art" study designs are used.

Specific Concerns:

3.1 Toxicity

Toxic potential is primarily associated with the toxins or metabolic (by)products which may be involved in the mode of action on the host. The toxic potential also exists of cell components of organisms killed and lysed within a living system. Such products could also prove toxic to humans and/or mammals and so acute toxicity testing is proposed using both the technical grade and formulated product. Expected and possible routes of exposure should be chosen for dosing (oral, dermal, inhalation) with a maximum challenge of inoculum. This uses the highest possible dose of viable organisms which usually represents the largest quantity of technical grade material that can be handled or administered. Doses will likely vary between agents. These tests are usually combined with an assessment of infectivity (see below).

Irritation

The pathogens per se, (by)products from the production medium, residues from the medium, (by)products and toxins from the microorganism, contaminants or formulation ingredients could all possibly act as irritants. Ocular and dermal irritation studies are therefore required on both the technical grade and formulated product.

3.1.10 A. Infectivity

Microorganisms are replicating agents and as such can injure mammalian tissues by multiplication or persistance within them. This can be manifested by overt clinical disease (acute, subacute or chronic), a latent infection which could be activitated at any time, the "carrier" state, or an asymptomatic infection. Infectivity studies are therefore to be considered an essential part of the data base for evaluation of biological pesticides. Toxic effects on mammalian systems are rarely encountered, and very rarely, would acute toxicity be a limiting factor. Tier 1 infectivity/toxicity tests can therefore be designed to use maximum challenge doses. At the start of the study, the organisms to be used must be shown to be viable and therefore to have infectivity potential. Test animals are inoculated via the expected and possible routes of infection (oral, dermal, inhalation). These studies are normally combined with an assessment of toxicity. The technical grade and formulated product are to be tested in these studies. Unusual routes of exposure, to test infectivity only, are also chosen, maximizing the possibility of producing an infection. These studies only require that the technical grade be tested. Half of the animals in these tests are to be immunosuppressed. Most studies of this nature use athymic (bald) mice.

Maximum challenge doses allow a maximum opportunity for the microorganism to infect, invade or persist within the test animals. Since this a "worst possible" situation, agents which yield negative results at Tier 1 do not require further testing. Any positive result necessitates further testing in Tier 2. Effects may then be quantified to assess more accurately the possible risk of deleterious effects upon exposure to the agent, and at what exposure levels.

Tier 1 studies are to include observations which would detect the spread, persistence and possible replication of the organism within the tissues of the test animal, or the rate of its elimination from the tissues. It is recommended that these studies are of at least 28 days duration, and that animals be serially sacrificed and examined over this time period.

B. Immune Response

These studies are designed to determine whether the biological pesticide has any effect on the immune system, i.e., by either suppressing or activating certain immune responses. Many immunological assays are available to measure these effects. A suggested battery of tests is listed in Table 1; other tests may be acceptable, especially since rapid advances are being made in the field.

C. Hypersensitivity

Since all microorganisms contain proteins, all are potential allergens and require delayed hypersensitivity testing. Data on hypersensitivity and irritancy reactions in humans exposed during manufacture of the product should be reported.

D. Tissue Culture

Studies using tissue cultures are a sensitive method for testing the capacity of a virus to infect and interact with cells of non-target species. An advantage is the ability to use human cell lines in the test cultures. Viruses are considered the most likely of the organisms to be carcinogenic. Certain families are known to be related to tumour development. In this respect, tissue culture testing for the incorporation of viral nucleic acid into different cell types may be useful as a preliminary indicator of the oncogenic potential.

Additional Tests:

Additional testing is required if an organism produces a toxin or metabolic (by) product which will be a part of the final product. Evidence to date indicates that toxins and metabolic (by) products fail to accumulate or persist in mammals and suggests that long-term and cumulative exposure hazards may be minimal. However, not many data are available on the fate of entomocidal organisms in mammals, most such data being circumstantial. It is proposed, therefore, that toxins undergo a battery of tests to measure genotoxic potential. These tests serve as an indicator of the carcinogenic potential of these products. If the toxin is related to a chemical or toxin which is already known to be carcinogenic, additional long-term oncogenic testing may be required.

Part 5 RESIDUE STUDIES:

5.1 General:

Residue data are required when a microbial pest control product is intended for use on food, feed or tobacco. Much of the data on residues will be obtained with formulated products and includes information on:

5.2 - analytical methodology (food crops and tobacco)
5.3 - crop residue data
5.5 - livestock, poultry, egg and milk residue data (from feeding of treated crops)
5.6 - residue data for crops used as livestock feed
5.7 - tobacco residue data
5.8 - freezer stability tests

Use of a microbial agent on food requires the establishment of residue limits or an exemption from the requirement for a residue limit under the Food and Drug Act and Regulations.

Special Points of Consideration Regarding Residue Limits:

- efficacy of an organism often depends on its ability to replicate in the target pest which is not likely to remain on the crop after harvest.
- living form of the organism usually will not replicate in absence of the specific target pest.
- time of application of the organism as a control agent is not close to the harvest date of the crop.
- environmental conditions such as sunlight (and UV), rainfall, wind, humidity, and temperature often greatly reduce the viability of the organism, therefore, the residues are likely to be reduced or become relatively insignificant soon after application.
- when toxicology data indicate the organism would not likely pose a hazard to humans or other mammals.
- when the organism is already normally present in the environment and has demonstrated no adverse effects. In some cases, it may be impossible to distinguish between natural and introduced microbial populations.
- residues of an organism may be rendered nonviable or be removed by the usual processing of such foods and feeds (i.e., washing, drying, heat sterilization, and additions of sugar, salt, and other preservatives).

Part 6 ENVIRONMENTAL EXPRESSION

Environmental expression is concerned with:

a) the growth characteristics of the test microbial agent.
b) the ability of the microbial agent to propagate and become established in a new niche or host after it has been introduced.

6.2 a) Physiological/Physiochemical Properties and Growth characteristics include information on:

- pH, temperature and oxygen requirements
- optimum growth
- ranges for survival and growth

- essential nutrients for growth:
- carbon source (CO_2, carbonate, other)
- minerals
- organic compounds
- nitrogen source (amino acids)

- potential for autotrophic growth
- potential for survival as a saprophyte
- growth response to variations in salinity
- response to known antagonists:
  - chemical
  - biological
  - other

- serological comparison with known pathogens (for identification and/or environmental marker(s)).
- biochemical characteristics unique to the organism
- morphological variation in response to adverse conditions:
  - humidity
  - inorganic or organic content of water
  - salinity

6.2 b) Laboratory Studies:

Tests in the laboratory are intended to determine survival, persistence, mobility and replication of a microbial agent in various environments (terrestrial, freshwater, marine or estuarine) thereby indicating potential exposure to non-target organisms. Growth of the organism should be determined when it is introduced into a new niche as well as evaluation of its growth pattern when the population in its normal niche is increased.

Initial testing with the microbial agent should consist of simulated trials in the laboratory, greenhouse, and in aquaria to assess fate in soil, vegetation, leaf litter, water and sediment for both terrestrial and aquatic applications.

In tests to determine effects on the survival and growth of a microbial agent population, including overwintering, parameters such as the following, should be varied:

(i) Terrestrial: temperature, humidity, soil moisture, oxygen content, precipitation (amount, frequency, pH), sunlight, pH (soil and foliar surfaces), nutrients (soil, vegetation).
(ii) Freshwater: temperature, pH, nutrients, sunlight, oxygen content, hardness, turbulence.
(iii) Marine or Estuarine: temperature, pH, nutrients, salinity, sunlight, oxygen, turbulence.

See Table 2.
See Appendix II.

6.5 <u>Field Studies</u>:

Field studies are required to confirm that the results relating to environmental expression obtained in the laboratory will be realized under the ambient conditions of the natural environment. Environmental fate of the microbial agent in the field must be assessed under Canadian conditions in the major areas of intended use. The objective of these field studies is to address aspects such as:

- persistence (survival, replication, population growth and subsidence to naturally occurring levels) in both the terrestrial and aquatic environments.
- mobility

Following the completion of <u>all</u> laboratory studies, the initial field trials are to be small plot studies. Progression to further testing on an operational scale may be required.

See Table 2.
See Appendix II.

6.4 <u>Storage, Disposal and Decontamination</u>

Supporting scientific information on the appropriate storage conditions, on disposal procedures for emptied containers and unused, unwanted product, and on detoxificiation or neutralization methods and procedures, for the product(s) concerned is to be provided.

Part 7 ENVIRONMENTAL TOXICOLOGY

7.0 Introduction:

Concern exists regarding the introduction of large numbers of microbial agents into the environment at a specific time. The potential for spread of the microbial agent over living and non living components of the target site, as well as adjacent areas (drift), could result in exposure of greater numbers of non-target organisms than under natural conditions. Unlike conventional pesticides, the environmental levels of microbial agents and any related toxins may increase when the product is effective. Following an application, target insect hosts would likely contain the highest concentrations of the control agent and these would be available to non-target organisms via feeding. Pathogenicity and toxicity effects are the major concerns regarding terrestrial and aquatic non-target organisms.

7.1 Terrestrial Wildlife:

An avian single-dose oral toxicity and pathogenicity test and an avian injection pathogenicity test will be required for all organisms. A test duration of 30 days is required to provide time for incubation, infection, and manifestation of pathogenic effects. Immature animals are potentially more susceptible to infection and possibly to the effects of any toxin produced by the control organism. Therefore, animals should be exposed to the most infectious or toxic form of the test organism. Young bobwhite quail or mallard ducks between 10 and 17 days of age at the beginning of the test period should be used in tests. Theoretically there is a potential for microbial pesticides to disrupt the function of rumen bacteria. Tests on wild ruminant animals may be required if effects are reported in domestic animals.

See Table Number 3.

7.2 Aquatic Animals:

Little distinction should be made between terrestrial and aquatic use patterns regarding potential effects on aquatic animals since a terrestrial use may also have an effect on an aquatic system through drift and runoff/leaching.

In those cases where the use patterns are likely to impact freshwater aquatic systems the tests are to include one cold water fish species (e.g., trout), and one warm water fish species (e.g., bluegill). In the case of those use patterns likely to impact estuarine or marine waters, the tests should also include one estuarine or marine fish species; and two aquatic invertebrate species, one of which is to be *Daphnia magna*.

The microbial agent should be administered: a) as a suspension in the water (aqueous exposure); b) in the diet in the form of diseased host insects or treated feed; c) by injection; or d) preferably as a combination of all three routes of exposure, to ensure that the susceptible route of exposure has been tested and that the non-target test animal has received the maximum possible challenge.

Following exposure, observation should extend for at least 30 days and the cause of any deaths (toxicity vs. pathogenicity) should be determined.

The rainbow trout should be used as one of the freshwater fish test species because: it is a good indicator species in terms of sensitivity to chemical toxicants; it is partially insectivorous; there is considerable background data on this species pertaining to its diseases; and, standard tissue culture procedures are available for it.

See Table Number 4.

7.3 Non Target Invertebrates:

Determination of the host range is an important factor since most microbials will work through pathogenicity. The majority of microbial control agents will be insecticides and therefore, specifically selected and/or designed for their ability to control pest insects. As such, non-target insects closely associated with the target organism would be at risk. Difficulties arise in attempting to extrapolate across species lines, therefore, testing with representatives from a number of "beneficial insect"* taxa will be necessary.

Basic testing will involve assessing toxicity and pathogenicity of the microbial agent to earthworms and to the honey bee and three species of predaceous and parasitic insects. Predator and parasite test species selected should be representative of groups which will be exposed under the conditions of proposed use and which have some important relationship with the target pest.

See Table Number 5.

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* There are very few non-target insects whose importance to man can be measured economically.

7.4 Non-Target Plants:

In cases where a microbial agent is used in an area where it does not occur naturally, tests would be required to determine any phytotoxic effects. Where persistence occurs due to sporulation, detrimental effects of the viable spores and their products would need to be investigated.
See Table Number 6.

Part 8 Efficacy

Efficacy data, both laboratory and field trials, are required for each pesticide product. Final tests to support the effectiveness of a product must be conducted with the formulation proposed for registration and the commercial market.

Canadian field and operational efficacy data at proposed label use rates are mandatory to support a registration. Data from other countries may be used to supplement Canadian trials.

TABLE 1. TOXICOLOGY DATA REQUIREMENTS TIER 1 (PART 3)

I. Type of Test/Route of Administration	Species	B	V	F	P
Acute Toxicity[1]					
3.1.2 Oral	Rat (other species may be acceptable)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.3 Dermal	Rat (other species may be acceptable)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.3 Inhalation	Rat (other species may be acceptable)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.5 Eye Irritation	Rabbit	AI,FP	AI,FP	AI,FP	AI,FP
3.1.6 Dermal Irritation	Guinea Pig or Rabbit	AI,FP	AI,FP	AI,FP	AI,FP
3.1.10 A) Infectivity[1]	(half of test animals to be immunosuppressed)				
a) Intravenous	Newly weaned mouse and hamster	AI	AI		
b) Intraperitoneal	Rat or mouse, and rabbit				AI
c) Intraperitoneal	Rat or mouse and rabbit			AI	
Intracerebral[2]	Newborn mouse or hamster		AI		
Intracerebral[2]	Rat or mouse, and rabbit				AI
B) Cellular Immune Response[3]					
a) Blood Cell Count	Mouse	AI	AI	AI	AI
b) Leucocyte response (T and B cells)	Mouse	AI	AI	AI	AI
c) Total Leucocyte Number (T&B cell ratios)	Mouse	AI	AI	AI	AI

TABLE 1 (cont'd)

I. Type of Test/Route of Administration	Species	B	V	F	P
(3.1.10 cont'd)					
d) Macrophage Cell Number & Function	Mouse	AI	AI	AI	AI
e) Serum Protein Determination	Mouse	AI	AI	AI	AI
C) Hypsensitivity Delayed	Guinea pig or hamster	AI,FP	AI,FP	AI,FP	AI,FP
D) Tissue Culture					
a) Gross morphological changes (cytophatic effects) (CPE)	Various cell lines[4]		AI		
b) Inhibition of cell division	Various cell lines		AI		
c) Bioassay of culture fluid	Various cell lines		AI		
d) Assay for decay of input virus and potential appearance of viral protein and nucleic acid	Various cell lines		AI		

AI - ACTIVE INGREDIENT (purest form)
FP - FORMULATED PRODUCT
B - BACTERIA
V - VIRUS
F - FUNGI
P - PROTOZOA

TABLE 1 (cont'd)

1 - highest possible dose of organisms

2 - intracerebral testing required for Tier I only when organism is neurotrophic in the host or is related to a neurotrophic agent.

3 - these studies are suggestions; due to rapid advances in immunology testing, tests protocols should be submitted or discussed before testing to ensure the most up-to-date, valid and precise techniques are used.

4 - human line e.g., W138; human primary cell type, e.g., foreskin; one human continuous line, e.g., HeLa; one primate continous line, e.g., monkey CV-1 or BSC-1; mouse 3T3 cells.

Additional Information:

- Growth at mammalian body temperature; in vitro 34-37°C
- Extraneous life forms in typical product
- Susceptibility to anticibiotics.

II. Additional test requirements for organisms which produce toxins or metabolic by-products which will be present in the final product.

1. Genotoxic potential, testing of the isolated toxin is preferred:

   a) Ames test (bacterial assay)

   b) Mammalian cell point mutation assay, "in vitro"

   c) Prophage induction assay in lysogenic bacteria

   d) Mammalian in vitro cytogenetic assay

   e) DNA damage/repair assay or assay for mitotic recombination

2. An oncogenicity bioassay may be required if the toxin or metabolic (by) product under question is structurally related to a recognized carcinogen.

TABLE 2. Environmental Expression Testing[1] (PART 6)

Type of Test	B	V	F	P
Tier 1:				
6.2 Lab Studies				
- soil	AI	AI	AI	AI
- vegetation	AI	AI	AI	AI
- leaf litter	AI	AI	AI	AI
- water	AI	AI	AI	AI
- freshwater				
- marine				
- estuarine (brackish)				
6.3 Field Studies 2,3				
- small plot and actual field testing (environmental compartments correspond to those for the lab studies)	FP	FP	FP	FP

1. Environmental expression refers to the fate (persistence and mobility - see text for Sections 6.2 and 6.3) of the microbial agent in the environment.

2. The environmental compartments in which the studies are to be conducted are determined by the use pattern and hence the compartments likely to be impacted. For example, a foliage application could involve studies on vegetation, soil, leaf litter and water, whereas an application directly to bare soil could involve only soil and water (runoff and leaching).

3. Field studies are to be conducted only as the final stage of <u>all</u> testing - see text for Section 6.3

TABLE 3. Terrestrial Wildlife Testing (PART 7.1)

Type of Test	Species	B	V	F	P
Tier 1:					
7.1.2 Avian Oral LD50	(Mallard or Bobwhite Quail, 10-17 days old)	AI	AI	AI	AI
Avian Injection Pathogenicity	(Mallard or Bobwhite Quail, 10-17 days old)	AI	AI	AI	AI
Tier 2:					
7.1.3 Avian Dietary Oral LC_{50} (infected insects)	(Mallards or Quail)	AI	AI	AI	AI
7.1.4 Long Term Avian Pathogenicity and Reproduction Test	(Mallard, Quail)	AI	AI	AI	AI

TABLE 4. Aquatic Organism Testing (PART 7.2)

Type of Test	Species	B	V	F	P
Tier 1:					
7.2.2 Acute Toxicology					
a) Freshwater:					
Acute LC_{50} [1]	(Rainbow Trout, Blue Gill Sunfish)[2]	AI,FP	AI,FP	AI,FP	AI,FP
Acute LC_{50} [1]	(Daphnia magna + 1 other invertebrate species)	AI,FP	AI,FP	AI,FP	AI,FP
b) Marine or Estuarine	(1 Marine or Estuarine fish, & 1 Invertebrate)[2]	AI,FP	AI,FP	AI,FP	AI,FP
Acute LC_{50}	(Rainbow Trout)[2]	AI,FP	AI,FP	AI,FP	AI,FP
Acute LC_{50}	(Daphnia magna)	AI,FP	AI,FP	AI,FP	AI,FP
c) Tissue Culture - Inhibition of cell division - RNA, DNA protein synthesis	Cell Lines: e.g., Fathead Minnow, Trout (RT6-2)	AI	AI	AI	AI
Tier 2					
7.2.3 Chronic Oral LC_{50} [3]	(Rainbow Trout)	AI	AI	AI	AI
7.2.4 Aquatic Animal Pathogenicity	(Each Group: 1 or more species)	AI	AI	AI	AI
Fish & Invertebrate Life Cycles	(Each Group: 1 or more species)	AI	AI	AI	AI
Aquatic Organism/ Ecosystem Accumulation/ Pathogenicity	(variety of organisms)	AI	AI	AI	AI
7.2.4 Aquatic Field Studies		FP	FP	FP	FP

1 Methods of Administration: Aqueous, dietary, intraperitoneal (fish only) injection.
2 Both juvenile and adult life stages should be tested in separate experiments.
3 In addition to acute toxicity, chronic toxicity tests may be necessary e.g., both acute and chronic infections of fungi can occur in fish.

TABLE 5. Non Target Invertebrate Testing (PART 7.3)

Type of Test	Species	B	V	F	P
Tier 1:					
7.3.2 Insect predator toxicity and pathogenicity	3 species (one/group) from: (predaceous) hemiptera (predaceous) coleoptera (predaceous) mites (predaceous) neuroptera	AI	AI	AI	AI
7.3.3 Insect parasite toxicity and pathogenicity	(parasitic) hymenoptera)	AI	AI	AI	AI
7.3.4 Honey Bee toxicity and pathogenicity	(*Apis mellifera*)	AI	AI	AI	AI
7.3.5 Earthworm		AI	AI	AI	AI
Tier 2:					
7.3.8 Simulated or acutal field testing	(pollinators)	AI	AI	AI	AI

TABLE 6. Non Target Plant Studies (PART 7.4)

Type of Test	Species	B	V	F	P
Tier 1:[1]					
7.4.(i) Microbial used to Control Plants: Evaluation of effects re:	(5 species of same genus or of same family)[2]	AI	AI	AI	AI
7.4.2 - target area phytotoxicity - non target area phytotoxicity	(5 species of same genus or of same family)[2]	AI	AI	AI	AI
7.4.3 - growth and reproduction of vegetative vigor	" "	AI	AI	AI	AI
7.4.4 - growth and reproduction of aquatic plants	" "	AI	AI	AI	AI
7.4 (ii) Microbial used to control animals: Evaluation of effects re:	" "	AI	AI	AI	AI
7.4.2 - seed germination/seedling emergence	" "	AI	AI	AI	AI
7.4.3 - vegetative vigor	" "	AI	AI	AI	AI
7.4.4 - growth and reproduction of aquatic plants	" "	AI	AI	AI	AI
Tier 2					
7.5 Terrestrial field studies		FP	FP	FP	FP
7.6 Aquatic field studies		FP	FP	FP	FP

1. Tier I would be carried out in the laboratory, greenhouse and/or growth chamber

2. Species should be of economic importance e.g., horticultural, agronomic crops, vegetation useful to domestic or wild animals.

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Appendix II

Supplementary Information Re: Environmental Expression

Foliar application is generally associated with short-term control as it requires frequent application of quantities of the microbial agent larger than the endemic microbial population.

Soil application is associated with long-term control and requires introduction of an inoculum which can spread and persist independent of any host organism.

Special Considerations in Various Environments:

i) Terrestrial/Forest: offers a highly diversified ecosystem in which a microorganism can propogate and maintain a continuous population e.g., leaf litter, soil, water and foliage. The microbial agent may have the capacity to remain in the soil or litter for years. Physical factors such as wetting and drying may influence the dispersal of organisms. Foliar surfaces provide substrate which may affect the dislodging and survival of the organism.

ii) Freshwater: The organic and inorganic content of freshwater varies the most and may affect the fate of the microbial agent. Sediment may offer an excellent habitat for growth and propagation.

iii) Marine: Salinity may be a limiting factor in the fate of most pathogens in marine and estuarine environments. Microbial agents having the capability to remain near the surface of the water may be subjected to sunlight (UV) inactivation. Sediment is less important in marine than in estuarine environments.

iv) Brackish: Salinity and sunlight may be limiting factors as above. The relative importance of current and characteristics of the hydrosoil or sediment will depend on whether the agent is buoyant or its density carries it below the surface. The organic and inorganic content of the water will also affect the fate of the microbial agent (greater in freshwater).

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GUIDE D'HOMOLOGATION

DES

PESTICIDES MICROBIENS NATURELS

ET BIOLOGIQUES

AU CANADA

S.W. ORMROD

TABLE DES MATIÈRES

Partie 1. INTRODUCTION :

1.0 Généralités :

La présent guide porte sur le type de données exigées pour l'homologation des pesticides microbiens au Canada. Il s'applique à tous les agents microbiens utilisés comme pesticides, notamment les bactéries, les champignons, les virus et les protozoaires de souche naturelle ou de souche améliorée ainsi qu'à leurs produits et sous-produits ou métabolites non dissociés résultant des procédés de fabrication. Par contre, il ne s'applique pas aux agents biochimiques* ni aux organismes génétiquement manipulés ou modifiés qui feront l'objet d'une circulaire distincte.

Le présent guide s'inspire des lignes directrices qui ont été élaborées par l'Environmental Protection Agency (EPA), le Royaume-Uni et l'Organisation mondiale de la Santé. On trouvera les références bibliographiques pertinentes dans l'Annexe I. Bien que les exigences canadiennes soient semblables à celles de l'EPA, le guide contient des exigences supplémentaires propres au contexte canadien. Par exemple, des études sur le terrain et des essais d'efficacité en fonction des modes d'utilisation sont obligatoires au Canada.

Étant donnée les nombreuses variables dont il faut tenir compte pour chaque pesticide microbien, le guide ne vise pas à imposer des règles rigides, mais plutôt à déterminer les données de base qui sont nécessaires à l'évaluation des organismes vivants complexes. Chaque demande sera traitée individuellement étant donné que les exigences particulières peuvent varier dans chaque cas. Les exigences et les protocoles d'essais particuliers devraient vraisemblablement changer à mesure que la recherche progresse et que nos connaissances sur les organismes biologiques augmentent.

En général, les lignes directrices de l'EPA peuvent servir de guide pour la conception des expériences. L'Annexe I contient des renvois à certains protocoles d'essai normalisés, scientifiquement reconnus. Comme on l'a déjà indiqué, il est souhaitable de faire preuve de souplesse en ce qui concerne les protocoles individuels étant donné que la tecnologie évolue et que les exigences d'essai varient en fonction de chaque organisme. Par conséquent, il est recommandé aux demandes de présenter chaque protocole d'essai pour qu'une analyse en soit faite avant d'entreprendre l'essai.

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*Agents biochimiques : produits chimiques existant à l'état naturel (ou produits synthétiques identiques) qui sont isolés ou dérivés de sources biologiques naturelles, p. ex.: phéromones, régulateurs de croissance des plantes, régulateurs de croissance des insectes.

Il est importante de noter que la numérotation et la présentation du guide empruntent le système établi par la Direction des pesticides et présenté dans les Circulaires à la profession T-1-237-240. Comme toutes les sections (numériques) du guide sur les pesticides ne s'appliquent pas aux agents biologiques, certaines sections (numériques) ont été omises.

Les tests qu'il faut réaliser pour évaluer l'innocuité d'un microorganisme et ses répercussions sur les humains, l'environnement et les organismes non visés sont classés selon un système à niveaux multiples. Dans le cas de nombreux organismes et utilisations, si le pesticide testé ne présente aucun danger au Niveau 1, il n'est pas nécessaire de procéder à d'autres tests. Cependant, si on obtient un résultat positif individuel au Niveau 1, il sera nécessaire de procéder aux tests prévus pour le Niveau 2 et peut-être aux tests d'un niveau supérieur. L'obtention d'un seul résultat positif ne signifie pas qu'il faudra procéder à tous les tests prévus pour les niveaux suivants, mais seulement aux tests pertinents.

Les pesticides microbiens qui doivent être utilisés pour traiter d'autres culture vivrières doivent nécessairement répondre à des exigences d'essai plus complexes*.

Les résultats des études en laboratoire et sur le terrain seront évalués par la Direction des pesticides par les conseillers de la Direction de l'hygiène du milieu, de la Direction des aliments, du Service de la protection de l'environnement, du Service canadien de la faune, de Pêches et Océans Canada, afin de déterminer si d'autres tests doivent être effectués compte tenu du mode d'emploi prévu du pesticide et de son devenir. Si on suit les indications fournies dans le présent guide, les données obtenues devraient être suffisantes pour permettre cette évaluation qui sera faite conformément au principe adopté par l'OCDE, à savoir qu'il faut faire prevue de jugement scientifique et non pas s'en remettre exclusivement à des critères rigides pour accepter ou rejeter les résultats des tests.

1.1 Critères d'acceptation des agents microbiens utilisés comme pesticides

Tout agent microbien destiné à la lutte microbiologique doit satisfaire aux critères suivants:

- sélectivité à l'égard de l'organisme visé
- absence de tout effet nocif chez l'être humain
- absence de tout effet nofif chez les animaux domestiques, les poissons, les animaux sauvages, les insectes non visés ou les plantes utiles.
- limite de l'influence, c-à-d, n'entraîne jamais l'élimination complète d'une espèce végétale ou animale cible.

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* Consulter la Direction des aliments, Santé et Bien-être social Canada

- absence d'effets défavorables sur la qualité de l'eau
- non-accumulation dans les organismes non visés
- facilité de production
- facilité de dissémination
- capacité de se maintenir après implantation
- efficacité dans les conditions environnementales qui sont propres aux sites d'utilisation prévus
- simplicité des méthodes de détection (quantitatives et qualitatives) permettant de déceler l'agent lorsqu'il il est présent en petites quantités.

Partie 2: EXIGENCES (CHIMIQUES) EN CE QUI CONCERNE LES ECHANTILLONS, LES DONNES TECHNIQUES ET LES METHODES D'ANALYSE

2.0 Échantillons :

Conformément à l'article 11 du Règlement sur les produits antiparasitaires, le demandeur peut être appelé à fournir des échantillons de qualité technique de l'ingrédient actif (sous sa forme la plus pure) et du produit formulé. Se reporter au document T-1-238 pour obtenir des détails sur la taille des échantillons, etc.

Données techniques :

2.1 Nom et adresse du fabricant original
2.2 Date des spécifications
2.3 Nom commercial
2.4 Nom commun et autres noms connus
2.11 Nom et adresse de l'usine de fabrication

2.12 Méthodes de fabrication :

Il faut fournir une description complète de la méthode de fabrication pour les matériaux initiaux et intermédiaires (s'il y a lieu) et des mesures prises pour assurer l'intégrité de ces matériaux et pour limiter la contamination externe, chimique et biologique. Pour faciliter la compréhension du procédé utilisé, il peut être nécessaire de fournir un schéma du déroulement des opérations ainsi que des données concernant les quantités ou les proportions utilisées, les températures, le pH, etc.

Il faut fournir une description détaillée du procédé utilisé pour établir l'identité et la pureté de la culture servant à produire l'ingrédient actif, de la méthode de fabrication et des techniques utilisées pour que le produit soit uniforme et normalisé.

2.13 Spécifications de l'ingrédient actif (IA) technique (sous sa forme la plus pure)

- Position taxinomique, sérotype et souche (bactéries, champignons, protozoaires)
- Fréquence naturelle et répartition géographique de l'agent microbien.
- Tout lien pathogène avec un agent pathogène humain, mammalien ou végétal connu.
- Propriétés biologiques de l'ingrédient actif relativement aux espèces cibles, à la diversité des parasites hôtes possibles, au cycle vital et au mode d'action (chez les espèces cibles), à la relation température-croissance et à la sensibilité aux antibiotiques.
- Description de toute caractéristique morphologique, biochimique ou de résistance inhabituelle de l'organisme (si elle est différente de la description classique de l'organisme).
- Tout danger possible (p. ex. infectivité, toxines ou métabolites) pour l'être humain, l'environnement ou les espèces non visées.
- Certification des limites de l'ingrédient : les limites de confiance de la puissance ainsi que la quantité garantie de l'ingrédient actif dans le produit doivent être exprimées en unités reconnues telles que les unités internationales de puissance par milligramme, le pourcentage en poids, les unités de viabilité ou de multiplication ou autre expression de l'activité biologique.

2.14 Méthode de contrôle de la qualité

Il faut fournir des renseignements sur le moment et la fréquence de l'échantillonnage ainsi qu'une série de résultats typiques, et indiquer les méthodes courantes utilisées pour le contrôle de la qualité. Il faut démontrer l'intégrité de l'ingrédient actif en utilisant la méthode chimique ou sérologique la plus pertinente et la plus efficace. S'il ne s'agit pas d'une méthode normalisée reconnue, il faut fournir une description détaillée de la méthode utilisée ainsi que des renseignements sur la sélectivité, les substances perturbatrices, la justesse et la sensibilité de la méthode.

2.15 Données analytiques et méthodes d'analyse

Il faut fournir une description détaillée des méthodes d'analyse des échantillons. Par exemple, un test sérologique quantitatif de l'agent microbien viendrait remplacer "l'anlayse chimique" courante.

A. Produit de qualité technique :

Il faut fournir des précisions sur les méthodes d'essai et les critères d'identification (morphologique, biochimique, analytique [physique, chimique], sérologique et autres) de l'ingrédient actif et de toutes les impuretés dépassant 0,1 % en poids.

Impuretés ou matières étrangères :

Il faut fournir des détails sur les procédés utilisés pour assurer l'exclusion des impuretés (p. ex., toxines bactériennes et fongiques, allergènes, et autres produits métaboliques, souches mutantes, contaminants microbiens - en particulier, les formes potentiellement infectieuses et les antagonistes -, sous-produits dérivés de réactions chimiques au cours de la fabrication, résidus de fermentation résultant de la croissance des bactéries ou des champignons, résidus d'hôtes - dans le case des virus produis en culture cellulaire ou à partir d'animaux entiers ou d'autres formes vivantes -, résidus de contaminants après les étapes de purification ou d'extraction et impuretés contenues dans les substances chimiques utilisées dans la fabrication. Si la pureté est impossible à obtenir, il faut préciser les moyens utilisés pour que les contaminants ne dépassent pas une certaine concentration acceptable.

Si certaines substances reconnues comme dangereuse pour l'être humain et d'autres espèces mammaliennes non visées sont présentes ou susceptibles d'être présentes à une étape quelconque de la fabrication, elles doivent être identifées chimiquement ou biologiquement. Il faut fournir des garanties (résultats des tests) pour démontrer que ces substances ne sont pas présentes dans le produit final.

B. Produit formulé :

Identification du produit : il faut indiquer la composition en pourcentage de chaque ingrédient contenu dans le produit formulé, ainsi que le rôle et l'identité de chacun. Le nom et l'adresse du fabricant de chacun des ingrédients de base de la formulation doivent être indiqués.

2.16 Résumé des propriétés physiques et chimiques (qualité technique) :

Couleur
État physique
Odeur
Masse volumique, masse volumique apparente ou densité
Stabilité
Stabilité à l'entreposage
Viscosité
Miscibilité
Propriétés du point de vue de la corrosion (oxydation ou réduction)

Partie 3 TOXICOLOGIE

Les exigences en ce qui a trait aux tests du Niveau 1 sont résumées dans le tableau 1. Un document sur les tests qui seront exigés au Niveau 2 et au Niveau 3 en fonction des résultats positifs individuels obtenus au Niveau 1 est en voie de préparation et sera diffusé prochainement.

3.0 Généralités :

Avant d'entreprendre les tests du Niveau 1, il est indispensable d'obtenir des données préliminaires sur l'identité exacte et les caractéristiques de l'agent en question et de toute toxine ou tout métabolite qui pouraient être présents.

Il faut préserver l'identité et la pureté des cultures mères d'où provient l'ingrédient actif de qualité technique. Un contrôle de la qualité au moyen des méthodes les plus perfectionnées est nécessaire pour s'assurer que les cultures restent pures et pour déceler la contamination par d'autres microorganismes ou l'apparition d'un mutant. Il faut tester chaque lot de produit pour s'assurer de leur identification exacte et pour vérifier si le produit correspond à la culture mère. Il faut utiliser la technique la plus valide et la plus précise que l'on connaît pour identifier la souche et l'espèce. Le produit final, qu'il s'agisse du produit de qualité technique ou du produit formulé, doit se présenter sous la même forme que le produit utilisé au cours des tests.

Le Tableau 1 présente un résumé des tests proposés pour des organismes particuliers au Niveau 1. Il ne contient aucun protocole précis. Il est recommandé aux demandeurs d'homologation de consulter la Direction des pesticides et Santé et Bien-être social Canada avant de réaliser des tests afin de s'assurer qu'ils utilisent bien les méthodes les plus perfectionnées et les plus reconnues.

Questions particulières :

3.1 Toxicité

La toxicité est principalement associée aux toxines et aux métabolites qui peuvent être liés au mode d'action chez l'hôte. La toxicité peut également être liée aux composantes cellulaires d'organismes tués ou lysés à l'intérieur d'un système vivant. Les produits doués d'un pouvoir toxique peuvent être dangereux pour l'être humain ou les mammifères, c'est pourquoi il est proposé de réaliser des tests de toxicité aigue en utilisant à la fois le produit de qualité technique et le produit formulé. Il faudrait chosir les voies prévues et possibles d'exposition (orale, cutanée et respiratoire) pour l'adminstration d'un dose maximale d'inoculum. Il s'agit d'utiliser la dose la plus élevée possible d'organismes viables représentant habituellement la plus grande quantité de produit de qualité technique qui peut être manipulée ou administrée. Les doses varient selon l'agent. Ces tests sont habituellement combinés à une évaluation de l'infectivité (voir ci-dessous).

Irritation

Les agents pathogènes comme tels, les produits et sous-produits du milieu de production, les résidus de milieu, les produits, sous-produits et toxines du microorganisme, les contaminants et ingrédients de la préparation peuvent tous avoir des effets irritants. Il faut donc effectuer des études sur l'irritation oculaire et cutanée du produit de qualité technique et du produit formulé.

3.1.10 A. Infectivité

Les microorganismes sont des agents qui ont la faculté de se multiplier et, de ce fait, ils peuvent endommager les tissues mammaliens dans lesquels ils ont trouvé refuge. Cette situation peut se traduire par une maladie clinique déclarée (aiguë, subaiguë ou chronique), par infection latente qui pourrait être activée à tout moment, par l'état de porteur ou par une infection asymptomatique. Les études d'infectivité sont, par conséquent, jugées essentielles à l'évaluation des pesticides biologiques. Les effets toxiques sur les systèmes mammaliens sont peu fréquents et il est très rare que la toxicité aiguë soit un facteur limitatif. Les tests d'infectivité et de toxicité du Niveau 1 peuvent donc être conçus de façon à utiliser des doses provocatrices maximales. Au début de l'étude, il faut établir que les organismes utilisés sont viables et, par conséquent, qu'ils sont doués d'un pouvoir infectieux. Les animaux test sont inocculés par les voies prévues et possibles d'infection (orale, cutanée, respiratoire). Ces études sont habituellement combinées à une évaluation de la toxicité. Le produit de qualité technique et le produit formulé doivent être testés dans le cadre de ces études. Des voies d'exposition inhabituelles sont également utilisées, pour l'étude de l'infectivité <u>seulement</u>, de façon à maximiser les chances de provoquer une infection. Seul le produit de qualité technique doit être testé. La moitié des animaux utilisés dans ces tests doivent être immuno-déprimés. Dans la plupart des études de cette nature, on a recours à des souris athymiques (glabres).

En utilisant des doses provocatrices maximales, on donne au microorganisme les meilleures chances possibles d'infecter les animaux test, de les envahir ou de s'y implanter de façon durable. Comme il s'agit du pire cas possible, les agents qui donnent des résultats négatifs au Niveau 1 n'ont pas à subir d'autres tests. Par contre, si l'un des résultats est positif, l'agent doit subir les tests prévus au Niveau 2. On peut alors quantifier les effets de façon à évaluer plus précisément le risque d'effets délétères résultant de l'exposition à l'agent en question et les degrés d'exposition nécessaires.

Les études du Niveau 1 doivent inclure des observations qui permettent de déterminer la dissémination, la persistance et la multiplication possible du microorganisme dans les tissus de l'animal test, ou son taux d'élimination. Il est recommandé que ces études soient d'une durée d'au moins 28 jours et que les animaux soient sacrifiés en série et examinés au cours de cette période.

B. Réponse immunitaire

Ces études sont conçues pour déterminer si le pesticide biologique a un effet quelconque sur le système immunitaire, c-à-d. suppression ou activation de certaines réponses immunitaires. Il existe de nombreux tests immunologiques pour mesurer ces effets. Le Tableau 1 présente la liste des tests proposés; d'autres tests peuvent être acceptables d'autant plus que ce domaine ne cesse d'évoluer.

C. Hypersensibilité

Étant donné que tous les microorganismes contiennent des protéines, ils peuvent provoquer des allergies. Il faut donc réaliser des tests d'hypersensibilité chez l'être humain exposé au produit pendant sa fabrication doivent être signalées.

D. Culture tissulaire

Les études fondées sur les cultures tissulaires constituent une méthode sensible pour vérifier la capacité d'un virus à infecter les cellules d'espèces non visées et à réagir avec elles. Un des avantages, de cette méthode , c'est qu'elle permet d'utiliser des lignées de cellules humaines dans les cultures test. Les virus sont les organismes les plus susceptibles d'être cancérogènes. Certaines familles sont associées à la formation de tumeurs. À ce égard, les tests réalisés au moyen des techniques de culture tissulaire et portant sur l'incorporation d'acide nucléique viral dans différents types de cellules peuvent servir d'indicateurs préliminaires du pouvoir oncogène.

Tests additionnels :

Il faut procéder à des tests additionnels lorsqu'un organisme produit une toxine ou un métabolite qui fera partie du produit final. Les données recueillies jusqu'à ce jour indiquent que les toxines et les métabolites ne s'accumulent par ou ne persistent pas dans les tissus des mammifères, ce qui laisse supposer que les dangers liés à une exposition à long terme et répétée sont néglibeables. Toutefois, il existe peu de données sur le devenir des organismes entomocides dans les tissus des mammifères, la plupart de ces données étant circonstantielles. C'est pourquoi il est proposé de soumettre les toxines à une batterie de tests pour déterminer leur génotoxicité. Ces tests servent d'indicateurs de la cancérogénicité de ces produits. Si la toxine est apparentée à un produit chimique ou à une autre toxine dont la cancérogénicité est établie, il peut être nécessaire d'effectuer d'autres tests de cancérogéncité à long terme.

Partie 5 ÉTUDES PORTANT SUR LES RÉSIDUS :

5.1 Généralités :

Il faut fournir des données sur les résidus lorsqu'un pesticide microbien doit être utilisé pour traiter des aliments destinés à la consommation humaine ou animale ou pour traiter le tabac. Les données sur les résidus doivent provenir en grande partie de tests réalisés avec les produits formulés et comporter des renseignements sur:

5.2 - les méthodes d'analyse (cultures vivrières et tabac)
5.3 - les résidus dans les récoltes
5.5 - les résidus présents dans le bétail, le volaille, les oeufs et le lait (résultant de la consommation de cultures traitées)
5.6 - les résidus présents dans les cultures utilisées pour alimenter le bétail
5.7 - les résidus présents dans le tabac
5.8 - tests de stabilité sous congélation

En vertu de la Loi et des Règlements sur les aliments et drogues, il faut avant de pouvoir utiliser un pesticide microbien sur des produits alimentaires, établir des limites concernant la teneur en résidus ou obtenir une dispense à cet égard.

Il faut tenir compte des points suivants en ce qui concerne les limites de résidus :

- l'efficacité d'un agent microbien dépend souvent de sa capacité à se multiplier à l'intérieur de l'organisme du parasite cible lequel ne devrait vraisemblablement pas demeurer sur les plantes cultivées après la récolte.
- la forme vivante de l'organisme ne se reproduit habituellement pas en l'absence du parasite cible.
- la date d'application de l'agent microbien no doit pas être proche de celle de la recolte.
- les conditions environnementales telles que le rayonnement solaire (et l'UV), les précipitations, le vent, l'humidité et la température réduisent souvent considérablement la viabilité de l'organisme; par conséquent, la quantité de résidus devrait vraisemblablement diminuer ou devenir relativement négligeable peu de temps après l'application.
- les données toxicologiques peuvent indiquer que l'agent microbien ne devrait pas constituer un danger pour l'être humain et les autres mammifères.
- l'agent microbien peut être un microorganisme qui est déjà présent et qui n'a pas d'effes défavorables. Dans certains cas, il peut être impossible de distinguer entre les populations microbiennes naturelles ou introduites.

- les résidus de l'agent microbien peuvent devenir non viables ou être éliminés par suite des traitements habituels auxquels sont soumis les produits alimentaires destinés à la consommation humaine ou animale (c.-à-d. lavage, séchage, stérilisation par la chaleur et addition de sucre, de sel et d'autres agents de conservation).

Partie 6 EXPRESSION DANS L'ENVIRONNEMENT

L'expression dans l'environnement concerne :

a) les caractéristiques de croissance de l'agent microbien testé.
b) la capacité de l'agent microbien à se propager et à s'établir dans une nouvelle niche ou un nouvel hôte après son introduction.

6.2 a) Propriétés physiologiques et physiochemiques et caractéristiques de croissance. Il faut obtenir des renseignements sur les questions suivantes :

- besoins en matière de pH, de température et d'oxygène
- croissance optimale
- les valeurs limites favorables à la survie et à la croissance
- nutriments essentiels à la croissance
- sources de carbone (CO_2), carbonate, autre)
- minéraux
- composés organiques
- sources d'azote (acides aminés)
- aptitude à l'antotrophie
- aptitude à survivre comme saprophyte
- croissance en fonction de la variation de la salinité
- réaction aux antagonistes connus: - chimiques
  - biologiques
  - autres

- comparison sérologique avec des agents pathogènes connus (aux fins d'identification et (ou) à titre d'indicateur environnemental)
- caractéristiques biochimiques dues à des conditions défavorables :
  - humidité
  - teneur de l'eau en matières inorganiques ou organiques
  - salinité

6.2 b) Études en laboratoire

Les tests réalisés en laboratoire visent à déterminer la survie, la persistance, la mobilité et la reproduction d'un agent microbien dans divers types d'environnement (milieu terrestre, eaux douces, eaux marines ou estuariennes), ce qui permet de prévoir quelle pourrait être l'exposition des organismes non visés. Il faudrait évaluer la croissance d'un agent microbien lorsqu'il est introduit dans une nouvelle niche et lorsque la population de sa niche normale est accrue.

Les premiers tests portant sur l'agent microbien devraient comporter des tests simulés, réalisés en laboratoire, en serre et en aquarium, de façon à évaluer le devenir de l'agent en question dans le sol, la végétation, la litière feuillue, l'eau et les sédiments; c'est tests doivent porter aussi bien sur l'application en milieu terrestre que sur l'application en milieu aquatique.

Dans le cadre des tests visant à déterminer les effets sur la survie et la croissance des populations d'agents microbiens notamment sur la survie hivernale, il faudra faire varier les paramètres suivants :

(i) Sur terre : température, humidité, humidité du sol, teneur en oxygène, précipitations (quantité, fréquence, pH), rayonnement solaire, pH (surfaces composées de sol et de feuilles), nutriments (sol, végétation).

(ii) En eaux douces : température, pH, nutriments, rayonnement solaire, teneur en oxygène, dureté, turbulence.

(iii) En eaux marines ou estuariennes : température, pH, nutriments, salinité, rayonnement solaire, oxygène, turbulence.

Voir Tableau 2
Voir Annexe II

6.5 <u>Études sur les terrain</u> :

Il faut réaliser des études sur le terrain pour s'assurer que les résultats obtenus en laboratoire concernant l'expression dans l'environnement reflètent bien la réalité. Le devenir de l'agent microbien dans l'environnement doit être évalué dans des conditions que l'on rencontre dans les principales régions canadiennes où l'on se propose de l'utiliser. Ces études ont pour but de nous renseigner sur certains facteurs comme :

- la persistance (survie, reproduction, croissance de la population et sa diminution à des niveaux naturels) dans les milieux terrestres et aquatiques.
- la mobilité.

Une fois <u>toutes</u> le études de laboratoire terminées, on peut commencer les études sur le terrain, main au début, il doit s'agir d'études réalisées sur une échelle réduite (petites parcelles). Plus tard, il pourrait s'avérer nécessaire de procéder à d'autres essais à une échelle opérationelle)

Voir Tableau 2.
Voir Annexe II.

6.4 Entreposage, élimination et décontamination

Il faut fournir des renseignements scientifiques sur les conditions appropriées d'entreposage, sur les méthodes d'élimination des contenants vides et inutilisés, des produits non voulus et sur les méthodes et procédés de désintoxication et de neutralisation des produits en question.

Partie 7 TOXICOLOGIE ENVIRONNEMENTALE

7.0 Introduction :

L'introduction d'un grand nombre d'agents microbiens dans l'environnement à un moment particulier soulève certaines inquiétudes. La possibilité que l'agent microbien se propage à des composantes vivantes et non vivantes du site traité ainsi qu'à des régions voisines (dérive) pourrait se traduire par l'exposition d'un plus grand nombre d'organismes non visés qu'en conditions naturelles. Contrairement aux pesticides classiques, les concentrations environnementales d'agents microbiens et de toxines peuvent s'accroître lorsque le produit est efficace. Après une application, les insectes hôtes cibles contiendraient vraisemblablement des concentrations très élevées de pesticides et les organismes non visés pourraient être exposés par l'entremise de la chaîne alimentaire. Les effets de la pathogénicité et de la toxicité sont les principales sources de préoccupation en ce qui concerne les organismes terrestres et aquatiques non visés.

7.1 Faune sauvage terrestre

Un test de toxicité et de pathogénicité aviaires (dose unique administrée par voie orale) et un test de pathogénicité aviaire par injection seront exigés dans le cas de tous les agents microbiens. Le test doit durer 30 jours de façon à permettre l'incubation, l'infection et la manifestation d'effets pathogènes. Comme les jeunes animaux pourraient être plus sensible à l'infection et, peut-être, aux effets des toxines produites par les agents microbiens, il faudrait exposer de jeunes animaux à la forme la plus infectieuse ou toxique des divers agents microbiens. On recommande l'utilisation de jeunes colins de Virginie ou canards malards âgés de 10 à 17 jours, au début du test. Théoriquement, les pesticides microbiens peuvent perturber la flore bactérienne du rumen. Il pourrait être nécessaire d'effectuer des tests sur les ruminants sauvages si des effets sont signalés chez des animaux domestiques.

Voir Tableau 3

7.2 Animaux aquatiques :

Lorsqu'on veut évaluer les effets potentiels des pesticides microbiens sur les animaux aquatiques, il ne faudrait pas faire une distinction très nette entre les modes d'utilisation terrestre et aquatique, car une utilisation terrestre peut également avoir des effets sur un système aquatique par suite des phénomènes et dérive et de ruissellement/lessivage.

Dans les cas où les modes d'utilisation risquent d'avoir des répercussions sur les systèmes aquatiques d'eau douce, les tests doivent porter sur une espèce de poisson d'eau froide (p.ex. truite) et une espèce de poisson d'eau chaude (p. ex. crapet arlequin). Dans le cas où ces modes d'utilisation risquent d'avoir des répercussions sur les eaux marines ou estuariennes, les tests devraient porter sur des espèces de poissons estuariens ou marins ainsi que sur deux espèces d'invertébrés aquatiques dont l'une doit être Daphnia magna.

L'agent microbien devrait être administré : a) sous forme de suspension dans l'eau (exposition aqueuse); b) dans l'alimentation (insectes hôtes malades ou nourriture traitée); c) par injection; ou d) par ces trois voies d'exposition. Cette dernière solution est préférable aux autres parce qu'elle permet de s'assurer que la voie d'exposition la plus susceptible de donner des résultats a été testée et que l'animal test non visé a reçu la dose maximale possible.

Les observations devraient se poursuivre pendant au moins 30 jours après l'exposition et la cause de tout décès (toxicité ou pathogénicité) doit être établie.

Il faudrait utiliser la truite arc-en-ciel comme l'une des espèces test de poisson d'eau douce étant donné qu'il s'agit d'un bon indicateur de la sensibilité à l'égard des toxiques chimiques. Ce poisson est en partie insectivore et il existe une abondante documentation sur les maladies de cette espèce. De plus, des méthodes normalisées de culture tissulaire ont déjà été mises au point pour cette espèce.

Voir Tableau 4.

7.3 Invertébrés non visés

La détermination des hôtes possibles est importante étant donné que la plupart des agents microbiens agissent par le biais de leur pouvoir pathogène. La majorité des agents de lutte microbiologique sont des insecticides; c'est pourquoi ils sont choisis ou conçus spécifiquement en fonction de leur capacité à lutter contre les insectes nuisibles. A ce titre, les insectes non visés étroitement associés à l'organisme cible sont exposés. Comme l'extrapolation des effets entre les espèces pose des difficultés, il est nécessaire d'utiliser des insectes représentatifs d'un certain nombre de taxons d'"insectes utiles"*.

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* Il y a très peu d'insectes non visés dont l'importance pour l'homme peut être mesurée du point de vue économique.

Les tests de base comprendront une évaluation de la toxicité et de la pathogénicité de l'agent microbien pour le ver de terre et l'abeille domestique et pour trois espèces d'insectes prédateurs et parasites. Dans le cas des insectes prédateurs et parasites, les espèces choisies doivent être représentatives des groupes d'insectes qui seront exposés dans les conditions d'utilisation prévues; il faut aussi qu'il existe une relation importante entre les espèces choisies et le parasite cible.

Voir Tableau 5.

7.4 Plantes non visées

Dans le cas où l'agent microbien est utilisé dans une région où il n'est pas présent à l'état naturel, il faut effectuer des tests pour déterminer s'il y a des effets phytotoxiques. Lorsque la persistance est attribuable à la sporulation, il faut étudier les effets néfastes des spores viables et de leurs produits.

Voir Tableau 6.

Partie 8 Efficacité

Pour chaque pesticide, il faut fournir des données sur l'efficacité basées sur des études en laboratoire et sur le terrain. Les derniers tests visant à démontrer l'efficacité d'un produit doivent être réalisés en utilisant le produit formulé pour lequel on a présenté une demande d'homologation et qui sera vendu sur le marché.

Il est obligatoire que l'homologation puisse s'appuyer sur des données d'efficacité opérationnelle obtenues sur le terrain au Canada en utilisant les quantités indiquées sur l'étiquette. Les données provenant de l'étranger peuvent être utilisées pour compléter les tests réalisés au Canada

TABLEAU 1. EXIGENCES EN MATIÉRE DE DONNÉES TOXICOLOGIQUES NIVEAU 1 (PARTIE 3)

I. Type de test et voie d'administration	Espèces	B	V	F	P
Toxicité aigue[1]					
3.1.2 Orale	Rat (d'autres espèces peuvent être acceptables)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.3 Cutanée	Rat (d'autres espèces peuvent être acceptables)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.3 Respiratoire	Rat (d'autres espèces peuvent être acceptables)	AI,FP	AI,FP	AI,FP	AI,FP
3.1.5 Irritation oculaire	Lapin	AI,FP	AI,FP	AI,FP	AI,FP
3.1.6 Irritation cutanée	Cobaye ou lapin	AI,FP	AI,FP	AI,FP	AI,FP
3.1.10 A) Infectivité[1]	(la moitié des animaux test doivent être immuno-déprimés)				
a) Intraveineuse	Souris et hamster venant d'être sevrés	AI	AI		
b) Intrapéritoneale	Rat ou souris, et lapin				AI
c) Intrapéritoneale	Rat ou souris, et lapin			AI	
Intracérébral[2]	Souris ou hamster nouveau-né		AI		
Intracérébral[2]	Rat ou souris, et lapin				AI
B) Réponse immunitaire cellulaire[3]					
a) Numération globulaire	Souris	AI	AI	AI	AI
b) Réponse leucocytaire cellules T et B)	Souris	AI	AI	AI	AI
c) Nombre total de leucocytes rapports des cellules T et B)	Souris	AI	AI	AI	AI

TABLEAU 1 (suite)

I. Type de test et voie d'administration	Espèces	B	V	F	P
(3.1.10 suite)					
d) Nombre et fonction des macrophages	Souris	AI	AI	AI	AI
e) Détermination des protéines sériques	Souris	AI	AI	AI	AI
C) Hypersensibilité retardée	Cobaye ou hamster	AI,FP	AI,FP	AI,FP	AI,FP
D) Culture tissulaire					
a) Changements morphologiques patents (effets cytopathiques) (CPE)	Diverses lignées cellulaires		AI		
b) Inhibition de la division cellulaire	Diverses lignées cellulaires		AI		
c) Dosage biologique de liquide de culture	Diverse lignées cellulaires		AI		
d) Test pour déterminer la disparition du virus administré et l'apparition éventuelle de protéine et d'acide nucléique viraux	Diverse lignées cellulaires		AI		

AI - INGRÉDIENT ACTIF (dans sa forme la plus pure)
FP - PRODUIT FORMULÉ
B - BACTÉRIES
V - VIRUS
F - CHAMPIGNONS
P - PROTOZOAIRES

TABLEAU 1 (suite)

1 - Dose maximale d'organismes

2 - Au niveau 1, les tests par voie intracérébrale ne sont nécessaires que si l'organisme est neurtrope chez l'hôte ou s'il est associé à un agent neurotrope.

3 - Il s'agit de propositions d'études. Compte tenu de l'évolution rapide des tests immunologiques, les protocoles d'essai doivent être présentés ou examinés avant d'être utilisés pour s'assurer qu'ils sont à jour, valides et précis.

4 - Lignée humaine p. ex. W138; culture primaire de cellules humaines, p.ex. prépuce; une lignée continue humaine, p.ex. HeLa; une lignée continue de primate, p.ex. signe CV-1 ou BSC-1; cellules 3T3 de souris.

Renseignements additionnels

- Croissance à la température du corps (mammifères); 34-37°C in vitro.
- Formes de vie étrangères dans le produit typique.
- sensibilité aux antibiotiques.

II. Les organismes qui produisent des toxines ou des métabolites dans le produit final doivent subir des tests additionnels.

1. Potentiel génétoxique (il est préférable de tester la toxine isolée) :

   a) Test d'Ames (test bactérien)

   b) Test de mutation ponctuelle dans des cellules mammaliennes "in vitro"

   c) Test d'induction de prophages chez des bactériens lysogènes

   d) Test cytogénétique in vitro (mammifères)

   e) Test de lésion/réparation de l'ADN ou test de recombination mitotique

2. Il peut être nécessaire d'effectuer un test de cancérogénicité si la toxine ou le métabolite en question a une structure apparantée à celle d'un cancérigène connu.

TABLEAU 2. Tests portant sur l'expression dans l'environnement[1] (PARTIE 6)

Type de Test	B	V	F	P
Niveau 1 :				
6.2 Études en laboratoire				
- sol	AI	AI	AI	AI
- végétation	AI	AI	AI	AI
- litière feuillue	AI	AI	AI	AI
- eau	AI	AI	AI	AI
- eaux douces				
- eaux marines				
- eaux estuariennes (saumâtres)				
6.3 Études sur le terrain 2,3				
- Études portant sur de petites parcelles et études réelles sur le terrain (les compartiments environnementaux correspondant à ceux des études en laboratoire)	FP	FP	FP	FP

1. L'expression dans l'environnement concerne le devenir (la persistance et la mobilité, voir Sections 6.2 et 6.3) de l'agent microbien dans l'environnement.

2. Les compartiments environnementaux dans lesquels les études doivent être réalisées sont définis en fonction du mode d'utilisation; il s'agit de ce fait des compartiments susceptibles de subir des répercussions. Par exemple, pour une application sur le feuillage, il peut être nécessaire de réaliser des études sur la végétation, le sol, la litière feuillue et l'eau, tandis que pour une application directement sur le sol nu, des études portant sur le sol et l'eau (ruissellement et lessivage) pourraient suffire.

3. Les études sur le terrain doivent être réalisées à la toute fin, c.-à.d. une fois que tous les autres tests sont terminés (voir Section 6.3).

TABLEAU 3. Tests portant sur la faune sauvage terrestre (PARTIE 7.1)

Type de Test	Espèces	B	V	F	P
Niveau 1 :					
7.1.2 Toxicité aviaire DL_{50} (par voie orale)	(Malard ou colin de Virginie âgé de 10 à 17 jours)	AI	AI	AI	AI
Pathogénicité aviaire (par injection)	(Malard ou colin de Virginie âgé de 10 à 17 jours)	AI	AI	AI	AI
Niveau 2 :					
7.1.3 Toxicité aviaire CL_{50} (par voie orale) - alimentaire au moyen d'insectes infectés)	(Malard ou colin)	AI	AI	AI	AI
7.1.4 Test de pathogénicité et de reproduction aviaires à long terme	(Malard, colin)	AI	AI	AI	AI

TABLEAU 4. Tests portant sur les organismes aquatiques (PARTIE 7.2)

Type de Test	Espèces	B	V	F	P
Niveau 1 :					
7.2.2 Toxicité aigue					
a) Eaux douces :					
CL_{50} aigue[1]	(Truite arc-en-ciel, crapet arelquin)[2]	AI,FP	AI,FP	AI,FP	AI,FP
CL_{50} aigue[1]	(Daphnia magna + une autre espèce d'invertébré)	AI,FP	AI,FP	AI,FP	AI,FP
b) Eaux marines ou estuariennes	(1 poisson marin ou estuarien et un invertébré)[2]	AI,FP	AI,FP	AI,FP	AI,FP
CL_{50} aigue	(Truite arc-en-ciel))[2]	AI,FP	AI,FP	AI,FP	AI,FP
CL_{50} aigue	(Daphnia magna)	AI,FP	AI,FP	AI,FP	AI,FP
c) Culture tissulaire - Inhibition de la division cellulaire	Lignée cellulaires : p. ex. Tête-de-boule	AI	AI	AI	AI
- synthèse des protéines ARN et ADNthesis	Truite (RT6-2)				
Niveau 2					
7.2.3 CL_{50} chronique (par voie orale)	(Truite arc-en-ciel)	AI	AI	AI	AI
7.2.4 Pathogénicité chez des animaux aquatiques	(chaque groupe : une ou plusieurs espèces)	AI	AI	AI	AI
Cycles vitaux de poissons et d'invertébrés	(chaque groupe : une ou plusieurs espèces)	AI	AI	AI	AI
Organisme aquatique/ accumulation dans l'écosystème/ pathogénicité	(Divers types d'organismes)	AI	AI	AI	AI

Niveau 2 (suite)

Type de Test	Espèces	B	V	F	P
7.2.5 Études sur le terrain (en milieu aquatique)		FP	FP	FP	FP

1 Voies d'administration : aqueuse, alimentaire, injection, intrapéritonéale (poissons seulement).

2. Des truites juvéniles et adultes devraient être testées séparément.

3. En plus des tests de toxicité aigue, il peut être nécessaire de réaliser des tests de toxicité chronique, par exemple, les champignons peuvent déterminer des infections aigues et chroniques chez les poissons.

TABLEAU 5. Tests portant sur les invertébrés non visés (PARTIE 7.3)

Type de Test	Espèces	B	V	F	P
Niveau 1 :					
7.3.2 Test de toxicité et de pathogénicité	3 espèces (un/groupe) : hémiptère (prédateur) coléoptère (prédateur) acariens (prédateur) neuroptère (prédateur)	AI	AI	AI	AI
7.3.3 Test de toxicité et de pathogénicité chez les insectes parasites	hyménoptère (parasite)	AI	AI	AI	AI
7.3.4 Test de toxicité et de pathogénicité chez l'abeille	(*Apis mellifera*)	AI	AI	AI	AI
7.3.5 Ver de terre		AI	AI	AI	AI
Niveau 2 :					
7.3.8 Études sur le terrain simulés ou véritables	(pollinisateurs)	AI	AI	AI	AI

TABLEAU 6. Tests portant sur les plantes non visées (PARTIE 7.4)

Type de Test	Espèces	B	V	F	P
Niveau 1 :[1]					
7.4.(i) Agents microbiens utilisés pour lutter contre les plantes nuisibles :	(5 espèces du même genre ou de la même famille)[2]	AI	AI	AI	AI
évaluation des effets concernants :					
7.4.2 - phytotoxicité dans la zone cible - phytotoxicité dans la zone non visée	(5 espèces du même genre ou de la même famille)[2]	AI	AI	AI	AI
7.4.3 - croissance et reproduction (vigeur végétative)	" "	AI	AI	AI	AI
7.4.4 - croissance et reproduction des plantes aquatiques	" "	AI	AI	AI	AI
7.4 (ii) Agents microbiens utilisés pour lutter contre les animaux nuisibles :	" "	AI	AI	AI	AI
Évaluation des effets concernant :					
7.4.2 - germination des semences/ émergence des semences		AI	AI	AI	AI
7.4.3 - vigueur végétative		AI	AI	AI	AI
7.4.4 - croissance et reproduction des plantes aquatiques	" "	AI	AI	AI	AI

Type de Test	Espèces	B	V	F	P
Niveau 2					
7.5 Études sur le terrain en milieu terrestre		FP	FP	FP	FP
7.6 Études sur le terrain en milieu aquatique		FP	FP	FP	FP

1. Les tests du Niveau I seront réalisés en laboratoire, en serre ou dans une chambre de croissance.

2. Les espèces choisies devraient avoir une importance économique, c.-à.d. cultures horticoles, cultures agronomiques, végétation utile aux animaux domestiques ou sauvages.

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Annexe I : BIBLIOGRAPHIE

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Annexe II

Renseignements additionnels concernant l'expression dans l'environnement

L'application foliaire est généralement associée à la lutte antiparasitaire à court terme étant donné qu'elle exige une application fréquente d'agents microbiens en nombre supérieur à la population microbienne endémique.

L'application sur le sol est associée à la lutte antiparasitaire à long terme et exige l'introduction d'un inoculum qui peut être réapandu et qui peut persister indépendamment de tout organisme hôte.

Il faut tenir compte des considérations suivantes selon le type d'environnement:

i) L'environnement terrestre forestier : Il s'agit d'un écosystème très diversifié dans lequel un microorganisme peut se reproduire et maintenir une population continue, par exemple dans la litière feuillue, le sol, l'eau et le feuillage. L'agent microbien peut avoir la capacité de demeurer dans le sol ou le litière pendant des années. Les facteurs physiques tels que l'humidité et l'assèchement peuvent influencer la dipersion des organismes. Les surfaces foliaires fournissent un substrat qui peut avoir un effet sur le déplacement et la survie de l'organisme.

ii) Les eaux douces : La teneur en matières organiques et inorganiques des eaux douces est la plus variable et elle peut avoir un effet sur le devenir de l'agent microbien. Les sédiments peuvent constituer un excellent habitat pour leur croissance et leur propagation.

iii) Les eaux marines : La salinité peut constituer un facteur limitatif dans le devenir de la plupart des agents pathogènes dans les environnements de type marin et estuarien. Les agents microbiens qui peuvent demeurer près de la surface de l'eau peuvent être inactivés par le rayonnement solaire (UV). L'importance des sédiments dans l'environnement marin est moindre que dans les estuaires.

iv) L'eau saumâtre : La salinité et le rayonnement solaire peuvent constituer des facteurs limitatifs. L'importance relative du courant et les caractéristiques du sol saturé d'eau ou des sédiments dépendent de deux conditions, à savoir si l'agent flotte ou si sa densité l'entraîne sous la surface. La teneur en matières organiques et inorganiques de l'eau influera également sur le devenir de l'agent microbien, (moins que dans le cas des eaux douces).

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CANADIAN PULP AND PAPER ASSOCIATION

FOREST PROTECTION PROGRAM

by

Jean-Pierre Martel, F.E.

Forest Pest Forum

Ottawa, Ontario

November 18, 1986

INTRODUCTION

First, I would like to thank you for the opportunity you are giving us to speak to such a select group of pest managers as the Pest Forum. We hope that this first participation by the industry is just another step in an ongoing exchange of information between industry and government agencies.

This presentation will cover three major aspects of the Forest Protection Committee Program. First, the industry concerns; secondly, the CPPA perspective, and finally, the details of the CPPA Forest Protection Program elements.

1. THE INDUSTRY CONCERNS

As you all know, Canada is a major world exporter of forest products and our challenge in the next decade will be to maintain, and if possible, increase that share to ensure continued major economic benefits for Canadians. The future of the Canadian forest industry is inextricably linked with the continuing availability of world fibre.

Based on a 1983 Annual Allowable Cut of 175 million cubic metres and the projection for a 1995 harvest of 186 million cubic metres, Canada will be experiencing a shortage of softwood fibre within a relatively short time. It has been demonstrated that the continued availability of wood fibre is in jeopardy throughout Canada and in some areas it is at a point of crisis. In turn, this has generated a response by the forestry community.

Attitudes have changed significantly in Canada concerning the need to improve forest management programs, and there is clear evidence that governments, industry and the public now recognize the importance of forest renewal to Canada's future.

As proof, governments and industry significantly increased their outlays for forest management and silvicultural programs during the years between 1977 and 1983, and the trend is expected to continue. Another indication of commitment to a new forest is the number of seedlings produced by governments and industry. But much remains to be done, however, if Canada is to reap the benefits of a new forest after the turn of the century.

The challenge for the next decade is to keep the existing forest sufficiently productive and competitive, so that it can meet Canada's needs into the early years of the next century, when the new forest will reach maturity. A major key to meeting both the short term and longer term forest challenge lies in better protection of the mature and growing forest resource.

If fire, insects and disease are allowed to continue to cut a swath through the forest as large as they have in the past 15 years, the 1995 softwood supply deficit will be much larger than projected. Moreover, it makes no sense for either government or industry to invest in a new forest without ensuring against its loss to competing vegetation, insects, fire and disease.

2. THE CPPA PERSPECTIVE

Coinciding with the recent accelerating pace of forest management activities and the use of insecticides and herbicides, opposition has grown. It has been spearheaded by various groups opposed to the use of approved pesticides in forest management who have very successfully employed their considerable skills in communication and in obtaining media attention. Their focus has been the risk to public health in the use of insecticides and herbicides and they have aroused the concern of the public about continuing use. In doing so, they have created in their wake, increasing numbers of activists who are compounding their successes.

Local examples such as the non-spraying decision in the case of the Cape Breton spruce budworm infestation, the Nova Scotia herbicide trial, the Skeena herbicide testing, and others, indicate that the use of these forestry tools, essential to the maintenance and development of the forest industry in Canada, have been denied, restricted or subjected to unpredictable approval.

Under these conditions, the potential success of forest management practices are severely clouded. The issue is not technical; rather, it is a communications issue, one that requires a commitment to speak out to ensure continuing fibre availability.

To face that reality, a special task force was set up by the CPPA Executive Board on a recommendation of the Forest Policy Committee at its meeting on November 30, 1982. The Task Force report advocated the establishment of a Forest Protection Committee, whose continuing objective would be to promote the industry's viewpoint on the need for pesticides in forestry. The Committee would also be concerned with other forest environmental issues such as the possible effects of air borne pollutants on forest health, and the impact of wildfire. In 1983, CPPA member companies approved the formation of the Forest Protection Committee. Because of the special nature of the problem, the membership of the Forest Protection Committee was drawn from various sectors: forestry, public information and government affairs.

The Committee meets three times a year to direct the program. Two of these meetings are held in locations where important forest protection problems exist. As well as the on-site review of regional problems, these meetings also afford the Committee an opportunity to meet with local industry, political leaders, and the media. The Committee is divided into several sub-committees which deal with sub-programs and projects.

3. THE CPPA FOREST PROTECTION PROGRAM

The four major sub-programs are firstly, "Public Affairs"; secondly, technical and factual information; thirdly, policy and regulation; and finally, co-operation/collaboration with allies. Energy devoted to these sub-programs is presently expanded in the order listed.

a) PUBLIC AFFAIRS

The major focus of the Forest Protection Program is on public affairs. Activities under this sub-program include the employee awareness program, an intra-company program to help gain the support of management and mill and woodlands employees for good forest management and forest protection, emphasizing on the need for approved pesticides. We are also involved in developing public information material and press releases supporting industry policies.

The material produced under this sub-program includes two audio-visuals.

The first audio-visual, "Protecting the Forest Resource", focuses on the use and safety of pesticides. It complements the booklet "A Matter of Safety", which explains the registration process of forestry pesticides.

The second audio-visual, "Pesticides in Forestry: The Essential Edge", explains the need for pesticides in forestry.

As part of the "Employee Awareness Campaign", the Committee produced a series of three posters and a pamphlet on the issues of Forest Management, The Use of Insecticides, and The Use of Herbicides. These posters were distributed widely across the country to industry and non-industry groups. The booklet, "Farming Canada's Forest", was also produced under this program. This publication describes forest management objectives and technology.

We also have a periodical newsletter, "Forest Resource Update", distributed widely across the country, which covers current forestry issues and topics of interest.

The Committee is also involved in sponsoring workshops such as "Public Affairs and Forest Management", which was held in Toronto in 1985.

In 1987, the Employee Awareness Campaign will include a new audio-visual presentation for use with employees. It will aim to enlist their support for good forest management and forest protection. As part of our continuing effort to put forest protection issues in the forest management context, we may produce a film on forest management in Canada.

b) TECHNICAL AND FACTUAL INFORMATION

Other important aspects of the CPPA Forest Protection Program are to ensure that all public information documents are based on sound technical and factual information, and to distribute specialized information to interested groups.

Activities under this sub-program include technical and factual projects, intra-sector communications and co-operation with technical groups such as the Pest Forum.

Reference material of a technical nature is prepared and distributed to the industry in a fact sheet format for inclusion in a special binder called "Technical References". Under this project the pesticides Glyphosate, Hexazinone, Triclopyr, 2,4-D, and Fenitrothion were reviewed. General information fact sheets were also prepared for a "List of Registered Herbicides for Woodlands and Forest Management" and for a glossary of commonly used pest management terms.

In 1987, we will develop Technical References on Bt, NPV, a list of registered insecticides for woodlands and forest management, as well as information on toxicity.

A new series of fact sheets called "Information Reports" are also part of the 1987 program. The "Case Studies" will present positive and negative experiences in forest management and forest protection in Canada. The subject of spruce budworm infestations in Cape Breton and New Brunswick was identified as a priority. Another section in the Information Reports will present information in a Questions & Answers format. I should emphasize that we are developing a co-operative approach with the Forest Pest Management Institute for the preparation of some of this technical information.

Finally, we have an intra-industry newsletter called "Forest Resource Environment News", which provides information to industry and allies on current developments in forest protection related issues.

c) POLICY AND REGULATION

Another sub-program of the Forest Protection Program is policy and regulation.

The Committee is involved in the development and the communication of CPPA policies on matters related to forest protection. The Committee also ascertains that its views and concerns are made known.

CPPA policy statements on the use of herbicides, the use of insecticides, fire protection, and the potential impact of airborne pollutants on the forest resource have been developed.

Also, through its regular meetings with provincial Cabinets and federal agencies, CPPA continually raised forest protection concerns.

Continuous dialogue with groups such as the Pest Management Advisory Board, pesticide regulators, CFS, and others are essential.

d) CO-OPERATION/COLLABORATION WITH ALLIES

The Committee believes that it is very important for those with mutual interest in a problem to work together. So the Committee, in the future, will try to lead in the development of a constituency. First, at the regional level, industry personnel will have to build their own network of allies. Secondly, at the national level, the Forest Protection Committee must act to gain the support of politicians and influential groups such as the Canadian Chamber of Commerce.

Communication with and among those groups is a major component of a successful venture. The newsletter, "Forest Resource Environment News", could serve as a communication vehicle.

This sums up, in a condensed version, the CPPA Forest Protection Program.

CONCLUSION

In conclusion, I would like to reiterate our desire to work with all organizations having the same objectives and create, if possible, a synergistic effect.

The conclusion of the 1983 Task Force report states: "No contest is ever won from the sidelines. Active and continuing involvement is essential and must provide the weight and substance to firm out all activities...".

Thank you very much for your attention.

14th ANNUAL PEST CONTROL FORUM

FPMI Report on Staffing and Program Changes and Areas of Concern

G.W. Green, Director, Forest Pest Management Institute

My report to the Forum this year will be brief dealing primarily with staff changes and program changes since the 1985 Forum and highlighting some particular areas in forest protection that deserve mention and further consideration.

1. Staff Changes

There have been several significant staff changes over the year, viz:

- Mr. Dean Thompson has been appointed as Study Leader, Herbicide Chemical Accountability replacing Joe Feng who moved to herbicide studies at Northern Forestry Centre in Edmonton. Dean comes to the Institute from the University of Guelph and will return to the University of Guelph January-March, 1987 to complete residence requirements for his PhD. In addition, this study is being further strengthened by provision of an additional technician utilizing the position previously occupied by Cecelia Feng in our Insecticide Chemical Accountability project. This position is currently in staffing action.
- Lorne Pollock, our pilot retired in May after a long and illustrious career. He was replaced in June, 1986 by Art Robinson who was formerly Chief Pilot at J.D. Irving Ltd.
- Tim Burns has just recently been appointed as Systems analysis

technician to support Richard Fleming in our Biological Systems Analysis project.

- Tim Mackay, technician to Phillip Reynolds in our Herbicides Application Study left FPMI in December, 1985 to join Dow Chemical. Staffing action is currently in progress to staff this position with a Forestry Officer.

2. Program Changes

Person-year resource constraints and impending additional restraints over the next few years have forced FPMI to review our R&D programs carefully. As a result of this we have (or are about to) institute the following changes:

- Jean Percy, Project Leader, Cellular Interactions left us in July, 1985. We will not restaff this position and, instead, will utilize our electron microscopist and senior technician in this project to perform a service function in electron microscopy to other Institute R&D projects.
- We have decided not to replace David Perry, Study Leader, Fungal Epizootiology in our Fungal Pathogens project. This will slow down development of fungi as control agents but we will still retain expertise in the fungal field with David Tyrrell.
- At the end of this fiscal year, we will cease our active research project in Protozoan Pathogens and Gary Wilson, who has headed this project over the years, will assume responsibilities for insect and pathogen production. We will still have, in-house, the expertise in microsporidia inherent in Gary but, since experience has indicated that these organisms have minimal potential as direct control agents we will no longer conduct an active R&D program on them.

- Changes as noted above in our Protozoan Pathogen project will allow us to move an additional technical position to our Bacterial Pathogens project to strengthen our input in the BIOCIDE project which is described in more detail in Dr. Ennis's overview and Dr. Fast's report to the Forum.
- It is no longer possible for us to proceed with staffing of a Study Leader, Dispersal Systems within our Spray Atomization & Dispersal Project. This aspect of our program in Application Technology will now be handled by Nick Payne working cooperatively with other FPMI projects and cooperating with NRC and other agencies as appropriate.

It is unfortunate that research in certain of these areas must be abandoned or severely constrained because of the PY restraints we will be forced to work within over the immediate future. However, the manner in which we have reacted to these constraints will allow us to maintain at least core expertise in these areas, will allow us to strengthen certain key areas (e.g. B.t., herbicide residues) and will not have a direct negative impact on existing staff.

3. Areas of Concern

i) The Biological vs Chemical Insecticide Question

This is an area of concern to all of us. There is a great deal of pressure out there to develop and use biologicals in place of chemical insecticides and the increasing acceptance of B.t. over the past few years, I am sure, will suggest to some, that B.t. is the answer to all of our problems. At the moment, except perhaps in New Brunswick and Newfoundland this, indeed, would seem to be the case.

There is absolutely no question that B.t. is a good and viable alternative to chemical insecticides against the budworm in certain situations and that its effectiveness will undoubtedly improve even more as better formulations, more potent and/or genetically altered strains, and improved use technologies are developed. Currently, it is a publicly, and hence politically, more preferred alternative to chemical insecticides.

But it is pure folly to place, or for forest managers to be seen to be placing, all of our eggs in the B.t. basket. If this is allowed to occur, two things will undoubtedly happen:

- The availability of good chemical insecticides will dry up if a reasonable market for them is not maintained. There are strong indications that this is about to happen with Matacil and the impetus to obtain final registration for Zectran has disappeared for this and other reasons.
- If the public and the political decision makers get too firmly entrenched with B.t., it will be tremendously difficult to reintroduce chemical insecticides when they are the only viable alternatives for specific situations.

This will place forest managers and forest management in Canada in an extremely poor position and this must not be allowed to happen. We have gone so far this way now that, in Ontario, not even research applications of chemical insecticides were allowed on Crown Land in 1986. If this persists, it does not take much imagination to visualize it spreading to other jurisdictions. Not only will this militate against the development of new and improved chemical insecticides but it will also prevent developing improved technologies for utilizing already registered materials or extending their registrations to other pests.

If we really believe that forest protection is an essential component of good forest management, and I think we must subscribe to this, then individually, collectively, and by whatever means possible, we must turn this situtation around before it is too late. I would think that the Pest Control Forum is a logical place from which to initiate this turn around but it won't happen unless we work very hard to make it happen.

Biologicals are great - but we can't force-fit them; we can't make them do what they're not capable of doing; and we will always require chemical insecticides in forestry to a greater or lesser extent. We'd better not lose them by default!

ii) Vegetative Control Demonstration Areas

For some strange reason, herbicides do not yet appear to be under the 'antis' guns to the extent that chemical insecticides are. However, the danger signals are certainly there and it would be prudent for us to attempt to head this off at the pass. In a way, this might be somewhat easier for us to orchestrate than the same thing would be with insecticides.

What I think we really need in this regard are permanent, relatively easily accessible, demonstration areas in virtually all provincial jurisdictions when the utility of all techniques of competing vegetative management are vividly and accurately portrayed and evident. I do not believe that it would be a monumental job to cooperatively establish and maintain such areas. Besides providing an easily visualized perception of the utility of the various methods of vegetation management concerned, these same areas could be used very effectively to generate hard data on the cost/benefit side of this equation - data that are singularly lacking now - and the lack of which contributes significantly to our inability to convince the unbelievers, some of whom exist within the forest management ranks, of the relative utilities of these various vegetation management techniques.

I think this is well worth considering within the Pest Control Forum, and, should such an approach appear useful, FPMI would be pleased to investigate the concept further with any CFS regional forestry centre or provincial jurisdiction and cooperate as much as possible in the establishment of such areas.

14th ANNUAL PEST CONTROL FORUM

FPMI Report on Studies Carried Out by the Chemical Control Agents Program - 1986

E.T.N. Caldwell

Introduction

The 1986 season saw FPMI being less involved on the development side of new chemical insecticides than in the previous 2 years when major efforts were expended to gather registration data for Zectran and Sumithion flowable products. There is a continuing trend in the Chemical Industry because of economic and political constraints, resulting in few if any new insecticides or products being developed for forest use. In fact there are signs that the future of effective products such as Matacil and Zectran are very much in doubt from the Industrial viewpoint. This is beginning to be reflected in our research program and we are concentrating more heavily on improving the use and application of currently available insecticide active ingredients as opposed to the development of new actives. Fortunately there continues to be some Industrial interest in the continued development of new forestry herbicides as evidenced in our herbicide R&D activities.

Our research program continues to be subjected to political perceptions of public opinion with regard to the use of chemicals in our forest pest management endeavours. Political decisions in Ontario this year forced the cancellation of several important FPMI research projects. We simply must do a far better job of public and political education as far as the need for reasoned forest pest management activities is concerned. As part of our own communication activities we have produced an audio visual presentation entitled "Forest Pest Management, A Challenge for the Future". Copies of this AV will be made available to as wide an audience as possible. Other communication activities are currently in the planning stage. These include closer ties with client groups such as the Canadian Pulp and Paper Association (CPPA) through its Forest Protection Committee.

The following are highlights only, of 1986 accomplishments. Further details can be found in the project and study handouts.

FP-50 - Insecticide Toxicology and Screening

A new synthetic pyrethroid produced by Zoecon, SAN 811-I, has proven to be almost as effective as permethrin against a number of forest pests including spruce budworm. This pyrethroid exhibits less toxicity to fish than other pyrethroids. Additional tests are planned but the manufacturer's intentions for further development are unknown. Other tests have included residual toxicity determinations of Matacil under natural weathering conditions on various crop tree species; verifications of the toxicity of Matacil 180F, Zectran UCZF 19, Sumithion 20F and Sumithion technical with Triton X114 against a range of insects such as jackpine budworm, Choristoneura orae, Douglas fir tussock moth, and Eastern hemlock looper, Zectran appears to be a good candidate for further field tests against hemlock looper. Tests were performed to identify potential insecticides for control of Black army cutworm, white pine weevil and Hylobius congener. Finally the residual behaviour of a new IGR (UC 84572) was assessed using a bioassay with mosquito larvae.

FP-51 - Insecticide Field Efficacy

Because of the decision of the Ontario Ministry of Natural Resources not to allow aerial application of chemical insecticides on crown lands, our research efforts with Sumithion 20F to identify lower effective dosage rates, had to be cancelled. In addition, associated research with the Futura ULV formulation of B.t. was cancelled as well since the two trials were associated with each other. Research activities of the project were limited to investigations of developmental timing of spruce budworm larvae to host tree phenology.

FP-52 - Plantation Pest Management

Major efforts were devoted to seed and cone insect research on Black spruce and jackpine in Ontario. Peter de Groot is currently working on this doctoral thesis research in this regard. The project remains active in the search for effective control strategies for spruce budmoth.

FP-54 - Herbicides Research and Development

Compared to previous years, this project took a very low key approach to herbicide testing in 1986. Perhaps as a result, a considerable number of trials were initiated, the final year of post-spray vegetation assessment has been completed for the 1984 Roundup treatment of Carnation Creek in B.C. In cooperation with other CFS establishments and Industry, trials with Pronone, Velpar L, Oust and Ally formulations have been successfully carried out in N. Ontario and New Brunswick.

Greenhouse and small scale field tests have further defined the most effective droplet size ranges for herbicide efficacy and have also indicated that a number of spray adjuvants can play an important role in increasing herbicide efficacy.

Chemical accountability studies associated with the Roundup Carnation Creek project are nearing completion and a number of PRUF contracts have been supervised with different Universities to further define the chemical behaviour of glyphosate, hexazinone and trichlopyr in forest ecosystems.

FP-61 - Pesticide Formulations

Six lab studies were undertaken and these included:

- Droplet and deposit characteristics of Pseudoplastic and newtonian formulations of 3 insecticides;
- Influence of adjuvants on spray atomization, drop size spectra drift, deposits, and/or physicochemical properties of fenitrothion, glyphosate or B.t. formulations; and
- Influence of temperature on physical properties of non-aqueous pesticide formulations and spray diluents.

In addition, field studies were undertaken to determine the effect of volume rate on drop size spectra and deposit of two Dimilin spray mixtures applied in Ontario, as well as the formulation properties, drop size spectra, ground deposits and foliar residues of aminocarb and fenitrothion in flushed and one year old balsam fir needles from aerial applications in Newfoundland.

FP-62 - Pesticide Atomization and Dispersal

A major field study was undertaken in N. Ontario to assess the drift of glyphosate under various meteorological conditions using the TVB (Through valve boom) application system attached to FPMI's Cessna 188 aircraft. The information report was completed for the 1984 permethrin drift study and supervision of a PRUF contract to provide atomiser characterizations for a range of atomizer types and pesticide formulations continued.

FP-70 - Environmental Impact

Research continued in the Icewater Creek watershed area in order to gather baseline data on various forest ecosystem components. A fenitrothion application which was scheduled for Icewater in 1986 to assess songbird, pollinator and other impacts, had to be abandoned because of the Ontario decision not to allow aerial application of chemical insecticides on Crown lands. Instead, a small ground-based application was made to individual trees in partial fulfillment of Rhonda Millikin's masters thesis research.

An aquatic impact study was carried out near Kaladar, Ontario for Dimilin insecticide. This study will hopefully provide information for full registration of Dimilin for control of Gypsy moth.

FP-71 - Insecticide Chemical Accountability

Major efforts were devoted to determining the chemistry and fate of Dimilin in a forest ecosystem in collaboration with the aquatic environmental impact study carried out near Kaladar. This included development of analytical methodology and the effect of different volume rates on deposition and behaviour under lab and field conditions. Significant contributions to the research made at Icewater Creek were also made by assessing the deposition and distribution of fenitrothion applied by a backpack mistblower.

FPMI Report on Studies Carried Out by the Biorational Control Agents Program - 1986

T.J. Ennis, Program Director

Dr. Green's overview statement has covered the overall program and staff changes that have occurred in this program in the past year, so I will limit this presentation to a highlighting of achievements. More detailed information will be provided in the project and study statements, and some staff members are here for presentations and discussion.

Microbial Control Agents

FP-10 - Bacterial Pathogens

The cooperative research network, BIOCIDE, which was formed in 1984 to provide a concerted research effort into the molecular biology, chemistry and mode of action of B.t., is now well established. Cooperators include scientists at FPMI, the Biological Sciences Division of National Research Council of Canada (NRCC), the NRCC Biotechnology Research Institute in Montreal, the NRCC Plant Biotechnology Research Institute in Saskatoon, Laurentian University in Sudbury and the Universities of Ottawa and Waterloo. Funding for the group, apart from salaries, is derived from NRC and CFS Biotechnology Initiative Funds, NSERC Strategic operating grants and a PRUF contract from CFS. Coordination roles are shared by Paul Fast of FPMI and Lou Visentin, Biotechnology Coordinator of NRC. Progress to date includes cloning of the toxic crystal gene from NRD-12, a strain that appears to kill faster than currently available commercial strains. Crystal structure has been identified, and the first steps taken to identifying and purifying the receptor site in the insect. The very practical problem of sunlight degradation is being addressed with the use of a sunlight simulator. An important part of the activities is screening for activity against a range of insect pests, both for BIOCIDE isolates and other isolates as they become available.

Studies on B.t. - insect interactions have been extended from the spruce budworm to include the western spruce budworm, the jackpine budworm, the blackheaded budworm and the gypsy moth. These studies include the effects of temperature on toxicity of B.t. to the budworm, relative toxicities of B.t. to the various defoliators, and the effects of additives such as stickers on the residual activity of B.t. Recent advances in increasing concentrations of available formulations, as well as better knowledge of the effects of dosage, droplet size and concentration, have improved the results that can be obtained against the spruce budworm, and extension of these studies to additional species offers the potential for greater efficacy against a broader spectrum of target insects.

FP-11 - Protozoan Pathogens

The spruce budworm and the jackpine budworm demonstrate cross-susceptibility to their respective microsporidian parasites - *Nosema fumiferanae* and *Nosema sp.* At a dosage level of $2x10^7$ spores/insect, these parasites induced levels of mortality for the spruce budworm of 60 and 43 percent, respectively, while the accompanying results for the jackpine budworm were 85 and 75 percent. Both caused decreased pupal weight and adult longevity, though *N.*

greatest detrimental effects. These microsporidia probably represent different strains adapted to different hosts.

Tests also indicated that infected females passed the infection on transovarially in an average of 98 percent of cases.

Continued study of the two spruce budworm populations north of Sault Ste. Marie indicated that the population at Gargantua collapsed after maintaining a level of infection of about 60 percent for four years. Prevalence of the microsporidia at Black Sturgeon Lake remained the same as in 1985, at about 31 percent. Intensity of infection dropped from 9.4×10^6 (1985) to 2.3×10^6 spores per insect. It appears that the prevalence of microsporidia increases with the age of infestation, reaching levels of 60 percent or higher until the population collapses.

FP-12 - Fungal Pathogens

The Mycology Project once again handled the diagnosis of dead insects for the joint GLFC-FPMI Black Sturgeon Lake spruce budworm population dynamics study. Fungus was detected in 75 insects out of 3333 collected. Of these, 27 were infected with *Entomophaga aulicae*, 9 with *Hirsutella gigantea*, and one each with *Erynia radicans*, *Paecilomyces farinosus*, *Beauveria bassiana* and *Verticillium lecani*, this latter fungus being identified for the first time in this study as a budworm pathogen. In the remaining 35 insects the fungus was either not identified, or was identified as a known saprophytic organism such as *Penicillium* or *Aspergillus*. *V. lecani* was the only recognized pathogen isolated from overwintering insects, while *H. gigantea* was the most prominent pathogen during the first 11 days of sampling. *E. aulicae* was numerically the most important pathogen, and again occurred late in the larval cycle, being observed only on samples collected during the last eleven days of sampling, but at an overall prevalence of 0.81% had little effect on budworm population size. New isolates of E. aulicae, H. gigantea and V. lecani were added to our culture collection.

FP-13 - Viral Pathogens

Experimental aerial applications of virus this year included the use of gypsy moth virus over two plots at once and twice the registered, recommended U.S. dosage. Material used was produced at the FPMI. Epizootics were created in both plots, with the severity in one reflecting high initial population levels. The course of development of the epizootics, effects on pupal numbers and potential carryover effects were also determined. The Douglas fir tussock moth virus, Virtuss, was also tested against the white marked tussock moth in Newfoundland to develop efficacy data to support application for extension of the label to include this insect. High levels of infection were obtained in these ground applications. As a followup to applications of NPV against the jackpine budworm in Ontario in 1985, levels of infection were determined in larval samples from sprayed areas. Though results were confounded by a population collapse, levels of infection found were probably too low to have any effect on population levels.

The registered NPV for the redheaded pine sawfly, Lecontvirus, was applied by OMNR staff in eight districts on 83 plantations for a total area of 342 ha, an increase of 112 percent over 1985. Additional virus was produced for the European pine sawfly, a virus submitted for registration in 1985 under the name Sertifervirus.

Biochemical and biophysical studies of the various insect specific viruses continue to emphasize the determination of their physical structure, protein and nucleic acid components, and the factors involved in replication, infection and virulence. These studies are aimed at determining if such characteristics can be modified or enhanced to improve their effectiveness.

Biological Interactions

The Institute continues to carry out basic and complementary research in the areas of Insect Pathogens *in vitro*, Cell Biology and Immunochemistry. These projects are essential in the isolation, identification and production of insect pathogens, as well as in the determination of the mode of action and cellular effects of microbial, physiological and conventional chemical control agents. Dr. S.S. Sohi, Project Leader in Insect Pathogens *in vitro*, has returned from Career Development Leave in Japan, where he became familiar with techniques in the replication of insect viruses in insect tissue and cell culture. The Immunochemistry Project has developed strong working relationships with both the B.t. and Virology projects, and is, as expected, contributing significantly by applying recent technology in these areas. Because of the departure of the Project Leader in Cell Biology, and staffing limitations due to cuts, this project has been reorganized somewhat and assigned on an interim basis to supervision by the Virology Project.

Biological Systems Analysis has contributed to the study of permethrin drift, the phenological modelling of the development of fungal pathogens, analysis of the effect of Zectran spraying on songbirds, and the design and interpretation of efficacy field tests.

Physiological and Genetics Mechanisms

FP-30 - Pheromones

Recent studies have centered on the identification of pheromones, pheromone components and attractive compounds for several important cone, seed and shoot moths. These include species of *Dioryctria*, *Eucosma*, and *Rhyacionia*. Detailed studies on the spruce coneworm *Dioryctria reniculloides*, have identified the components in a lure that is competitive with female baited traps, and have provided information on time of adult emergence, duration of flight season and changes in population level from year to year. The important influence of trap height on trap catch and selectivity has also been demonstrated.

Efforts also continued on the use of pheromones for monitoring and, perhaps, control of such insects as *Cydia youngana*, *Croesia semipurpana* and *Choristoneura conflictana*.

FP-31 - Insect Growth Regulators

With increasing interest of the industry in this class of compounds, several new candidates have been screened against selected forest insect pests. A ground application of Dimilin against the spruce budmoth in Quebec offered some promise of control potential, but these tests must be repeated to confirm the effects found this year. Biological studies continued on the white pine weevil, but tests of stickers for control showed little potential. The biochemical determination of the effects and mode of action of this class of compounds continued.

PEST PREDICTIONS AND INSECTICIDE DEVELOPMENT

Blair Helson
Forest Pest Management Institute

As the Insecticide Toxicologist at the Forest Pest Management Institute, one of my major responsibilities is to identify effective insecticides for the control of new insect pests and to evaluate new products on recurring pests which will likely reach economically damaging levels sometime in the future. Over the past 4 years examples of new pests we have worked with include the spruce budmoth, black army cutworm and the debarking weevil, *Hylobius congener*, while examples of recurring pests are the jackpine budworm and eastern hemlock looper. A consistent problem I have encountered in carrying out such research is that we do not have enough time after the need for such research is recognized to conduct the necessary tests, analyse the data and make recommendations for appropriate field tests before or at least by the time there is an urgent need to control the pest. We are typically doing this research during the outbreak when control is already needed. This is not to say that the results being generated are not useful. If the problem continues for several years, control measures based on this research can eventually be instituted or the results may prove useful for the next outbreak of a recurring pest. However, the usefulness of this research would be much greater if we could provide recommendations in a more timely manner. I am presenting this problem to the Forum for your comments and suggestions on possible ways this might be done. I believe it is very important to try to solve this problem because insecticides are often the first line of defense we have against new insect pests. The more information on the effectiveness of different products we have by the time a pest requires control, the sooner and more effectively we can institute this defense.

It typically takes about two years to conduct the necessary laboratory research on an insect to obtain scientifically sound insecticde recommendations. First, sufficient quantities of the insect must be obtained to do the tests. There are two approaches which we use to do this and we usually attempt to combine the two. The first is to collect enough insects to establish a laboratory colony from which test insects can be reared. If a laboratory colony of the particular insect already exists and large numbers are readily available quickly then less than 2 years may be required to do the research but this rarely occurs, particularly with new pests. Even with recurring pests there is usually not enough continuing research demand to justify maintaining a colony which was established during the last outbreak, particularly if the endemic period is long. Consequently, it is frequently the case that a laboratory colony has to be established, rearing techniques developed if they don't already exist and the numbers built up to levels sufficient for the tests. Although the use of laboratory material is preferable for toxicological research for several reasons, we often must rely on the second approach, field collections, for the tests at least initially. Large numbers, in the order of several thousand are necessary to obtain reliable results. Several tests with each insecticide must be conducted particularly with field insects because of their greater potential variability in response than laboratory reared material due to such factors as disease, parasites, nutrition and weather. Our first round of tests with black army cutworm larvae had to be discarded because many were subsequently found to have nematode infections. Such large numbers can be difficult to obtain if the pest is not already at outbreak levels. Furthermore, we have found that with field collections, there is often only a short period of time for testing depending on the target stage and the duration of this stage. We also have to learn how to handle the insects, develop appropriate bioassay procedures and determine the correct insecticide dosages to test. Consequently we often obtain only preliminary results with the initial collection of insects. If the species is univoltine which most are, another field season is then required to obtain definitive results which can be reliably used to make insecticide recommendations. With either approach for obtaining test insects, two years, more or less are typically required to do the necessary research.

Because of the unpredictable nature of most insect populations, it would be extremely difficult to make reliable forecasts of probable pests this far in advance of outbreaks. Typically new pests are first recognized when they are found doing serious and extensive damage to trees. Outbreaks of recurring pests may occur very rapidly without much forewarning. Although they may be detected a few years in advance of a major outbreak, subsequent trends in population levels must be examined to determine if they are likely to reach outbreak proportions and if control measures will be required. Understandably, pest predictions in order to be as reliable as possible are usually made within a year of the potential outbreak so that as much information on population trends can be used to make the prediction in time for control measures to be planned and carried out. If control products are not available, are limited or are unacceptable politically this will usually not provide enough time to conduct the necessary toxicological research.

To overcome this problem at least partly, I recommend that a prioritized list of potentially significant insect pests be drawn up based on the best available information currently available. Admittedly, a considerable amount of uncertainty will be associated with such a list. With insects which have not yet or over before reached pest status, their mere presence in a valuable forest resource might have to be the major criteria used without any solid evidence on the potential for population increase. Recurring or cyclical insects may be easier to list since historical records on past outbreaks will be available. The list could be reviewed annually and modified as necessary.

Perhaps the Forest Insect and Disease Survey Unit along with Forest Protection personnel of each regional CFS Establishment could compile a list of potentially significant pests in consultation with provincial officials. These regional lists could then be consolidated by FIDS at Headquarters into one priorized national list. The national list could be tabled at the Forum each year for discussion and further action.

Such a list would allow us to get a head start on at least some insects which might become pests in the future. We could first determine what control products if any are registered for these potential pests and if further research is needed in this area. The list would also be very useful in identifying other research needs for particular insects. Perhaps working groups of the type organized by Dr. Tom Smith for Hylobius congener could be formed for some of the high priority insects on the list. These groups could assess the research needs and make recommendations on what research is required and who could do it most appropriately. In particular the groups could assess the current knowledge on the biology and behaviour of the insects and consequently the most effective control strategies available against them. Such information is an essential prelude to toxicological research so that relevant bioassay procedures can be used for evaluating insecticides in the laboratory. Studies by Jean Turgeon on the biology and behaviour of the spruce budmoth led to the development of a control strategy aimed against first instar larvae which required the use of specialized bioassays for testing insecticides against this pest. The groups could also determine the availability of insect material for research purposes and develop systems to provide this material to researchers such as myself.

I suggest that the nucleus of each working group be made up of a FIDS regional representative, a provincial forestry official, a forest manager from the private sector and a CFS scientist most familiar with the particular pest. Additional members could be added as required. Perhaps these working groups could be set up at the Forum each year for those pests on the list which are deemed to require such action. The Forum could also provide the opportunity for working groups to meet annually and to report progress and future needs to the Forum members.

Hopefully the approach I am suggesting will improve our ability to have effective control recommendations available for some potential pests by the time they are needed. I realize there is going to be an element of risk in this approach but I for one would certainly like to gain the upper hand on at least a few of the insects which will become economically important pests in the future.

In summary I recommend that:

1. A prioritized list of potential pests be formally established by FIDS and other CFS and provincial personnel and reviewed annually at the Forest Pest Control Forum.
2. Working groups be formed to assess research needs for these insects and to make appropriate recommendations.
3. The necessary research be conducted as quickly as possible and control recommendations developed for these potential pests.

OPERATIONAL TRIALS CARRIED OUT BY FPMI IN 1986 WITH NEW FORESTRY HERBICIDES

Report to the 14th Annual Forest Pest Control Forum

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Operational Trials Carried out by FPMI in 1986 with New Forestry Herbicides

Introduction

This report describes research carried out by FP-54-1 during 1986 in cooperation with other agencies.

Unsuccessful attempts to carry out environmental impact/fate research with GARLON (triclopyr) during 1984 and 1985 in British Columbia has forced FP-54-1 to redirect its efforts to other herbicide products deemed to be viable candidates for future forestry use in Canada. In 1986, these efforts included extensive field research with VELPAR (liquid hexazinone), PRONONE (granular hexazinone), OUST (sulfometuron-methyl) and ALLY (metsulfuron-methyl). In addition, continuing political uncertainties affecting aerial application of herbicides in Canada, contributed to our decision to conduct all 1986 research with skidders equipped with ground herbicide application equipment.

Small scale research trials by DuPont Canada with OUST and ALLY in 1984 and 1985 has confirmed the potential of these two products as site preparation herbicides across Canada. Their potential as conifer release herbicides, however, remains to be proven. OUST has been registered for industrial uses i.e. (rights-of-way, gravel areas) with United States for several years and recently was registered for conifer release of loblolly and Virginia pines in the U.S. ALLY is registered for use under the trade name ESCORT in the U.S., and is very close to being registered for cereal use in Canada.

At present, the potential niche for OUST and ALLY in Canadian forest renewal appears to be site preparation. Although the two herbicides are both sulfonylureas, they exhibit notable differences in weed control, and hence potential use patterns. OUST is predominantly a pre-emergence, soil-applied grass herbicide whereas ALLY appears to be predominantly a post-emergence, foliar brush herbicide. However, both herbicides exhibit both pre- and post-emergence activity. DuPont trials with the two herbicides throughout Canada have indicated that OUST shows great promise for control of Rubus species (i.e. raspberry, salmonberry and thimbleberry) and that ALLY appears promising for the control of a number of Canadian deciduous brush species (e.g. maple). In light of recent and persisting difficulties in doing research with GARLON, and the uncertain future of other phenoxy herbicides (i.e. 2,4-D), the potential of ALLY, or other brush herbicides (e.g. ARSENAL, dicamba, etc.) is of considerable interest. In addition, the potential registration of ALLY as a Canadian agricultural herbicide, is likely to make this herbicide a more viable candidate for forestry use than herbicide products having only non-agricultural uses.

Operational herbicide trials carried out by FP-54-1 in 1986 were conducted in northwestern New Brunswick and in northern Ontario in cooperation with Pfizer Canada, DuPont Canada, J.D. Irving Ltd., McChesney Lumber Ltd., Great Lakes Forestry Centre (GLFC) and The Forestry Applicators Ltd. In addition, continuing research in conjunction with previous ROUNDUP (glyphosate) research in British Columbia (Vancouver Island, Carnation Creek) and previous VELPAR research in New Brunswick was carried out. These studies are described below.

1. Northern Ontario Research with VELPAR and PRONONE

Currently VELPAR has a temporary ground registration for forestry use in Canada. This registration is based upon previous research with VELPAR on heavier textured soils (i.e. clays, silty clays and silts). In order to extend the registration of hexazinone to include use on lighter textured soils (i.e. sands, silty sands), additional weed efficacy and crop tolerance research is needed for both VELPAR and PRONONE. In addition, side-by-side comparative trials designed to elucidate weed efficacy or crop tolerance differences between the two formulations have not been performed in Canada. In 1985, Pfizer carried out a number of PRONONE trials across Canada which were installed adjacent to 1984 VELPAR trials. However, 1986 trials are unique in that both formulations were applied concurrently.

Operational use of VELPAR (2 kg ai/ha) on crown lands (McChesney Lumber TFL license from the Ontario Ministry of Natural Resources (OMNR)] in 1986 near Foleyet, Ontario (Silk Township) provided a unique opportunity for FP-54-1, in cooperation with GLFC and Pfizer to obtain data to extend registration of hexazinone to lighter textured soils. Spring (early June) and fall (September) treatments were carried out with PRONONE, using an OMNI granular herbicide applicator unit mounted on a Timberjack 240 (spring) or 230 (fall), as outlined in Table 1. The OMNI is a computerized application system originally developed for granular herbicide application in the United States. Use of the OMNI in this and other herbicide trials described in this report, provided a first-time opportunity to evaluate the performance of the OMNI for Canadian forestry conditions. Liquid VELPAR was applied using a skidder towed OMNR sprayer unit equipped with a Dickey-John computerized sprayer control. Treatments were made to three major site types: silty sand wind-rows, sand wind-rows and corridors, as outlined in Table 1.

Initial weed efficacy (FP-54-1, Pfizer) and crop tolerance (GLFC) data for the three site types were collected in August 1986 using a POLYCORDER data logging system. Major weed competition consists of a

TABLE 1. Northern Ontario VELPAR/PRONONE Treatments.

Treatment	Rate	Location	Timing	Crop Species Planted
VELPAR	1.0 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
PRONONE	1.0 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
VELPAR	1.5 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
PRONONE	1.5 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
VELPAR	2.0 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
PRONONE	2.0 kg/ha	silty sand wind-rows	spring	jack pine (86 & 87)
PRONONE	1.0 kg/ha	sand wind-row	spring	jack pine (86 & 87)
PRONONE	1.9 kg/ha	sand wind-row	spring	jack pine (86 & 87)
PRONONE	2.0 kg/ha	sand wind-row	spring	jack pine (86 & 87)
PRONONE	4.0 kg/ha	sand wind-row	spring	jack pine (86 & 87)
PRONONE	2.0 kg/ha	silty sand corridors	spring	white spruce (86 & 87)
PRONONE	4.0 kg/ha	silty sand corridors	spring	white spruce (86 & 87)
PRONONE	2.0 kg/ha	silty sand wind-rows	fall	jack pine (87)
PRONONE	2.0 kg/ha	silty sand corridors	fall	white spruce (87)
PRONONE	4.0 kg/ha	silty sand corridors	fall	white spruce (87)

number of deciduous (particulary aspen) brush species, and to a lesser extent of a number of herbaceous species other than raspberry or grass. Paper pot jack pine was planted in wind-rowed areas in 1986 and corridored areas were planted with bare root 2+2 white spruce in 1986. Data analysis using in-house VAX and IBM computers will begin later this year or early in 1987. Additional crop trees (same as 1986) are scheduled to be planted in the spring of 1987. Weed efficacy and crop tolerance assessments are scheduled to continue through the 1988 growing season. In addition, crop tree growth response will be monitored through 1992.

2. <u>Northwestern New Brunswick Research with OUST/ALLY/PRONONE/VELPAR</u>

Previous FP-54-1 research with soil applied VELPAR in New Brunswick during 1984 has established that 2 kg ai/ha is an optimal rate for satisfactory control of the major weed competition (i.e. raspberry and grass) on rich silt sites. However, the optimal rate for other site preparation herbicides (e.g. OUST or ALLY) or for other hexazinone formulations (i.e. PRONONE) has not been determined. In addition, long-term operational costs associated with chemical site preparation using various possible site preparation herbicides has not been quantified, and is a topic of considerable interest and concern to operational foresters.

With these objectives in mind, as well as those outlined elsewhere in this report, the studies described in Table 2 were initiated in 1986, in cooperation with J.D. Irving Ltd., Pfizer and DuPont. As in the Ontario trials PRONONE was applied, spring (May) and fall (September), using a ground OMNI unit mounted on a Timberjack 240E. Liquid herbicide applications (VELPAR, OUST and ALLY) were made in spring, summer (August) or fall using a skidder mounted sprayer unit supplied by the CFS

TABLE 2. Northwestern New Brunswick OUST/ALLY/PRONONE/VELPAR Treatments.

Treatment	Rate	Timing	Crop Species Planted
OUST	150 g ai/ha	Spring	Black spruce (86 & 87)
OUST	300 g ai/ha	Spring	Black spruce (86 & 87)
OUST	450 g ai/ha	Spring	Black spruce (86 & 87)
ALLY	36 g ai/ha	Spring	Black spruce (86 & 87)
ALLY	72 g ai/ha	Spring	Black spruce (86 & 87)
VELPAR	2.0 kg ai/ha	Spring	Black spruce (86 & 87)
PRONONE 10G	1.0 kg ai/ha	Spring	Black spruce (86 & 87)
PRONONE 10G	2.0 kg ai/ha	Spring	Black spruce (86 & 87)
PRONONE 10G	4.0 kg ai/ha	Spring	Black spruce (86 & 87)
PRONONE 5G	2.0 kg ai/ha	Spring	Black spruce (86 & 87)
ALLY	36 g ai/ha	Summer	Black spruce (87)
ALLY	72 g ai/ha	Summer	Black spruce (87)
OUST	150 g ai/ha	Summer	Black spruce (87)
OUST	300 g ai/ha	Summer	Black spruce (87)
VELPAR	2.0 kg ai/ha	Fall	Black spruce (87)
PRONONE 10G	2.0 kg ai/ha	Fall	Black spruce (87)

Maritimes Forestry Centre. The sprayer was not computerized. Initial weed efficacy, crop tolerance and crop growth data were collected in August 1986 using a POLYCORDER data logging system as previously described. Crop trees planted in 1986 consisted of 2+2 bare root black spruce. Data analysis of first-year results is scheduled for later this year or early next year. Additional bare root black spruce will be planted in the spring of 1987, as described in Table 2. Continued weed efficacy, crop tolerance and crop growth measurements are planned for a five year period. A goal of the study is to establish costs of the various treatments in relationship to the total number of years of satisfactory weed control.

3. <u>1984 New Brunswick VELPAR Research</u>

VELPAR was aerially (fixed-wing) applied to another J.D. Irving forest site in May 1984 in conjunction with other FPMI environmental fate/residue studies. Weed efficacy and crop tolerance data collected in August 1984 and again in August 1985 were presented in the 1986 Proceedings of the Northeastern Weed Science Society. In July 1986, weed efficacy and crop tolerance were further assessed at 3 years post-treatment. Noteworthy trends in plant succession following VELPAR treatment were observed, and will be summarized in a future paper to be submitted to the Northeastern Weed Science Society.

4. 1984 Carnation Creek ROUNDUP Research

ROUNDUP (glyphosate) was aerially (helicopter equipped with MICROFOIL BOOM) applied at the Carnation Creek watershed on Vancouver Island in September 1984 in conjunction with other FPMI/DFO/PFC/BCMOF/Monsanto environmental impact/fate studies. Silvicultural findings (weed efficacy, crop tolerance and crop tree growth) for one growing season (i.e. 1985) after treatment were presented in the 1986 Proceedings of the Western Society of Weed Science. Briefly, these included acceptable control of salmonberry and quite variable control of red alder, the two major weed competitors; after one growing season. No long-term injury of sitka spruce, western hemlock or western red cedar were noted, and the hemlock and cedar were observed to have noteworthy growth increases following herbicide release from weed competition. Further silvicultural assessments of the Carnation Creek watershed were made in September 1986, and revealed a significant decline in weed efficacy for both alder and salmonberry. It is likely that crop tree growth increases attained during the first growing season following herbicide release have now been slowed or even halted by renewed weed competition. It is likely that advanced growth weed conditions at Carnation Creek prior to glyphosate treatment (i.e. 10-15 year old red alder and salmonberry in excess of 10 feet in height) may have contributed significantly to the reduced weed control. Our 1986 results seem to confirm that more potent, broader-spectrum brush herbicides, such as GARLON or ALLY, are likely to be needed to reclaim rich backlogged forestry sites across Canada, and particularly those located within the B.C. coastal zone. Results of the 1986 Carnation Creek silvicultural survey will be summarized in a future paper to be submitted to the Western Society of Weed Science.

As a final note, environmental impact/fate studies (FP-54-3) for Carnation Creek are nearing completion (i.e. target date is March 1987). These studies will be summarized in a Symposium, sponsored by FPMI, to be held sometime in 1987.

SUMMARY REPORT OF THE STUDIES ON HERBICIDES TOXICOLOGY AND SCREENING

[Project No. FP-54-2 - Herbicide Toxicology]

Report to The 14th Annual Forest Pest Control Forum

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Summary Report of the Studies on Herbicide Toxicology and Screening

Introduction

The aims of the Herbicide Toxicology and Screening Study are to determine the toxicological and physiological properties of herbicides and their formulations and other chemicals on forest weed species and selected crop trees and for those that show potential for use, to provide possible dosage levels and use patterns for further field testing. This is accomplished by carrying out extensive studies in the greenhouse as well as under natural forestry situations employing small (field) plot techniques.

A. Greenhouse Studies

(i) Evaluation of Surfactants on Herbicide Efficacy and Crop Tolerance

Spray adjuvants are a class of chemicals which, when added to herbicide formulations, modify and facilitate the effectiveness of the active ingredients. In so doing they reduce the cost of application and chemical burden in the environment. Using three forest weeds (alder, aspen and white birch) and three forest crops (balsam fir, jackpine and white spruce), the activities of 8 additives (Enhance, Ethokem, Frigate, LI-700, Multifilm, Regulaid, Triton XR and Tween-20) were first screened for efficacy and crop tolerance. It was found that a concentration range (0.1-0.5%) of all adjuvants did not produce any phytotoxic symptoms and was henceforth used for monitoring the efficacy of glyphosate, Garlon and Velpar on these plant spp. At field dosage levels (2 kg/ha of all 3 herbicides), the impact of adjuvants was completely masked because of undue phytotoxicity to greenhouse plants. When the concentration of the active materials of the 3 herbicides was lowered to ca. 1/10th level, the addition of adjuvants to herbicide mixtures markedly enhanced their efficacy. As usual different spp. reacted differently to combinations of herbicide and adjuvants but, in general, all adjuvants appeared to facilitate foliar penetration of herbicides and thereby increased their efficacy. This was confirmed by feeding C^{14} glyphosate to weed species in the presence and absence of an adjuvant (G3780A). All 3 conifer spp. tolerated the mixture of herbicides and adjuvants and no phytotoxicity was apparent.

(ii) Influence of Droplet Size on Herbicide Efficacy

Considerable controversy exists in regard to droplet size, volume and dosage rates on herbicide efficacy; some believe that smaller droplets are more potent than larger ones while others hold the opposite view. Because newer herbicides (glyphosate, Garlon and Velpar) are more expensive than 2,4-D, any economy in their use via droplet behaviour research would be of great benefit. A controlled study using 4 month old white birch seedlings grown under constant conditions of light, temp., relative humidity and nutrition was carried out. A monosize droplet generator was used to deposit droplets (155, 335, 465, 665 um) of uniform sizes on single leaf surfaces. Solutions of glyphosate (2 kg/ha), Garlon (1.8 kg/ha) and Velpar (2.1 kg/ha) with 0.1% rhodamine dye were prepared and then homogeneous droplets of above sizes were applied on the 3rd leaf. Evaluation of necrosis, epinasty, bleaching and phytotoxicity were made after 3 and 6 weeks by a standard procedure both on the individually treated leaves as well as on untreated (translocated) areas. Results demonstrated that irrespective of the type of herbicide or the weed species tested, the smaller the size of droplets (155-365um), the greater was the phytotoxicity; the largest size droplets (665u) proved to be least efficacious. Larger droplets induced localized "islands" of phytotoxicity on the treated leaves and thereby impeded penetration and translocation of the herbicides. Smaller droplets of translocated herbicides (glyphosate and Garlon) caused severe damage to shoot apices, petioles and younger leaves and complicated evaluation procedures. It seems that a better coverage of the target with finer droplets was responsible for enhanced phytotoxicity. Velpar behaved like a contact herbicide on white birch under these sets of conditions and provided a better correlation with droplet size vs. efficacy than the other two systemic herbicides. Even when the concentration of glyphosate was altered @ 1, 2, and 4 kg/ha, smaller size droplets (150-365 um) showed greater phytotoxicity than large size (665 um) droplets. This research was carried out jointly with Leo Cadogan (FP-51).

B. Field Studies

(i) Evaluation of a Modified Sprayer for Treatment of Small Plots

A herbicide sprayer was modified and tested for treatment of small (5x5) plots for evaluation of herbicides and their formulations and mixtures. Testing carried out in 2 locations over a 3 year period showed that this modified sprayer is most suited for application of herbicides to aspen, pincherry, alder (and raspberry) especially when they are 5-10 feet tall. We have named it as an "H-boom" sprayer.

(ii) Effects of Adjuvants on Efficacy of Forestry Herbicides under Small Plot Conditions

The effectiveness of 6 adjuvants Enhance, Ethokem, Frigate, LI-700, Tritron XR and Tween-20 with Roundup and Velpar (@ 0.5 kg/180 L/ha) was tested in Thessalon, Ont. employing the small plot technique and the "Solo" backpack hand sprayer. A randomised block layout with buffer zones and three replications was designed and the herbicides alone, and in combination with each adjuvant, were sprayed on a stand of aspen-poplar in mid-August, 1986. Evaluations were carried out after a month. Results showed that all adjuvants added @ 0.1-0.5% to each of the herbicide formulations appeared to increase the efficacy of Roundup and Velpar at reduced dosage levels (0.5 kg/ha). Further observations will be conducted next year (1987) to ascertain the effects on resprouting.

(iii) Effects of Nozzle types on Efficacy of Forest Herbicides

Two nozzle types (i) CDA-Herbi, emitting a droplet spectrum with a median droplet size ca. 250 um and (ii) a modified CDA nozzle with lower rotatory speed and widened orifice, and emitting a droplet spectrum with a median droplet size ca. 550 um, were used to assess the influence of small and large size droplets on efficacy of Velpar-L and Roundup @ 2 kg/40 L/ha. The experiment was conducted in a stand of aspen poplar ca. 1-2 m tall. The volume (40 L/ha) and the dosage (2.0 kg/ha) were kept constant and the plots (5x5 m) were sprayed on 15 August/86. The design of the experiment was a randomised block layout with small buffer zones. To minimize variability, treatments were replicated three times and a total of 120 plants were assessed for phytotoxicity. Kromekote cards were used to monitor the distribution pattern and size of droplets emitted by each type of nozzle. Observations were made in early Sept. (12/86). An analysis of the results demonstrated that no firm conclusion can be drawn from these experiments because the variability was very high. However, the data from Velpar treated plots indicated that CDA-Herbi nozzle (droplet size - 250 um) produced greater mortality of weeds than the modified CDA rotary nozzle with widened orifice (droplet size - 550 um). The effects of Roundup were not so clear because being a systemic herbicide its effects are somewhat delayed. However, a trend similar to Velpar was evident: smaller droplets appeared more toxic. Under field conditions it is rather difficult to discern, with precision and clarity, the influence of droplet size on efficacy probably because of so many interacting factors. Large numbers of samples, well-designed and statistically laid out experiments and several fold replications are needed to sort out subtle differences between the impact of small and large size droplets. The author is grateful to Dr. Nick Payne (FP-62) for providing advice in this study.

SEX PHEROMONES OF FOREST INSECT PESTS

[Project No. FP-30 - Pheromones Physiology]

Report to The 14th Annual Forest Pest Control Forum

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Among the important cone and seed pests of spruces and firs across Canada is the spruce coneworm, *Dioryctria reniculelloides* Mutuura and Monroe. As one of the goals of the FPMI pheromone project, we have identified, through a cooperative research study, the sex pheromone of the spruce coneworm and investigated the effects of trap placement on moth capture (G.G. Grant, Y.H. Prevost, K.N. Slessor, G.G. King and R.J. West, in prep.). The main sex pheromone component was identified by chemical analysis, EAG bioassay, and field tests as (Z)-9-tetradecenyl acetate (Z9-14:Ac), which is also a sex pheromone component or attractant of several other North American *Dioryctria* species (Table 1). However, two additional chemicals, (Z)-7-dodecenyl acetate (Z-12:Ac) and (Z)-7-dodecenal (Z7-12:Ald), synergize the main component. These compounds have not been found in the other *Dioryctria* species.

Based on trapping results from 1982 to 1986, a lure composed of 3 ug Z9-14:Ac + 0.15 ug Z7-12:Ac + 0.15 ug Z7-12:Ald applied to a rubber septum (e.g. No. 1780 J07, A.H. Thomas Co.) is competitive with female-baited traps and is suitable for monitoring traps. Our trapping results have provided information on time of adult emergence, duration of the flight season, and changes in the population level from year to year. Monitoring traps are also potentially useful for predicting cone crop damage due to the coneworm. Unlike other *Dioryctria* species (Table 1), the spruce coneworm responds to a relatively low trap dosage of pheromone; quantities of pheromone greater than about 3 ug are relatively unattractive. Another important factor affecting trap catch is trap placement within the tree crown. Traps at cone height or at mid-crown in either black spruce or white spruce produced a significantly greater catch than traps a head height (1.5 m), and appear to better reflect actual population levels. Orchard ladders can be used to hang traps in the upper canopy and if the traps are attached to a pulley (string attached to the trap and passed through a wire loop on a suitable branch) they can be serviced during the flight season if necessary. The Pherocon 1CP (Zoecon Co.) was an effective commercial trap. Its smaller than usual trap opening significantly reduces the catch of extraneous insects, particularly the spruce budworm which flies at the same time as the coneworm in eastern Canada and would otherwise blunder into the traps.

Table 1. Known sex attractants for North American *Dioryctria* species

Species (Common name)	Pheromone Components	Optimum trap dose (ug/rubber septum)	Ref.
D. reniculelloides (spruce coneworm)	Z9-14:Ac + Z7-12:Ac + Z7-12:Ald	3 + 0.15 + 0.15	1
D. disclusa (webbing coneworm)	Z9-14:Ac	30-100	2
D. clarioralis (blister coneworm)	Z9-14:Ac + 12% E9-14:Ac + 10% Z11-16:Ac	30	3
D. amatella (southern pine coneworm)	Z11-16:Ac	100-300	4
D. merkeli	Z9-14:Ac + 6-15% E9-14:Ac	30	3

(1, This report; 2, Meyer et al. 1982, Environ. Ent. 11: 986-988; 3, Meyer et al. 1984, Environ. Ent. 13: 854-858; 4, Meyer et al. Environ. Ent. 15: 316-320)

It should be noted that of the *Dioryctria* species listed in Table 1, only *D. disclusa* is sympatric with the spruce coneworm; the other species occur in the southern states of the U.S.A. Because *D. disclusa* flies at the same time of year as the spruce coneworm (mid-July through early August) and shares the same major pheromone component, Z9-14:Ac, it could be attracted to the same pheromone traps. However, there are several factors which would reduce the likelihood of this happening. First the optimum trap dose for *D. disclusa* is at least 10-fold higher than for the spruce coneworm. Second the host preferences of the two species are different: the spruce coneworm is found mainly on spruces and firs, the webbing coneworm on pines. Finally, should *D. disclusa* be attracted to spruce coneworm traps, its bright orange colour would distinguish it from the whitish-grey spruce coneworm, making evaluation of trap catchs straightforward.

This study was carried out in cooperation with Y. Prêvost, University of Guelph; Drs. K.N. Slessor and G.G. King, Simon Fraser University; and Dr. R.J. West, Newfoundland Forestry Centre, CFS.

INSECTICIDE FIELD EFFICACY: SUMMARY REPORT FOR 1986

[Project No. FP-51 - Insecticide Field Efficacy]

Report to the 14th Annual Forest Pest Control Forum

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Insecticide Field Efficacy: Summary Report for 1986

During 1986 the following field trials were planned:

1) The efficacy of Sumithion 20F flowable insecticide sprayed neat (i.e. undiluted) at 180 g AI/ha.
2) The efficacy of Sumithion 20F sprayed as an aqueous mix at 180 g AI in 1.5L of mix per ha; and
3) The efficacy of Sumithion 20F as an aqueous mix at 210 g AI in 1.5L of mix per ha.
4) B.t. Futura XLV sprayed neat at 20 and 30 BIU/ha. The above trials were targeted against spruce budworm Choristoneura fumiferana (Clem.) in balsam fir Abies balsamea.
5) Trials were also planned against jackpine budworm Choristoneura pinus pinus Freeman using Matacil 180F at 70 g AI in 1.5L of aqueous mix per hectare.

After these trials were finalised and the plots selected in Nipigon, Ontario. The Minister of Ontario, Ministry of Natural Resources, The Honourable Vincent Kerrio announced that no aerial application of chemical insecticides would be allowed on provincial crown lands.

Efforts to secure plots on freehold property were unsuccessful despite support from the pulp and paper industry. Because the chemical and biological studies were interconnected all of the trials were cancelled.

Population development of spruce budworm

A study was initiated in Nipigon (to take advantage of the plots that were already made available for the cancelled trials) aimed at better understanding the development, numerically and by instars, of spruce budworm on balsam fir, black spruce Picea mariana and white spruce Picea glauca.

Preliminary results indicate that in the field, budworm populations develop slightly slower on black spruce than on white spruce or balsam fir. These differing insect developments appear to be related to the host trees phenological developments. Understanding these developments will improve the biological assessments of efficacy trials when spruce budworm are the target insects.

RESEARCH STUDIES ON PHYSICOCHEMICAL ASPECTS OF PESTICIDE PERFORMANCE
(conducted in 1986)

[Project No. FP-61 - Pesticide Formulations]

Report to The 14th Annual Forest Pest Control Forum

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Research Studies on Physicochemical Aspects of Pesticide Performance

(conducted in 1986)

Introduction

During 1986, the Pesticide Formulations Project at FPMI undertook six laboratory investigations and two cooperative studies involving field investigations that are related to forestry spray activities. The major areas of research are grouped under two headings, A and B:

A. Laboratory Studies:

(i) Droplet and Deposit Characteristics of Pseudoplastic and Newtonian Formulations of Three Insecticides Following Spray Application Under Laboratory Conditions (in collaboration with FP-71 Project)

Three spray formulations, labelled as FDA-3409, AA-3409 and ZE-UC19-EML respectively, were prepared from fenitrothion, aminocarb and mexacarbate using oils, surfactants and/or cosolvents. The fourth formulation, Sumi-210 was prepared from fenitrothion, polymeric adjuvants and humectants. Their physical properties showed that the first three formulations were Newtonian, whereas the fourth one, Sumi-210, was pseudoplastic in behaviour. They were sprayed over potted balsam fir seedlings and Kromekote® card/glass plate units (collection units) in a laboratory chamber, using a spinning disc atomizer. The volume rate of application was 1.5 L/ha for all formulations. However, the dosage rates were lower for the aminocarb and mexacarbate formulations [at 70 g active ingredient (AI)/ha] than those for the fenitrothion formulations (at 210 g AI/ha). Foliar samples and collection units were removed from the spray chamber at 1.0 h post-treatment. Droplets on the fir needles and on Kromekote cards were counted and the size spectra were obtained. Insecticide deposits on the glass plates and foliar concentrations were measured by gas-liquid chromatography. The data indicated that, among the four formulations tested, the pseudoplastic formulation Sumi-210 provided a markedly larger droplet size spectrum and much greater deposit concentrations of the insecticide both on the conifer foliage and on the collection units.

(ii) Influence of Adjuvants on Spray Atomization, Droplet Size Spectra and Deposits of Four Fenitrothion Formulations

A study was conducted to investigate the influence of three adjuvants, viz., two surfactants Atlox® 3409F and Triton® X-114, and a cosolvent Dowanol® TPM (abbreviated as Atlo-3409, Trit-114 and Dow-TPM respectively) on spray atomization, droplet size spectra and deposit patterns of four fenitrothion formulations. Spray atomization was carried out in a laboratory chamber using a spinning disc atomizer, and droplets were sampled with Kromekote® cards and glass plates. Physical properties measured were: relative viscosity, surface tension, volatility and apparent viscosity-shear rate relationship. Between the two formulations containing Atlo-3409 and Dow-TPM, the one containing 1.5% (v/v) of each adjuvant provided a higher proportion of the small droplets and lower deposits than the formulation containing 1.5% of Atlo-3409 and 4% of Dow-TPM. Between the other two formulations containing Trit-114 surfactant, the one containing 7% of the adjuvant was more pseudoplastic than the one containing 5% adjuvant. However, both formulations provided similar number and volume median diameters, although the formulation with greater pseudoplasticity provided more droplets/cm^2 on the sample cards and greater deposits on the glass plates. Thus, the droplet size spectra, droplets/cm^2 and deposits on glass plates, were all relatable to the physical properties of the formulations studied.

(iii) Influence of Surfactants and Polymeric Adjuvants on Physicochemical Properties, Droplet Size Spectra and Deposition of Fenitrothion and *Bacillus thuringiensis* Formulations Under Laboratory Conditions

The effect of two surfactants and two polymeric adjuvants on droplet size spectra and deposition patterns of nine spray formulations was investigated following atomization in a laboratory chamber using a spinning disc atomizer that can produce a narrow droplet size spectrum. Spray droplets were sampled using Kromekote® cards and deposit recoveries were examined on glass plates. Physicochemical properties such as viscosity-shear rate relationship, volatility, pH, conductance, electrophoretic mobility and zeta potential of the spray media were measured to determine what properties would contribute to differences in atomization. The data indicated that formulations containing low surfactant concentrations provided Newtonian liquids with low viscosities. These liquids atomized into small droplets and provided low recoveries of spray deposits on sampling units. However, formulations containing a high surfactant concentration or polymeric adjuvants provided pseudoplastic liquids with high viscosities. These formulations resulted in large droplet size spectra with higher recoveries of spray deposits on sampling units.

(iv) Role of Adjuvants on Physicochemical Properties and Droplet Size Spectra for Drift Control of Glyphosate Sprays

The effect of two spray modifier adjuvants, Nalco-Trol® and Nalco-Trol® II, on atomization was studied to examine their use as potential drift control agents in glyphosate applications. Six spray media were selected with and without the two adjuvants in Roundup® formulations and in water. These were atomized in a laboratory chamber using spinning disc, twin-fluid and hydraulic nozzles to study the droplet size spectra and deposit levels on Kromekote® card/glass plate units. Physicochemical properties such as relative viscosity, surface tension, viscosity-shear rate relationship, volatility, pH, conductance, electrophoretic mobility and zeta potential of the spray media were measured to determine what properties would contribute to difference in atomization of the spray mixtures with and without the two adjuvants. The data indicated that the two adjuvants greatly reduced the proportion of the fine droplets in the spray cloud produced by all three atomizers. However, the effect was more pronounced with the twin fluid and hydraulic nozzles than with the spinning disc nozzle. Among the physicochemical properties studies, surface tension, electrophoretic mobility and zeta potential played important roles. All other properties were very similar for the spray media with and without the two adjuvants.

(v) <u>Influence of Adjuvants on Physicochemical Properties, Droplet Size Spectra and Deposit Patterns: Relevance in Pesticide Applications</u>

The influence of adjuvants on physicochemical properties, droplet size spectra and deposit patterns of five aqueous spray mixtures was studied under laboratory conditions, using two surfacants, Atlox® 3409F and Triton® X-114; two humectants, propylene glycol and glycerol; and one polymeric adjuvant, Agrisol® FL-100F. For the sake of comparison, two fenitrothion formulations containing polymeric adjuvants, and water were also included in the study. Spray was applied at 25°C and 75 ± 5% relative humidity, in an enclosure using a twin fluid atomizer. Deposits were collected on Kromekote® cards and glass plates. Physicochemical properties studied were: relative viscosity, surface tension, apparent viscosity-shear rate relationship, volatility, pH and conductance. The first four of these properties played significant roles on droplet and deposit patterns on sampling units. However, the chemical nature of the adjuvants also played some role. Between the two surfactants studied, Triton® X-114 provided a pseudoplastic medium, but both surfactant solutions provided similar droplet size spectra and deposit patterns. Between the two humectants, glycerol provided greater advantages than propylene glycol. The polymeric adjuvant provided droplet sizes similar to those of the two surfactants, although the recovery of the applied spray volume was higher. Among the two fenitrothion formulations, the one containing lower amounts of polymeric adjuvants showed some advantages, although deposits on the actual biological target should be examined before any definite conclusions can be drawn on the optimum adjuvant concentrations in the end-use formulations.

(vi) <u>Influence of Temperature on Physical Properties of Non-Aqueous Pesticide Formulations and Spray Diluents: Relevance in ULV Applications</u>

The viscosity, surface tension and volatility of a range of ultra-low-volume (ULV) spray diluents and pesticide formulations were measured at 5°C and 20°C. For ULV application of 1.0 to 1.5 litre/ha, it is concluded that the spray medium should have a viscosity of ≤30 mPa.s at 20°C, using the conventional boom and nozzle systems, or rotary (Micronair®) atomizers. The surface tension values covered only a narrow range and showed little temperature dependence. There was no clear optimum and all surface tensions within the range measured would appear to be acceptable for ULV applications. The optimum value of the volatility factor, $1/(A.T\frac{1}{2})$, where 'A' represents the percent non-volatile materials present in the spray mixture, and $T\frac{1}{2}$, the half-life (minutes) of evaporation, was considered to be $<40 \times 10^{-5}$.

B. Field Studies

(i) Effect of Volume Rate of Application on Droplet Size Spectra and Deposit Characteristics of Two Dimilin® Spray Mixtures in an Aerial Spray Trial

The field aspects of the study were completed in Newfoundland in 1985; but the droplet analysis on Kromekote cards, deposit analysis on glass plates, spread factor determinations, and physicochemical investigations were all carried out in 1986 under the responsibilities of the Pesticide Formulations Project. This cooperative study was undertaken in collaboration with Drs. Arthur Retnakaran, Arthur Raske and Rick West.

Summary: The wettable powder formulation of diflubenzuron, Dimilin® WP25 was aerially sprayed as an aqueous suspension over four 15 ha plots in conifer forests in Newfoundland, using different volume and emission rates of application. A Piper Pawnee aircraft equipped with six Micronair® AU5000 atomizers delivered the spray mixtures. Plot P9-35/4.7 was treated with 35 g active ingredient (AI) in 4.7 L/ha; plots P10-70/4.7 and P16-70/4.7, with 70 g AI in 4.7 L/ha; and

plot P11-30/2.0, with 30 g AI in 2.0 L/ha. The former three plots were sprayed each at the emission rate of 48.13 L/min, and the fourth plot, at 20.48 L/min. Spray droplets were sampled with Kromekote® cards to determine the size spectra of the spray cloud reaching the ground level. The use of a tracer dye, Erio Acid Red, facilitated droplet measurements on the sampling cards. Glass plates were used to collect deposits of the tracer dye for colorimetric determination of the percent recovery of the spray volume emitted.

The higher emission rate of 48.13 L/min used in plots P9-35/4.7, P10-70/4.7 and P16-70/4.7 resulted in large droplets, higher droplets/cm^2 and greater recovery of the applied spray volume at ground level. The lower emission rate of 20.48 L/min used in plot P11-30/2.0 to accommodate for the lower volume rate of application, resulted in smaller droplets, lower droplets/cm^2 and a smaller percent recovery of the spray volume on glass plates. The smaller droplets have a tendency to linger longer near the forest canopy, increasing the chance of impaction on the conifer needles. The lower emission rate might provide a better target coverage at canopy level, with minimum ground contamination; and warrants further field testing. The relationship between volume rate of application and deposit characteristics of Dimilin WP25 was discussed in relation to the droplet sizes emitted.

(ii) Formulation Properties, Droplet Size Spectra, Ground Deposits and Foliar Residues of Aminocarb and Fenitrothion in Flushed and One-Year-Old Balsam Fir Needles Following Aerial Application in Newfoundland Forests

The field aspects of this study were completed in 1985. The foliar residues were also determined in 1985. However, the droplet analysis on the sampling cards, spread factor determinations, and physicochemical investigations were all carried out in 1986 under the responsibilities of the Pesticide Formulations Project. This cooperative study was undertaken in collaboration with Drs. K.M.S. Sundaram, A. Retnakaran, A.G. Raske, R.J. West.

Summary: A study was conducted in 1985 in Newfoundland to investigate the inter-relationships between physical properties of spray formulations, droplet size spectra and deposits on ground sampling units, and residues in flushed and one-year-old balsam for foliage following aerial application of aminocarb and fenitrothion at different dosage rates, but using the same volume rates. The fenitrothion formulations were pseudoplastic due to the presence of polymeric ingredients; and provided more deposits on the ground sampling units and on the foliage than the aminocarb formulations, which were nearly Newtonian. At similar dosage rates, the ground deposits of fenitrothion were about twice as much as those of aminocarb, whereas the corresponding foliar residues were about 6 to 8 times higher than those of aminocarb, suggesting possible advantages of pseudoplastic formulations in providing optimum droplet sizes for enhanced deposition on balsam fir needles.

The foliar residues generally showed an increase when the dosage rates of the two insecticides were increased. Residues in flushed foliage were slightly higher than those in mature foliage. This is probably due to the location of the flushed needles at the extreme periphery of the tree canopy, which caused efficient deposition of the spray droplets on them.

SUMMARY REPORT OF PESTICIDE ATOMIZATION AND DISPERSAL RESEARCH

[Project No. FP-62 - Pesticide Atomization and Dispersal]

Report to the 14th Annual Forest Pest Control Forum

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Summary Report of Pesticide Atomization and Dispersal Dispersal Research

Introduction

The aim of the Pesticide Atomization and Dispersal project is to 'advance knowledge of spray formation, dispersal and deposition with a view to improving pesticide application techniques by increasing efficacy, reducing off-target deposit and the cost of forestry pesticide applications'. This project was formed at the beginning of this fiscal year by amalgamating the former Spray Cloud Behaviour and Dispersal Systems projects. Research is carried out in both field and laboratory-based investigations. This report summarizes the main thrusts of FP-62 activity during the past year.

1. Estimating buffers required around water during forestry permethrin applications.

   This research was carried out in response to a need expressed by Pesticides Directorate to provide a scientific basis and data with which to estimate buffers required around water to protect fish and aquatic arthropods during forestry permethrin applications. To resolve the problem of the multiplicity of buffers required under different conditions, e.g. of atmospheric boundary-layer stability, a worst case scenario was developed and buffers estimated on this basis. Upwind, crosswind and downwind buffers were considered separately. Spray cloud dispersal experiments were conducted to measure permethrin deposit on water from single swaths applied with ground-based equipment or aerially, under worst case meteorological, plant canopy and application conditions. These measurements were then used to construct a mathematical model to calculate permethrin deposit on water from multiple swath applications, again using a worst case scenario. Buffers were then estimated from calculated permethrin deposits in conjunction with in-house and published measurements of mortality-concentration relationships for species sensitive to permethrin including Aedes aegypti mosquito larvae, Gammarus pseudolimnaeus water shrimp and rainbow trout. Suggested downwind buffers were 10 to 100 m for ground-based and aerial applications at a rate of 35 g/ha or less. This collaborative research involved FPMI scientists from the Insecticide Toxicology, Insecticide Chemical Accountability, Environmental Impact, Biological Systems Analysis and Plantation Pest Management projects. A full account of this investigation has been published in Information Report FPM-X-70. This research provides regulators and others with a rational technique for estimating buffers, which can be used for other types of forestry pesticide application.

2. Comparing off-target deposit from aerial forestry glyphosate applications and estimating buffers required around water.

An investigation has also been carried out to measure off-target deposit from rotary-wing forestry glyphosate applications and provide a scientific basis and data with which to estimate buffers required around water to protect fish and aquatic invertebrates from direct toxicological effects of glyphosate. Again buffers were based on a worst case scenario. Spray cloud dispersal experiments were conducted to measure glyphosate deposited on water and foliar surfaces, and airborne drop concentrations from single swaths aerially applied under worst case meteorological conditions, using three different dispersal systems, the

Microfoil boom, Through Valve Boom and D8-46 hydraulic nozzle. Glyphosate deposit on water from multiple swath applications was calculated using a mathematical model based on the experimental measurements of deposit from a single swath. Buffers for a.i. application rates of 2.1 kg/ha or less were then estimated using published mortality-concentration relationships including those for Salmo gairdneri and Daphnia magna. Off-target deposit was lowest from the Microfoil boom, and highest from the hydraulic nozzle. A buffer of 10 m is suggested around water to prevent significant environmental impact at a.i. application rates of 2.1 kg/ha or less. This collaborative research involved FPMI scientists from the Herbicide Development and Use project; an account of the investigation will soon be published as an Information Report.

3. Comparison of off-target deposit from aerial glyphosate applications made under different meteorological conditions.

This investigation was carried out to measure and compare off-target deposit on water and foliar surfaces and airborne drop concentrations resulting from aerial glyphosate applications, made under a variety of atmospheric boundary-layer stabilities and windspeeds. Measurements of off-target deposit and airborne drop concentrations were made at various downwind distances from applications made using a Through Valve Boom mounted on a Cessna 188, flown over a recent cutover. Glyphosate residues from these 1986 field experiments are now being analyzed by the Herbicide Development and Use project. These data will provide further information about the meteorological conditions under which off-target can be minimized and can be used to estimate buffers required for this type of application.

4. <u>Herbicide atomizer-performance comparison</u>.

An investigation to measure dropsize spectra generated by various herbicide atomizers has been carried out under PRUF contract with Dr. J. Picôt, University of New Brunswick. Dropsize spectra from the Microfoil, and Through Valve Boom, AU 5000 atomizer, and hollow cone hydraulic nozzles were measured using scattering and imaging laser spectrometers and photographic techniques. Atomizers were mounted in a wind tunnel to provide realistic crosswinds, and dropsize spectra were measured over a range of flow rates and airspeeds. These data will be used to compare the driftable drop fraction and efficacy dropsize range produced by various atomizers. In conjunction with data gathered in studies carried out by the FPMI Herbicide Development and Use project on optimum dropsizes for efficacy this investigation will facilitate more efficacious herbicide applications with lower off-target deposit.

STUDIES ON THE ENVIRONMENTAL CHEMISTRY AND FATE OF FORESTRY INSECTICIDES USED IN 1985 FIELD RESEARCH PROGRAMS AT FPMI

[Project No. FP-71 - Chemical Accountability]

Report to the 14th Annual Forest Pest Control Forum

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Studies on the Environmental Chemistry and Fate of Forestry Insecticides Used in 1985 Field Research Programs at FPMI

The objectives of the Chemical Accountability Project are to develop analytical methods and to determine the distribution and fate of forest insect control chemicals in order to evaluate objectively their benefits and potential risks to the forest ecosystem. These objectives have been successfully accomplished by conducting in-house and field oriented researches as well as by participating in viable cooperative programs. This report summarizes the achievements made in field related researches conducted during 1986.

1. <u>Ground deposition and canopy penetration and distribution of fenitrothion applied to an immature mixed forest near Searchmont, Ontario by aircraft and by motorized knapsack mistblower: a comparative study</u>.

   The conclusions arrived from this two year comparative study are very significant and are summarized below. The relevant data are given in Tables 1 to 3.

   a) Amount of fenitrothion deposited on forest floor varied according to application method. With the mistblower, the deposit found on the forest floor was only 0.6% of the applied dosage (280 g A.I./ha) compared to 26% by aircraft. Screening of droplets by foliage was appreciable in the former compared to the latter.

   b) Droplet density, D_{min}, D_{max} and size spectra obtained by mistblower are small compared to aerial application (Table 1) (droplet density 5 <u>vs</u> 14; VMD (um) 31 <u>vs</u> 58; NMD (um) 18 <u>vs</u> 36; D_{min} (um) 6 <u>vs</u> 10, D_{max} (um) 83 <u>vs</u> 117).

c) The insecticide concentration found on fir and birch foliage [simulated (Al coils for fir and Al leaves for birch) and real] varied within the 20 m swath when applied by the mistblower. Maximum insecticide concentration was at 10 m and it decreased as follows: 10 m > 18 m > 2 m. Such distinct variations were not observed in the aerial application.

d) Canopy penetration and concentration of the active ingredient (A.I.) in fir were influenced by needle density, location on tree, spray volume and mode of application. Usually the gradation of A.I. in the fir canopy was significant in simulated and real samplers. The decrease in concentration was from top canopy to middle and bottom and periphery to interior. Such distinct gradations were not found in birch canopy (Tables 2 and 3).

e) Average deposit (ng/cm^2) levels found on Al coils (simulated sampler) during the mistblower application was only 69 ng/cm^2 compared to a high value (nearly 3 times higher) of 195 ng/cm^2 found in aerial application (Table 2). On the other hand, the deposits on fir needles found in both methods of application were close, <u>i.e.</u>, 39 ng/cm^2 <u>vs</u> 49 ng/cm^2 or 2.6 ppm <u>vs</u> 3.2 ppm. Droplet capture and retention by fir needles in both cases appear to be similar (impaction and sedimentation) provided the droplets are of similar size range.

f) Average deposit levels found on Al birch foliage (simulated sampler) during ground (mistblower) application was only 16 ng/cm^2 compared to 210 ng/cm^2 found in aerial application i.e., nearly 13 times higher in the aerial spraying (Table 3). Similarly mean deposit level found on real birch foliage during mistblower application was only 5 ng/cm^2 or 1.5 ppm (poor impaction of smaller droplets) compared to the value of 73 ng/cm^2 or 21.4 ppm found in aerial (high impaction of larger droplets, ref. Table 1). The ratio of deposit levels in both cases was nearly 1:14. Flat birch foliage (simulated and real) appeared to be a poor collector of smaller droplets of aerosol size compared to nearly cylindrical and thin fir needles (simulated and real).

2. Chemistry and fate of Dimilin® (diflubenzuron) in a Canadian forest environment.

Dimilin belongs to a novel group of insecticidal compounds, the substituted 1-benzoyl-3-phenylureas, discovered by Duphar B.V., Holland and introduced commercially in 1976. It acts by interfering with the deposition of chitin, one of the main components of the insect cuticle. Last summer an experimental aerial spray program was conducted near the Kaladar area in Southern Ontario to evaluate the environmental chemistry (fate, persistence, distribution etc.) and impact of Dimilin. The chemistry program had the following four distinct objectives:

a) Analytical methods development for diflubenzuron in environmental substrates and their validation.

b) Effect of different volume rates of application of Dimilin WP-25 on ground and canopy deposits and on droplet size spectra.

c) Comparison of deposit levels on different collectors under laboratory and field conditions following different volume rates of application and associated influence of the physicochemical properties on them and;

d) Distribution, persistence and fate of diflubenzuron in terrestrial and aquatic components of a forest environment following different volume rates of application.

Analytical methodology

Published methods for the analysis of diflubenzuron in environmental substrates were reviewed and laboratory tested. Results of the experimental trials indicated that among the methods available, the Duphar method, after considerable modification and improvement, met our present requirements although the method is still time-consuming, expensive and tedious. The analytical steps included sample preparation, solvent (polar/nonpolar organic, aqueous/organic etc.) extraction (refluxing and/or homogenization), partition, column cleanup and quantification by high-performance liquid chromatography (HPLC). The analytical steps varied according to the nature and type of the substrates. The fortified samples were extracted according to the developed and/or modified method. The recoveries and minimum detection limits were acceptable, consistent, reproducible and reasonably accurate.

Effect of different volume rates

The wettable powder formulation of diflubenzuron, Dimilin WP-25 was aerially sprayed as an aqueous suspension over three blocks (25, 15, 15 ha) in a mixed forest near Kaladar, Ontario, using the same dosage rate 70 g A.I./ha but at different volume rates (10, 5, 2.5 L/ha) of application. A Piper Pawnee aircraft equipped with four Micronair

AU 4000 atomizers delivered the spray mixtures. Details of the application are given in Table 4.

Spray droplets were sampled with Kromekote cards to determine the size spectra of the spray cloud reaching the ground level. The use of a tracer dye, Rhodamine B, facilitated droplet measurements on the sampling cards. Glass plates were used to collect deposits of the A.I. for HPLC determination to evaluate percent of the material reaching the forest floor.

The higher volume rate (10 L/ha) used in block 1 resulted in larger droplets (Table 5, NMD 132 um, VMD 250 um and D_{max} 490 um) higher droplets/cm^2 (19.9) and greater recovery of the applied material (83%) at ground level. The lower volume rates correspondingly produced, as can be seen from the data in Table 5, progressively lower droplet densities, droplet sizes and ground depositions. The histograms for the frequency distribution and volume distribution were distinctly different reflecting the different volume rates. Similar trends were also observed in water, soil, litter and foliar concentrations. Usually higher volume rates of application yielded disproportionately higher residue levels.

<u>Deposit levels of Dimilin WP-25 under laboratory and field condiditons</u>

The inter-relationships between different volume rates of application of the insecticide and physicochemical properties of the spray mix to droplet size spectra and deposit concentrations found on various static collectors were investigated in the spray chamber using simulated aerial spray applications. The data generated were compared with those obtained under field conditions. Although the deposit levels found on static collectors varied considerably under laboratory conditions, good correlations between various parameters were established. Such correlations were not found under field conditions probably due to variations in environmental factors. In both cases physical properties played significant roles in influencing droplet size spectra and deposition patterns of the sprays on collection units.

Persistence and fate of diflubenzuron in a forest environment

Following the application of Dimilin WP-25 aqueous suspensions to the three spray blocks at different volume rates (70 g A.I. in 10L/ha, 5 L/ha and 2.5 L/ha) foliage (white pine and maple), soil, litter, water, sediment, caged fish and aquatic plants were sampled at intervals of time up to 120 d postspray and were analyzed for the insecticide residues.

Aquatic samples were collected from 2 ponds (Block 1) and from 2 stream areas (Blocks 2 and 3). The physical and chemical characteristics of the ponds and the streams are given in Table 6. The residue levels found in the waters are given in Table 7. The maximum residue levels in pond waters ranged from 5.90 ppb (large pond) to 13.82 ppb (small pond) and more than 50% of them were lost within 1 d. Detectable levels of diflubenzuron persisted up to 15 d. The stream waters contained much lower levels of diflubenzuron (range 3.25 to 1.59 ppb) and dissipated rapidly below the detection limit (0.1 ppb) within 1 d probably due to dilution. Aquatic plants and sediment samples contained less than 1 ppm as the initial concentration. Caged fish samples did accumulate detectable levels of the chemical (about 0.1 ppm) on 1 d postspray but 3 d postspray samples did not contain any diflubenzuron.

The concentration levels of the insecticide found in white pine needles and maple foliage collected from the three blocks are given in Tables 8 and 9 respectively. The highest concentrations (fresh wt. ppm) of the chemical in pine needles were 13.07 (Block 1), 6.90 (Block 2) and 4.67 (Block 3). The residues dissipated gradually and the TD_{50} values obtained from the depletion curves were 13.4 d, 7.0 d and 5.8 d for the samples from blocks 1, 2 and 3 respectively. Low levels of diflubenzuron persisted in pine needles (0.24 ppm) and maple foliage (1.04 ppm) beyond the 120 d sampling period in block 1. In the other two blocks, the chemical dissipated from the foliage after the 30 d sampling period. Soil and litter samples contained about 1 ppm initially and detectable levels (0.1 ppm) of the chemical persisted up to 7 d post spray. Soil cores collected below 5 cm level (6-10 cm cores) did not contain detectable levels of the chemical indicating that the chemical is strongly bound to the top layers and vertical mobility of the material is absent. [The analyses of some of these substrates (soil, litter, sediment, aq. plants and fish) are not yet complete - the values reported are tentative].

The droplet and deposit density values found on the collection units correlated well with the initial maximum concentrations of diflubenzuron found in various substrates from all the three blocks. The study indicated that under the experimental conditions used, the material has a definite tendency to persist in forest foliage for some time and it could also linger for a while in stagnant waters. Otherwise, the material has a low tendency either to persist or to accumulate in other components of the forest environment.

TABLE 1

Comparison of Droplet and Deposit Densities of Fenitrothion Sprays Found on Collection Units at Forest Floor Level Following Aerial and Ground Applications

Application	Droplet density (drops/cm^2)	Dmin (um)	Dmax (um)	NMD (um)	VMD (um)	Amount deposited (g/ha)	Percent deposited
Aircraft	14 ± 9	10	117	36 ± 5	58 ± 16	73 ± 35	26 ± 13
Mistblower	5 ± 2	6	83	18 ± 3	31 ± 4	1.69 ± 0.86	1.04 ± 0.31

TABLE 2

Comparison of Average Fenitrothion Deposits on Simulated and Natural Balsam Fir Needles Obtained by Aerial and Ground Applications

Samplers	Location in tree crown					Mean
	T	M	B	MI	BI	
			AERIAL			
Al coil (ng/cm^2)	431 ± 204	301 ± 208	110 ± 68	68 ± 11	65 ± 24	195 ± 138
Fir needles						
(ng/cm^2)	75 ± 20	54 ± 30	43 ± 8	41 ± 13	30 ± 3	49 ± 17
(ng/needle)	30 ± 8	22 ± 12	17 ± 3	17 ± 5	12 ± 1	20 ± 7
(ng/g)	4987 ± 1303	3585 ± 1987	2895 ± 530	2763 ± 846	2030 ± 240	3252 ± 1116
			GROUND			
Al coil (ng/cm^2)	132 ± 48	74 ± 34	55 ± 27	52 ± 22	32 ± 17	69 ± 30
Fir needles						
(ng/cm^2)	61 ± 12	43 ± 11	41 ± 14	32 ± 10	18 ± 6	39 ± 11
(ng/needle)	25 ± 5	17 ± 5	16 ± 6	13 ± 4	7 ± 2	16 ± 4
(ng/g)	4095 ± 793	2850 ± 143	2717 ± 944	2133 ± 650	1217 ± 386	2602 ± 703

TABLE 3

Comparison of Average Fenitrothion Deposits on Simulated and White Birch Foliage Obtained by Aerial and Ground Applications

Samplers	Location in tree crown					Mean
	T	M	B	MI	BI	
			AERIAL			
Al leaves (ng/cm^2)	207 ± 53	226 ± 106	264 ± 116	198 ± 57	155 ± 59	210 ± 91
Birch foliage						
(ng/cm^2)	66 ± 24	90 ± 24	71 ± 29	72 ± 16	64 ± 18	73 ± 10
(ng/needle)	4108 ± 1492	5585 ± 1468	4396 ± 1772	4458 ± 986	3942 ± 1138	4498 ± 643
(ng/g)	19560 ± 7459	26597 ± 7338	20933 ± 8860	21230 ± 4931	18773 ± 5688	21419 ± 3064
			GROUND			
Al leaves (ng/cm^2)	18 ± 6	15 ± 7	17 ± 7	16 ± 6	13 ± 6	16 ± 6
Birch foliage						
(ng/cm^2)	6 ± 2	7 ± 3	3 ± 1	4 ± 2	4 ± 2	5 ± 2
(ng/needle)	392 ± 149	476 ± 182	221 ± 87	249 ± 106	252 ± 111	318 ± 127
(ng/g)	1867 ± 713	2267 ± 867	1050 ± 413	1183 ± 503	1200 ± 527	1513 ± 605

TABLE 4

Weather Conditions, Aircraft Parameters and Formulation Compositions During the 1986 Dimilin Spray Application

PARAMETER	BLOCK 1	BLOCK 2	BLOCK 3
Date of Application	June 5	June 5	June 5
Time of Application (EDT)	0645	0745	1215
Windspeed (km/h) (Av.)	7.2	5.7	6.6
Wind Direction	NE	NE	NE
Temp. (°C) (Av.)	13.6	13.4	10.6
R.H. (%)	84.9	86.6	85.7
Cloud Cover	9/10	9/10	8/10
Precipitation	Nil	Nil	Very Light
Block Size (ha)	25	15	15
Comp. of Tank Mix (Wt.%)			
Dimilin 25W	2.8	5.6	11.2
Water	96.2	93.4	87.8
Rhodamine B Dye	1.0	1.0	1.0
Volume Rate (L/ha)	10	5	2.5
Dosage Rate (g A.I./ha)	70	70	70

Aircraft Type:	Piper, Pawnee Brave, PAC 6-3000
Atomizer:	Four Micronair AU 4000
Blade Angle:	35°
Aircraft Speed:	160 km/h
Spray Height Above Canopy:	20 m
Swath Width:	45 m

TABLE 5

Spray Deposit Data Following Aerial Application of Dimilin W.P.-25 Formulation at Different Volume Rates

PARAMETERS	BLOCK 1 (70 g A.I. in 10 L/ha)	BLOCK 2 (70 g A.I. in 5 L/ha)	BLOCK 3 (70 g A.I. in 2.5 L/ha)
No. of K-cards	30	21	21
Droplet Density	19.9	12.2	8.9
Droplet Range (um)	5-490	5-420	5-327
NMD (um)	132	95	77
VMD (um)	250	195	150
Ground Deposit (g A.I./ha)*)	57.8	22.0	13.3
Percent A.I. Deposited*	83	31	19
Percent A.I. Deposited†	81	44	17

*Glass plate eluates by HPLC and computed the percent A.I. deposited

†Computed from droplet data

TABLE 6

Physical and Chemical Characteristics of the Study Ponds and Stream During the Aerial Application of Diflubenzuron

Characteristics	Ponds			Stream	
	Control	Small	Large	5.0 l/ha	2.5 L/ha
Area (av.) (m^2)	3800	3400	15300	-	-
Depth (max.) (m)	1.10	1.35	0.75	0.85	1.2
Width (av.) (m)	-	-	-	3.2	2.1
Discharge (L/s)	-	-	-	22	17
Gradient (m/km)	-	-	-	1.7	1.2
pH	6.21	5.79	6.22	7.00	6.99
Specific conductance (umho/cm)	29.1	23.7	20.1	144	144
Turbidity (JTU)	33	60	12	25	25
Total alkalinity (mg/L as $CaCO_3$)	19.9	6.8	6.0	135	135
Hardness (mg/L as $CaCO_3$)	10.1	10.0	5.0	37.5	37.5
CO_2 (mg/L)	14.6	18.6	7.5	21.8	22.4
NO_x (mg/L)	0.011	0.014	0.013	0.011	0.017
NH_3 (mg/L)	0.112	0.113	0.028	0.025	0.014
Total Cations ($Na^+ + K^+ + Mg^{++} + Ca^{++}$) (mg/L)	5.73	4.90	3.52	28.2	28.0
Total anions ($Cl^- + SO_4$) (mg/L)	0.87	1.27	2.70	2.76	2.68
SiO_2 (mg/L)	1.60	0.43	2.56	10.6	12.0

TABLE 7

Average Concentrations of Diflubenzuron in Pond and Stream Waters Collected at Intervals of Time Following Application of the Chemical at Different Volume Rates

Time after application	Average (n=3) concentrations (ppb) of diflubenzuron			
	Block 1*		Block 2**	Block 3†
	Large Pond	Small Pond	Stream	Stream
Prespray††	N.D.	N.D.	N.D.	N.D.(0.26)
1 h	5.90 ± 0.21	13.82 ± 1.17	3.25 ± 0.41	1.59 ± 0.61
3 h	5.87 ± 0.90	9.67 ± 0.81	2.22 ± 0.27	1.81 ± 0.44
6 h	6.09 ± 0.63	5.99 ± 0.43	0.71 ± 0.34	1.61 ± 0.51
12 h	4.22 ± 0.21	6.28 ± 0.99	0.15 ± 0.07	0.52 ± 0.33
1 d	2.76 ± 0.20	4.31 ± 0.46	N.D.	0.13 ± 0.03
2 d	2.06 ± 0.32	3.36 ± 0.23	N.D.	N.D.
3 d	1.40 ± 0.28	1.84 ± 0.47	N.D.	N.D.
5 d	0.44 ± 0.15	0.63 ± 0.32		
7 d	0.23 ± 0.06	0.47 ± 0.40		
10 d	0.45 ± 0.18	1.02 ± 0.62		
15 d	0.11 ± 0.05	0.22 ± 0.07		
20 d	N.D.	N.D.		
30 d	N.D.	N.D.		

* Volume rate of application 70 g. A.I. in 10 L/ha
** Volume rate of application 70 g. A.I. in 5 L/ha
† Volume rate of application 70 g. A.I. in 2.5 L/ha
N.D. *Not* detected; detection limit 0.10 ppb
†† Prespray samples were collected 3 h prior to application. The value in parenthesis in Block 3 shows the residue level found in down-stream water from Block 2 sampled 0.5 h prior to spraying of Block 3.

TABLE 8

Average Concentrations of Diflubenzuron in White Pine Foliage Collected at Intervals of Time Following Application of the Chemical at Different Volume Rates.

Time After Application	Average Concentration (ppm) of Diflubenzuron		
	Block 1	Block 2	Block 3
	70 g A.I. in 10 L/ha	70 g A.I. in 5 L/ha	70 g A.I. in 2.5 L/ha
Prespray	N.D.*	N.D.	0.33 ± 0.08†
1 h	13.07 ± 2.99	6.90 ± 2.91	4.67 ± 1.77
3 h	13.01 ± 3.22	6.43 ± 2.94	4.64 ± 1.09
6 h	12.15 ± 2.11	5.23 ± 2.07	3.62 ± 0.97
12 h	10.43 ± 1.89	4.12 ± 1.88	–
1 d	11.07 ± 2.01	4.61 ± 1.99	3.52 ± 0.88
2 d	8.46 N 1.31	4.59 ± 1.73	3.42 ± 0.73
3 d	6.51 ± 0.98	3.57 ± 2.11	2.71 ± 0.41
5 d	5.41 ± 1.01	2.95 ± 1.83	2.23 ± 0.27
7 d	4.93 ± 0.75	1.61 ± 0.61	1.40 ± 0.11
10 d	3.81 ± 0.62	1.05 ± 0.73	0.82 ± 0.19
15 d	3.50 ± 0.44	0.72 ± 0.39	1.02 ± 0.13
20 d	3.41 ± 0.38	0.40 ± 0.18	0.34 ± 0.10
30 d	2.76 ± 0.47	0.29 ± 0.11	0.17 ± 0.06
120 d	0.24 ± 0.17	N.D.	N.D.

* N.D. = Not detected; detection limit 0.10 ppm (wet wt.)

† Prespray samples were collected 1 h prior to application. The residue level found in prespray sample from Block 3 is due to drift from Block 2.

TABLE 9

Average Concentrations of Diflubenzuron in Maple Foliage Collected at Intervals of Time Following Application of the Chemical at Different Volume Rates.

Time After Application	Average Concentration (ppm) of Diflubenzuron		
	Block 1	Block 2	Block 3
	70 g A.I. in 10 L/ha	70 g A.I. in 5 L/ha	70 g A.I. in 2.5 L/ha
Prespray	N.D.*	N.D.	0.49 ± 0.15†
1 h	19.09 ± 3.76	4.10 ± 2.27	3.36 ± 0.31
3 h	19.07 ± 4.15	4.02 ± 1.89	3.27 ± 0.28
6 h	18.08 ± 6.32	3.95 ± 1.77	3.20 ± 0.41
12 h	18.26 ± 5.11	3.08 ± 1.06	-
1 d	17.22 ± 4.99	2.90 ± 0.89	2.81 ± 0.46
2 d	15.88 N 2.81	2.23 ± 0.71	2.26 ± 0.33
3 d	16.04 ± 4.02	2.01 ± 0.78	1.95 ± 0.44
5 d	12.72 ± 3.12	1.72 ± 0.61	1.45 ± 0.27
7 d	9.23 ± 2.77	1.41 ± 0.63	1.52 ± 0.43
10 d	8.75 ± 1.83	1.01 ± 0.38	0.63 ± 0.36
15 d	7.54 ± 1.61	0.66 ± 0.22	0.34 ± 0.26
20 d	5.46 ± 1.71	0.42 ± 0.19	0.26 ± 0.17
30 d	4.67 ± 2.10	0.21 ± 0.08	0.11 ± 0.08
120 d	1.04 ± 0.67	N.D.	N.D.

* N.D. = Not detected; detection limit 0.10 ppm (wet wt.)

† Prespray samples were collected 1 h prior to application. The residue level found in prespray sample from Block 3 is due to drift from Block 2.

SUMMARY REPORT ON STUDIES OF PESTICIDE IMPACTS ON FOREST ECOSYSTEMS

[Project No. FP-70 - Environmental Impact]

Report to The 14th Annual Forest Pest Control Forum

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Summary Report on Studies of Pesticide Impacts on Forest Ecosystems

Introduction

Activities of FPMI's Environmental Impact Project in 1986 were again primarily focused on in-depth environmental impact research in the Icewater Creek research area. Plans to conduct aerial sprays for continuing songbird and pollinator exposure-response studies were thwarted by a provincial ban on aerial applications of chemical insecticides to forests in Ontario. A mist-blower application of fenitrothion was made to a small songbird study block. Foliage insect and songbird responses to the treatment were evaluated. A number of forest plants were evaluated for their dependence on arthropod vectors of pollen for successful reproduction. The pre-treatment data baseline for brook trout and aquatic invertebrate populations in Icewater Creek was extended in preparation for an insecticide impact study in 1987. The effects of the insect growth regulator Dimilin on aquatic invertebrates was evaluated in small ponds in the Kaladar region of Ontario where gypsy moth outbreaks are occurring.

Icewater Creek Studies

In 1980, the Environmental Impact Section of FPMI, through the co-operation of the Sault Ste. Marie District Office of the Ontario Ministry of Natural Resources, set up an ongoing research program in the Icewater Creek watershed about 50 km north of Sault Ste. Marie, Ontario. The objective of this programme is: To examine in-depth a number of aquatic and terrestrial habitats and micro-habitats and their resident animal populations to determine: (1) the nature and degree of inherent risk, (2) the level of actual exposure, and (3) actual response to forest pest management strategies involving aerial applications of pest control agents.

The program is designed to generate information on three aspects of the effects of forest pest control activities on the environment: (1) potential risk (2) actual exposure and (3) actual response. In general, the actual impact on each part of the environment is primarily a factor of the susceptibility of that portion of the ecosystem to the particular pest control procedure and its level of exposure to the pest control agent used, i.e., Risk + Exposure = Response. To this extent, part of the objective of the program is to help predict potential hazards of any suggested pest control action. Experimental pesticide treatments are applied to test actual responses and elucidate the nature of and ecosystem responses to actual impacts. This involves relating impacts at lower trophic levels or among specific groups of organisms to secondary impacts on higher trophic levels and changes within the ecosystem (e.g., altered food supply, changes in basic processes such as predation or pollination, etc.).

Songbird Studies

Plans to conduct an aerial application of fenitrothion to the Icewater Creek songbird study plot in 1986 had to be abandoned due to a provincial ban on aerial applications of chemical insecticides to crown land forests. This decision was a severe setback to the songbird activity initiated on this plot in 1983. When it became clear that an aerial treatment would not be allowed, a nearby site approximately 3 ha in size was prepared by clearing paths at 20 m intervals to allow treatment from the ground using a motorized backpack mistblower. Songbird foraging activities in coniferous and deciduous trees were evaluated on this plot in conjunction with evaluations of foliage insect abundance and knockdown. Following the ground application of 280 g fenitrothion/ha, drop tray catches of foliage insects were substantially increased for several days and insect numbers in the crowns of fir trees declined. Songbird response to these changes in terms of changes in foraging behavior is currently being assessed. The distribution of fenitrothion deposits within various portions of the trees utilized by songbirds was also evaluated in conjunction with the Insecticide Chemical Accountability Project.

Terrestrial Arthropod Studies

A research grant provided by the Ontario Pesticides Advisory Committee made possible some preliminary investigations into the identification of native plant species whose reproduction is dependent upon arthropod vectors of pollen. Monitoring of the reproductive rates of such species could allow the identification of indirect effects of reductions in pollinator populations.

Seven species of plant were studied but two species were sufficiently damaged by frost as to eliminate them completely from analysis. Preliminary analysis indicates that of the five remaining species, Polygonatum pubescens (Hairy Solomon's Seal) and Streptopus roseus (Rose Twisted Stalk) appear to be dependent upon insect pollinators and are exclusively or primarily out-crossers. These two species, therefore, show the greatest promise for incorporation into an impact monitoring program. Heracleum lanatum (Cow Parsnip) is also apparently dependent upon insects but bagged inflorescences set fruit equally well with pollen derived from the same plant or from another individual. Trillium cernuum (Nodding Trillium) is indicated not to be dependent upon insects for pollen transfer. The data for Smilacina racemosa (False Solomon's Seal) are equivocal and no clear indication of insect dependence or independence was provided.

Insect visitors to the flower species above were qualitatively sampled and are being processed. Initial indications are that *P. pubescens* is visited primarily by bumblebees and secondarily by hover flies. Only one specimen of a visitor to the flowers of *S. roseus* was encountered and this was a hover fly. Flower visitors to *H. lanatum* are both diverse and abundant being comprised of a variety of Coleoptera, Hymenoptera, Diptera, and a few Hemiptera and Lepidoptera. A few visitors to *S. racemosa* indicate an attraction of primarily Coleoptera and Diptera. No insect visitors were encountered on *T. cerhuum*.

Initial trials to attract wild, ground-nesting Andrenidae and Halictidae to establish nests in portable sand boxes were not successful. No bees were passively attracted and two attempts to actively encourage colonization by restraining females on the boxes with window screens overnight, were also unsuccessful.

In addition to the above investigations, other ongoing qualitative sampling of the resident insect fauna in the Icewater Creek research area was substantially extended.

Aquatic Studies

Systematic brook trout population sampling within selected study sites in the upper Icewater Creek watershed continued throughout 1986. The data collected from these sites since 1984 has provided a comprehensive picture of seasonal patterns of density, growth, movement, age class structure and production of resident brook trout populations. Aquatic invertebrate populations at these sites were also evaluated throughout 1986, and tracer dye movement within this portion of the creek was evaluated under several conditions of streamflow. An experimental introduction of insecticide into the creek is planned for the spring of 1987. This should provide a detailed evaluation of fish response to an insecticide caused disturbance of stream invertebrates.

Dimilin® Aquatic Impact Studies

Diflubenzuron (Dimilin®) is an insect growth regulator of considerable promise for use against forest pests such as Gypsy moth and hemlock looper. Environmental impact and fate studies were carried out by the Environmental Impact and Insecticide Chemical Accountability projects in 1986 to provide data required before forestry registrations for this product will be granted. Experimental aerial applications were made to small blocks of gypsy moth infested private land in the Kaladar area of Ontario. Aquatic impact and fate studies were carried out in small ponds within a block treated with 70 g/ha.

The Dimilin® treatment had severe effects on crustacean zooplankton in the study ponds. Cladocera disappeared from one treatment pond for about three months and from the other treated pond for over two months. It should, however, be noted that Cladocera populations also declined dramatically in the untreated control pond three weeks after treatment, and remained low for the rest of the summer. This suggests that although the Dimilin® treatment strongly affected Cladocera, their recovery was hampered by adverse natural conditions. Copepoda were affected to a lesser extent in both treated ponds and recovered to exceed numbers in the untreated control within two months of treatment. Caged invertebrate studies and sweep sampling showed limited effects of the treatment on benthic invertebrates. Mortality of caged amphipods over the first four days after treatment was about twice as high in treated ponds as at the control site. There were no indications of effects on amphipods from sweep sample catches. Both caging and sweep sampling suggested some effect on immature waterboatmen (Hemiptera: Corixidae) but no effect on phantom midge larvae (Diptera: Chaoboridae). In general, benthic invertebrate populations appeared to be only lightly impacted by the Dimilin® treatment.

THE EXPERIMENTAL SPRAY PROGRAM AGAINST THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1986

Raske, A.G., A. Retnakaran, and J. Hudak

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THE EXPERIMENTAL SPRAY PROGRAM AGAINST THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1986

by

Raske, A.G., A. Retnakaran and J. Hudak

INTRODUCTION

The eastern hemlock looper (*Lambdina fiscellaria fiscellaria* Guen.) outbreak that started in Newfoundland in 1984 was forecast to cover about 912 000 ha of fir and fir-spruce forest in 1986 including 219 000 ha in the moderate and severe defoliation category. Many of these stands were still in a weakened condition following the recent spruce budworm outbreak and some of them were also defoliated by the hemlock looper in 1985. The Newfoundland Department of Forest Resources and Lands sprayed about 81 000 ha in 1986 with fenitrothion and about 5 000 ha with *B.t.*

In 1985 experimental sprays by the Canadian Forestry Service, excellent population control was achieved with two applications of Thuricide 64B, at 30 BIU/ha, and two applications of Dimilin at 70 g ai/ha. However neither pesticide provided foliage protection when applied at late second- and early third-larval instars. Furthermore Dimilin was sprayed at 4.7ℓ/ha; a volume rate too large for efficient application.

In 1986 the Canadian Forestry Service, in cooperation with the Newfoundland Department of Forest Resources and Lands, planned to test earlier applications of pesticides, especially Dimilin; a lower volume rate of Dimilin at 2.5ℓ/ha; and a new water-based formulation of Sumithion (fenitrothion) at a reduced dosage of 180 g ai/ha.

The experimental project was approved by Agriculture Canada and the Newfoundland Department of Environment following recommendations of the Pesticide Advisory Board.

METHODS

The dosages and formulations of insecticides sprayed at the peak second-instar larval stage (30% third instar) were as follows:

1. Dimilin 2 x 70 g ai/ha[1], at 4.7ℓ/ha

   (new) 2 x 70 g ai/ha, at 2.5ℓ/ha

2. Sumithion 2 x 210 g ai/ha, at 1.5ℓ/ha, oil base

   (new) 2 x 180 g ai/ha, at 0.9ℓ/ha, water base

Each new formulation could be compared to unsprayed control areas and to the standard formulation. The dye Rhodamine B was added to the Dimilin formulation and the water-based formulation of Sumithion, and Automate B to the oil-based formulation of Sumithion.

Suitable spray plots were chosen near Gallants, Newfoundland (Fig. 1). Dimilin treatments were applied to 51 ha plots (2 120 m x 240 m), and Sumithion to 30 ha plots (1 000 m x 300 m). Three control plots were selected to match the population density in the various treatment blocks. One Grumman AgCat aircraft equipped with AU-5000 micronair spray units was calibrated to deliver the desired volume in 30 m swath widths. The interval between first and second application was five days or more depending upon suitable weather.

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[1]g ai/ha = grams of active ingredient per hectare.

Larval population levels were determined with "beating samples" using 20 trees per plot, and pupal population levels with burlap traps placed near breast height on the bole of 40 trees per plot.

Spray deposit was assessed at ground level with Kromekote[R] cards and glass plates for all treatments. Metal coils and water-filled trays placed on the ground were also used to assess Dimilin spray deposit. Foliage samples, collected at mid-crown, were also collected to determine spray deposit and insecticide persistence. Foliage samples were collected on the day of the spray, the day after, and at three day intervals to 15 days post-spray. In addition, 40 cm long plastic brushes, resembling test tube cleaners, were placed on foliage to determine the cause of within branch variation of insecticide deposit.

Weather parameters recorded were precipitation, wind speed and direction, cloud cover and temperature at 2.5 m and 13 m above ground.

Larvae from pre-spray, mid-spray and post-spray samples and pupae from pupal traps were reared to determine survival, parasitism and incidence of disease. Larvae from Dimilin-treated plots were reared on foliage collected from those plots to subject larvae in both the field and laboratory to the same dosage of insecticide.

RESULTS

It was not possible to obtain the aircraft for the early application planned. Unsuitable spray weather further delayed the first application, and also delayed the second application. The first sprays were applied 6-8 July. At the time of the first application 19.7% were first instar larvae, 78.6% were seconds and 1.7% thirds (n = 21 393). However, most of the second instar larvae were in the inactive pre-molt phase at the time of application and would not have ingested appreciable amounts of insecticide till the third instar. The second spray was applied 13-17 July. At the time of this application 3.9% were estimated to be first-instar larvae, 31.1% were second and 65.0% third (n = 11 479).

Weather at the time of spray was excellent for all applications. A side wind that caused the spray cloud to drift 20 m perpendicular to the flight line of the Dimilin application at 4.7ℓ/ha did not prevent sample trees from receiving their intended dose of insecticides, as ascertained by visual examination of Kromekote[R] card deposit.

Analysis of spray deposit on Kromekote[R] card and glass plates is still in progress. Foliage and brush samples were ruined by freezer breakdown and cannot be analyzed for insecticides. Furthermore the dye, was absorbed by the polyethylene bristles of the brushes and these could not be analyzed for the amount of dye present. The amount of dye could have been related to the amount of insecticide. A different type of plastic or a metal brush should be used in any repeat experiment.

All applications of insecticide gave good population reductions (Table 1). In the Dimilin plots most larvae died during pupation in the first days of August, and in the Sumithion plots they died before major feeding by the fourth instar and shortly after the post-spray sample. Subsamples showed over 90% larval mortality 7 to 10 days after the spray. Larvae in Sumithion-treated plots were moribund 2 to 3 days after each treatment but then seemed to recover both in the field and when taken to the laboratory. Over 90% of the larvae in the field died, but larvae reared in the lab fed on unsprayed foliage survived for more than 10 days.

Proportionate pupal reductions were almost equal for all four treatments, however, a smaller proportion of moths emerged in the Dimilin plots than in the Sumithion plots.

Proportion of foliage saved was lower in the Dimilin plots than in the Sumithion plots (Table 1). However, Dimilin at the standard dosage and volume rate saved considerable amounts of foliage; (40%), about two-thirds of the Sumithion plots (x = 62%).

The proportion of moths that emerged from the pupal samples was decidedly lower in the Dimilin plots than in the Sumithion and in the control plots (Table 1). Therefore the overall survival to the adult stage was equal for the two Dimilin treatments, and sub-equal to that in the oil formulation of Sumithion.

Fungal diseases of looper larvae can be abundant, but were not an important factor in the 1986 trials. Incidence of fungi were only measurable among pupae in the control plot used to evaluate the Dimilin treatments. Disease adjustment would only slightly increase the proportion of pupal reduction. Parasites of looper larvae and pupae were rare in all samples, and did not influence reduction estimates.

DISCUSSION

The oil-based formulation of Sumithion at 210 g ai/ha gave excellent population control, but early instar larval feeding before the spray, resulted in less foliage protection than expected. The reduced dosage of Sumithion at 180 g ai/ha was almost equal in pupal reduction and also provided reasonable foliage protection. Both sprays gave better results than did similar water-based formulations in Newfoundland in 1985 (See Pest Control Forum Report for 1985). The post-spray larval samples of Sumithion should be taken 10 days after the last spray because of the delayed mortality of larvae.

Differences in residual effects, spray cloud behaviour and ease of handling of oil and water base formulations of Sumithion probably will determine which formulation is preferred for looper control. Also, early application at the beginning of the second instar could provide better foliage protection than that obtained in 1986. This should be tested.

The reduced volume of Dimilin spray provided slightly less reductions in larval and pupal populations than the 4.7ℓ/ha rate usually used against forest insects. Foliage protection was poor, because of the damage by early larval instars. Since Dimilin persists on the foliage, earlier applications, at the beginning of second instar, should be tried to see if foliage protection as well as larval reduction can be obtained.

The persistence of insecticides of various formulations on foliage under field conditions is important information needed to determine the effectiveness of early insecticide application. Since 1986 samples could not be used for this purpose, this work should be repeated.

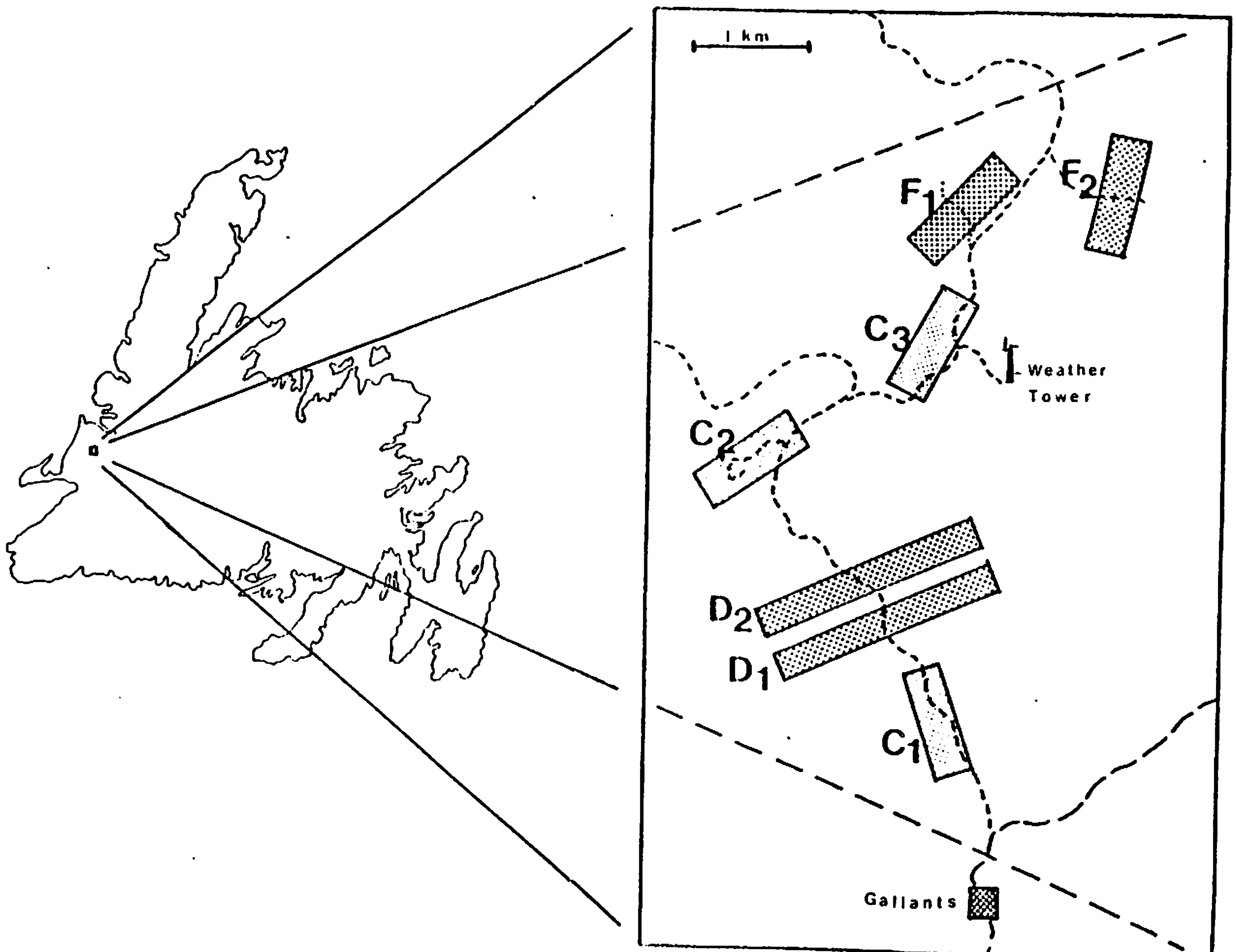

Fig. 1. Experimental plots for testing effectiveness of insecticides against the hemlock looper in Newfoundland in 1986. C = control plots, D = Dimilin plots, F = Sumithion plots.

Table 1. Effectiveness of aerial application of insecticides against the eastern hemlock looper in Newfoundland in 1986.

Treatment	No. applications and dosage (g ai/ha)	Volume applied (ℓ/ha)	Average pre-spray population per sample	% Population reduction[1] Post-spray larvae	% Population reduction[1] Pupae	% Moth emergence of survivors to pupal stage	% Foliage saved[2]
Dimilin	2 x 70	2.5 (water)	185	26	90	7	0
Control	-		202			70	
Dimilin	2 x 70	4.7 (water)	269	62	93	18	40
Control	-		202			70	
Sumithion	2 x 210	1.5 (oil)	118	60	99	53	59
Control	-		107			55	
Sumithion	2 x 180	0.9 (water)	86	54	92	53	65
Control	-		107			55	

[1]Calculated with Abbott's formula.

[2] $\frac{\text{Defoliation in controls-defoliation in plot}}{\text{defoliation in controls}}$.

SUMMARY OF 1986 FIELD AND LABORATORY RESEARCH REGARDING THE USE OF B.t. FOR CONTROL OF FOREST INSECT PESTS

[Project No. FP-10-2 - Bacterial Applications]

Report to The 14th Annual Forest Pest Control Forum

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November 1986

Summary of 1986 Field and Laboratory Research Regarding the Use of B.t. for Control of Forest Insect Pests

Bacillus thuringiensis (*B.t.*) is now widely used for effective control of the eastern spruce budworm in Canada. Goals of the Applications Research Project at FPMI are to further improve the effectiveness of *B.t.* for spruce budworm control and to transfer the knowledge and experience gained from work with this species to other defoliating forest insect pests. The research program comprises three major components:

1. To obtain a thorough understanding of the interaction between foliar deposits, the target insects and the host tree as affected by post spray weather,
2. To ascertain the relative susceptibility of major forest insect pests to various strains of *B.t.* in order to assess control potential,
3. To quantify residual activity of currently used *B.t.* formulations in relation to weather conditions and to assess spray adjuvants to increase the foliage life of *B.t.*

During 1986 work was conducted in each of these areas and is summarized below.

1. *B.t.*-target insect - weather interactions

The effect of temperature on toxicity of *B.t.* to spruce budworm larvae was examined in the lab. Between 13° and 28° C temperature had no effect on the level of toxicity but larval mortality progressed more rapidly with increasing temperature. LT50s ranged from 2-8 days at 28°C and 11-20 days at 16° depending on the dose. Low ambient air temperature in the field is expected to slow down the expression of B.t. toxicity in terms of larval mortality but not in terms of foliage protection - larvae that died did so without further feeding, regardless of the time needed to reach mortality.

2. Susceptibility of defoliators to B.t.

Diet bioassays were performed to test susceptibility of the eastern spruce budworm (ESBW), jackpine budworm (JPBW), western budworm (WBW), eastern hemlock looper (EHL), white marked tussock moth (WMTM), black-headed budworm (BHBW), gypsy moth (GM), and black army cutworm (BACW) to a variety of B.t. strains. These included the two strains currently used in commercial formulations (HD-1 and NRD-12) and the U.S. reference standard, HD-1-5-1980. Toxicity of HD-1 and NRD-12 were very similar but species differed widely in their susceptibility. WBW, BHBW, and WMTM were 5-10 times more susceptible than the ESBW, while BACW was ast least 50 times less susceptible. Operational field experience with ESBW control combined with these data indicate excellent potential for the use of B.t. against WSBW, BHBW, and WMTM.

Foliar bioassays were performed to further assess this potential. Higher susceptibility of these species implies that effective control might be possible with less concentrated formulations than currently used for ESBW control. Balsam fir shoots were sprayed with Thuricide 48LV diluted to 32, 16 and 8 BIU/gal. at about 1.5 60u drops/needle and bioassayed against ESBW and WBW. Mortality of WBW was higher than ESBW mortality in all treatments (70-90% as compared with 40-70% for ESBW) and occurred earlier. Based on the high mortality of WBW in even the lowest dilution (70% at 8 BIU/gal) I suggest that aerial sprays at a concentration of 24 BIU/gal will yield significant foliage protection provided the foliar deposits are adequate (≥1 drop needle). Preliminary assays were conducted with BHBW. Western hemlock shoots were sprayed with 48LV diluted to 32, 16 and 8 BIU/gal. at a deposit of about 1 50m drop/needle and bioassayed against last instar BHBW larvae received from the FIDS unit in Victoria (PFC). A dipteran parasite caused heavy (up to 45%) mortality in all treatments. Nevertheless, B.t. caused > 50% mortality of non-parasitized larvae at 16 and 32 BIU/gal.

3. Residual activity of Thuricide 48LV and effect of Bond

Residual activity of aerially applied Thuricide 48LV was studied this summer in a white spruce plantation near Thunder Bay. Foliage was collected immediately post spray (day 0) and every other until 14 days post spray and bioassayed against ESBW. An average deposit of 2.5 drops/needle resulted in only 50% mortality on day 0 foliage. After 2 days of weathering and only 7mm of rain this mortality dropped to background levels. Poor efficacy and poor residual activity was attributed to dilution of B.t. with heavy dew present on the needles during spray application.

Residual activity of Thuricide 48LV with and without a latex sticker (Bond) was examined on potted seedlings sprayed at 0.5 drop (50 m)/needle and placed outside. During 90h of exposure, 56mm rain fell over 2 days with one sunny day inbetween. Foliage of fully covered trees (no sun or rain) retained full insecticidal activity, as measured by ESBW bioassay. Trees sheltered from the rain but exposed to the sun retained 85% of the original (day 0) activity, while fully exposed trees lost 90% with or without the sticker. Obviously 56mm of rain is too much for the Bond sticker.

INSECT VIRUSES: RECENT PROGRESS

[Project No. FP-13 - Viral Applications]

Report to The 14th Annual Forest Pest Control Forum

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Summary

A 10 ha and 87.5 ha plot were aerially treated with Gypsy moth NPV using an accumulated dosage of 5×10^{12} PIB/ha and 5×10^{11} PIB/ha respectively. The deposit created an epizootic in both plots. In the plot receiving the high dose the gypsy moth population was eliminated, while in the plot receiving 5×10^{11} PIB/ha, 66.5% of the insect population remaining after five weeks was found infected with NPV disease. Douglas-fir tussock moth NPV (Virtuss) was applied to populations of white-marked tussock moth and caused infection which spread to untreated check areas.

Gypsy moth and Douglas-fir tussock moth NPV were produced in the laboratory and European pine sawfly NPV was produced in the field.

Red-headed pine sawfly NPV usage increased 112% from 1985 with OMNR staff treating 83 plantations with an area of 342 ha.

Gypsy moth, *Lymantria dispar*

The NPV product used to control the gypsy moth in the U.S. is called Gypchek. In 1985-86 FPMI obtained a sample of this virus as inoculum to infect 141,000 gypsy moth larvae. This produced 20 kg of freeze dried material and was enough to treat 400 ha with the dosage of 5×10^{11} PIB/ha (Table 1).

In collaboration with OMNR and GLFC, gypsy moth NPV was applied to a 10 ha (plot 1) and 87.5 ha (plot 2) area in Olden Twp. Two check areas were also selected, but unfortunately one was inadvertently treated with *B.t.* Plot 1 was treated with two applications of 2.5×10^{12} PIB/ha (total of 5×10^{12} PIB/ha) five days apart on May 18 and May 22, while Plot 2 was treated with two applications of 2.5×10^{11} PIB/ha (total of 5×10^{11} PIB/ha) on the same dates. A helicopter equipped with micronair units, calibrated to deliver 9.5 L/ha was used for these tests. The aqueous mix contained the virus, 25% molasses and 60 g/L Orzan L.S. Spraying was carried out in early morning at R.H. above 80%. Instar development at each spray application is shown on Table 2.

The effectiveness of the treatment in creating a viral epizootic was assessed by microscopic examination of prespray and post spray samples of larvae. Initially levels of NPV infection in the population ranged from 6.3%-8.8% (Table 3), and represented the incidence of natural, virus infection. Post spray samples indicated a three-fold increase in virus infection attributable to spray application (Table 3). Plot 1 and plot 2 were found to have 36.5% and 39.9% of larvae infected with NPV while check 1 and check 2 had 12.6% and 14.8% infected respectively. Infection levels increased in plot 2, which had a very high density of larvae, as the epizootic increased in impetus. At five weeks post spray, 66.5% of the remaining population was infected with NPV. Levels of disease in plot 1 increased to 46.7% after two weeks, but decreased thereafter as a result of the dramatic decrease in host population density due to virus disease. Low level of infection observed in both plots at the third week of sampling represent a period of abatement in the epizootic caused by insect mortality from virus application. The epizootic resumed impetus as this new source of inoculum infected the remaining population. This is observed more clearly in Fig. 1. Levels of disease infection in check 1 increased to 26.9%, then decreased to 17.6% as population mortality affected disease spread. Levels of disease in check 2 indicated the development of a disease epizootic despite being treated with 3 applications of B.t.

The effect of host population density on epizootic development was illustrated in these trials. The gypsy moth population in plot 1 was decimated by the application of 2.5×10^{12} PIB/ha and this, in turn, was reflected in the lower levels of disease incidence and rate of epizootic development. The high gypsy moth population in plot 2 provided the conditions for a severe epizootic reflected in high incidence of infection and greater rate of epizootic development. However, because of the high density population, red oak trees in plot 2 still suffered 30% defoliation, as compared to 22% in plot 1 and 19% in check 1.

At the termination of sampling, gypsy moth pupae were collected from each plot to determine if any effect of the virus application was manifested in pupal emergence. Pupae were reared individually, and all dead pupae were examined microscopically. Results indicated that slightly fewer females than males emerged and that levels of mortality from virus was same in all plots. However, virus treatment was observed to reduce parasitism (Table 4).

The effect of virus application to reduce populations from one year to the next was assessed by egg mass density studies. Overall the gypsy moth population collapsed in all check areas with a 1985 average of 26.3 masses/.01 ha reduced to 2.9 masses/.01 ha based on 14 check plots. Egg mass density was reduced in plot 2 from 32.4 masses/.01 ha in 1985 to 15.6 masses/.01 ha. Egg mass density in plot 1 dropped to 0.1 masses/.01 ha from 15.4 masses/.01 ha in 1985, indicating that our virus application successfully controlled this population.

Results from these trials indicate that dosage and the density of the gypsy moth population are the two important factors to consider in control operations. Unfortunately, the high dosage which was so successful in this trial is uneconomical to suggest for gypsy moth control at this time. The dosage of $5x10^{11}$ PIB/ha did not adequately control the high density population in plot 2 in 1986, but this result has also been observed when viruses are used to control high density populations of other insect species. Consequently, future work will be directed to generate efficacy data based on this recommended dosage.

Douglas-fir tussock moth, _Orgyia pseudotsugata_

At FPMI, Douglas-fir tussock moth NPV is propagated in white-marked tussock moth larvae and this produce has been called Virtuss. It received temporary registration under the PCPA in 1983. A similar American product, TM-BioControl-1 was registered under PCPA to allow quantities to be imported into Canada. A commercially prepared label has been printed for TM-BioControl-1.

Virtuss is registered for the control of Douglas-fir tussock moth and tests were conducted this year to determine the efficacy of Virtuss to control the white-marked tussock moth. The virus was applied to populations of white-marked tussock moth feeding on balsam fir and birch in Newfoundland. Four sample lines, 100 m apart, were located within the infested area and Virtuss was applied to two of these lines using mist blowers. A dosage of 2.5×10^{11} PIB/ha was applied at a rate of 20 L/ha. A prespray sample and five post spray samples consisting of 100 larvae collected from each line were sent to Sault Ste. Marie for diagnosis. Pre-spray and two post spray population counts were also done.

Examination of prespray samples indicated that NPV was already present in the population, but at a low level (Table 5). Application of Virtuss increased the incidence of virus infection in the treated population from 23.5% and 31.0% for lines 1 and 2 respectively at one week post spray, to 62.4% and 68.9% respectively at five weeks post spray (Table 5). The highest level of infection observed in lines 3 and 4, the check lines, was at the fifth week post spray with 20.8% and 18.3% of larvae infected. Application of Virtuss to this population of white-marked tussock moth created a virus epizootic which interacted with the insect population spreading to the check lines by the fifth post spray sample.

Population assessment was carried out by counting the numbers of larvae from ten stations on each line collected by beating birch trees, balsam fir or collected from an 45 cm branch sample of balsam fir. Results indicated no dramatic population reduction on the treated lines as compared to the check lines (Table 6). Failure to detect any population reduction, as expected from the infection levels, may be the result of collecting the final post spray samples prior to the collapse of the tussock moth population with virus disease. Although this sample was collected as larvae were pupating, infection levels indicate that the impact of virus disease may have been measurable at a later date. However, these preliminary results on the efficacy of Virtuss to control white-marked tussock moth larvae are promising in that a high level of infection was achieved.

In Nova Scotia, populations of white-marked tussock moth were not sufficiently high enough to conduct efficacy trials. However, samples of larvae were collected throughout the province by Nova Scotia Department of Lands and Forests personnel, shipped to Sault Ste. Marie and diagnosed for virus infection. Naturally-occurring single-enveloped NPV was found in 14 of the 15 samples examined, with 12 samples having the incidence of NPV greater than 5% (Table 7).

In the winter of 1985-86, 105,073 white-marked tussock moth larvae were infected, harvested and processed. They yielded sufficient material to treat 242 ha (Table 1).

Jack pine budworm, *Choristoneura pinus pinus*

In 1985 a 50 ha plot in Garvey Twp. was treated with spruce budworm NPV when jack pine budworm were at the peak of the fourth instar. A dosage of 7.5×10^{11} PIB/ha contained in a mixture of 25% emulsifiable oil, 75% water and 0.1% w/v Erico acid red was applied at a rate of 9.5 L/ha. The larval population reduction due to treatment was calculated to be 61% with 40.6% of the larvae in the post-spray sample found infected with NPV (Table 8). Subsequent post-spray samples saw a reduction in the incidence of NPV infection, and because of the slow acting nature of the pathogen, this NPV was not recommended as a control for this insect species.

In 1986 the incidence of virus carry over from the 1985 treatment was assessed by rearing larvae collected from the treated and check areas individually on diet until adult emergence. Dead larvae were examined microscopically to determine the cause of death. Results are reported on Table 8. In the NPV-treated plot 8.1% of the larvae died from virus infection as compared to 1.5% mortality due to virus found in the check area. The incidence of parasitism between the treated and check plots was similar as was the number of larvae successfully completing emergence. The lower incidence of microsporidian infection found in the treated plot for both years probably reflects local differences in the distribution and incidence of this protozoan parasite.

Although NPV is still in the jack pine budworm population one year following application, its potential in population regulation, and hence as a control agent, is difficult to assess because of the collapse of the insect population in the area. However, from previous experimental work with spruce budworm NPV, the levels of infection observed herein have been found unsuccessful in population regulation.

European pine sawfly, <u>Neodiprion sertifer</u>

A registration petition for European pine sawfly NPV, named Sertifervirus, was submitted for evaluation in March, 1985 and is presently under review. This year 400 European pine sawfly colonies were collected from Manitoulin Island, transferred to trees in a plantation near Sault Ste. Marie, Ontario, sprayed with NPV, harvested and processed. The operation produced 95g of material, enough to treat 285 ha at the recommended dosage of 5×10^9 PIB/ha. (Table 1).

Red-headed pine sawfly, Neodiprion lecontei

Red-headed pine sawfly NPV, called Lecontvirus, received a temporary registration under PCPA in 1983. Because of the increased demand for this product a label was commercially prepared incorporating information previously distributed on photocopied sheets (Fig. 2). This year OMNR staff in 8 districts treated 83 plantations with a total area of 342 ha (Table 9). This represented an increase of 112% over the 1985 usage. Staff in Carleton Place, Tweed and Pembroke districts were dissatisfied with the results, and these complaints will be investigated fully in the 1987 season.

Plans for 1987

1. To conduct efficacy trials with gypsy moth NPV to generate efficacy data based on the recommended dosage of 5×10^{11} PIB/ha.
2. To continue efficacy tests with Virtuss on white-marked tussock moth if suitable infestations can be located and if scientists in these areas are again willing to collaborate in the assessment.
3. To propagate NPVs for control of gypsy moth, European pine sawfly and red-headed pine sawfly.

4. To supply Lecontvirus and Sertifervirus to provincial forestry service clients. Experimental permits will be required for Sertifervirus.
5. To survey white-marked tussock moth populations in Nova Scotia to determine the incidence of NPV and assess the need to apply Virtuss to control this defoliator.

Table 1

Nuclear Polyhedrosis Virus Produced by FPMI Staff Between Dec., 1985 and July, 1986

Virus	Host insect	Number of larvae processed	Wt. of larval powder	Number of PIBs/g*	Area which can be treated (ha)
Douglas-fir tussock moth	White-marked tussock moth	105,073	3,023 g	20	242
Gypsy moth	Gypsy moth	141,000	20,000 g	10	400
European pine sawfly	European pine sawfly	10,000	95 g	15	285

* ($x10^9$)

Table 2

Gypsy Moth Larval Development at Time of Virus Application at Sharbot Lake, Olden Twp., 1986

	First application			Second application		
		Instar			Instar	
Area	I	II	III	I	II	III
Plot 1	64%	35%	1%	34%	62%	4%
Plot 2	41%	58%	1%	28%	67%	5%

Table 3

Incidence of NPV in Gypsy Moth Larvae Collected from NPV-treated plots and Check Plots from Sharbot Lake, Olden Twp., 1986

		Days post-spray				
Plot	Prespray	12	19	26	33	42
1	8.8	36.5	46.7	19.5	28.8	25.2
2	6.3	39.9	57.2	39.2	55.9	66.5
Check 1	7.7	12.6	11.8	14.4	26.9	17.6
Check 2*	7.6	14.8	20.9	40.2	33.4	27.9

*aerially sprayed with _Bacillus thuringiensis_

Table 4

Mortality of Gypsy Moth Pupae Collected from Spray Plots and Check Plots at Sharbot Lake, Ontario

Plot	Emerged female	Emerged male	Parasitized	NPV	Unknown	Total
1	26.2*	52.4	9.5	9.5	2.4	84
2	36.3	33.0	14.7	9.8	6.2	306
C1	21.1	42.4	25.1	8.6	2.8	455
C2	21.0	24.3	35.4	6.8	12.4	647

*mortality is expressed as a percentage of the total pupae

Table 5

Incidence of NPV in White-marked Tussock Moth Larvae Collected from Virus Treated Lines and Untreated Check Lines at Bottom Brook, Newfoundland, 1986

Line	Prespray (12.7.86)	Post-spray samples (22.7.86)	(28.7.86)	(4.8.86)	(11.8.86)	(18.8.86)
1	1.2	23.5	24.0	28.4	47.3	62.4
2	1.9	31.0	22.0	46.2	74.4	68.9
3*	1.8	9.0	1.0	0.8	9.0	20.8
4*	0.9	2.9	0	0	4.9	18.3

*untreated check lines

Table 6

Numbers of White-marked Tussock Moth Larvae Found on Samples Collected from NPV-treated and Untreated Check Lines at Bottom Brook, Newfoundland, in 1986

	Line 1 (NPV)			Line 2 (NPV)			Line 3 (CHECK)			Line 4 (CHECK)		
	*BB	BF	18"BF	BB	BF	18"BF	BB	BF	18"BF	BB	BF	18"BF
Prespray	663	123	53	777	140	33	1011	179	90	884	101	24
First Post-spray	775	47	17	435	30	18	678	78	26	690	39	14
Second Post-spray	253	16	4	105	10	5	221	22	10	242	32	11

BB - Beating sample from Birch
BF - Beating sample from Balsam Fir
18"BF - 18" Balsam Fir sample

Table 7

WHITE-MARKED TUSSOCK MOTH NPV SURVEY ... NOVA SCOTIA

	Percent larvae with NPV infection	Date
Stillwater Guys. Co.	0	3.8.86
Sherbrooke Guys. Co.	9.7	4.8.86
Island Lke. Giants Lake, Guys. Co.	5.9	28.7.86
Giants Lake Fire Tower, Guys. Co.	1.0	28.7.86
Sheet Harbour, Halifax Co.	38.3	15.8.86
Fourth Lake, Quoddy River, Halifax Co.	2.1	10.8.86
Ogden-Gorden Taylor, Guys. Co.	88.5	19.8.86
North Ogden, SME Guys. Co.	100.0	19.8.86
County Harbour, 100 m west of P.O. Guys. Co.	35.5	15.8.86
Giants Lake, Guys. Co.	62.8	15.8.86
West Erinville Guys. Co.	15.0	15.8.86
Giants Lake Fire Tower Guys. Co.	56.3	18.8.86
Pentz Lunenburg Co.	18.9*	13.8.86
Salman Park, County Harbour Guys. Co.	90.9	21.8.86

* microsporidia observed in larvae

Table 8

Incidence of pathogens and parasites in jack pine budworm larvae collected from a NPV-treated plot and a check plot, Gogama District, 1986 as compared to levels in 1985

Plot	Date	Number of insects examined*	% NPV	% CPV	% Micro.	% Para.	% Emerged
NPV	8-6-86	320	8.1	0	4.7	15.9	48.4
Check	8-6-86	137	1.5	0	8.8	19.7	51.1
NPV	26-6-85	251	40.6	0	2.8	17.1	43.0
Check	26-6-85	291	0	0	6.9	18.2	65.6

* reared on diet

Table 9

Use of LECONTVIRUS by OMNR staff in 1986

District	Number of plantations	Area (ha)
Bancroft	7	40.0
Brockville	6	38.0
Bracebridge	4	28.0
Carlton Place	2	10.0
Minden	36	14.4
Parry Sound	17	191.2
Pembroke	10	20.0
Tweed	1	0.4
Total	83	342.0*

*increase of 112% from 1985 usage

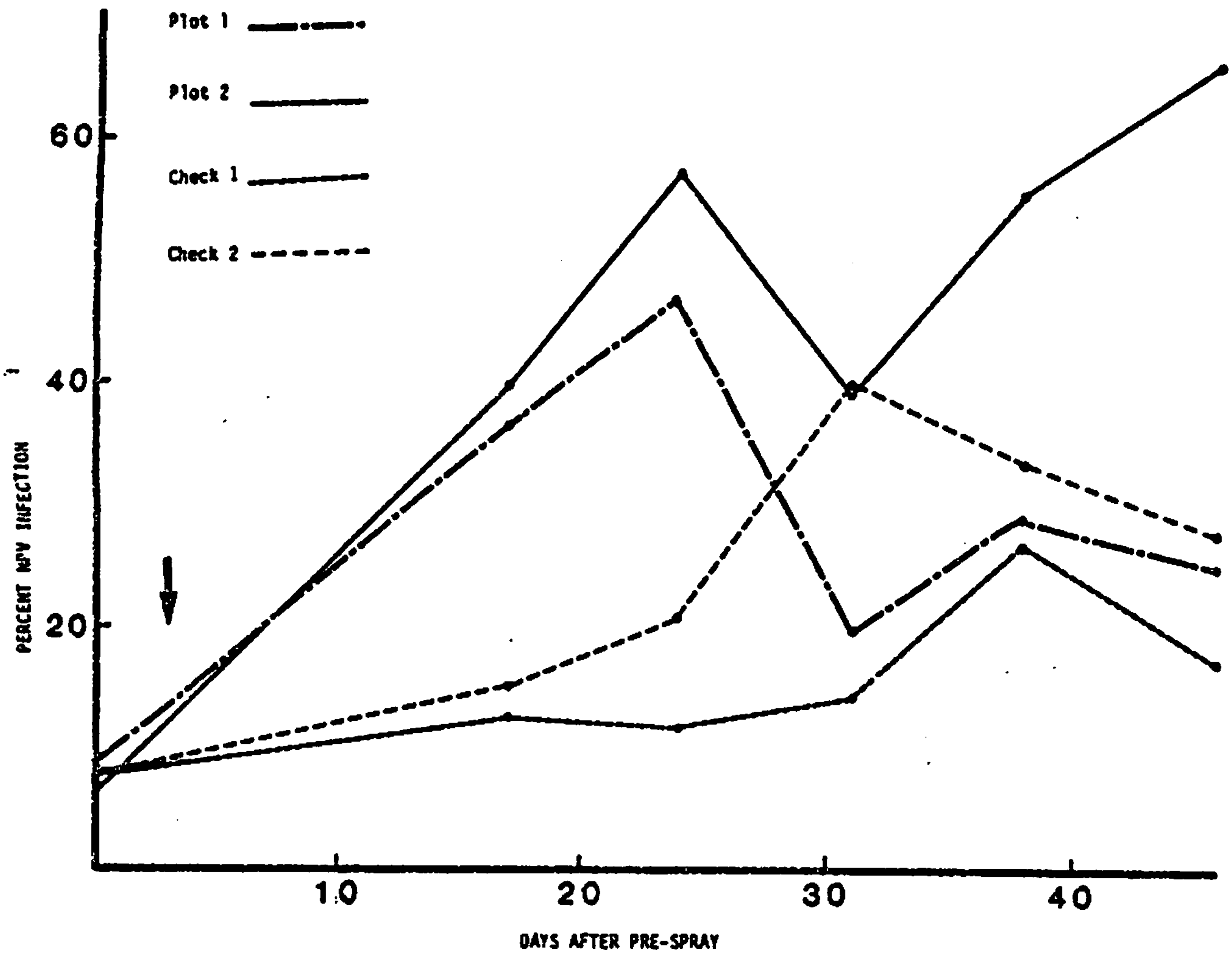

Fig. 1 The development of NPV epizootics in gypsy moth populations treated with virus as compared to naturally developing epizootics in check populations.

LECONTVIRUS

Nuclear Polyhedrosis Virus

BIOLOGICAL INSECTICIDE FOR REDHEADED PINE SAWFLY (NEODIPRION LECONTEI)

FOR FOREST WOODLAND AND ORNAMENTAL USE

EMULSIFIABLE OIL CONCENTRATE

RESTRICTED

GUARANTEE: Polyhedral inclusion bodies of redheaded pine sawfly nuclear polyhedrosis virus . . 0.0015%
(Contains at least 5 x 10^8 polyhedral inclusion bodies per millilitre)

READ LABEL BEFORE USING

CAUTION: SKIN and EYE IRRITANT. Avoid contact with skin, eyes or clothing. Avoid inhalation.

REGISTRATION NUMBER 17824 PEST CONTROL PRODUCTS ACT

NET CONTENTS: ________ ML

USE BEFORE. ________

FOREST PEST MANAGEMENT INSTITUTE
Canadian Forestry Service
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7

NOTICE TO USER. RESTRICTED. This control product is to be used in accordance with the directions on this label. It is an offence under the Pest Control Products Act to use a control product under unsafe conditions.

NATURE OF RESTRICTION. This product is to be used only in the manner authorized, consult local pesticide regulatory authorities about use permits which may be required.

RESTRICTED USE

This product is to be used only under the direct supervision of Federal or Provincial Forestry Service personnel.

DIRECTIONS FOR USE

Lecontvirus is a highly selective insecticide for the control of redheaded pine sawfly larvae. Applications should be made when most of the eggs have hatched and larvae are in the first and second instars. It is also effective on third instar larvae, but should not be applied after the majority of larvae reach the fourth instar. A higher dosage is recommended for third and fourth instar larvae. Fourth instar larvae can easily be recognized by black spots which are not present on the earlier instars. Larvae must eat polyhedra to become infected. If one larva in a colony becomes infected, it will transmit the disease to the rest of the larvae in that colony.

The emulsifiable oil concentrate contains virus-infected redheaded pine sawfly larvae which have been freeze-dried and ground to a fine powder. Material tends to settle on the bottom of the container.

SHAKE BOTTLE WELL AND ENSURE ALL SEDIMENT IS RESUSPENDED BEFORE MEASURING OUT REQUIRED DOSAGE.

AERIAL APPLICATION

For aerial application, it is recommended that Lecontvirus be used with conventional boom and nozzle or Micronair® spinning nozzles on fixed wing aircraft or Beecomist® spinning nozzles with drilled sleeves on helicopters. Aircraft should be calibrated to deliver droplet diameters of 100-250 microns. To ensure a good deposit, Lecontvirus should be applied only under conditions of highest possible relative humidity and low wind velocity, i.e., in the early morning or early evening when good spray conditions prevail. Do not mix Lecontvirus with any materials other than water.

RATES FOR AERIAL APPLICATION

	Larval instar	RATE OF LECONTVIRUS per hectare		WATER*	TOTAL EMITTED volume per hectare
		Millilitres	PIB	Litres	Litres
Plantations	1st & 2nd	10	5×10^9 (5 billion polyhedral inclusion bodies)	9.4	9.4
	3rd & 4th	20	10×10^9 (10 billion polyhedral inclusion bodies)	9.4	9.4

GROUND APPLICATION

This product may be applied from the ground with a variety of equipment and using a variety of techniques. With backpack mistblowers, every third or fourth row in a plantation can be treated taking advantage of any wind to carry the spray cloud across rows. With pressurized, handheld hydraulic sprayers, individual colonies can be sprayed. Here, particular care should be taken to treat those at the tops of the trees as virus will spread to those located lower on the trees. Usually redheaded pine sawfly are not evenly distributed throughout plantations and particular attention should be given to obtaining good spray coverage on "hot spots". Do not mix Lecontvirus with any materials other than water.

RATES FOR GROUND APPLICATION

	Larval instar	RATE OF LECONTVIRUS per hectare		WATER*	TOTAL EMITTED volume per hectare
		Millilitres	PIB	Litres	Litres
Plantations	1st & 2nd	10	5×10^9 (5 billion polyhedral inclusion bodies)	20	20
	3rd & 4th	20	10×10^9 (10 billion polyhedral inclusion bodies)	20	20

MIXING FOR AERIAL AND GROUND APPLICATIONS

Thoroughly shake the bottle of emulsifiable oil concentrate and add the required volume to the appropriate volume of water*. Agitate thoroughly. With mistblowers and handheld pressure sprayers mix material directly in their tanks. Mix only the amount of material to be sprayed that day and do not store the final diluted preparation.

PRECAUTIONS

Keep Out of Reach of Children.

Skin and Eye irritant: Avoid contact with skin, eyes or clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists. Avoid inhalation. Wear mask or respirator during preparation and application of this material. Do not spray into lakes, streams or ponds. Do not contaminate any body of water by cleaning of equipment or disposal of wastes. Do not reuse empty container. Destroy or discard in safe place. Do not store at temperatures above 32°C.

Limitation of Warranty: Guarantee shall be limited to the terms set out on the label and subject thereto, the user assumes the risk to persons or property arising from the use or handling of the product and accepts the product on that condition.

*Chlorinated or highly alkaline water should not be used in tank mixes. Tank mix pH should be between 5.0 and 8.0. If only chlorinated water is available, it should be allowed to stand for 24 hours before use.

Fig. 2

INSECT GROWTH REGULATOR SPRAY TRIALS AGAINST THE SPRUCE BUDWORM IN MATAPEDIA (1986)

[Project No. FP-31 - Insect Growth Regulators]

Report to The 14th Annual Forest Pest Control Forum

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Insect Growth Regulator Spray Trials Against

the Spruce Budmoth in Matapedia (1986)

Introduction

Benzoylphenyl urea - Insect Growth Regulators upon ingestion selectively inhibit *in vivo* chitin synthesis in insect larvae and the effects are manifested at ecdysis. The insect usually dies attempting to moult and for this reason these compounds have been referred to as "moult inhibitors". Topical effect is rare and has been reported as ovicidal activity on some weevil and fly eggs.

Diflubenzuron or Dimilin is by far the best known IGR belonging to this class. Although this IGR is refractory to tortricids such as the spruce budworm (*Choristoneura fumiferana*), it is very effective against other tortricids such as the green oak tortrix (*Tortrix viridana*), oak leaf shredder (*Croesia semipurpurana*), and the oak budmoth (*Zeiraphera insertana*). Also other experimental benzoylphenyl ureas that are effective on diflubenzuron-refractory species are currently available.

We tested 3 benzoylphenyl urea-IGRs on the spruce budmoth (*Zeiraphera canadensis*) in a white spruce plantation in Matapedia, Quebec using a backpack sprayer. The results of our spray trial is presented in this report.

Methods and Materials

Five, 5x10 m plots with buffer zones in between were marked in a plantation in St. Jean de Matapedia containing 2m high white spruce trees. Plots 1, 2 and 3 were sprayed with aqueous formulations of Diflubenzuron-25 WP (200 g AI/10 L/ha), BASF 153-100-50 WP (400 g AI/10 L/ha) and HOE-00522-20w/v flowable (formerly CME-134, 200 g AI/10 L/ha) respectively with a back-pack sprayer on 24th May, 1986, in the morning. The other two plots served as controls. Fifteen cm branch samples, 30/plot were taken 24 h before spraying as pre-spray samples (23 May, 86) and the same number taken 2 weeks later (6 June, 86) as post-spray samples. Based on the pre-spray larval counts, control plots were matched with treatment plots having a similar larval density and the % population reduction was computed using Abbott's formula (Table 1).

In addition, male moths were sampled using Multi-Pher (type 1) traps, 4/treatment plot and 3/control plot using PVC pheromone lures, each containing 10 ug of (E)-9-tetradecenyl acetate. Damage was assessed on 30 trees/plot according to scarring (0 = no scarring; 1 = scarring on the leader past 5 cm from terminal bud; 2 = scarring within 5 cm of terminal bud; 3 = scarring with broken shoot or loss of terminal bud) as described by Turgeon (FPMI, Sault Ste. Marie). Eggs were counted from 15 cm branches, 15/plot (collected on 2 Oct. 86). Terminal leader growth in 1986 was measured on 30 trees/plot.

Results and Discussion

All 3 IGRs were quite effective in reducing the larval population. This was confirmed by the pheromone catch and egg sampling (Table 1). Damage index and leader growth showed the effect of the IGRs on the performance of the trees.

The use of 3 different dosages warrants an explanation. We originally planned on spraying 400 g AI/10 L/ha. Diflubenzuron was available as 25 WP which made the tank mix very thick and therefore it was diluted to 200 g AI/10 L/ha. HOE-00522 was in limited supply and therefore sprayed at 200 g AI/10 L/ha.

Spraying was conducted after the larvae had hatched and were in the process of entering the bud. Even though they do not actively feed at emergence, they might have nibbled at the base of the IGR contaminated bud. The backpack sprayer could have blown the material into the bud where the larvae were feeding. We are currently in the process of testing the IGR on eggs and larvae of different ages.

While we are cautiously optimistic of the results, the effects have to be confirmed using perhaps a helicopter.

Table 1. IGR spray trials against the spruce budmoth in Matapedia (1986)

Plot no. & treatment	Larval population ($\bar{x}$ no./branch) Pre-spray	Post-spray	% Population reduction*	$\bar{x}$ male moths/trap	Damage index** (0-3)	$\bar{x}$ growth/ leader (cm)	$\bar{x}$ no. eggs/ branch
1. Diflubenzuron	1.6	0.8	84	15.8	0.67	39.8	0.5
Control	1.8	5.6	--	33.3	1.73	27.7	4.5
2. BASF-153-100	1.2	0.07	98	14.8	0.16	44.4	0.7
Control	1.8	5.6	--	33.3	1.73	27.7	4.5
3. HOE-00522	2.3	1.1	73	16.8	0.60	40.9	2.1
Control	2.7	4.8	--	51.0	2.23	11.4	7.4

$$* \text{ \% Population reduction} = \left[1 - \left(\frac{\text{post-spray density in treatment}}{\text{pre-spray density in treatment}} \times \frac{\text{pre-spray density in control}}{\text{post-spray density in control}}\right)\right] \times 100$$

$$** \text{ Damage index (Turgeon)} = \frac{(0 \times t_0) + (1 \times t_1) + (2 \times t_2) + (3 \times t_3)}{t_0 + t_1 + t_2 + t_3}$$

where 0, 1, 2, 3 indicate the degree of damage and t_0, t_1, t_2, t_3 represent the number of trees within each class; values above 1 indicate intolerable damage (loss of growth and multi-leadering).

RELEASES OF *TRICHOGRAMMA* IN ONTARIO
FOR SPRUCE BUDWORM

Report to the 14th Annual Forest Pest Control Forum

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November 1986

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RELEASES OF TRICHOGRAMMA IN ONTARIO FOR SPRUCE BUDWORM

BACKGROUND

In 1982, a cooperative project was initiated between the Ontario Ministry of Natural Resources, the University of Guelph, the University of Toronto, and the Canadian Forestry Service to assess the potential of using inundative releases of the egg parasite, *Trichogramma minutum* Riley, for biological control of the spruce budworm, *Choristoneura fumiferana* (Clemens). This project was completed in 1985 with the 3 objectives met:

1. the technology to mass produce *Trichogramma* in Canada was developed;
2. the techniques for field handling and aerial or ground release of *Trichogramma* were perfected; and
3. significant increases in egg parasitism and corresponding reductions in larval populations of spruce budworm were shown.

As well, the techniques to monitor and assess inundative releases under forest conditions were developed.

During 1986, our objective was to fine-tune the release strategy using *T. minutum* we had developed over the previous 4 years. Specifically, we wanted to determine the number of parasites/ha we would need for an optimal level of egg parasitism. This required the derivation of a dose/response curve for application rates.

RELEASES IN 1986:

The research area, as in the previous 4 years, was near Hearst, Ontario (50°N, 84°W). This area was selected because of the naturally high levels of spruce budworm (greater than 30 egg masses/ m^2 foliage) and low levels of egg parasitism by T. minutum (less than 3% of the eggs parasitized). Information from previous years showed that because of equal survival, ground applications of parasites would be as effective as aerial releases. To reduce the pressure on the production facility for large numbers of parasites, therefore, 18 small (25 by 25 m) plots were established in this research area to receive ground applications of T. minutum.

The development of spruce budworm larvae taken from samples collected on 16 June 1986 and incorporated into a simulated phenological model accurately predicted emergence of spruce budworm adults. This allowed time for emergence of the parasites to be programmed by the production facility. In January, although funding was not immediately available, the University of Guelph had agreed to supply ca. 36 million (M) female parasites during the first 2 weeks of July in 1986.

The first male moth was collected by pheromone trap on 25 June with populations peaking twice, once each on 7 and 13 July (Fig. 1). Spruce budworm populations remained low (endemic) throughout the summer, never exceeding 7.0 moths/trap/night. The first egg mass laid on natural foliage was reported on 11 July although peak oviposition did not occur until 23 July, approximately 1 week earlier than in previous years. Of the few natural egg masses found (24), all had hatched by this same date.

Based on the release strategy against the spruce budworm derived in previous years, T. minutum was applied from the ground, twice on the 5 and 12 July. These two releases were timed to synchronize with budworm oviposition. To derive a dose/response curve for parasite applications, parasites were released at 4 different densities: 3; 6; 12; and 18 M females/ha. Rates of 3 and 6 M/ha were replicated twice while rates of

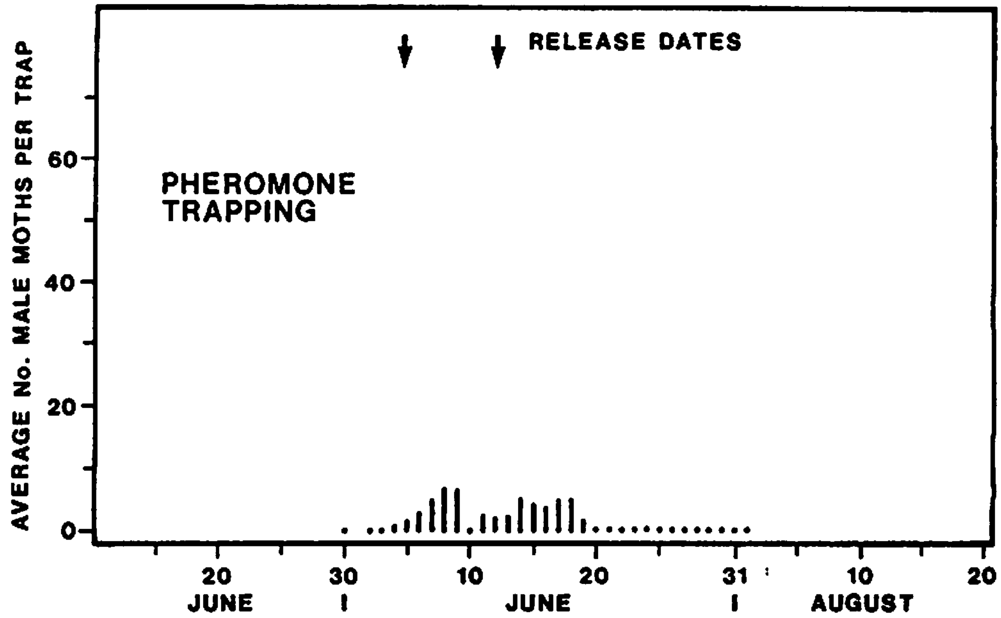

Figure 1. Mean number of male moths collected per pheromone trap near Hearst, Ontario during 1986.

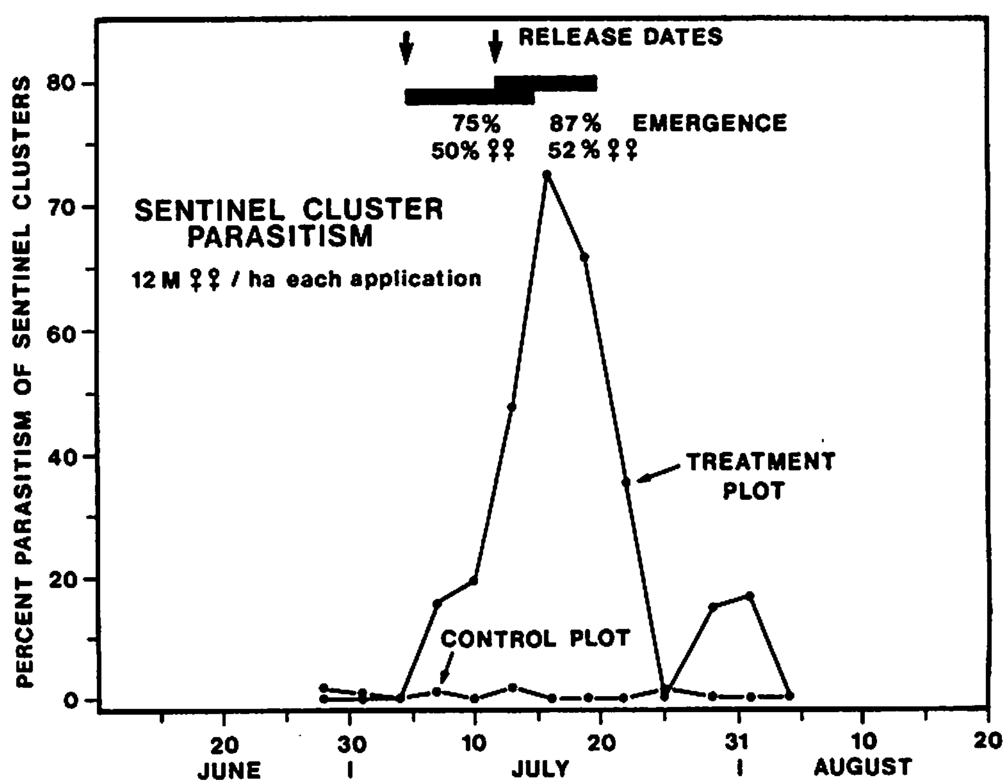

Figure 2. Daily parasitism of sentinel egg masses in a control plot and one plot receiving 2 releases of 12 M female *Trichogramma minutum*/ha each on 5 and 12 July 1986 near Hearst, Ontario.

12 and 18 M/ha were applied on only 1 experimental plot each.

The parasitized host eggs were dispersed into the canopy on these release plots with a hand-held leafblower. To ensure a relatively uniform application on each plot, equal volumes of parasitized host eggs were measured into coffee creamer cups according to the required rate of application. The cups were emptied by dropping the contents of each into the airstream of the leafblower. The contents of each cup were distributed on a 5 by 5 m block within each plot (i.e. 25 blocks/plot). The quality of the parasites released in this manner, measured by emergence, sex ratio, longevity, and fecundity before and after application, was not affected.

Parasites emerged over a period of 8 to 10 days following each release with 77% emerging within the first 3 days of release. Parasitism of sentinel egg masses was observed on all plots for a minimum of 18 days. Figure 2 shows the change in parasitism of sentinel egg masses over time for that plot which received two releases of 12 M females/ha. Maximum parasitism of sentinel spruce budworm egg masses following the first release was 19, 41, 47, and 68% for release rates of 3, 6, 12, and 18 M females/ha, respectively. Following the second release, parasitism of sentinel egg masses at these same application rates was increased to 53, 67, 84, and 85%, respectively.

The effect of the parasite releases on parasitism of naturally occurring egg masses was difficult to interpret due to the collapse of spruce budowrm populations during 1986 in the Hearst area. As a result of the releases at 3, 6, 12, and 18 M females/ha, final parasitism of spruce budworm egg masses laid naturally averaged 33, 50, 50, and 50%, respectively, compared to 0% parasitism on the control plots. These data, however, despite searching over 800 branches (100 from each plot), are derived from only 14 naturally-laid spruce budworm egg masses providing less than 2 egg masses/plot for comparison. Statistical analysis, therefore, is meaningless on these data because of the small sample sizes and the high variability between plots receiving the same application rates.

The relationship between the rate of application and the rates of parasitism was determined from sentinel egg masses (i.e. fresh, susceptible egg masses changed in the field every 3 days) (Fig. 3). Between 13 and 19 July, parasitism of sentinel egg masses averaged 51, 65, 80, and 84% at application rates of 3, 6, 12, and 18 M females/ha, respectively. This suggests that, depending on the unit cost of _T. minutum_, increasing the rate of application much beyond 12 M females/ha would not be cost effective; above 12 M females/ha, the law of diminishing returns applies.

LARVAL REDUCTIONS FROM 1985:

To examine the effectiveness of those releases conducted in the previous year, 186 branches were collected from the upper mid-crown of balsam fir and white spruce on all plots treated in 1985 (5 plots). The number of spruce budworm larvae/branch was counted and totals compared between these plots and control areas on 18 June.

In 1985, final parasitism of spruce budworm eggs laid naturally on plots receiving 3, 6, and 12 M females/ha was 15.6, 22.2, and 30.4%, respectively (Table 1). In 1986, no significant difference ($p \leq 0.05$) in numbers of larvae on the control plot and those 2 plots receiving 3 M females/ha was observed. At an application rate of 6 and 12 M in 1985, however, there was a significant reduction ($p \leq 0.05$) of 31.3 and 52.2%, respectively, in spruce budworm larvae over populations on the

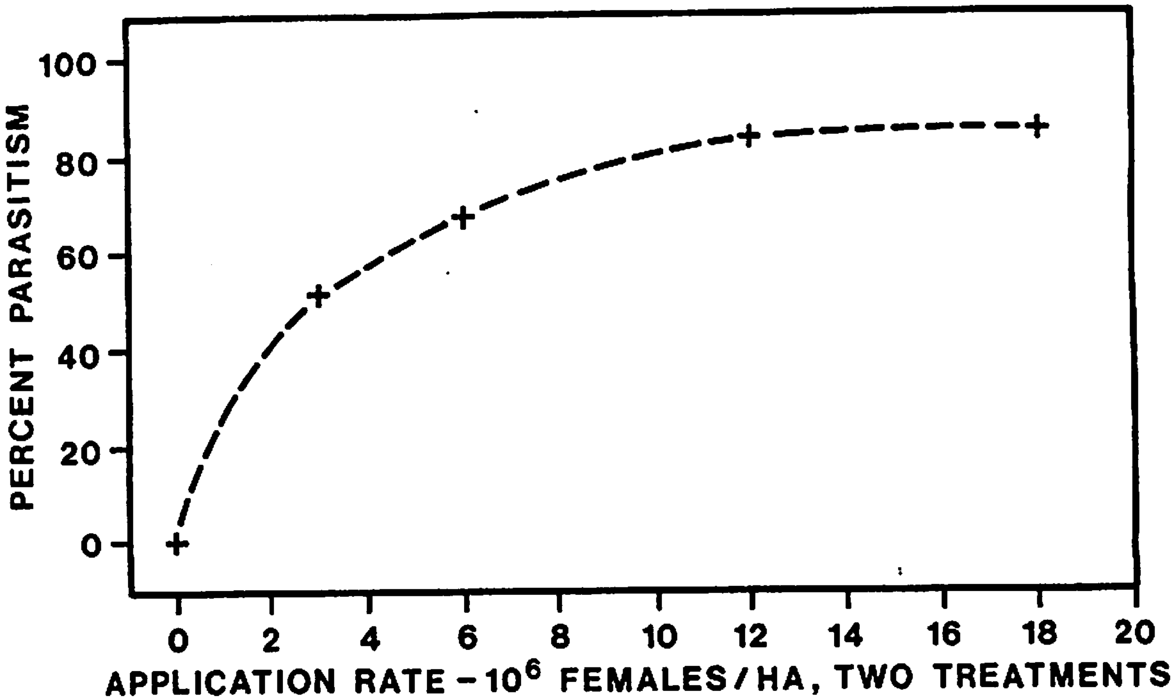

Figure 3. The dose/response curve for *Trichogramma minutum* parasitizing sentinel egg masses following inundative release in 1986.

2 APPLICATIONS X 10^6 ♀♀/ha	PARASITISM OF EGGS IN YEAR OF RELEASE		LARVAL POPULATION REDUCTION NEXT YEAR	
	YEAR	%	YEAR	%
12	1984	81.2 *	1985	82.3
12	1985	30.4 *	1986	52.2
6	1985	22.2	1986	31.3
3	1985	15.6	1986	0

* negligible parasitism was measured in check areas

Table 1. The relationship between egg parasitism by *Trichogramma minutum* following inundative release and reduction in larval populations of the spruce budworm the following year.

control plot. These values compare to the results for releases made in in 1984, also listed in this Table, where the weather conditions were optimal.

CARRYOVER OF PARASITISM FROM 1985:

Carryover or the maintenance of parasitism by T. minutum following release in 1985 was assessed in 1986. On the control plots where parasites had never been applied, parasitism of sentinel egg masses averaged 0.4%. On those plots where T. minutum had been applied in 1985 at 3, 6, and 12 M females/ha, parasitism of sentinel egg masses averaged 0.5, 0.1, and 1.8%, respectively. This suggests that there may have been very slight carryover at the highest rate of application but as in past years, high parasitism levels were not sustained into the year following application.

THE BIOLOGICAL INTERFACE BETWEEN

BUDWORM BEHAVIOR IN ITS MICROHABITAT ON DIFFERENT HOSTS

AND THE EFFICACY OF CONTROL PRACTICES

STUDY LEADER:

P.C. NIGAM

PROBLEM OR OPPORTUNITY:

Chemical or biological insecticides are use against spruce budworm after laboratory and field screening, against target and non-target species of the forest ecosystem. In order to improve effectiveness of field operations, a detailed knowledge of (a) insecticide mode of entry into and action during the various life stages of the spruce budworm, (b) budworm behavior, and (c) budworm microhabitat is essential. Weather affects larval behavior and microhabitat construction. Study of post-spray weather in relation to larval behavior and deterioration of insecticide residues in the microhabitat is required to study correlation with efficacy. In-depth study of interactions of host phenology by species and various stages of spruce budworm encountered in spray plots is necessary to determine the importance of various types of toxicities, i.e. contact, stomach, systemic, residual and vapor (either separately or interactive), so that maximum efficacy of emitted spray can be achieved with a minimum of side effects and costs. Understanding may increase efficacy of insecticides and may help to improve the acceptability of certain control practices. A team approach for better understanding of spruce budworm control strategies and spray tactics has been adopted by the Spray Efficacy Research Group (SERG) in New Brunswick. CFS - Maritimes is actively cooperating in this program by involving various scientists in work aimed at improving the efficacy of various registered control agents.

OBJECTIVE:

To elucidate mode of entry into, and action of insecticides in spruce budworm larvae and their microhabitat after operational or simulated aerial applications, and to determine the significance of post-spray weather on the insecticide-budworm interface activity under field conditions.

CURRENT STATUS OF STUDY:

This study was started in 1982. Methods to study mode of entry of fenitrothion as vapor, direct contact and systemic action, under field conditions were established. These field methods and techniques were tested and modified during 1983 and 1984. The literature review for selection of laboratory methods and techniques was done. The establishment of a laboratory is in progress, the purchase and assembly of laboratory equipment has been underway since 1982. Equipment is in various stages of development. The vapor activity studies are ready for statistical analysis and publication. Studies of contact and systemic action are still preliminary.

The vapor of fenitrothion observed under field and laboratory conditions does not contribute directly to foliage protection. If vaporization were reduced by modification of formulations then efficacy of fenitrothion would be increased substantially.

The vapor play very minor roles in the overall efficacy of fenitrothion. Residual toxicity contributes to maximum efficacy and direct impingement of droplets on the larvae took place under very special circumstances in the field i.e. when larvae were 5th instar and overnight temperature and budworm activity were high.

It appears that droplets impinging on webbing play an important role in budworm mortality. Biological assay and chemical analysis of fenitrothion deposit in a field test showed that in the first spray, deposition of fenitrothion was less than in the second spray and duration of biological activity was short. In the second spray higher deposits of fenitrothion and longer biological activity was observed. This study was originally started in 1982 to investigate the toxicological parameters, but subsequently emphasis was changed to the biological interface between the budworm behavior in its microhabitats and mode of entry of fenitrothion droplets after aerial or simulated application in order to comply with CFS HQ's report on Allocation of Research and Technical Services Responsibilities.

Environmental impacts of spruce budworm control operations at CFS-Maritimes.

(a) Effects of fenitrothion on bog pond ecosystems. W.L. Fairchild and D.C. Eidt.

Four bog ponds (750 to 2600 m^2, pH 4) were treated as follows: one sprayed in 1984, one sprayed in 1985, one treated in both 1984 and 1985, and one not treated. Treatments were from the shore or a boat with a backpack mist blower, using fenitrothion in aqueous formulation twice at 210 g/ha. The effective treatment was much greater than operational sprays because loss during descent was less. The sphagnum fringe of the ponds was treated as an integral part of the ponds. We are confident that our sampling method collects most animals down to 250 µm.

The immediate effect was to knock out the corixids, which collected along the downwind shore. Notonectids were also virtually wiped out. Dragonflies were severely affected although not eliminated, the current year's hatchlings were apparently not affected, perhaps because they appeared after the hazard had passed. Chironomids, which dominated the animal community, and to a lesser extent, mites, were also reduced, and the treated ponds came to be dominated by oligochaetes and nematodes. We did not measure biomass, but the survivors multiplied to partially compensate for the groups eliminated. It took 13 to 14 months for the fauna to return to normal, thus in the pond treated two years, recovery was not complete before we sprayed again. Most identifications are to genus, but we have many more identifications and analyses of data to complete before we will have the whole story.

We also sampled plankton, and a partial analysis does not show changes that can be attributed to the 1984 sprays. We are currently sorting 1985 samples.

(b) Fenitrothion as a hazard to pitcher plant fauna. D.C. Eidt, W.L. Fairchild, and C.A.A. Weaver.

While we were bounding about the bog we wondered about the hazard to the unique inhabitants of pitcher plant leaves. In a different bog we injected fenitrothion into the fluid in the leaves. We estimated LC 50s for the two commonest, most sensitive species: 1.5 µg/L for the pitcher plant mosquito, Wyeomyia smithii, and 5 µg/L for the midge, Metriocnemus knabi.

We estimated the possible concentration in the fluid of pitchers at 13 µg/L, which is about 8 times the LC 50 of the mosquito, and 3 times that of the midge.

(c) Frequency of forest respraying and use of B.t. in New Brunswick, 1975-1986. By D.C.Eidt and C.A.A.Weaver. CFS-M Information Report M-X-158. 6pp.

This new report is an update of one done in 1982 by Eidt and Fisher. Its purpose is to document the amount of coverage to answer any misconceptions about extent and intensity of forest spraying in New Brunswick. The increasing proportional use of Bt documents a trend away from "chemical insecticides".

Status of the CFS-Maritimes project "Development of strategies to minimize losses to spruce budworm"

D.C. Eidt

IMPACTS

Three scientists deal with the effects on growth, yield, and regeneration of spruce budworm-damaged stands. Dave MacLean deals with the mature spruce-fir forest, Harald Piene studies young balsam-fir stands, and Michel Huot is concerned with regeneration and succession. Much of this work is in the data-collection phase because the nature of the work is long term.

Future wood supply and its prediction has become a primary concern in the Maritimes. Because there is little or no surplus wood in the forest, depredations of the spruce budworm constitute a considerable obstacle to realistic wood-supply planning. Through cooperation with New Brunswick Natural Resources and Energy, defoliation-growth-mortality data are being incorporated into yield tables for wood-supply forcasting. For example, it was found that one year of 100% defoliation of current needles of balsam fir results in 20% growth reduction and 2 years results in 50% growth reduction. These tables can be used to schedule interventions such as spraying and early harvesting.

MacLean has an extensive set of permanent sample plots in New Brunswick wherein he measures current and cumulative defoliation using a combination of field scanning and more precise but less extensive laboratory counting methods.

Piene has ten-years' information on the impact of spruce budworm on the growth and yield of young balsam fir stands in the form of defoliation, shoot length, needle length, volume increment, foliage production, and tree mortality data. He is in the process of sorting out what all this means through the use of modelling techniques. Piene's data are important to wood supply forecasting. These same tree-growth parameters have been demonstrated by Piene and MacLean to vary with spacing and protection, or the lack of it (which can be another way to effect spacing), and some results have been published.

Huot is in the early stages of his study, having reviewed past work, and having set up plots to answer the questions raised. Indications are that budworm-thinned stands in Cape Breton have adequate preharvest regeneration. However it will require post-harvest surveys to clarify the situation.

Through contract with R.G.Thompson, the use of electrical capacitance of the cambium to predict tree vigor is being investigated. Capacitance is positively correlated with foliage biomass and growth rate of fir and spruce trees,and negatively correlated with cumulative defoliation. Next year the method will be further refined by determining seasonal change, particularly as it relates to dormancy and budbreak.

BIOLOGY AND POPULATION DYNAMICS

Analysis of historical data by Tom Royama has led to new basic concepts about the mechanisms of budworm population gradations. Royama and Eldon Eveleigh, in cooperation with GLFC and LFC, are in the fifth year of an intensive field study of small larval dispersal, parasitoids, hyperparisitoids, diseases, and other factors. Deaths of budworms heretofore attributed to 'unknown factors' are being investigated. Postdoctoral Fellow Doug Strongman is studying phylloplane fungi, and Tony Thomas is investigating foliage quality. George Strunz works closely with Doug and Tony studying the biochemical basis of the toxicity of isolates from fungi and foliage, as well as testing possible antifeedants. It is too early to say much about this work, except that some promising leads are opening up.

Tony Thomas has developed a 24-h bioassay method for B.t. in aqueous suspension, using budworms. It is sufficiently faster than any other quantitative method of analysis that it can be used to assess deposit from a first spray application and allow time to make decisions about a second.

SPRAY EFFICACY

Most of the work at CFS-M that belongs in this subproject falls under the studies of Chandra Nigam and Ed Kettela, who are both here to give their own reports. The environmental impact work of Wayne Fairchild (UNB PhD candidate) and mine, which is efficacy in the negative sense, is reported under a more appropriate heading.

A field experiment was conducted by Ed Kettela and me to determine if the efficacy of fenitrothion was affected by post-spray weather, and if so, to determine if it was mediated by differences in deposit or budworm behaviour.

We placed budworms on small trees in the nursery at Acadia Forest Experiment Station and sprayed them using a ULV nozzle under a canopy. This was done with four replicate plots of twelve trees, every day, regardless of weather, during the entire larval feeding period. We located individual larvae 1 h before and 1 h, 24 h, and 48h after treatment. At these same times, foliage was collected for GC.analysis and bioassay using early 4th instar lab-reared budworms.

The GC results have not been received yet, but the bioassays show a consistent diminuation of foliage toxicity from an average of 73% mortality at 1 h to 28% at 24 h to 20% at 48 h. A graph of these results (Fig. 1) shows that the 1 and 2-day samples aren't much different. Survival on 1-h post-spray foliage seems to have some trends that we can't yet explain.

Field results (Fig.2) show an expected increase in mortality with time and an increase in mortality as the larvae get older. Instars are not shown on the graph because we had not the time to determine the proportions, but it begins at peak 3rd and runs to peak 6th. On cursory examination, the ups and downs on this graph do not relate to days with rain, temperature at time of treatment, or daily maximum temperature.

We just received the detailed weather data and have not had a chance to analyse the results further. These preliminary results suggest no clear cut relationship between post-spray weather and efficacy. There is some suggestion that moisture on the foliage at time of spray is important, and the GC results should clarify this.

It is our intention to run a similar experiment with Bt next year.

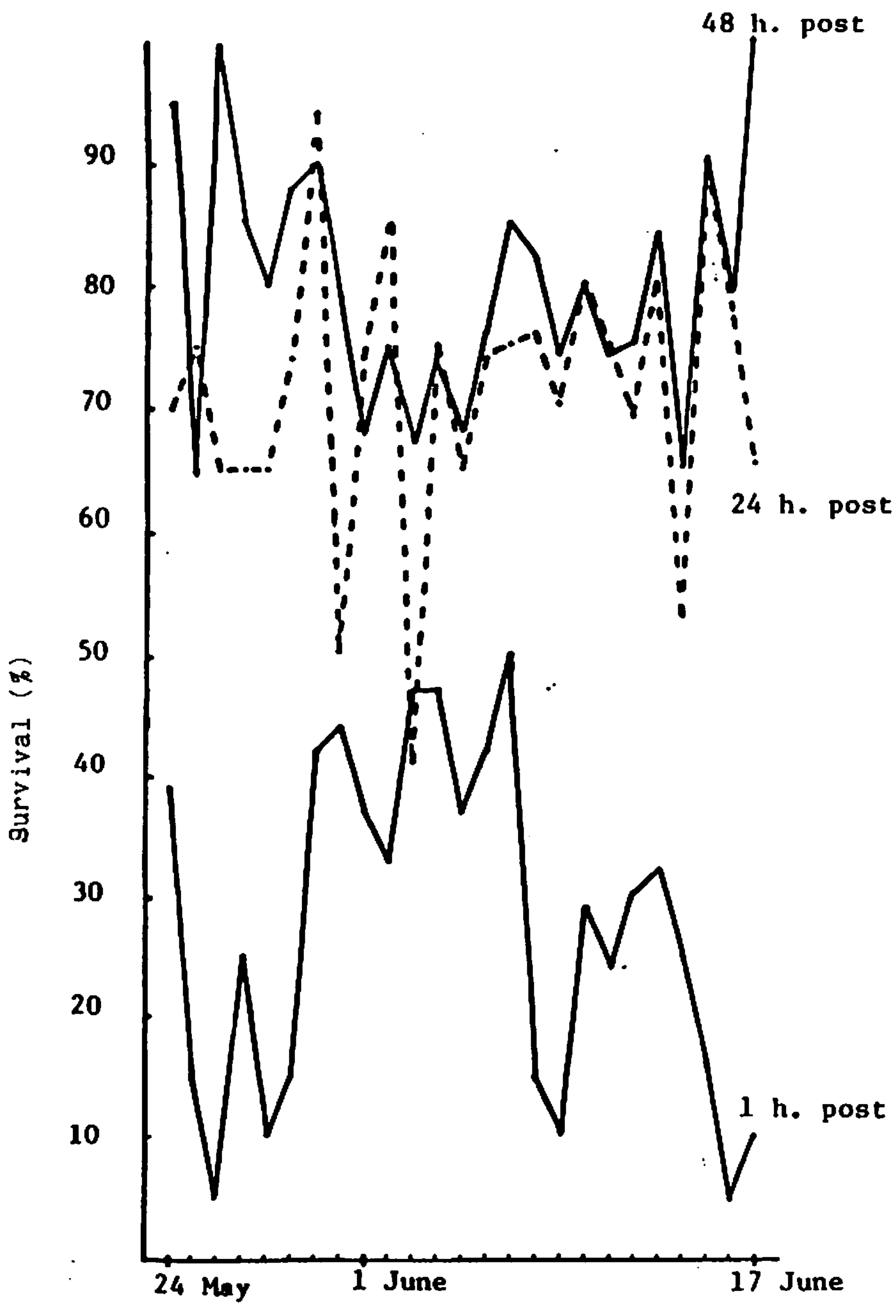

Fig. 1. Survival of late L_3 and early L_4 spruce budworms in bioassays of foliage collected after sprays with fenitrothion.

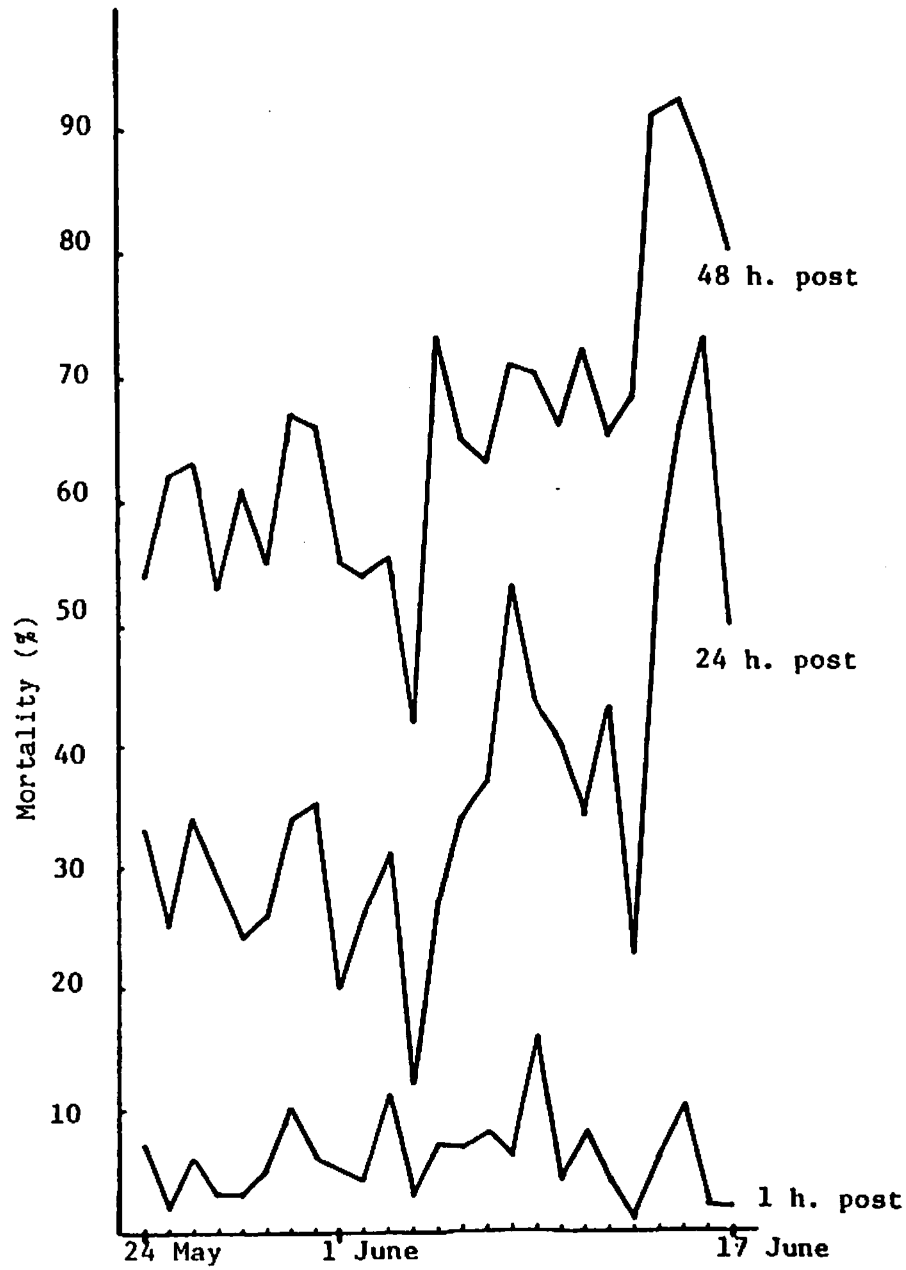

Fig. 2. Mortality of spruce budworm larvae 1, 24 and 48 h after trees infested were sprayed with fenitrothion.

Entomophilic Nematodes for Insect Control

D.C.Eidt

To my knowledge entomophilic nematodes have never been discussed at this Forum. Because recent developments indicate that they may have considerable potential against some forest insects, it may be useful to discuss them now.

Mode of action

Entomophilic nematodes are soil animals. What is involved in a pest control program using nematodes is an augmentation and inundation program, not introduction of exotic species. These nematodes carry a bacterium in the buccal cavity. The nematode seeks the insect on a gradient of CO_2, or scent clues from frass or other substances. It more or less swims and will die if it dries out suddenly. (Slow normal drying can result in a dormant stage than can persist for as long as 20 years.) The nematode enters the insect via spiracles, anus, or the intersegmental folds in soft-bodied insects. Larvae or pupae are vulnerable, but this varies. Diptera pupae are very resistant because of the puparial skin.

Only one nematode need infect, because they are hermaphroditic or already mated. The bacteria cause a sepsis and kill the insect, the interior of which becomes a mass of bacteria on which the nematodes feed and increase. By the end of the cycle there may be 100,000 to 500,000 nematodes that can infect other larvae. In soil treatments, this can result in further kills in a year after treatment.

State of the art

Nematodes are currently being used for control of fly maggots in chicken manure in British Columbia, for root weevils on replanted cutovers in Europe, and various other insects in other countries. There is apparently only the one commercial use in Canada, but there are several candidate pests. Jean Finney-Crawley, Memorial U., has been attempting to control chrysanthemum leaf miner in greenhouses. She has tested the infectivity of a number of forest insects, including spruce budworm, to nematodes under contract to NFC. Guy Belaire, CDA St.-Jean, has been concentrating on root weevils in carrots and strawberries. Oswald Morris, CDA Winnipeg, spends a third of his time on nematodes particularly against cutworms. Tom Rutherford and John Webster, Simon Fraser U., have investigated control of root weevils on tree transplants, spruce bark beetle, fir bark beetle and flies in chicken manure. Some of their work has been supported by PFC.

Nematodes are not as selective as many of the biological pest control agents generally used. Susceptibility is a question of conditions of survival of the nematodes and infectivity of the target insect. Nematodes need moisture and oxygen. The target insect ideally has accessible body openings, e.g. lots of open spiracles, and is soft bodied.

These are soil animals that work best in soil where moisture is high. Under the right conditions each infection results in release of more than 100,000 nematodes for reinfection of new hosts.

For arboreal stages of insects, techniques will have to be refined. For boring insects it should be easier than for foliage feeders. For root insects, soil drenches are effective. For Hylobius in plantations it may be as simple as treating the planting hole, dipping the roots of trees as they are planted, or treating the roots just before the trees are taken to the planting area.

Nematodes for control of Zeiraphera

It had seemed curious to me for some time that CFS had shown no great interest in nematodes for insect control. At the same time CFS-M and FPMI were under considerable client pressure to find an effective control for Zeiraphera canadensis, a cryptic insect that defies usual methods. Through Malcolm Shrimpton, I persuaded CFS-HQ to sponsor a meeting of interested people to discuss the feasibility of investigating nematodes for control of arboreal insects and to set up an action plan to find out. The meeting was held in February 1986. In addition to the nematologists already named, present were: Roger Anderson and Barry Ebsary, Nematology Section, BRC; Jim Kelleher, Research Program Services, CDA Ottawa; Pridham Singh, CFS-HQ; Malcolm Shrimpton who chaired the meeting; and me. FPMI did not send a participant. Unfortunately, a formal report was not produced, but as long as the stimulation and initiative found there continues, it may not matter.

The group liked the idea of concentrating effort on one arboreal species because it would concentrate their effort and the technology would be transferrable to other pests. Insect control with nematodes is at the stage where Bt was 25 years ago, and concentrated effort could substantially reduce development time.

Suitability of nematodes for control of Zieraphera involves problems with Zeiraphera and problems with nematodes.

D. Problems concerning Zeiraphera

1. Mass rearing is the greatest problem because a continuous supply is needed for bioassay. We can develop a method here, given the rearing facility and help. We could do it a lot faster if we knew how to mate adults and get them to oviposit in the lab.
2. One has to allow that soil applications against prepupae and pupae may be easiest because moisture conditions in soil are favorable. Therefore we must determine where in relation to depth and the organic layer that pupation takes place and how long the insect persists as a larva after it drops to the ground. Soil temperatures and moistures have to be determined for that time of year.
3. Foliar applications are possible, but we must know temperature and humidity conditions under the budcaps and among needles proximal of the budcap during the larval period.
4. Weather conditions that prevail during the potential treatment season must be determined. Historical data have to be searched to determine the size of the spray window, i.e. the period when the target stage is present, temperature is high enough for nematodes to be active and moisture high enough to prevent drying until the

nematodes enter the shoot or the target insect, but not so much that the nematodes are washed to ground.

5. The rate of reinvasion of stands by <u>Zeiraphera</u> is important to know because this can affect the economics of foliar applications if high volume sprays are necessary. Higher spray costs could be acceptable if effective for 2 or 3 seasons.
6. We have to know the size of larvae of all stages because of certain lower critical sizes for increase of nematodes, and the characteristics of the pupal case vis-à-vis infectivity.
7. We will have to know the distribution of attack by <u>Zeiraphera</u> within the crowns of trees.

C. <u>Problems concerning nematodes</u>

1. Various nematodes and strains will have to be assayed against the target insect.
2. The greatest barrier to assay is the lack of a continuous supply of <u>Zieraphera</u> of various stages.
3. We already know enough about the behavior of nematode strains to say which we would try first for foliar sprays and which we would use for deep soil and shallow soil targets.
4. Mass rearing and storage of nematodes are not problems. These are essentially engineering, not biological problems. Costs diminish with scale and can be brought down to economical levels. One Canadian company is already involved.
5. Application technology would need refinement because high volume sprays are presently needed. Desiccation problems would have to be overcome and protection from UV would be necessary. All these

problems are not insurmountable for present day spray technology and are essentially engineering, not biological problems.

6. Relative infectivity of healthy, sick and parasitized target insects is not known.
7. Strains that are active and infective at low temperatures may be needed. These are available down to at least 10°C.
8. It is necessary to think of two organisms, the nematode and the symbiotic bacterium. The two could have slightly different temperature requirements for example.
9. It is not enough that the nematode survives storage, the bacterium must also.
10. Nematologists know which strains are likely to be most successful for foliar, shallow soil, or deep soil trials.
11. Alien strains work better than local strains.

In cooperation with Jean-Finney-Crawley of Memorial University, Ed Kettela and I are pressing on with the *Zeiraphera* - nematode work. We would gladly accept any suggestions or other help we can get. We hope to stimulate interest in nematodes to determine as quickly as possible if they can constitute an economical alternative to chemical insecticides.

THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1986

Hudak, J., A.G. Raske, K.P. Lim and L.J. Clarke

REPORT PREPARED FOR THE FOURTEENTH ANNUAL FOREST PEST CONTROL FORUM
OTTAWA, 18-20 NOVEMBER 1986

NEWFOUNDLAND FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
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THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1986

by

Hudak, J., A.G. Raske, K.P. Lim and L.J. Clarke

Larval Development and Defoliation - The decreasing major outbreak of the spruce budworm collapsed in 1985 and limited egg surveys and over-wintering larval surveys indicated that no moderate and severe defoliation would occur in 1986. Light defoliation was forecast for 1986 in about 7500 ha distributed mostly in western Newfoundland. However, larval sampling showed high budworm numbers at three locations and severe defoliation occurred on about 2000 ha. Light defoliation was recorded on 1800 ha (Table 1, Fig. 1).

Control Program - There was no operational or experimental control program conducted against the spruce budworm in 1986.

Biological Mortality Factors - In 1986, samples of spruce budworm were collected from a residual population near Baie Verte. The major larval parasite was *Glypta fumiferanae*. The usually abundant Apanteles fumiferanae was very scarce this year. The major pupal parasite was *Phaeogenes hariolus*. About 15% of spruce budworm samples were parasitized.

Less than 1% of the spruce budworm samples were infected by the entomopathogenic fungi, *Paecilomyces farinous* and *Erynia radicans*. No microsporidian disease was detected in the samples.

Pheromone Trapping of Moths - Pheromone traps were placed at 46 locations throughout the Island. Moths were caught at 83% of the locations. The highest numbers were recorded near two severe infestations in western Newfoundland. Generally, some moths were trapped in all regions except the Avalon Peninsula. This rather uniform distribution is evidence of a wide-spread, endemic population. Generally much higher number of moths were caught in 1986 than in 1985 but it may be the result of improved potency of the lures in 1986 rather than increased population.

Forecast of Spruce Budworm Defoliation for 1986 - Sampling was conducted in conjunction with the hemlock looper egg survey in late October. The forecast will be provided after the completion of processing of samples.

Table 1. Areas (ha) of defoliation caused by the spruce budworm in productive forests of Newfoundland in 1986.

Management Unit No.	Defolilation Class[1]			
	Light	Moderate	Severe	Total
9	1 680	-	837	2 517
12	68	-	371	439
14	86	-	994	1 080
Total	1 834	-	2 202	4 036

[1]Light - 1-25%.
Moderate - 26-75%
Severe - 76-100%.

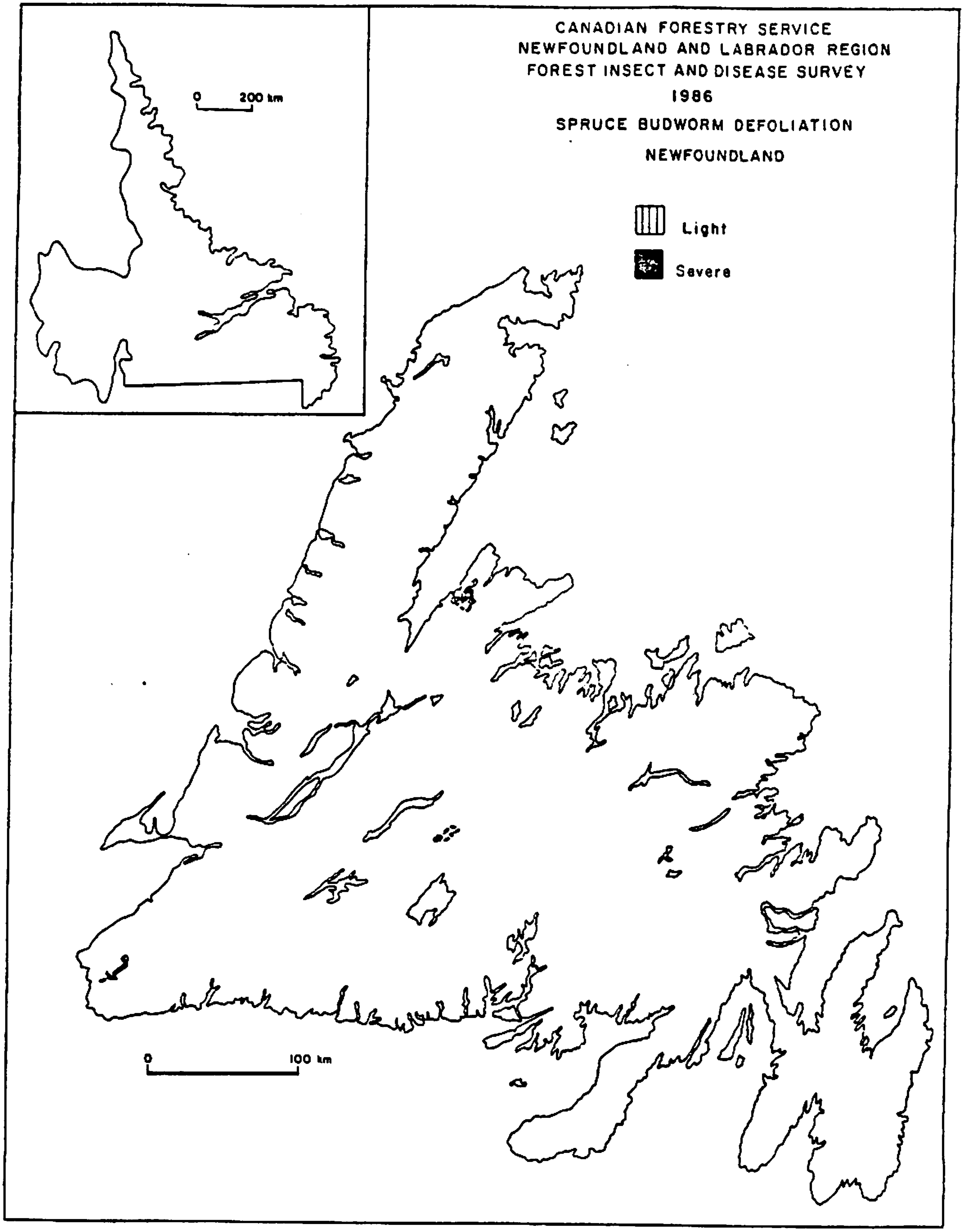

Figure 1. Areas of defoliation caused by the spruce budworm in productive forests of Newfoundland in 1986.

Spruce Budworm Population
In Nova Scotia, 1986

by

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Misc. Publication

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November 1986

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SPRUCE BUDWORM POPULATIONS IN NOVA SCOTIA

I. INTRODUCTION

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

The L-2 survey of 1985 noted the continuation of the infestation along the Northumberland Coast and Central Cumberland County (Figure 1).

II. AERIAL DEFOLIATION SURVEY

The aerial defoliation survey is conducted by the Forest Insect and Disease Survey of the Canadian Forestry Service - Maritimes - Truro with assistance from the Department of Lands and Forests. The results of the survey will be published as a separate CFS-M Technical Note.

III. MOTH FLIGHT SURVEY

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

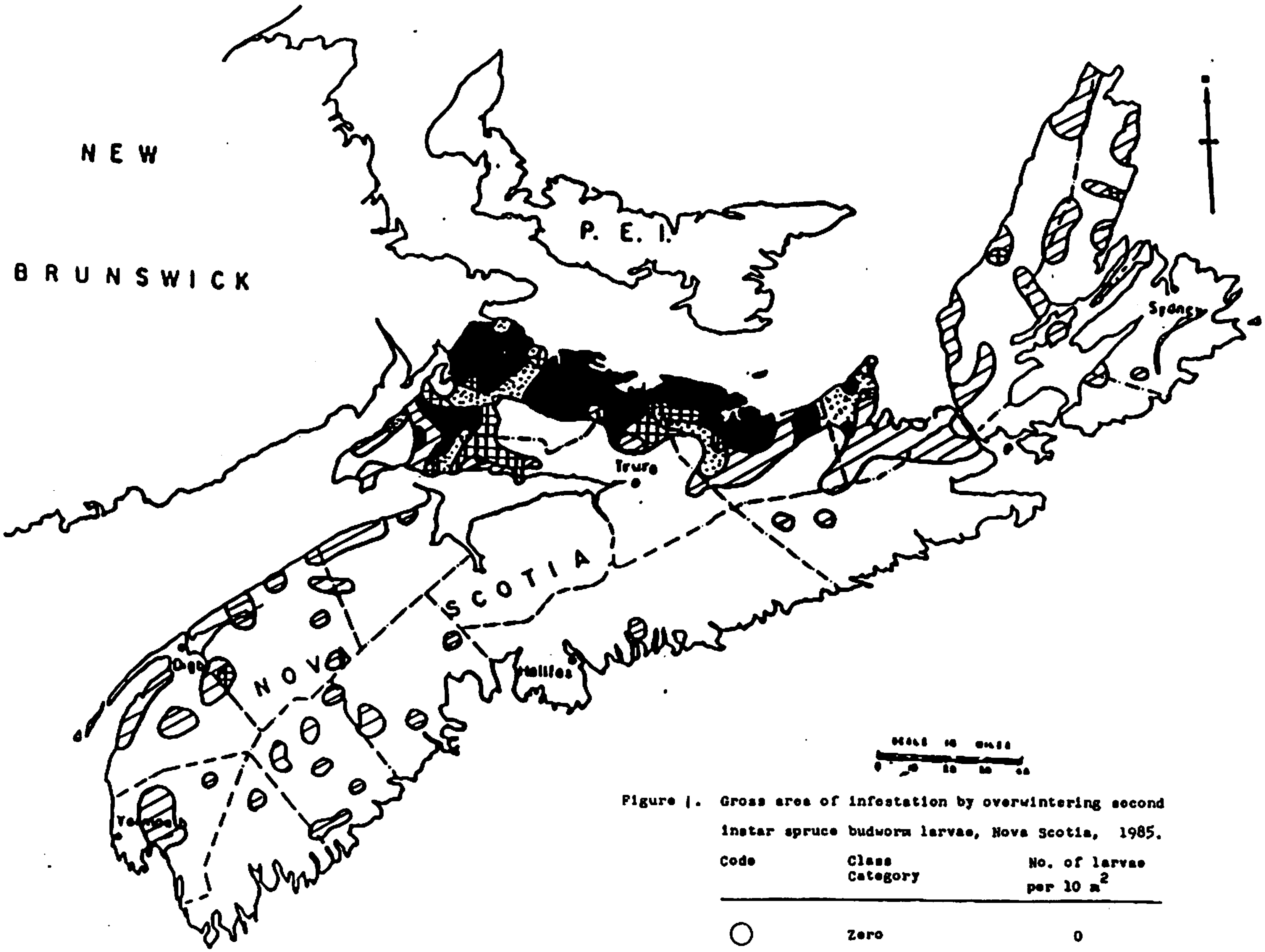

Figure 1. Gross area of infestation by overwintering second instar spruce budworm larvae, Nova Scotia, 1985.

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

Nova Scotia Agriculture and Marketing operate a system of light traps to sample photopositive night flying insects. The Department's light traps are operated during the time of moth flights of spruce budworm. Inclement weather during the time of adult activity was unfavourable for moth flight. No major adult migrations were noted this year. This does not assume that local moth flights did not occur.

IV. L-2 SURVEY

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

A. Methods

1. Field

There were 420 L-2 sample points used for this year's survey. Field samples from 367 (87.4%) locations were collected by Departmental personnel and samples from 53 (12.6%) locations were collected by Bowater-Mersey personnel. In order to compensate for long leader growth on spruces the length of the branch samples was increased from 45 cm to 75 cm. All samples were submitted on time.

2. Laboratory

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

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

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

(Dorais and Kettela 1982)

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

Sample areas of similar population densities are mapped to produce the L-2 map (Figure 2) (Appendix 1). The L-2 map for 1985 is presented for comparison (Figure 2).

3. Results

In general the current spruce budworm epidemic in Nova Scotia is in a state of flux. In some areas the epidemic has collapsed, in others remained stable or intensified. Over all there is no significant change in the total area mapped for the infestation for 1985 and 1986. There are significant reductions in the areas of extreme (89.9%) and high (37.9%) whereas there are increases in area of moderate (25.6%) and low (18.7%) (Appendices 2, 3). Spruce and fir trees in areas supporting moderate to extreme numbers of larvae are at risk of noticeable defoliation.

A. Cape Breton

There has been an increase in the frequency of number of samples with low populations on the Cape Breton Highlands. This situation is similar to that of 1985.

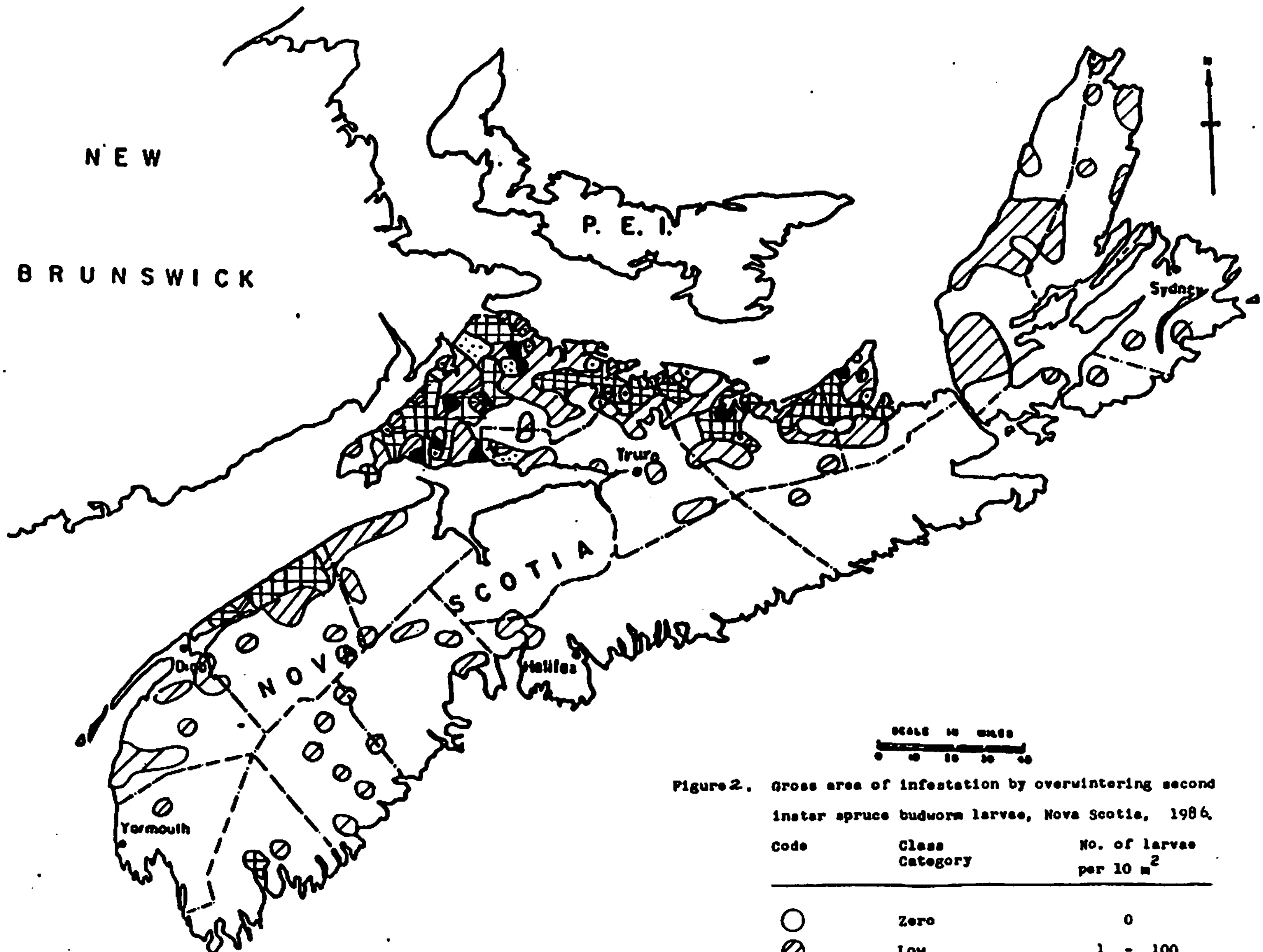

Figure 2. Gross area of infestation by overwintering second instar spruce budworm larvae, Nova Scotia, 1986.

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

B. Mainland Nova Scotia

(i) Southern Counties

The situation has changed somewhat from that of 1985. A small area of low population is located at the Head of St. Margaret's Bay in Lunenburg, Hants and Halifax counties. There is an area of moderate populations on the North Mountain in Annapolis County. Patches of low populations are noted throughout the Southern counties (Appendix 3).

(ii) Northern Counties

The decline in the intensity of the number of second instar larvae noted in 1985 has continued in 1986 (Tables 2-6). In some areas there has been a population collapse whereas in other areas it continues to be present in moderate to extreme class categories (Tables 2-6, Appendices 2,3). Population declines are noted in Cape George area, central Pictou County and southwestern Colchester County. Population increases are noted in western and southwestern Cumberland County.

Table 2. Frequency of the numbers of occurrences of L-2 survey class categories for Antigonish County, 1984-1986.

Class Category	Frequency of the Number of Occurrence					
	1984		1985		1986	
	No.	%	No.	%	No.	%
Zero	0	0	2	10.5	6	23.1
Low	0	0	7	36.8	12	46.2
Moderate	1	16.7	5	26.3	6	23.1
High	3	50.0	4	21.1	1	3.8
Extreme	2	33.3	1	5.3	1	3.8
TOTAL	6	100.0	19	100.0	26	100.0

Table 3. Frequency of the number of occurrences of L-2 survey class categories for Colchester County, 1984-1986.

Class Category	Frequency of Number of Occurrence					
	1984		1985		1986	
	No.	%	No.	%	No.	%
Zero	0	0	7	23.3	10	27.0
Low	0	0	10	33.3	16	43.2
Moderate	3	18.7	5	16.7	6	16.2
High	4	25.0	1	3.3	5	13.6
Extreme	9	56.3	7	23.3	0	0.0
TOTAL	16	100.0	30	99.9	37	100.0

Table 4. Frequency of the number of occurrences of L-2 survey class categories, Cumberland County, 1984-1986.

Class Category	Frequency of the number of Occurrences					
	1984		1985		1986	
	No.	%	No.	%	No.	%
Zero	0	0.0	11	14.1	14	13.7
Low	5	13.9	23	29.5	40	39.2
Moderate	11	30.5	18	23.1	28	27.5
High	5	13.9	9	11.5	13	12.7
Extreme	15	41.7	17	21.8	7	6.9
Total	36	100.0	78	100.0	102	100.0

Table 5. Frequency of the number of occurrences of L-2 survey class categories for Pictou County, 1984-1986.

Class Category	Frequency of the number of Occurrences					
	1984		1985		1986	
	No.	%	No.	%	No.	%
Zero	0	0.0	3	11.5	12	29.3
Low	1	4.5	4	15.4	13	31.7
Moderate	0	0.0	4	15.4	11	26.8
High	6	27.3	3	11.5	3	7.3
Extreme	15	68.2	12	46.2	2	4.9
Total	22	100.0	26	100.0	41	100.0

Table 6. Comparison of gross areas of infestation by overwintering second instar spruce budworm larvae for Antigonish, Colchester, Cumberland and Pictou counties, Nova Scotia, 1985-1986.

County	Area (ha) per L-2 Class Category				
	Low	Moderate	High	Extreme	Total
Antigonish					
1985	83 750	90 000	29 750	3 500	207 000
1986	48 250	22 000	2 500	2 000	74 500
Diff.	-35 500	-68 000	-27 250	-1 500	-132 500
Colchester					
1985	40 250	39 750	3 250	26 500	109 750
1986	69 750	22 500	18 500	-	110 750
Diff.	+29 500	-17 250	+15 250	-26 500	+1 000
Cumberland					
1985	57 500	68 500	64 250	140 500	330 750
1986	165 000	139 250	47 500	18 750	370 500
Diff.	+107 500	+70 750	-16 750	-121 750	-39 750
Pictou					
1985	52 250	18 750	24 000	76 000	171 000
1986	77 250	48 750	6 750	4 250	137 000
Diff.	+25 000	+30 000	-17 250	-71 750	-34 000
Total					
1985	233 750	217 000	121 250	246 500	818 500
1986	360 250	232 500	75 250	25 000	693 000
Diff.	126 500	15 500	46 000	221 500	125 500
%	+54.1	+7.4	-37.9	-89.9	-15.3
1985	Total:	moderate + high + extreme			584 750
1986	Total:	moderate + high + extreme			332 750
Diff					-252 000
%					-43.1

C. Other Pests

Care must be taken to monitor possible range overlaps and combined defoliation of spruce budworm with spruce coneworm (Dioryctria reniculelloides Mut. & Mun.) and/or spruce budmoth (Zeiraphera canadensis Mut. & Free.). Populations of spruce coneworm declined throughout northern Nova Scotia this year. Only background numbers were noted in the L-2 survey. Populations of spruce budmoth were noted in Gulf Shore region of Colchester County and Cape George area in Antigonish County during the spray program.

The hemlock looper (Lambdina fiscellaria (Guen.)) occupies a similar ecological niche as the spruce budworm. It does however utilize a greater variety of hosts and feeds from mid-July to mid-August. High numbers of both spruce budworm and hemlock looper can be expected to occur in stands of trees between Fox River and Diligent River in Cumberland County.

The infestation (0.5 ha) on Île Bon Portage in Shelburne appears to be confined to the island. Small moth flights of hemlock looper were noted by causal observation in Kemptown and MacBains Corner in Colchester County; and in Lyon's Brook in Pictou County.

V. SUMMARY

The spruce budworm infestation in Nova Scotia is in a state of flux with significant decline in numbers in some areas of Northern Nova Scotia are significant increase in numbers in western and southwestern Cumberland County and in a small areas on North Mountain in Annapolis County. Areas of low populations have been noted on the Cape Breton Highlands and in the Southern counties, trace to light defoliation may occur in these areas in 1987. The spruce budworm infestation in continuing to persist in the northern counties in both reduced numbers and area.

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Appendix 1
Population densities of overwintering second instar spruce budworm larvae by county, Nova Scotia, 1986.

File: L 2 data

Report: L-2 SURVEY

Selection: ANTIGONISH

Page 1986

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
56(4)506(6)	ARISAG	1158	EXTREME	ws
58(2)505(6)	HARBOUR RD.	636	HIGH	ws
57(6)505(5)	LOWER NORTH GRANT	250	MODERATE	ws
56(2)506(1)	KNOYDART	221	MODERATE	ws
58(0)506(6)	BROPHY	183	MODERATE	ws
56(1)506(4)	MCARRAS BROOK	179	MODERATE	ws
59(0)505(3)	POMQUET	154	MODERATE	ws
56(8)505(3)	BROWNS MTN	115	MODERATE	ws
57(4)507(3)	GEORGEVILLE	79	LOW	ws
58(3)504(2)	DUNMORE	71	LOW	ws
57(4)506(5)	MARYVALE	61	LOW	ws
57(5)505(8)	NORTH GRANT	54	LOW	ws
57(7)507(4)	GEORGEVILLE	53	LOW	ws
58(2)507(8)	BALLYNTYNES COVE	48	LOW	ws
58(3)506(8)	WEST LAKEVALE	42	LOW	ws
58(4)506(2)	ANTIGONISH HARBOUR	37	LOW	ws
57(8)507(2)	GLEBE RD.	21	LOW	ws
56(8)505(9)	HIGHFIELD	20	LOW	ws
56(9)504(4)	ADDINGTON FORKS	19	LOW	ws
58(5)504(9)	LWR.SOUTH RIVER	13	LOW	ws
57(6)503(6)	GLEN ALPINE	00	ZERO	ws
57(3)504(9)	WEST RIVER	0	ZERO	ws
59(4)504(4)	BLACK AVON	0	ZERO	ws
60(7)505(0)	MONASTERY	0	ZERO	ws
61(5)505(8)	HAVRE BOUCHER	0	ZERO	ws
57(2)506(9)	MALIGNANT COVE	0	ZERO	ws

File: L 2 data

Report: L-2 SURVEY

Selection: ANNAPOLIS

Page 1986

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
33(2)498(1)	DOUGLAS ROAD	184	MODERATE	ws
29(2)495(7)	NORTH MTN RANGE	160	MODERATE	ws
30(1)496(2)	GRANVILLE	151	MODERATE	ws
33(9)497(5)	NICTAUX FALLS	143	MODERATE	ws
32(5)497(7)	EAST ARLINGTON	128	MODERATE	ws
31(6)497(3)	HAMPTON	120	MODERATE	bf
33(5)496(6)	WEASEL HILL	65	LOW	bf
30(7)496(5)	BELLISLE	32	LOW	ws
34(9)494(2)	SPRINGFIELD	32	LOW	bf
32(2)496(0)	DALHOUSIE LAKE	24	LOW	bf
32(4)495(8)	BIRCH HILL LAKE	20	LOW	bf
34(1)495(4)	ALBANY CROSS	17	LOW	bf
30(9)495(0)	PEROTTE	11	LOW	bf
30(3)495(3)	LAKE LA ROSE	0	ZERO	ws
32(3)495(4)	WEST DALHOUSIE	0	ZERO	bf
33(3)493(9)	MEDWAY LAKE	0	ZERO	bf
30(0)494(5)	PRINCEDALE	0	ZERO	bf
33(5)495(3)	DALHOUSIE HILL	0	ZERO	bf
33(8)495(7)	TROUT LAKE	0	ZERO	bf
32(5)493(7)	BEAR LAKE	0	ZERO	bf
33(0)493(3)	SNOWSHOE LAKE	0	ZERO	bf
33(1)494(7)	LITTLE BEAR LAKE	0	ZERO	bf
32(3)494(4)	LONG LAKE	0	ZERO	bf
30(2)493(7)	VICTORY	0	ZERO	bf
30(7)493(4)	SUNDOWN LAKE	0	ZERO	bf
32(5)492(3)	MAITLAND BRIDGE	0	ZERO	bf
31(2)495(4)	GOLDSMITH LAKE	0	ZERO	bf
31(3)493(2)	BUSTIN LAKE	0	ZERO	bf
32(1)492(6)	THOMAS MEADOW	0	ZERO	bf

File: L 2 data
Report: L-2 SURVEY
Selection: CAPE BRETON

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
72(4)510(6)	MORRISON LAKE	35	LOW	ws
72(0)508(4)	OCEANVIEW	11	LOW	bf
69(5)509(4)	BEN EOIN	10	LOW	BF
70(1)508(1)	SILVER MINE	8	LOW	bf
70(2)510(9)	MCLEANVILLE	0	ZERO	bf
69(2)507(8)	NORTH GLEN	0	ZERO	bf
68(4)508(0)	MIDDLE CAPE	0	ZERO	bf
70(9)507(6)	UPPER GRAND MIRA	0	ZERO	bf
73(6)509(1)	LORRAINE	0	ZERO	bf
71(3)508(8)	CAMPBELLDALE	0	ZERO	bf
71(2)509(5)	MARION BRIDGE	0	ZERO	bf
68(4)510(6)	POINT CLEAR	0	ZERO	bf
70(5)513(2)	MCCREADYVILLE	0	ZERO	bf

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Selection: COLCHESTER

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
47(2)505(7)	MILL BROOK	645	HIGH	rs/bs
41(3)503(5)	LYNN	567	HIGH	rs/bs
48(6)506(4)	BRULE	471	HIGH	ws
42(9)503(1)	BEAVER MEADOW	383	HIGH	rs/bs
42(2)503(0)	BEAVER BROOK	309	HIGH	rs/bs
41(7)502(6)	FIVE ISLANDS PK.	219	MODERATE	ws
47(7)506(0)	TATAMAGOUCHE	176	MODERATE	rs/bs
47(6)505(3)	CENTRAL NEW ANNAN	147	MODERATE	ws
46(6)506(1)	MATTALL LAKE	137	MODERATE	ws
48(7)506(0)	DENMARK	120	MODERATE	rs/bs
41(9)503(3)	NEW BRITTAIN	112	MODERATE	rs/bs
43(1)502(4)	ECONOMY POINT	58	LOW	rs/bs
49(2)505(2)	NORTH EARLTOWN	43	LOW	rs/bs
47(8)506(3)	BARRACHOIS	33	LOW	ws
47(8)504(3)	SILICA LAKE	30	LOW	bf
46(9)505(1)	WARRICK MTN.	24	LOW	ws
43(0)503(9)	ECONOMY LAKE	24	LOW	rs/bs
43(8)503(2)	UPPER BASS RIVER	23	LOW	rs/bs
49(8)500(6)	OTTERBROOK	20	LOW	rs/bs
47(1)502(5)	ONSLOW	17	LOW	rs/bs
48(4)505(6)	BALMORAL MILLS	15	LOW	ws
50(7)500(9)	NEWTON MILLS	15	LOW	ws
49(2)504(8)	BERICHAN	10	LOW	bf
50(5)502(8)	LANSBURG	8	LOW	rs/bs
48(5)502(5)	VALLEY	8	LOW	ws
49(0)505(7)	EAST EARLTOWN	7	LOW	rs/bs
48(4)505(0)	SPIDELL HILL	6	LOW	ws
45(0)503(5)	LORNEVALE	0	ZERO	ws
45(6)503(6)	FOLLY MTN.	0	ZERO	ws
46(5)503(5)	DEBERT	0	ZERO	ws
47(2)502(9)	CROWS MILLS	0	ZERO	rs/bs
47(5)499(7)	STEWIACKE	0	ZERO	bf
47(8)502(0)	MILLBROOK	0	ZERO	rs/bs
48(0)503(7)	MCCALLUM SETTLEMENT	0	ZERO	ws
48(1)500(8)	BROOKFIELD	0	ZERO	bf
48(1)504(5)	NUTTBY	0	ZERO	bf
48(7)505(0)	EARLTOWN	0	ZERO	bf

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Selection: CUMBERLAND

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
42(6)507(6)	MANSFIELD	1138	EXTREME	rs/bs
40(9)502(9)	MOOSE RIVER	965	EXTREME	rs/bs
41(1)505(4)	SPRINGHILL	786	EXTREME	rs/bs
42(8)506(8)	LITTLE RIVER	784	EXTREME	rs/bs
38(3)503(1)	GLASGOW MTN.	760	EXTREME	rs/bs
39(5)505(1)	THUNDERHILL	722	EXTREME	rs/bs
39(3)503(7)	HALFWAY RIVER	678	EXTREME	rs/bs
40(8)505(6)	ATHOL ROAD	595	EXTREME	rs
43(2)507(4)	BECKWITH	553	HIGH	rs/bs
39(3)503(1)	KIRKHILL	536	HIGH	rs/bs
46(1)505(9)	WEST TATAMAGOUCHE	512	HIGH	rs/bs
43(0)508(4)	LWR. SHINIMICAS	472	HIGH	ws
42(3)506(8)	LEICESTER	451	HIGH	rs/bs
45(8)507(0)	KERRS MILL RD.	410	HIGH	rs/bs
39(6)507(1)	MINUDIE	405	HIGH	ws
41(2)508(0)	TYNDAL ROAD	393	HIGH	rs
40(5)508(2)	FORT LAWRENCE	380	HIGH	rs/bs
41(0)507(4)	BROOKDALE	378	HIGH	rs
41(0)505(2)	MAPLETON	325	HIGH	bf
36(8)504(2)	SAND RIVER	309	HIGH	rs/bs
40(4)505(5)	SOUTH ATHOL	275	HIGH	rs
44(3)506(6)	CONNS MILLS	268	MODERATE	rs/bs
38(6)502(8)	DILIGENT RIVER	265	MODERATE	rs/bs
45(4)506(8)	MIDDLEBORO	261	MODERATE	rs/bs
42(3)508(9)	BEECHAM SETTLEMENT	247	MODERATE	rs/bs
41(5)508(8)	TIDNISH	212	MODERATE	rs/bs
45(8)505(7)	WENTWORTH CTR.	198	MODERATE	ws
39(6)503(6)	LAKELANDS	192	MODERATE	rs/bs
42(4)508(0)	AMHERST HEAD	182	MODERATE	rs/bs
42(3)508(4)	BEECHAM ROAD	174	MODERATE	ws
40(7)504(6)	SOUTH BROOK	173	MODERATE	rs
39(7)504(8)	THUNDER HILL	170	MODERATE	rs/bs
41(8)508(9)	GREEN ROAD	168	MODERATE	rs/bs
38(4)504(4)	FORTY PUZZLE LAKE	163	MODERATE	rs/bs
47(8)507(1)	MALAGASH POINT	156	MODERATE	rs/bs

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CUMBERLAND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
38(5)505(8)	RAGGED REEF	152	MODERATE	rs
46(5)506(6)	MALAGASH STN.	152	MODERATE	rs/bs
42(1)505(7)	SALT SPRINGS	147	MODERATE	ws
41(2)507(1)	WEST LEICESTER	144	MODERATE	rs/bs
36(6)503(9)	EAST APPLE RIVER	140	MODERATE	rs
35(9)502(3)	WEST ADVOCATE	133	MODERATE	rs
43(6)506(2)	WEST HANSFORD	129	MODERATE	rs/bs
41(4)506(6)	STANLEY	128	MODERATE	rs/bs
37(5)504(1)	SHULIE RIVER	125	MODERATE	rs/bs
43(1)507(8)	LAKE KILLARNEY	116	MODERATE	rs/bs
39(1)504(1)	HALFWAY RVR.	111	MODERATE	rs/bs
38(4)505(1)	CHIGNECTO	104	MODERATE	rs
37(8)505(1)	SHULIE	102	MODERATE	rs
45(4)507(8)	GULF SHORE	97	LOW	ws
39(3)505(6)	RIVER HEBERT	94	LOW	rs/bs
40(1)503(0)	NEW PROSPECT	93	LOW	rs/bs
46(9)506(9)	MALAGASH	89	LOW	ws
43(9)507(9)	PORT HOWE	86	LOW	rs/bs
37(8)503(1)	NORTH GREVILLE	77	LOW	rs/bs
41(1)504(8)	STH. HAMPTON	77	LOW	rs/bs
39(6)506(5)	LOWER MACCAN	76	LOW	bf
38(3)505(6)	TWO RIVERS	75	LOW	rs/bs
40(8)503(4)	MOOSE RIVER	74	LOW	rs/bs
40(7)506(7)	FENWICK	70	LOW	ws
42(2)507(3)	MANSFIELD	66	LOW	rs/bs
44(4)505(2)	WESTCHESTER STN	60	LOW	rs/bs
37(4)504(8)	SHULIE	59	LOW	rs/bs
43(3)508(1)	WEST LINDEN	58	LOW	rs/bs
44(3)504(3)	GLEASON BROOK	58	LOW	ws
36(5)502(7)	BEECH HILL	57	LOW	rs/bs
43(2)505(9)	OXFORD JUNCTION	57	LOW	rs
42(3)506(2)	CHASE LAKE	54	LOW	rs/bs
40(2)504(4)	SOUTH BROOK	50	LOW	rs/bs
41(8)507(8)	TRUEMANVILLE	50	LOW	rs/bs
44(6)507(7)	PUGWASH	44	LOW	rs/bs

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
43(7)505(7)	THOMSON STSTION	39	LOW	rs
40(5)503(0)	MOOSE RIVER	39	LOW	rs/bs
42(8)508(5)	CHAPMAN SETTLEMENT	37	LOW	ws
40(4)505(3)	SOUTH ATHOL	24	LOW	rs/bs
46(5)507(5)	NORTH WALLACE	22	LOW	rs/bs
43(6)507(1)	RIVERVIEW	22	LOW	rs/bs
45(0)504(9)	WESTCHESTER	21	LOW	bf
39(2)504(0)	HALFWAY RIVER	20	LOW	rs/bs
43(0)507(3)	RIPLEY LOOP	20	LOW	ws
40(9)506(3)	LITTLE FORKS	17	LOW	rs/bs
43(0)504(5)	FARMINGTON	14	LOW	rs
38(2)503(8)	WELTON LAKE	14	LOW	rs/bs
42(1)509(1)	TIDNISH BRIDGE	12	LOW	rs/bs
45(3)507(2)	HD. WALLACE BAY	12	LOW	rs/bs
43(9)506(6)	ROSLIN	11	LOW	rs/bs
35(4)503(4)	PUDSEY PT.	11	LOW	rs/bs
46(2)505(4)	EAST WENTWORTH	9	LOW	rs/bs
36(6)503(4)	ADVOCATE	7	LOW	rs/bs
39(1)506(7)	MILL CREEK	0	ZERO	rs/bs
41(8)502(7)	FIVE ISLANDS	0	ZERO	rs/bs
41(2)504(5)	EAST MAPLETON	0	ZERO	rs/bs
39(4)505(0)	BOARS BACK	0	ZERO	rs
40(8)505(0)	MAPLETON	0	ZERO	bf
40(1)506(5)	HARRISON ROAD	0	ZERO	rs/ws
36(2)503(8)	EAST APPLE RIVER	0	ZERO	rs/bs
44(7)504(1)	SUTHERLAND LAKE	0	ZERO	rs/bs
35(4)502(8)	EATONVILLE	0	ZERO	rs/bs
36(2)503(2)	ADVOCATE	0	ZERO	rs/bs
43(7)504(8)	SUGARLOAF MTN	0	ZERO	bf
45(0)505(6)	WEST WENTWORTH	0	ZERO	rs/bs
45(3)506(0)	MAHONEYS CORNER	0	ZERO	rs/bs
44(4)506(9)	CONNS MILLS	0	ZERO	rs/bs

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Selection: HALIFAX

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
47(3)495(6)	PORTERS LAKE	10	LOW	bf
42(5)495(7)	MUSKRAT LAKE	9	LOW	bf
42(2)495(2)	POGWA LAKE	9	LOW	rs/bs
43(3)495(0)	STILLWATER LAKE	8	LOW	bf
45(9)497(3)	OLDHAM	0	ZERO	bf
45(4)495(8)	WAVERLY	0	ZERO	bf
41(6)496(7)	SHADY LAKE	0	ZERO	bf
41(2)495(1)	INDIAN HILL	0	ZERO	bf
48(2)496(7)	GIBRALTER	0	ZERO	bf
48(0)495(6)	CONROD SETTLEMENT	0	ZERO	bf
46(8)496(2)	EAST LAKE	0	ZERO	bf
50(2)498(6)	MOOSE RIVER	0	ZERO	bf
48(8)499(1)	GLENMORE	0	ZERO	bf
53(6)497(8)	SHEET HARBOUR	0	ZERO	bf
53(8)499(5)	HORSE LAKE	0	ZERO	bf
53(3)500(0)	LISCOMBE	0	ZERO	bf
51(9)497(4)	MOOSELAND	0	ZERO	bf
51(1)496(2)	SHIP HARBOUR	0	ZERO	bf
42(8)495(1)	MILL LAKE	0	ZERO	rs/bs

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Selection: HANTS

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
40(1)497(6)	CASTLE FREDRICK	8	LOW	bf
40(2)496(8)	VAUGHAN	0	ZERO	bf
41(2)500(6)	STARRATT PT.	0	ZERO	bf
42(2)497(4)	STILLWATER	0	ZERO	bf
42(6)500(0)	PINNACLE HILL	0	ZERO	bf
43(2)497(2)	MT.UNIACKE	0	ZERO	bf
43(0)501(3)	CAPE TENNY	0	ZERO	bf
43(8)500(4)	WET MEADOW	0	ZERO	bf
46(7)500(2)	ADMIRAL ROCK	0	ZERO	bf
44(9)500(6)	UPPER KENNETCOOK	0	ZERO	bf
44(5)501(7)	DENSMORES MILLS	0	ZERO	bf

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Selection: DIGBY

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
28(3)493(0)	BIG TOM WALLACE LK.	45	LOW	bf
26(4)489(6)	WENTWORTH LAKE	23	LOW	bf
28(9)493(0)	LINT LK.	22	LOW	bf/rs
28(1)490(0)	TOAD LAKE	20	LOW	bf
25(3)490(3)	LOWER CONCESSION	13	LOW	rs/bs
22(8)493(9)	BEAR RIVER	12	LOW	bf/rs
27(4)492(0)	FIRE TOWER	12	LOW	bf
26(5)491(7)	SCOTS LK.	11	LOW	rs/bs
28(5)492(8)	LAKE JOLI	7	LOW	bf
27(4)489(8)	BARRIS DEADWATER	6	LOW	bf
24(9)489(0)	CLARE	6	LOW	bf
28(6)491(2)	BIRCH LAKE	5	LOW	bf
26(3)490(3)	FIRMAIN	0	ZERO	rs/bs
28(0)493(4)	MORGANVILLE	0	ZERO	bf
27(6)490(7)	BARNS BROOK	0	ZERO	bf
27(5)491(0)	BARN BROOK	0	ZERO	bf/rs
26(7)492(4)	MALLETTES MEADOWS	0	ZERO	bf
27(8)491(3)	DOYLES LK.	0	ZERO	bf

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Selection: GUYSBOROUGH

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
54(8)501(4)	CALEDONIA	19	LOW	rs
63(0)504(4)	MIDDLE MELFORD	0	ZERO	bf
62(5)505(1)	MULGRAVE	0	ZERO	bf
61(3)504(0)	LINCOLNVILLE	0	ZERO	bf
57(7)499(6)	GOLDENVILLE	0	ZERO	bf
59(0)501(8)	NELSONS LAKE	0	ZERO	bf
56(8)501(4)	SMITHFIELD	0	ZERO	ws
60(7)502(2)	OGDEN	0	ZERO	bf
62(2)503(3)	MACPHERSON LAKE	0	ZERO	bf

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Selection: INVERNESS

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
64(3)506(8)	MARSHES	53	LOW	ws
68(0)518(8)	FOX LAKE	46	LOW	ws
65(1)511(3)	GILLANDERS MTN	41	LOW	bf
63(5)512(1)	CAMPBELLTON RD.	37	LOW	ws
65(7)512(6)	FIRST LAKE OLAW	33	LOW	ws
62(3)506(3)	CREIGNISH HILLS	30	LOW	ws
63(2)511(6)	KENLOCK	30	LOW	ws
63(4)508(2)	UPPER RIVER DENYS	29	LOW	ws
62(3)510(9)	MABOU HIGHLANDS	23	LOW	bf
64(5)513(2)	MARGAREE FORKS	22	LOW	ws
65(2)516(1)	PLATEAU	21	LOW	ws
65(4)513(1)	NE MARGAREE	20	LOW	`bf
65(9)513(6)	FRASERS MTN	19	LOW	bf
62(6)511(4)	NTH. CAPE HIGHLANDS	11	LOW	bf
61(8)507(4)	LONG POINT	11	LOW	ws
65(6)514(0)	PORTREE	11	LOW	ws
63(2)507(2)	MAPLE BROOK	9	LOW	bf
63(4)510(7)	HAYS RIVER	0	ZERO	ws
61(5)509(6)	PORT HOOD	0	ZERO	ws
65(7)516(7)	PETIT ETANG	0	ZERO	bf
66(2)517(8)	COVE RIVER	0	ZERO	bf
66(6)518(7)	PLEASANT BAY	0	ZERO	ws
64(8)514(5)	BELLE COTE	0	ZERO	bf
65(5)512(2)	SECOND LAKE	0	ZERO	bf
63(8)509(6)	STEWARTDALE	0	ZERO	bf
64(9)509(9)	HUME	0	ZERO	bf
66(7)515(1)	SECONDS FORK BR. RD.	0	ZERO	bf
66(7)515(8)	CAMPBELLS BARREN	0	ZERO	bf

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Selection: KINGS

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
36(6)500(1)	WHITES CORNER	71	LOW	ws
34(3)498(9)	BISHOP MTN.	42	LOW	ws
35(0)497(5)	TORBROOK EAST	38	LOW	ws
36(0)495(1)	EAST DALHOUISE	33	LOW	bf
35(3)499(5)	VICTORIA HBR.	26	LOW	ws
35(8)499(4)	VIEWMOUNT	13	LOW	ws
35(5)469(6)	FROG LAKE	10	LOW	rs/bs
39(2)501(7)	SCOTS BAY	0	ZERO	bf
37(9)498(6)	SOUTH-ALTON	0	ZERO	ws
38(0)497(5)	FOREST HOME	0	ZERO	ws
36(8)498(1)	AYLESFORD LAKE	0	ZERO	rs/bs
36(7)497(0)	LAKE PAUL	0	ZERO	rs/bs
39(3)498(9)	FOREST HILL	0	ZERO	ws
39(3)501(3)	BLOMIDON	0	ZERO	bf
38(5)500(4)	ARLINGTON	0	ZERO	ws
37(4)500(2)	W. HALLS HARBOUR RD.	0	ZERO	ws
35(1)497(9)	ROCKVILLE LAKE	0	ZERO	bf

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Selection: LUNENBURG

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
35(9)491(0)	UPPER CHELSEA	44	LOW	rs
37(6)494(8)	HARLOW LAKE	32	LOW	rs/bs
35(8)492(8)	NINEVEN	26	LOW	rs
40(3)493(8)	LABRADOR LAKE	18	LOW	bf
38(3)495(2)	LAKE DARLING	17	LOW	bf
39(8)495(1)	SHERWOOD	12	LOW	bf
37(5)490(2)	ITALY CROSS	10	LOW	rs
40(8)494(2)	BIG WHITFORD LK.	9	LOW	rs/bs
37(6)492(1)	LOWER BRANCH	8	LOW	bf
37(1)491(2)	HEBBVILLE	0	ZERO	rs
36(0)494(0)	STANBURN	0	ZERO	bf
37(4)489(8)	MIDDLEWOOD	0	ZERO	rs
39(9)493(8)	MARIOTTS MEADOW	0	ZERO	rs

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Selection: PICTOU

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
51(8)504(6)	ALMA	2283	EXTREME	ws
55(7)505(9)	PONDS	739	EXTREME	ws
55(1)505(7)	LOWER BARNEYS RIVER	544	HIGH	ws
52(7)503(9)	FORBES LK.	400	HIGH	ws
50(2)506(9)	SEAFOAM	361	HIGH	ws
55(3)505(5)	BAILEYS BROOK	290	MODERATE	ws
49(2)507(0)	CAPE JOHN	267	MODERATE	ws
50(1)505(6)	BLACK RIVER	247	MODERATE	ws
53(2)507(3)	PICTOU ISLAND	233	MODERATE	ws
51(7)505(4)	LOCH BROOM	220	MODERATE	ws
54(8)505(0)	MERIGOMISH	207	MODERATE	ws
52(9)503(6)	IRISH MTN.	191	MODERATE	ws
49(7)506(0)	MINE BRK.	181	MODERATE	ws
51(4)504(3)	GREENHILL	136	MODERATE	ws
52(0)505(0)	GRANTON	121	MODERATE	ws
52(4)506(3)	CARIBOU FERRY	120	MODERATE	rs/bs
51(7)506(4)	WATERSIDE	76	LOW	ws
51(2)505(6)	HARDWOOD HILL	75	LOW	ws
50(1)505(2)	DIAMOND BROOK	46	LOW	ws
53(2)505(1)	TRENTON	40	LOW	rs/bs
54(0)505(0)	WEST MERIGOMISH	32	LOW	ws
51(6)503(7)	ROCKLAND	28	LOW	ws
50(3)505(1)	DIAMOND BROOK	23	LOW	ws
49(6)505(2)	LOGANVILLE	21	LOW	bf
49(8)506(6)	FITZPATRICK	21	LOW	bf
52(5)503(0)	ELGIN	20	LOW	ws
50(7)505(8)	PLAINFIELD	14	LOW	bf
55(6)504(5)	ROSS FIELD	10	LOW	ws
56(5)502(7)	EAST RIVER,ST.MARY'S	10	LOW	ws
50(0)503(8)	UPPER MT.THOM	0	ZERO	bf
54(2)502(5)	SUNNYBRAE	0	ZERO	bf
56(2)504(8)	MARSHY HOPE	0	ZERO	ws
54(4)504(6)	FRENCH RIVER	0	ZERO	bf
53(9)504(6)	TELFORD	0	ZERO	ws
50(8)506(4)	POPLAR HILL	0	ZERO	bf

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Selection: PICTOU

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
50(2)506(2)	ROGERS	0	ZERO	bf
50(5)504(6)	DALHOUSIE MTN.	0	ZERO	ws
51(0)504(0)	MILLBROOK	0	ZERO	ws
49(9)504(5)	DALHOUSIE SETTLEMENT	0	ZERO	ws
53(7)505(6)	ROY ISLAND	0	ZERO	ws
50(5)506(2)	POPLAR HILL	0	ZERO	rs/bs

File: L 2 data

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Selection: QUEENS

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UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
34(3)492(6)	CRANBERRY LAKE	80	LOW	bf
35(6)488(4)	MILTON	75	LOW	bf
34(3)489(6)	BLACK LAKE	44	LOW	bf
35(0)486(8)	RIVER HEAD	8	LOW	bf
31(8)491(2)	KEJIMKAJIK PARK	0	ZERO	rs
31(3)490(0)	LITTLE PINE LAKE	0	ZERO	bf
32(2)490(1)	SAND LAKE	0	ZERO	bf
32(7)488(5)	COADE LAKE	0	ZERO	bf
33(8)491(4)	CALEDONIA	0	LOW	bf
33(5)490(8)	WHITEBURN MINES	0	ZERO	bf/ws
34(5)491(2)	MOLEGA	0	ZERO	bf
34(8)488(6)	NINE MILE BROOK	0	ZERO	bf
35(3)488(4)	LWR.GREAT BROOKS MEA	0	ZERO	bf
36(5)489(3)	RIVERSDALE	0	ZERO	bf
35(7)487(8)	MILTON	0	ZERO	bf/rs
34(0)486(4)	WILKINS	0	ZERO	rs/bs
32(9)492(1)	KEMPT	0	ZERO	bf

File: L 2 data

Report: L-2 SURVEY

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Selection: RICHMOND

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
66(2)506(4)	OBAN	81	LOW	bf
68(6)506(6)	HD.LOCH LOMOND	32	LOW	bf
65(0)504(6)	PORT ROYAL	0	ZERO	bf
67(2)506(0)	BARRA HEAD	0	ZERO	bf
67(9)507(5)	IRISH COVE	0	ZERO	bf
70(1)506(7)	NORTH FRAMBOISE	0	ZERO	bf

File: L 2 data

Report: L-2 SURVEY

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Selection: SHELBURNE

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
30(8)485(2)	WELSHTOWN	112	MODERATE	bf
32(0)486(1)	STH.BLUE HILL	23	LOW	bf
30(4)487(2)	PHILIP LAKE	0	ZERO	bf
30(3)486(2)	UPPER CLYDE RIVER	0	ZERO	bf
32(8)487(2)	NORTH BLUE HILL	0	ZERO	rs/bs
32(6)485(7)	BLUE HILL BOG	0	ZERO	bf

File: L 2 data

Report: L-2 SURVEY

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Selection: VICTORIA

UTM Grid No.	Location	Ave.No.L2/10(m^2)	Pop. Category	Tree Spp
69(4)514(6)	LITTLE RIVER	36	LOW	ws
67(7)515(7)	WRECK COVE	30	LOW	bf
66(7)513(7)	FIRE CAMP	26	LOW	bf
69(7)515(5)	WRECK COVE PT.	23	LOW	ws
70(1)518(1)	GREEN COVE	21	LOW	rs/bs
66(8)512(0)	CROWDIS AIR.	18	LOW	bf
68(6)520(9)	MEAT COVE	14	LOW	ws
69(5)518(9)	MICA HILL	11	LOW	ws
69(4)518(0)	BRANCH POND	6	LOW	ws
66(6)509(4)	ST. COLUMBO	0	ZERO	bf
65(8)510(6)	WEST MIDDLE RIVER	0	ZERO	bf
68(9)515(9)	WRECK COVE	0	ZERO	rs/bs
65(7)511(2)	GAIRLOCH	0	ZERO	ws
67(1)511(8)	NEW GLEN	0	ZERO	ws
66(4)511(2)	HUNTERS MTN	0	ZERO	bf
68(5)513(6)	TARBOTUOLE	0	ZERO	ws
69(1)512(4)	KELLYS MTN.	0	ZERO	bf
69(7)517(0)	INGONISH CENTRE	0	ZERO	ws
69(2)520(6)	ST. MARGARETS VIL.	0	ZERO	ws

File: L 2 data

Report: L-2 SURVEY

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Selection: YARMOUTH

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

Appendix 2
Gross area of infestation by overwintering second instar spruce budworm larvae, by County, Nova Scotia, 1985-1986.

Gross area of infestation by overwintering second instar spruce budworm larvae by County, Nova Scotia, 1985.

County	Class Category Area (ha)				
	Low	Moderate	High	Extreme	Total
A. Cape Breton I.					
Cape Breton	6 250	-	-	-	6 250
Inverness	86 750	5 250	-	-	92 000
Richmond	4 000	-	-	-	4 000
Victoria	75 000	3 500	-	-	78 500
B. Mainland N.S.					
Southern					
Annapolis	73 000	1 000	-	-	74 000
Digby	75 000	3 500	-	-	78 500
Guysborough	42 250	-	-	-	42 250
Halifax	13 000	-	-	-	13 000
Hants	4 500	-	-	-	4 500
Kings	50 750	-	-	-	50 750
Lunenburg	18 250	-	-	-	18 250
Queens	48 250	-	-	-	48 250
Shelburne	7 500	-	-	-	7 500
Yarmouth	45 750	-	-	-	45 750
Northern					
Antigonish	83 750	90 000	29 750	3 500	207 000
Colchester	40 250	39 750	3 250	26 500	109 750
Cumberland	57 500	68 500	64 250	140 500	330 750
Pictou	52 250	19 750	24 000	76 000	171 000
Total	784 000	230 250	121 250	246 500	1 392 000

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

County	Class Category Area (ha)				
	Low	Moderate	High	Extreme	Total
A. Cape Breton Island					
Cape Breton	19 000	-	-	-	19 000
Inverness	157 750	-	-	-	157 750
Richmond	13 750	-	-	-	13 750
Victoria	58 500	-	-	-	58 500
B. Mainland					
Southern					
Annapolis	41 500	50 250	-	-	91 750
Digby	96 500	-	-	-	96 500
Guysborough	7 500	-	-	-	7 500
Halifax	22 500	-	-	-	22 500
Hants	10 750	-	-	-	10 750
Kings	43 250	-	-	-	43 250
Lunenburg	56 000	-	-	-	56 000
Queens	31 250	-	-	-	31 250
Shelburne	6 000	6 500	-	-	12 500
Yarmouth	6 000	-	-	-	6 000
Northern					
Antigonish	48 250	22 000	2 500	2 000	74 750
Colchester	69 750	22 500	18 500	-	110 750
Cumberland	165 000	139 250	47 500	18 750	370 500
Pictou	77 250	49 750	6 750	4 250	137 000
Total	930 500	289 250	75 250	25 000	1 320 000
% ▲ 1985	+18.7	+25.6	-37.9	-89.9	+4.9

Appendix 3
The frequency of the number of occurrences
of L-2 class categories by County
for Nova Scotia, 1985-1986.

Frequency of the number of occurrences of L-2 class categories by county for Nova Scotia, 1985-1986.

Class	Annapolis 1985 No.	Annapolis 1985 %	Annapolis 1986 No.	Annapolis 1986 %	Antigonish 1985 No.	Antigonish 1985 %	Antigonish 1986 No.	Antigonish 1986 %
Zero	2	10.5	16	55.2	1	7.3	6	23.6
Low	7	36.8	7	24.1	11	91.7	12	46.2
Moderate	5	26.3	6	20.7	0	0.0	6	23.1
High	4	21.1	0	0.0	0	0.0	1	3.8
Extreme	1	5.3	0	0.0	0	0.0	1	3.8
Total	19	100.0	29	100.0	12	100.0	26	100.0

Class	Cape Breton 1985 No.	Cape Breton 1985 %	Cape Breton 1986 No.	Cape Breton 1986 %	Colchester 1985 No.	Colchester 1985 %	Colchester 1986 No.	Colchester 1986 %
Zero	14	93.3	9	69.2	7	23.3	10	27.0
Low	1	6.7	4	30.8	10	33.3	16	43.2
Moderate	0	0.0	0	0.0	5	16.7	6	16.2
High	0	0.0	0	0.0	1	3.3	5	13.6
Extreme	0	0.0	0	0.0	7	23.4	0	0.0
Total	15	100.0	13	100.0	30	100.0	37	100.0

Class	Cumberland 1985 No.	Cumberland 1985 %	Cumberland 1986 No.	Cumberland 1986 %	Digby 1985 No.	Digby 1985 %	Digby 1986 No.	Digby 1986 %
Zero	11	14.1	14	13.7	7	38.9	6	33.3
Low	23	29.5	40	39.2	10	55.6	12	66.7
Moderate	18	16.7	28	27.5	1	5.5	0	0.0
High	9	3.3	13	12.7	0	0.0	0	0.0
Extreme	17	23.4	7	6.9	0	0.0	0	0.0
Total	78	100.0	102	100.0	18	100.0	18	100.0

Class	Guysborough 1985 No.	Guysborough 1985 %	Guysborough 1986 No.	Guysborough 1986 %	Halifax 1985 No.	Halifax 1985 %	Halifax 1986 No.	Halifax 1986 %
Zero	4	50.0	8	88.9	15	88.1	15	78.9
Low	4	50.0	1	11.1	2	11.8	4	21.1
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	8	100.0	9	100.0	17	100.0	19	100.0

Frequency of the number of Occurrences

	Hants				Inverness			
Zero	11	92.7	10	90.9	11	52.4	11	39.3
Low	1	7.3	1	9.1	9	42.8	17	60.7
Moderate	0	0.0	0	0.0	1	4.8	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	12	100.0	11	100.0	21	100.0	28	100.0
	Kings				Lunenburg			
Zero	11	64.7	10	58.8	12	80.0	4	30.8
Low	6	35.3	7	41.2	3	20.0	9	69.2
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	17	100.0	17	100.0	15	100.0	13	100.0
	Pictou				Queens			
Zero	3	11.5	12	29.3	10	62.5	13	76.5
Low	4	15.4	13	31.7	6	37.5	4	23.5
Moderate	4	15.4	11	26.8	0	0.0	0	0.0
High	3	11.5	3	7.3	0	0.0	0	0.0
Extreme	12	46.2	2	4.9	0	0.0	0	0.0
Total	26	100.0	41	100.0	16	100.0	17	100.0
	Richmond				Shelburne			
Zero	9	90.0	4	66.7	5	83.3	4	66.7
Low	1	10.0	2	33.3	1	16.7	1	16.6
Moderate	0	0.0	0	0.0	0	0.0	1	16.7
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	10	100.0	6	100.0	6	100.0	6	100.0
	Victoria				Yarmouth			
Zero	11	34.4	10	52.6	5	50.0	8	88.9
Low	20	62.5	9	47.4	5	50.0	1	11.1
Moderate	1	3.1	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	32	100.0	19	100.0	10	100.0	9	100.0

	Nova Scotia			
Zero	149	37.0	170	40.5
Low	124	30.8	160	38.1
Moderate	35	8.7	58	13.8
High	58	14.3	22	5.2
Extreme	37	9.2	10	2.4

Appendix 4
Tree species per treatment area

TREATMENT AREA	BLOCK/CLUSTER	TREE SPP
1,2	PARRSBORO	RED SPRUCE
3	DILIGENT RIVER	RED SPRUCE
4,7-9	HALFWAY RIVER	RED SPRUCE
5,6	NEW CANAAN	RED SPRUCE
11	CHIGNECTO	RED SPRUCE
12,13	FLAT BROOK	RED SPRUCE
14	THUNDER HILL	RED SPRUCE
15,16,17	BARRON BROOK	RED SPRUCE
18,19,23	SOUTHAMPTON	RED SPRUCE
20,21,22	LAWRENCE	RED SPRUCE
24,25	SPRINGHILL	RED SPRUCE
26,27,28	RIVER HERBERT	RED SPRUCE
30,31	MACCAN	RED SPRUCE
32,33	LEICESTER	RED SPRUCE
63-69	OXFORD	RED SPRUCE
40,43	AMHERST	RED SPRUCE
54	SHINIMICAS	RED SPRUCE
55,71-74,74a,73b	LINDEN	RED SPRUCE
56-60,75,75a,76	MT PLEASANT	RED SPRUCE
35-38,38a	BROOKDALE	RED SPRUCE
77,80-83,75a	CONN MILLS	RED SPRUCE
78,79,84-86	HANSFORD	RED SPRUCE
97,98,106,107	PUGWASH JUNCTION	RED SPRUCE
99-104,104a	GULF SHORE	WHITE SPRUCE
105,126-130,132	MALAGASH	RED SPRUCE
108-112,114,115,117-123	WENTWORTH	RED SPRUCE
124,125,133-138,140-143	TATAMAGOUCHE	RED SPRUCE
144,145,145a	BALMORAL MILLS	RED SPRUCE
146-155,157,158	SPIDELL HILL	WHITE SPRUCE
159,174,175	WEST BRANCH	RED SPRUCE
160-167	MOUNTAIN RD	RED SPRUCE
163a,163c-163e	MELVILLE	RED SPRUCE
168-171,187,190-196,173 192a-b	POPLAR HILL	RED SPRUCE
183-185,185a-185d	ORTONVILLE	WHITE SPRUCE
186,188,189,197.186a,b	SCOTSBURN	WHITE SPRUCE
200,200a	ROY ISLAND	WHITE SPRUCE

File: BUDWORM.2

Report: TREE SPECIES

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TREATMENT AREA	BLOCK/CLUSTER	TREE SPP
198,199	BOAT HARBOUR	RED SPRUCE
180	DALHOUSIE MTN	WHITE SPRUCE
201,201a	PEIDMONT	WHITE SPRUCE
202-205	AVONDALE	WHITE SPRUCE
206-210,212,211c	EIGG MTN	WHITE SPRUCE
211-214,222,222a-b, 211a-b	BIG MARSH	WHITE SPRUCE
223,224,225	ANTIGONISH HARBOUR	WHITE SPRUCE
226	CLOVERDALE	WHITE SPRUCE

AERIAL FOLIAGE PROTECTION PROGRAM

NOVA SCOTIA, 1986

by

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Deputy Minister
Mr. J. Mullally

Minister
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November 1986

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AERIAL FOLIAGE PROTECTION PROGRAM

NOVA SCOTIA, 1986

I. INTRODUCTION

In 1986 the spruce budworm continued to be the foremost insect pest in Nova Scotia. Epidemic numbers persisted in stands of spruce and fir in the northern counties of Nova Scotia (Figure 1) (Smith and Georgeson 1985). Stands supporting moderate or higher numbers of larvae were expected to experience noticeable defoliation this year. This year's expanded program reflects both the concentrated infestation along the northern Mainland and the desire of 2200 individuals to maintain healthy trees.

II. OBJECTIVE

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

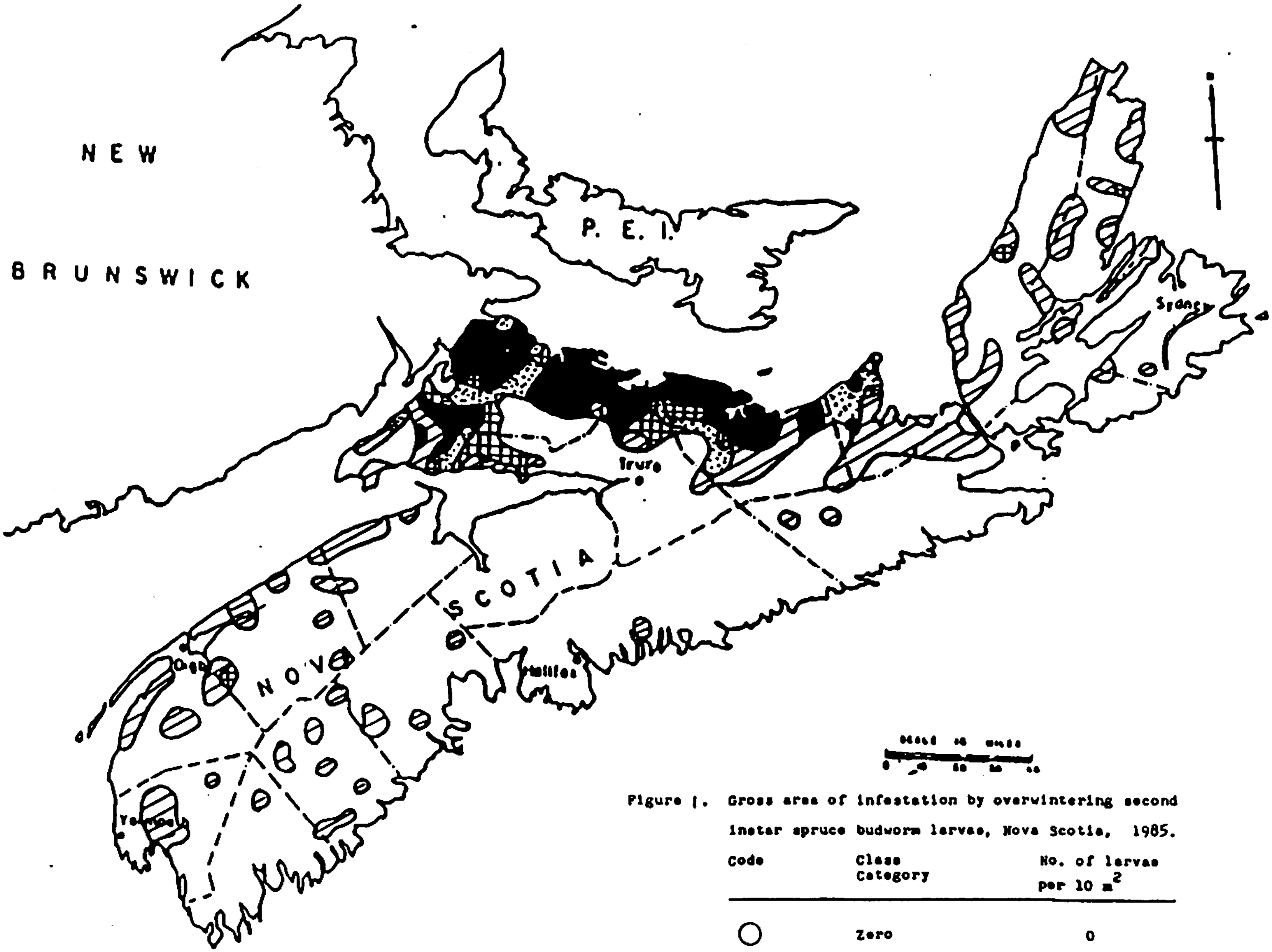

Figure 1. Gross area of infestation by overwintering second instar spruce budworm larvae, Nova Scotia, 1985.

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

III. TREATMENT AREAS

A. Area

The goal of this year's program was to protect spruce and fir trees on 81 000 ha. A variety of forest holdings were included in this year's program (Table 1). The majority of the treatment area was concentrated in Cumberland County (Table 2). The spray program is also subject to the vagaries of nature as a total of 20 643.1 ha were deleted from the program (Table 3).

B. Environmental Parameters

The wind speed limits for this year's program were from 0 to 15 $km \cdot hr^{-1}$. The relative humidity limits were lowered from 65% (1985) to 35% for this year. Relative humidity data, during spraying, were grouped in class intervals of four percent. The mean relative for spraying from Parrsboro was 77.0% and at Trenton was 72.6% whereas the model relative humidity was 87.0% and 77.0% respectively. The lowering of the relative humidity limits afforded more time for spraying in the morning but had no major effect on the time for spraying in the evening. The additional area sprayed due to the lowering of the relative humidity limits was 13 376.9 ha or 23.8% of the program (Table 4, 5). The majority of this area (10 060.2 ha or 75.2 %) was from Parrsboro Airport and the remainder (3 316.7 ha or 24.8 %) was from Trenton Airport.

Table 1. Area treated in the Aerial Foliage Protection Program, Nova Scotia, 1986

Applicants	Area Treated (ha)	Area %
Large Land Owners		
Eddy	340.6	0.6
Scott	3 744.6	6.7
Stora	1 325.4	2.3
Crown		
- District	6 516.0	11.6
- Parks[1]	87.2	0.2
- Indian & Northern Affairs	282.6	0.5
Subtotal	(12 296.4)	(21.9)
Small Land Owners		
Woodlots	43 858.4	78.1
Total	56 154.8	100.0

Applicants	Area ha	Σ ha	%	Σ %
Private				
Large	5 410.6		9.6	
Small	43 858.4	49 269.0	78.1	87.7
Crown				
Prov.	6 603.2		11.8	
Federal	282.6	6 885.8	0.5	12.3

1. Ground spray 35.0 ha, aerial spray 52.2 ha

Table 2. Area treated by County, Aerial Foliage Protection Program, Nova Scotia, 1986.

County	Treatment Area			
	ha	%	No.	%
Antigonish	3 806.5	6.8	19	8.8
Colchester	3 389.1	6.0	26[2]	12.0
Cumberland	41 507.6	73.9	106[2]	49.1
Pictou	7 451.6	13.3	65	30.1
Total	56 154.8[1]	100.0	216	100.0

1. Ground spray 35.0 ha aerial spray 56 119.8
2. Two treatment areas in common

Table 3. Area deleted from the Aerial Foliage Protection Program, Nova Scotia, 1986.

	Area		
		% of	
Reason for Deletion	ha	Area deleted	Total Program
Buffer Zone Restriction	394.7	1.9	0.5
Timber Harvesting	258.5	1.2	0.3
Larval numbers ≤4 per branch	1 373.4	6.7	1.8
Larval Development ≥ 40% 6th instar	12 527.2	60.7	16.3
Diseased Larvae	6 066.5	29.4	7.9
Areas inaccessible from ground or air	22.8	0.1	0.1
TOTAL	20 643.1	100.0	26.9

Table 4. Increase in area treated as a result of lowering the relative humidity levels from 65% to 35%, 1986.

Base of Operations	Below 65% RH ha	%.c	%.r	%..	Above 65% RH ha	%.c	%.r	%..	Total ha	% ..
Parrsboro	10 060.2	75.2	24.9	17.9	30 380.0	71.0	75.1	54.1	40 440.2	72.0
Trenton	3 316.7	24.8	21.1	5.9	12 397.9	29.0	78.9	22.1	15 714.6	28.0
Total	13 376.9	100.0	23.8	23.8	42 777.9	100.0	76.2	76.2	56 154.8	100.0

Table 5. Comparison of the mean flying time between Parrsboro and Trenton Airports, Nova Scotia spruce budworm spray program, 1985.

Parameter	Parrsboro 1985	Parrsboro 1986	Trenton 1985	Trenton 1986
Qualitative				
% Spray periods used	27.3	43.3	40.9	44.4
% AM	27.3	46.2	40.0	65.2
% PM	54.5	53.8	60.0	35.7
% Noon	8.2	-	-	-
Quantitative				
Mean flying time (hrs)	1.7	1.7	1.8	1.7
+ 1 sd (hrs)	0.6	0.7	0.9	0.8
Total flying time (hrs)	18.9	22.4	18.2	22.6
Theoretical maximum No. hrs	132	126	77	105
% Flying hours used	14.2	21.3	23.6	21.5
Rh limits	95-65	95-35	95-65	95-35
Area Treated	30 769.7	40 440.2	9 810.3	15 714.6
No. of spray aircraft	6-9	6-12	3	5

IV. AIRPORTS

Two airports were used in this year's program - Parrsboro and Trenton (Table 4, 5). Three roads were upgraded to service the Cessna Pawnee. Other airports available for use in Nova Scotia were Nappan, Debert, Garden-of-Eden and Crowdis Mountain. This year the mobile helicopter team was replaced by (1) a single guidance aircraft and a team of three cessna pawnee spray aircraft, and (2) a guidance helicopter and a single Ayers thrush spray aircraft used to treat small areas the single guidance helicopter plus Ayers Thrush was the most effective and efficient method having treated 5 717.1 ha, the area treated by the Pawnee team was 5 473.0 ha (1986) and the area sprayed by the helicopter was 2 955.8 ha (1985). The area treated by the helicopter team was approximately 1.5 that of a single Cessna pawnee but half of the single Ayers Thrush. The Cessna Pawnee team was grounded for two days, due to radio malfunctions and fog at Parrsboro Airport, otherwise the area treated per pawnee spray aircraft may have approached that of the single helicopter (Table 6).

V. BIOCIDE

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

Table 6. Area treated by type of spray aircraft, Aerial Foliage Protection Program, Nova Scotia, 1986.

Type	Aircraft			Area			
	No.	Hopper Volume (l)	Swath Width (m)	Total Area Treated	%	$\bar{x}$	$\pm$ 1 sd
Cessna Pawnee	3	450	30	5 473.0	9.7	1 824.3	131.6
Grumman Ag Cat	6	910	60	33 203.3	59.0	5 533.9	450.5
Ayers Thrush	3	1100	90	17 579.3	31.3	5 859.8	1104.3
Total[1] Aerial	**12**			**56 255.6[1]**	**100.0**		

1. Includes 135.8 ha treated for hemlock looper *Lambdina fiscellaria* (Guen).

Table 7. Foliage protection and reduction in survival, Aerial Foliage Protection Program, Nova Scotia, 1986.

Tree Specie	Absolute			Proportional			Reduction in Survival		
	$\bar{x}$	± 1 sd	Range	$\bar{x}$	± 1 sd	Range	$\bar{x}$	± 1 sd	Range
Spruce									
Red	6.1	4.0	0.0-14.3	31.1	20.3	0-74.4	66.8	25.9	0-100
White	3.7	4.8	0.8-15.3	21.0	15.2	12.6-51.2	58.1	34.9	0-100

VI. OTHER INSECTS

Two other species of insects caused defoliation of spruce and fir in some treatment areas. In 1985 populations of spruce coneworm (Dioryctria reniculelloides Mut. and Mun.) were noted in the Gulf Shore region. These populations declined in 1986 and only background numbers were noted during the L-2 survey. Populations of the spruce budmoth (Zeiraphera canadensis Mut. and Free.) were noted in the Gulf Shore and Cape George area during the spray program. A major moth flight of hemlock looper (Lambdina fiscellaria (Guen)) was noted in both the Diligent River and Fox River areas of Cumberland County.

VII. PROTECTION

A) Foliage Protection

The principal species scheduled for protection are red spruce (Picea rubens spp. complex) and white spruce (Picea glauca). While the weather was generally inclement during the spray program no significant storms occurred to help in the removal of the bud caps (Appendix 1). the mean absolute foliage protection on red spruce was 6.1 ± 4.0 whereas the mean relative foliage protection was 31.1 ± 20.3 percent (Table 7). The mean absolute foliage protection and mean relative foliage protection on white spruce were 3.7 ± 4.8 and 21.0 ± 15.2 percent respectively (Table 7) (Appendix 2).

B) Efficacy

The mean relative efficacy or mean reduction of survival of B.t.k. against the spruce budworm larvae was 66.8 ± 25.9 percent for red spruce and 58.1 ± 34.9 for white spruce (Table 7) (Appendix 3). There is no correlation between efficacy and foliage protection as sublethal doses of B.t.k. will at times afford adequate foliage protection and the converse is equally true (Appendices 2, 3).

VIII. COSTS

The estimated cost of this year's program is $1.885 million. The cost per hectare flown is $33.57 (Table 8). The cost in 1985 was $27.21. The increase in cost relfect the inclement weather experienced during June, and increased costs for aircraft and biocide.

IX. REFERENCES

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Smith, T.D. and Georgeson, E., Cameron, T., Guscott, R., Burgess, J., Baird, D. 1985. Spruce budworm spray program, Nova Scotia, 1985. Entomological Services, Nova Scotia Dept. Lands and Forests, Truro, N.S., Can. Misc. Publ. 21 pp.

Table 8. Budget for the Aerial Foliage Protection Program, Nova Scotia, 1986.

Group	$	%	$·ha^{-1}
1) Salaries & Wages			
Monitors	193,000	10.24	3.44
Loaders	8,800	0.47	0.16
Navigators	62,700	3.32	1.12
Security & Misc.	30,000	1.59	0.53
Overtime	30,000	1.59	0.53
TOTAL SALARIES & WAGES	**324,500**	**17.21**	**5.78**
2) **TRAVEL**	**30,000**	**1.59**	**0.53**
3) Supplies & Services			
General Office			
Administration	500	0.03	0.01
Op. Expense Acct	3,000	0.16	0.05
Misc.	2,000	0.11	0.04
General Operating			
Administration	1,000	0.05	0.02
Chemical	687,100	36.44	12.24
Restaurant	63,000	3.34	1.12
Accommodations	58,500	3.10	1.04
Insectary & Trailers	7,000	0.37	0.12
Miscellaneous	42,600	2.26	0.76
Equipment Repairs & Maintenance	9,000	0.48	0.16
Other Services			
Spray Aircraft	437,700	23.21	7.80
Guidance Aircraft	66,400	3.52	1.18
Airports & Fuel	59,800	3.17	1.06
Navigator Training	7,400	0.39	0.13
Aircraft Calibration	5,000	0.27	0.09
TOTAL SUPPLIES/SERVICES	**1,450,000**	**76.90**	**25.82**
4) Other			
Equipment Rentals			
Equipment	12,000	0.64	0.21
Trucking	10,000	0.53	0.18
Automobiles	40,000	2.12	0.71

Group	$	%	$ ha^{-1}
Equipment Purchases			
Equipment	5,000	0.26	0.09
Sundry Equipment	12,000	0.64	0.21
Purchase Orders	2,000	0.11	0.04
TOTAL OTHER	**81,000**	**4.30**	**1.44**
GRAND TOTAL	**1,885,500**	**100.00**	**33.57**

X. DISCLAIMER STATEMENT

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

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

Appendix 1
Larval and Host Development
at time of spraying

DEVELOPMENT AT SPRAY

File: BUDWORM.2

Report: DEVELOPMENT

TREATMENT AREA	BLOCK/CLUSTER	WHEN SPRAYED June, 1986	LARVAE INDEX	% BUD FLUSHED	BUD DENSITY	DROPS/cm^2	REMARKS
1,2	PARRSBORO	21	4.5	NA	NA	NA	NO PLOTS
3	DILIGENT RIVER	22	4.6	52.7	57.8	17.4	-
4,7-9	HALFWAY RIVER	20-22	4.8	63.2	535.0	10.3	-
5,6	NEW CANAAN	18	4.7	46.6	462.0	7.0	-
11	CHIGNECTO	21	4.8	NA	NA	NA	NO PLOTS
12,13	FLAT BROOK	26	4.6	71.4	714.0	15.5	-
14	THUNDER HILL	20,21	4.8	91.4	503.8	9.3	-
15,16,17	BARRON BROOK	19,20	4.6	84.4	424.2	13.6	-
18,19,23	SOUTHAMPTON	18-19	4.7	77.6	331.2	15.1	-
20,21,22	LAWRENCE	18-21	4.6	90.2	387.8	NA	CARDS NOT SPRAYED
24,25	SPRINGHILL	19-21	5.0	88.5	403.5	NA	PLOTS NOT SPRAYED
26,27,28	RIVER HERBERT	19	4.6	76.0	738.0	NA	PLOTS NOT SPRAYED
30,31	MACCAN	20	4.8	92.0	906.0	NA	CARDS NOT SPRAYED
32,33	LEICESTER	21,22	4.9	83.6	789.2	23.8	-
63-69	OXFORD	16	4.5	30.0	359.7	6.9	-
40,43	AMHERST	22	4.9	NA	NA	NA	CARDS NOT SPRAYED
54	SHINIMICAS	22	5.0	69.0	89.0	NA	CARDS NOT SPRAYED
55,71-74,74a,73b	LINDEN	22	5.0	69	89.0	NA	CARDS NOT SPRAYED
56-60,75,75a,76	MT PLEASANT	20-21	5.3	55.0	107.0	4.5	-
35-38,38a	BROOKDALE	21,22	4.8	73.0	128.0	3.6	-
77,80-83,75b	CONN MILLS	19,20	4.8	18.0	948.0	14.5	-
78,79,84-86	HANSFORD	19,21	4.7	84.0	1216.0	6.3	-
97,98,106,107	PUGWASH JUNCTION	22	4.7	99.0	1027.0	4.3	-
99-104,104a	GULF SHORE	12	5.1	97.0	869.0	10.5	-
105,126-130,132	MALAGASH	21,22	5.5	94.0	973.0	NA	-
108-112,114,115,117-123	WENTWORTH	22,24	5.3	100	838.0	1.6	-
124,125,133-138,140-143	TATAMAGOUCHE	19,21	4.9	97.0	864.0	8.6	-
144,145,145a	BALMORAL MILLS	19-20	5.1	75.4	756.0	6.0	-
146-155,157,158	SPIDELL HILL	12,13,15	5.0	93.0	673.0	4.1	-
159,174,175	WEST BRANCH	20	5.1	78.3	504.3	15.0	-
160-167	MOUNTAIN RD	19,20	5.2	82.2	648.4	7.9	-
163a,163c-163e	MELVILLE	21,22	4.8	NA	NA	NA	NO PLOTS
168-171,187,190-196,173 196a,196b	POPLAR HILL	19,20	5.3	91.8	939.2	3.3	-
183-185,185a-185d	ORTONVILLE	12	5.3	99.0	448.0	1.3	-
186,188,189,197,186a, 186b	SCOTSBURN	5,6	4.5	90.8	617.8	2.1	-

DEVELOPMENT AT SPRAY

File: BUDWORM.2

Report: DEVELOPMENT

1986

TREATMENT AREA	BLOCK/CLUSTER	WHEN SPRAYED June 1986	LARVAE INDEX	% BUD FLUSHED	BUD DENSITY	DROPS/cm^2	REMARKS
200,200a	ROY ISLAND	7	4.6	95.0	543.0	2.3	-
198,199	BOAT HARBOUR	21	4.5	NA	NA	NA	PLOTS NOT SPRAYED
180	DALHOUSIE MTN	6	5.3	NA	NA	NA	PLOTS NOT SPRAYED
201,201a	PEIDMONT	12	5.2	96.5	376.5	10.0	-
202-205	AVONDALE	6,7	4.4	90.0	881.0	4.2	-
206-210,212,211c	EIGG MTN	12	5.2	97.2	1009.0	6.2	-
211-214,222,222a-b,	211a-b BIG MARSH	12,13	4.6	98.8	893.2	5.4	-
223,224,225	ANTIGONISH HARBOUR	16	5.4	98.2	925.0	4.5	-
226	CLOVERDALE	16	5.0	99.4	1134.2	8.3	-

Appendix 2
Foliage Protection

FOLIAGE PROTECTION

File: BUDWORM.2

Report: DEFOLATION

Page 1

1986

TREATMENT AREA	BLOCK/CLUSTER	DEFOL % SPRAY Obs	DEFOL % SPRAY Exp	FOL SAVED METH.1 Abs.	FOL SAVED METH.2 %
1,2	PARRSBORO	NA	NA	NA	NA
3	DILIGENT RIVER	35.5	34.6	0	0
4,7-9	HALFWAY RIVER	18.4	22.5	4.1	18.2
5,6	NEW CANAAN	5.7	13.2	7.5	56.8
11	CHIGNECTO	NA	NA	NA	NA
12,13	FLAT BROOK	2.6	6.5	3.9	60.0
14	THUNDER HILL	1.8	6.6	4.8	72.7
15,16,17	BARRON BROOK	4.1	12.5	8.4	67.2
18,19,23	SOUTHAMPTON	3.3	12.9	9.6	74.4
20,21,22	LAWRENCE	4.7	7.9	3.2	40.5
24,25	SPRINGHILL	NA	NA	NA	NA
26,27,28	RIVER HERBERT	NA	NA	NA	NA
30,31	MACCAN	NA	NA	NA	NA
32,33	LEICESTER	4.0	14.3	10.3	72.0
63-69	OXFORD	32.3	38.9	6.6	17.0
40,43	AMHERST	NA	NA	NA	NA
54	SHINIMICAS	15.0	18.6	.9	4.8
55,71-74,74a,73b	LINDEN	24.0	29.4	5.4	18.4
56-60,75,75a,76	MT PLEASANT	14.3	24.2	9.9	40.9
35-38,38a	BROOKDALE	25.3	30.2	4.9	16.2
77,80-83,75b	CONN MILLS	22.6	31.9	9.3	29.2
78,79,84-86	HANSFORD	14.4	23.3	8.9	38.2
97,98,106,107	PUGWASH JUNCTION	24.2	23.0	0	0
99-104,104a	GULF SHORE	14.6	29.9	15.3	51.2
105,126-130,132	MALAGASH	32.7	31.4	0	0
108-112,114,115,117-123	WENTWORTH	14.2	21.8	7.6	34.9
124,125,133-138,140-143	TATAMAGOUCHE	16.7	12.9	0	0
144,145,145a	BALMORAL MILLS	12.4	18.6	6.2	33.3
146-155,157,158	SPIDELL HILL	5.0	5.8	.8	13.8
159,174,175	WEST BRANCH	.9	9.4	8.5	90.4
160-167	MOUNTAIN RD	5.1	12.8	7.7	60.2
163a,163c-163e	MELVILLE	NA	NA	NA	NA
168-171,187,190-196,173 196a,196b	POPLAR HILL	7.8	15.1	7.3	48.3
183-185,185a-185d	ORTONVILLE	13.0	14.5	1.5	12.6
186,188,189,197,186a, 186b	SCOTSBURN	12.7	16.8	4.1	24.4

FOLIAGE PROTECTION

File: BUDWORM.2

Report: DEFOLATION

TREATMENT AREA	BLOCK/CLUSTER	DEFOL % SPRAY	DEFOL % SPRAY	FOL SAVED METH.1	FOL SAVED METH.2
200,200a	ROY ISLAND	NA	NA	NA	NA
198,199	BOAT HARBOUR	NA	NA	NA	NA
180	DALHOUSIE MTN	NA	NA	NA	NA
201,201a	PEIDMONT	7.3	5.1	0	0
202-205	AVONDALE	29.4	37.7	8.3	22.0
206-210,212,211c	EIGG MTN	7.8	6.4	0	0
211-214,222,222a-b,	211a-b BIG MARSH	6.5	8.7	2.2	25.3
223,224,225	ANTIGONISH HARBOUR	5.6	7.2	1.6	22.2
226	CLOVERDALE	1.8	4.5	2.7	60.0

Appendix 3
Reduction in Survival

% POPULATION REDUCTION

File: BUDWORM.2

Report: REDUCT OF SURVIVAL

TREATMENT AREA	BLOCK/CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	POPUL REDUCTION
1,2	PARRSBORO	NA	NA	NA	NA	NA
3	DILIGENT RIVER	20.2	1.9	36.5	1.0	68.2
4,7-9	HALFWAY RIVER	20.8	2.6	22.1	1.2	58.4
5,6	NEW CANAAN	8.4	0.4	10.9	0.1	85.7
11	CHIGNECTO	NA	NA	NA	NA	NA
12,13	FLAT BROOK	4.5	0.4	2.9	0.4	0
14	THUNDER HILL	7.3	0.7	3.1	0	100.0
15,16,17	BARRON BROOK	6.7	0.5	5.1	0.2	41.6
18,19,23	SOUTHAMPTON	9.6	0.5	2.9	0	100
20,21,22	LAWRENCE	6.0	0.3	4.6	0.2	0
24,25	SPRINGHILL	NA	NA	NA	NA	NA
26,27,28	RIVER HERBERT	NA	NA	NA	NA	NA
30,31	MACCAN	NA	NA	NA	NA	NA
32,33	LEICESTER	7.0	0.6	4.9	0	100
63-69	OXFORD	30.5	4.9	44.6	4.2	41.8
40,43	AMHERST	NA	NA	NA	NA	NA
54	SHINIMICAS	34.0	2.9	14.9	0.4	64.5
55,71-74,74a,73b	LINDEN	28.3	3.6	30.4	2.1	44.6
56-60,75,75a,76	MT PLEASANT	45.5	5.1	30.2	1.8	46.5
35-38,38a	BROOKDALE	21.3	1.8	31.3	0.1	96.5
77,80-83,75b	CONN MILLS	10.3	1.2	34.1	0.6	85.5
78,79,84-86	HANSFORD	15.7	2.2	21.3	0.5	83.2
97,98,106,107	PUGWASH JUNCTION	20.8	5.3	20.8	0.7	86.7
99-104,104a	GULF SHORE	30.7	8.6	36.3	1.7	83.5
105,126-130,132	MALAGASH	12.7	3.4	33.4	2.4	73.1
108-112,114,115,117-123	WENTWORTH	4.0	0.9	3.4	0.2	79.8
124,125,133-138,140-143	TATAMAGOUCHE	17.4	4.3	5.6	0.3	77.1
144,145,145a	BALMORAL MILLS	220.0	2.7	142.0	0.5	67.9
146-155,157,158	SPIDELL HILL	158.8	1.8	25.0	0.1	72.9
159,174,175	WEST BRANCH	108.7	1.0	3.3	0	100
160-167	MOUNTAIN RD	192.8	1.2	22.0	0	100
163a,163c-163e	MELVILLE	NA	NA	NA	NA	NA
168-171,187,190-196,173	196a,196b POPLAR HILL	134.4	1.2	89.6	0.6	35.0
183-185,185a-185d	ORTONVILLE	149.0	2.1	146.0	0.9	57.4
186,188,189,197,186a,	186b SCOTSBURN	128.4	1.0	179.0	1.2	11.9

% POPULATION REDUCTION
File: BUDWORM.2
Report: REDUCT OF SURVIVAL

TREATMENT AREA	BLOCK/CLUSTER	CHECK L-4	CHECK PUPA	SPRAY L-4	SPRAY PUPA	POPUL REDUCTION
200,200a	ROY ISLAND	NA	NA	NA	NA	NA
198,199	BOAT HARBOUR	NA	NA	NA	NA	NA
180	DALHOUSIE MTN	NA	NA	NA	NA	NA
201,201a	PEIDMONT	26.6	3.2	10.8	0	100
202-205	AVONDALE	46.4	4.2	47.3	3.3	23.4
206-210,212,211c	EIGG MTN	3.5	0.2	3.2	.4	0
211-214,222,222a-b,	211a-b BIG MARSH	8.3	0.1	4.9	0	100
223,224,225	ANTIGONISH HARBOUR	4.8	0.4	4.3	0.1	75.5
226	CLOVERDALE	1.1	0.1	0.5	0.1	0

Appendix 4
Tree species per treatment area

File: BUDWORM.2

Report: TREE SPECIES

TREATMENT AREA	BLOCK/CLUSTER	TREE SPP
1,2	PARRSBORO	RED SPRUCE
3	DILIGENT RIVER	RED SPRUCE
4,7-9	HALFWAY RIVER	RED SPRUCE
5,6	NEW CANAAN	RED SPRUCE
11	CHIGNECTO	RED SPRUCE
12,13	FLAT BROOK	RED SPRUCE
14	THUNDER HILL	RED SPRUCE
15,16,17	BARRON BROOK	RED SPRUCE
18,19,23	SOUTHAMPTON	RED SPRUCE
20,21,22	LAWRENCE	RED SPRUCE
24,25	SPRINGHILL	RED SPRUCE
26,27,28	RIVER HERBERT	RED SPRUCE
30,31	MACCAN	RED SPRUCE
32,33	LEICESTER	RED SPRUCE
63-69	OXFORD	RED SPRUCE
40,43	AMHERST	RED SPRUCE
54	SHINIMICAS	RED SPRUCE
55,71-74,74a,73b	LINDEN	RED SPRUCE
56-60,75,75a,76	MT PLEASANT	RED SPRUCE
35-38,38a	BROOKDALE	RED SPRUCE
77,80-83,75a	CONN MILLS	RED SPRUCE
78,79,84-86	HANSFORD	RED SPRUCE
97,98,106,107	PUGWASH JUNCTION	RED SPRUCE
99-104,104a	GULF SHORE	WHITE SPRUCE
105,126-130,132	MALAGASH	RED SPRUCE
108-112,114,115,117-123	WENTWORTH	RED SPRUCE
124,125,133-138,140-143	TATAMAGOUCHE	RED SPRUCE
144,145,145a	BALMORAL MILLS	RED SPRUCE
146-155,157,158	SPIDELL HILL	WHITE SPRUCE
159,174,175	WEST BRANCH	RED SPRUCE
160-167	MOUNTAIN RD	RED SPRUCE
163a,163c-163e	MELVILLE	RED SPRUCE
168-171,187,190-196,173 196a-b	POPLAR HILL	RED SPRUCE
183-185,185a-185d	ORTONVILLE	WHITE SPRUCE
186,188,189,197,186a,b	SCOTSBURN	WHITE SPRUCE
200,200a	ROY ISLAND	WHITE SPRUCE

File: BUDWORM.2

Report: TREE SPECIES

TREATMENT AREA	BLOCK/CLUSTER	TREE SPP
198,199	BOAT HARBOUR	RED SPRUCE
180	DALHOUSIE MTN	WHITE SPRUCE
201,201a	PEIDMONT	WHITE SPRUCE
202-205	AVONDALE	WHITE SPRUCE
206-210,212,211c	EIGG MTN	WHITE SPRUCE
211-214,222,222a-b, 211a-b	BIG MARSH	WHITE SPRUCE
223,224,225	ANTIGONISH HARBOUR	WHITE SPRUCE
226	CLOVERDALE	WHITE SPRUCE

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NO. 165

Canadian Forestry Service-Maritimes
TECHNICAL NOTE

SPRUCE BUDWORM DEFOLIATION IN NOVA SCOTIA - 1986

Defoliation by the spruce budworm in Nova Scotia is assessed annually through an aerial survey of the degree of redness of spruce and fir foliage. The 1986 survey, conducted during the first week of July, was a cooperative project of the Forest Insect and Disease Survey of the Canadian Forestry Service and the Nova Scotia Department of Lands and Forests.

Survey Results

For the second consecutive year, defoliation detectable from the air was restricted to the north-central Nova Scotia counties of Cumberland, Colchester, Pictou and Antigonish. No defoliation was detected on Cape Breton Island or in the Annapolis Valley (Figure 1).

The total area of defoliation in 1986 increased to 431 000 ha from 345 000 ha in 1985 however the area in the moderate or severe category decreased to 289 000 ha in 1986 from 319 000 ha in 1985. It is moderate and severe defoliation which causes more significant forest damage and so this decrease is seen as a positive trend. Whereas in 1985 a substantial area was described as being severely defoliated with moderate patches interspersed (280 000 ha), in 1986 a reverse situation of an area of moderate defoliation with severe patches interspersed (76 000 ha) and a large area of just moderate (207 000 ha) defoliation was described. Table 1 summarizes the defoliation areas by county for 1986.

Light defoliation, which is often difficult to judge from the air and is more subject to the effects of rain was much greater in 1986 than 1985. An extended rain, reported in 1985, may have washed off enough of the reddened needles to apparently reduce the area of light defoliation that year. The 1985 aerial defoliation map is provided in Figure 2 for comparison.

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Factors Affecting the 1986 Aerial Survey

This year weather conditions leading up to the aerial survey were relatively good. Inclement weather towards the end of the survey and the fact that the survey was left later than the optimum, an impression shared by the observers, may have had the effect of reducing some categories in Pictou and Antigonish counties.

Late spring frosts in Nova Scotia caused foliage reddening which may have been confused with defoliation during the survey. This would have the effect of causing defoliation to appear worse than it actually was. Areas of moderate and low defoliation along the Midas Basin coast east of Five Islands, Colchester Co. are suspect here.

Additional Observations of Defoliation

In addition to what was detected from the air, ground surveys have reported areas of significant defoliation in a coastal band from Merigomish, Pictou County to Cape George Point, Antigonish County. Along the Colchester/ Cumberland County lines, near the Lynn Road small patches of severe, moderate and light were detected.

Historical Trends

A comparison of defoliation levels over the last five years for the forest sub-divisions of Nova Scotia is given in Table 2. While 1986 presents the greatest total area of measured defoliation it also has the least amount of severe defoliation in five years.

Summary

A 10% decrease in the area of moderate to severe defoliation occurred in Nova Scotia between 1986 and 1985. Most significant was a sharp reduction in the area of severe defoliation.

Defoliation remained concentrated in north-central Nova Scotia. Cape Breton Island and the Annapolis Valley/Hants County sub-divisions have been almost defoliation-free for three years.

Table 1. Areas of spruce budworm defoliation in Nova Scotia by County in 1986 (hectares).

COUNTY	LIGHT	MODERATE	MODERATE WITH SEVERE	SEVERE	TOTAL
Antigonish	2 569	4 558	--------	------	7 127
Pictou	30 395	41 440	4 983	2 100	78 918
Colchester	34 676	24 242	8 003	-----	66 921
Cumberland	75 060	136 960	62 514	3 800	278 334
TOTAL	142 700	207 200	75 500	5 900	431 300

Table 2. Areas of spruce budworm defoliation by region since 1982 ('000 hectares)

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

[1] 1985 severe with some moderate patches.

[2] 1986 moderate with severe patches.

-B.A. Pendrel[1], T.D. Smith[2] and L.P. Magasi[1]

November, 1986

[1] Forest Insect and Disease Survey, Canadian Forestry Service-Maritimes

[2] Nova Scotia Department of Lands and Forests

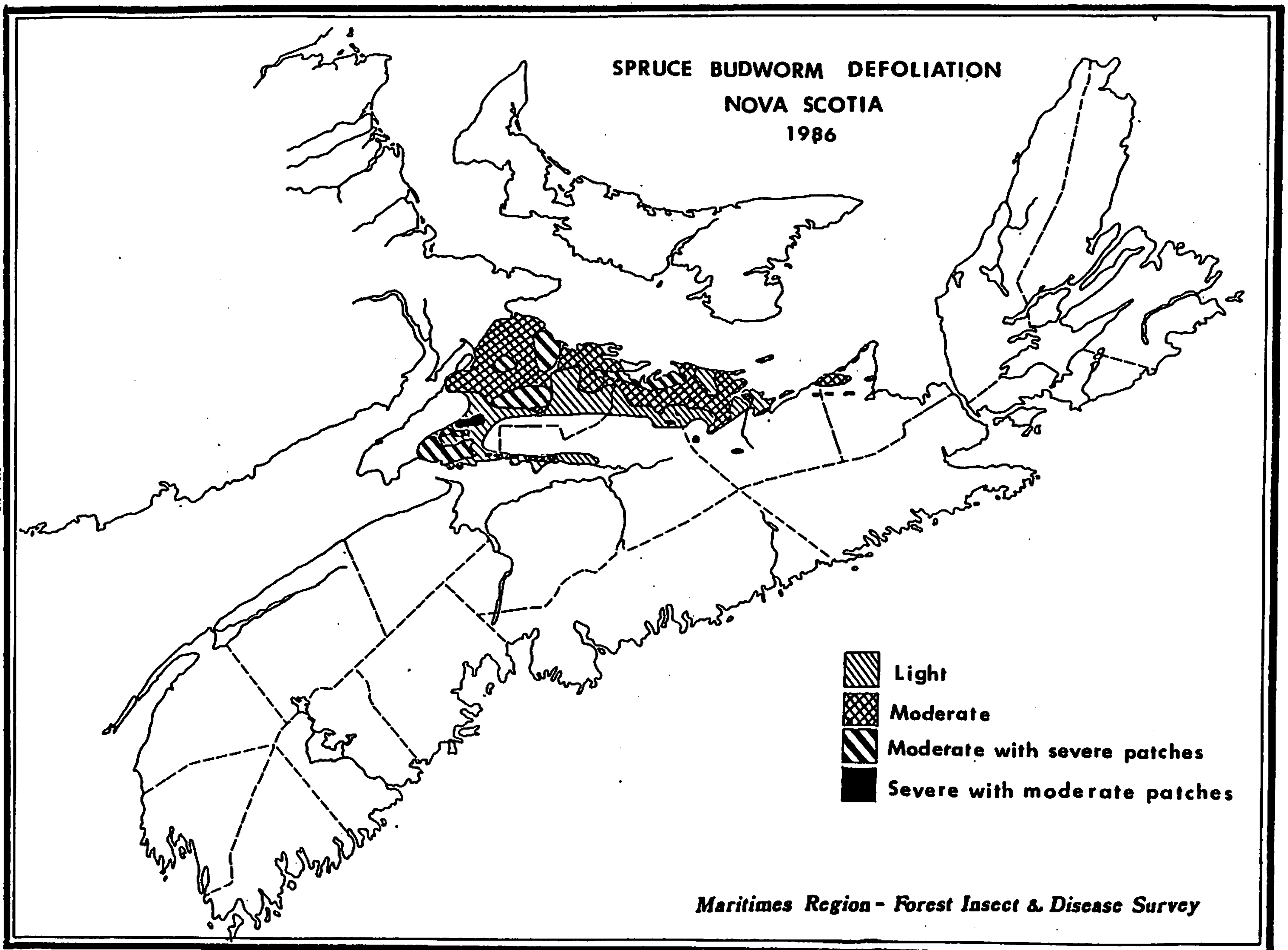

Figure 1. Spruce budworm defoliation in Nova Scotia - 1986

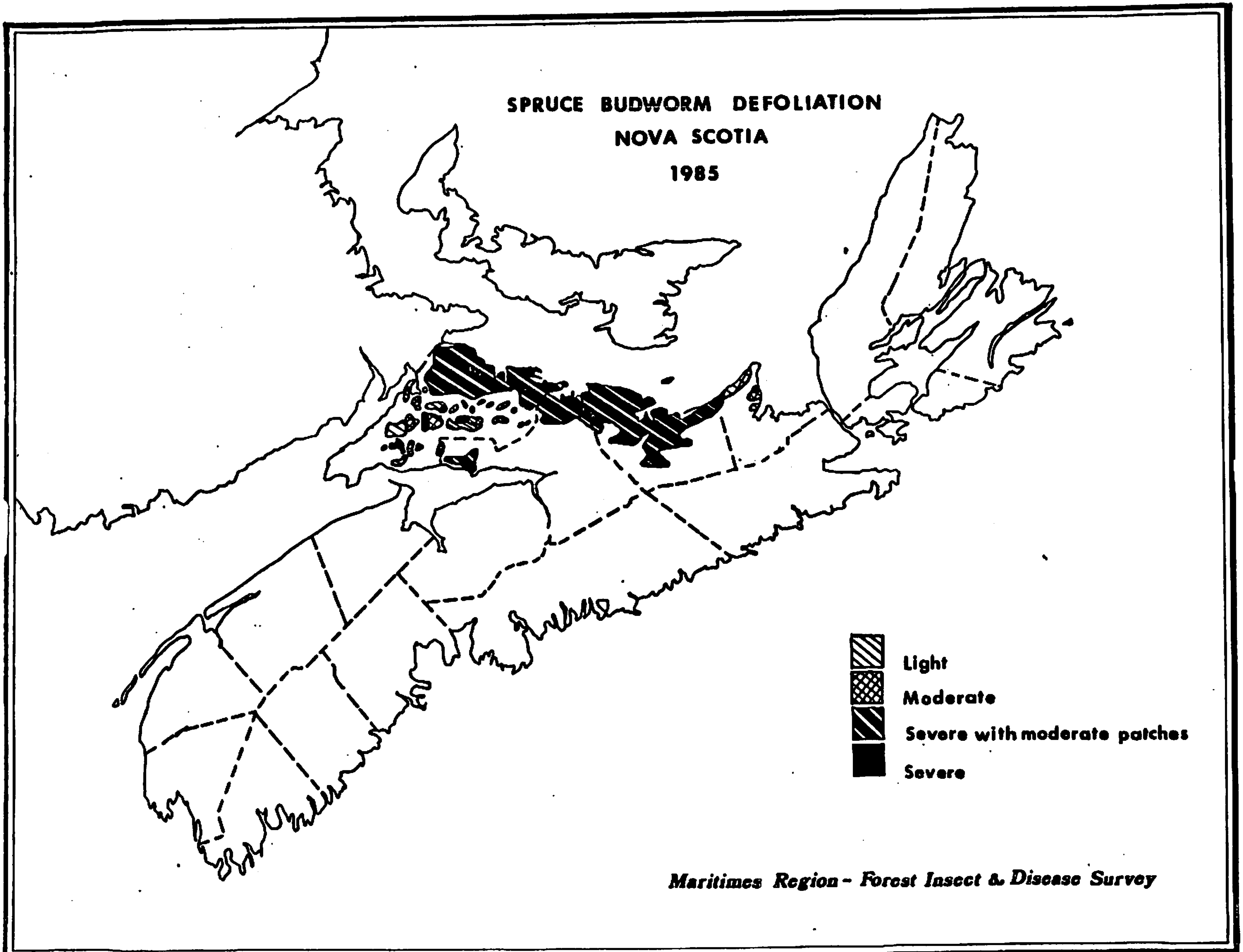

Figure 2. Spruce budworm defoliation in Nova Scotia - 1985

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Canadian Forestry Service / Service Canadien des forêts

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NO. 167

Canadian Forestry Service-Maritimes TECHNICAL NOTE

NURSERIES
PLANTATIONS
SILVICULTURE
UTILIZATION
ECONOMICS
TREE IMPROVEMENT
INSECTS AND DISEASES

SPRUCE BUDWORM DEFOLIATION ON PRINCE EDWARD ISLAND IN 1986 AND A FORECAST FOR 1987

Defoliation by the spruce budworm on Prince Edward Island is assessed annually through an aerial survey of the degree of redness of spruce and fir foliage. A forecast of the infestation expected in the coming year is made through a survey of overwintering larvae, the L_2 survey.

The 1986 defoliation survey was conducted during the first week of July and the L_2 in October by the Forest Insect and Disease Survey of the Canadian Forestry Service.

Defoliation

Defoliation again occurred throughout Prince Edward Island in 1986, affecting 98,000 ha, an increase of about 28,000 ha or 40% over 1985 (Figures 1 and 2). This years defoliation was distributed as: severe 565 ha; moderate with severe patches 23 000 ha; moderate 41 000 ha; and light 33 000 ha. Only the severe category showed a reduction, to its lowest point in at least 10 years (Table 1). This was countered by estimates of moderate and light defoliation at their highest levels in over 10 years. The greatest increase occurred in Kings County and eastern Queens County while total defoliation in Prince County changed little (Table 2).

Weather for the 1986 aerial survey was good prior to the survey in terms of needle retention, however, during the actual survey over-cast conditions lead observers to conclude that their observations may have been an underestimate in some cases.

Ground defoliation checks supported the opinion that some areas suffered more defoliation than observed from the air. Despite this precaution, the 1986 survey was considered to be successful in describing the current defoliation condition.

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Cette publication est aussi disponible en francais sur demande

Table 1. Spruce budworm defoliation on Prince Edward Island from 1977 to 1986 (hectares).

Year	Light	Moderate	Severe	Total
1977	28 900	39 600	69 600	138 100
1978	9 900	26 700	84 900	121 500
1979	7 700	11 100	17 600	36 400
1980	2 100	7 100	23 900	33 100
1981	15 900	36 600	54 500	107 000
1982	2 200	2 700	10 400	15 300
1983	23 889	15 824	10 070	49 783
1984	500	6 900	8 200	15 600
1985	16 300	12 800	41 000[1]	70 100
1986	*33 400*	*64 000*[2]	*600*	*98 000*

1. Severe and severe with moderate patches.
2. Moderate and moderate with severe patches.

Table 2. Spruce budworm defoliation on Prince Edward Island in 1986 by county (hectares).

County	Defoliation				Total
	Light	Moderate	Moderate with Severe	Severe	
Prince	3 600	12 600	2 500	0	18 700
Queens	9 300	20 800	16 700	600	47 400
Kings	20 500	7 500	3 900	0	31 900
Total	33 400	40 900	23 100	600	98 000

Forecast for 1987

The L_2 survey was conducted at 42 locations throughout Prince Edward Island.[1] The predictions from these are: 2% high; 37% moderate and 58% low populations of spruce budworm for 1987 (Figure 3). In 1985, of 55 points assessed 9% were extreme, 33% were high, 29% were moderate and 29% were low. The highest populations are expected in Queens and southern Kings counties. Prince County will suffer generally low populations with the occasional moderate pocket.

Many of the locations sampled were predominantly white spruce (Table 3), which usually hosts a larger budworm population while suffering less damage than does balsam fir growing in the same location.

Summary

A reduction in the extent of severe defoliation during 1986 was compensated in part by a substantial increase in the areas of moderate defoliation in Queens and Kings counties. The prediction for 1987 is for a continued reduction in the high categories although significant areas of moderate defoliation can be expected.

Table 3. Number of L_2 sample locations in each severity category and percent of total number of locations (brackets) by tree species. Extreme = 41+ larvae per branch; High = 21-40; Moderate = 7-20; Low = 1-6; Nil = 0.

	Tree Species		
Category	balsam fir	white spruce	Total
Extreme	0 (0%)	0 (0%)	0
High	0 (0%)	2 (5%)	2 (5%)
Moderate	2 (5%)	14 (32%)	16 (37%)
Low	8 (20%)	16 (38%)	24 (58%)
NIL	0 (0%)	0 (0%)	0

-B.A. Pendrel and L.P. Magasi
Forest Insect and Disease Survey

November, 1986

[1] Our thanks to E.G. Kettela, CFS-Maritimes, for processing L_2 samples.

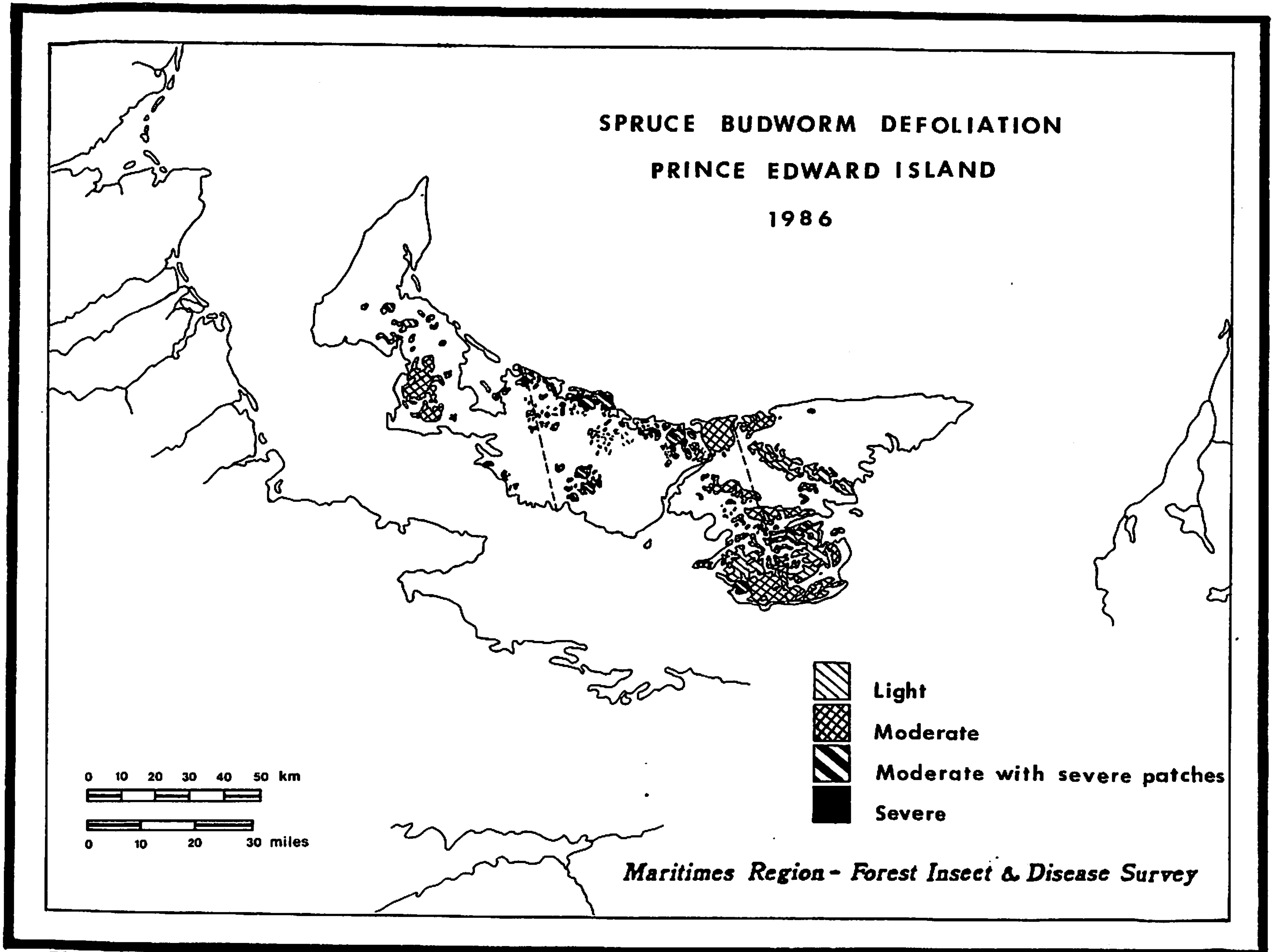

Figure 1. Defoliation due to the spruce budworm on Prince Edward Island during 1986.

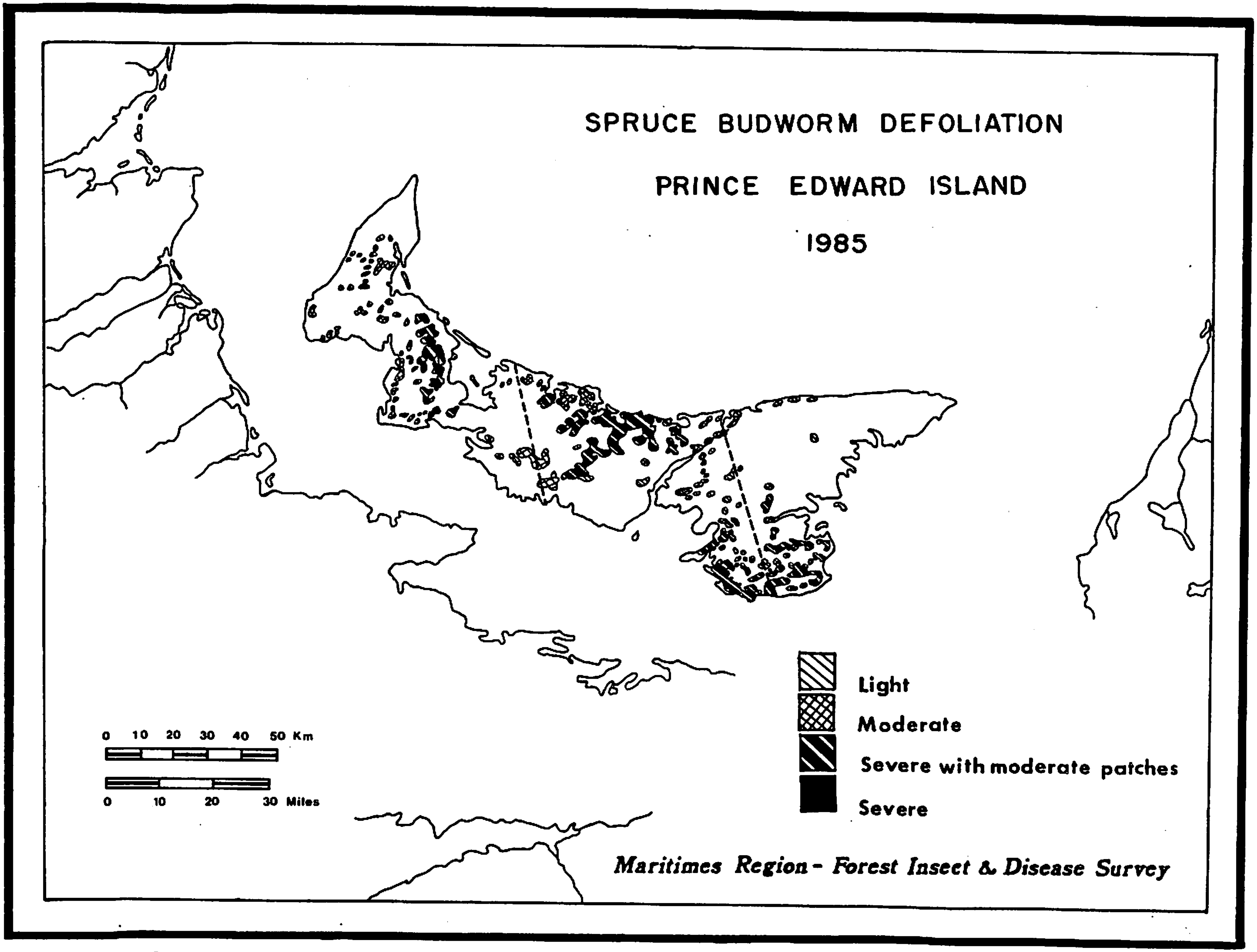

Figure 2. Defoliation due to the spruce budworm on Prince Edward Island during 1985.

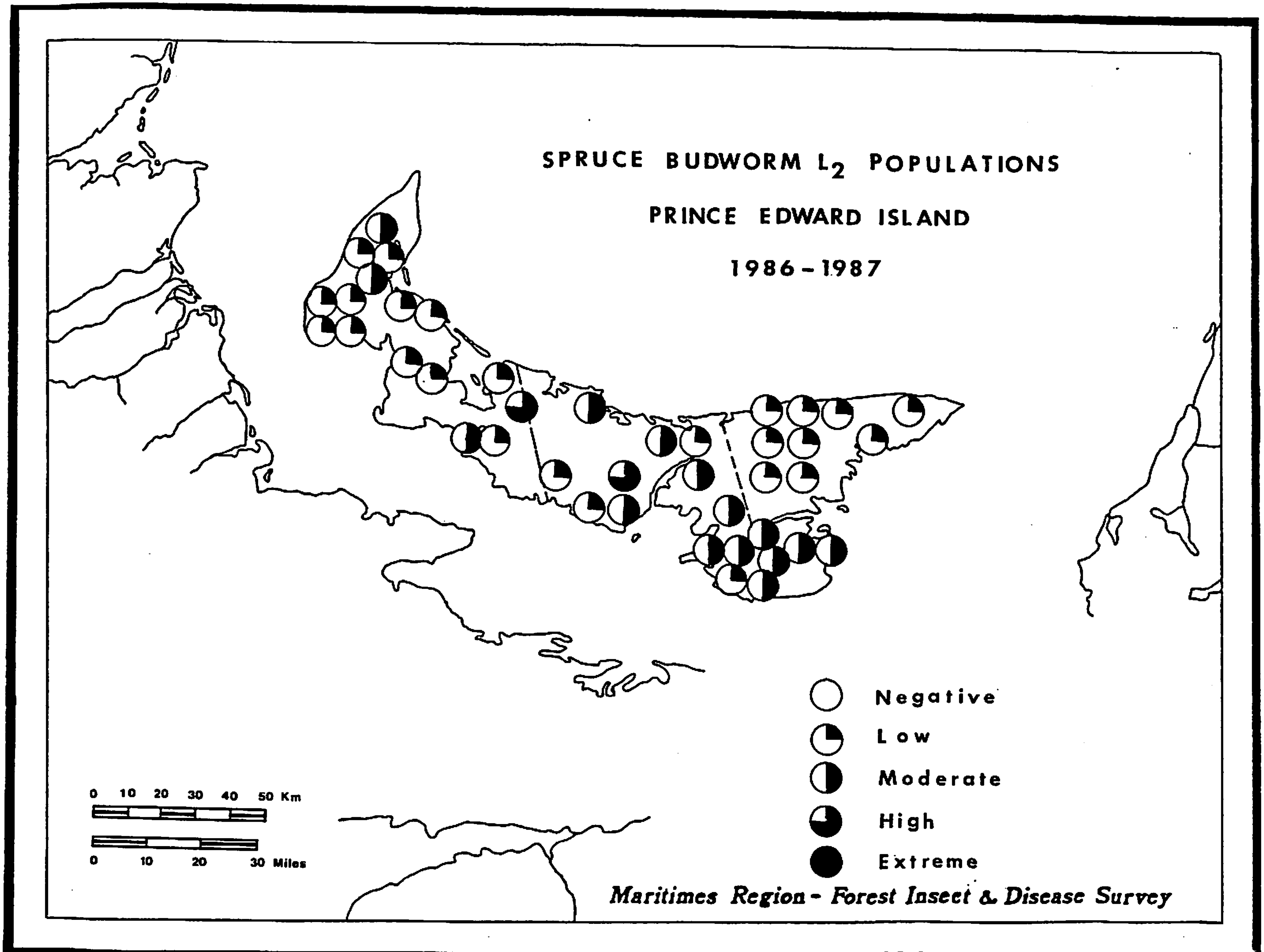

Figure 3. Forecast of spruce budworm infestation levels on Prince Edward Island in 1987, based on L_2 populations in the fall of 1986.

1986 NEW BRUNSWICK PROTECTION PROGRAM AGAINST SPRUCE BUDWORM

(Annual Forest Pest Control Forum, November 18-20, 1986)

1986 Spray Program

The 1986 Spruce Budworm Spray Program (Figure 1) conducted by Forest Protection Limited, in New Brunswick covered approximately 496 000 hectares. This represents a 29 percent reduction from 1985. Of the total area treated, about 90 percent was in the industrial part of the program (i.e. beyond 1.6 km from habitation) and the balance was in the non-industrial sector consisting primarily of small private woodlots.

Chemical insecticides were used over 78% of the program and B.t., the remainder. Aminocarb (Matacil 180 F) was sprayed in double applications over 126 000 ha; fenitrothion (Sumithion) in double applications over 118 000 ha; and 141 000 ha received a single application of one chemical followed by the other. B.t. was sprayed over 111 000 ha (Table 1). Most of the chemical treatments were applied in water-based formulations and B.t. was applied undiluted.

A total of 63 aircraft were involved in the program - 29 of which were spray planes, including 9 TBMs, 16 agricultural-type spray planes, and 4 helicopters (Bell 206s) (Table 2). TBMs were restricted to the industrial part of the program and sprayed 64% of the total area.

The first blocks were opened for spraying on May 24th. After a short weather delay spray operations commenced on the morning of May 26th. Curiously, the commencement date was the same as in the past two years yet later than in the past. Fortunately, however, acceptable spray weather occurred most mornings and evenings throughout the program and resulted in minimum delays for treatments. All chemical treatments were completed by the morning of June 16th. The majority of the B.t. blocks were timed for red-black spruce protection and some were not opened until June 18th. The project was completed on the evening of June 21st.

Results of Spray Program

At present, the objectives of the spray program in New Brunswick are to retain 60% or more of the current year's needles on balsam fir and 50% or more on red-black spruce. Virtually all the red-black spruce trees sampled met the foliage protection objectives regardless of treatment (Table 3). Results on balsam fir were also successful but more variable with 69-94% of all samples meeting the objective (Table 3).

Based on the aerial defoliation survey there were about 94 970 ha of moderate and severe defoliation detected within all spray areas (Table 4). This represented 10% of the total Province-wide moderate and severe defoliation, or 19% of the total area treated by all insecticides. On a treatment basis moderate and severe defoliation was detected by the survey on 1% to 32% of the areas sprayed (Table 4). It must be cautioned that the aerial survey is influenced by many factors, and also since it is not a block-specific survey these results are more relative than absolute.

Spruce Budworm Conditions in 1986

The 1986 aerial defoliation survey was conducted in the standard manner and revealed an estimated 160 000 ha of light, 229 000 ha of moderate, and 698 000 ha of severe defoliation (Figure 2). Only 10% of the M-S defoliation was inside the treated areas. Defoliation was again scattered around the Province, with largest concentrations found throughout the north-central, northwest and in the southeast. The western border, and much of the south, and central parts of the Province were undamaged. The 927 000 ha of M-S defoliation represent a 13% decrease from 1985, a 27% increase from 1984, and a significant 54% decrease from the 2.03 million ha in 1983.

Forecast of Infestation for 1987

As noted last fall, the traditional egg mass survey in New Brunswick has been replaced by the overwintering larval or L2 survey. The year's survey has been completed and a total of 1 586 L2 sample points have been processed. Table 5 provides a comparison of forecast data since 1981 revealing an almost steady decrease in the intensity of the infestation to the point where 77 percent of the sample locations have low populations. Although high populations are not prevalent as in previous years, moderate populations still occur throughout much of the northern part of the province and in smaller though significant patches elsewhere. In the absence of protection and under favourable weather conditions, these populations are still capable of causing unwanted levels of damage. The total area forecast to support moderate and high populations in 1987 is approximately 1.706 million ha (Figure 3) and is a 46 percent reduction from the 3.15 million ha forecast last year. The forecast area of infestation has been decreasing annually since 1982 (Table 6).

Plans for 1987

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

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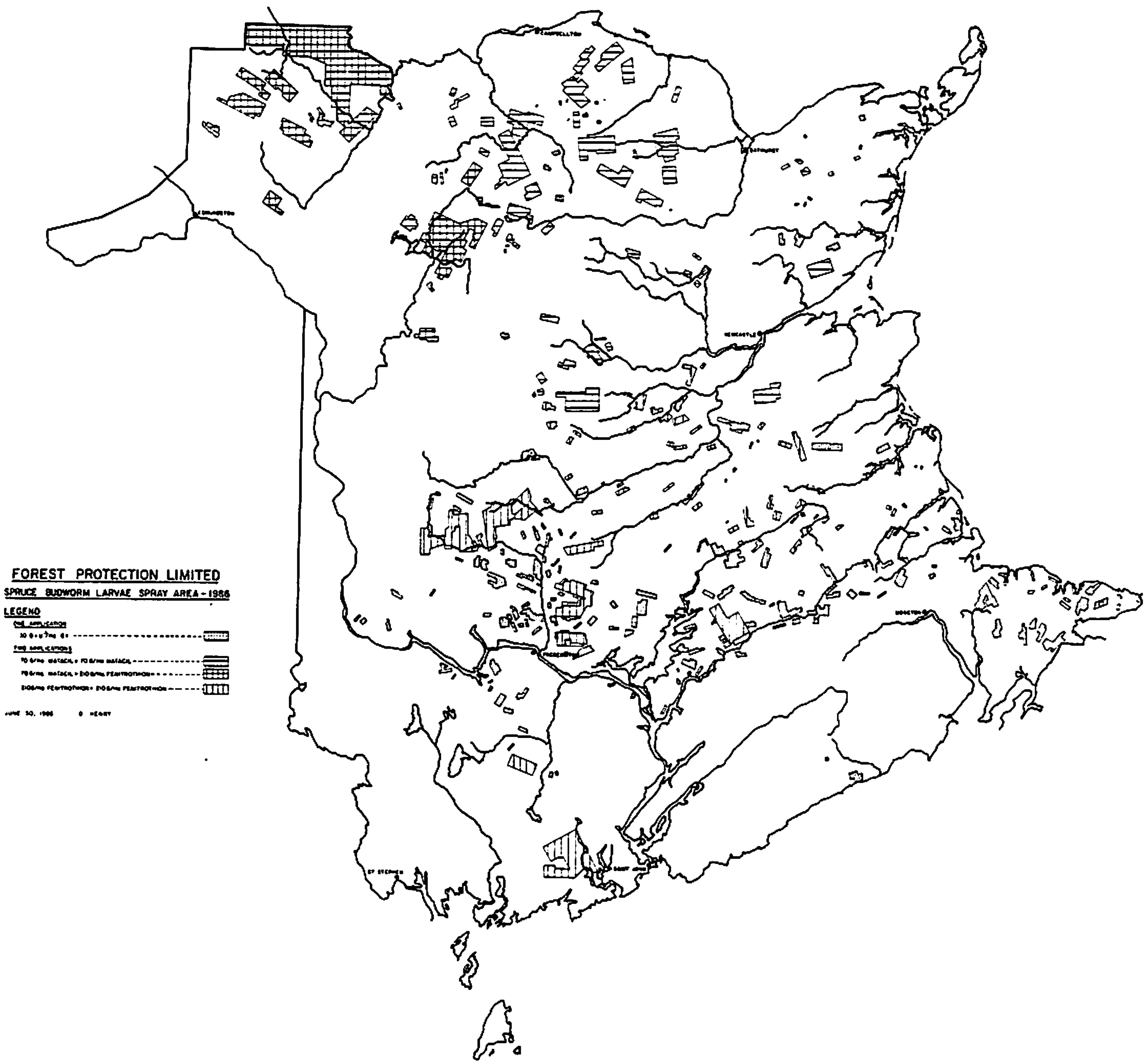

Figure 1. Distribution of blocks treated in the 1986 Spruce Budworm Spray Program in New Brunswick.

Table 1. Areas treated by Forest Protection Limited for spruce budworm control in 1986 in New Brunswick*

Treatment	Hectares Thousands	Acres Thousands	Aircraft Type
One Application			
30 B.I.U./ha B.t.	111.5	275.4	Ag Cat, Ag Truck Bell 206
SUB-TOTAL	111.5	275.4	
Two Applications			
I. At 1.46 L/ha			
(a) 210 g/ha Fenitrothion + 210 g/ha Fenitrothion	110.4	272.8	TBM, Ag Truck, Ag Cat
(b) 70 g/ha Matacil + 70 g/ha Matacil	119.5	295.3	TBM, Ag Truck, Ag Cat
(c) 210 g/ha Fenitrothion + 70 g/ha Matacil	141.1	348.7	TBM
II. At 0.4 L/ha			
(a) 210 g/ha Fenitrothion + 210 g/ha Fenitrothion	7.2	17.9	Ag Truck Ag Cat
(b) 70 g/ha Matacil + 70 g/ha Matacil	6.4	15.9	Ag Truck Ag Cat
SUB-TOTAL	384.6	950.6	
GRAND-TOTAL	496.1	1 226.0	

*Source: Forest Protection Limited.

Table 2. Aircraft fleet used by Forest Protection Limited for Spruce budworm control in 1986 in New Brunswick.*

Aircraft Type	FPL Owned FPL Operated FPL Controlled	Dry Leased FPL Operated FPL Controlled	Contracted FPL Controlled	Total
Spray Aircraft				
TBM Avenger	9	---	---	9
Ag-Cat	---	---	8	8
Cessna 188	2	---	6	8
Bell 206	---	---	4	4
Total Spray	11	---	18	29
Non-Spray Aircraft				
Cessna 185	---	3	---	3
Cessna 172	---	26	---	26
Cessna 206	---	2	---	2
Bell 206 (Rescue)	---	---	1	1
Bell 47	---	---	2	2
Total Non-Spray	---	31	3	34

29 Spray Aircraft + 34 non spray aircraft = 63 Total

* Source: Irving, H. J. 1986. Forest Protection Limited 1986 Program Report.

Table 3. Number of trees sampled and precent meeting foliage protection objectives on balsam fir and red-black spruce in each treatment.

TREATMENT	BALSAM FIR		RED-BLACK SPRUCE	
	Number	(%)	Number	(%)
TBM				
2 x MATACIL	481	(81)	280	(100)
2 x FENITROTHION	-	(-)	141	(99)
1 x FEN. + 1 x MAT.	732	(84)	39	(100)
SSP*				
2 x MATACIL	382	(81)	145	(97)
2 x MAT. (0.4L/HA)	168	(74)	93	(100)
2 x FENITROTHION	186	(69)	248	(99)
2 x FEN. (0.4L/HA)	124	(94)	100	(100)
1 x B.T.	438	(82)	878	(100)

SSP* = Small Spray Planes

Table 4. Area (ha) of moderate and severe defoliation within each treatment based on the 1986 aerial defoliation survey.

TREATMENT	AREA (HA) DEFOLIATED	AREA (HA) SPRAYED	% OF SPRAY AREA DEFOLIATED
TBM			
2 x MATACIL	7 563	94 797	8%
2 x FENITROTHION	12 144	83 724	15%
1 x FEN. + 1 x MAT.	32 373	141 086	23%
Sub-Total	52 080	319 607	16%
SSP*			
2 x MATACIL	8 025	24 701	32%
2 x MAT. (0.4 L/HA)	86	6 433	1%
2 x FENITROTHION	7 636	26 652	29%
2 x FEN. (0.4 L/HA)	1 232	7 252	17%
1 x B.T.	25 911	111 462	23%
Sub-Total	42 890	176 500	24%
GRAND TOTAL	94 970	496 107	19%

SSP* = Small Spray Planes

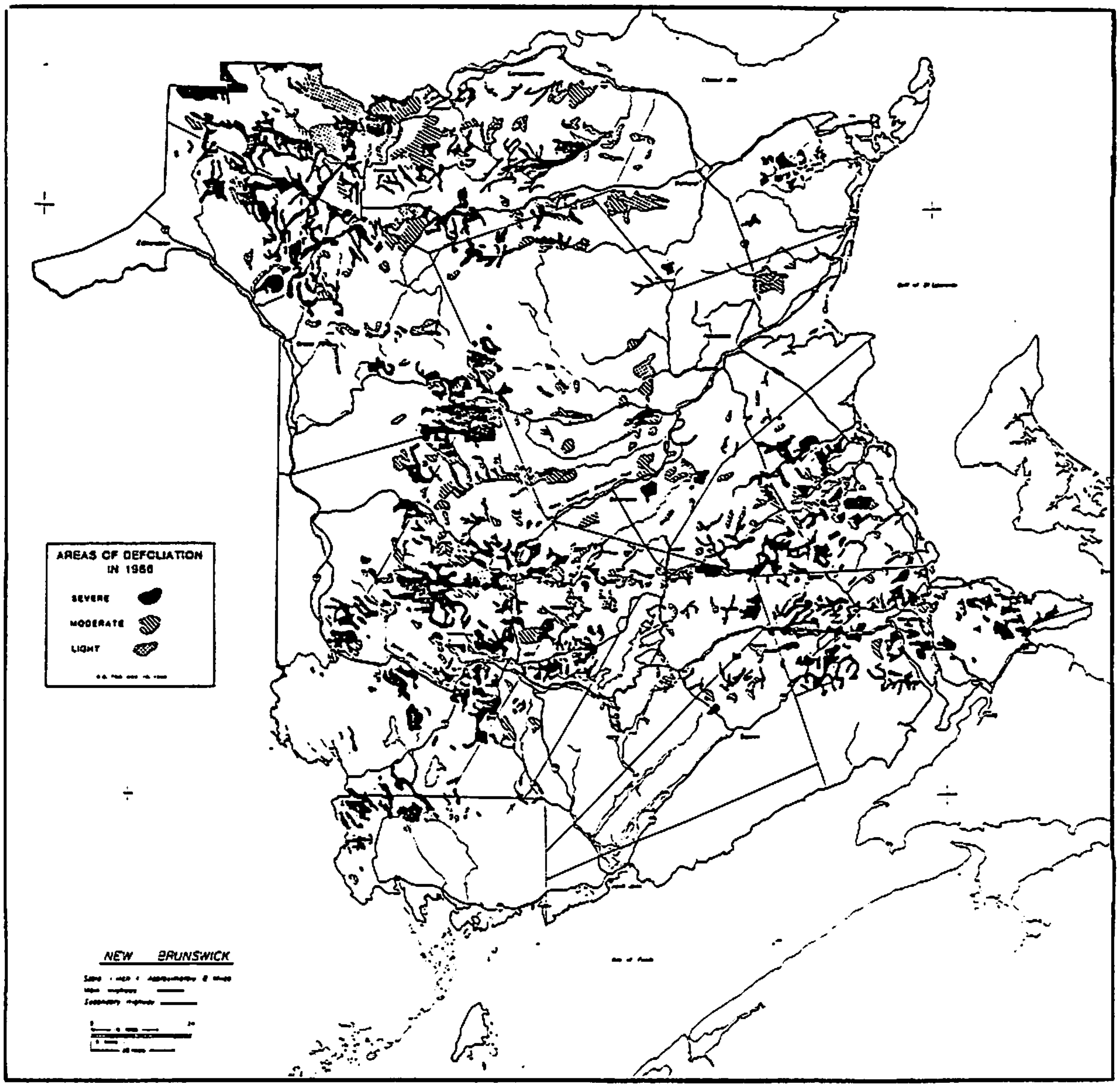

Figure 2. Areas of Light, Moderate and Severe defoliation mapped during the 1986 aerial defoliation survey in New Brunswick.

Table 5. Comparison of Spruce Budworm Forecast Infestation Levels 1981-1986.

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

Table 6. Comparison of Forecast Area (ha) of Moderate and High Infestations 1982-1986.

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

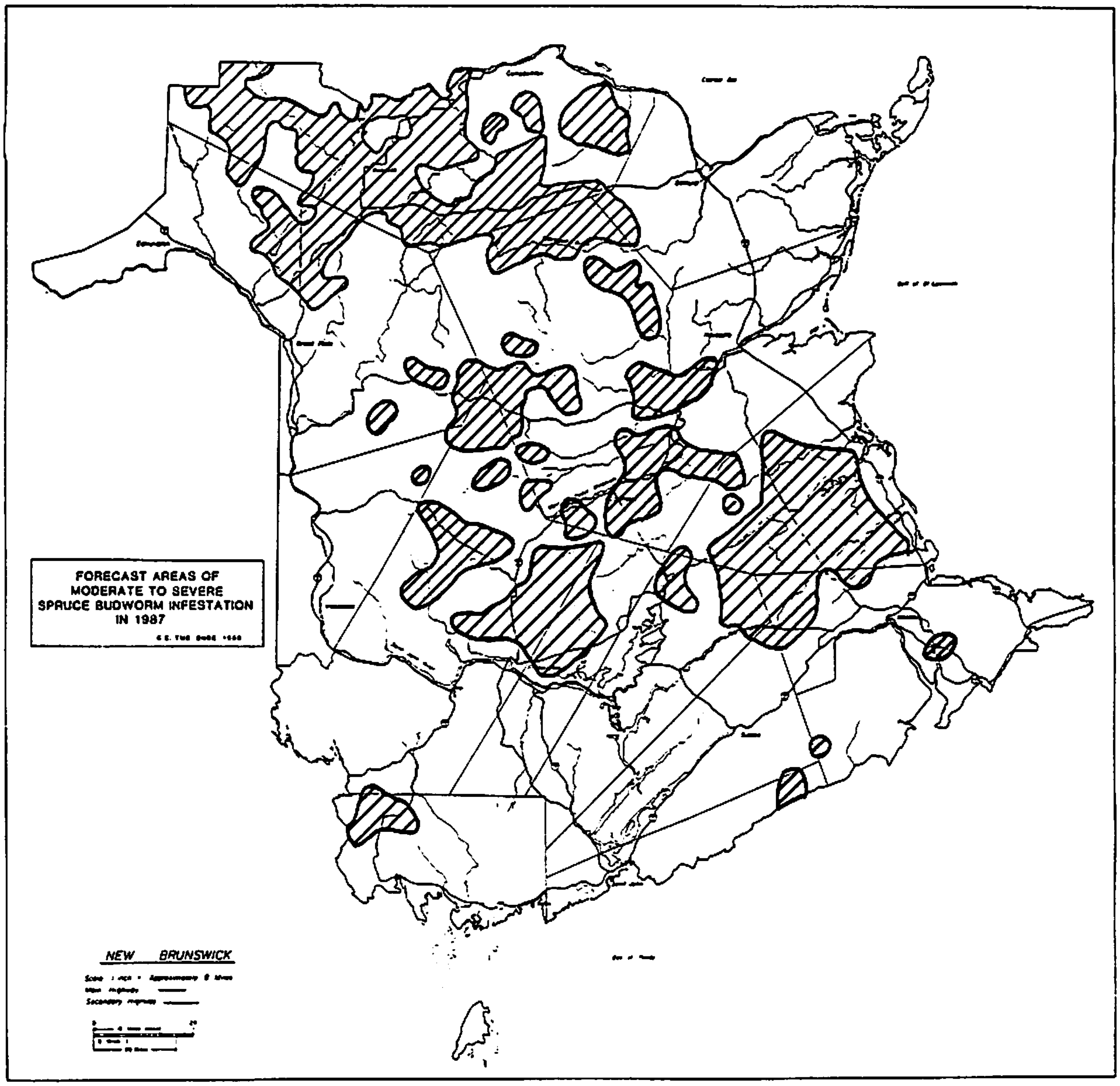

Figure 3. Forecast areas of moderate and high budworm populations for 1987 based on the 1986 L2 survey.

ENVIRONMENTAL MONITORING OF FOREST INSECT CONTROL OPERATIONS (EMOFICO)

1985 REPORT

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ERRATA

Page 16 should read:

Protection Limited 1976). It was not possible at that time to document the extent of bee mortality or to implicate forest spraying, but the evidence was sufficient to stimulate more research and create a greater concern for pollinators in future spray programs. The resulting research showed evidence of bee mortality, and a no-spray zone of at least 3.2 km was recommended (Wood 1974). The interim injunction was dissolved in 1976 and was replaced by a declaratory order that did not mention specific distances (Bridges Brothers Ltd. v. Forest Protection Limited 1976). Although Forest Protection Limited has been mostly self-regulating over the years in the area of blueberry field setbacks, the buffer zones instituted by the PAB are 3.2 km (about 2 mi.) from blueberry fields for chemical formulations such as fenitrothion and aminocarb (Townsend 1982).

However, it was really, in the 1970's, when attention to human health risks was directed towards Reye's Syndrome with apparently high incidence rates reported in New Brunswick (Hatcher and White 1984) that the movement towards the use of buffer zones or no spray areas as regulatory tools began. It was hypothesized that the disease was related to the viral enhancing property of emulsifiers (Hatcher and White 1984). In 1976, a task force was struck to examine the possible association. Drift studies done in 1976 found spray deposit at least 1.6 km beyond block boundaries (Varty 1976, Spitzer 1984). The combined public pressure against the spray program and the drift study information resulted in a government decision to institute a 1.6 km setback from human habitation for the 1977 spray program (Table 2) for all formulations. In addition to the setback from habitation, a 3.2 km setback from municipal drinking water supplies (Table 2) was instituted in the same year, the theory being that

On page 45, Table 1, the blue mussel LC50 for the fenitrothion flowable formulation should read 15.0 ppm rather than 1.5 ppm.

ABSTRACT

This multi-disciplinary compilation of 22 reports concerns primarily the environmental monitoring of the spruce budworm aerial spray operations in New Brunswick in 1985 with some information from other jurisdictions. The 29 authors report on the operational and regulatory aspects of the spray program, and on the insecticide ecology in ecosystems associated with spruce-fir forests which include studies on songbirds, freshwater fauna, toxicology, insecticide analysis, insecticide transport, persistence and contamination. The insecticides studied were fenitrothion, matacil, mexacarbate and *Bacillus thuringiensis.*

TABLE OF CONTENTS

FOREWORD

The New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO) is an informal association of biologists, foresters, environmental specialists and chemists from federal and provincial governments, industry and universities. Its prime objective is to assess the impact of operational spray programs on non-target organisms and ecological processes in forest and adjacent ecosystems. By implication this includes experimental sprays and complementary laboratory studies. Efficacy is also considered, insofar as it relates to environmental effects. Potential consequences of forest spray programs for human health are beyond the Committee's terms of reference. Although the Committee's focus is on spray activities in New Brunswick, it seeks to keep aware of forest insect control operations and related environmental studies in the Atlantic region as well as in Quebec and Maine.

The Committee assumed its present name and structure in 1976, and has been under the aegis of the Department of Municipal Affairs and Environment (formerly the Department of the Environment) since 1980. The 1985 report, like its predecessors, is aimed at a broad readership - scientists, regulators, resource managers and, not the least important, the public. It consists essentially of preliminary reports and abstracts of reports completed.

For further information on the role of the New Brunswick Committee for EMOFICO as well as an instructive statement on insecticide ecology, the reader is referred to the Committee's combined 1978-1979 report.

Steering Committee

D. I. Besner (Department of Municipal Affairs and Environment)
D. C. Eidt (Canadian Forestry Service)
P. A. Pearce (Canadian Wildlife Service)
W. A. Sexsmith (Department of Municipal Affairs and Environment)

RECOMMENDATIONS

A consensus of the EMOFICO Committee:

It is recommended:

(1) that government agencies continue to support research and monitoring of the environmental effects of pesticides,

(2) that regulatory agencies continue to review the rationale for the specifications for buffer zones recognizing that much work has been done in the area of spray technology,

(3) that monitoring, research and regulatory agencies make a greater effort to explain to the public the significance of their findings,

(4) that the environmental implications of the use of *Bacillus thuringiensis* be clarified,

(5) that the environmental implications of the potential use of mexacarbate be reviewed,

(6) that monitoring and research agencies make a concerted effort to determine the routes and time frames for degradation of insecticides and adjuvants to innocuous products in various matrices,

(7) that further work be encouraged on the biological significance of pesticide residues in the forest environment, and

(8) that continued liaison with monitoring groups in other jurisdictions be encouraged.

OPERATIONAL SPRAYING

1985 SPRUCE BUDWORM PROTECTION PROGRAM IN NEW BRUNSWICK

N. CARTER

1985 Spray Program

The 1985 spruce budworm spray program conducted by Forest Protection Limited, in New Brunswick covered approximately 701,000 ha. (Figure 1). This represents a 32% reduction from 1984. Of the total area treated, about 85% was in the industrial part of the program (i.e. beyond 1.6 km from habitation) and the balance was in the non-industrial sector consisting of small private woodlots.

Chemical insecticides were used over 88% of the program and B.t. on the remainder. Aminocarb (Matacil 180 F) was sprayed over 452,000 ha; fenitrothion (Sumithion) over 168,000 ha; and B.t. was sprayed over 81,000 ha. Both chemicals were applied in water-based formulations and B.t. was applied undiluted (Table 1).

A total of 75 aircraft were involved in the program, 38 of which were spray planes, including 12 TBMs, 22 agricultural-type spray planes, and 4 helicopters (Bell 206s) (Table 2). TBMs were only used in the industrial part of the program and sprayed 66% of the total area treated.

Spray operations commenced on the evening of May 26 and terminated on June 26. The commencement date was the same as in 1984 and for the second consecutive year was later than normal due to cool spring weather. At the termination date, approximately 9,000 ha of B.t. spraying were left undone. These areas were in the southeastern portion of the province and were scheduled for treatment based on spruce timing. A combination of the late timing, poor spray weather, and presence of visible defoliation accounted for these areas not being sprayed.

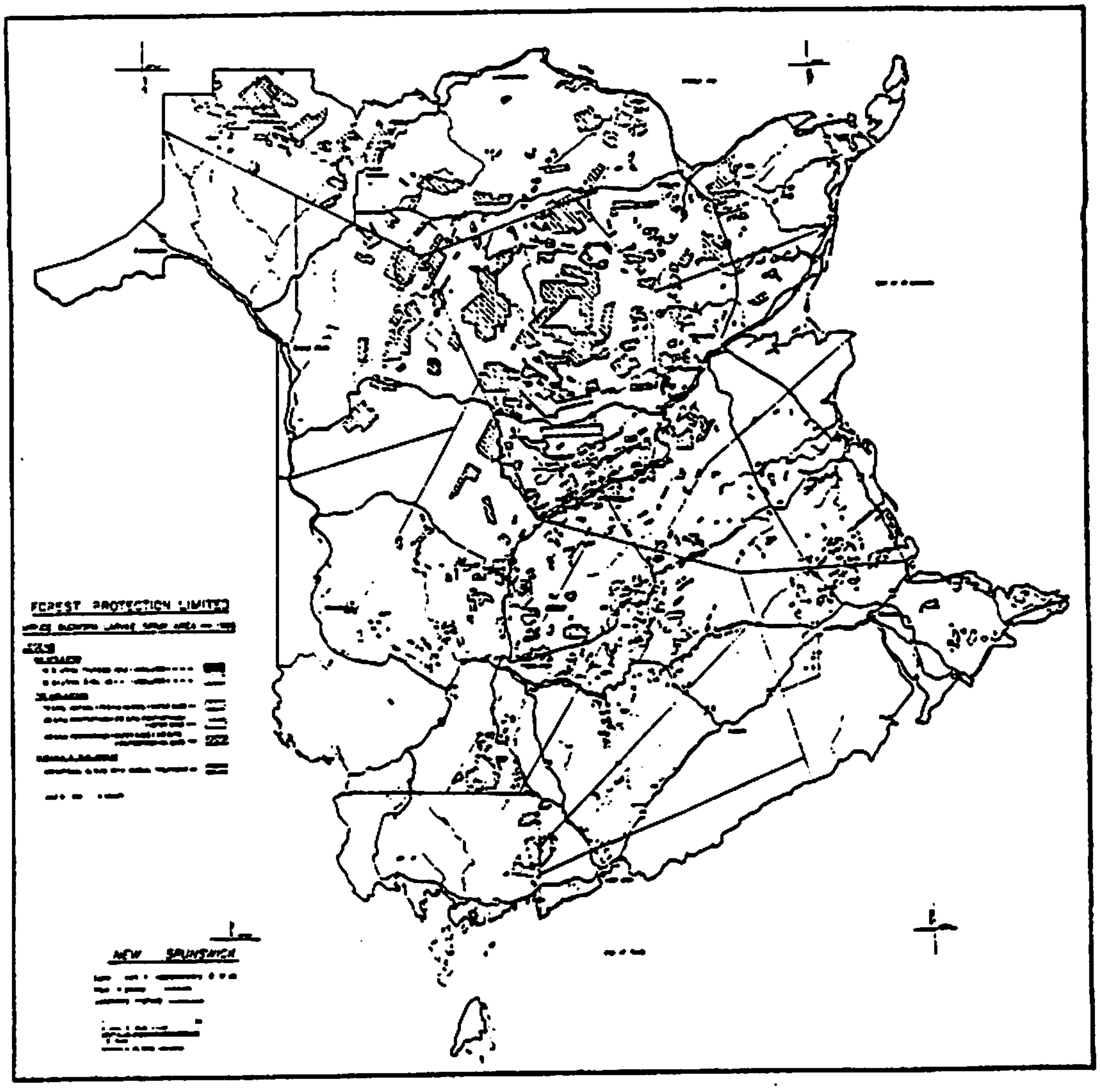

Figure 1. Distribution of spray blocks for the 1985 spruce budworm spray program in New Brunswick. (Detailed larger scale maps available at DFME).

Table 1. Areas Treated Operationally in the 1985 New Brunswick Spray Program*

Area Sprayed (ha and ac) By Insecticide, Application Rate, Formulation & Aircraft Type

Application	Hectares Thousands	Acres Thousands	Aircraft Type
One Application			
(a) 30 B.I.U./ha Dipel 132 Undiluted - 2.35 L/ha	78	192	TBM, M18, Ag Cat, Bell 206 Pawnee, Ag Truck
(b) 30 B.I.U./ha Thuricide 48LV Undiluted - 2.35 L/ha	3	8	M18
	81	200	
Two Applications			
(a) 210 g/ha Sumithion in 1.46 L/ha + 210 g/ha Sumithion in 1.46 L/ha - Dowanol, Atlox 3409F and water.	165	408	TBM, M18, Ag Truck, Pawnee, Ag Cat, Bell 206
(b) 210 g/ha Sumithion in 1.46 L/ha - Dowanol Atlox 3409F and water + 210 g/ha Sumithion in 1.46 L/ha Cyclosol 63 and Oil	3	8	TBM
(c) 70 g/ha Matacil 180F in 1.46 L/ha + 70 g/ha Matacil 180F in 1.46 L/ha Atlox 3409F and water.	447	1 105	TBM, Ag Cat
(d) 70 g/ha Matacil 180F + 70 g/ha Matacil 180F - Undiluted - 0.4 L/ha	5	11	Ag Truck
TOTAL	620	1 532	
GRAND TOTAL	701	1 732	

* Source - Irving, H.J. 1985. Forest Protection Limited 1985 Program Report

Table 2. Aircraft fleet used in the 1985 New Brunswick Spray Program*

Aircraft Type	FPL Owned FPL Operated FPL Controlled	Dry Leased FPL Operated FPL Controlled	Contracted FPL Controlled	Total
Spray Aircraft				
TBM Avenger	12	---	---	12
Ag-Cat	---	---	8	8
Cessna 188	2	---	6	8
M-18	---	---	4	4
Pawnee	---	---	2	2
Bell 206	---	---	4	4
Total Spray	14	---	24	38
NonSpray Aircraft				
Cessna 185	---	3	---	3
Cessna 172	---	28	---	28
Robinson 22	---	---	3	3
Bell 206 (Rescue)	---	---	1	1
Bell 47	---	---	2	2
Total NonSpray	---	31	6	37

38 Spray Aircraft + 37 NonSpray Aircraft = 75 Total

* Source: Irving, H.J. 1985. Forest Protection Limited 1985 Program Report

Results of Spray Program

At present, the objectives of the spray program in New Brunswick are to retain 60% or more of the current year's needles on balsam fir and 50% or more on red-black spruce. Virtually all the red-black spruce trees sampled met the foliage protection objectives regardless of treatment (Table 3). Results on balsam fir were also greatly successful though not to the same high degree.

During the aerial defoliation survey there were approximately 134,000 ha of moderate and severe defoliation detected within all spray areas (Table 4). This represented 12.5% of the total province-wide defoliation, or 19.1% of the total area treated by all insecticides. On a treatment basis, 15.0% of the aminocarb areas were defoliated, 28.8% of the fenitrothion areas were defoliated, and 21.8% of the B.t. areas were defoliated.

Spruce Budworm Conditions in 1985

The 1985 aerial defoliation survey was conducted in the standard manner and revealed an estimated 1.07 million ha of combined moderate and severe defoliation (Figure 2). Ground checks revealed that rain and wind prior to the survey had removed some evidence of defoliation making it impossible to distinguish light defoliation from the air, and likewise made it impossible to reliably distinguish between moderate and severe defoliation. Although defoliation was scattered throughout the province, the largest concentrations were in the northwest, central and southeast parts of the province. For the sake of comparison the total estimated area of defoliation for 1985 is about 50% higher than 1984 (0.73 million ha) and about 50% lower than for 1983 (2.03 million ha).

Forecast of Infestation for 1986

The traditional egg mass survey for predicting spruce budworm infestation levels in New Brunswick was replaced completely this year by the overwintering larval of L2 survey. A total of 1 521 L2 sample points have been processed. Comparing these sample results with last year's egg mass survey, there was a 15 percent decrease in the proportion of forecast points falling in the HIGH category (Table 5). This

Table 3. Number (and percent) of sampled trees meeting foliage protection objectives on balsam fir and red-black spruce in each treatment.

TREATMENT	BALSAM FIR	RED-BLACK SPRUCE
TBM		
2x Matacil	3021 (94)	2242 (92)
2x Fenitrothion	121 (79)	15 (100)
1x Dipel	60 (90)	6 (100)
SSP*		
2x Matacil	319 (91)	390 (100)
2x Fenitrothion	1375 (91)	683 (99)
1x Dipel	418 (75)	1055 (83)
1x Thuricide	30 (100)	12 (100)

SSP = Small Spray Planes

Table 4. Area (ha) defoliated within each treatment.

TREATMENT	AREA (ha) DEFOLIATED
TBM	
2x Matacil	64 985
2x Fenitrothion	17 563
1x B.t.	2 248
SUB-TOTAL	84 796
SSP*	
2x Matacil	2 925
2x Fenitrothion	30 845
1x B.t.	15 393
SUB-TOTAL	49 163
GRAND TOTAL	133 959

*SSP = Small Spray Planes

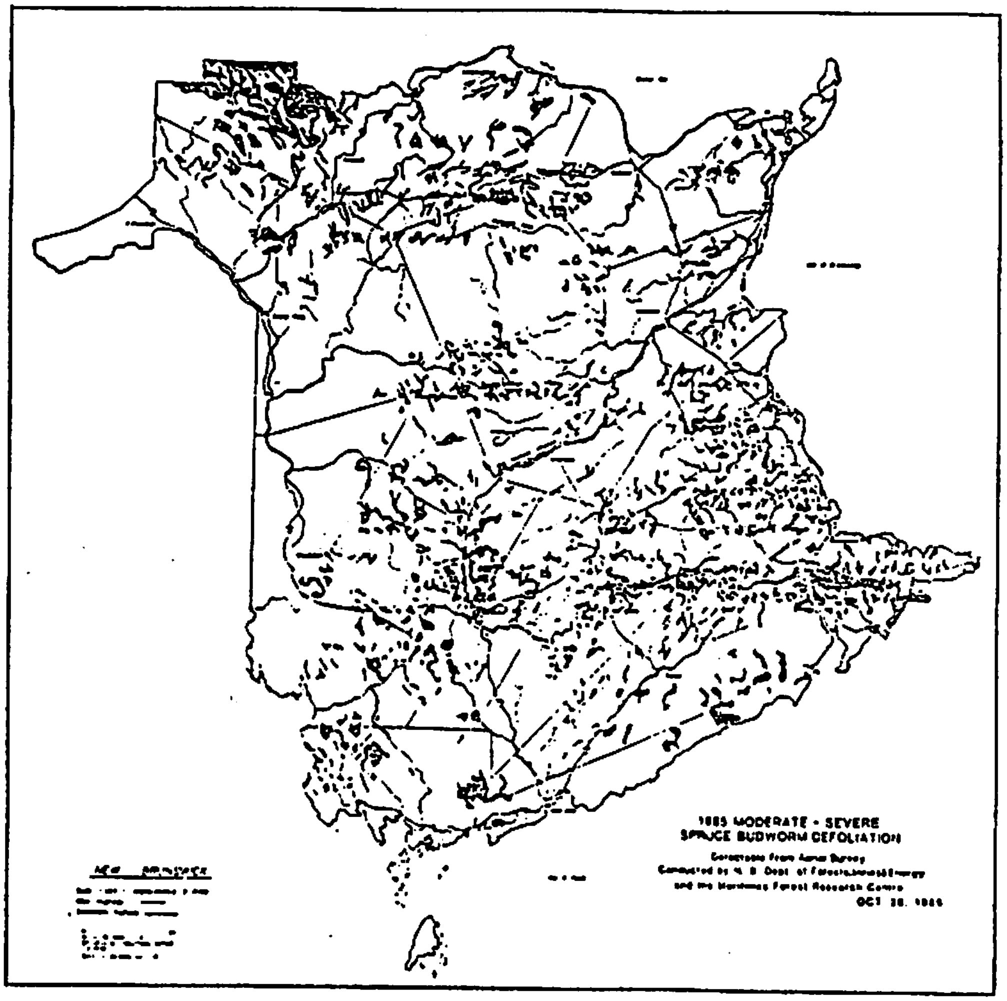

Figure 2. Distribution of moderate and severe spruce budworm defoliation in New Brunswick detected in the 1985 aerial defoliation survey.

Table 5. Comparison of 1985 Spruce Budworm L2-Survey Data With The 1981 to 1984 Egg-Mass Data.

	FORECAST INFESTATION LEVEL			
	LOW	MODERATE	HIGH	
1981 egg-mass	591 (34%)	441 (25%)	708 (41%)	n=1740
1982 egg-mass	458 (26%)	512 (29%)	783 (45%)	n=1753
1983 egg-mass	636 (48%)	257 (20%)	423 (32%)	n=1316
1984 egg-mass	747 (51%)	331 (22%)	398 (27%)	n=1476
1985 L2	833 (55%)	503 (33%)	185 (12%)	n=1521

Table 6. Comparison of size of moderate to high infestations forecasted from 1982 to 1985.

YEAR (n)	AREA FORECAST (n + 1)
1982	5.30 million ha
1983	4.10 million ha
1984	3.57 million ha
1985	3.15 million ha

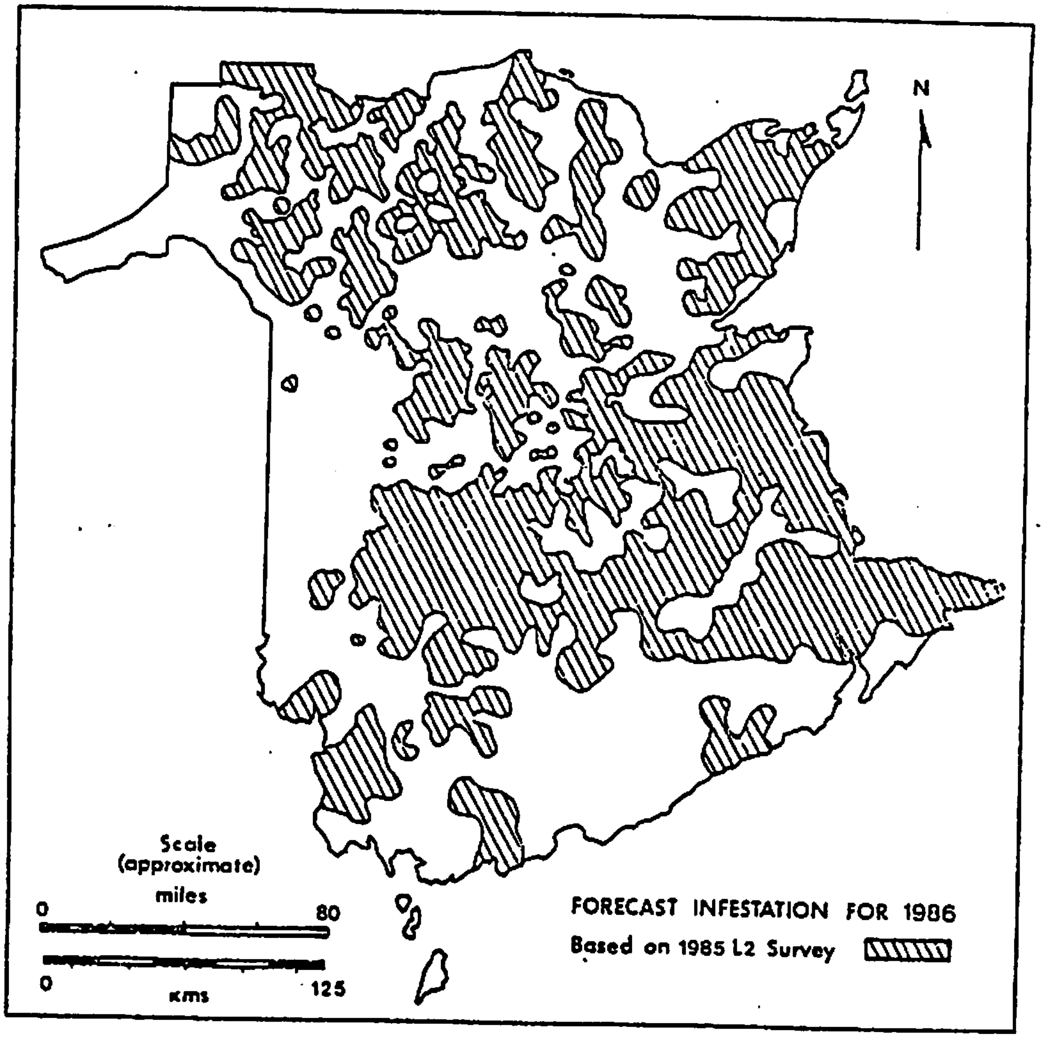

Figure 3. *Moderate and severe spruce budworm infestation forecast for 1986 in New Brunswick (based on 1985 L2 survey).*

has resulted in a 4 percent increase in the proportion of plots in the LOW and 11 percent increase in the MODERATE categories. In terms of overall distribution, however, MODERATE and HIGH populations are still present in large patches across the northern part of the province and in a large band across the south-central region into the southeast. Most of the western, north-central, and southern portions of the province are LOW. The total area forecast (Figure 3) to be moderately to severely infested in 1986 is approximately 3.15 million ha - a continuation of the decline over the past few years (Table 6).

Plans for 1986

Spray plans for 1986 have not been formulated at this time. It appears, however, that a protection program similar to the 1985 program will be required in New Brunswick in 1986. We anticipate that chemical insecticides will be used in the bulk of the industrial forest areas and B.t. within the 1.6 km set-back from habitation. Tentative spray plans will be known by mid-December.

YEAR TO YEAR RESPRAY IN NEW BRUNSWICK

D.C. Eidt and C.A.A. Weaver

The distribution and degree of overlap of spray blocks from year to year change because of the shifting patterns of hazard to trees posed by forest insects. It is important to know the history of respraying and the chances of future respraying because of the possibilities of persistent residues, environmental perturbations, and resistance in the target insect. Eidt and Fisher, C.F.S. Res. Notes 2:13-16, 1982, published estimates of chances of respray based on years up to 1978. We measured areas of overlap on spray maps to update the chances to 1985. Barring substantial changes in budworm infestation or spray strategy, we estimate the chances of any particular forested area in New Brunswick being sprayed two consecutive years at about 15% and three years in a row at about 6%. The odds on an area sprayed one year being sprayed again the next are higher, about 50%, and the next two years, about 11%. For further details see D.C. Eidt and C.A.A. Weaver 1986. Frequency to forest spraying

and use of B.t. in New Brunswick, 1975-1980. Canadian Forestry Service Information Report M-X-158.

THE EVOLUTION OF BUFFER ZONES IN NEW BRUNSWICK

W. A. Sexsmith

Introduction

Buffer zones or no-spray areas have become important regulatory tools in the spruce budworm spray program in New Brunswick. The following report outlines the evolution of buffer zone regulation in New Brunswick including the evolution of the regulatory role of the province, the types and definitions of areas given spray buffer protection , the buffer zones applied to each type of buffered situation, and the rationale behind buffer establishment in each situation.

The Evolution of the Provincial Regulatory Role

Although a Pesticides Control Act (PCA) under the New Brunswick Department of Agriculture was enacted in 1973 (Table 1), the formal mechanism for the authorization of insecticide use in forest insect control operations was established in 1974 under provisions of the Pest Control Products Act, administered by Agriculture Canada. The province was involved in the review and approval of the budworm spray programs via an interdisciplinary committee, but the permit to spray was signed by the district supervisor for Agriculture Canada in accordance with Agriculture Canada Memorandum T-104 requirements.

In 1976 , the PCA was amended, and , in 1977, Regulations for the Act were created. This resulted in the establishment of the Pesticides Advisory Board (PAB) consisting of provincial government representatives. Part of the responsibility of this Board is to review and grant budworm spray permits. It is within these permits that the conditions, such as buffer zones, under which spraying must take place, are issued. In this first year of its existence, both Agriculture Canada and the PAB, under

TABLE 1

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

<u>Evolution of legislation and provincial role in pesticides control</u>

DATE	LEGISLATION	ROLE
1973	Pesticides Control Act- N.B.Agriculture	
1974		- province involved in review and approval of projects via inter-disciplinary committee - permit signed by district supervisor Ag Canada -T-104
1976	PCA-amended	
1977	Agriculture Regulations for PCA - Ag	- both Ag Canada and PAB/Ag signed permit
1978		- PAB/Ag
1979	PCA-amended Environment	- PAB/Ag
1980		- PAB/Env. - Minister signed permit
1981		- PAB/Env.
1982	PCA-amended Environment	- PAB/Env.
1983	Regulations for PCA-Env.	- PAB/Env.

the Department of Agriculture, reviewed and issued the permits to spray.

In 1978, permits were issued by the PAB only. The PCA was amended and became the responsibility of the Department of the Environment in 1979. However this occurred late in the year so that the PAB under the auspices of the Department of Agriculture issued the permits for the spray season. By 1980, the Department of Environment was fully ensconced as the regulatory agency for pesticide applications in the province. The PAB, operating under this Department, reviews permit applications, but it is the Minister who actually grants the permits, on PAB advisement. The PCA was amended in 1982, and new Regulations were created in 1983.

The PAB plays a very important role in the development of buffer zones . This interdisciplinary body, made up of representatives from provincial departments such as Municipal Affairs and Environment, Health and Community Services, Natural Resources and Energy, Agriculture, receives, solicits and assesses information pertaining to setbacks and other information pertinent to regulation of spraying of pesticides for spruce budworm control.

<u>Buffer Zone Types and Definitions</u>

In New Brunswick, there are eight types of areas (Table 2) that have or have had buffer zones over the years.

Habitation is defined as a dwelling or structure that has permanent human occupation. The setback is measured from the structure not the property boundary.

Lakes are bodies of water that are greater than 40 ha in size. Rivers that are of a significant size (roughly greater than 100 m wide) are considered major rivers. When the proposed spray areas

TABLE 2

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

	1977*	1978	1979	1980
HABITATION	1.6 km	1.6 km	1.6 km	1.6 km
LAKES (> 40 ha)	400 m	400 m	400 m	
DESIGNATED MAJOR RIVERS	400 m	400 m	400 m	
OPEN WATER BODIES				
ECOLOGICAL RESERVES				400 m
MUNICIPAL WATER (point of extraction)	3.2 km	3.2 km	3.2 km	3.2km
BLUEBERRY FIELDS	3.2 km	3.2 km	3.2 km	3.2km
COAST			1.6 km	1.6 km

* - all formulations

are reviewed, these waters to be buffered are designated by the reviewing agency.

Open water bodies are considered to be waters that are visible to the pilot and/or the spotter pilot soon enough for the spray booms to be shut off.

Ecological reserves are areas of land that have been officially proclaimed as such and have been set aside in order to preserve samples of the New Brunswick ecosystem for present and future biological research (Anonymous 1985).

Municipal waters are municipal water reservoirs, impoundments, or other bodies of surface water from which drinking water is taken for municipalities. The setback is measured from the point where the water is extracted.

Blueberry fields are areas where blueberries are grown commercially.

Coast refers to the line where land meets the sea, Bay of Fundy, Northumberland Strait, etc.

Buffer Zones and their Rationale

Although aerial spraying for spruce budworm control has been going on in the province almost annually since 1952 (Varty 1976), buffer zones were not in use until 1977. During the sixties, what could perhaps be termed types of discretionary buffers were implemented from time to time (Irving 1986) such as booming off for water and avoidance of fish hatcheries. From 1963 to 1968, the enc of DDT spraying, phosphamidon, with low toxicity to fish, was used for safety zone spraying (152-300 m) along streams and rivers to minimize the effects to aquatic life (Prebble 1975).

In 1970, several blueberry growers, whose fields were located near fenitrothion-sprayed forests, reported unusually low pollinator activity and attributed their crop losses to the spray operation. As a result, in 1971, an interim injunction ordered Forest Protection Limited, the main agency responsible for the spray program, to conduct no spraying program against the spruce budworm within a two mile radius of blueberry fields (Bridges Bros. v. Forest

Protection Limited 1976). It was not possible at that time to document the extent of bee mortality or the implication of forest spraying, but the evidence was sufficient to stimulate more research and create a greater concern for pollinators in future spray programs. The resulting research showed evidence of bee mortality, and a no-spray zone of at least 3.2 km was recommended (Wood 1974). The interim injunction was dissolved in 1976 and was replaced by a declaratory order that did not mention specific distances (Bridges Brothers Ltd. v. Forest Protection Limited 1976). It was not possible at that time to document the extent of bee mortality or the implication of forest spraying, but the evidence was sufficent to stimulate more research and create a greater concern for pollinators in future spray programs. The resulting research showed evidence of bee mortality, and a no-spray zone of at least 3.2 km was recommended (Wood 1974). The interim injunction was dissolved in 1976 and was replaced by a declaratory order that did not mention specific distances (Bridges Brothers Ltd. v. Forest Protection Limited 1976). Although Forest Protection Limited has been mostly self-regulating over the years in the area of blueberry field setbacks, the buffer zones instituted by the PAB are 3.2 km (about 2 mi.) from blueberry fields for chemical formulations such as fenitrothion and aminocarb (Townsend 1982).

However, it was really, in the 1970's, when attention to human health risks was directed towards Reye's Syndrome with apparently high incidence rates reported in New Brunswick (Hatcher and White 1984) that the movement towards the use of buffer zones or no spray areas as regulatory tools began. It was hypothesized that the disease was related to the viral enhancing property of emulsifiers (Hatcher and White 1984). In 1976, a task force was struck to examine the possible association. Drift studies done in 1976 found spray deposit at least 1.6 km beyond block boundaries (Varty 1976, Spitzer 1984). The combined public pressure against the spray program and the drift study information resulted in a government decision to institute a 1.6 km setback from human habitation for the 1977 spray program (Table 2) for all formulations. In addition to the setback from habitation , a 3.2 km setback from municipal drinking water supplies (Table 2) was instituted in the same year, the theory being that the extra 1.6 km would provide additional protection to the watersheds that drain into the drinking water supplies. This setback has remained unchanged through 1985.

In 1978, two new buffer zones were added (Table 2). Spray operators were required to avoid spraying within 400 m(the swath width of a 3-T.B.M. spray team) directly adjacent to, and surrounding, all bodies of water greater than 40 ha. These buffer zones were also applied to all major rivers. The rationale was that this would be the minimum size that could be sighted from the air while allowing reaction time on the part of the spray pilots. Field studies conducted in conjunction with the 1980 spray program indicated that a 400-m, no-spray "buffer zone" was sufficient to significantly reduce the incidental deposit of formulation (Ernst et al. 1980). Traces of fenitrothion, one of the pesticides used in the budworm spray program, were found in shellfish in 1976. Additional studies done in 1977 also showed residues to be present. Concerns about these findings were raised in the 1977 EMOFICO report (Varty 1978). As a result, a 1.6-km setback was required from coastal waters.

There were no additions or changes for 1979,and two in 1980 (Table 2). The 1.6 km coastal buffer zone was dropped, with the stipulation that spraying take place in blocks near the coast only when the wind was blowing from the coast. This change resulted from further studies regarding fenitrothion residues in shellfish, the conclusions being that although trace amounts of residues were found, fenitrothion will not accumulate to any appreciable extent in marine shellfish and that these residues are transient(Varty 1980).A 400-m setback was instituted for proclaimed ecological reserves (areas of New Brunswick reserved for ecological purposes). Proclaimed reserves have been in existence since 1976; however, it wasn't until 1980 that any fell within a spray block. It was thought that, as with the aquatic setback, 400-m would provide sufficient protection from any significant terrestrial impact.

Until 1981, the spruce budworm spray program in New Brunswick consisted of large blocks primarily sprayed by large aircraft (T.B.M.s). In 1980, the New Brunswick Department of Natural Resources became concerned about the deterioration of the forested areas within the 1.6-km setback zones. In order to have a guaranteed wood supply for the future, these areas, many of which were privately owned forest land, had to be protected from budworm damage. Drift studies done in 1980 (Crabbe _et al._) using smaller agricultural type aircraft showed that 300 m would provide an adequate buffer from human habitation, thus allowing a large portion of the forest within the 1.6-km setback to be protected. This 300 m buffer zone from human habitation (Table 3) for agricultural type aircraft was instituted for the 1981 spray program, along with a 65 m buffer for open water. This heralded the beginning of the two-part spray program for Forest Protection Limited with large blocks (woodland) being sprayed with large aircraft 1.6 km from habitation and 400 m from large lakes and rivers, and with small blocks (woodlots) being sprayed with small aircraft 300 m from habitation and 65 m from open water. The 65 m setback (the average swath width of an agricultural-type aircraft) was used as an aquatic setback for aerial spraying of agricultural crops, and was adopted as appropriate for woodlot spraying. Gordon (1982) found that the 65-m buffer zone from aquatic systems was adequate to reduce incidental contamination by forest herbicides.

In the spring of 1982, the First Report of the New Brunswick Task Force on the Environment and Reye's Syndrome (Spitzer 1982) made recommendations against the use of the emulsifier Atlox and against the use of solvents containing fractions of fossil fuel oil, such as Cyclosol 63. Since both Atlox and Cyclosol 63 were ingredients in the formulations planned for 1982, certain compromises were made for that year. It was decided that the oil formulations would be allowed but that a 3.2-km setback from habitation was required (Table 4). Water based formulations flown by agricultural aircraft had a 300 m setback from habitation and 65 m from open water as in the previous year. A 155-m setback from open water was required for the formulation of fenitrothion and Dowanol without water because of concerns about the effects of the large amount of solvent on aquatics. The setbacks for _Bacillus thuringiensis (B.t.)_, sprayed operationally in 1982, were the same as the ones for the water-based formulations sprayed by small aircraft, except that the setback from blueberry fields, because _B.t._ is non-toxic to Hymenoptera, was eliminated.

TABLE 3

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

1981*

	WOODLANDS**	WOODLOTS***
HABITATION	1.6 km	300 m
LAKES (> 40 ha)	400 m	
DESIGNATED MAJOR RIVERS	400 m	
OPEN WATER BODIES		65 m
ECOLOGICAL RESERVES	400 m	
MUNICIPAL WATER (point of extraction)	3.2 km	3.2 km
BLUEBERRY FIELDS	3.2 km	3.2 km

* - all formulations
** - large aircraft (T.B.M.s)
*** - small aircraft (agricultural)

TABLE 4

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

1982

	WOODLANDS oil*	WOODLOTS H_2O	WOODLOTS B.t.
HABITATION	3.2 km	300 m	300 m
LAKES (> 40 ha)	400 m		
DESIGNATED MAJOR RIVERS	400 m		
OPEN WATER BODIES		65 m**	65 m
ECOLOGICAL RESERVES	400 m		
MUNICIPAL WATER (point of extraction)	3.2 km	3.2 km	3.2 km
BLUEBERRY FIELDS	3.2 km	3.2 km	0

* - formulation
** - 155 m for fenitrothion and Dowanol

Consideration was given to a request by the Department of Natural Resources to reduce the habitation setback for B.t. in order to protect more of the private lands so vital to future wood supply needs. In 1983, the 300-m setback from habitation (Table 5) for B.t. was reduced to 155-m . This 155-m setback was adopted from the agricultural setback for insecticides.

A request by the Department of Natural Resources to reduce the 400-m setback around ecological reserves for the woodlot or small aircraft spray program was reviewed by the PAB. For the 1984 spray season, the decision was made to allow small aircraft to spray within 65 m of ecological reserves (Table 6) , using the rationale that 65 m would provide sufficient distance to reduce incidental contamination in a terrestrial situation as with an aquatic situation. In addition, Natural Resources requested that the 65 m buffer zone for open water be waived to allow the spraying of B.t. adjacent to watercourses. Work done by Eidt (1985) showed that B.t. as used in budworm spray operations posed no hazard to aquatic insects. Because of this information, the 65 m buffer zone for open water was reduced to 0 for the 1984 spray season (Table 6).

Summary

Buffer zones have become an integral part of the spruce budworm spray program in New Brunswick. These no-spray areas serve to reduce or eliminate the possible impact on specific parts of the environment. It is important to note here that these buffers also provide guidelines within which the applicators can work, giving them some protection from objection to spraying by individuals or groups. There have been no changes in the buffer zones since 1984. However, because of the dynamics of the spruce budworm spray program, as new information becomes available, and as new situations arise, the Pesticides Advisory Board is in place to review and assess and make recommendations appropriate to the data available.

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TABLE 5

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

1983

	WOODLANDS		WOODLOTS	
	oil	H_2O	H_2O	B.T.
HABITATION	3.2 km	1.6 km	300 m	155 m
LAKES (> 40 ha)	400 m	400 m		
DESIGNATED MAJOR RIVERS	400 m	400 m		
OPEN WATER BODIES			65 m	65 m
ECOLOGICAL RESERVES	400 m	400 m		
MUNICIPAL WATER (point of extraction)	3.2 km	3.2 km	3.2 km	3.2km
BLUEBERRY FIELDS	3.2 km	3.2 km	3.2 km	0

TABLE 6

EVOLUTION OF BUFFER ZONES - NEW BRUNSWICK

1984 & 1985

	WOODLANDS H_2O	WOODLOTS H_2O	WOODLOTS B.t
HABITATION	1.6 km	300 m	155 m
LAKES (> 40 ha)	400 m		
DESIGNATED MAJOR RIVERS	400 m		
OPEN WATER BODIES		65 m	0
ECOLOGICAL RESERVES	400 m	65 m	65 m
MUNICIPAL WATER (point of extraction)	3.2 km	3.2 km	3.2 km
BLUEBERRY FIELDS	3.2 km	3.2 km	0

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EXPERIMENTAL SPRAYING

REVIEW OF RESEARCH AND DEVELOPMENT PROGRAM CONDUCTED IN NEW BRUNSWICK IN 1985 WITH VARIOUS INSECTICIDES, EQUIPMENT AND BIOLOGICAL CONTROL AGENTS

E. G. Kettela

INSECTICIDES

Bacillus thuringiensis:

Four sets of research and development trials with *B. t.* were conducted in New Brunswick in 1985. These trials included 1) semi-operational tests with Futura XLV at 2 dosage rates, 20 and 30 b.i.u./ha, 2) comparative tests wth Dipel 132 aqueous, Dipel 176 aqueous and Dipel 176 oil base all applied at 30 b.i.u.ha, 3) comparative tests with Thuricide 32 LV, 48 LV and 64 B as part of a three-year program to examine the relationship between deposit, concentration and efficacy, and 4) trials with Futura XLV, Dipel 176 and 132, Thuricide 64B and SAN-415 as possible control agents for *Zeiraphera* spp. infesting white spruce plantations. In the *Zeiraphera* trials efficacy on spruce budworm was determined as well.

In all cases these trials were conducted with small agricultural type aircraft such as Cessna 188's equipped with Micronaire AU 3000 atomizers. All the *B. t.*'s were applied undiluted.

The results indicate that Futura at 30 b.i.u./ha provides enhanced protection over 20 b.i.u./ha but that both results are acceptable. Dipel aqueous and oil base formulations at 30 b.i.u./ha provide similar and adequate results in terms of foliage protection. In the case of the Thuricide trials the 48 LV and 64 B products afforded better protection than the 32 LV product. The highest deposits were obtained with the 64 B. The results with the 48 LV and 64 B were similar suggesting an upper effective limit of *B. t.* concentration. Efficacy is clearly linked to deposit. Trials with most of the *B. t.*'s against *Zeiraphera* were inconclusive.

These were all cooperative studies involving support from the manufacturers, Forest Protection Limited, Maine, Quebec and the CFS.

Chemicals:

Three sets of research and development trials with chemicals were conducted in New Brunswick in 1985. One set of trials over 9 spray blocks tested Zectran (mexacarbate) as a possible control agent for *Zeiraphera canadensis*; the other two sets of trials were conducted against spruce budworm larvae.

These two sets of trials included 1) tests with fenitrothion to compare the standard formulation, an emulsion at 1.5 l/ha, against UULV applications of fenitrothion in solution with Dowanol TPM at a total volume of 0.4 l/ha and Sumithion 20F (a new product containing fenitrothion) at a reduced dosage of 140 g/ha in 1.5 l/ha, and 2) an operational evaluation of Matacil (aminocarb) 180F applied undiluted at a dosage of 70 g/ha in a volume of 0.4 l/ha. In addition, deposit of Matacil on foliage was compared to deposit on foliage in T.B.M. sprayed blocks. All test blocks were sprayed with Cessna 188 aircraft equipped with Micronaire AU 3000 nozzles.

The results indicate that against *Zeiraphera* Zectran, at all dosages tested, did not provide adequate protection. Tests against the spruce budworm indicate that:

1) fenitrothion as a UULV spray provides efficacy similar to that of the conventionally used emulsion and that Sumithion 20F at 140 g/ha appears to be a marginal dosage, but when similar deposit levels are compared it is as efficacious as either of the other fenitrothion formulations examined; and

2) Matacil 180F applied undiluted through Micronaire nozzles provided excellent foliage protection and corroborated the findings in 1984. Further deposit levels, expressed as ppm's of aminocarb were similar in both the UULV blocks and in operational blocks treated with T.B.M.'s.

EQUIPMENT

In an endeavour to develop ways to provide maximum protection to high value forest stands, Forest Protection Limited supported and participated in a study with CFS-Maritimes, R.P.C. and the Chemical Engineering Dept. of U.N.B. to evaluate spraying with helicopters equipped with Beecomist atomizers. Beecomist atomizers produce spray droplet spectra (with solutions) that approach the theoretical maximum for enhanced foliage impingement. Two areas were treated with a fenitrothion simulant, with the helicopter flying at 40 kph, the other at 120 kph. Results of chemical analysis indicate fairly high and uniform deposit throughout the crowns of trees and what appears to be, at first analysis, enhanced deposition.

Is this real, and does it mean enhanced efficacy?

BIOLOGICAL CONTROL AGENTS

In 1984 an inundative release of *Trichogramma minutum* (an insect egg paraasitoid) was carried out against *Zeiraphera*. Some 20×10^6 *T. minutum* were released on a .1 ha block. Results were encouraging and set the stage for further testing in 1985.

Sufficient *T. minutum* were obtained from the University of Guelph to carry out releases against both spruce budworm and *Zeiraphera*. With respect to budworm, 3 high value areas were treated, 2 young spaced forest stands, and a hedge. The results were very encouraging and parasitism of spruce budworm eggs was increased dramatically.

A 0.5-ha area of white spruce plantation in northern New Brunswick infested with *Zeiraphera* was also treated (at a release rate of 10x106 *T. minutum*/ha). Results show enhanced parasitism by *T. minutum* at about the same rate as in 1984. These tests indicate that *T. minutum* can be used to successfully elevate parasitism of pest eggs but it has yet to be demonstrated that this level of parasitism will effect a significant reduction in the next generation. Further tests are planned for 1986. *T. minutum* is not commercially available in Canada, and it is important to use select strains of *T. minutum*.

RESIDUES

PERSISTENCE OF FENITROTHION IN BALSAM FIR LEAF LITTER

D. C. Eidt, V. N. Mallet, C. A. A. Weaver

On July 9, 1984, 19 bags containing 30 g each of balsam fir foliage were placed on the forest floor in the U.N.B. woodlot. This foliage had been collected in a heavily sprayed area several weeks after spray so that the surface deposit would have been lost. The entire sample was thoroughly mixed and the concentration of fenitrothion in the foliage was determined to be 0.32 ug/g. The means for two lots of foliage collected on five dates in 1984 were reported in the 1984 EMOFICO Report. Further samples were collected until October 1985, when the last bag was taken.

Results were:

Date	Lapsed days	Concentrations (ug/g fresh weight
9 July 84	0	0.24, 0.40
13 July 84	4	0.22, 0.22
16 July 84	7	0.21, 0.38
23 July 84	14	0.32, 0.28
6 Aug. 84	28	0.35, 0.31
27 Aug. 84	49	0.29, 0.17
15 Oct. 84	98	0.36, 0.47
22 Apr. 85	287	0.33, 0.42
21 June 85	347	0.55, 0.83
26 Aug. 85	413	0.44, 0.40
16 Oct. 85	464	0.47

We cannot recognize any loss of fenitrothion over the 15 months exposure. The apparent increase in concentration was probably due to loss of other compounds, possibly water, because we did not determine moisture content.

Our original hypothesis was that the fenitrothion would be lost within a season, therefore we did not use enough bags to continue the experiment. To begin a new field experiment would put us back two years. It is questionable if it would be worthwhile to pursue the subject further because released fenitrothion would be attacked and decomposed very quickly by microorganisms. Using respiration as the criterion, Salonius (J. econ. Ent. 65-1089- 1090, 1972) found a massive dose of fenitrothion did not affect the decomposition process in forest soil.

OPERATIONAL DRIFT MONITORING WITH AN AIRCRAFT-MOUNTED SAMPLER

C. M. Riley and C. J. Weisner

A high volume sampler was designed and constructed to operate isokinetically when mounted on a Cessna 182. The Cessna flew a series of one kilometre sampling runs downwind of TBM teams spraying Matacil. Gas chromatographic analysis of the samples provided a time series of mean drift concentrations in the sampling region (2-3 km downwind of block). Drift concentrations varied from undetectable to 4.2 ug/m3 and agreed well with results of previous experimental drift studies.

STUDIES ON THE ENVIRONMENTAL CHEMISTRY OF FORESTRY INSECTICIDES USED IN FPMI 1985 RESEARCH TRIALS

K. M. S. Sundaram, C. Feng, R. Nott and J. Broks

Introduction

This report describes the environmental chemistry and fate of three forestry chemicals, viz., aminocarb, fenitrothion and mexacarbate used during 1985 research programs in New Brunswick, Newfoundland and Ontario.

1. Canopy interception, deposition and fate of mexacarbate in a New Brunswick forest ecosystem

Mexacarbate insecticide residues and some of its common metabolites were evaluated in an aquatic field system in New Brunswick forest aerially sprayed with 70 g AI/ha twice at an interval of five days. Deposits and droplet spectra were recorded at various canopy depths, on ground cover and in open forest floor to determine patterns of foliar interception, and ground deposition, and if correlations existed among foliar concentrations, droplet densities and size spectra. Concentrations of the insecticide in stream and pond waters, sediment, aquatic plants and animals were measured at intervals of time. Residues in stream and pond waters peaked respectively at 0.73 ppb and 18.74 ppb and decreased rapidly below the detection limit (0.02 ppb) with 24h. Concentrations in some aquatic plants (slender spikerush, manna grass,etc.) were higher (ca. 500 ppb), persisted up to two days but decreased rapidly. Sediment, fish (caged and wild), tadpoles, aquatic insects, moss, and green algae did not accumulate detectable amounts of mexacarbate. Data indicate that mexacarbate at the dosage used will not accumulate to sufficient extent in the aquatic forest environments to pose any noticeable hazard to nontarget organisms. Demethylated (mono) N-methylcarbamate and dimethylaminoxylenol were detectable by thin-layer chromatography in some of the substrates studied but they also degraded rapidly.

2. Distribution and depositon of fenitrothion aerially applied to a boreal forest area near Searchmont, Ontario

In collaboration with the Environmental Impact group at the Institute, the distribution and deposition of the insecticide fenitrothion on nontarget biota was investigated to study the interactions between them if possible, to quantify the potential vulnerability and stress arising from pesticide exposure. The fenitrothion effects on biota following spraying could be direct as well as indirect and the magnitude and duration of these effects depend upon the chemical sprayed, dosage, organism exposure, susceptibility and biotope.

Samples of foliage (balsam fir and white birch) at different vertical and horizontal canopy position, different types of wild flowers, a variety of wild and caged bees, and water (inside and outside the spray blocks) were collected one day prior to and 1h following the insecticide application at 280 g AI/ha. Water samples were collected up to one day post-spray. Simulated foliar and floral samples and collection units containing Kromekote cards/glass plates were placed throughout the spray blocks to compare the deposition levels and droplet spectra of fenitrothion sprays on the targets. Insecticide residues in the extracts of samples (natural and simulated) were determined as well as the deposit levels on glass plates and droplet spectra on Kromekote cards. Deposits on the simulated samplers (fir needle and birch foliage made from aluminum wire and aluminum sheet respectively) and foliar concentrations in balsam fir decreased from top to bottom and laterally from outside to towards the tree trunk. Whereas such patterns were not observed in birch probably due to poor trapping of spray droplets. Regression analysis showed an approximately linear relationship between the deposits on the two (artificial and natural) fir surfaces. Similar correlations were also found on foliar (artificial) to ground deposits. Correlations were good between deposits found on different types of simulated and natural flowers but the amounts varied according to the geometry of the flowers under consideration.

Fenitrothion residue was detected (31 ppb) in stream water immediately after its aerial application and it dissipated very rapidly within the first 24h after the spray. The rapid dissipation of the chemical was due to dilution, degradation and possibly adsorption to other matrixes.

Fenitrothion-nontarget biota interactions are quite complex, requiring detailed analysis and critical interpretations using the residue levels found in various substrates. The field biologists are currently evaluating the primary (toxicological) and secondary (ecosystem changes) effects on nontarget biota arising from fenitrothion spray application over a boreal forest.

3. Post-spray residue concentrations of aminocarb and fenitrothion in balsam fir foliage at the mid-canopy level and deposit levels of the chemicals measured from glass plate rinses on the forest floor during the 1985 hemlock looper control program in Newfoundland.

The mid-crown foliar samples (1984 and 1985 growths) and the glass plates kept on the forest floor to receive the spray deposits were collected from the spray blocks and were extracted, concentrated, partitioned, cleaned-up using column adsorption chromatography, N-evaporated and analysed by GLC. The results are given in Tables 1 and 2. Plots 7, 9 and 15 were sprayed with Matacil - 180F (aminocarb) at 90, 135 and 185 g AI/ha respectively using a water-based formulation. Plots 12 and 13 were sprayed with fenitrothion flowable (FF) with a polymeric additive at 140 and 210 g AI/ha respectively. Plot 17 was sprayed with the conventional fenitrothion emulsion formulation (FE) at 210 g AI/ha.

From the data the following points emerge:

Table 1 (aminocarb)

1. Mean deposits of aminocarb on the forest floor increased with dosage. The increase appeared to be nonlinear. On average about 8% of the sprayed material reached the forest floor.

2. Similar trends were found between foliar concentrations and dosage, but the correlation seemed to be linear.

3. Needles of the 1985 growth appeared to be better collectors compared to the needles of 1984 growth. Needle exposure, geometry, needle size, terpene content, etc. could have had some role in the collection and retention of the material.

4. Correlations among dosage, foliar concentration and mortality of insects shoud be explored.

Table 2 (fenitrothion)

1. Mean deposits on the forest floor were unusually

TABLE 1

Aminocarb residues in balsam fir foliage following experimental application of the insecticide as an emulsion formulation at three different dosages during the 1985 hemock looper control program in Newfoundland

Plot	Dosage (g/ha)	Sample Sites in the sprayline used for composite sample preparation (m)	Deposit on glass plates (g/ha)	Mean deposit on glass plates (g/ha)	Aminocarb concn. (ppm) in foliage (fresh wt.)+ Needles of 1984 growth	Mean of the needles from 1984 growth (+ SD)	Needles of 1985 growth	Mean of the needles from 1985 growth (+ SD)
7	90	0,30,60	--*		0.55		0.57	
		90,120,150	7.21	7.73±0.90	0.50	0.55±0.05	0.45	0.64±0.19
		180,210,240	7.21		0.55		0.64	
		270,300	8.77		0.61		0.90	
8	135	0,30,60	2.21		0.49		0.24	
		90,120,150	6.99	8.74±5.16	0.63	0.80±0.28	0.28	1.07±0.94
		180,210,240	12.90		1.07		1.78	
		270,300	12.85		1.01		1.98	
15	180	0,30,60	21.87		1.53		1.74	
		90,120,150	16.18	15.32±7.02	0.80	1.22±0.31	1.48	1.99±1.05
		180,210,240	--*		1.31		3.53	
		270,300	7.91		1.24		1.20	

*Samples were lost in transit.
+Triplicate measurements.

TABLE 2

Fenitrothion residues in balsam fir foliage following experimental application of the insecticide as flowable and emulsion formulations during the 1985 hemlock looper control program in Newfoundland

Plot	Formulation and dosage	Sample sites in the sprayline used for composite sample preparation (m)	Deposit on glass plates (g/ha)	Mean deposit on glass plates (g/ha) (± SD)	Fenitrothion concn. (ppm) in foliage (fresh wt.)+ Needles of 1984 growth	Mean of the needles from 1984 growth (± SD)	Needles of 1985 growth	Mean of the needles from 1985 growth (± SD)
12	Fenitro	0,30,60	25.10		5.08		9.25	
	thion F	90,120,150	22.13	22.13±2.98	5.42	5.09±1.22	10.89	9.24±2.02
	140 g/ha	180,210,240	--*		3.46		6.40	
		270,300	19.15		6.40		10.42	
13	Fenitro	0,30,60	43.83		10.05		14.08	
	thion F	90,120,150	31.67	37.77±6.08	5.40	7.72±1.98	11.01	12.54±1.77
	210 g/ha	180,210,240	--*		8.39		14.06	
		270,300	37.82		7.04		11.01	
17	Fenitro	0,30,60	6.71		1.37		1.37	
	thion Emul.	90,120,150	4.08		0.46		0.84	
	210 g/ha	180,210,240	5.86	7.47±3.98	1.07	1.06±0.42	1.47	1.47±0.56
		270,300	13.21		1.34		2.20	

*Samples were lost in transit.
+Triplicate measurements.

high for fenitrothion F compared to aminocarb at equal dosages (plot 12 vs. plot 8). Deposit levels for fenitrothion F on the forest floor increased with dosage (plots 12 and 13). Higher deposit levels could possibly be due to polymeric additives in the formulation (FF). Such formulations also would give large NMD and VMD and the role of viscosity in deposition should be considered. The emulsion formulation (FE) gave poor ground deposition (3.6%) possibly due to volatilization of the adjuvant and accompanying codistillation of the AI.

2. Similarly very high deposition on the needles was observed for FF and it increased with dosage. Such a phenomenon has never been encountered before either with the same or with other formulations. As expected, the emulsion formulation gave poor deposition on the needles compared at the same dosage level (Plot 17 vs Plot 13). Physicochemical properties in addition to other factors could have played a key role in the depositon of AI on conifer needles.

3. Needles of the 1985 growth acted as better receptors to the spray cloud compared to the mature needles of 1984. Geometry of the growing branch tip, exposure to spray cloud and chemical content of the new foliage would have played some part. Additional research is necessary to be more definitive.

4. Correlations among dosage, formulation properties (role of adjuvants, viscosity, vapour pressure, surface tension, etc), foliar concentration and insect mortality should be explored and documented.

TERRESTRIAL IMPACTS

THE EFFECTS OF ZECTRAN (mexacarbate) ON SONGBIRDS

D. G. Busby, P. A. Pearce and N. R. Garrity

Perspective

The carbamate insecticide Zectran UCZF-19 is currently being evaluated for registration against the spruce budworm. Should it become registered for that purpose there is considerable potential for the product to become widely used. One of the primary

concerns remaining is its high acute toxicity to birds, especially songbirds occupying the forest canopy which is also prime habitat of the target insect.

During the past two field seasons the Canadian Wildlife Service, Atlantic Region, Toxic Chemicals Project, has devoted considerable time to evaluation of the impact of Zectran on songbirds. The insecticide is, like other carbamates and organophosphates, a cholinesterase (ChE) inhibitor. In 1984, a joint study by the Forest Pest Management Institute and the Canadian Wildlife Service determined that the effect of Zectran on brain ChE activity in adult songbirds was minimal and that the margin of safety was at least twofold the probable eventual operational dosage rate of 70 g AI (active ingredient)/ha. In the present study, the impact of Zectran on nestling songbirds was investigated. Additionally, the effects on songbirds of experimental high-dose application of Zectran to control spruce budmoth in plantations are reported.

The impact of experimental aerial application of Zectran on the growth and development of White-throated Sparrow nestlings.

Considerable overlap exists between the timing of spruce budworm spraying operations and the period of nestling rearing by songbirds. Although Zectran appears to be relatively safe to adult songbirds, there is some concern for the safety of nestlings. Concern lies primarily in the high acute toxicity of mexacarbate (active ingredient of Zectran) to birds and the low levels of ChE activity found in young nestlings. The assumption is that nestlings, having only minimal ChE activity to carry out whatever nervous functions would be required at that age, would be less able to tolerate any ChE inhibition. Any mortality of nestlings could theoretically impact on future population levels, the ultimate parameter of greatest importance.

In the present study we investigated the effects of an experimental aerial application of Zectran on the growth and development of White-throated Sparrow nestlings. We consider the White-throated Sparrow to be a good representative songbird which we can use as a model for impact assessment. The insecticide was formulated in Triton X 114 (emulsifier) and water (carrier) and applied by Cessna aircraft at a rate of 70 g AI/ha, the probable eventual operational dosage. The insecticide was applied twice, 5 days apart, according to usual budworm spraying strategy. The study technique involved location of breeding pairs within the spray block boundaries and in a nearby untreated control area. Each pair was monitored throughout the nest building and egg laying periods. Upon hatching of the first egg, each nest was visited at about the same time each day. At each visit several measurements of nestling growth were taken; they were weight, tarsus length, wing length and 9th primary length. We had hoped to arrange the spray timing such that the maximum number of nestlings were exposed to both sprays - a worst case scenario. Unfortunately, due to poor weather and mechanical problems, spraying was delayed and only two nestlings from one nest fell into that category.

The effect of Zectran on nestling growth was examined in two ways. First, the growth data for exposed nestlings were subjected to a daily comparison with control data, for all four parameters. Second, the growth rates of both groups of nestlings were calculated and compared using regression analyses.

Neither method of data analysis gave any indication that growth of exposed birds was significantly different from controls. Further, visual examination of the data did not uncover any sources of possible statistically non-significant differences. The only possible effect of the spray involved direct observation of three nestlings, a few hours after the first spray, that appeared to be lethargic and non-responsive to being handled. The next day, however, they behaved normally and their growth was not affected.

<u>The response of free-living White-throated Sparrow nestlings to experimental dosing of Zectran.</u>

The present study was conducted to gather further information on the effects of Zectran on nestling White-throated Sparrows. This type of study has several advantages over others utilizing aerial application as the method of exposing nestlings to the insecticide. 1) a location can be chosen to provide optimum availability of subject specimens so that statistically valid sample sizes can be obtained; 2) a spray block can only be treated as one unit, no matter what different stages of the nestling cycle the individual birds within the block may be at when the spray is applied. With dosing studies, treatment can be attuned to specific age groups, a parameter we now know to be relevant to nestling sensitivity; 3) exposure can be accurately controlled and quantified. Spray applications invariably leave many unanswered questions with regards to weather, evenness of spray, actual deposit, calibrations, etc.

It is recognized, however, that oral dosing is not a replacement but rather a supplement to aerial application studies. Some types of information we can obtain from dosing studies are 1) a relative acute oral toxicity of different budworm insecticides to free-living birds, whether adults or nestlings; 2) the relative sensitivity of different aged nestlings or adults to various insecticides; and 3) the effects of pure versus formulated insecticides on birds.

The dosing technique involved weighing of nestlings and, based on that weight, injecting an amount of Zectran, measured by microsyringe, into a common food item of the birds which was force-fed to the nestling. Several dosing regimes were followed. The results have not yet been analysed but some general statements can be made at this time. Single oral doses (based on the active ingredient, mexacarbate) as low as 5 mg/kg are lethal to young nestlings. Results from single oral doses at the 2.5 mg/kg rate are inconclusive. Administration of 1 mg/kg in single oral doses had no effect on growth. The 5 mg/kg and 2.5 mg/kg doses, when administered in three equal quantities on three consective days, did not appear to affect survival or growth.

Two assumptions were then made; that the maximum likely residue level of Zectran in the food supply of songbirds after aerial application would be 2.5 mg/kg and the maximum likely duration of Zectran residues in the food supply would be 2 days. Both assumptions are without substantiation from field data but seem reasonable given what is known about the insecticide. Selected nests were then visited every second hour of the daylight period for two days and fed food items containing Zectran at levels equating to a diet concentration of 2.5 mg/kg. This scenario approximately simulates the frequency of feeding of nestlings by adult birds. Preliminary results of this experiment indicate that there was little or no effect of the insecticide on nestling survival or growth and development.

The effects on songbirds of experimental high-dose application of Zectran UCZF-19 to control spruce budmoth in plantations in northern New Brunswick.

An experimental spray program using Zectran UCZF-19 at dosages of 150 and 300 g AI/ha to treat an outbreak of *Zeiraphera canadensis* in white spruce plantations in northwestern New Brunswick provided the opportunity for the Canadian Wildlife Service to study the impact of high-dosage spraying on songbirds. Spray operations were carried out by Forest Patrol Ltd. under the supervision of the Canadian Forestry Service. The spraying was done using a Bell Jet Ranger 206 helicopter equipped with boom and nozzle hardware and a Sorenson spray tank. An emulsion consisting of Zectran (active ingredient mexacarbate), Triton x 114 (emulsifier), and water (carrier) was emitted at a dosage of 150 AI/ha in two back-to-back applications on one block and 150 g AI/ha on a second.

The impact of the spray program was assessed using a modified songbird census survey in which all birds seen or heard within a 50 m radius of fixed stops located every 100 m along walked routes were recorded. The starting time and sequence of the surveys, as well as the observer, remained constant throughout the study. Four census routes were established and conducted on four days pre-spray and four days post-spray. Routes 1 and 2 were in the 150 g AI/ha block, route 3 was in the 300 g AI/ha block and route 4 was the control route. To determine if smaller birds were more susceptible to spraying the population was divided into group 1, consisting of kinglets and warblers, and group 2, consisting of all other birds. Census data were subjected to a three factor analysis of a variance test.

No significant differences occurred between the pre- and post-spray numbers in group 2, the larger birds, on either route 1, route 2 or route 3. Similarily, no significant differences were noted between the pre- and post-spray numbers in group 1, the smaller birds, on route 1 and route 3. However, there was a significant decline in numbers of group 1 birds on the post-spray counts on route 2. The two most likely causes of such a decline are spring migration and insecticide effects. Migration has been a problem in similar studies and may result in an influx of warblers prior to spray application, many of which may depart shortly before or after the application, giving the impression of a toxic effect. The drop in post-spray numbers of several warbler species on route 2 can be attributed to migration. The possibility of a toxic effect on the Magnolia Warbler population cannot be ruled out, although the decrease was observed on the low-dose block suggesting a non spray-related cause.

SUMMARY

To date, studies by the Canadian Wildlife Service indicate that Zectran will not pose a serious hazard to songbirds should it become registered for use against spruce budworm. The margin of safety is broad: at least twice the intended eventual operational dosage appears to be essentially non-impactive, a situation not realized with the use of the organophosphate insecticide fenitrothion. Clearly, from the standpoint of hazard to songbirds, Zectran and another carbamate insecticide, Matacil (active ingredient aminocarb) are preferable to fenitrothion as currently used for spruce budworm control.

TOXICITY OF FENITROTHION TO ARTHROPODS IN PITCHER PLANTS

D. C. Eidt, W. L. Fairchild, and C. A. A. Weaver

Pitcher plants grow in bogs in close proximity to sprayed forests where they may directly receive fenitrothion. Fifteen pitcher plant leaves contained an average of 20 ml of fluid and had a opening of about 6 cm^2 which would theoretically result in 63 ug of fenitrothion per litre of fluid under a spray of 210 g/ha. Considering the usual 70 to 80% loss between spray aircraft and the ground, and the screening effect of the hood and surrounding vegetation, a concentration of less than 15 ug/L would be expected.

The fluid in ten pitchers was treated with each of four rates of fenitrothion in aqueous formulation using Dowanol TPM and Atlox on 29 July 1985. The average concentrations in the pitchers were 6.60, 3.31, 1.65 and 0.83 ug AI/L. Because of the different amounts of water in the pitchers, treatments actually ranged from an estimated 9.45 ug/L down to 0.31 ug/L.

Contained arthropods were removed, identified, and determined to be living, moribund, or dead. The pitcher plant mosquito Wyeomyia smithii and the midge Metriocnemus knabi were present in most pitchers. There was kill and intoxication of mosquito and midge larvae and pupae at both the 6.60 and 3.31 ug/L rates but not at the two lower rates or in the controls. Some larvae and pupae survived in all treatments. Mites and rotifers found in most pitchers were apparently not affected.

On the basis of these results, a hazard to pitcher plant mosquitos and midges is inferred. Although both species are beneficial to the plant, neither is essential.

THE BIOLOGICAL CONSEQUENCES OF LINGERING FENITROTHION RESIDUES IN CONIFER FOLIAGE - A SYNTHESIS

D. C. EIDT AND P. A. PEARCE

ABSTRACT*

Conifer foliage is a sink for fenitrothion, with a limited capacity for accumulation. Fenitrothion, not derivatives or metabolites, is retained from year to year and for at least one year in foliage in forest litter. Translocation can occur but has not been demonstrated to new foliage from foliage of the previous year.

Among forest animals, only insects have been identified as confined entirely to a diet of conifer needles. Diprionid sawflies, among those tested and observed, have been determined to be most sensitive to fenitrothion poisoning. Diprionids and conifer-feeding pamphiliid sawflies are most threatened because most eat old foliage and, in New Brunswick, may have to feed on contaminated foliage even in years when spraying does not occur.
Vertebrates that feed extensively on conifer foliage (none does exclusively) are deer, moose, snowshoe hares, and spruce grouse: spruce grouse is probably the most sensitive to fenitrothion. It is estimated that a 550-g grouse would have to eat 29 kg of foliage containing 1 ppm fenitrothion to ingest a dose lethal to 50% of a test population and that significant sublethal effects are unlikely.

*From a manuscript accepted for the August 1986 issue of Forest Chronicle.

AQUATIC IMPACTS

PRELIMINARY REPORT ON STUDIES OF THE IMPACT OF FORESTRY PESTICIDES ON AQUATIC FAUNA

W. Ernst

BIOASSAY STUDIES - FENITROTHION FLOWABLE FORMULATIONS

A series of bioassays was undertaken to compare the aquatic toxicity of the new fenitrothion flowable formulations with that of the presently used fenitrothion soluble formulations. Acute (96 h and 48 h) toxicity tests were conducted using threespine stickleback (*Gasterosteus aculeatus*), rainbow trout (*Salmo gairdneri*), water flea (*Daphnia magna*), blue mussel (*Mytilis edulis*), and the freshwater clam (*Anodonta spp*.) as test organisms. The results of these studies (Table 1) indicate that, with the exception of the freshwater clam, the new flowable product is not appreciably less toxic to aquatic organisms than is the older oil-soluble product. This is in contrast to the observations for previously tested aminocarb formulations, in which it was determined that the flowable formulation was much less toxic to aquatic organisms than the soluble formulations. In the case of the fresh water clam, the older fenitrothion formulation was approximately 4 times more toxic than the new formulations.

Since the fenitrothion flowable formulation consists of a suspension of fine particles of active ingredient, a bioconcentration test was conducted using a test organism whose feeding mechanism is to selectively concentrate fine particles. Blue mussels were exposed to fenitrothion flowable solutions (0.10 and 0.60 ug/L measured AI concentration) for 30 days and depurated in clean water for 30 days. Fenitrothion concentrations in the mussel tissues (Table 2) became elevated within 1 day of exposure but did not increase appreciably after that time. Bioconcentation factors (concentration in tissue wet weight/concentration in water) ranged from 15-20 in the low exposures and 15-40 in the high exposures. This is approximately the same as bioconcentation factors (30) noted previously for mussels exposed to

TABLE 1 ACUTE TOXICITY OF FENITROTHION FLOWABLE AND FENITROTHION SOLUBLE FORMULATIONS TO AQUATIC ORGANISMS

TEST	TEST DURATION (hours)	LC 50[a]	
		FENITROTHION FLOWABLE FORMULATION[b]	FENITROTHION SOLUBLE FORMULATION[c]
Daphnia magna	48	10.3 ppb	7.6 ppb
Threespine Stickleback	96	3.1 ppm	3.1 ppm
Rainbow Trout	96[d]	2.2 ppm	1.7 ppm
Blue Mussel	96[d]	1.5 ppm	18.8 ppm
Freshwater Clam	96[d]	29.0, 25.0 ppm	8.1, 5.2 ppm

(a) LC 50's calculated using nominal fenitrothion (ai) concentration.

(b) Fenitrothion flowable formulation - Sumithion 20 FL concentrate.

(c) Fenitrothion soluble formulation - Sumithion Technical (11%), Atlox 3409 F (1.5%), Dowanol (1.5%), Water 86%).

(d) Exposure of test organisms to toxicant for 96 hours was followed by exposure to clean water for 96 hours.

TABLE 2 FENITROTHION CONCENTRATIONS IN BLUE MUSSELS EXPOSED TO TWO CONCENTRATIONS OF FENITROTHION FLOWABLE

EXPOSURE TIME (days)	FENITROTHION CONCENTRATION IN TISSUES (ug/g wet weight)			
	TEST CONCENTRATION A (0.1 ug/L)		TEST CONCENTRATION B (0.6 ug/L)	
	NO DEPURATION	1 DAY DEPURATION	NO DEPURATION	1 DAY DEPURATION
3	1.67	0.11	12.50	0.47
1	1.85	0.93	13.66	0.74
2	2.29	0.02	10.41	0.29
4	1.56	0.01	17.68	0.91
10	1.66	0.09	17.02	0.72
30	1.54	0.03	21.73	0.37

the fenitrothion soluble product. Depuration was also very rapid with 80% of the accumulated pesticide being lost from tissues once the shellfish were placed in clean water.

These results would seem to indicate that the new fenitrothion flowable formulations pose approximately the same hazard to the aquatic organisms tested as do the older fenitrothion soluble formulations.

FIELD STUDIES - AQUATIC IMPACTS OF HIGH DOSE MEXACARBATE APPLICATIONS

A field project was conducted to determine the aquatic impacts of high dose mexacarbate applications aimed at spruce budmoth in the white spruce plantations of J.D. Irving in northern New Brunswick. Zectran UCZF-19, was applied by helicopter at a dosage rate of 150 g/ha, in a formulation of Zectran UCZF-19 (22%), Triton X-114 (3%) and water (75%) to a stream, from its source to the sampling point. The stream was located within an experiment spray block which was 200 ha in size. Measured parameters included pesticide concentrations in water, aquatic invertebrate drift, aquatic invertebrate colonization of artificial substrates, and brain acetylcholinesterase activity of captive brook trout (*Salvelinus fontinalis*).

Results available to date indicate a very low deposit of mexacarbate in the stream with the only detectable residues of approximately 0.10 ppb occurring between 5 and 45 minutes post-spray. The treatment stream was low in aquatic invertebrate abundance and diversity. The available invertebrate drift data indicate a reduction in numbers of three of the five Ephemeroptera taxa present in the samples. These include *Ameletus spp.*, *Epeorus spp.* and *Cinygmula subaequalis*. There was also a reduction in these taxa on artificial substrates after spray. The artificial substrate data also indicate a reduction in total numbers of insects between 24 and 96 h after spray (Table 3). Numbers remained depressed until the final sample period 1 month after spray. Analysis of samples from the control stream continues.

TABLE 3 IDENTIFIED INVERTEBRATES IN ARTIFICIAL SUBSTRATES TAKEN FROM TREATED BROOK

TAXA			MEAN (± 1 S.D.) NUMBERS OF INVERTEBRATES (N=6)				
ORDER	FAMILY	GENUS SPECIES	1 DAY PRE	1 DAY POST	4 DAYS POST	8 DAYS POST	30 DAYS POST
Ephemeroptera	Siphlonuridae	*Ametus*	0.7 ± 1.0	0.3 ± 0.8	0.3 ± 0.8	0	0
	Baetidae	*Baetis*	0.8 ± 0.7	0.3 ± 0.5	1.5 ± 1.5	0.2 ± 0.4	1.5 ± 1.5
	Heptagenidae	*Epeorus*	0.3 ± 0.5	2.2 ± 1.9	6.8 ± 1.0	0.5 ± 0.4	2.0 ± 2.2
		C. subaequalis	3.0 ± 1.7	1.8 ± 2.1	1.3 ± 1.0	0.3 ± 0.8	0.2 ± 0.4
	Ephemeridae	*Ephemerella*	0.3 ± 0.5	0.2 ± 0.4	0	0	0
Plecoptera	Nemouridae	*Nemoura*	1.2 ± 1.6	2.2 ± 2.7	1.3 ± 2.0	2.8 ± 3.8	2.8 ± 3.8
	Leuctrinidae	*Leuctra*	0.8 ± 0.4	1.5 ± 2.0	2.2 ± 1.5	0.2 ± 0.4	0.2 ± 0.4
	Chloroperlidae	*Alloperla*	0.7 ± 1.2	0.3 ± 0.5	0.3 ± 0.5	0	0
Trichoptera	Hydropsychidae	*Actopsyche*	0.2 ± 0.4	0	0	0	0
	Limnophilidae	*Limnophilus*	0	0	0	0.2 ± 0.4	0.2 ± 0.4
Diptera	Simuliidae	*Simulia vittatum*	0	0.2 ± 0.4	0.8 ± 1.3	0	0
	Chironomidae		24.7 ±12.6	29.7 ±	25.7 ± 13.8	14.3 ± 6.7	11.2 ± 8.5

Fish brain acetylcholinesterase analyses are not complete at this time. However, it is worth noting that at 48 h after spray a number of the fish held in the treatment stream appeared sluggish and several had lost their righting response.

EFFECTS OF FOREST SPRAYING ON THE VERTEBRATE COMMUNITY OF BOG PONDS

W. L. Fairchild and D. C. Eidt

In 1985 the second year of study of the side effects of forest spraying in acidic (pH = 4.0) bog ponds was carried out. The treatment plan over the two years was:

Pond	1984	1985	
A	0	0	-control
B	0	T	-baseline then treated
C	T	0	-treated then recovery
D	T	T	-treated twice

0 = No spray T = Two fenitrothion sprays of 210g AI/ha spaced 5 to 7 days apart

An additional pond was treated each year with aminocarb (2 x 210g AI/ha). All sprays were applied from a boat with a Solo® backpack mistblower.

Pesticide residue analysis from 0.3m depth water samples in 1985 (XAD-4 resin and GLC; Vic Mallet, U. de Moncton) indicated peak concentrations of 49.5 and 42.2 ug/L 1/2 h after the initial spray. Concentration decreased to 5.9 and 8.3 ug/L 7 days later just prior to the second 1985 spray. Peak concentrations from the second spray were 18.8 and 24.3 ug/L at 24 h. Fenitrothion concentration after initial spray decayed rapidly from a sharp peak. Sampling after the second spray revealed no sharp peaks; the rise and fall in concentration was gradual. Three days after initial spraying concentrations fell below 10 ug/L whereas in the second spray 7 days elapsed before reaching 10 ug/L. Residues were 0.45 and 1.9 ug/L 3 weeks after spraying and reached nondetectable and 0.06 ug/L at 6 weeks.

Mean numbers for Gyrinidae (whirligig beetles) and for total organisms in extracted moss samples are now available. In the fenitrothion-treated ponds the Gyrinidae were eliminated in both 1984 and 1985. Recovery to near control levels took about 30 days. The gyrinid populations exceeded control levels by the end of the season. In 1985 the increase in treated ponds was accompanied by a decrease in control ponds (50 ind./quadrant, treated; >5, control; for 1985). This would indicate some interaction which makes treated ponds more attractive to gyrinids later in the season (removal of predators or competitors? increase in prey availability?).

Mean numbers of organisms extracted from moss samples were depressed after spraying and rose to or exceeded control numbers within 30 days. This rise was due in large part to a rapid increase in the nematode and annelid portion of the fauna. When nematodes and annelids were excluded from the mean the treated ponds showed deceases in the remaining fauna which lasted over winter from post spray 1984 until prespray 1985. Pond C, which was treated in 1984 and allowed to recover in 1985, did not show a return to control numbers until 15 months after it was sprayed. Analysis of these data and preparation of a more detailed set is currently underway.

Plans for 1986 include: (1) sampling to monitor recovery in all ponds, (2) an experiment on the notonectids and corixids, (3) further identification of faunal samples for preparation of a detailed data set.

MEXACARBATE-AQUATIC IMPACT STUDIES

S. B. Holmes

Studies on the environmental effects of mexacarbate (Zectran) when applied as a spruce budworm larvicide were conducted in Kent County, New Brunswick near the Trout Brook airstrip. A 500 ha block of forest surrounding the East Branch Little Forks Brook was sprayed twice with a water-based formulation of Zectran at a dosage rate of 70 g AI/ha. Brain acetylcholinesterase activity was measured in samples of native brook trout and Atlantic salmon collected by electro-seining as well as in hatchery-reared brook trout held in cages in the treated stream. Benthic invertebrate populations and drift were monitored in the treated stream and in the West Branch Little Forks Brook which served as an untreated control. Aquatic invertebrate populations were also monitored in two small ponds, one inside and one outside the spray block. Green frog tadpoles were caged in the ponds to assess the acute toxicity of the insecticide at levels likely to be encountered in forest spray operations. Knockdown of arboreal and flying insects was measured using drop buckets placed under balsam fir trees along the treated and control streams. Results are not available at this time.

FIELD STUDIES - AQUATIC IMPACTS OF HEMLOCK LOOPER SPRAYS-NEWFOUNDLAND

W. Pierce

A study was undertaken by the Newfoundland District Office of EPS to determine if the fenitrothion treatments of the 1985 hemlock looper control program were having significant impacts on stream aquatic invertebrates. A previous study (Coady 1978) had indicated that Newfoundland stream biota were more severely impacted by fenitrothion sprays than studies from other jurisdictions would predict.

A treated and control stream were monitored after two operational sprays (direct overspray of streams) of fenitrothion (Folithion -11%, Cyclosol 63-40%, 585 diluent - 45%) at 210 g AI/ha. Parameters sampled included: water quality, stream flow, temperature, aquatic insect drift, aquatic insect colonization of artificial substrates and pesticide concentrations in water.

Maximum pesticide residue concentratin in water was 4 ppb 10 minutes after the first spray and 21 ppb 30 minutes after the second spray. Analysis of invertebrate samples collected is not complete at this point.

ECOLOGICAL IMPACTS OF NON PROTECTION

ECOLOGICAL IMPACTS OF THE BUDWORM-KILLED FOREST

P. Lane

Over the past century, the softwood forests of eastern Canada have experienced severe infestations of balsam fir by the spruce budworm, Choristoneura fumiferana. In the last decade, the forests of Cape Breton Island have sustained considerable damage from this insect. Forest managers have been divided on how best to control the insect damage and optimize multiple uses of the ecosystem. In particular, whether to employ chemical spraying or not has been a controversial issue. Nova Scotia was somewhat unusual in not allowing chemical control methods. The central question has been the following: is the risk-benefit ratio higher for the spraying or the unsprayed forest? Although the ecological risks associated with the sprayed forests are well documented, those related to the budworm-killed forest are not. This study attempts to synthesize existing information on ecological impacts in the budworm-killed forest with a central focus on Cape Breton Island. Thus, this study is preliminary to answering the central question. A variety of information sources were reviewed and organized into annotated bibliographies.

A set of maps is used to illustrate graphically how three biogeographical scales (Eastern North America, Atlantic Provinces and Cape Breton Island) are interrelated in regard to softwood defoliation and mortality. Both primary and secondary impacts associated with the budworm-killed forest are discussed under five general subjects: vegetation, soils and geology, water resources, fisheries, and wildlife. Many of the secondary impacts are associated with management practices such as harvesting, clear cutting, mechanical site preparation and replanting. The study concludes with the formulation of a two- phase research plan designed to supplement the current information base on ecological impacts reported here (Phase I). Phase II consists of a field study plan for the Cape Breton Highlands and a compilation of information on sprayed and unsprayed forests. For Phase III, a risk-benefit comparison of sprayed versus nonsprayed forest is proposed. In addition, a related question requiring future research is outlined.

Major conclusions for each of the five subject areas for potential impacts are as follows: The immediate impact of the feeding of spruce budworm on a conifer forest is defoliation, loss of photosynthetic capability, cessation of growth, loss of productivity with more severe consequences occurring such as moribundity and mortality of trees. Defoliated trees are stressed and become increasingly susceptible to other insect pests, canopy and understory plants, and changes in successional patterns. Nutrient recycling, microclimate, and habitat structure are altered. In addition, management strategies all impact on the forest ecosystem. Changes in the forest, both budworm and human-induced, have consequences for soils, water resources, fisheries and wildlife.

It is likely that soil impacts are minor in budworm-killed forests which are not clear-cut. The flat topography, poor drainage, podzolic soils and peat bogs should mitigate large scale soil damage provided there is no disruption of the soil horizon. The most likely locations to observe possible soil impacts would be the steep slopes of the escarpment where there may be increases in infiltration rates, soil moisture, ion concentrations, bog area, and erosion.

There are no predictive models based on field data pertaining to the effects of spruce budworm-caused tree mortality on either surface or groundwater resources in eastern Canada or the United States. Impacts on the local water resources are likely to result from human interference with the succession of the forest. A review of available data for streams draining the Cape Breton Highlands indicates that they reflect conditions downstream of the Highlands Plateau, but not the Plateau itself. One study demonstrated, however, that degradation of water quality has occurred in Highland streams because of logging activities. An increasing volume of total runoff from the Highlands and increased sedimentation of some streams have been reported for the Northeastern Margaree River. It is not known how much of this impact is attributable to budworm defoliation or to human activities such as the Wreck Cove hydroelectric development and clear cutting practices. Impacts on groundwater users in villages located along the base of the escarpment are likely to be minimal.

The impacts on fisheries are of a secondary nature and probably related mostly to management practices following softwood mortality. Changes in the terrestrial ecosystem in regard to the water cycle and mechanical movement of soil and biota translate into changes in stream flow, water quality, and spawning and feeding habitat quality, in neighbouring aquatic ecosystems.

There can be increased water temperatures from loss of shade, higher stream flows, more sedimentation, lower oxygen concentrations, more sediment barriers to fish emergence from the bottom and changes in available fish foods such as the diversity, abundance and productivity of benthic invertebrates. Most of these effects are negative, however, increased stream flow could be beneficial for environments normally subject to stressful low flow periods. Of the many possible changes in water chemistry, increased acidity, decreased pH and increased solubility of toxic metals such as aluminum compound acid precipitation impacts that are harmful to fish populations.

Among the mammals rated as rare, only the American marten has undoubtedly been severely impacted and the American red squirrel, has also certainly been negatively affected. Almost certainly, snowshoe hares and probably lynx, white-tailed deer, and moose have benefitted from clear cutting, although the balance between positive effects of browse release and negative effects of shelter destruction have not been given detailed study in the Highlands.

For the major pre-epidemic components of the Highlands avifauna, there are few quantitative data on relative or absolute abundances. Insectivorous species probably benefitted from, but obviously could not control, the budworm outbreak. It has been indicated in the Highlands, and demonstrated elsewhere, that abundances, although not diversities of bird species, are depressed in killed stands. The composition of the avifauna has been changed and even more so with subsequent clear cutting.

Within-habitat changes were probably more important than habitat fragmentation. Among rare bird species, only the boreal owl and three-toed woodpecker (these only hypothetically nesting) are candidates for negative impacts. Among gamebirds, only the scarce spruce grouse must have similarly suffered.

OTHER MONITORING PROGRAMS

ENVIRONMENTAL MONITORING IN NEWFOUNDLAND AND LABORADOR, 1985

S. Bonnyman

Spruce Budworm Environmental Monitoring Program

Environmental monitoring of the spruce budworm spraying program has been conducted annually in Newfoundland since 1977. Monitoring continued during years when no control program was necessary, in order to obtain a better baseline of data.

The 1985 monitoring program was consistent with a planned phase-down of monitoring activities for aminocarb. A final year of aquatic invertebrate work centered on use of artificial substrates. This represents the second and final year for the reversal of one set of control and sprayed streams. The 1984 results suggested some "rebounding" in the previously sprayed stream, which currently is not being treated. Some "depression" was evident in the original control, currently being treated. The results of the 1985 analysis are not yet available, but a preliminary report will be produced by March 31, 1986.

A two-year pollinator study to examine impacts of aminocarb began in 1985. The intended approach to use artificial domiciles proved successful for red ants but very unsuccessful for pollinators. An alternative program was developed using transects and observations of pollinator activity (number, species of pollinator, species of flower visited, weather, etc.). Results are currently unavailable. A second year of pollinator work is planned for the summer of 1986.

Hemlock Looper Environmental Monitoring Program

The Department of Forest Resources and Lands was required to conduct environmental monitoring associated with a control program for hemlock looper. Two studies were conducted, by contract, one to examine impacts on pollinators, and second, to examine impacts on songbirds. A brief summary of these two reports follows.

Pollinators And Berry Production

Experimental blocks were located on the Avalon Peninsula. The original study was designed for aerial application during the blueberry flowering period, however, the operation program made this unrealistic. Instead, a late flowering species, raspberry, was selected as the target flowering species for pollinator activity. Visual spray plots were established, with pollinator activity observed for one minute, close to mid-day. Pollinators, and flowers were identified. Sweep net collections were made weekly. Fruit set was estimated by comparing the numbers of flowers and buds per stem to the number of ripening berries per stem.

This study was conducted to monitor the potential effect of fenitrothion spraying on pollinator activity and raspberry fruit set in the central Avalon Peninsula. Pollinator abundances in sweep net collections and activity on flowers were extremely variable due to a variety of factors. Data on fruit set were also inconclusive due to vandalism in the block that was sprayed and inadequate analysis (to be redone). Little speculation can therefore be made with regard to the effect of spraying on pollinators or berry production at this time.

Song Bird Study

A study was conducted to monitor the effect of fenitrothion spraying on several song-bird species in central Newfoundland through the depression of brain cholinesterase activity relative to unsprayed controls. From 29% - 100% of all birds collected from spray blocks had brain ChE activities depressed by more than 20% compared to average control values for those species, indicating probable exposure to a ChE inhibitor such as fenitrothion. No behavioural abnormalities were noted in the field, however, indicating that birds may not have been exposed to lethal levels of spray.

ENVIRONMENTAL MONITORING IN MAINE, 1985

S. Oliveri

Maine's Long Term Environmental Monitoring (LTEM) project continued for a third consecutive year in 1985. This study is designed to monitor chronic effects upon the forest ecosystem from spruce budworm suppression projects as well as uncontrolled budworm infestations. Aquatic invertebrates, fish, birds, tree condition, budworm and budworm parasitoids are monitored.

To date, no significant differences have been found in fish or invertebrate populations between streams with a history of insecticide spray activity nearby and those with no spray activity. It appears that populations of sensitive aquatic organisms, such as Plecoptera, have recovered from earlier impacts. This implies that Maine's spray buffer zones and use of insecticides less toxic to aquatic organisms have been successful mitigation measures. However, unsprayed stream borders that exhibit high levels of budworm induced tree mortality appear to have had an adverse impact on some streams. Increased water temperature, from loss of shade, and excessive numbers of dead trees that have fallen into the streams have degraded aquatic habitat. Invertebrate and fish populations in these streams have changed from cold water salmonid associations to those more characteristic of warmer, less oxygenated waters.

Bird populations have not been affected by past insecticide applications. Parasitoid populations appear to be more affected by budworm populations than by insecticide application. In many areas where budworm populations have declined, affected trees (both fir and spruce) are recovering.

In addition to the LTEM project, Maine has also been monitoring levels of microsporidial infection in budworm populations. Preliminary analyses indicate that there may be a relationship between currently declining budworm populations in Maine and microsporidian infection. This project will continue through 1986. The LTEM project however, will not be continued in 1986 due to lack of funding.

ENVIRONMENTAL MONITORING OF AERIAL SPRAYING OF INSECTICIDES AGAINST THE SPRUCE BUDWORM IN QUEBEC IN 1985

FATE OF BACILLUS THURINGIENSIS IN STREAMS WITHIN TREATED AREAS

S. Delisle, R. Dostie, and P.-M. Marotte

In 1985, the sixteenth year of the aerial spraying of insecticides against spruce budworm (*Choristoneura fumiferana*) Clem.), the Ministère de l'Energie et des Ressources of Quebec carried out a sampling program in order to evaluate the maximum concentrations and the persistance of viable spores of *Bacillus thuringiensis* (B.t.) in streams situated inside the treated areas. A total of 115 samples was taken during this program. Ninety samples were collected in areas treated by four-engine aircraft and twenty-five in areas treated by single-engine aircraft. The results of this study show that there was no trace of *B.t.* before the spraying operations in areas which have never been treated with biological insecticides. Moreover, maximum concentrations observed immediately after the application of insecticide ranged from 58.0 to 610.0 x 10^4 C.F.U./l in areas treated by four-engine aircraft, and from 140.0 to 860.0 x 104 C.F.U./l in areas treated by single-engine aircraft. These concentrations appeared between 20 and 120 minutes after spraying in areas treated by four-engine aircraft while in those treated by single-engine aircraft, the maximums were observed at 20 minutes. After a period of 11 to 50 days, concentrations ranging from 0.22 to 4.6 x 104 C.F.U./l were detected in the streams of the areas treated by four-engine aircraft. These concentrations represent less than 3% of the maximum concentration found in each stream.

RESIDUS DE FENITROTHION ET D'AMINOCARBE DANS L'EAU ET LE FEUILLAGE

R. Dostie, P-M. Marotte and G. Parent

En 1983, dans le cadre du programme du lutte contre la tordeuse des bourgeons de l'epinette (*Choristoneura fumiferana*, le Ministère de l'Energie et des Ressources a procedé a la recolte d'échantillons d'eau et de feuillage. En milieu lotique, une heure après l'application, des residus maximum de 9,31 ug/l d'aminocarbe et de 5,94 ug/l de fénitrothion ont été détectés. En milieu lentique, les concentrations de fénitrothion et d'aminocarbe ont peu varie dans les deux nares echantillonnées durant des periodes respectives de six et 68 heures aprés l'application. Dans le feuillage de sapin baumier, des residus maximums de 14,1, de 13,6 et de 2,0 ug/g (poids sec) ont été détectés une a deux heures après l'application respectivemes pour le fénitrothion, le Matacil 180F et 180D. Toutes ces valeurs (eau et feuillage) sont comparables à celles detectées de 1979 à 1982.

Une analyse d'assiocation non-parametrique a été effectuée entre le feuillage du sapin baumier recolté en bordure des chemins forestiers et le depot enregistré au sol (aluminium et Kromekote MD). Des correlations significatives ont été obtenués entre le feuillage et les feuilles d'aluminium pour le fénitrothion et le Matacil 180F.

Avant les opérations 1983, des prélévements ont été effectués pour verifier la persistance des residus dans le feuillage traité antérieurement. Des concentrations de fénitrothion sont demeurées identiques à toutes les stations echantillonnées trois et cinq ans après une application experimentale. L'étude tend à demontrer que les residus de fénitrothion presents dans le feuillage une année aprés l'application sont stables et peuvent persister durant plusieurs années.

A l'intérieur d'une superficie traitée annuellement au fénitrothion, une valeur exceptionnelle de 6,34 ug/g a été détectée dans un échantillon prélevé dans le tiers supérieur des arbres 8 mois après les pulvérisations. A l'intérieur des peuplements semenciers, de nouvelles valeurs maximales ont été atteintes, soit 0,149 et 0,481 ug/g d'aminocarbe dans du feuillage traité en 1982 et récolté 11 mois après l'arrosage.

PERSISTENCE OF BIOLOGICAL INSECTICIDES IN THE FOREST AQUATIC ENVIRONMENT

J. Dugal, L. Major, P. Cardinal and S. Delisle

Within the environmental follow-up related to the fifteenth program of aerial spraying of insecticides to fight the spruce budworm (Choristoneura fumiferana), the ministère de l'Energie et des Ressources monitored the areas affected in order to study the fate and the persistence of Bacillus thuringiensis (B.t.) in the aquatic environment. A total of 237 water samples were taken in lotic (streams) and lentic (ponds) environments. The maximum concentrations of insecticides immediately after spraying were 500 x 10^4 and 3530 x 10^4 c.f.u./l respectively in these environments. The rate at which B.t. decreases differs considerably from one sampling station to another. Nevertheless, B.t. concentrations tended to decrease quickly right after spraying at all stations. In lentic environments,concentrations ranging between 135 and 3850 c.f.u./l were detected eleven months after spraying. In lotic environments, soil leaching may account for the presence of B.t. spores several months after spraying; concentrations ranging from 34 to 3289 c.f.u./l were detected.

The project regarding the persistence of B.t. in natural waters in the forest environment enabled us to observe that B.t. spores can persist in water despite Quebec's climatic variations. These residual concentrations proved to be less than 1% of maximum values.

EFFECTS OF FENITROTHION AND AMINOCARB ON FRUIT SET OF FOUR FOREST PLANT SPECIES.

R. Perreault

The fruit sets measured by the "fruit/flowers x 100" ratio were determined for Maianthemem canadense, Cornus canadensis, Clintonia borealis, and Aralia nudicaulis. The fecundity of C. borealis, expressed by the number of seeds/fruit, was also determined. These studies were carried out in the Quebec City, Rivière-du-Loup, Rimouski and Amqui areas. The ratios were compared in eight experimental insecticide-sprayed areas and eight neighboring non-sprayed areas.

Study results show that fenitrothion and aminocarb spraying causes a fruit set reduction in _M. canadense_ and _C. canadensis_. This decrease is no longer significant one year after the spraying.
The same conclusions can be made for the fecundity (expressed as the number of seeds/fruit) of C._borealis_.

Insecticides also cause fruit sets to decrease in _A.nudicaulis_ and C._borealis_. Effects on these species may however extend beyond one year after spraying.

The repeated use of chemical insecticides causes a significant reduction in flower production in _C. canadensis_, and it seems that fenitrothion is the main element in this phenomenon.

It appears that fenitrothion and aminocarb sprays do not cause a decrease in the number of plants within treated areas. However, in order to confirm this observation and, more specifically, the absence of any long-term impact, a more detailed and better designed survey should be carried out.

Results do not allow one to distinguish the effects of repeated spraying of fenitrothion and those of aminocarb on the fruits sets of _M.canadense_, _C.canadensis_ and _C.borealis_, nor on the seed production of the latter species. Decreased fruit set of _A.nudicaulis_ does, however, seem to be related to the repeated use of fenitrothion.

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The effects of forest insecticides on songbirds: a summary report of Canadian Wildlife Service (Atlantic Region) 1986 field studies

Report to the Fourteenth Annual Forest Pest Control Forum

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__Perspective__: The carbamate insecticide Zectran UCZF-19 (active ingredient [AI] mexacarbate) is currently being tested for possible registration for use against spruce budworm. Should the product become registered for that purpose there is considerable potential for it to become widely used. One of the primary environmental concerns regarding use of Zectran is its relatively high acute oral toxicity to birds. During the past three field seasons the Canadian Wildlife Service, Atlantic Region, Toxic Chemicals Project, has studied the effects of Zectran on songbirds under operational field conditions. The insecticide is a cholinesterase (ChE) inhibitor. In 1984 a joint study with the Forest Pest Management Institute concluded that the effect of Zectran on brain ChE activity in adult songbirds was minimal and that a spray dosage rate at least twice the anticipated operational one would allow for a margin of safety. In 1985 further studies verified the safety of the chemical to adult songbirds and investigated the impact on the growth and development of White-throated Sparrow nestlings under operational spraying conditions. The preliminary results indicated that there was essentially no impact. Artificial dosing studies of free-living birds, however, confirmed that small quantities of Zectran may be lethal to nestlings. To determine the operational margin of safety of Zectran to nestlings we studied the effect of high-dose aerial spraying. Earlier studies were reported in the 1984 and 1985 Annual Forest Pest Control Forum proceedings.

Earlier formulations of fenitrothion have been found to be marginally acceptable in terms of hazard to songbirds. Previous work indicated that spray formulation (and other spray variables) may influence the impact on birds of spraying. A new formulation of fenitrothion, ultra ULV, currently being tested for use against spruce budworm, consists of only two ingredients, 40% technical Sumithion and 60% Dowanol TPM by volume, and is applied twice at a dosage of 210 g AI/ha and a rate of 0.4 L/ha. It was thought that this fenitrothion formulation represented a sufficient departure from conventional fenitrothion spraying to warrant investigation of effects on birds.

<u>Zectran - songbird studies:</u>

Growth and development of White-throated Sparrow nestlings exposed to high-dosage aerial application of Zectran

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The methodology employed in this study followed that reported in the 1985 Forum proceedings except that only one of the usual two treatments for budworm control was applied. Parameters investigated were weight, tarsus length, wing length, and ninth primary feather length. Because nesting chronology varies considerably within a given population, spray application was timed to expose the maximum number of nestlings rather than to be optimum for budworm control.

Growth and development data were examined by comparisons of growth curves between exposed and control birds and by univariate and multivariate analysis of variance. Analysis of the four variables indicated that the growth rates of exposed birds were not significantly affected by the spray application. None of the four parameters, when analyzed separately, indicated significant spray impact. It can be concluded that Zectran, when applied at double the intended operational dosage does not significantly affect the growth and development of nestlings of the White-throated Sparrow, considered to be a good indicator species.

In summary, three separate studies have determined that at likely operational spray dosages Zectran is essentially non-impactive on songbirds, and that there is considerable margin of safety. Zectran and another carbamate insecticide, Matacil, appear to be less hazardous to songbirds that the organophosphorus insecticide fenitrothion.

Mexacarbate residues in the food of songbirds

Earlier studies of dosing of free-living White-throated Sparrow nestlings (reported in the 1985 Forum proceedings) determined that mexacarbate is lethal in small amounts. The present study was initiated to address the concern that immediately following spray application, and before degradation of the active ingredient, the "pulse" of insecticide would be sufficient to induce acute effects. This would be especially applicable to young nestlings which are known to be more sensitive than adults to cholinesterase-inhibiting insecticides.

Insect samples were collected in two areas, one sprayed at a dosage of 70 g AI/ha and one at 140 g AI/ha. Sampling was done primarily with sweep nets but drop cloths and hand-held aspirators were also used. Both sprays were applied in early morning. Sampling was divided into four three-hour periods and done on the two days following each spray. For each three-hour period triplicate samples, each of one-to-two grams, were collected and stored in liquid nitrogen. Residue analyses were performed by K.M.S. Sundaram, Forest Pest Management Institute.

Residue levels were highest in the high-dosage block and in the earliest sampling periods. A gradual decrease in residues occurred during the sampling period in both blocks but residues persisted longer in the high-dosage one. Residue levels ranged from ND to 2.5 mg/kg wet weight. The results suggest that exposure through the food supply is below the level where acute effects might occur.

<u>UULV fenitrothion study</u>:

The effect of Ultra ULV fenitrothion spraying on brain cholinesterase activity in forest songbirds

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Spray impact was assessed by comparing brain cholinesterase activity of exposed and control birds. Four species, representing foragers at different levels of the forest canopy, were studied. A total of 240 birds was collected by shooting (.410 shotgun).

Sampling was done on the day of spray (Day 1) and the day following spray application (Day 2) for each of the two sprays. Control birds were collected in nearby unsprayed forest.

Most species showed a decrease in brain ChE activity after exposure to the insecticide. The upper canopy-foraging Tennessee Warbler showed the greatest impact; the ground-to-low-canopy-dwelling White-throated Sparrow was affected the least. Analysis of the results indicates that overall impact was similar to that of conventional formulations of fenitrothion.

Spruce Budworm Council
Aerial Spray Program
Quebec - 1986

Prepared by: Michel Auger, F.Eng.

MINISTERE DE L'ENERGIE ET DES RESSOURCES
DIRECTION DE LA CONSERVATION
SERVICE DE LA PROTECTION CONTRE
LES INSECTES ET LES MALADIES

Paper presented at the
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I 1986 SPRAY PROGRAM

Introduction

Québec's current spruce budworm infestation, which began in 1969, shows every indication of having slowed down considerably in the last two years. Consequently, the Service de protection contre les insectes et les maladies (insect and disease control service) had to select the areas to be sprayed most cautiously so as to treat only those stands identified in the L2 inventory as susceptible to be severely or very severely infested by the budworm.

In 1986, the ministère de l'Énergie et des Ressources (Québec Department of Energy and Resources) carried out its 17th spray program. Much less extensive than in previous years, this program covered only the Trois-Rivières, Côte-Nord and Saguenay - Lac-Saint-Jean regions. For the first time since 1971, the Bas-Saint-Laurent - Gaspésie region was not included in the program.

1. Areas Treated

The spray program covered a total surface area of 51,155 hectares, broken down as follows: 12,000 ha in the Trois-Rivières region, 37,492 ha in the Côte-Nord area and 1,663 in the Saguenay - Lac-Saint-Jean (see Fig. 1 - Table 1).

2. Insecticides and Dosages

The biological insecticide Bacillus thuringiensis Thuricide 48LV was sprayed over a total area of 18,160 hectares located primarily in the Trois-Rivières region. The selected dosage consisted of 30 BIU in a volume of 2.37 litres per hectare.

The chemical insecticide Fenitrothion was sprayed twice over 33,038 hectares, representing 65% of the area treated. The dosage used in both applications was 210 g of active ingredient in a volume of 1.4 litres per hectare (Table 2).

3. Spray Aircraft

Actual spraying began on May 29 in the Trois-Rivières area and ended on July 3 in the Côte-Nord region. A total of 126 flights were carried out using five single-engine craft: two Bull Thrushes and three Ag-Cat Bs.

All operations were conducted by way of visual navigation with the help of a guidance aircraft. Each plane was fitted with a flow meter and six Mini-Micronair AU-5000 atomizers.

4. Timing of Applications

Bt applications were well timed and coincided with bud flare in all cases. However, as the budworm's development was slow, **Bt** treatments were completed before the fifth instar larvae peak (Table 3).

The chemical insecticide Fenitrothion was initially sprayed over 2% of the territory prior to bud flare. Despite the adverse weather, a second application covering 87% of the blocks was carried out before the insects had developed into sixth instar larvae.

5. Climatic Conditions and Insect Development

Climatic conditions prevailing in the Trois-Rivières and Côte-Nord regions in April and May accelerated both insect and shoot development. By early June, the budworm and shoots had a head start of almost 12 days as compared with last year's rate of growth (Fig. 2).

Thereafter, the insects developed at a much slower pace owing to cooler temperatures in June and July.

In the Trois-Rivières and Bas-Saint-Laurent - Gaspésie regions, below zero temperatures recorded between June 2 and 10 partly destroyed the new shoots which by that time were already fully expanded. It is estimated that on average 25% of the annual growth in these areas was adversely affected by the late frost. Some stands were severely affected (50%), while damage to others was only slight.

6. Larval Populations

Blocks to be sprayed were selected on the basis of the hibernating larval population survey (L2). In 88% of the survey sites, 5 or more larvae were recorded per 45 cm branch; in 59% of the sites, there were over 10 larvae per branch.

The Bas-Saint-Laurent - Gaspésie region, excluded from the 1986 spray program, was severely affected in some localized sectors which had 20-25 larvae per branch (Fig. 3 - Table 4).

7. Projected Defoliation Curve

The projected defoliation curve based on larval population data collected in untreated stands is significantly different to that of last year; indeed, marked differences may be observed from year to year (Fig. 4). Spraying of stands is warranted when high insect population densities appear likely to cause severe defoliation. It is thus essential that the factors responsible for year-to-year variations be fully understood.

This year, once again, annual defoliation for a given larval population at the start of the season was less than in previous years.

8. Efficacy of Treatments

Insecticide spraying has protected 42% of the annual foliage growth. Only 5% of the total area sprayed was severely defoliated. Average defoliation in 196 survey sites was 32% in treated sectors and 55% in control sectors. Nearly three fourths (72%) of the treated survey sites had less than 50% annual defoliation (Tables 5 and 6 - Fig. 5).

Larval mortality averaged 89.3% in the treated areas, while in the untreated areas natural mortality was much higher than in previous years at an estimated 80.4%.

The biological insecticide Thuricide 48LV, used on 34% of the area sprayed, produced slightly better results this year than did the chemical spray. Given similar larval populations, only 2% of the area treated with Bt was severely defoliated, compared with 7% severe defoliation with the chemical formulation (Table 7).

The 1986 spray program has been successful in that it has prevented severe defoliation on the majority of new shoots. Despite declining infestation levels, some stands were in very poor condition and unlikely to survive in the event of further defoliation. In other severely infested stands, the spray program has permitted to maintain the trees' vigour and thus to avoid the deterioration of the stands in the longer term. In addition, the program has enabled the control of residual budworm population pockets, both in extent and in intensity. This analysis is further confirmed by the results of the projected budworm population inventory (L2) carried out in the Bas-Saint-Laurent - Gaspésie region, where residual budworm pockets were not sprayed in 1986.

II SPRUCE BUDWORM INFESTATION IN THE PROVINCE OF QUÉBEC IN 1986

The budworm infestation covered an area of 2.83 million hectares in 1986, down from 9.26 million in 1985. Damage was light on 0.75 million hectares, moderate on 1.35 million and severe on 0.75 million. A more or less significant drop in the infestation levels was recorded in every region. Moreover, no damage was observed in the Estrie, Outaouais and Abitibi - Témiscamingue (Fig. 6 - Table 8).

Marked drops in budworm infestation levels were recorded chiefly in the province's western and central regions. However, severe infestation continued to plague the Côte-Nord region, while in parts of the Gaspé and Trois-Rivières regions the infestation has levelled off to moderate levels.

III FORECAST FOR 1987

To complete the hibernating population inventory (L2), 2,000 survey sites will be monitored province-wide. Data have already been collected on almost three fourths of these sites. In the western and central parts of the province, the budworm is expected to be only marginally present, except for a small sector in the Trois-Rivières area which was severely infested in 1986 and will again have a large larval population in 1987.

In the Bas-Saint-Laurent - Gaspésie region, the few pockets of infestation which persisted in 1986 have increased in intensity and in most cases there has been some expansion as well. These pockets are found south of the Rimouski Reserve, in the peninsula's central and northern parts. In the Rivière-du-Loup region, losses are expected to be marginal for the second year in a row.

Finally, the budworm infestation will remain intense on the Côte-Nord, despite a slight decline as compared with 1986.

In view of the intensification of pockets of infestation in the Gaspésie region, the 1987 spray program of the ministère de l'Énergie et des Ressources (MER) will cover a total surface area of 150,000 hectares located west of the Matapédia River Valley along the New Brunswick border and in northcentral part of the peninsula as well as on the Côte-Nord.

IV OTHER PROJECTS IN 1986

1. Budworm Population Dynamics

The MER, in collaboration with the Laurentian Forest Research Centre, has pursued the study of budworm population dynamics initiated in 1985 in 17 localities spread across the central and eastern parts of the province. The purpose of the project is to identify and assess bacterial flora and parasites of the budworm. The department was responsible for collecting foliage samples in predetermined sites, as well as removing larvae from the foliage. A total of 50,000 larvae were collected for this project. At the Laurentian Forest Research Centre, David Perry and his team monitored larval development and analyzed each specimen to identify and assess the causes of natural mortality.

2. Calibration Program

In the last few years, particularly since 1985, the Division des techniques et du soutien aux opérations (technical and operations support division) of the Service de la protection contre les insectes et les maladies (insect and disease control service) has been studying the characteristics of spray aircraft vortices. This work has led us to analyze the effect of atomizer position on spray deposits and spectrum. We have thus studied the impact of various AU-5000 rotation speeds on the spectrum of insecticide droplets as well as the effect of weather conditions on the spray deposits and evaporation rates. A method for sampling spray deposits was developed and validated, and it is currently being used to recalibrate the various types of spray aircraft according to a range of different products.

3. Efficacy of Treatments in Relation to Insecticide Spray Deposits

For the third consecutive year, the efficacy of treatments has been determined by measuring spray deposits on balsam fir. In all, 114 trees treated with Thuricide 48LV and 152 treated with Fenitrothion were sampled. The results are presented as a series of equations and regression curves that enable us to determine the quantity of insecticide necessary to achieve the desired level of control. Current results indicate that 0.75 of a drop per needle on natural foliage ensures maximum larval mortality and a minimum of annual defoliation.

A weather tower equipped with two anemometres and two thermistors was used to study how air stability affects insecticide deposits (number of drops per needle). Data were collected on the crowns of fir trees at three different heights and in all four directions. The results of both projects are expected to be available in the up-coming months.

4. Utilization of Electrical Resistance to Assess the State of Health of Balsam Fir

Studies conducted in 1985 using a Shagometre indicated greater variation in the electrical resistances of fast growing trees than in trees which grow more slowly due to the greater evapotranspiration rate of healthy trees. A significant correlation was established between the air's hydric potential and the electrical resistance at the cambial level in firs with no defoliation, whereas no correlation was observed in defoliated trees. These observations were confirmed in 1986 (14 trees were monitored over a 9-week period) on firs with four defoliation levels: 0-25%, 26-50%, 51-75% and 76-100% (Fig. 7).

Readings taken early in the morning are always lower and more precise than those taken in early afternoon, regardless of the level of defoliation, and the results will be analyzed taking this fact into account.

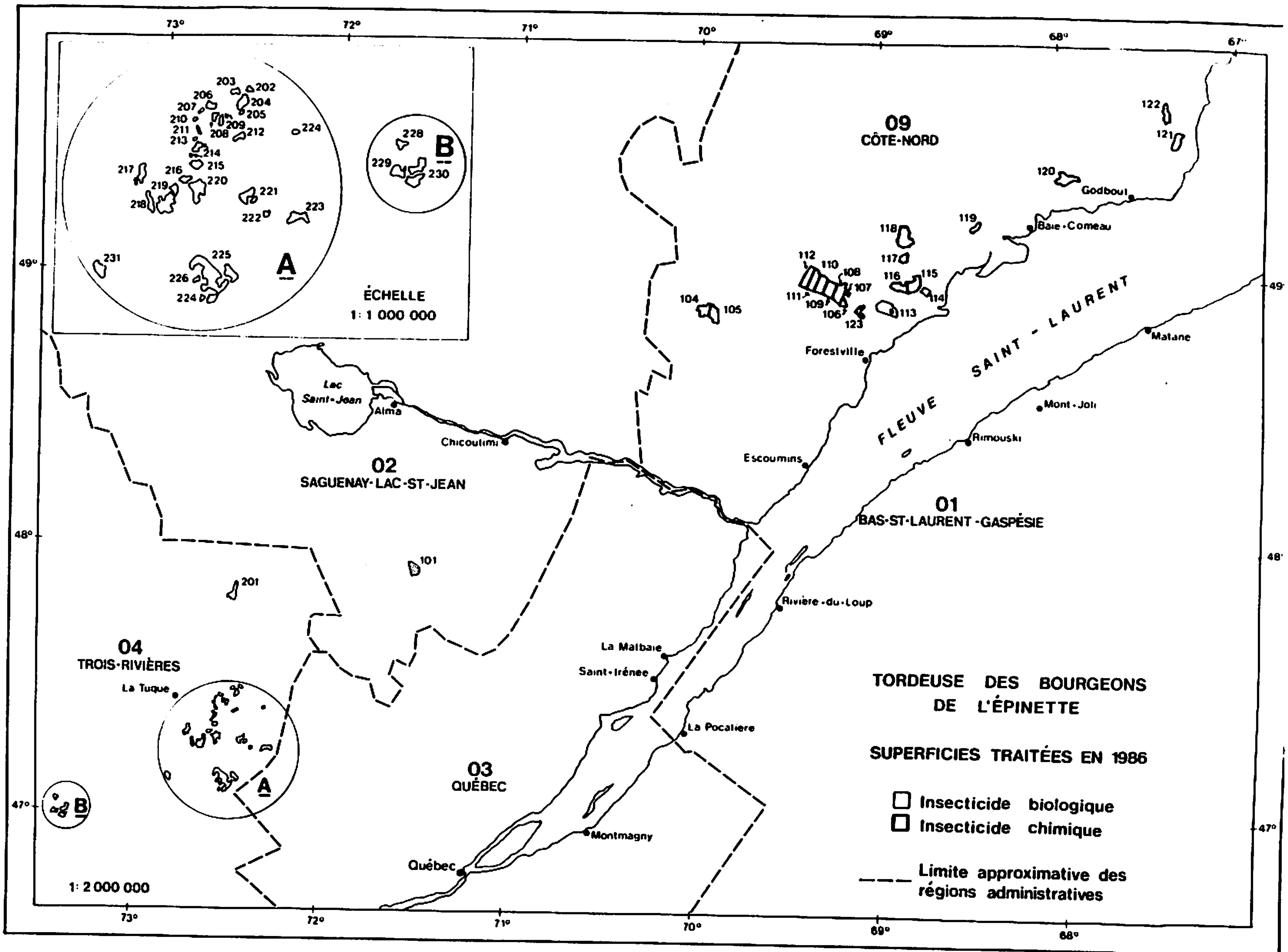

Fig. 1 : Superficies traitées en 1986 contre la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.)

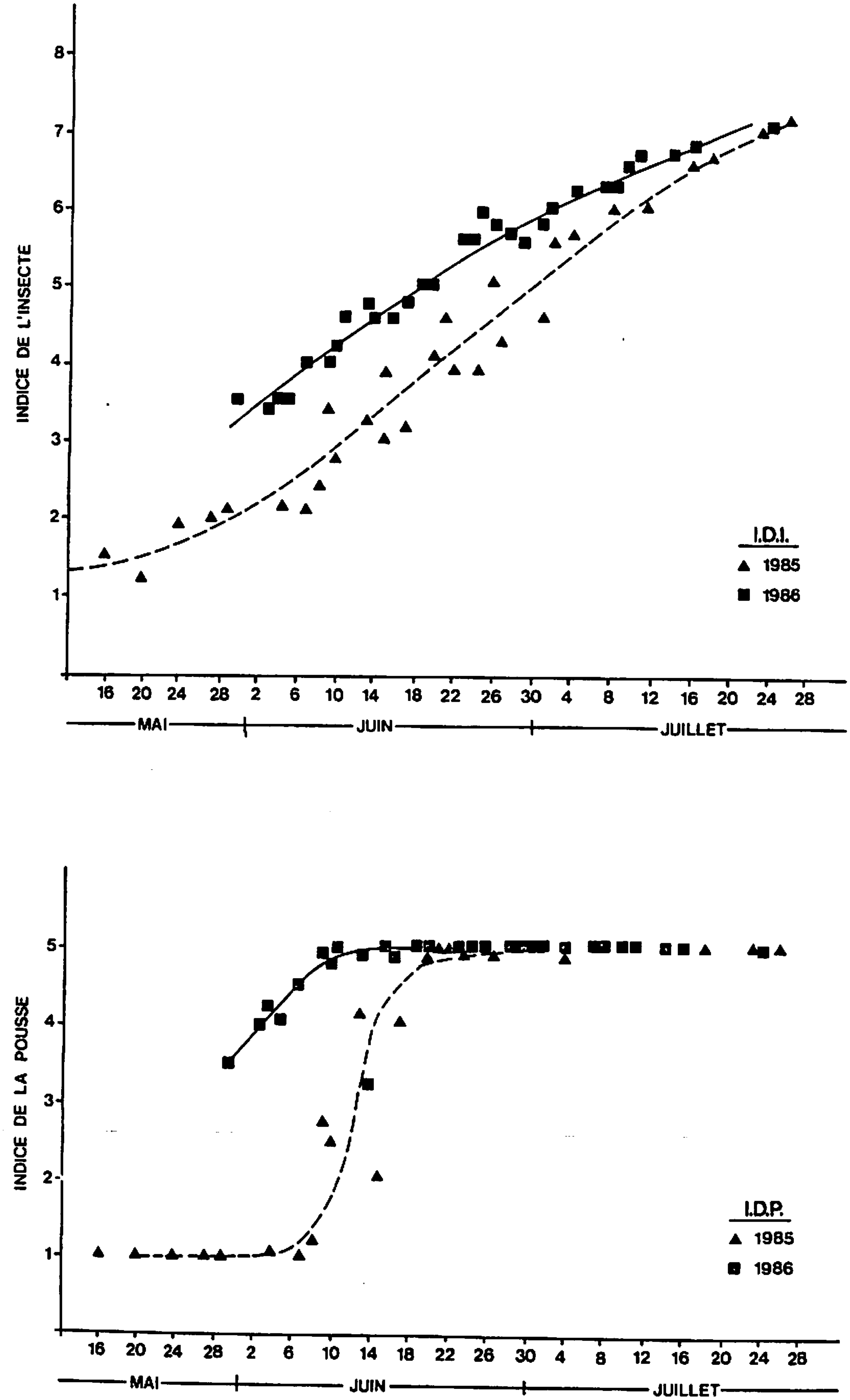

Figure 2 : Courbes de développement de la tordeuse et de la pousse du sapin en 1986 pour la région de la Côte-Nord.

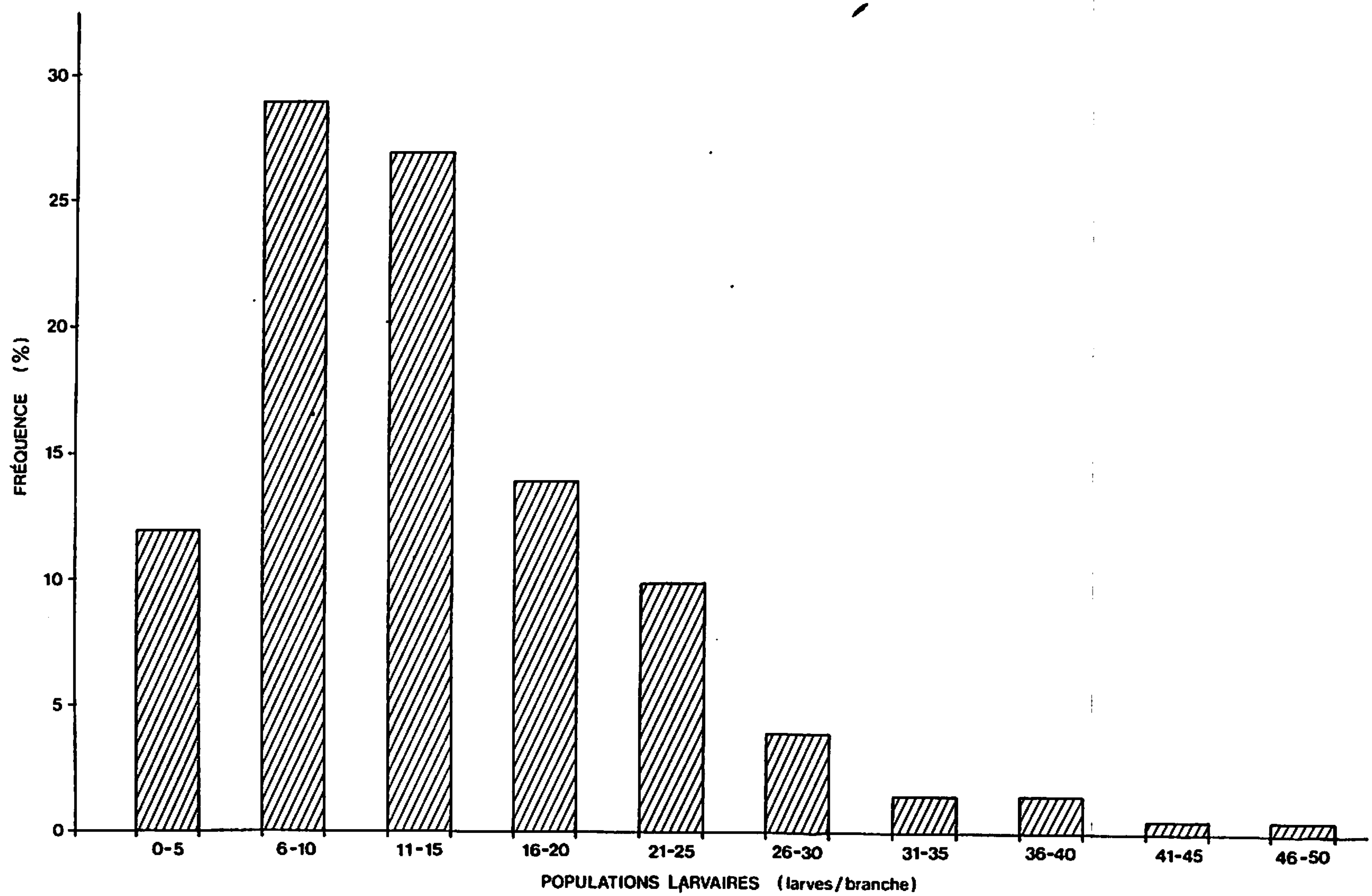

Figure 3 : Répartition des populations larvaires de la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.), dans les secteurs traités en 1986.

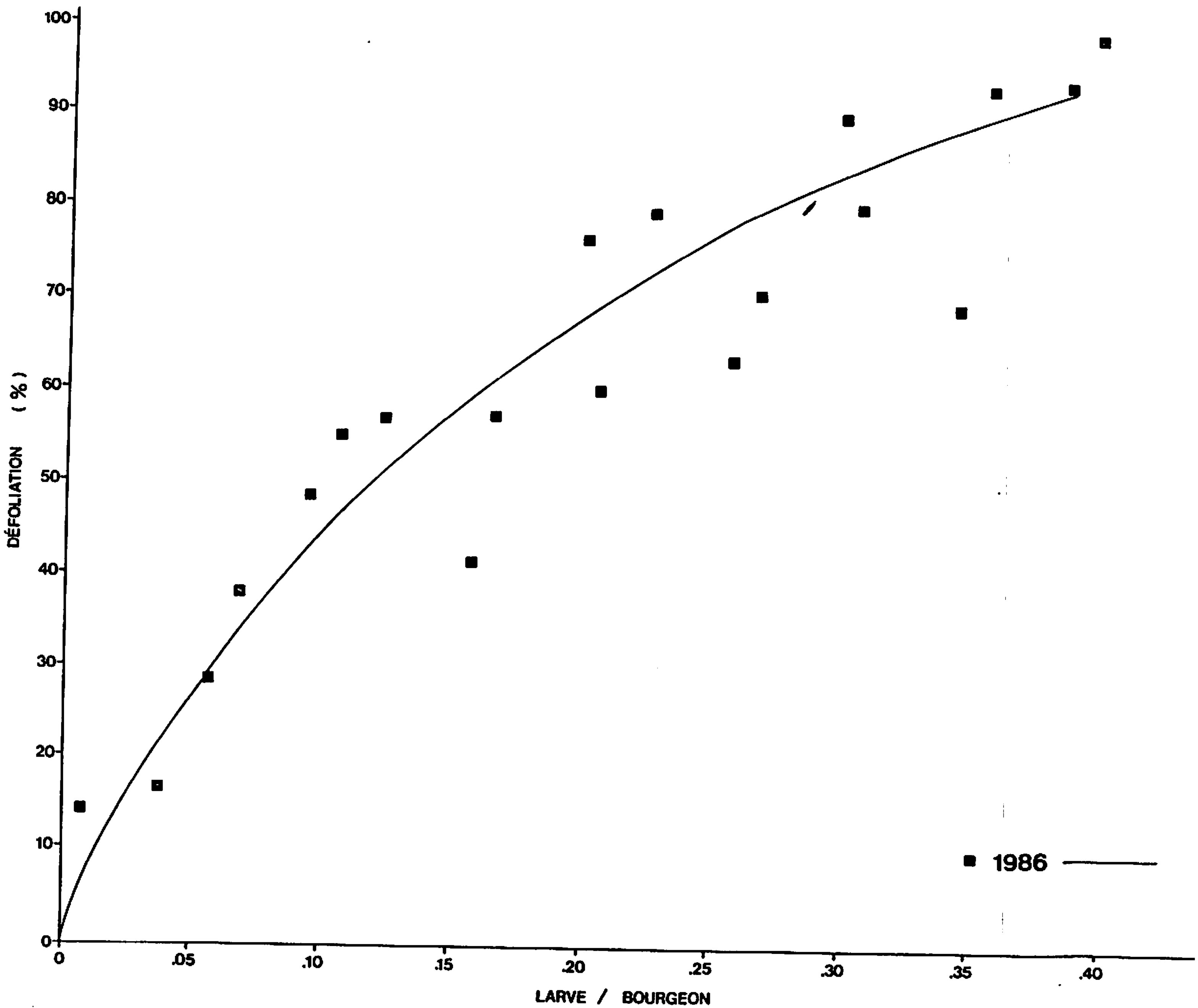

Figure 4 : Défoliation (%) prévue en 1986 en fonction du nombre de larves par bourgeon.

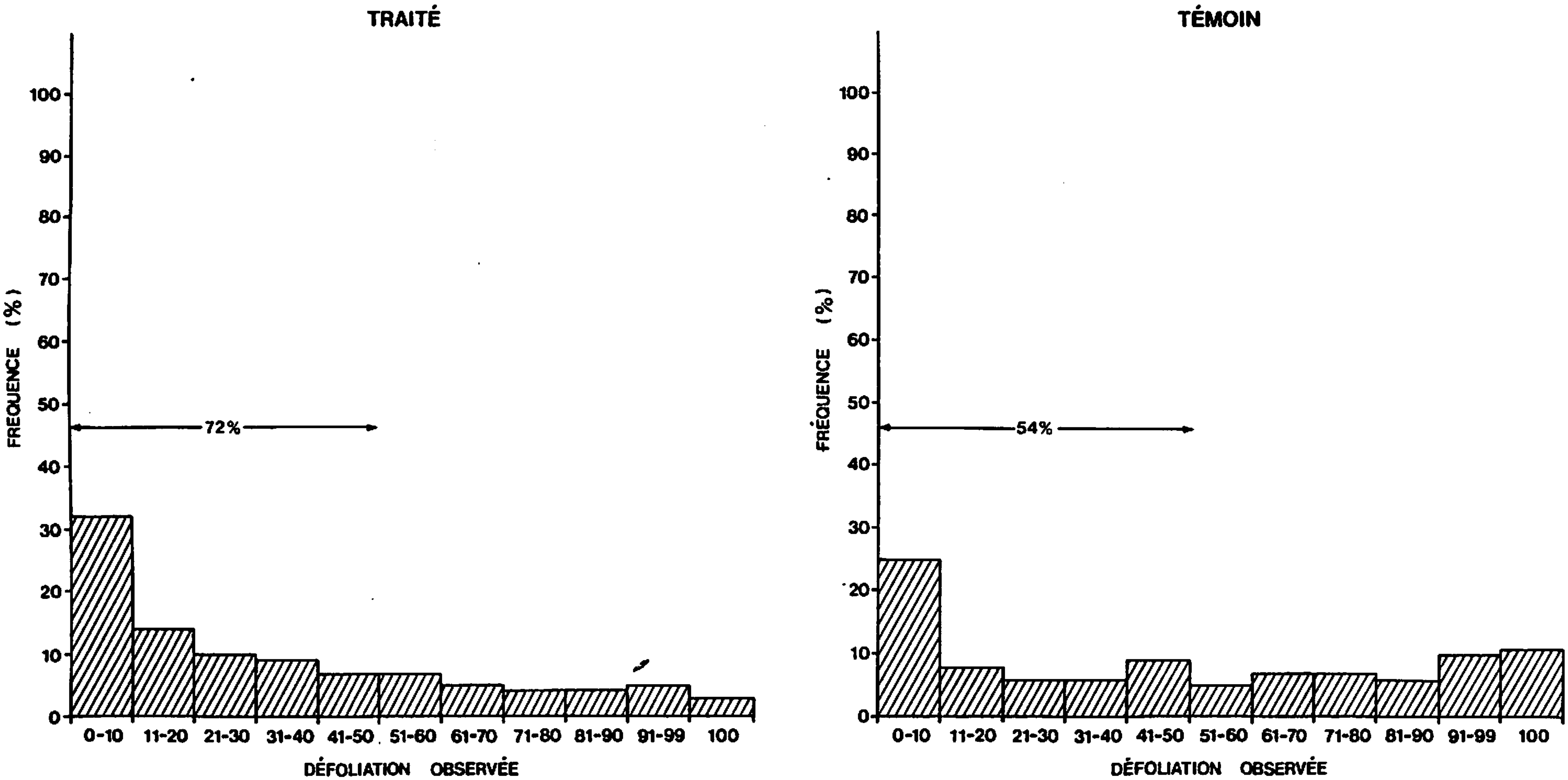

Figure 5 : Répartition de la défoliation annuelle dans les secteurs traités et témoins en 1986.

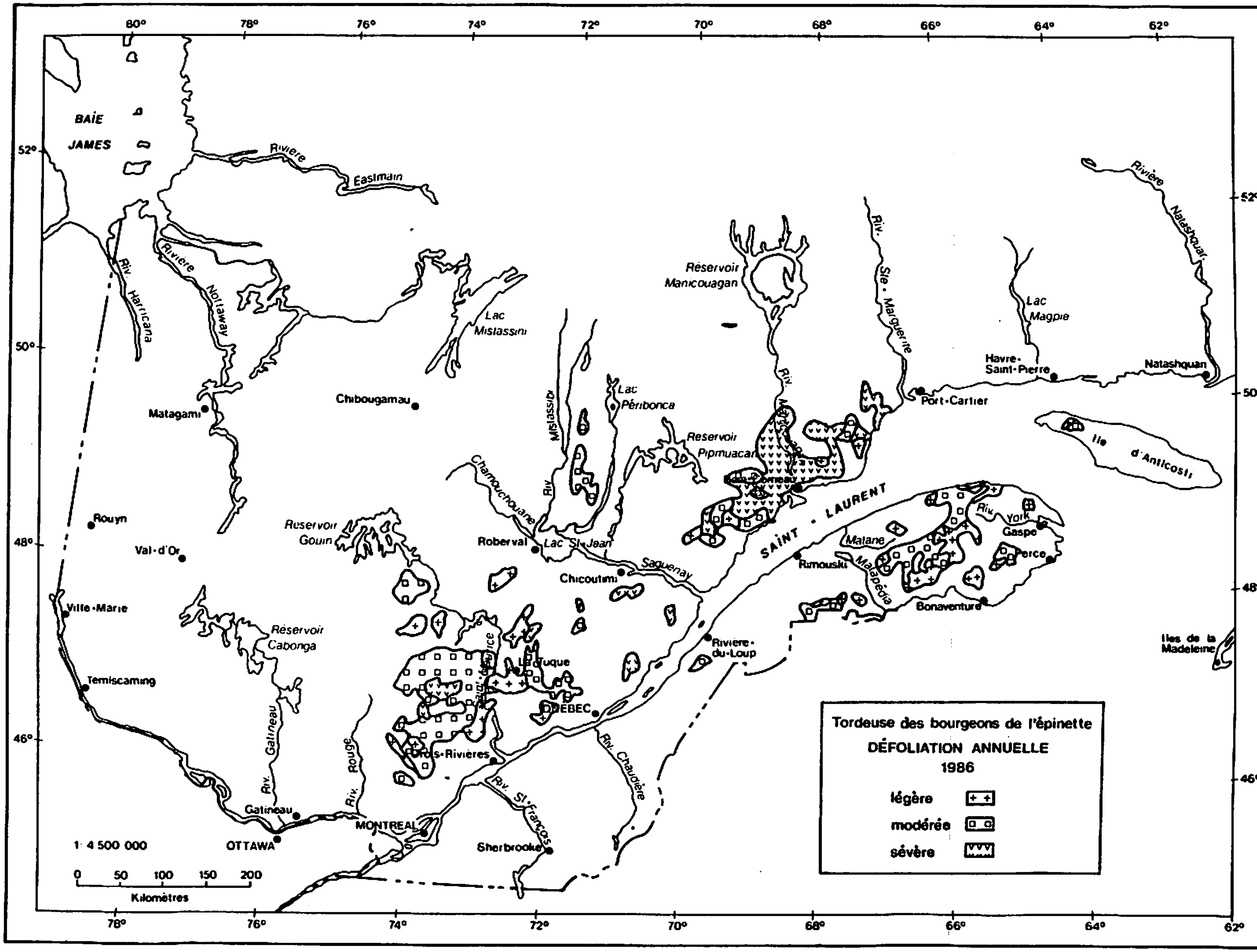

Fig. 6 : Superficies affectées par la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.) en 1986.

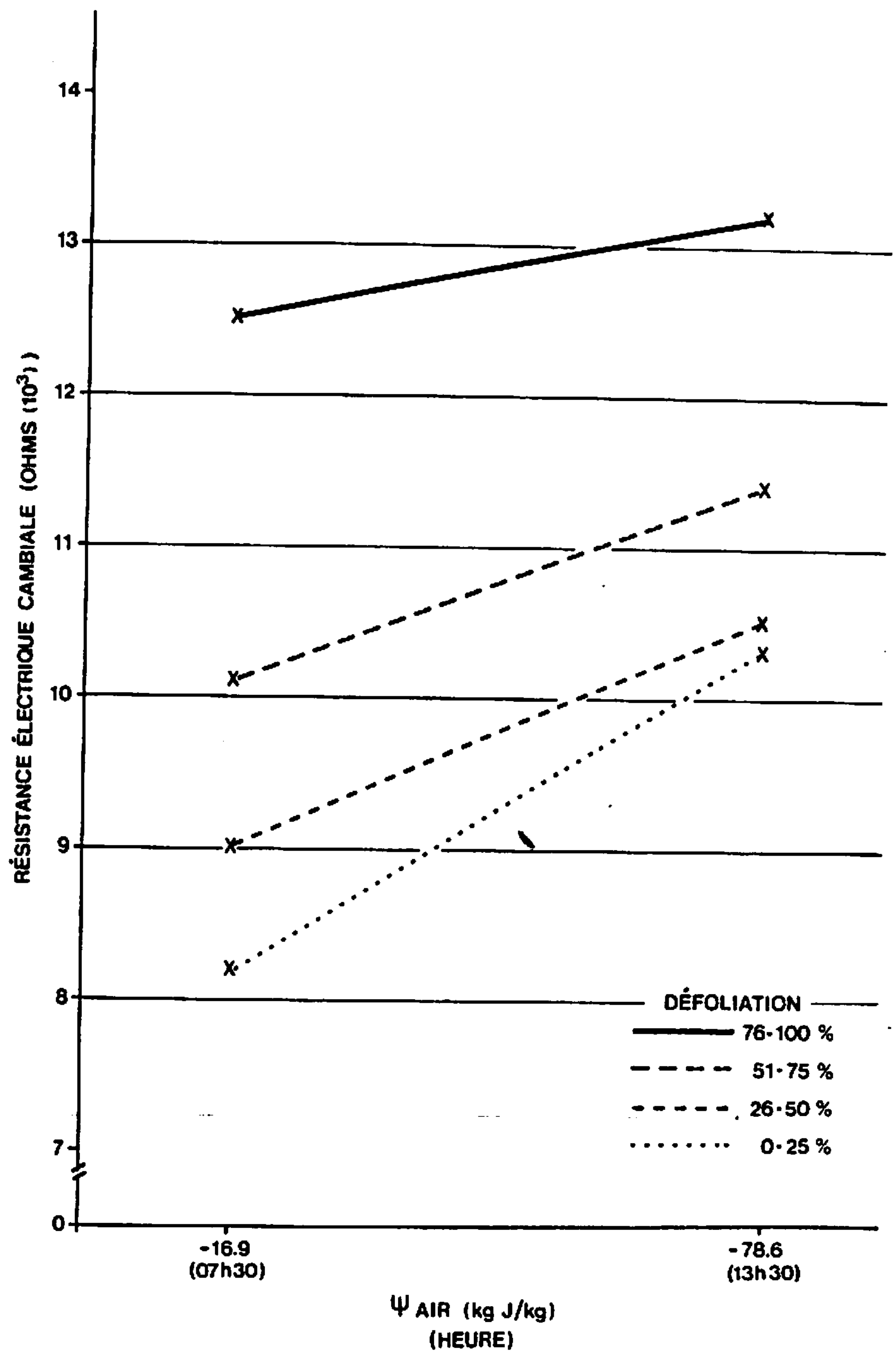

Figure 7 : Résistance électrique cambiale mesurée le matin et l'après-midi sur des sapins baumiers defoliés selon quatre intensités.

TABLEAU 1: Superficies (ha) traitées, en 1986, par région administrative et unité de gestion

Unité de gestion	Superficies			
	Retenues (ha)		Annulées	Traitées
	Biologique	Chimique		
Saguenay-Lac St-Jean				
Saguenay-sud (21)	-	1 663	-	-
Total	-	1 663	-	-
Québec				
Québec (33)	-	4 199	4 199	-
Total	-	4 199	4 199	-
Trois-Rivières				
Bas St-Maurice (41)	7 881	-	-	7 881
Windigo (42)	4 153	-	34	4 119
Total	12 034	-	34	12 000
Côte-Nord				
Escoumins (91)	-	4 346	-	4 346
Forestville (92)	2 634	13 500	-	16 134
Hauterive (93)	1 868	12 158	-	14 026
Sept-Iles (94)	1 615	1 371	-	2 986
Total				
Opération total	18 151	37 237	4 233	51 155

TABLEAU 2: Préparations chimique et biologique pour la pulvérisation aérienne contre la tordeuse des bourgeons de l'épinette en 1986, au Québec

Préparation de fénitrothion

	% V/V	Ml/ha
Sumithion[MD] 210 g/ha	12	168,36
Cyclo-Sol 63[MD]	40	561,20
Diluant 585	47,5	666,43
Colorant Red "B"	0,5	7,02
	100,0	1,403 ml/ha

Préparation de Bacillus thuringiensis

Thuricide 48LV[MD] 30 MUI/ha	100	2,370 ml/ha

TABLEAU 3: Synchronisation des applications d'insecticide chimique et biologique réalisées en 1986 contre la tordeuse des bourgeons de l'épinette

	Développement de la pousse		
Indice	Biologique	1e chimique	2e chimique
2.5 - 3.0	0	0	0
3.1 - 3.5	0	2	0
3.6 - 4.0	0	0	0
4.1 - 4.5	48*	12	0
4.6 - 5.0	52	88	100

	Développement de l'insecte		
Indice	Biologique	1e chimique	2e chimique
2.5 - 3.0	0	2	0
3.1 - 3.5	4	14	0
3.6 - 4.0	16	1	0
4.1 - 4.5	72	37	13
4.6 - 5.0	8	28	14
5.1 - 5.5	0	7	4
5.6 - 6.0	0	11	56
6.1 - 6.5	0	0	13

* Pourcentage de la superficie traitée

TABLEAU 4: Mortalité larvaire occasionnée par le traitement réalisé contre la tordeuse des bourgeons de l'épinette en 1986

Région	Nb de branche	Pop. pré-traitement L/br		Pop. pré-traitement L/bourg.	Pop. post-traitement L/br	Pop. post-traitement L/bourg.	Mortalité Totale (%)	Mortalité Abbott (%)
Saguenay-Lac St-Jean	15	11,7	-*	0,12	0,4	0,4	96,9	61
Non traité	35	10,3	2,6	0,12	0,9	0,6	91,3	
Trois-Rivières								
Bas St-Maurice (41)	105	12,2	2,2	0,12	1,8	0,6	85,3	43
Non-traité	45	13,5	1,5	0,14	3,5	1,0	74,1	
Windigo (42)	135	13,5	1,8	0,11	1,6	0,4	88,2	29
Non traité	70	11,5	2,2	0,11	1,9	0,4	83,5	
Total	240	13,0	1,4	0,11	1,7	0,4	86,9	35
Non traité	120	12,3	1,8	0,12	2,5	0,6	79,7	
Côte-Nord								
Escoumins (91)	40	5,9		0,08	0,2	0,2	96,6	74
Non traité	20	6,8	2,8	0,06	0,9	0,6	86,8	
Forestville (92)	170	13,2	1,4	0,12	1,2	0,2	90,9	56
Non traité	75	17,3	3,2	0,17	3,6	0,6	79,2	
Hauterive (93)	150	19,2	2,6	0,15	2,0	0,4	90,0	50
Non traité	55	18,1	3,2	0,17	3,5	0,8	80,6	
Sept-Iles (94)	30	15,1	4,2	0,15	0,8	0,8	94,7	77
Non traité	30	23,7	4,2	0,18	5,5	2,8	76,8	
Total	390	14,9	1,2	0,13	1,4	0,2	90,6	56
Non traité	180	17,4	2,0	0,16	3,6	0,6	79,3	
Total	645	14,0	0,8	0,13	1,5	0,2	89,3	40
Non traité	335	14,3	1,2	0,13	2,8	0,4	80,4	

* Intervale de confiance à 95%

TABLEAU 5: Superficies (ha) attaquées par la tordeuse des bourgeons de l'épinette dans les secteurs traités en 1986

Unité de gestion	Nul	Léger	Modéré	Sévère	Total
Saguenay-Lac St-Jean					
Saguenay-sud (21)	-	1 663	-	-	1 663
Trois-Rivières					
Bas St-Maurice (41)	-	4 861	2 770	250	7 881
Windigo (42)	-	2 784	1 335	-	4 119
TOTAL	-	7 645 (64%)	4 105 (34%)	250 (3%)	12 000
Côte-Nord					
Escoumins (91)	-	4 346	-	-	4 346
Forestville (92)	-	6 764	9 021	349	16 134
Hauterive (93)	-	2 706	9 428	1 892	14 026
Sept-Iles (94)	-	2 835	151	-	2 986
TOTAL	-	16 651 (44%)	18 600 (50%)	2 241 (6%)	37 492
GRAND TOTAL	-	25 959 (51%)	22 705 (44%)	2 491 (5%)	51 155

TABLEAU 6: Protection du feuillage accordée par le traitement réalisé contre la tordeuse des bourgeons de l'épinette en 1986

Unité de gestion	Nb de branche	Pop. pré-trait. L/branche	Défoliation (%) Observée	Défoliation (%) prévue	Protection (%) (Prév.-Obs.)/Prév.
Saguenay-Lac St-Jean	15	11,7	8	50	84
Trois-Rivières					
Bas St-Maurice (41)	105	12,2	33	50	34
Windigo (42)	135	13,5	30	48	38
Total	240	13,0	31	50	38
Côte-Nord					
Escoumins. (91)	40	5,9	10	39	74
Forestville (92)	170	13,2	27	50	46
Hauterive (93)	150	19,2	52	57	9
Sept-Iles (94)	30	15,1	25	57	56
Total	390	14,9	35	55	36
GRAND TOTAL	645	14,0	32	55	42

TABLEAU 7: Efficacité du traitement chimique et du traitement biologique réalisés en 1986

A. Mortalité et défoliation

Traitement	Nb de PE	Population avant le traitement L/br		Population avant le traitement L/bourg.	Population après le traitement L/bourg.	Mortalité totale %	Défoliation
Chimique (Fénitrothion)	68	13,8	1,2*	0,14	0,9	93,5	33
Biologique (Thuricide)	63	14,4	0,8	0,11	2,0	86,1	31

B. Superficies infestées (ha)

Traitement	Léger	Modéré	Sévère	Total
Chimique	15 343 (46%)	15 644 (47%)	2 051 (7%)	33 038
Biologique	10 616 (59%)	7 061 (39%)	440 (2%)	18 117

* Intervale de confiance à 95%

TABLEAU 8: Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette, <u>Choristoneura fumiferana</u> (Clem.) dans les régions administratives du Québec en 1986, excluant les zones de mortalité

Régions administratives	Niveaux d'infestation Léger (ha)	Modéré (ha)	Sévère (ha)	Total (ha)
Bas St-Laurent-Gaspésie (01)	315 314	322 032	56 094	693 440
	953 128*	325 740	275 552	1 554 420
Saguenay-Lac St-Jean (02)	26 662	32 656	13 282	72 600
	727 451	70 503	1 196 307	1 994 261
Québec (03)	36 721	100 782	41 095	178 598
	958 596	121 209	575 132	1 654 937
Trois-Rivières (04)	274 208	440 980	81 814	797 002
	58 907	186 876	2 031 564	2 277 347
Estrie (05)	-	-	-	-
	2 813	-	-	2 813
Montréal (06)	43 281	255 626	35 313	334 220
	16 875	13 594	372 345	402 814
Outaouais (07)	-	-	-	-
	100 626	37 344	51 250	189 220
Abitibi-Témiscamingue (08)	-	-	-	-
	1 407	21 251	10 313	32 971
Côte-Nord (09)	55 558	199 694	500 835	756 087
	149 036	37 732	964 265	1 151 033
Province	751 744	1 351 770	728 433	2 831 947
	2 968 839	814 249	5 476 728	9 259 816

* Superficies affectées en 1985

Pulvérisations aériennes d'insecticides réalisées contre la tordeuse des bourgeons de l'épinette au Québec en 1986

Préparé par: Michel Auger, ing.f.

MINISTERE DE L'ENERGIE ET DES RESSOURCES
DIRECTION DE LA CONSERVATION
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Rapport présenté au
Colloque annuel sur la lutte
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Rapport présenté au
Conseil de l'Est de la Tordeuse
des bourgeons de l'épinette
Frédéricton, Novembre 1986

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I - Programme de pulvérisation 1986

Introduction

La présente infestation de la tordeuse des bourgeons de l'épinette qui sévit au Québec depuis 1969 connaît de toute évidence un ralentissement évident depuis les deux dernières années. Face à cette baisse le Service de la Protection contre les insectes et les maladies a dû faire un choix judicieux des superficies à traiter en ne conservant uniquement les peuplements dont le niveau d'infestation prévu par l'inventaire des L2 était élevé et très élevé.

Le ministère de l'Energie et des Ressources a conduit en 1986 un 17ième programme de pulvérisation très réduit par rapport aux années précédentes et localisé dans les régions de Trois-Rivières, de la Côte-Nord et du Saguenay-Lac St-Jean. La région du Bas St-Laurent-Gaspésie n'a pas été retenue en 1986 pour la première fois depuis 1971.

1. - Superficies traitées

Le programme de pulvérisation a couvert une superficie totale de 51 155 hectares répartie dans les régions de Trois-Rivières (12 000 ha), de la Côte-Nord (37 492 ha) et du Saguenay-Lac St-Jean (1 663 ha) (Fig. 1 - TABLEAU 1).

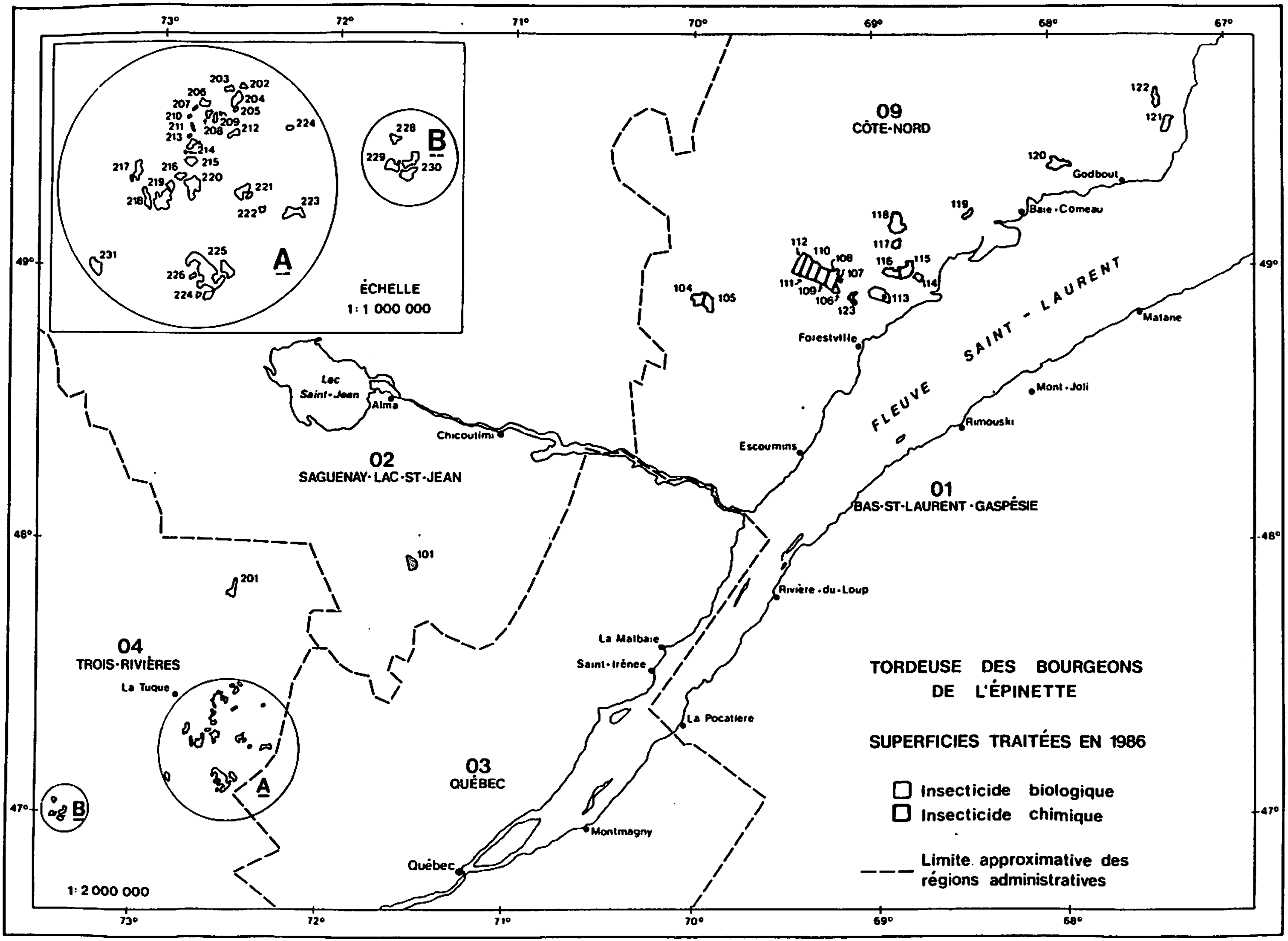


Fig. 1 : Superficies traitées en 1986 contre la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.)

TABLEAU 1: Superficies (ha) traitées, en 1986, par région administrative et unité de gestion

Unité de gestion	Superficies			
	Retenues (ha)		Annulées	Traitées
	Biologique	Chimique		
Saguenay-Lac St-Jean				
Saguenay-sud (21)	-	1 663	-	-
Total	-	1 663	-	-
Québec				
Québec (33)	-	4 199	4 199	-
Total	-	4 199	4 199	-
Trois-Rivières				
Bas St-Maurice (41)	7 881	-	-	7 881
Windigo (42)	4 153	-	34	4 119
Total	12 034	-	34	12 000
Côte-Nord				
Escoumins (91)	-	4 346	-	4 346
Forestville (92)	2 634	13 500	-	16 134
Hauterive (93)	1 868	12 158	-	14 026
Sept-Iles (94)	1 615	1 371	-	2 986
Total				
Opération total	18 151	37 237	4 233	51 155

2. - Insecticides et dosages

L'insecticide biologique <u>Bacillus thuringiensis</u> Thuricide 48LV a été employé au taux de 30 MUI/hectare dans un volume de 2,37 litres par hectare. Le Bt a été pulvérisé sur une superficie totale de 18 160 hectares principalement dans la région de Trois-Rivières.

Par ailleurs, l'insecticide chimique fénitrothion fut pulvérisé sur une superficie de 33 038 hectares, soit 65% du territoire traité. Le dosage employé à chacune des deux applications fut de 210 gr. d'ingrédient actif dans un volume de 1,4 litre à l'hectare (TABLEAU 2).

3. - Avions de pulvérisation

La pulvérisation d'insecticide a débuté le 29 mai dans la région de Trois-Rivières pour prendre fin le 3 juillet dans la région de la Côte-Nord. Cinq (5) appareils monomoteurs soit deux (2) Bull Thrush et trois (3) Ag-Cat B ont effectué un total de 126 voyages.

La navigation a été faite de façon visuelle à l'aide d'un avion pointeur et chacun des avions était muni d'un débitmètre et de six (6) atomiseurs Mini-Micronair AU-5000.

TABLEAU 2: Préparations chimique et biologique pour la pulvérisation aérienne contre la tordeuse des bourgeons de l'épinette en 1986, au Québec

Préparation de fénitrothion

	% V/V	Ml/ha
Sumithion[MD] 210 g/ha	12	168,36
Cyclo-Sol 63[MD]	40	561,20
Diluant 585	47,5	666,43
Colorant Red "B"	0,5	7,02
	100,0	1,403 ml/ha

Préparation de Bacillus thuringiensis

Thuricide 48LV[MD] 30 MUI/ha	100	2,370 ml/ha

4. - La synchronisation des applications

La synchronisation de l'application effectuée au Bt a été excellente alors que dans tous les cas, la pousse était bien étalée. Par ailleurs, dû au développement ralenti de la tordeuse, l'ensemble de l'application au Bt fut réalisée avant le pic du 5ième âge larvaire (TABLEAU 3).

Dans le cas du traitement avec l'insecticide fénitrothion, 2% du territoire a reçu une première application d'insecticide chimique avant que la pousse soit bien étalée et malgré les mauvaises conditions climatiques 13% seulement des blocs ont été traités, lors de la 2ième application, à un développement de l'insecte supérieur au 6ième âge larvaire.

5. - Les conditions climatiques + le développement de l'insecte

Les conditions climatiques enregistrées en avril et en mai ont favorisé dans les régions de Trois-Rivières et de la Côte-Nord un développement de l'insecte et de la pousse plus hâtif que l'an dernier. Au début de juin, la tordeuse ainsi que l'étalement de la pousse avaient près de 12 jours d'avance par rapport à l'an dernier (Fig. 2).

Par la suite, affecté par des températures plus froides au cours des mois de juin et juillet, le développement de l'insecte a été grandement ralenti.

Dans la région de Trois-Rivières et du Bas St-Laurent-Gaspésie, des températures sous le point de congélation enregistrées entre le 2 et 10 juin ont dé-

TABLEAU 3: Synchronisation des applications d'insecticide chimique et biologique réalisées en 1986 contre la tordeuse des bourgeons de l'épinette

Développement de la pousse

Indice	Biologique	1e chimique	2e chimique
2.5 - 3.0	0	0	0
3.1 - 3.5	0	2	0
3.6 - 4.0	0	0	0
4.1 - 4.5	48*	12	0
4.6 - 5.0	52	88	100

Développement de l'insecte

Indice	Biologique	1e chimique	2e chimique
2.5 - 3.0	0	2	0
3.1 - 3.5	4	14	0
3.6 - 4.0	16	1	0
4.1 - 4.5	72	37	13
4.6 - 5.0	8	28	14
5.1 - 5.5	0	7	4
5.6 - 6.0	0	11	56
6.1 - 6.5	0	0	13

* Pourcentage de la superficie traitée

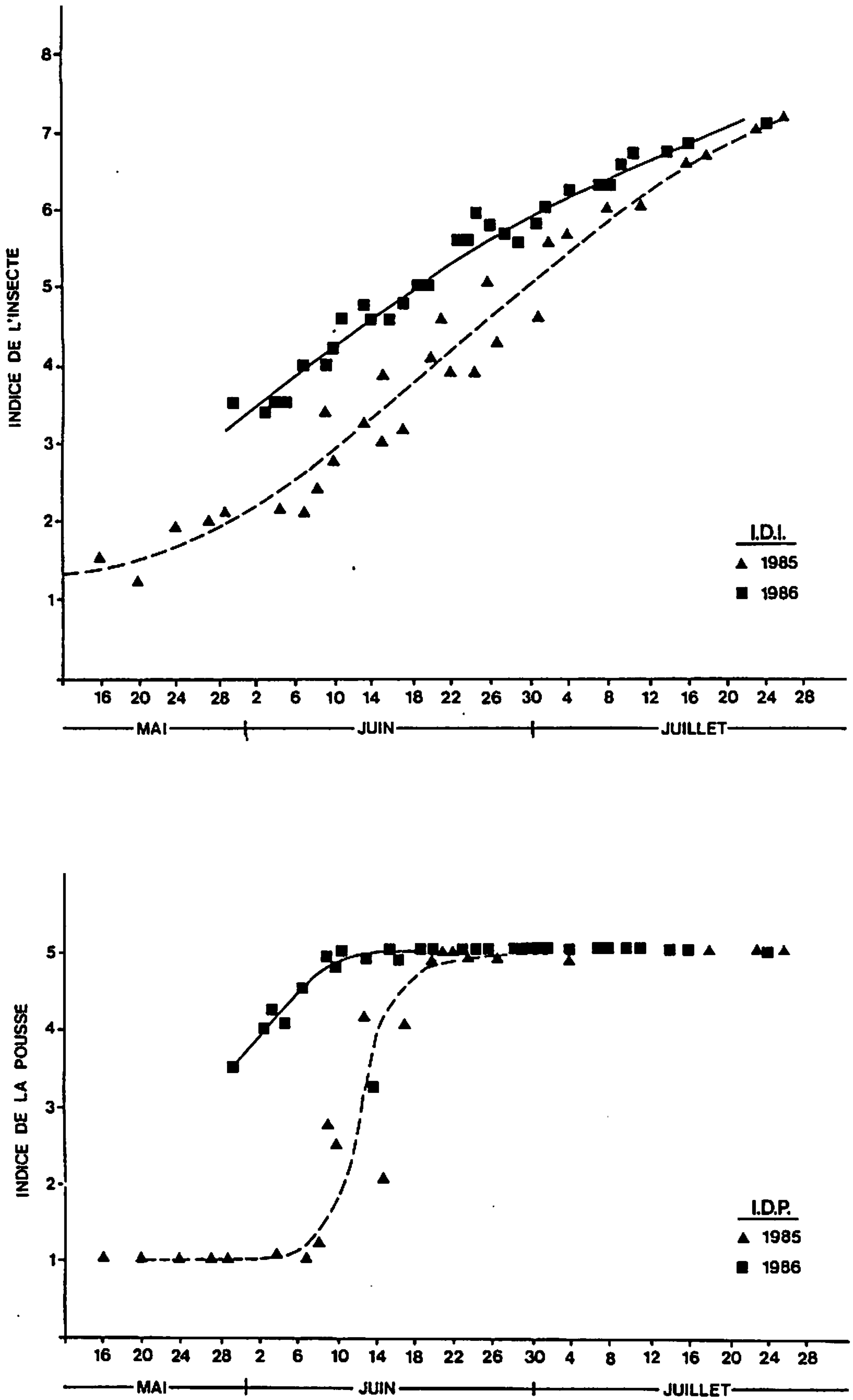


Figure 2 : Courbes de développement de la tordeuse et de la pousse du sapin en 1986 pour la région de la Côte-Nord.

truit une partie des pousses annuelles qui étaient à ce moment-là déjà bien étalées. On estime que cette gelée tardive a pu affecter en moyenne 25% des pousses annuelles dans l'ensemble de ces régions. Certains peuplements ont été très affectés (50%) alors que d'autres l'ont été en partie seulement.

6. - Les populations larvaires

Dans les blocs d'arrosage sélectionnés à partir de l'inventaire des populations larvaires en hibernation (L2), 88% des places d'étude ont enregistré une population de 5 larves et plus par branche de 45cm et 59% des places d'étude avaient une population supérieure à 10 larves par branche. Les plus fortes populations ont été localisées dans la région de la Côte-Nord et la moyenne sur l'ensemble du territoire traité fut de 14,0 larves par branche.

La région du Bas St-Laurent-Gaspésie exclue du programme de pulvérisation en 1986 a été également sévèrement infestée dans des secteurs bien localisés où la population a atteint 20 à 25 larves par branche (Fig. 3 - TABLEAU 4).

7. - Courbe de prévision de la défoliation

La courbe de la prévision de la défoliation élaborée à partir des populations larvaires obtenues dans les secteurs non traités diffère de façon significative par rapport à l'an dernier et selon les années, elle peut varier de façon considérable (Figure 4). La décision de traiter un peuplement repose sur un

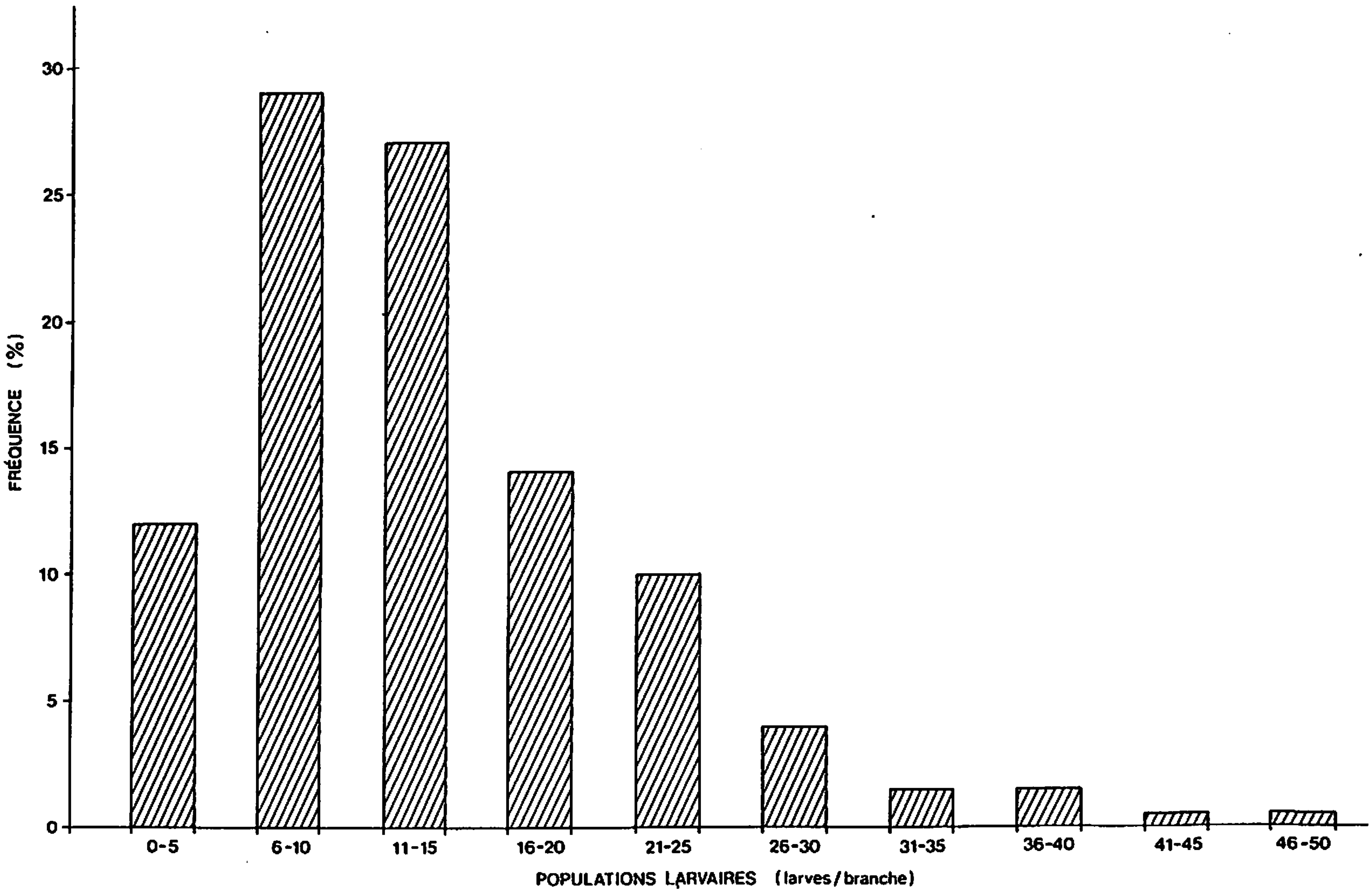


Figure 3 : Répartition des populations larvaires de la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.), dans les secteurs traités en 1986.

TABLEAU 4: Mortalité larvaire occasionnée par le traitement réalisé contre la tordeuse des bourgeons de l'épinette en 1986

Région	Nb de branche	Pop. pré-traitement L/br		Pop. pré-traitement L/bourg.	Pop. post-traitement L/br	Pop. post-traitement L/bourg.	Mortalité Totale (%)	Mortalité Abbott (%)
Saguenay-Lac St-Jean	15	11,7	-*	0,12	0,4	0,4	96,9	61
Non traité	35	10,3	2,6	0,12	0,9	0,6	91,3	
Trois-Rivières								
Bas St-Maurice (41)	105	12,2	2,2	0,12	1,8	0,6	85,3	43
Non-traité	45	13,5	1,5	0,14	3,5	1,0	74,1	
Windigo (42)	135	13,5	1,8	0,11	1,6	0,4	88,2	29
Non traité	70	11,5	2,2	0,11	1,9	0,4	83,5	
Total	240	13,0	1,4	0,11	1,7	0,4	86,9	35
Non traité	120	12,3	1,8	0,12	2,5	0,6	79,7	
Côte-Nord								
Escoumins (91)	40	5,9		0,08	0,2	0,2	96,6	74
Non traité	20	6,8	2,8	0,06	0,9	0,6	86,8	
Forestville (92)	170	13,2	1,4	0,12	1,2	0,2	90,9	56
Non traité	75	17,3	3,2	0,17	3,6	0,6	79,2	
Hauterive (93)	150	19,2	2,6	0,15	2,0	0,4	90,0	50
Non traité	55	18,1	3,2	0,17	3,5	0,8	80,6	
Sept-Iles (94)	30	15,1	4,2	0,15	0,8	0,8	94,7	77
Non traité	30	23,7	4,2	0,18	5,5	2,8	76,8	
Total	390	14,9	1,2	0,13	1,4	0,2	90,6	56
Non traité	180	17,4	2,0	0,16	3,6	0,6	79,3	
Total	645	14,0	0,8	0,13	1,5	0,2	89,3	40
Non traité	335	14,3	1,2	0,13	2,8	0,4	80,4	

* Intervale de confiance à 95%

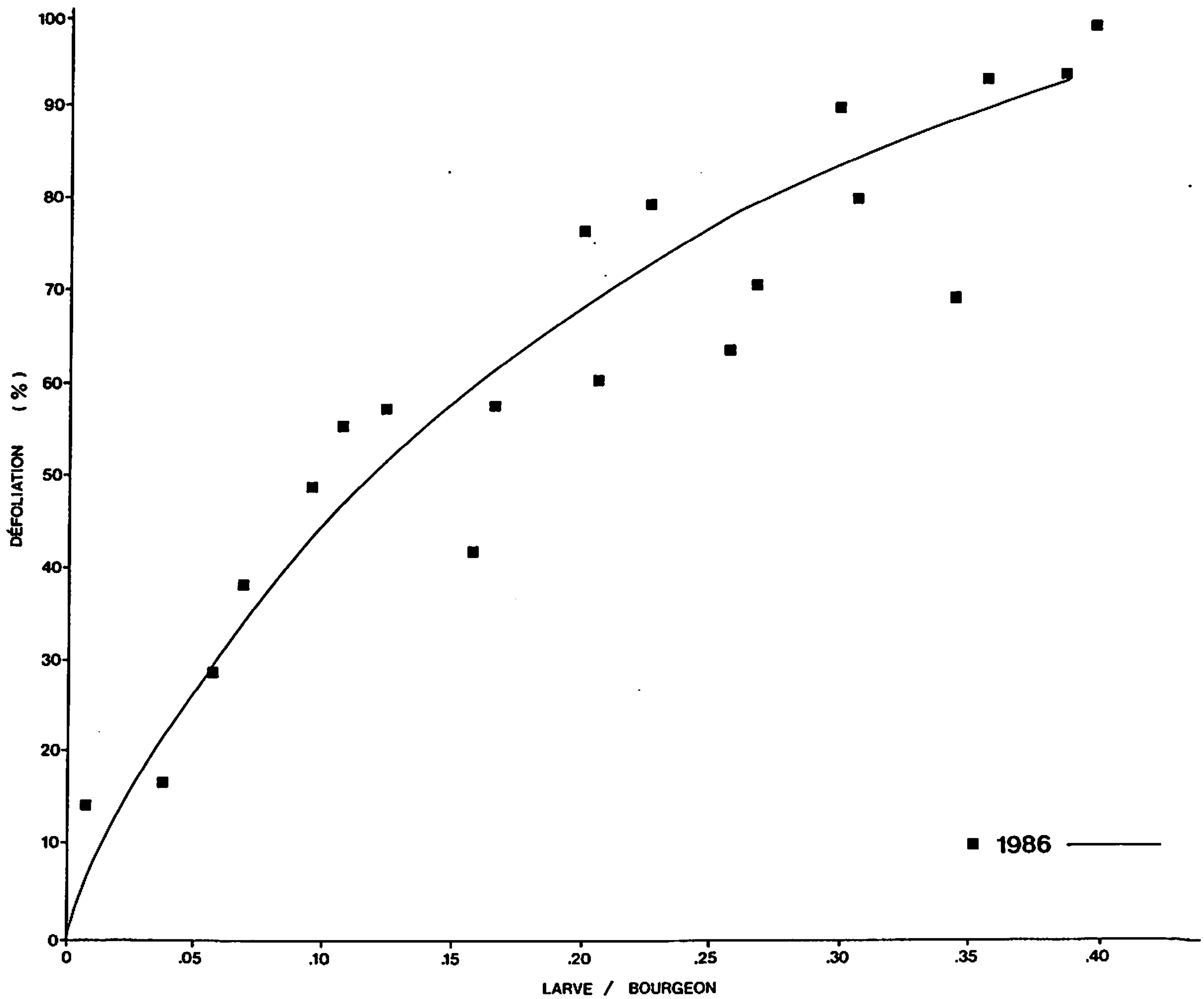


Figure 4 : Défoliation (%) prévue en 1986 en fonction du nombre de larves par bourgeon.

niveau de population susceptible d'occasionner une défoliation sévère. Il est important de bien comprendre les facteurs pouvant expliquer les variations d'année en année.

Une fois de plus cette année, la défoliation annuelle obtenue pour une population larvaire donnée en début de saison a été inférieure aux dernières années.

8. - Efficacité des traitements

La pulvérisation d'insecticide a permis de protéger 42% du feuillage annuel. Seulement 5% de toute la superficie traitée a été sévèrement défoliée. La défoliation moyenne obtenue dans 196 places d'étude fut de 32% dans les secteurs traités et de 55% dans les secteurs témoins. Près des trois quarts (72%) des places d'étude traitées ont subi une défoliation annuelle inférieure à 50% (TABLEAUX 5 et 6 - Figure 5).

La mortalité larvaire fut de 89,3% sur l'ensemble du territoire pulvérisé alors que celle obtenue dans les secteurs non traités a été évaluée à 80,4% ce qui constitue une forte mortalité naturelle par rapport aux années antérieures.

L'insecticide biologique Thuricide 48LV utilisé sur 34% du territoire traité, en 1986 a donné dans l'ensemble un rendement légèrement supérieur au traitement chimique. Face à des populations larvaires comparables, seulement

TABLEAU 5: Superficies (ha) attaquées par la tordeuse des bourgeons de l'épinette dans les secteurs traités en 1986

Unité de gestion	Nul	Léger	Modéré	Sévère	Total
Saguenay-Lac St-Jean					
Saguenay-sud (21)	-	1 663	-	-	1 663
Trois-Rivières					
Bas St-Maurice (41)	-	4 861	2 770	250	7 881
Windigo (42)	-	2 784	1 335	-	4 119
TOTAL	-	7 645 (64%)	4 105 (34%)	250 (3%)	12 000
Côte-Nord					
Escoumins (91)	-	4 346	-	-	4 346
Forestville (92)	-	6 764	9 021	349	16 134
Hauterive (93)	-	2 706	9 428	1 892	14 026
Sept-Iles (94)	-	2 835	151	-	2 986
TOTAL	-	16 651 (44%)	18 600 (50%)	2 241 (6%)	37 492
GRAND TOTAL	-	25 959 (51%)	22 705 (44%)	2 491 (5%)	51 155

TABLEAU 6: Protection du feuillage accordée par le traitement réalisé contre la tordeuse des bourgeons de l'épinette en 1986

Unité de gestion	Nb de branche	Pop. pré-trait. L/branche	Défoliation (%) Observée	Défoliation (%) prévue	Protection (%) (Prév.-Obs.)/Prév.
Saguenay-Lac St-Jean	15	11,7	8	50	84
Trois-Rivières					
Bas St-Maurice (41)	105	12,2	33	50	34
Windigo (42)	135	13,5	30	48	38
Total	240	13,0	31	50	38
Côte-Nord					
Escoumins (91)	40	5,9	10	39	74
Forestville (92)	170	13,2	27	50	46
Hauterive (93)	150	19,2	52	57	9
Sept-Iles (94)	30	15,1	25	57	56
Total	390	14,9	35	55	36
GRAND TOTAL	645	14,0	32	55	42

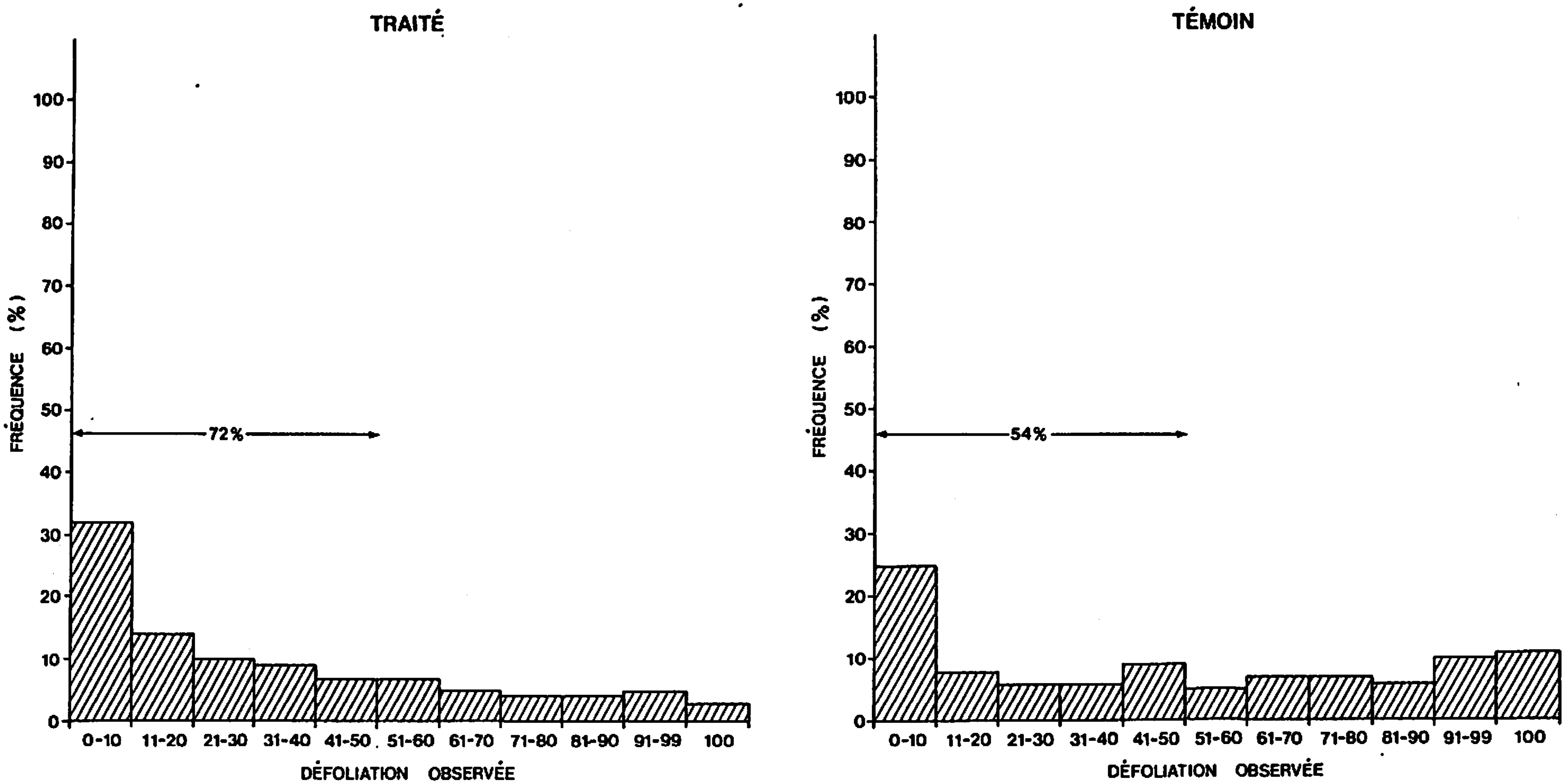


Figure 5 : Répartition de la défoliation annuelle dans les secteurs traités et témoins en 1986.

2% du territoire traité au Bt a été défolié sévèrement comparativement à 7% dans le cas du chimique (TABLEAU 7).

Le programme de pulvérisation en 1986 a donné les résultats escomptés en évitant une défoliation sévère des pousses annuelles sur la majorité des pousses annuelles. Malgré la baisse de l'infestation, certains peuplements étaient dans un mauvais état et ne pouvaient supporter une défoliation supplémentaire. Dans d'autres cas où les peuplements étaient sévèrement infestés, le programme de pulvérisation a permis, en maintenant la vigueur des arbres, d'éviter à plus long terme une détérioration des peuplements. De plus, ce programme de pulvérisation a permis de contenir, en étendue et en intensité, les foyers résiduels de populations de tordeuse. Cette analyse est d'ailleurs confirmée par les résultats de l'inventaire de prévisions de populations de tordeuse (L2) réalisé dans la région du Bas St-Laurent-Gaspésie où aucun programme de pulvérisation n'a été effectué en 1986 dans les foyers résiduels de tordeuse.

TABLEAU 7: Efficacité du traitement chimique et du traitement biologique réalisés en 1986

A. Mortalité et défoliation

Traitement	Nb de PE	Population avant le traitement L/br	Population avant le traitement L/bourg.	Population après le traitement L/bourg.	Mortalité totale %	Défoliation
Chimique (Fénitrothion)	68	13,8 1,2*	0,14	0,9	93,5	33
Biologique (Thuricide)	63	14,4 0,8	0,11	2,0	86,1	31

B. Superficies infestées (ha)

Traitement	Léger	Modéré	Sévère	Total
Chimique	15 343 (46%)	15 644 (47%)	2 051 (7%)	33 038
Biologique	10 616 (59%)	7 061 (39%)	440 (2%)	18 117

* Intervale de confiance à 95%

II - **Infestation de la tordeuse des bourgeons de l'épinette dans la province de Québec en 1986**

L'infestation de la tordeuse a couvert une superficie de 2,83 millions d'hectares en 1986 comparativement à 9,26 millions en 1985. Les dommages ont été légers sur 0,75 million d'hectares, modérés sur 1,35 million d'hectares et sévères sur 0,73 million d'hectares. Toutes les régions ont connu une baisse plus ou moins importante de l'infestation. D'autre part, aucun dommage ne fut décelé dans les régions de l'Estrie, de l'Outaouais et de l'Abitibi-Témiscamingue (Fig. 6 - TABLEAU 8).

Les baisses sensibles de l'infestation de tordeuse se sont manifestées principalement à l'ouest et au centre de la province. L'infestation est par contre demeurée sévère dans la région de la Côte-Nord et s'est abaissée à un niveau modéré dans plusieurs secteurs de la péninsule gaspésienne et de la région de Trois-Rivières.

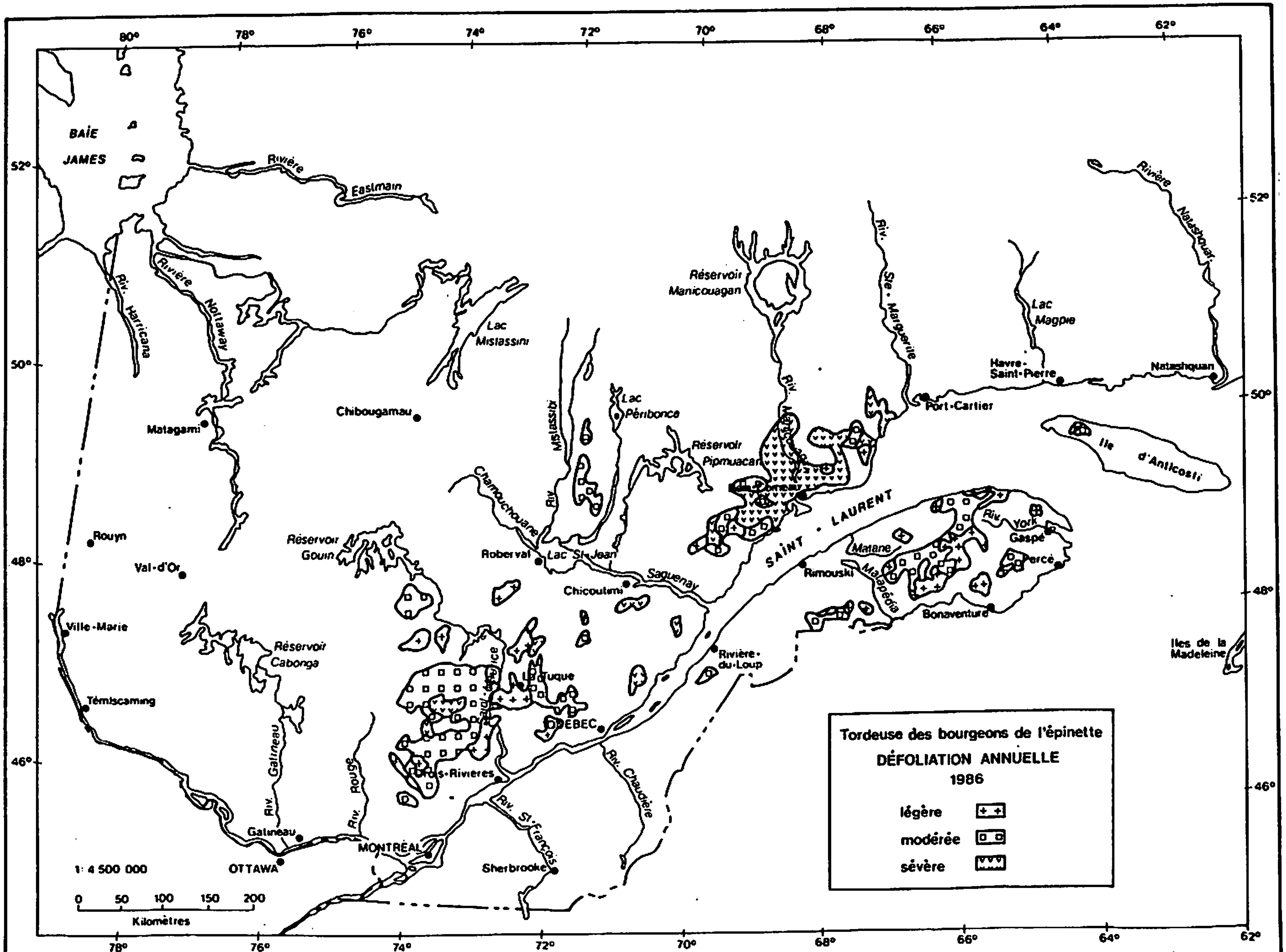


Fig. 6 : Superficies affectées par la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.) en 1986.

TABLEAU 8: Superficies (ha) affectées par la tordeuse des bourgeons de l'épinette, <u>Choristoneura</u> <u>fumiferana</u> (Clem.) dans les régions administratives du Québec en 1986, excluant les zones de mortalité

Régions administratives	Niveaux d'infestation Léger (ha)	Modéré (ha)	Sévère (ha)	Total (ha)
Bas St-Laurent-Gaspésie (01)	315 314	322 032	56 094	693 440
	953 128*	325 740	275 552	1 554 420
Saguenay-Lac St-Jean (02)	26 662	32 656	13 282	72 600
	727 451	70 503	1 196 307	1 994 261
Québec (03)	36 721	100 782	41 095	178 598
	958 596	121 209	575 132	1 654 937
Trois-Rivières (04)	274 208	440 980	81 814	797 002
	58 907	186 876	2 031 564	2 277 347
Estrie (05)	-	-	-	-
	2 813	-	-	2 813
Montréal (06)	43 281	255 626	35 313	334 220
	16 875	13 594	372 345	402 814
Outaouais (07)	-	-	-	-
	100 626	37 344	51 250	189 220
Abitibi-Témiscamingue (08)	-	-	-	-
	1 407	21 251	10 313	32 971
Côte-Nord (09)	55 558	199 694	500 835	756 087
	149 036	37 732	964 265	1 151 033
Province	751 744	1 351 770	728 433	2 831 947
	2 968 839	814 249	5 476 728	9 259 816

* Superficies affectées en 1985

III - PREVISIONS POUR 1987

L'inventaire des populations en hibernation (L2) prévoit l'évaluation de 2 000 places d'étude réparties sur l'ensemble de la province. Près des trois quarts des places d'étude ont été récoltées jusqu'à maintenant. Dans l'ouest et le centre du Québec, la présence de la tordeuse en 1987 sera très faible à l'exception d'un petit secteur dans la région de Trois-Rivières sévèrement infesté en 1986 où les populations larvaires seront encore élevées en 1987.

Dans la région du Bas St-Laurent-Gaspésie, les quelques foyers d'infestation qui persistaient en 1986 se sont intensifiés et dans la plupart des cas, ils ont pris une certaine expansion. Ces foyers se situent au sud de la Réserve de Rimouski, au centre et au nord de la péninsule gaspésienne. La région de Rivière-du-Loup sera très peu affectée par la tordeuse pour une deuxième année consécutive.

Finalement sur la Côte-Nord, l'épidémie de la tordeuse sera intense malgré une faible régression par rapport à 1986.

Compte tenu de l'intensification des foyers en Gaspésie, le ministère de l'Energie et des Ressources prévoit protéger en 1987 une superficie de 150 000 hectares localisés à l'ouest de la Vallée de la Matapédia en bordure de la frontière du Nouveau-Brunswick, au centre et au nord de la Gaspésie ainsi que sur la Côte-Nord.

IV - Autres projets en 1986

1. - La dynamique de la tordeuse

En collaboration avec le Centre forestier des Laurentides, le MER a poursuivi l'étude sur la dynamique de la tordeuse amorçée en 1985 dans 17 localités réparties au centre et à l'est de la province afin d'identifier et de mesurer la flore bactérienne et les parasites présents chez la tordeuse. Le MER s'est chargé de la récolte des échantillons de feuillage sur le terrain et du prélèvement des larves sur le feuillage. Un grand total de 50 000 larves furent récoltées dans le cadre de ce projet. M. David Perry et son équipe du Centre forestier des Laurentides ont fait l'élevage et l'analyse de chacune des larves pour identifier et mesurer les causes de la mortalité naturelle.

2. - Programme de calibrage

La Division des techniques et du soutien aux opérations du Service de la Protection contre les insectes et les maladies a, au cours des dernières années et plus particulièrement depuis 1985, effectué des travaux sur la caractérisation du vortex des avions de pulvérisation. Cette caractérisation nous a amené à analyser l'effet de l'emplacement des gicleurs par rapport au dépôt et au spectre des gouttelettes. Nous avons étudié l'effet de la vitesse de rotation des AU-5000 sur le spectre des gouttelettes et nous avons regardé l'effet des conditions météorologiques sur le dépôt ainsi que le taux d'évaporation des gouttelettes. Une méthodologie d'échantillonnage du dépôt a été développée et validée et à partir de celle-ci nous avons commencé à refaire un calibrage complet des différents types d'avion de pulvérisation selon les différents produits.

3. - Efficacité des traitements en relation avec le dépôt d'insecticide

Pour une troisième année consécutive, l'efficacité des traitements en fonction du dépôt d'insecticide a été vérifiée sur le sapin baumier. Au total, 114 arbres traités au Thuricide 48LV et 152 au Fénitrothion ont été échantillonnés. Les résultats sont présentés sous formes d'équations et de courbes de régression nous permettant de déterminer la quantité d'insecticide requise pour atteindre la protection désirée. Les résultats démontrent jusqu'à maintenant qu'un dépôt de 0.75 goutte par aiguille sur le feuillage naturel permet d'obtenir le maximum de mortalité larvaire et un minimum de défoliation annuelle.

A l'aide d'une tour météo équipée de deux anémomètres et de deux thermistors, nous avons également étudié l'effet de la stabilité de l'air sur le dépôt d'insecticide (nombre de gouttes/aiguille) selon quatre (4) orientations et trois (3) hauteurs dans la cime de plusieurs sapins. Les rapports de ces deux projets seront disponibles dans les prochains mois.

4. - Utilisation de la résistance électrique pour évaluer l'état de santé du sapin baumier

Les travaux réalisés en 1985 à l'aide du Shagomètre ont montré des variations dans les résistances électriques plus importantes chez les arbres à croissance rapide que ceux à croissance lente dû au fait qu'un arbre en santé présente une bonne évapotranspiration. Une corrélation significative a été établie entre le potentiel hydrique de l'air et la résistance électrique au niveau du cambium chez les sapins exempts de défoliation tandis qu'aucune corrélation n'a été observée chez des arbres défoliés. Ces observations ont été confirmées en 1986 (14 arbres suivis pendant 9 semaines) sur des sapins défoliés selon quatre (4) niveaux: 0-25%, 26-50%, 51-75% et 76-100% (Fig. 7). Les mesures prises tôt le matin s'avèrent toujours inférieures et plus précises à celles prises tôt l'après-midi quelles que soient les classes de défoliation. Par conséquent, l'analyse des résultats devra en tenir compte.

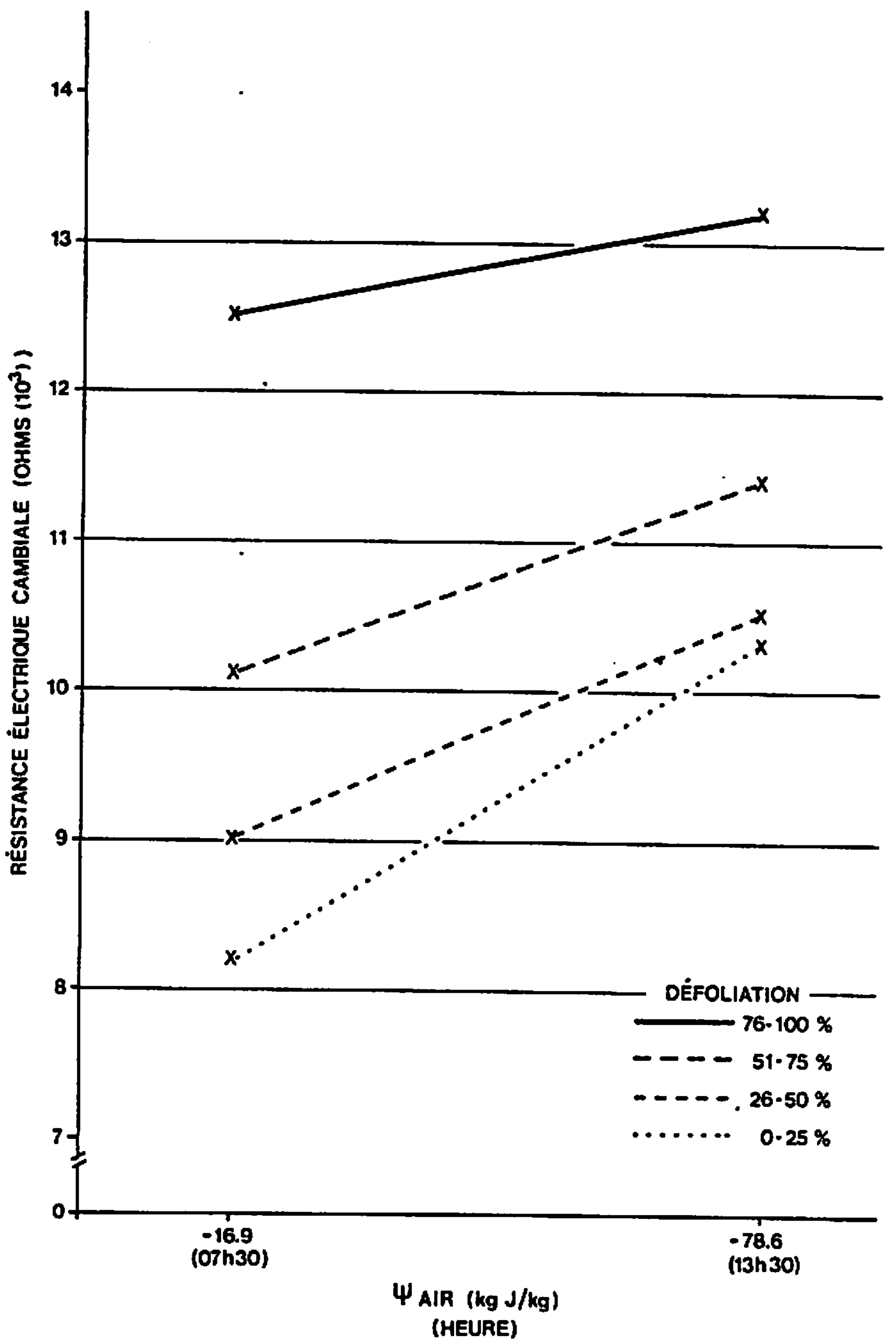


Figure 7 : Résistance électrique cambiale mesurée le matin et l'après-midi sur des sapins baumiers defoliés selon quatre intensités.

ENVIRONMENTAL MONITORING AND QUALITY CONTROL CARRIED OUT FOR THE AERIAL SPRAYING OF CHEMICAL AND BIOLOGICAL INSECTICIDES IN QUÉBEC IN 1986 AGAINST THE SPRUCE BUDWORM

REPORT PREPARED FOR THE
ANNUAL PEST CONTROL FORUM IN OTTAWA
NOVEMBER 18 - 19, 1986

BY: PIERRE-MARTIN MAROTTE, BIOLOGIST

GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

IN 1986, IN ACCORDANCE WITH THE ORDER ISSUED BY THE GOUVERNEMENT DU QUÉBEC, THE MER CARRIED OUT THE ENVIRONMENTAL MONITORING OF AERIAL INSECTICIDE SPRAYING AGAINST THE SPRUCE BUDWORM. THIS WAS DONE IN ORDER TO STUDY THE RESULTING ENVIRONMENTAL CONTAMINATION.

THIS YEAR STUDIES WERE CONDUCTED ON:

1) THE PERSISTENCE OF BACILLUS THURINGIENSIS (B.t.) AND FENITROTHION IN WATERS AND FOREST SOIL;

2) AN ENVIRONMENTAL FOLLOW-UP OF OPERATIONAL SPRAYINGS;

3) THE DEVELOPMENT OF SAMPLING AND ANALYSIS METHODS FOR TWO NEW SUBSTRATA WITH REGARD TO B.t.;

4) AND FINALLY, THE DETERMINATION OF B.t. STRATIFICATION IN THE FOREST SOIL.

FOR ALL PROJECTS, 682 SAMPLES WERE COLLECTED.

IN ADDITION, THE MER TESTED THE QUALITY OF THE PESTICIDES BEFORE THE SPRAYING OPERATIONS.

I SHOULD ADD THAT THE 1986 SPRAYING PROGRAM COVERED ONLY 51 155 HA, 65% OF WHICH WERE SPRAYED WITH FENITROTHION AND 35% WITH B.t.

TO BETTER ASCERTAIN THE BEHAVIOR AND PERSISTENCE OF B.T. AND FENITROTHION IN THE ENVIRONMENT, A NETWORK OF PERMANENT PLOTS WAS SET UP IN 1985. SINCE THE SPRAYING PROGRAM HAD BEEN SCALED DOWN AND A CERTAIN DISPLACEMENT OF THE SPRUCE BUDWORM POPULATIONS HAD TAKEN PLACE, THE MER DID NOT SPRAY ANY OF THE PERMANENT PLOTS THIS YEAR (FIG. I AND II). IN VIEW OF THESE FACTS, AND BECAUSE OF THE LOW CONCENTRATIONS DETECTED IN SOME PLACES IN 1985, ONLY SOME OF THE PLOTS WERE VISITED IN 1986.

WE SHALL NOW SEE, IN A SOMEWHAT MORE DETAILED MANNER, THE IMPORTANCE OF EACH PROJECT, BEGINNING WITH THE STUDY ON PERSISTENCE. WITH RESPECT TO FENITROTHION, TEN LITTER-SAMPLING PLOTS WERE SELECTED FOR TESTING. DESPITE TWO SPRAYINGS LAST YEAR, A VERY WEAK PERSISTENCE (0.136 µG/G) WAS FOUND.

HOWEVER, THE GREATER PART OF THE STUDY CONCERNED B.t., MORE PARTICULARLY ITS PERSISTENCE IN FOREST SOIL AND WATERS. IN 1986, WE COLLECTED SOME ORGANIC AND MINERAL PORTIONS ON THE FOREST SOIL OF 30 PLOTS SPRAYED IN 1985. WE WISHED TO DETERMINE THE PRESENCE OF VIABLE SPORES AND VEGETATIVE CELLS. THERE SEEMED TO BE NO CELL PROLIFERATION WATHEVER, BUT WE DID FIND A VERY HEAVY PERSISTENCE OF SPORES ON THESE AREAS. AFTER TWO THOROUGH INVESTIGATIONS, WE FOUND A STRATIFICATION OF DECREASING LEVELS OF B.t. THE HEAVIEST CONCENTRATIONS ARE FOUND IN THE TOP CENTIMETERS OF THE ORGANIC LAYER. WE PLAN TO RETURN EVERY YEAR TO TAKE SAMPLES, UNTIL THE B.t. CONCENTRATIONS ARE VERY LOW.

AS REGARDS THE AQUATIC ENVIRONMENT, SAMPLES HAVE BEEN TAKEN IN 1986 FROM LAKES LOCATED IN THE TERRITORIES SPRAYED IN 1985. TRIBUTARIES WHOSE RIVER BASIN HAD BEEN SPRAYED THE PREVIOUS YEAR REVEALED THE PRESENCE OF B.t. SPORES, JUST AS IN THE LAKES.

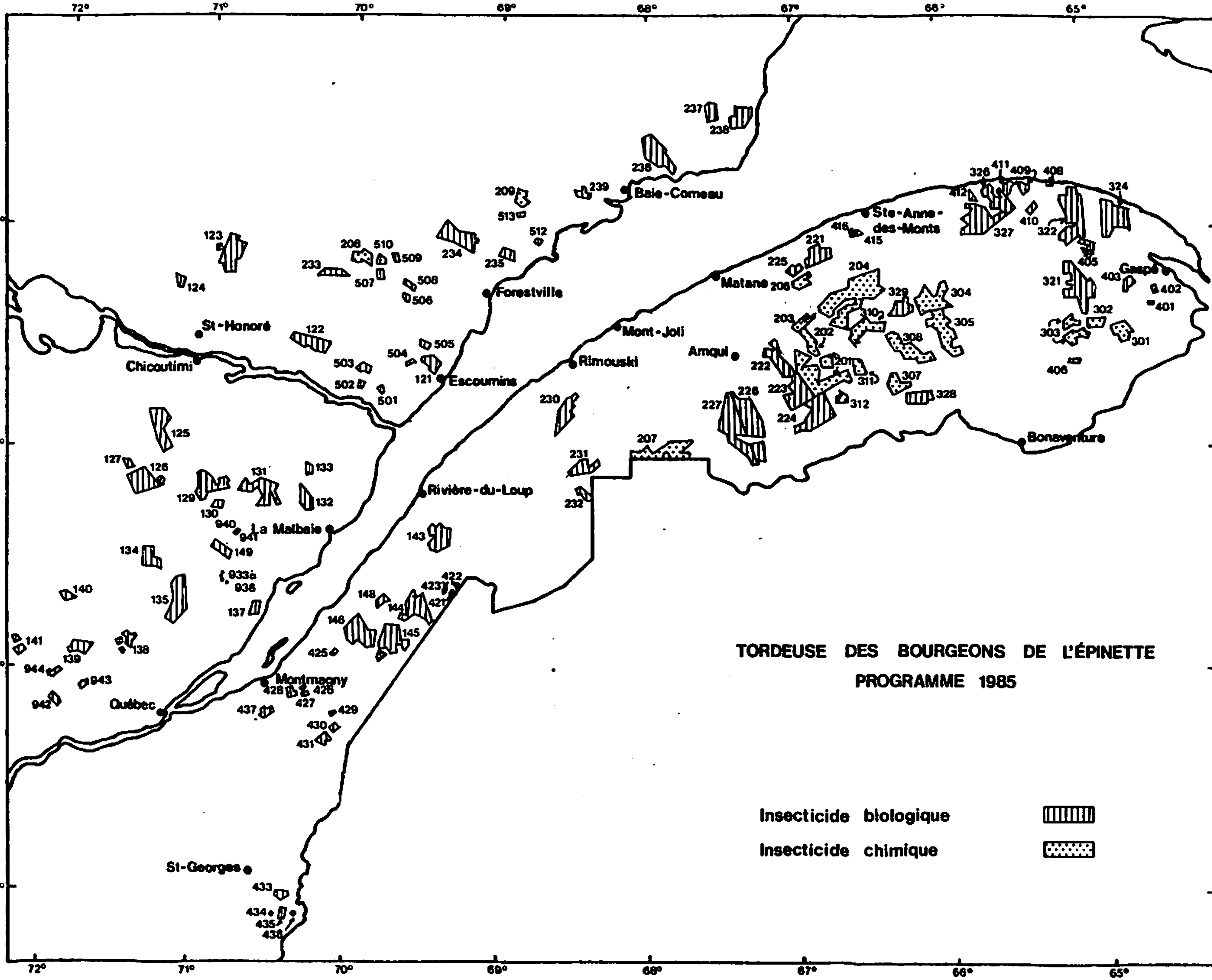
IN QUÉBEC, IT IS THE FIRST TIME SINCE 1974 THAT ONLY SINGLE-ENGINE PLANES ARE USED. AS SUCH, ENVIRONMENTAL MONITORING OF SPRAYING INVOLVED ON-SITE VISUAL CHECKING (TO ASCERTAIN WHETHER BUFFER ZONES, FLIGHT ALTITUDE AND AIR ROUTES HAD BEEN RESPECTED). IT ALSO INCLUDED SAMPLING FROM DRINKING-WATER OUTLETS NEAR SPRAYING AREAS, AS WELL AS NEAR SALMON RIVERS WHERE PART OF THE RIVER BASIN HAD BEEN SPRAYED. MOREOVER, WE HAVE TAKEN AIR SAMPLES IN SOME MUNICIPALITIES LOCATED NEAR THE SPRAYED AREAS (2 TO 13 KM). CONCENTRATIONS VARIED FROM NIL TO VERY LOW (6,68 C.F.U./M^3).

TO COMPLETE THE INFORMATION OBTAINED ON B.t., A PRELIMINARY STUDY WAS UNDERTAKEN BY SAMPLING SEDIMENTS AND PELECYPODS FROM LAKES. THESE SITES HAD BEEN TREATED A FEW TIMES WITH BIOLOGICAL INSECTICIDE A LITTLE OVER A YEAR AGO. INITIAL RESULTS INDICATE THE PRESENCE OF THIS MICROORGANISM.

REGARDING QUALITY CONTROL, ALL THE B.t. LOTS USED IN 1986 WERE APPROVED BEFORE THE SPRAYING OPERATIONS. THIS PRODUCT WAS CHECKED MAINLY FOR THE PRESENCE OF PATHOGENS, THE LEVEL OF PESTICIDE STRENGTH AND THE PRESENCE OF VEGETATIVE CELLS. NO TRACES OF PATHOGENS OR OF VEGETATIVE CELLS WERE FOUND. WITH RESPECT TO POTENTIAL INSECTICIDE EFFECTIVENESS, SOME LOTS SHOWED CONCENTRATIONS CLOSE TO THE MINIMAL ACCEPTABLE LIMIT. THESE LOTS WERE MIXED WITH THE MORE HEAVILY CONCENTRATED LOTS, SO AS TO OBTAIN MAXIMUM EFFICIENCY AGAINST THE SPRUCE BUDWORM.

IN LIKE MANNER, QUALITY CONTROL PROCEDURES WERE APPLIED TO FENITROTHION. THIS CONTROL WAS TO ENSURE THAT THE LEVEL OF ACTIVE INGREDIENT WAS WITHIN THE ACCEPTABLE NORMS (175 TO 220.5 G A.I./HA).

TO CONCLUDE, I SHOULD LIKE TO MENTION THAT THE 1986 PROGRAM WAS SUCCESSFUL, AND THAT THERE WERE NO EMERGENCY SPILLS.


TORDEUSE DES BOURGEONS DE L'ÉPINETTE
PROGRAMME 1985
Insecticide biologique
Insecticide chimique
Baie-Comeau
Ste-Anne-des-Monts
Gaspé
Matane
Forestville
St-Honoré
Chicoutimi
Mont-Joli
Amqui
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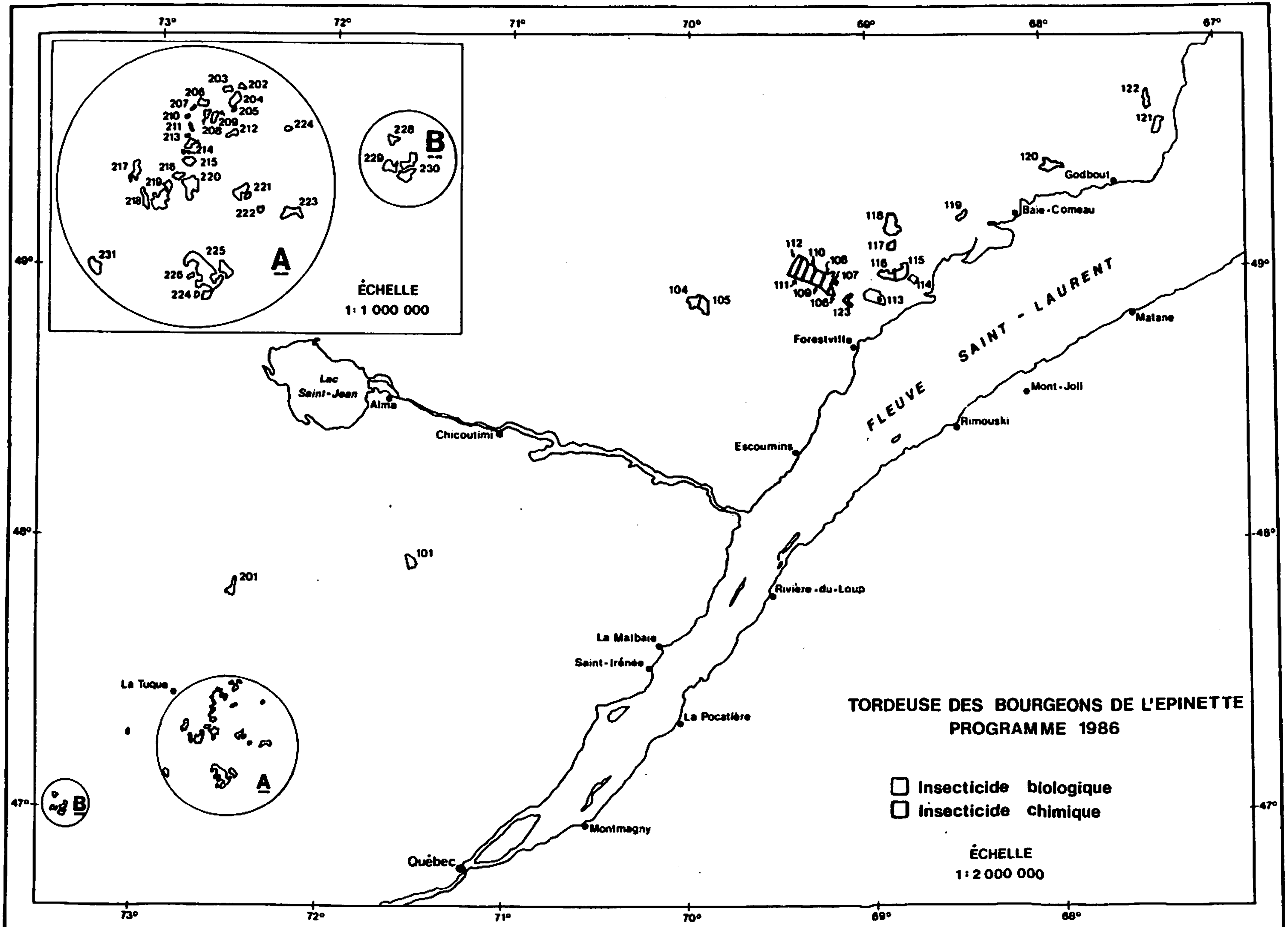
TORDEUSE DES BOURGEONS DE L'EPINETTE
PROGRAMME 1986
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Insecticide chimique
ÉCHELLE
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FLEUVE SAINT - LAURENT
Lac Saint-Jean
Alma
Chicoutimi
Forestville
Escoumins
Baie-Comeau
Godbout
Matane
Mont-Joli
Rimouski
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TABLE 1: NUMBER OF STATIONS AND SAMPLES COLLECTED IN THE FRAMEWORK OF SOME PROJETS REALIZED IN QUEBEC IN 1986

	STATIONS		SAMPLES	
PERMANENT STATIONS NETWORK	FEN.	B.t.	FEN.	B.t.
LAKES	-	14	-	42
RIVERS	-	9	-	27
FOREST SOILS	10	28	10	56
ENVIRONMENTAL FOLLOWING				
SALMON RIVERS	4	-	84	-
DRINKING WATER POINTS	1	4	11	25
AIR	2	3	71	70

TABLE 2: PRELIMINARY CONCENTRATIONS OF <u>B.t.</u> (C.F.U. X 10^4) FOUND AT PERMANENT STATIONS LOCATED INSIDE TREATED AREAS

	PRE 85		1-3 DAYS AFTER SPRAYING		11-42 DAYS AFTER SPRAYING		11 MONTHS AFTER SPRAYING	
	MEAN	MAX.	MEAN	MAX.	MEAN	MAX.	MEAN	MAX.
LAKES	0,11/1	0,87/1	83/1	380/1	1,7 /1	8,2/1	0,11/1	0,37/1
FOREST SOILS								
ORGANIC	7,6/g[1]	93/g	28/g	140/g	23/g	120/g	14/g	55/g
MINERALE	0,09/g	0,41/g	-	-	0,12/g	0,65/g	0,44/g	2,3/g

[1] PER GRAMME OF DRY WEIGHT

TABLE 3: PRELIMINARY CONCENTRATIONS OF <u>B.t.</u> (C.F.U. X 10^4) FOUND AT PERMANENT STATIONS LOCATED OUTSIDE TREATED AREAS

	PRE 85	1-6 DAYS AFTER SPRAYING	11 MONTHS AFTER SPRAYING
	MAX	MAX	MAX
RIVERS	0,086/1	250/1	5,8[2]/1

[2] PARTICULAR CONCENTRATION

SURVEILLANCE ENVIRONNEMENTALE ET CONTRÔLE DE QUALITÉ RÉALISÉS DANS LE CADRE DES PULVÉRISATIONS AÉRIENNES D'INSECTICIDES CHIMIQUES ET BIOLOGIQUES EFFECTUÉES AU QUÉBEC EN 1985 CONTRE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE

RAPPORT PRÉPARÉ POUR LE QUATORZIÈME COLLOQUE ANNUEL
SUR LA LUTTE CONTRE LES RAVAGEURS FORESTIERS À OTTAWA,
DU 18 AU 19 NOVEMBRE 1986

PAR: PIERRE-MARTIN MAROTTE

GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ÉTUDES ENVIRONNEMENTALES

EN 1986, CONFORMÉMENT AU DÉCRET ÉMIS PAR LE GOUVERNEMENT DU QUÉBEC, LE MER (MINISTÈRE ÉNERGIE ET RESSOURCES) A RÉALISÉ UNE SURVEILLANCE ENVIRONNEMENTALE DES PULVÉRISATIONS AÉRIENNES D'INSECTICIDES CONTRE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE AFIN D'ÉVALUER LA CONTAMINATION DE L'ENVIRONNEMENT.

LES ÉTUDES RÉALISÉES CETTE ANNÉE PORTAIENT:

1) SUR LA PERSISTANCE DU BACILLUS THURINGIENSIS (B.t.) ET DU FÉNITROTHION DANS L'EAU ET LE SOL FORESTIER;

2) SUR UN SUIVI ENVIRONNEMENTAL DES PULVÉRISATIONS OPÉRATIONNELLES;

3) SUR LE DÉVELOPPEMENT DE MÉTHODOLOGIES D'ÉCHANTILLONNAGE ET D'ANALYSE (B.t.) DE DEUX NOUVEAUX SUBSTRATS;

4) ET FINALEMENT SUR UNE DÉTERMINATION DE LA STRATIFICATION DU B.t. DANS LE SOL FORESTIER.

POUR CES ÉTUDES, 682 ÉCHANTILLONS ONT ÉTÉ RÉCOLTÉS.

DE PLUS, LE MER S'EST ASSURÉ DE LA QUALITÉ DES PESTICIDES AVANT LEURS PULVÉRISATIONS.

RAPPELONS QUE LE PROGRAMME DE PULVÉRISATION DE 1986 A TOUCHÉ SEULEMENT 51 155 HA DONT 65% ÉTAIENT TRAITÉS AU FÉNITROTHION ET 35% AU B.t. (FIG. I). UNE BONNE PARTIE DES BLOCS D'ARROSAGE ÉTAIENT TRAITÉS POUR LA PREMIÈRE FOIS.

AFIN DE MIEUX CONNAÎTRE LE COMPORTEMENT ET LA PERSISTANCE DU B.t. ET DU FÉNITROTHION DANS L'ENVIRONNEMENT UN RÉSEAU DE STATIONS PERMANENTES AVAIT ÉTÉ CRÉÉ EN 1985. ÉTANT DONNÉ LA RÉDUCTION DU PROGRAMME D'ARROSAGE AINSI QUE D'UN CERTAIN DÉPLACEMENT DES POPULATIONS DE TORDEUSES, IL EST APPARU QU'AUCUNE STATION DU RÉSEAU DE PLACES PERMANENTES N'A FAIT L'OBJET DE TRAITEMENTS CETTE ANNÉE PAR LE MER (FIG. I et II). DEVANT CE FAIT, ET LES FAIBLES CONCENTRATIONS DÉTECTÉES À CERTAINS ENDROITS EN 1985, UNE PARTIE DES STATIONS SEULEMENT A ÉTÉ VISITÉE EN 1986.

VOYONS AVEC UN PEU PLUS DE DÉTAILS L'IMPORTANCE DE CHAQUE PROJET EN COMMENÇANT PAR L'ÉTUDE DE LA PERSISTANCE. EN CE QUI A TRAIT AU FÉNITROTHION, DIX STATIONS D'ÉCHANTILLONNAGE DE LITIÈRE ONT ÉTÉ ÉCHANTILLONNÉES. ON Y A OBSERVÉ UNE TRÈS FAIBLE PERSISTANCE (0,136 µG/G) MÊME S'IL Y AVAIT EU DEUX APPLICATIONS L'AN DERNIER.

TOUTEFOIS, LA MAJEURE PARTIE DE CETTE ÉTUDE PORTAIT SUR LE B.t. ET PLUS PARTICULIÈREMENT SUR SA PERSISTANCE DANS LE SOL FORESTIER ET L'EAU. EN 1986, NOUS AVONS RÉCOLTÉ LA PARTIE ORGANIQUE ET MINÉRALE DU SOL FORESTIER DE 30 STATIONS TRAITÉES EN 1985. NOUS VOULIONS VÉRIFIER LA PRÉSENCE DE SPORES VIABLES ET DE CELLULES VÉGÉTATIVES. IL SEMBLE N'Y AVOIR AUCUNE PROLIFÉRATION DE CELLULES MAIS LES SPORES S'AVÈRENT TRÈS PERSISTANTES DANS CE MILIEU. APRÈS VÉRIFICATION DÉTAILLÉE À DEUX REPRISES, IL APPARAÎT UNE STRATIFICATION DÉCROISSANTE EN PROFONDEUR DU B.t. LES PLUS FORTES CONCENTRATIONS SE RETROUVENT DANS LES PREMIERS CENTIMÈTRES DE LA COUCHE ORGANIQUE. NOUS AVONS PLANIFIÉ RETOURNER ANNUELLEMENT PRENDRE DES ÉCHANTILLONS JUSQU'À CE QUE LES POPULATIONS DE B.t. DEVIENNENT TRÈS FAIBLES LORSQUE CES AIRES NE SERONT PLUS TRAITÉES.

EN CE QUI CONCERNE LES MILIEUX AQUATIQUES, DES PRÉLÈVEMENTS ONT ÉTÉ EFFECTUÉS EN 1986 DANS DES LACS SITUÉS DANS DES TERRITOIRES TRAITÉS EN 1985. DES CONFLUENTS (RIVIÈRES) DONT LE BASSIN HYDROGRAPHIQUE AVAIT ÉTÉ TRAITÉ UN AN AVANT ONT RÉVÉLÉ UNE PRÉSENCE DE SPORES DE B.t. TOUT COMME DANS LES LACS.

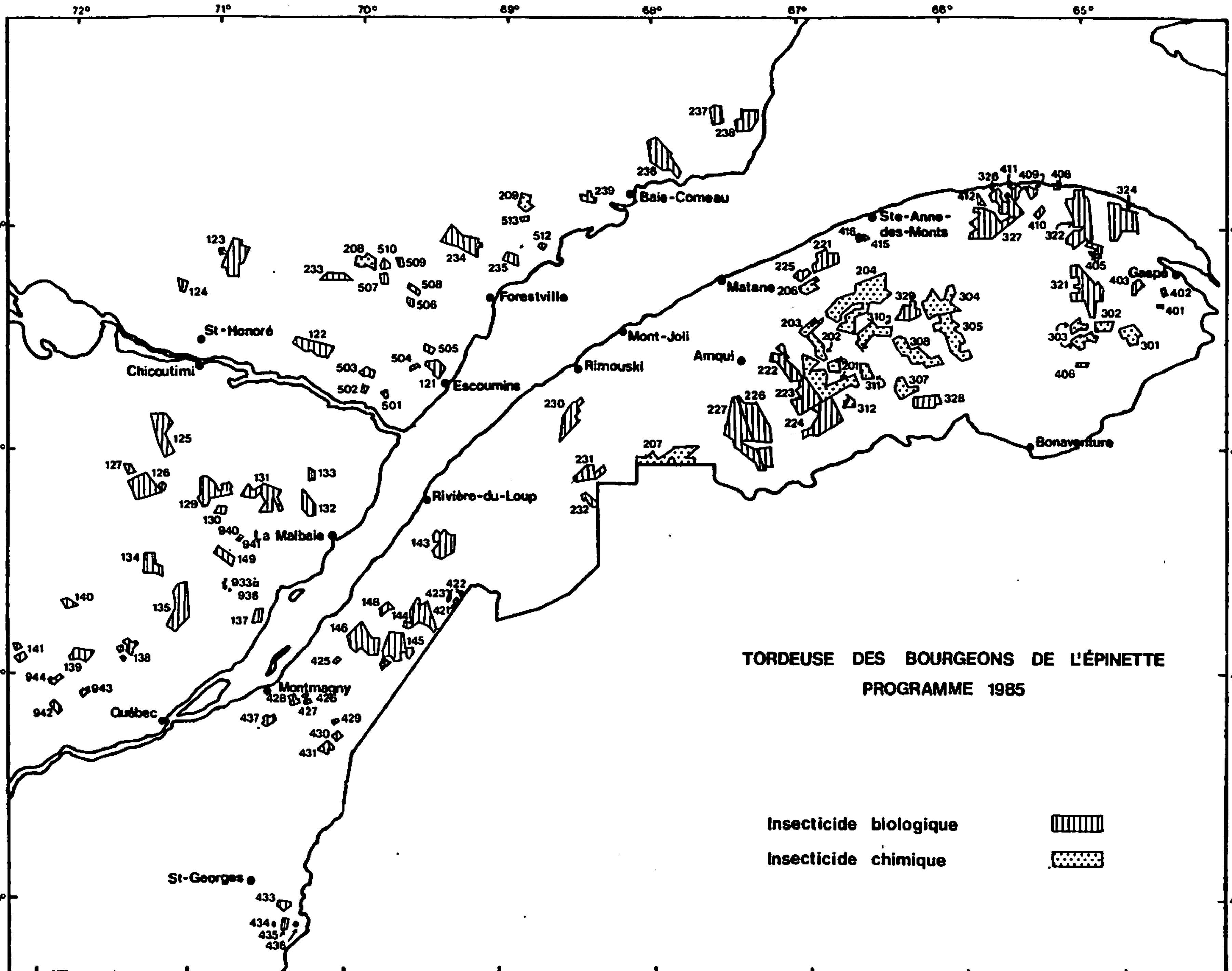
AU QUÉBEC, C'EST LA PREMIÈRE FOIS DEPUIS 1984 QUE L'ON A RECOURS EXCLUSIVEMENT AUX MONOMOTEURS. LA SURVEILLANCE ENVIRONNEMENTALE COMME TELLE DES PULVÉRISATIONS COMPRENAIT LA VÉRIFICATION VISUELLE AU SOL DES APPLICATIONS (RESPECT DES ZONES TAMPONS, DE L'ALTITUDE DE VOL ET DES LIGNES DE VOL) AINSI QUE L'ÉCHANTILLONNAGE DES PRISES D'EAU POTABLE SITUÉES À PROXIMITÉ DES AIRES TRAITÉES ET DES RIVIÈRES À SAUMONS DONT UNE PARTIE DU BASSIN HYDROGRAPHIQUE ÉTAIT AFFECTÉE PAR LES PULVÉRISATIONS. DE PLUS, NOUS AVONS RÉALISÉ UN ÉCHANTILLONNAGE D'AIR DANS CERTAINES AGGLOMÉRATIONS URBAINES SITUÉES PRÈS DES AIRES TRAITÉES (2 À 13 KM). DANS TOUS CES CAS, LES CONCENTRATIONS VARIAIENT DE NULLES À TRÈS FAIBLES.

POUR COMPLÉTER L'INFORMATION OBTENUE SUR LE B.t., UNE ÉTUDE PRÉLIMINAIRE A ÉTÉ ENTREPRISE EN PRÉLEVANT DES SÉDIMENTS ET DES PÉLÉCYPODES EN MILIEU LACUSTRE. CES MILIEUX AVAIENT ÉTÉ TRAITÉS BIOLOGIQUEMENT À QUELQUES REPRISES, IL Y A UN PEU PLUS D'UN AN. LES PREMIERS RÉSULTATS CONFIRMENT LA PRÉSENCE DE CE MICROORGANISME.

EN CE QUI A TRAIT AU CONTRÔLE DE QUALITÉ, TOUS LES LOTS DE B.t. UTILISÉS EN 1986 ONT ÉTÉ APPROUVÉS AVANT LA PULVÉRISATION. NOUS AVONS, POUR CE PRODUIT, VÉRIFIÉ PRINCIPALEMENT LA PRÉSENCE DE PATHOGÈNES, LA DÉTERMINATION DE LA POTENTIALITÉ INSECTICIDE ET LA PRÉSENCE DE FORMES VÉGÉTATIVES. AUCUN PATHOGÈNE, NI FORME VÉGÉTATIVE N'A ÉTÉ RETROUVÉ. QUANT À LA POTENTIALITÉ INSECTICIDE, QUELQUES LOTS ONT MANIFESTÉ DES CONCENTRATIONS PROCHES DE LA LIMITE MINIMALE ACCEPTABLE. CES LOTS ONT ÉTÉ MÉLANGÉS AVEC LES LOTS LES PLUS CONCENTRÉS AFIN D'OBTENIR UN MAXIMUM D'EFFICACITÉ COCNTRE LA TORDEUSE.

DE LA MÊME MANIÈRE, UN CONTRÔLE DE QUALITÉ A ÉTÉ EFFECTUÉ POUR LE FÉNITROTHION. LE CONTRÔLE CONSISTAIT À S'ASSURER QUE LA QUANTITÉ D'INGRÉDIENT ACTIF ÉTAIT À L'INTÉRIEUR DES LIMITES ACCEPTABLES (175 à 220,5 G I.A./HA).

POUR TERMINER, NOUS POUVONS MENTIONNER QUE LE PROGRAMME DE 1986 S'EST TRÈS BIEN DÉROULÉ ET QU'AUCUN DÉVERSEMENT D'URGENCE N'A EU LIEU.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PROGRAMME 1985
Insecticide biologique
Insecticide chimique
Baie-Comeau
Ste-Anne-des-Monts
Forestville
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Gaspé
St-Honoré
Mont-Joli
Chicoutimi
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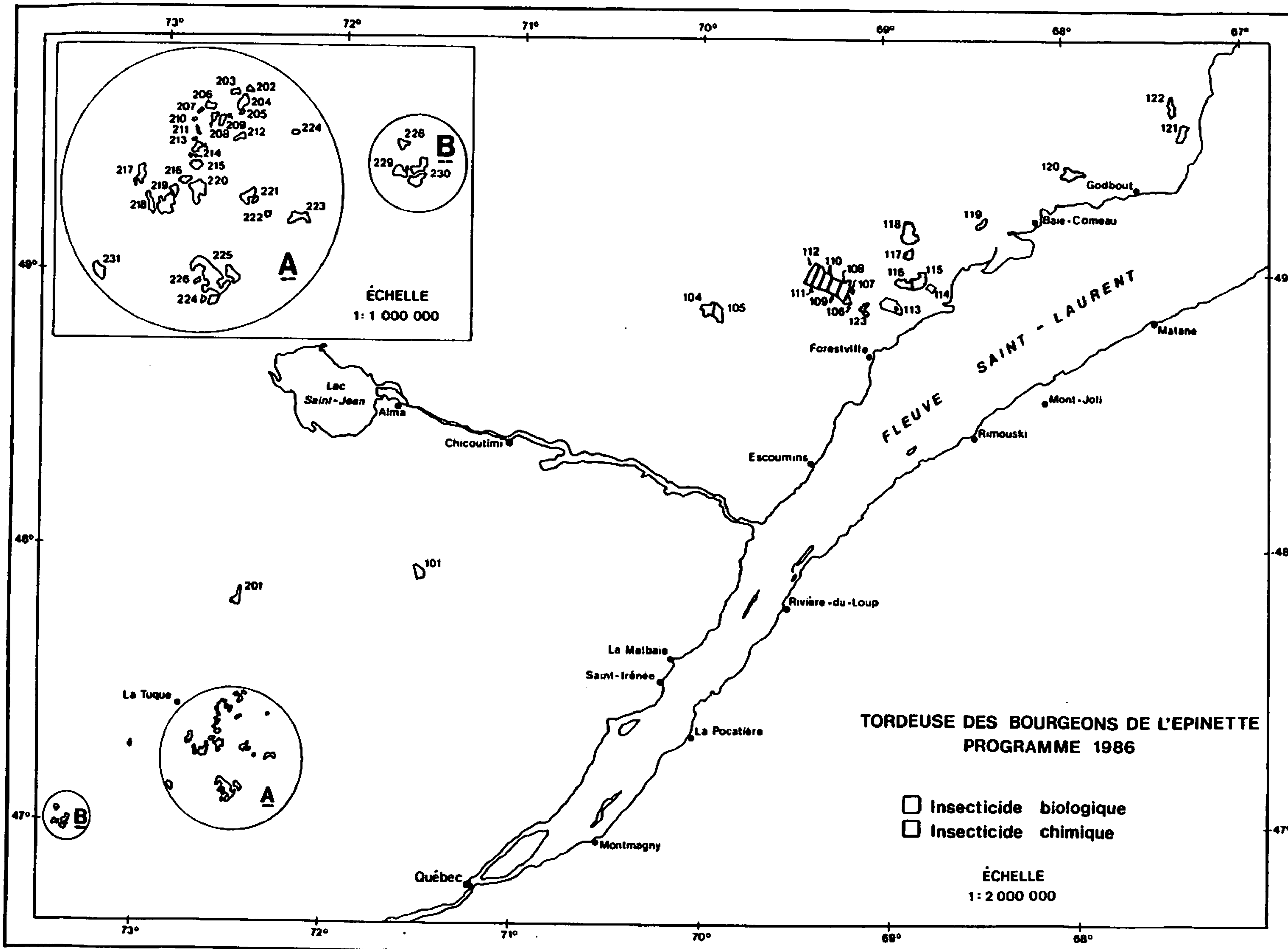

TORDEUSE DES BOURGEONS DE L'EPINETTE
PROGRAMME 1986
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Forestville
Escoumins
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Godbout
Matane
Mont-Joli
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TABLEAU 1: NOMBRE DE STATIONS ET D'ÉCHANTILLONS RÉCOLTÉS EN 1986 AU QUÉBEC DANS LE CADRE DE CERTAINS PROJETS

RÉSEAU DE PLACES PERMANENTES	STATIONS		ÉCHANTILLONS	
	FÉN.	B.t.	FÉN.	B.t.
LACS	-	14	-	42
CONFLUENTS	-	9	-	27
LITIÈRE	10	28	10	56
SUIVI ENVIRONNEMENTAL				
RIV. À SAUMONS	4	-	84	-
PRISES D'EAU POTABLE	1	4	11	25
AIR	2	3	71	70

TABLEAU 2: CONCENTRATIONS (PRÉLIMINAIRES) DE <u>B.t.</u> (U.F.C. X 10^4) RETROUVÉES DANS LE CADRE DU RÉSEAU DE STATIONS PERMANENTES (STATIONS SITUÉES À L'INTÉRIEUR DES AIRES TRAITÉES)

	PRÉ 85		1-3 JOURS APRÈS PULVÉRISATION		11-42 JOURS APRÈS PULVÉRISATION		11 MOIS APRÈS PULVÉRISATION	
	MOY.	MAX.	MOY.	MAX.	MOY.	MAX.	MOY.	MAX.
LACS	0,11/l	0,87/l	83/l	380/l	1,7 /l	8,2/l	0,11/l	0,37/l
LITIÈRE								
ORGANIQUE	7,6/g*	93/g	28/g	140/g	23/g	120/g	14/g	55/g
MINÉRALE	0,09/g	0,41/g	-	-	0,12/g	0,65/g	0,44/g	2,3/g

* PAR GRAMME DE POIDS SEC

TABLEAU 3: CONCENTRATIONS (PRÉLIMINAIRE) DE <u>B.t.</u> (U.F.C. X 10^4) RETROUVÉES DANS LE CADRE DU RÉSEAU DE STATIONS PERMANENTES SITUÉES À L'EXTÉRIEUR DES AIRES TRAITÉES

	PRÉ 85	1-6 JOURS APRÈS PULVÉRISATION	11 MOIS APRÈS PULVÉRISATION
	MAX	MAX	MAX
CONFLUENTS	0,086/l	250/l	5,8**/l

** VALEUR EXCEPTIONNELLE

AERIAL SPRAYING WITH <u>BACILLUS THURINGIENSIS</u> ON PRIVATE WOODLOTS IN EASTERN QUEBEC

Report of activities and results

PRESENTED AT THE FOURTEENTH ANNUAL INSECT PEST CONTROL FORUM

OTTAWA, NOVEMBER 18-20, 1986

ANDRÉ JUNEAU AND JACQUES ROBERT

CANADIAN FORESTRY SERVICE
FOREST DEVELOPMENT
BOX 10 225, STE. FOY
QUEBEC, G1V 4H5

INTRODUCTION

The private forests of eastern Quebec, as the private forests of other regions as well as the public forest of Quebec in general, have been seriously affected by spruce budworm outbreaks. In trying to answer repeated requests from private woodlot owners in eastern Quebec, the Canadian Forestry Service (CFS) developed a protection program through the Eastern Quebec Development Plan, Forest Program. Three wood producers' associations from the region agreed to carry out the program.

The program aims at keeping a maximum volume of fir and spruce alive in order to meet the needs.

Two phases of the program have been carried out: an experimental spray operation with Bacillus thuringiensis over 3 800 ha of forest in 1984, with the aim to develop new methods, and a first operational program over 30 925 ha in 1985.

The present paper reports the results of the 1986 spray program conducted over 14 629 ha.

DETERMINATION OF SPRAY BLOCKS

The process of selecting spray blocks started in fall 1985 preceeding the year of treatment. The following steps describe the procedures.

Step 1:

. Identifying softwood stands with a minimum of 50% of living stems by examining forest maps or forest management program maps (minimum living volume 63 m^3/ha);

. Tracing potential blocks on these maps;

. Contacting local forest management organizations to obtain further details on the potential blocks chosen such as recent cuttings, harvesting programs, opening of new roads, etc...

Step 2:

. Ground checking of potential blocks to identify recent changes concerning tree mortality, recent cuttings, new access, windfalls, etc...

Step 3:

. Observing larger or inacessible blocks from an helicopter.

Step 4:

. Sampling in accessible blocks for egg masses;

. Treating branches with sodium hydroxide to determine wintering larval population levels.

Step 5:

- Determining the areas to be treated;

- The preceeding steps allowed us to eliminate areas and restrict the program to highly potential stands (Table 1). Subsequently, each owner signed an agreement authorizing the treatment of his lot and made a request to obtain an authorization from the Quebec Department of the Environment. In the spring, areas were adjusted depending on the population levels.

HUMAN RESOURCES

Each wood producers' association (OPB/SPB) was responsible for selecting the personnel required for the operations on its territory. However, because of its strategic location (Rimouski), the "Syndicat des producteurs de bois du Bas St-Laurent" was responsible for providing the staff for the central laboratory and deposit assessment.

The CFS provided a technical adviser to help the associations during the operation and to assure that requirements of the Canadian and Quebec departments of the Environment were strictly followed. Moreover, to better plan the program, a technical committee was organized in February 1986. It was composed of three representatives from the wood producers associations and two from the CFS.

The human resources are summarized below:

THE CANADIAN FORESTRY SERVICE

The program was under the responsibility of the manager of the CFS office in Rimouski who was assisted by a forest engineer. The CFS office in Quebec provided the technical adviser.

Wood producers' Association

3 forest engineers;
18 forest technicians;
28 students.

Most of this staff was used during the operational phase of the program only.

MATERIAL AND SERVICES

Based on the experience of the past year, the following material and services were selected:

Insecticide

The preparation of Bacillus thuringiensis Futura® was from Chemagro Limited, Mississauga, Ontario. Dosage used was 2.5 L/ha:

1.5 L Futura®
1.0 L water
1.56 mL Chevron sticker®

Aircraft

Four Grumman AgCats®, 600 and 450 HP were provided by "Arrosages aériens du Saguenay/Lac St-Jean Limitée, Shipshaw, Quebec".

Water and insecticide analysis

The laboratory "Biologie Aménagement BSL Inc., Rimouski, Québec" carried out water and insecticide analysis and supplied the nutrient agar Petri dishes used for deposit assessment.

Mix plants

The Quebec Department of Energy and Resources kindly supplied two mix plants. The "SPB du Bas St-Laurent" used its own mix plant.

Radio systems

Mobile units in vehicles and walkie-talkies were rented from Quebec-Telephone, Rimouski, Quebec, for ground communications. The aircraft contractor, as part of its responsibilities, supplied walkie talkies for ground-aircraft communications.

Spray system

Twenty-four Teejet flat fan nozzles T 8004 were used on booms.

Navigation system

Where the spray blocks were accessible by roads helium inflated ballons were used, otherwise, navigation was provided by a Hughes 300-C helicopter from Aéro-culture Inc., St-Jean Chrysostome, Quebec.

TREATED AREA

Treated areas of 14 629 ha were sprayed between May 30 and June 12 1986.

Table 2 summarizes information on the treated area. Fifty-five of the 14 684 ha selected for treatment in the spring of 1986 were not treated. Figure 1 illustrates the location of the treated blocks affecting 371 owners who have obtained an authorization from the Quebec Department of the Environment.

RESULTS

Deposit:

As the spray techniques had been tested on many previous occasions, it was not necessary to use a complex deposit assessment system. Petri dishes containing nutrient agar placed at every 30 m on lines perpendicular to flight paths were used to determine deposit in terms of number of droplets/cm^2, which corresponds to the number of colonies/cm^2 (Table 3).

Examination of these data provides an evaluation of the navigation system and dispersion. All the blocks received the dosage required which averaged 9.2 colonies/cm^2 while the minimum deposit required was 6 colonies/cm^2.

Only block 151 showed abnormally high results with an average of 19.6 colonies/cm^2. We sampled 25% of the treated area and deposit was considered satisfactory.

Larval mortality

Table 4 summarizes larval mortality. Intermediate mortality was established 20 days after treatment. Sampling is usually carried out 15 days after treatment, however, the unseasonal cold temperatures forced a 5 day delay in sampling. Pretreatment populations were particularly high in the Matapédia River Valley (blocks 252 and 254) and on the north shore of the Peninsula (blocks 358 to 364).) Therefore, treatment efficiency was higher in these regions with 77.7% in the Matapédia River Valley and 66.9% on the north shore of the Peninsula. Also in these regions, intermediate larval mortality in treated blocks was 71.9 and 62.9% respectively. In untreated areas, larval mortality was 42.5 and 25.5%.

Current year growth defoliation

Results of current year growth defoliation are summarized in Table 4. In La Pocatière region, the impact of the treatment was minimal although average defoliation was 9.5% in treated blocks compared to 15.2% in untreated area. The reasons for this situation are described in the Conclusion. The same phenomenon was observed in block 251 in St-Modeste with 8.9 and 16.6% defoliation in treated block and untreated area respectively. In the Matapédia River Valley (blocks 252 and 254), the same values were a lot more meaningful with an average defoliation of 17.6% in treated blocks and 59.5% in untreated areas.

In the Baie des Chaleurs region of the Gaspé Peninsula (blocks 351, 356, and 357), the difference between defoliation in treated blocks (8.8%) and in the untreated area (21.7%) was acceptable. However, on the north shore of the peninsula (blocks 358 to 364) where the effect of the treatment was evident, defoliation in treated blocks averaged 26.1% while in untreated areas it was 62.3% with peaks of 76%.

INFORMATION ON PROGRAM COSTS

The 1986 operation costs were $645 860 or $44.15/ha (Table 5). Table 5 also compares the 1985 and 1986 costs. However, it should be emphasized that the comparison between the two years is affected by the withdrawing of an important part of the program projected for 1986 (Table 2).

Figures in Table 5 are for the treatment operation and they do not include costs of stocked material and planning in the falls of 1985 and 1986.

CONCLUSION

Generally, the program was justified and successful. All blocks treated were mostly composed of fir and spruce that had been subjected to severe damage by spruce budworm, and defoliation forecasts, established according to known methods, had all indicated moderate to severe levels.

However, two factors modified the original forecast a posteriori. These were temperature and behaviour of the spruce budworm populations. The unseasonally cold temperature in 1986 reduced considerably the larval and bacterial activities and prolonged larval development.

The second and most important factor was insect behaviour. The La Pocatière/St-Modeste and Baie des Chaleurs spruce budworm populations were less active, the Matapédia River Valley population was expanding and relatively active and the population on the north side of the Peninsula was also expanding and highly active. In the La Pocatière/St-Modeste and Baie des Chaleurs regions, the spruce budworm populations can be associated to a process of collapsing outbreak while the other populations can be associated to the early phase of an outbreak. These two factors were responsible for the 34% reduction of the original spray program and, consequently, some 7 749 ha were removed from the program in the La Pocatière and Baie des Chaleurs regions.

Also, analysis of the results revealed that treatment efficiency was good particularly in severely infested areas.

It should be emphasized that the decision making process for this program always considered the relatively small area of the private forest and its weaker condition after several years of spruce budworm attacks. In the fall of 1985, an intensive survey of the softwood stands, within the limits of responsibilities of the Eastern Quebec Development Plan, established that of the 114 700 ha of private softwood forest only 64 300 ha have enough living stock to be considered for treatment, provided that spruce budworm populations are sufficiently high.

Also, sampling was done on the best specimens, therefore figures may not always represent the situation and stands are in poorer and a more fragile condition than indicated, increasing the need for treatment.

The logistics of the operation are considerably improved in 1986. Improvements were mostly observed in the evaluation of the potential blocks, navigation, establishment of sampling plots, assessment of the results, and decision-making.

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1986

TABLE 1: AREA PROPOSED FOR 1986

Area identified on forest maps (ha)	Area (ha) eliminated after			Area in fall 1985 proposed for 1986 (ha)
	Visits in forest	Helicopter observation	Assessment of population level	
Step #1	Step #2	Step #3	Step #4	Step #5
		La Pocatière		
11 400	- 2 535	- 365	- 615	7 885
		Bas Saint-Laurent		
72 000	- 18 394	- 23 098	- 25 178	5 330
		Gaspésie		
31 304	0	- 5 934	- 16 152	9 218
TOTAL 114 704	- 20 929	- 29 397	- 41 945	22 433

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1986

TABLE 2: A SUMMARY OF THE TREATED AND UNTREATED AREA

BLOCK	AREA (HA)			REASONS FOR THE DEVIATION	AREA (HA)	REASON
	PROPOSED FALL 1985	ADDED OR SUBSTRACTED	PROPOSED SPRING 1986		TREATED	
				L A P O C A T I È R E		
151	3 370	- 1 270	2 100	Deciduous and total cuts	2 100	---
152	825	- 85	740	Total cuts	740	---
153	0	+ 260	260	Area needing treatment	260	---
154	1 600	- 1 600	0	Low population level	0	---
156	2 090	- 260	1 830	Total cuts	1 830	---
TOTAL La Pocatière	7 885	- 2 955	4 930		4 930	
				B A S S A I N T - L A U R E N T		
251	1 170	- 230	940	Total cuts	940	---
252	1 580	+ 315	1 895	Area needing treatment	1 095	---
253	440	- 440	0	Low population level	0	---
254	2 140	+ 425	2 565	Area needing treatment	2 545	Unfavourable meteorological conditions
TOTAL Bas St-Laurent	5 330	+ 70	5 400		5 380	
				G A S P É S I E		
351	249	+ 13	262	Block measurement	262	---
352	700	- 700	0	Low population level	0	---
353	1 175	- 1 175	0	Low population level	0	---
356	135	+ 27	162	Block measurement	162	---
357	316	- 11	305	Block measurement	305	---
358	350	+ 66	416	Area needing treatment	416	---
359	2 600	- 2 600	0	Rejected by the owners	0	---
360	225	+ 150	375	Block measurement	375	---
361	600	+ 170	770	Area needing treatment	770	---
362	706	+ 79	785	Area needing treatment	785	---
363	322	+ 53	375	Block measurement	340	Hilly area
364	900	+ 4	904	Block measurement	904	---
365	940	- 940	0	Low population level	0	---
TOTAL Gaspésie	9 218	- 4 864	4 354		4 319	
TOTAL	22 433	- 7 749	14 684		14 629	

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1986

TABLE 3: DEPOSIT ASSESSMENT

Block No	Number of Petri dishes	Number of samples < 6 colonies/cm^2	Average colonies/cm^2
151	60	0	19.5
152	41	9	6.8
156	42	13	6.9
252 (A)	26	10	6.0
252 (B)	24	0	9.4
254	24	0	10.7
356	20	7	7.5
360	23	7	8.0
362	28	8	7.9
AVERAGE	32	6	9.2

TREATMENT PROGRAM WITH B.T. ON PRIVATE WOODLOTS IN EASTERN QUEBEC - 1986
TABLE 4: LARVAL MORTALITY, TREATMENT EFFICIENCY AND DEFOLIATION

BLOCK NO	SAMPLING PLOT	PRETREATMENT POPULATION larvae/branch	PRETREATMENT POPULATION larvae/bud	INTERMEDIATE POPULATION larvae/branch	INTERMEDIATE POPULATION Mortality (%)	Efficiency (%)	RESIDUAL POPULATION larvae/branch	RESIDUAL POPULATION Mortality (%)	DEFOLIATION 1986 (%)
				LA POCATIÈRE					
151	treated	8.1	0.06	3.6	52.2	57.1	0.6	95.7	9.9
	untreated	5.0	0.05	6.0	22.5		0.1	98.4	11.9
152	treated	9.4	0.09	1.0	86.9	77.0	0.2	97.8	8.1
	untreated	4.4	0.06	4.0	9.1		0.2	95.4	21.3
153	treated	7.2	0.06	4.0	44.4	36.9	0.2	97.2	7.4
154	untreated	5.8	0.04	6.4	0		0.4	93.1	13.9
156	treated	9.3	0.07	3.6	56.9	13.1	0.3	98.2	12.5
	untreated	10.4	0.05	4.8	53.8		0.6	94.2	13.5
				BAS ST-LAURENT					
251	treated	15.8	0.08	2.9	69.8	39.6	0.5	98.1	8.9
	untreated	6.8	0.07	3.4	50.0		0	100.0	16.6
252	treated	14.2	0.26	3.5	74.8	86.7	1.6	88.8	23.7
	untreated	5.8	0.07	2.0	65.5		4.6	20.6	64.0
254	treated	9.2	0.08	2.5	69.0	68.7	0.8	85.1	11.6
	untreated	8.6	0.11	7.0	18.6		3.8	55.8	55.0
				GASPÉSIE					
351	treated	10.4	0.22	2.0	80.8	73.1	0.4	96.1	5.6
	untreated	5.6	0.05	4.0	28.6		1.2	78.5	22.0
356	treated	9.2	0.03	5.0	45.6	26.4	0.2	97.8	15.2
	untreated	3.0	0.03	2.2	26.0		1.8	40.0	40.2
357	treated	7.0	0.04	3.2	54.0	54.0	0	100.0	5.6
	untreated	2.8	0.07	5.4	0		0	100.0	3.1
358	treated	12.8	0	2.9	77.8	27.0	3.4	78.9	23.6
	untreated	18.4	0.11	5.6	69.5		1.8	90.2	47.2
360	treated	9.8	0.07	1.2	86.9	86.9	0.1	99.1	15.3
	untreated	9.4	0.06	10.0	0		3.2	65.9	64.0
361	treated	8.3	0.04	2.7	75.6	18.5	0.2	97.4	17.4
	untreated	10.4	0.13	2.8	73.0		1.4	86.5	65.9
362	treated	9.8	0.06	5.5	45.6	45.6	0.9	90.9	41.9
	untreated	9.0	0.05	12.4	0		0.6	93.3	76.0
363	treated	13.2	0.07	5.2	60.6	55.9	2.6	80.3	37.0
	untreated	17.0	0.10	15.2	10.5		4.4	74.1	76.0
364	treated	12.5	0.09	9.6	31.4	31.4	0.5	96.0	21.8
	untreated	5.2	0.08	6.6			1.2	76.9	[illegible]

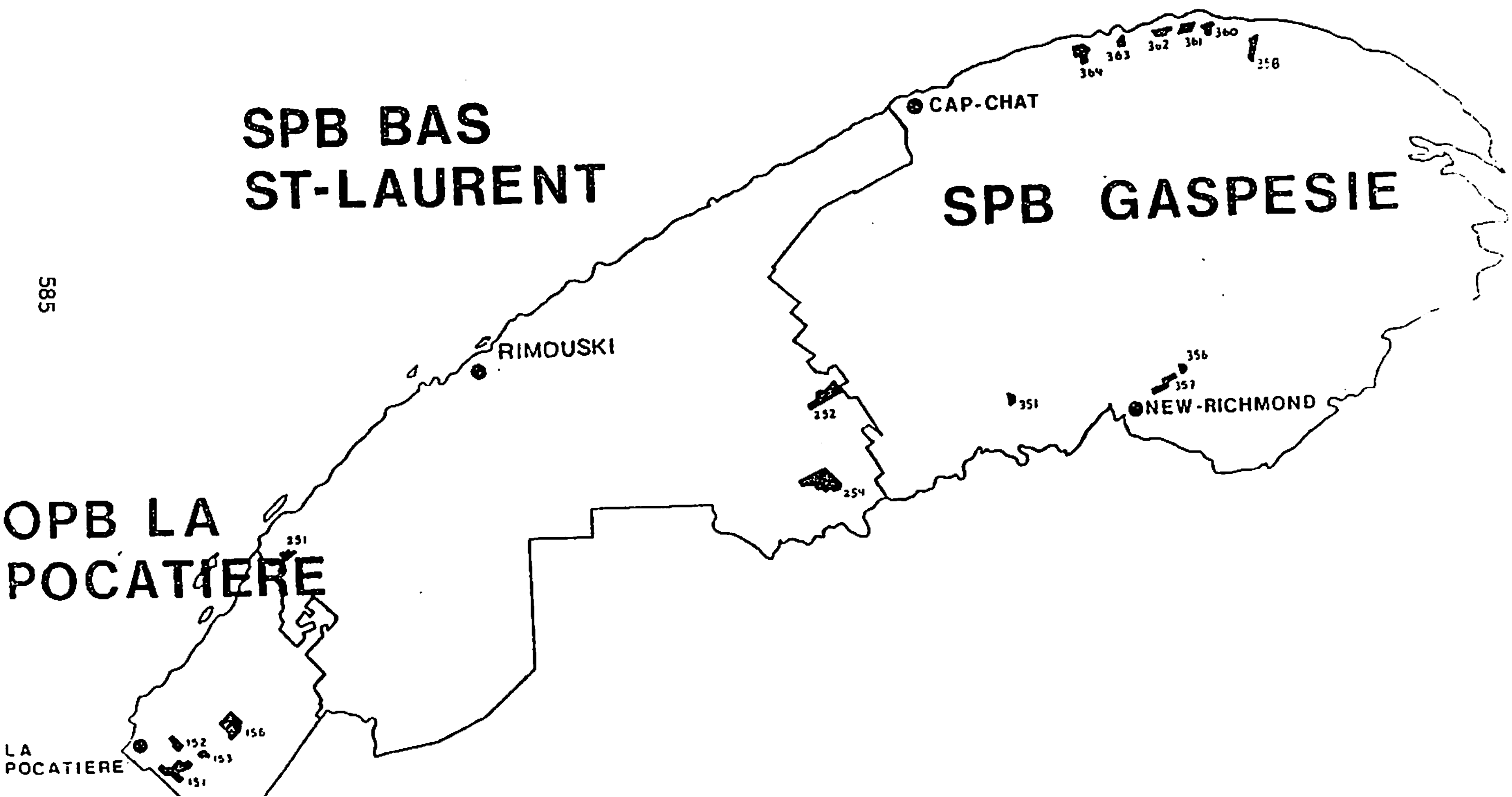
TREATMENT PROGRAM WITH B.T. ON PRIVATE FOREST WOODLOTS IN EASTERN QUEBEC - 1986

TABLE 5: COMPARATIVE ANALYSIS OF 1985 AND 1986 COSTS

TREATED AREA	1985 30 925 ha		1986 14 629 ha	
	Costs $	Costs $/ha	Costs $	Costs $/ha
1. Social costs				
- information, recruting and request for authorization	82 137	2.66	53 729	3.67
- printing and distribution of the final reports	1 407	.04	735	.05
SUB-TOTAL	83 544	2.70	54 464	3.72
2. Treatment costs				
- aircraft	305 317	9.87	163 332	11.16
- product	352 854	11.41	160 086	10.95
- calibration, navigation, mix plant, mobile radio	123 563	4.00	130 123	8.89
SUB-TOTAL	781 734	25.28	453 541	31.00
3. Biological assessment and advice				
- pretreatment	66 572	2.15	24 884	1.70
- post-treatment	78 331	2.53	46 646	3.19
- medical assessment	33 872	1.10	---	--
- laboratory	--	--	29 195	2.00
SUB-TOTAL	178 755	5.78	100 725	6.89
TOTAL	1 044 053	33.76	608 730	41.61
4. Internal costs CFS	95 458	3.09	37 130	2.54
TOTAL	1 139 511	36.85	645 860	44.15

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

Figure 1: Localization of treated blocks.



PULVÉRISATION AÉRIENNE DE <u>BACILLUS THURINGIENSIS</u> EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC

Résultats, saison 1986

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OTTAWA, LES 18-20 NOVEMBRE 1986

PRÉSENTÉ AU QUATORZIÈME COLLOQUE ANNUEL

SUR LA LUTTE CONTRE LES RAVAGEURS FORESTIERS.

ANDRÉ JUNEAU ET JACQUES ROBERT

SERVICE CANADIEN DES FORÊTS
DÉVELOPPEMENT FORESTIER
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INTRODUCTION

La forêt privée de l'est du Québec, à l'instar de celle des autres régions et de la forêt publique québécoise en général, a subi les effets néfastes de l'épidémie de la tordeuse des bourgeons de l'épinette. Suite aux demandes répétées des propriétaires de cette forêt privée, le Service canadien des forêts (SCF) a mis sur pied un programme d'aide par le biais du Plan de développement de l'Est du Québec, programme forestier. L'exécution de ce programme a par la suite été confiée par contrat aux trois (3) Office ou Syndicats de producteurs de bois (OPB/SPB) de la région concernée.

Le but essentiel du programme est de conserver vivant un maximum de volume de bois de sapins et d'épinettes de façon à échelonner la récolte en fonction des besoins du marché.

Deux phases du programme ont déjà été réalisées: soit une pulvérisation expérimentale de Bacillus thuringiensis (B.t.) sur 3 800 hectares de forêt en 1984, dont le but était de mettre au point les méthodes, et une première phase opérationnelle sur 30 925 hectares réalisée avec succès en 1985.

Le présent rapport résume les résultats du programme de pulvérisation aérienne de 1986, réalisé sur 14 629 ha.

DEFINITION DES BLOCS D'ARROSAGE

Le processus de sélection des blocs d'arrosage débute l'automne précédant la période d'intervention soit, dans notre cas, à l'automne 1985. Ce processus comprend une série d'étapes qui sont décrites ci-après:

Étape # 1

. Identification des peuplements résineux à plus de 50% vivants sur cartes forestières ou sur les cartes des plans de mise en valeur (volume vivant minimum de 63 m^3/ha).

. Délimitation de blocs provisoires sur les peuplements choisis.

. Contacts auprès des organismes de gestion en commun pour obtenir des informations plus précises sur les blocs choisis tels que coupes récentes, programme de coupe pour la prochaine année, nouveau réseau routier, etc...

Étape # 2

. Visites au sol des blocs pour vérifier les changements qui n'apparaissent pas sur les cartes forestières tels que mortalité du sapin, coupes récentes, châblis, etc...

Étape # 3

. Survol en hélicoptère des blocs de plus grandes dimensions ou les moins accessibles.

Étape # 4

a) Échantillonnage pour l'estimation du nombre de masses d'oeufs.

b) Récolte et traitement des branches à la soude pour déterminer quantitativement la population en hibernation.

Étape # 5

Détermination des superficies à traiter. Les données obtenues de chacune des étapes précédentes d'évaluation permettent l'élimination de territoires ou parties de territoires pour arriver aux superficies finalement retenues et proposées au programme (tableau 1). Par la suite, chacun des propriétaires concernés signe une entente autorisant la pulvérisation sur son lot et fait une demande d'autorisation auprès du ministère de l'Environnement du Québec. Au printemps, selon les populations de tordeuse, d'autres superficies sont retirées ou ajoutées au programme comme nous allons le constater un peu plus loin dans ce texte.

RESSOURCES HUMAINES

Chaque OPB/SPB avait la tâche d'engager le personnel nécessaire à l'arrosage des superficies sur son territoire. Cependant, dû à sa position stratégique (Rimouski), le Syndicat des producteurs de bois du Bas Saint-Laurent a assumé la responsabilité de l'engagement du personnel nécessaire pour le laboratoire central et pour le contrôle de la dispersion.

De son côté, le SCF a fourni un conseiller technique pour appuyer les OPB/SPB tout au long du programme de pulvérisation et s'assurer que les exigences du ministère de l'Environnement du Québec et du Canada soient respectées. Afin d'assurer une bonne planification de l'opération, un comité technique a été formé dès le mois de février. Celui-ci était formé de représentants des OPB/SPB (3) et du SCF (2).

En résumé, les ressources humaines affectées au programme furent les suivantes:

Service canadien des forêts

Le gérant du bureau de Rimouski était responsable du programme et était assisté d'un ingénieur forestier. Le SCF-Québec a fourni le conseiller technique.

OPB/SPB

3 ingénieurs forestiers
18 techniciens forestiers
28 étudiants

Il va sans dire que la période de l'opération correspond à une culmination des effectifs. Les périodes d'emploi ont été très variables selon les tâches.

RESSOURCES EN MATERIEL ET SERVICES

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

Insecticide

La préparation de Bacillus thuringiensis Futura® de Chemagro Limited, Mississauga, Ontario.

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

1,5 litre de Futura®
1,0 litre d'eau
1,56 mL de l'adhésif Chevron®

Avions

4 Grumman AgCat®, 600 ou 450 HP, qui ont été fournis par Arrosages aériens du Saguenay/Lac St-Jean Limitée, Shipshaw, Québec.

Analyse de l'eau et de l'insecticide

Le laboratoire Biologie Aménagement BSL Inc., Rimouski, Québec. Le même laboratoire a fourni les boites de Pétri avec gélose nutritive requises pour la dispersion.

Plans de mélange

Deux plans de mélange furent fournis par le Ministère de l'Énergie et des Ressources, Québec. Le SPB du Bas Saint-Laurent a utilisé un plan de mélange de sa fabrication.

Système de communication

Pour les communications sol-sol, nous avons loué de Québec Téléphone des unités mobiles pour installation dans les véhicules et des radios de type "Walkie-Talkie". Les communications air-sol étaient assurées par des "Walkie-Talkie" fournis par Arrosages aériens du Saguenay/Lac St-Jean, tel que stipulé dans son contrat.

Système de dispersion

Longerons et 24 buses (Teejet Flat Fan 80 04)

Navigation et balisage

Nous avons utilisé des ballons gonflés à l'hélium dans les secteurs accessibles par route et un hélicoptère Hughes 300-C® dans les autres cas. L'appareil était fourni par Aéro-Culture Inc., St-Jean Chrysostome, Québec.

BILAN DES SUPERFICIES TRAITEES

Les pulvérisations se sont déroulées du 30 mai au 12 juin inclusivement sur 14 629 hectares. Le tableau 2 résume les informations concernant les superficies traitées. Ainsi, sur l'ensemble des superficies retenues au printemps 1986, seulement 55 hectares n'ont pas été traités. La figure 1 montre la répartition des blocs traités. Par ailleurs, notons que le programme de 1986 a touché quelques 371 propriétaires de boisés qui ont tous obtenus un certificat d'autorisation du ministère de l'Environnement du Québec pour l'épandage.

RESULTATS

Dispersion

La méthode d'arrosage que l'on utilise ayant été maintes fois testée et vérifiée, il n'était donc pas nécessaire de mettre en place un système élaboré pour évaluer la dispersion. Ainsi, un réseau de boites de Pétri contenant de la gélose nutritive, disposées à tous les 30 mètres a permis d'évaluer le nombre de gouttelettes de mélange tombées au sol par cm^2 (tableau 3), exprimé en nombre de colonies de B.t./cm^2.

L'analyse de ces données nous permet d'évaluer l'efficacité du balisage et de l'épandage. Ainsi, tous les blocs ont été traités avec la dose recommandée de produit, car on obtient une moyenne générale de 9,2 colonies/cm^2 par rapport à une norme minimale de 6 colonies/cm^2. Seul le bloc 151 présente des résultats en dehors de la normale avec 19,6 colonies/cm^2. Ces résultats sont satisfaisants et représentent un échantillonnage de 25% de la superficie totale traitée.

Mortalité larvaire

L'ensemble des résultats sur la mortalité larvaire est résumé au tableau 4. La mortalité intermédiaire a été évaluée 20 jours après le traitement. D'habitude, cet échantillonnage est requis 15 jours après le traitement, mais le temps anormalement froid de l'été dans la région concernée, nous a amenés à réajuster la date d'échantillonnage. Les populations avant le traitement étaient particulièrement importantes dans la Vallée de la Matapédia (blocs 252 et 254) et sur la rive nord de la Gaspésie (blocs 358 à 364). C'est dans ces secteurs que l'efficacité du traitement établie suivant la formule d'Abbott a été la plus importante avec une moyenne de 77,7% dans la Vallée de la Matapédia et 66,9% sur la rive nord de la Gaspésie. Dans les deux mêmes secteurs, la mortalité intermédiaire dans les parcelles traitées fut de 71,9% et 62,9% respectivement. Dans les parcelles témoins, elle fut de 42,5 et 25,5%.

Défoliation de la pousse annuelle

Les résultats de la défoliation sont également présentés au tableau 4. Dans le secteur de La Pocatière, bien que la défoliation fut de 9,5% en moyenne dans les parcelles traitées par rapport à 15,2% dans les témoins, l'impact des pulvérisations a été minime pour des raisons qui seront exprimées plus loin. Le même phénomène se rencontre dans le bloc 251 de St-Modeste avec 8,9 et 16,6% de défoliation dans les parcelles traitées et les témoins respectivement. Dans la Vallée de la Matapédia (blocs 252 et 254), les mêmes valeurs sont nettement plus significatives avec 17,6% et 59,5% de défoliation en moyenne pour les deux blocs traités et les témoins.

En Gaspésie, dans le secteur de la Baie des Chaleurs (blocs 351, 356 et 357), l'écart de défoliation entre les parcelles traitées et les parcelles témoins est assez significatif soit 8,8% dans les parcelles traitées et 21,7% dans les parcelles témoins. Cependant, dans les deux (2) cas la défoliation demeure à un niveau acceptable. Dans le secteur nord (blocs 358 à 364), les pulvérisations ont nettement maintenu la défoliation à un niveau acceptable par rapport à celle observée dans les témoins. En effet, la défoliation a atteint en moyenne 62,3% dans les témoins, avec une culmination de 76%, alors qu'elle fut limitée à 26,1% en moyenne dans les blocs traités.

INFORMATION SUR LES COUTS DU PROGRAMME DE PROTECTION

Le tableau 5 nous apprend que le coût de l'opération 1986 a été de 645 860 $ ou de 44,15$/ha. Le même tableau trace une comparaison entre les coûts de l'opération 1985 avec celle de 1986. Cependant, il faut ici encore se rappeler que la comparaison entre les deux années souffre du retrait d'une partie importante des superficies initialement prévues pour 1986, tel qu'indiqué au tableau 2.

Finalement, notons que les données apparaissant au tableau 5 font état des coûts directement reliés à l'opération arrosage et ne tiennent pas compte de la valeur de l'inventaire et de la planification réalisée à l'automne 1985 et 1986 respectivement.

CONCLUSION

On peut conclure que généralement l'opération de protection était justifiée et a été efficace. Elle a été justifiée car tous les blocs choisis, sans exception, étaient composés en majorité de sapin et épinette et avaient subi d'importants dégâts par la tordeuse; les prévisions de défoliation établies, suivant des méthodes reconnues, indiquaient des niveaux sévères et modérés.

Cependant, deux facteurs sont venus, a posteriori, modifier les prévisions originales. Ces facteurs sont la température et la vitalité des populations de tordeuse. En ce qui concerne la température, mentionnons que les températures anormalement froides enregistrées ont réduit l'activité de l'insecte et de la bactérie, et ont prolongé la période du cycle larvaire.

Le deuxième facteur d'influence a été le comportement de la tordeuse. On peut ainsi conclure que les populations de La Pocatière, St-Modeste et de la Baie des Chaleurs ont montré une vitalité diminuée, tandis que celles de la Vallée de la Matapédia étaient en légère progression, et relativement actives, et que celles de la rive nord de la Gaspésie étaient nettement en hausse et actives. Essentiellement, dans le secteur de La Pocatière, St-Modeste et dans la Baie des Chaleurs, les populations s'identifient à un processus de fin d'épidémie de tordeuse, tandis que les autres s'apparentent davantage à une phase de début d'épidémie. Ces deux facteurs sont responsables du retrait de la plupart des blocs de la Baie des Chaleurs de même que d'un bloc de La Pocatière, soit une réduction de 7 749 hectares ou 34% par rapport aux prévisions de l'automne précédent.

En ce qui concerne l'efficacité du traitement, l'analyse des résultats révèle que celui-ci a été un succès, particulièrement dans les secteurs plus fortement infestés.

Il est bon de rappeler que, dans le cadre de ce programme, la décision d'intervenir tient compte des superficies restreintes et du morcellement de la forêt privée et de son état de stress suite aux défoliations précédentes de la tordeuse. Un inventaire exhaustif des massifs résineux, réalisé à l'automne 1985, a permis d'établir que sur les 114 700 hectares de forêt privée à majorité résineuse identifiés dans le territoire du Plan de l'est, seulement 64 300 hectares ou 56% de cette forêt ont un potentiel susceptible de justifier une intervention d'arrosage, pourvu que la population de tordeuse soit à un niveau suffisant.

Rappelons-nous aussi que les données d'échantillonnage pour les fins du suivi des dégâts de tordeuse sont prises sur les meilleurs arbres, et que l'état général des peuplements est inférieur en qualité et justifie davantage une intervention de protection.

En ce qui concerne la logistique de l'opération, celle de 1986 a marqué un net progrès sur celle de 1985. Notons particulièrement des améliorations dans le processus d'évaluation des blocs potentiels, dans le balisage, dans l'établissement des places échantillons, dans l'évaluation des résultats et dans la prise de décision en général.

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1986

TABLEAU 1: BILAN DES SUPERFICIES PROPOSÉES POUR 1986

Superficies potentielles après examen des cartes forestières (ha)	Superficies (ha) éliminées après...			Superficie retenues pour 1986 (ha) (automne 1985)
	Visite sur le terrain	Survol en hélicoptère	Analyse des indicateurs des niveaux de population	
Étape #1	Étape #2	Étape #3	Étape #4	Étape #5
La Pocatière				
11 400	- 2 535	- 365	- 615	7 885
Bas Saint-Laurent				
72 000	- 18 394	- 23 098	- 25 178	5 330
Gaspésie				
31 304	0	- 5 934	- 16 152	9 218
TOTAL 114 704	- 20 929	- 29 397	- 41 945	22 433

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1986

TABLEAU 2: BILAN DES SUPERFICIES TRAITÉES ET NON TRAITÉES

BLOC	SUPERFICIE (HA)			RAISON DE L'ÉCART	SUPERFICIE (HA)	RAISON
	RETENUE AUTOMNE 1985	AJOUTÉE OU ÉLIMINÉE	RETENUE PRINTEMPS 1986		TRAITÉE	
				L A P O C A T I È R E		
151	3 370	- 1 270	2 100	Partie feuillue, coupe totale	2 100	---
152	825	- 85	740	Coupe totale	740	---
153	0	+ 260	260	Secteur propice à l'arrosage	260	---
154	1 600	- 1 600	0	Faible population	0	---
156	2 090	- 260	1 830	Coupes totales	1 830	---
TOTAL La Pocatière	7 885	- 2 955	4 930		4 930	
				B A S S A I N T - L A U R E N T		
251	1 170	- 230	940	Coupe totale	940	---
252	1 500	+ 315	1 895	Secteur propice à l'arrosage	1 895	---
253	440	- 440	0	Faible population	0	---
254	2 140	+ 425	2 565	Secteur propice à l'arrosage	2 545	Conditions météorologiques
TOTAL Bas St-Laurent	5 330	+ 70	5 400		5 380	
				G A S P É S I E		
351	249	+ 13	262	Remesurage du bloc	262	---
352	700	- 700	0	Faible population	0	---
353	1 175	- 1 175	0	Faible pupulation	0	---
356	135	+ 27	162	Remesurage du bloc	162	---
357	316	- 11	305	Remesurage du bloc	305	---
358	350	+ 66	416	Secteur propice à l'arrosage	416	---
359	2 600	- 2 600	0	Refus des propriétaires	0	---
360	225	+ 150	375	Remesurage du bloc	375	---
361	600	+ 170	770	Secteur propice à l'arrosage	770	---
362	706	+ 79	785	Secteur propice à l'arrosage	785	---
363	322	+ 53	375	Remesurage du bloc	340	Topographie difficile
364	900	+ 4	904	Remesurage du bloc	904	---
365	940	- 940	0	Faible population	0	---
TOTAL Gaspésie	9 218	- 4 864	4 354		4 319	
GRAND TOTAL	22 433	- 7 749	14 684		14 629	

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1986

TABLEAU 3: RÉSULTATS DE LA DISPERSION

Numéro de bloc	Nombre de boites de Pétri	Nombre d'échantillons < 6 colonies/cm2	Moyenne colonies/cm2
151	60	0	19,5
152	41	9	6,8
156	42	13	6,9
252 (A)	26	10	6,0
252 (B)	24	0	9,4
254	24	0	10,7
356	20	7	7,5
360	23	7	8,0
362	28	8	7,9
MOYENNE	32	6	9,2

PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉBEC - 1986
TABLEAU 4: MORTALITÉ LARVAIRE, EFFICACITÉ DU TRAITEMENT ET DÉFOLIATION

NO. DU BLOC	PARCELLE ÉCHANTILLON	POPULATION PRÉTRAITEMENT larves/branche	larves/bourgeon	POPULATION INTERMÉDIAIRE larves/branche	Mortalité (%)	Efficacité (%)	POPULATION RÉSIDUELLE Larves/branche	Mortalité (%)	DÉFOLIATION 1986 (%)
				LA POCATIÈRE					
151	traitée	8,1	0,06	3,6	52,2	57,1	0,6	95,7	9,9
	témoin	5,0	0,05	6,0	22,5	-	0,1	98,4	11,9
152	traitée	9,4	0,09	1,0	86,9	77,0	0,2	97,8	8,1
	témoin	4,4	0,06	4,0	9,1	-	0,2	95,4	21,3
153	traitée	7,2	0,06	4,0	44,4	36,9	0,2	97,2	7,4
154	témoin	5,8	0,04	6,4	0	-	0,4	93,1	13,9
156	traitée	9,3	0,07	3,6	56,9	13,1	0,3	98,2	12,5
	témoin	10,4	0,05	4,8	53,8	-	0,6	94,2	13,5
				BAS ST-LAURENT					
251	traitée	15,8	0,08	2,9	69,8	39,6	0,5	98,1	8,9
	témoin	6,8	0,07	3,4	50,0	-	0	100,0	16,6
252	traitée	14,2	0,26	3,5	74,8	86,7	1,6	88,8	23,7
	témoin	5,8	0,07	2,0	65,5	-	4,6	20,6	64,0
254	traitée	9,2	0,08	2,5	69,0	68,7	0,8	85,1	11,6
	témoin	8,6	0,11	7,0	18,6	-	3,8	55,8	55,0
				GASPÉSIE					
351	traitée	10,4	0,22	2,0	80,8	73,1	0,4	96,1	5,6
	témoin	5,6	0,05	4,0	28,6	-	1,2	78,5	22,0
356	traitée	9,2	0,03	5,0	45,6	26,4	0,2	97,8	15,2
	témoin	3,0	0,03	2,2	26,0	-	1,8	40,0	40,2
357	traitée	7,0	0,04	3,2	54,0	54,0	0	100,0	5,6
	témoin	2,8	0,07	5,4	0	-	0	100,0	3,1
358	traitée	12,8	-	2,9	77,8	27,0	3,4	78,9	23,6
	témoin	18,4	0,11	5,6	69,5	-	1,8	90,2	47,2
360	traitée	9,8	0,07	1,2	86,9	86,9	0,1	99,1	15,3
	témoin	9,4	0,06	10,0	0	-	3,2	65,9	64,0
361	traitée	8,3	0,04	2,7	75,6	18,5	0,2	97,4	17,4
	témoin	10,4	0,13	2,8	73,0	-	1,4	86,5	65,9
362	traitée	9,8	0,06	5,5	45,6	45,6	0,9	90,9	41,9
	témoin	9,0	0,05	12,4	0	-	0,6	93,3	76,0
363	traitée	13,2	0,07	5,2	60,6	55,9	2,6	80,3	37,0
	témoin	17,0	0,10	15,2	10,5	-	4,4	74,1	76,0
364	traitée	12,5	0,09	9,6	31,4	31,4	0,5	96,0	21,8
	témoin	5,2	0,08	6,6	0	-	1,2	76,9	45,0

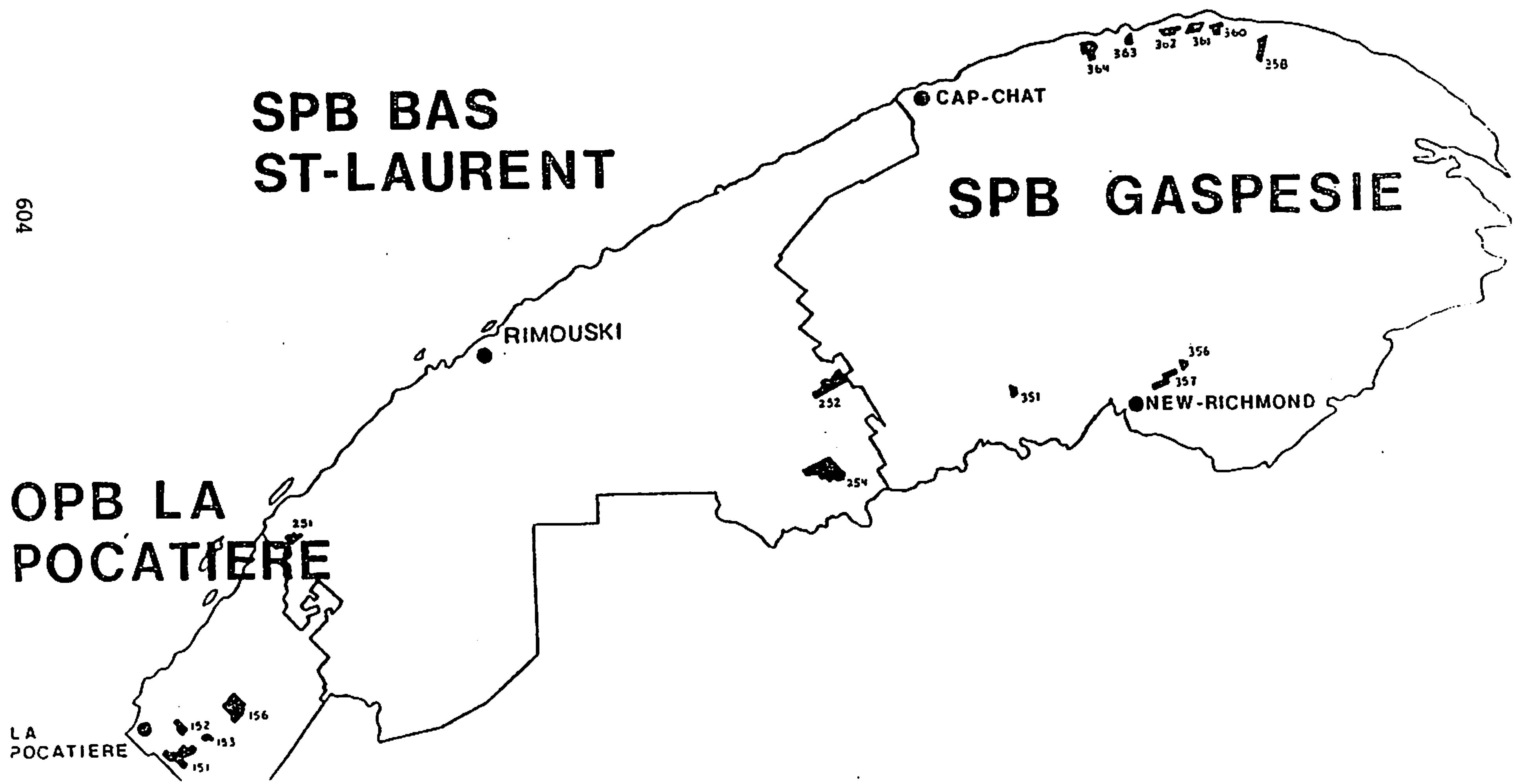
PROGRAMME DE PULVÉRISATION DE B.T. EN FORÊT PRIVÉE DANS L'EST DU QUÉEC - 1986

TABLEAU 5: ANALYSE COMPARATIVE DES COÛTS 1985/1986

SUPERFICIES TRAITÉES	1985 30 925 ha		1986 14 629 ha	
	Coûts $	Coûts $/ha	Coûts $	Coûts $/ha
1. <u>Coûts sociaux</u>				
- information, recrutement et demande de permis	82 137	2,66	53 729	3,67
- impression et distribution des rapports	1 407	,04	735	,05
SOUS-TOTAL	83 544	2,70	54 464	3,72
2. <u>Coûts directs de l'arrosage</u>				
- avion	305 317	9,87	163 332	11,16
- produit	352 854	11,41	160 086	10,95
- calibration, balisage, plan de mélange, radio mobile	123 563	4,00	130 123	8,89
SOUS-TOTAL	781 734	25,28	453 541	31,00
3. <u>Suivi biologique et encadrement</u>				
- phase préarrosage	66 572	2,15	24 884	1,70
- phase postarrosage	78 331	2,53	46 646	3,19
- suivi médical	33 872	1,10	---	--
- laboratoire	--	--	29 195	2,00
SOUS-TOTAL	178 755	5,78	100 725	6,89
TOTAL	1 044 053	33,76	608 730	41,61
4. <u>Coûts internes SCF</u>	95 458	3,09	37 130	2,54
GRAND TOTAL	1 139 511	36,85	645 860	44,15

Programme de pulvérisation de B.t. en forêt privée dans l'est du Québec-1986

Figure 1: Carte synthèse des blocs traités.



SPRUCE BUDWORM CONDITIONS IN THE UNITED STATES
1986

SPRUCE BUDWORM

LAKE STATES

A late freeze in May damaged shoots of spruce and fir and contributed to a collapse of budworm populations throughout much of Michigan and Wisconsin. Budworm populations were so low that no aerial surveys were made on State and Private lands. On Federal lands in Michigan, light defoliation occurred on 608 ha on the Hiawatha National Forest and 20 ha on Isle Royale National Park. In Minnesota, light to heavy budworm defoliation was recorded on 176,000 ha. An average of 450 male moths were caught in pheromone traps in the Lake States this year.

MAINE

Defoliation in the moderate to severe categories covered 248,820 ha, the lowest in several years. No suppression projects were conducted by the Maine Bureau of Forestry. However, 1,133 ha were sprayed experimentally with various B.t. formulations. The L-2 larval survey shows that defoliation in 1987 will be about 93,000 ha. Pheromone trap catches of male moths were in the single digit numbers throughout the State except at Loring Air Force Base where more than 100 male moths were captured in each trap.

No defoliation was reported in New York, New Hampshire, and Vermont. Pheromone trap catches were also low in these States.

WESTERN SPRUCE BUDWORM

REGION 1 (Northern Region)

Defoliation of various host species was recorded on about 1,018,500 ha on lands of all ownerships in Montana and northern Idaho.

A total of 283 ha was sprayed with B.t. at 30 BIU's per ha to control western spruce budworm on the Gallatin National Forest in Montana. This spray project was designed to improve regeneration in a timber sale area.

Presented at the Fourteenth Annual Forest Pest Control Forum, Ottawa, Ontario November 18-20, 1986 by Peter W. Orr, Assistant Director, Northeastern Area, State and Private Forestry, Broomall, Pennsylvania.

REGION 2 (Rocky Mountain Region)

About 400,000 ha of Douglas-fir, true firs, and spruce were defoliated in Region 2 in 1986. Only spotty defoliation occurred on the Front Range this year. Private landowners sprayed 10,000 ha in southwestern Colorado; most of the treatments involved the use of carbaryl.

The recovery of defoliated trees is very slow. In many areas, the Douglas-fir beetle has attacked and killed severely defoliated and weakened trees.

A suppression program has been proposed for the Grand Mesa, Uncompahgre, and Gunnison National Forests in Colorado in 1987.

REGION 3 (Southwestern Region)

An estimated 188,000 ha of Douglas-fir were defoliated on National Forest and other Federal lands. Most of this defoliation occurred in New Mexico.

This summer, 11 campgrounds on the Carson National Forest in New Mexico were sprayed from the ground with *B.t.* and another 1,133 has were aerially sprayed with *B.t.* Surveys are underway to determine if any treatments will be needed on the Carson National Forest in 1987.

REGION 4 (Intermountain Region)

Aerial detection surveys found defoliation on 1,269,500 ha, a marked increase over 1985. Much of the increased heavy defoliation occurred in southern Idaho on the Boise, Payette, and Sawtooth National Forests.

REGION 5 (Pacific Southwest Region)

The Modoc budworm (*C. retiniana*) caused moderate defoliation on 20,235 ha in the Warner Mountains and on Manzanita Mountain in northern California. This outbreak is significantly smaller than the 1982-85 outbreak.

The western spruce budworm (*C. carnana californica*) outbreak in Trinity and Shasta counties ended in 1985 due to a combination of climate factors and the application of *B.t.* In two light infestations found this year, parasitism was greater than 50 percent.

REGION 6 (Pacific Northwest Region)

Defoliation of Douglas-fir, true firs, and spruce increased by 202,350 ha from last year to a new total of 2,225,850 ha. Boise Cascade Company treated about 3,238 ha of their lands near LaGrande, Oregon with carbaryl. The biological insecticide B.t. was used to buffer streams in the project area. The spraying successfully reduced the budworm populations.

REGION 10 (Alaska Region)

In southeastern Alaska, light defoliation was detected on 97 ha of Sitka spruce in the Kelsall River drainage near Haines. C. fumiferana is believed to be the insect involved. No defoliation was seen in the interior forests.

Preliminary Estimate of Defoliation Caused by Spruce Budworm - 1986

STATE/REGION		AREA DEFOLIATED (Hectares)
Spruce Budworm		
MI		628
MN		176,000
ME		248,820
	TOTAL	425,448
Western Spruce Budworm		
R-1		1,018,500
R-2		400,000
R-3		188,000
R-4		1,269,500
R-5		20,235
R-6		2,225,850
R-10		97
	TOTAL	5,122,182
	GRAND TOTAL	5,547,630

SPRUCE BUDWORM SUMMARY
for MAINE 1986
Presented To
THE EASTERN SPRUCE BUDWORM COUNCIL

Tom Rumpf - State Entomologist

INTRODUCTION

Spruce budworm populations in Maine have declined steadily since 1982. The 1985 predictive survey showed the lowest budworm population levels recorded in Maine since 1972 with high and extreme populations being restricted to southeastern portions of the State. The last portions of the state to show budworm declines, the northwest and the southeast, showed the sharpest declines during 1984 and 1985.

Surveys conducted in the spring of 1986 showed that budworm populations were as low or lower than predicted. Nearly all of northern and western Maine had very low populations of L-3 larvae. Areas in the southeast, where high and extreme populations were predicted, had high and some moderate spring counts. Surveys of late instar larvae showed further declines in budworm numbers beyond what was expected from normal seasonal population decline. By the L-6 stage, budworm were difficult to find in northern and western Maine.

DEFOLIATION SURVEY

The 1986 aerial defoliation survey was much abbreviated due to low levels of defoliation throughout most of the state and considerable wind and rain which removed brown needles from the trees. The reduced aerial survey was supplemented with extensive ground observations to provide data for a defoliation map (Fig. 1). The areas of moderate to severe defoliation in 1986 was estimated to be 600,000 acres, about half the 1985 area, with nearly all the defoliation occurring in the southeastern portion of the state.

Bt SPRAY TRIALS

A small scale experimental spray trial using several Bt formulations was successfully conducted in southeastern Maine during 1986. The test covered 2800 acres and was a cooperative effort between the Maine Forest Service, the University of Maine (Dr. J.B. Dimond), Abbott Laboratories, Zoecon Corp. and Champion International Corp. Six Bt formulations and 8 spray regimes were tested (Table 1). All applications were made with a single thrush aircraft equipped with Micronair rotary atomizers. Spray deposit on fir needles was assessed.

TABLE 1. - 1986 MAINE Bt TRIALS - TREATMENTS TESTED

INSECTICIDE	# APP.	RATE BIU	VOLUME Oz./Acre
Dipel 8L	1	12 BIU	24
Dipel 8AF	1	8 BIU	16
Dipel 8AF	2	8 BIU Twice	16 Twice
Dipel Less Emulsifiers	1	12 BIU	24
Dipel 12L	1	12 BIU	16
Thuricide San 415-32LV	1	8 BIU	32
Thuricide San 415-32LV	2	8 BIU Twice	32 Twice
Thuricide 64LV	1	12 BIU	24

Data is still being analyzed and thus results are preliminary, but most of thw materials prevented 40% or more of the expected defoliation and killed 80% or more of the larvae. Budworm population means ranged from 8 to 30 in the area of the tests and untreated areas received heavy damage. Split applications of San 415-32LV and Dipel 8AF provided excellent foliage protection on both fir and spruce. A final report of the test by Dr. J.B. Dimond and H. Trial is being prepared at this time.

PHEROMONE TRAPPING

The Maine Forest Service, the USFS, and International Paper Company participated in the international effort to evaluate the budworm pheromone trapping system. Unlike the situation in 1985, trap catches seem to be well correlated to budworm populations measured by the L-II method. The MFS may adopt pheromone trapping as a survey method in 1987 due to the very low budworm populations expected in much of Maine and because of reductions in field staff.

L-II SURVEY

The 1986 predictive survey is nearing completion and a further decline in budworm numbers has been seen. Every sample taken in northern, central and western Maine had a low L-II count; many were 0's. In the southeast some areas of high and moderate population were identified, but counts are extremely variable and the size of these areas is greatly reduced from 1985 levels. Moderate to extreme defoliation is expected on about 230,000 acres in 1987 (Fig. 2), about a third of the 1986 area. All the areas are in the southeast.

ADMINISTRATIVE MATTERS

Associated with the declines in budworm populations in Maine there has been a similar decline in budworm staff. At present 4 of 36 full-time employees remain on the budworm account and all employees should be off the account by June, 1987. Most of the 4 remaining staff are expected to be incorporated into the general entomology program. A level of budworm expertise will be maintained and employed when budworm populations blow-up again.

Much of the MFS spray equipment will be sold in the near future. A core of equipment suitable to conduct a 300,000 acre project will be retained. Much of the equipment to be sold is not compatible to the current operational methods used in Maine.

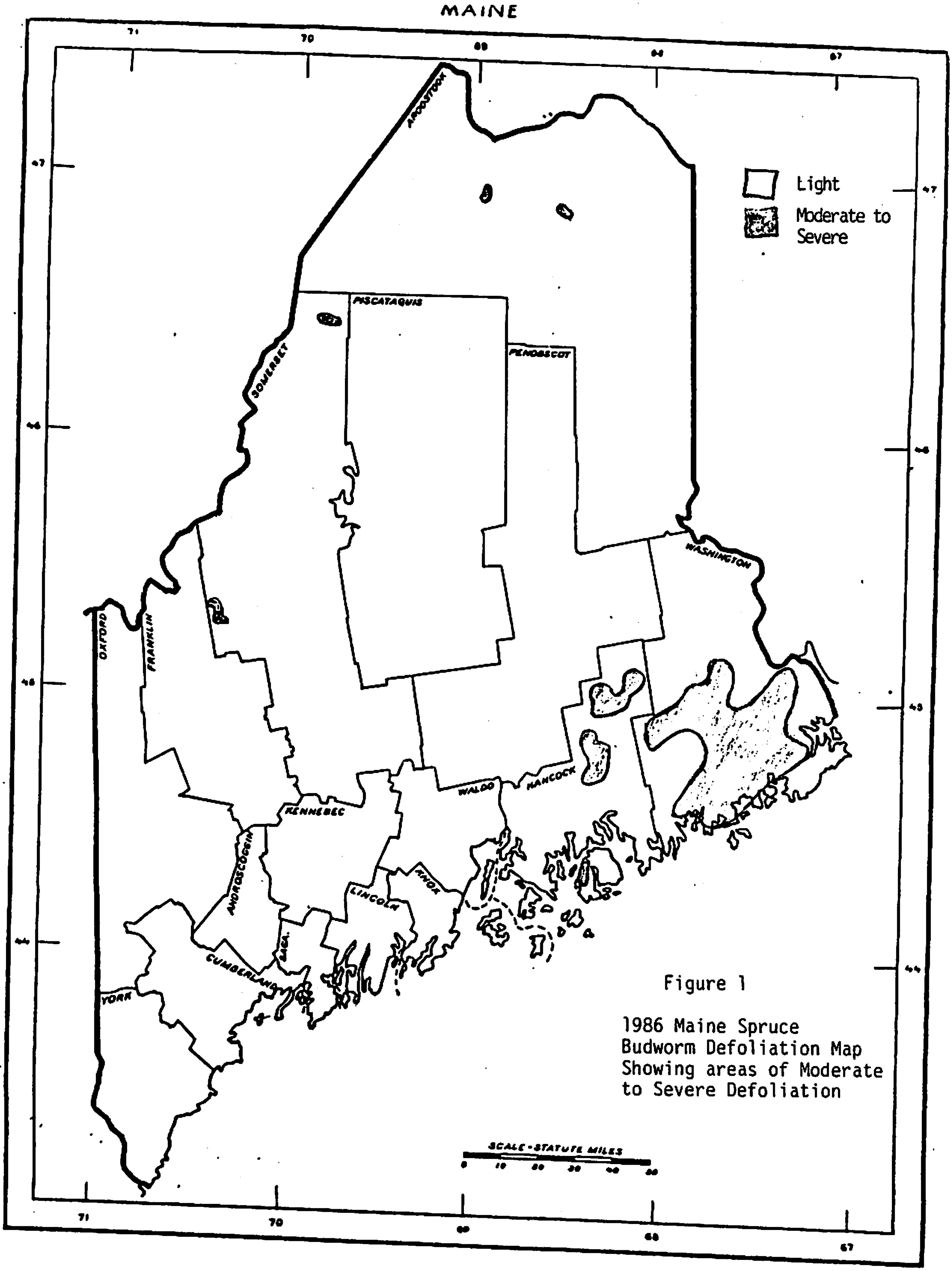


Figure 1

1986 Maine Spruce Budworm Defoliation Map Showing areas of Moderate to Severe Defoliation

MAINE

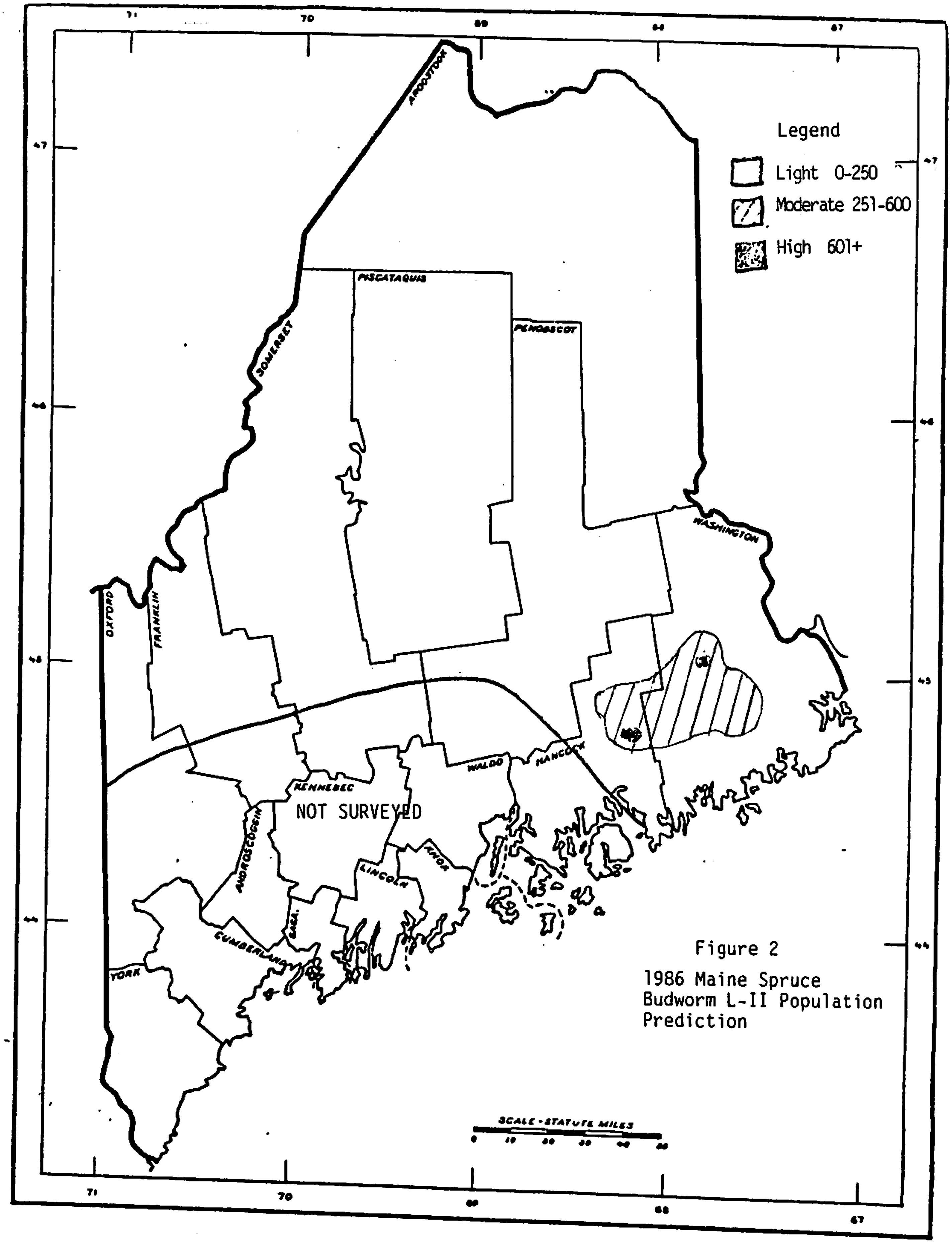


Figure 2
1986 Maine Spruce Budworm L-II Population Prediction

SPRUCE BUDWORM IN ONTARIO, 1986

- Outbreak Status 1986
- Forecasts 1987
- Results of Spraying Operations, 1986

by

J.H. Meating[2], G.M. Howse[1] and B.H. McGauley[3]

[1] Report prepared for the Annual Pest Control Forum, Ottawa, November 18-20, 1986.

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

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

OUTBREAK STATUS 1986

Spruce budworm infestations declined in Ontario in 1986. Across the province, some 8,855.687 ha of moderate-to-severe defoliation were mapped by ground and aerial surveys, a reduction of 3,476,678 ha or 28% from the 12,332,365 ha mapped in 1985 (Table 1 and Figure 1).

The biggest change occurred along the eastern edge of the main infestations in the Wawa and Hearst districts where decreases in excess of 2.5 million ha were recorded. Substantial declines also occurred in the main infestation in Thunder Bay, Nipigon, Geraldton, Dryden, Fort Frances and Terrace Bay districts. These were partially offset by increases in the Red Lake and Sioux Lookout districts. Nevertheless, a large infestation persists from the Pagwa River-Marathon area of the Geraldton and Terrace Bay districts westward to the Manitoba border, encompassing large areas of the Geraldton, Terrace Bay, Nipigon, Thunder Bay, Atikokan, Ignace, Fort Frances, Dryden, Kenora and Sioux Lookout districts.

Several pockets of moderate-to-severe defoliation occurred north of the main infestation in the Kenora, Red Lake and Thunder Bay districts, along with a number of small pockets that persist in previously infested areas in the Wawa and Hearst districts.

In the Thunder Bay District, two large areas totalling 101,719 ha showed considerable variation in the pattern of defoliation. While overall defoliation was still in the moderate-to-severe range, it was much less consistent than in surrounding areas, and consequently, aerial mappiing was extremely difficult.

Elsewhere in the northeastern part of the province infestations continued to decline rapidly, although a few pockets, totalling 2,665 ha, persisted in the Espanola, North Bay and Sudbury districts.

Infestations in southern Ontario were further reduced to 642 ha. These consisted of small, widespread patches in the Bracebridge and Algonquin Park districts.

FORECASTS 1986

In August 1986, 587 locations were sampled across the province for spruce budworm egg-masses. Overall, an increase of approximately 16% occurred compared to 1985 densities. However, this overall increase was caused by a large increase of 89% in the Northwestern Region in contrast to declines in the other regions.

Consequently, in 1987, moderate-to-severe defoliation is expected to persist throughout most of the area infested in 1986 with some possible expansion along the northern edge of the infestation. In the North Central Region, egg counts were more varied. Moderate-to-severe

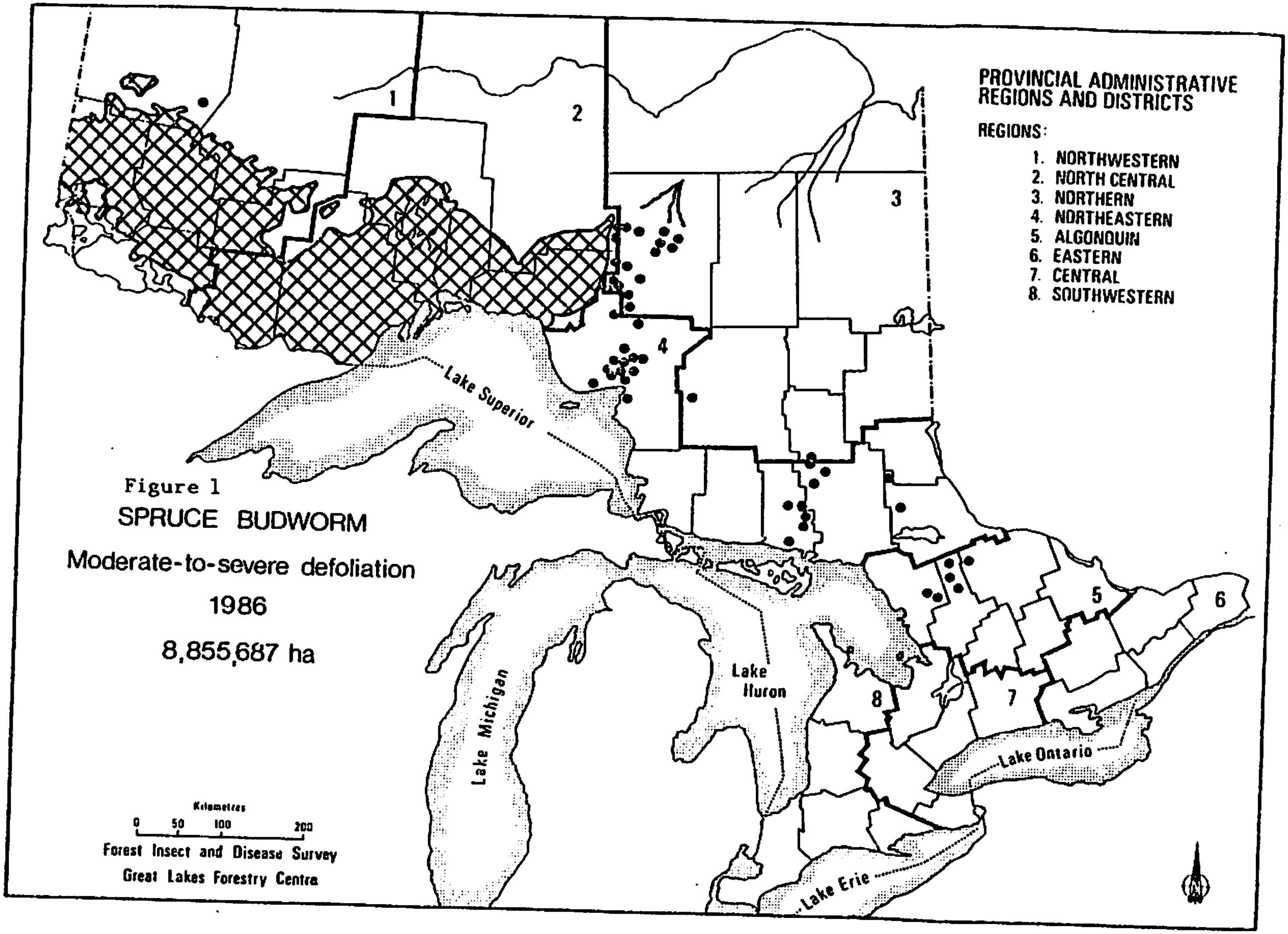


Figure 1
SPRUCE BUDWORM
Moderate-to-severe defoliation
1986
8,855,687 ha

Table 1. Gross area (ha) of current moderate-to-severe defoliation by spruce budworm from 1984 to 1986

Region	District	Area of moderate-to-severe defoliation 1984	1985	1986
Algonquin	Bracebridge	28,606	720	436
	Algonquin Park	44,234	800	206
	Parry Sound	0	0	0
		72,840	1,520	642
Northeastern	Blind River	4,935	0	0
	Espanola	42,278	1,980	408
	North Bay	345,062	20,305	1,802
	Sault Ste. Marie	30,255	7,875	0
	Sudbury	250,483	105,805	455
	Temagami	241,901	245	0
	Wawa	1,288,475	1,386,547	11,839
		2,203,389	1,522,757	14,504
Northern	Chapleau	0	6,120	70
	Cochrane	85,358	600	0
	Gogama	11,906	11,570	428
	Hearst	784,202	1,173,734	32,384
	Kapuskasing	6,827	0	0
	Timmins	0	0	0
	Kirkland Lake	35,633	1,125	0
		923,926	1,193,149	32,882
North Central	Atikokan	918,500	918,500	890,691
	Geraldton	189,863	683,178	400,486
	Nipigon	235,372	1,125,751	985,961
	Thunder Bay	1,809,741	2,315,563	2,005,718
	Terrace Bay	726,420	1,168,400	1,023,773
		3,879,896	6,211,392	5,306,629
Northwestern	Dryden	454,099	952,385	891,997
	Fort Frances	566,831	700,172	542,176
	Ignace	456,526	599,895	530,761
	Kenora	63,314	911,037	906,917
	Red Lake	200	10	200,349
	Sioux Lookout	126,831	240,048	428,830
		1,667,801	3,403,547	3,501,030
Total		8,747,852	12,332,365	8,855,687

defoliation is expected to persist in the Atikokan and Nipigon districts in most of the areas infested in 1986 but substantial declines in the extent and severity of defoliation are expected in the Geraldton and eastern Terrace Bay districts and the Thunder Bay District. The most substantial declines will probably occur in the southern Thunder Bay District where the infestation may begin to collapse but moderate-to-severe defoliation will probably persist on the Sibley Peninsula and along the Thunder Bay-Nipigon district boundaries. Increased defoliation is expected in the Black Sturgeon Lake area of the western Nipigon District.

In the Northern and Northeastern regions, egg-mass densities declined by some 89%, the fourth consecutive year of decline, and consequently, little defoliation is expected in 1987. The only exception could occur in the western Hearst District where a few pockets of moderate-to-severe defoliation may persist. No defoliation of any consequence is expected in southern Ontario.

Table 2. Comparison of spruce budworm egg-mass densities in Ontario in 1985 and 1986.

OMNR Region	No. of locations sampled in 1986	No. of locations common to both years	Average egg-mass density per 9.29 m^2		
			1985	1986	% change
Northwestern	139	104	400	756	+89
North Central	282	150 (17)*	308	237	-23
Northern	89	68 (4)*	153	16	-89
Northeastern	50	39	29	11	-61
Southern Ontario**	27	26	5	5	-1
Overall	587	387	257	299	+16

* Includes 21 locations sprayed in 1986.

** Southern Ontario includes the Algonquin, Eastern, Central and Southwestern Regions.

RESULTS OF SPRAYING OPERATIONS

In 1986, the Ontario Ministry of Natural Resources (OMNR) aerially sprayed a total of 150,633 ha of spruce-fir forest in eight districts in northern Ontario to protect stands from the spruce budworm (Table 3). The *Bacillus thuringiensis* formulation Thuricide 48LV (Sandoz) was used estensively in this year's program. Single and double applications at 20 or 30 BIU/l were applied from fixed-wing aircraft and helicopters. As in previous years, the 1986 spruce budworm protection program involved both commercial stands and high value forests such as provincial parks, plantations and wildlife habitat.

Unusually warm temperatures (30° C+) in late May and early June accelerated larval development across northern Ontario. This disrupted normal phenological patterns resulting in uniform larval development throughout the region. A summary of larval development at eight locations is presented in Table 4. Spray blocks in the southern part of Thunder Bay and Nipigon districts were opened May 27 and all remaining blocks on May 29. However, in many areas spraying was delayed because aircraft involved in the gypsy moth program in eastern Ontario had not arrived in northern Ontario or because of problems with airstrips.

Results of the 1986 spruce budworm aerial spraying program are presented in Tables 5 to 10. Blocks in the three most easterly districts, Hearst, Geraldton and Terrace Bay, were treated with a single application of Thuricide 48LV at a rate of 20 BIU/1.6 l/ha. Pre-spray populations in most of the assessment plots were not exceptionally high on either balsam fir or white spruce (Tables 5 to 7). High levels of natural mortality occurred during the larval and pupal stages in much of this area, resulting in light-to-moderate defoliation in both treated and check plots. This is reflected in the reduced area of moderate-to-severe defoliation described previously in the report for this region of the province. Further west, in Nipigon and Thunder Bay districts (Tables 8 & 9), pre-spray populations were generally higher, especially on white spruce. Larval and pupal mortality in untreated plots was not as heavy as observed in the three eastern districts and, consequently, defoliation rates were substantially higher. Two application rates, 20 and 30 BIU/l, were used in Thunder Bay District (Table 9). The higher rate was used on stands that had suffered several years of severe defoliation in the hope that this dosage would provide a greater level of protection. A number of white spruce plantations were also treated in Thunder Bay District, however, because pre-spray populations and subsequent defoliation levels were low, this portion of the program has not been included in this report. In the Northwestern Region, two provincial parks, Ojibway and Sandbar, totalling 168 ha, were treated with Thuricide 48LV. The results of these two treatments are presented in Table 10.

Overall, results of the 1986 spruce budworm aerial spraying program were quite variable. The rapid and uniform development of budworm larvae throughout the region and technical problems leading to delays in the program may account for some of the poorer results.

Table 3. Spruce budworm: Area treated by OMNR region in 1986.

OMNR Region	Area (ha)
Northwestern	168
North Central	99,381
Northern	36,618
Northeastern	14,466
Total	150,633

Table 4. Spruce budworm: Summary of larval development in northern Ontario in 1986.

Location	Date	Tree Species	Larval Instar (%) 2	3	4	5	6	P
Geraldton District								
Klotz Lake	May 22	bF	28	54	18			
	May 22	wS	52	22	26			
	June 1	bF	2	6	49	41	2	
	June 1	wS		2	52	35	11	
	June 11	bF		2	16	60	22	
	June 11	wS			10	75	15	
	June 18	bF			11	46	43	
	June 18	wS			6	44	50	
Terrace Bay District								
Bicknell Twp	May 22	bF	19	77	4			
	May 22	wS	20	61	17	2		
	May 28	bF		12	59	29		
	May 28	wS		4	40	46	10	
	June 2	bF		2	19	69	10	
	June 2	wS		8	14	31	47	
	June 11	bF			4	44	52	
	June 11	wS			6	20	74	
	June 19	bF				27	73	
	June 19	wS				18	82	
Hearst District								
Nagagamisis Prov. Pk.	May 27	bF		38	62			
	May 27	wS	4	40	48	8		
	June 10	bF			32	60	8	
	June 10	wS			22	62	16	
	June 17	bF			33	54	12	
	June 17	wS			29	57	14	
Thunder Bay District								
Shilabeer Creek	May 13	bF	36	64				
	May 13	wS	100					
	May 22	bF	32	58	10			
	May 22	wS	40	34	26			
	May 27	bF	6	36	58			
	May 27	wS		23	70	7		
	June 1	bF		12	54	34		
	June 1	wS			22	42	36	
	June 10	bF			42	52	6	
	June 10	wS			8	31	61	
	June 24	bF				7	68	25
	June 24	wS				4	23	72

(cont'd)

Table 4. Spruce budworm: Summary of larval development in northern Ontario in 1986 (concl.).

Location	Date	Tree Species	Larval Instar (%) 2	3	4	5	6	P
Thunder Bay District (cont'd)								
Cheeseman Lake	May 15	bF	92	8				
	May 15	wS	96	4				
	May 27	bF	11	78	11			
	May 27	wS	22	39	39			
	June 11	bF			6	60	34	
	June 11	wS			2	22	76	
	June 24	bF				23	72	5
	June 24	wS				5	4	51
Sibley	May 13	bF	88	12				
	May 13	wS	96	4				
	May 22	bF	63	35	2			
	May 22	wS	85	15				
	May 25	bF	4	90	6			
	May 25	wS	14	62	24			
	June 2	bF		2	44	52	2	
	June 2	wS		4	38	52	6	
	June 11	bF		2	38	40	20	
	June 11	wS			4	20	76	
	June 23	bF				13	78	9
	June 23	wS				18	63	19
Whitefish Lake	May 8	bF	89	11				
	May 8	wS	88	12				
	May 16	bF	72	28				
	May 16	wS	66	34				
	May 23	bF	8	84	8			
	May 23	wS	2	80	18			
	May 26	bF		62	38			
	May 26	wS		26	70	4		
	June 12	bF		2	6	42	50	
	June 12	wS				6	94	
Ignace District								
Sandbar Provincial Park	May 22	bF	18	82				
	May 24	bF	2	86	12			
	May 26	bF		62	38			
	May 27	bF		12	84	4		

Table 5. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Thuricide 48LV at 20 BIU/1.6 l/ha on balsam fir and white spruce in Hearst District, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Balsam Fir				
Fushimi Prov. Pk	11.0	0	100	8
Checks	10.7	0.9		46
Nagagamisis Prov. Pk	5.0	0	100	17
Checks	4.2	0.7		23
Chelsea Twp	6.7	0	0	9
Checks	6.8	0		25
Bayfield Twp	4.6	0	100	10
Checks	4.2	0.7		23
McEwing Twp	7.6	0.1	0	12
Checks	7.7	0		65
White Spruce				
Nagagamisis Prov. Pk	10.4	0	100	22
Checks	10.8	0.9		28
Chelsea Twp	9.4	0	100	8
Checks	9.2	0.5		46
Bayfield Twp	3.2	0	100	4
Checks	3.5	0.7		8
McEwing Twp	9.8	0	100	11
Checks	9.2	0.5		26

Table 6. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Thuricide 48LV at 20 BIU/1.6 l/ha on balsam fir and white spruce in Terrace Bay District, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Balsam Fir				
14-7	2.1	0.1	0	6
Checks	2.0	0.1		4
14-12	4.9	0	100	6
Checks	4.2	0.7		23
14-21	6.1	0	100	9
Checks	6.0	0.7		31
14-30	3.3	0.1	91	4
Checks	3.6	1.0		20
14-31	4.1	0.4	45	13
Checks	4.2	0.7		23
White Spruce				
14-7	7.5	0.1	92	5
Checks	7.3	1.5		30
14-10	11.9	1.5	0	9
Checks	10.8	0.9		28
14-12	5.4	0.1	53	6
Checks	6.2	0.3		12
14-30	10.1	0.1	92	6
Checks	10.8	0.9		28
14-31	5.8	0.3	0	12
Checks	6.2	0.3		12

Table 7. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Thuricide 48LV at 20 BIU/1.6 l/ha on balsam fir and white spruce in Geraldton District, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Balsam Fir				
15-3-E	7.8	0.1	0	33
Checks	7.7	0		65
15-4-A	10.9	0.1	87	30
Checks	10.7	0.9		46
15-4-B	9.9	0	100	18
Checks	9.8	0.3		41
Boyce Twp	3.7	0.1	93	10
Checks	3.6	1.0		20
White Spruce				
15-3-E	9.2	0.1	87	15
Checks	9.2	0.5		26
15-4-A	6.1	0	100	5
Checks	6.2	0.3		12
15-4-B	4.9	0	100	4
Checks	4.8	0.3		9
Boyce Twp	20.6	0.3	87	36
Checks	19.7	2.2		64

Table 8. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Thuricide 48LV at 20 BIU/1.6 l/ha on balsam fir and white spruce in Thunder Bay District, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Balsam Fir				
Black Sturgeon Lk 10	8.9	1.2	57	77
Checks	8.8	2.7		45
McMaster Twp 7	11.6	2.0	38	87
Checks	11.3	3.1		77
Mountain Lk 50	10.5	1.5	39	22
Checks	10.4	2.4		58
Sibley Prov. Pk	5.1	0.3	84	24
Checks	5.4	1.6		52
Conmee Twp 18	6.7	0.4	81	26
Checks	7.0	1.9		57
White Spruce				
Sandra Twp 16-A	16.2	3.5	0	61
Checks	15.6	1.6		69
Black Sturgeon Lk 10	21.0	0.8	77	38
Checks	21.1	3.6		80
McMaster Twp 7	27.9	5.0	0	95
Checks	27.6	2.5		67
Sibley Prov. Pk	11.2	3.9	0	43
Checks	11.2	2.7		86
Conmee Twp 18	16.5	5.9	0	51
Checks	16.8	2.2		72

Table 9. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to applications of Thuricide 48LV on balsam fir and white spruce in Thunder Bay and Nipigon districts, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Balsam Fir				
[a] 18-11	7.4	0.3	81	28
Checks	7.6	1.5		47
[a] 18-13	12.1	0.7	72	41
Checks	12.3	2.5		74
[b] 18-15	11.6	0	100	22
Checks	11.3	3.1		77
[b] 18-22	11.1	1.1	64	84
Checks	11.3	3.1		77
[b] 18-26	15.1	0.5	80	55
Checks	16.2	2.5		86
[c] 18-29	11.4	0.2	92	17
Checks	11.3	3.1		77
[a] 18-31	7.2	2.4	0	53
Checks	7.6	1.5		48
[a] 18-32	2.9	0.2	57	10
Checks	2.7	0.4		19
White Spruce				
[a] 18-11	19.3	3.1	18	26
Checks	20.4	4.0		77
[a] 18-13	17.1	0.7	75	28
Checks	17.5	2.8		68
[b] 18-15	15.8	0.4	76	13
Checks	15.6	1.6		69
[b] 18-22	36.4	2.7	38	89
Checks	35.6	4.3		66
[b] 18-26	36.7	0.2	95	85
Checks	35.6	4.3		66
[c] 18-29	25.1	0.7	69	31
Checks	24.7	2.2		79

(cont'd)

Table 9. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to applications of Thuricide 48LV on balsam fir and white spruce in Thunder Bay and Nipigon district, 1986 (concl.)

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
White Spruce (cont'd)				
[a]18-31	12.5	1.8	27	53
Checks	12.7	2.5		78
[a]18-32	8.2	0.4	85	5
Checks	9.0	3.2		79

[a] 30 BIU/2.4 l/ha - 1 application

[b] 20 BIU/1.6 l/ha - 1 application

[c] 30 BIU/2.4 l/ha - 2 applications.

Table 10. Spruce budworm: Population reduction, pupal survival and foliage protection attributable to a single application of Thuricide 48LV at 30 BIU/2.4 l/ha on balsam fir in two provincial parks in the North-western Region, 1986.

Location	Pre-spray larvae per 46 cm tip	Surviving pupae per 46 cm tip	Population reduction due to treatment (%)	1986 Defoliation (%)
Ojibway Provincial Park	14.8	4.3	45	43
Checks	11.0	5.8		59
Sandbar Provincial Park	15.3	5.2	12	51
Checks	18.1	7.0		62

WESTERN-NORTHERN REGION - 1986

STATUS OF IMPORTANT FOREST PESTS

Prepared for the Fourteenth Annual Pest Control Forum

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Ottawa,

H.F. Cerezke
Northern Forestry Centre
Edmonton, Alberta

The following is a summary of the major insects and diseases monitored in the Western-Northern Region.

Mountain Pine Beelte (Dendroctonus ponderosae)

Infestations of the mountain pine beetle continued to decline in southwestern Alberta and Saskatchewan, and in the Rocky Mt. National Parks, except in Kootenay and Yoho Parks. In Yoho Nat'l. Park about 110 1985-attacked trees were mapped, indicating a slight increase over last year. The largest increase occurred in Kootenay Nat'l Park where about 5500 trees were estimated as new mortality this year. This represents a near 2-fold increase over last year. Good overwinter survival and readily available mature host trees largely contributed to the increase.

Elsewhere in southwestern Alberta where the main infestation has persisted, only a few scattered lodgepole and limber pines were attacked, while virtual collapse seems apparent in the Cypress Hills area on the southern Alberta/Saskatchewan border.

Intensive detection and control programs on the beetle were carried out by provincial forestry and park staff in both Alberta and Saskatchewan, and involved the deployment of commercially-prepared pheromone lure and sanitation cuttings.

The Mountain Pine Beetle Interagency Committee involving CFS, Parks Canada, B.C. Ministry of Forests, B.C. Parks and Alberta Forest Service met to review infestations on or adjacent to the Alberta-BC border, and to discuss control proposals. Considerable focus was on infestations west of Jasper National Park, west of the Kananaskis area and in Kootenay National Park.

The Border Lodgepole Pine Management Coordinating Group formed under the Mountain Pine Beetle program of the Canada/USA Memorandum of Understanding met in the Kelowna area of B.C. to view and discuss bark beetle control, stand management strategies, and related land use issues such as recreation, cattle grazing and watershed management.

Jack Pine Budworm (Choristoneura pinus pinus)

Moderate to severe defoliations of jack pine in Manitoba, caused by the jack pine budworm were mapped over some 132,000 ha distributed mostly in the southeastern part of the province. This represented a decrease of over 90% of the areas mapped last year. Declines occurred in most areas except in the Lake Winnipeg East and Pineland Districts, while intensification occurred in the Whiteshell area.

In Saskatchewan, the total area moderately-severely defoliated occurred in six general areas and increased to some 176,000 ha, indicating a 35% increase over last year. Some decline in area of infestation occurred in east central Saskatchewan while increases were noted in the central region.

The outbreak in Alberta remained similar to last year, involving a few ha of mod-severe defoliation in the central part of the province.

Forestry staff in all three provinces have participated in the monitoring and assessment of the infestations. In addition, Weyerhaeuser Canada Ltd. at Prince Albert, Saskatchewan has intensively mapped its budworm-attacked lease areas to prioritize those most severely damaged for early removal. In both Manitoba and Saskatchewan outbreak areas, some tree mortality has occurred to date but is spotty in location, while considerable volume loss and top kill can be expected in most of the stands undergoing second and third year defoliations.

Studies in Manitoba have been underway to relate jack pine budworm development to the phenology of its pine host. Populations of eggs and larvae are being correlated with defoliation, and male flower development will be assessed to correlate with predicted levels of budworm next year. Plots have also been established to assess growth loss, top kill and mortality caused by the jack pine budworm. Funding under the federal-provincial agreements in Manitoba, Saskatchewan, and Alberta is being provided to support development of a consistent pheromone trap-bait and trapping system for the jack pine budworm through Dr. P. Silk at the Research and Productivity Council, N.B.

Studies, initiated in Saskatchewan have three main objectives: 1) to determine the functional relationship between jack pine budworm population density and defoliation levels; 2) assess the effects of defoliation on growth loss of stems; and 3) develop, modify or improve survey sampling procedures of egg, larval and moth stages.

In early 1986 a formal information exchange on the jack pine budworm, sponsored by the Forestry Branch of Manitoba National Resources, was held in Winnipeg, Manitoba. Proceedings of the workshop has been prepared by Manitoba Natural Resources.

Spruce budworm (*Choristoneura fumiferana*)

Areas of moderate-severe defoliation by the spruce budworm in Manitoba in 1986 were decreased by about 56% from that reported in 1985. Nearly all areas occurred in the southeast part of the province, with highest populations and increased area defoliated in the Whiteshell area. Total area defoliated was about 34000 ha.

In Saskatchewan defoliated white spruce-balsam fir stands occurred at five locations in the east-central part of the province, and amounted to some 18,500 ha, an increase of about 23% over last year. Heavy defoliation in some of these locations began as early as 1982 and 1983. In three of the main outbreak areas (Torch River, Usherville and Red Earth), the province has undertaken salvage harvesting of stands identified to be the most severely damaged by the budworm.

In Alberta small infestations causing mod-severe defoliation were noted at five locations within the central part of the province, amounting to 3-500 ha. Some of these infestations are located in high use areas of provincial parks and the city of Edmonton, and have been treated with Bt for two consecutive years. In addition to the spruce budworm in the city of Edmonton, high populations of the spruce bud moth *Zeiraphera canadensis* and *Dioryctria reniculelloides* were also noted.

In the Northwest Territories where about 12000 ha of severe defoliation was recorded last year, the outbreaks have now expanded to about 18,000 ha, but spread over a much larger area. Much of the increases occur along the Liard River drainage and in two new areas adjacent to the Slave River.

Spruce budworm pheromones were deployed in Multipher traps at widely scattered locations in Alberta, Saskatchewan and Manitoba. At each trap location foliage samples were collected for egg mass and defoliation data that may help to correlate with moth catches.

Aspen Defoliators, especially Forest Tent Caterpillar (*Malacosoma disstria*)

In Manitoba, a few small scattered areas of moderate-severe defoliation patches of aspen were mapped, caused mostly by the forest tent caterpillar. Most occurred in the west-central part of the province.

In Saskatchewan and Alberta, the forest tent caterpillar caused widespread defoliation in much the same areas as in 1985. The main infestation areas extend across the central part of Alberta nad into west-central Saskatchewan. Additional areas are located in the Grande Prairie area and in east-central Saskatchewan. Total area of infestation in the two provinces is estimated to extend over 1,000,000 ha (est. 398,000 ha in Saskatchewan).

Egg band surveys now being completed indicate that high populations are expected within the same areas in Alberta and Saskatchewan, and may even expand beyond that reported this year.

An area of recent and current forest tent caterpillar defoliations, extending throughout an area within the agricultural zone of about 17,000 km^2 in east-central Alberta and west-central Saskatchewan had variable amounts of aspen mortality and top kill. This is believed to have resulted from a combination of weakening by forest tent caterpillar defoliations, summer drought conditions during 1983 and 1984, and early and late spring frosts in 1986 prior to and at the time of budbreak.

Resource use of aspen is rapidly expanding in the prairie provinces and this may require a greater focus on monitoring and management for insect and disease organisms. In Alberta, extensive cull surveys are being planned in areas slated for expanded aspen utilization. Presently two of the most common disease fungi contributing to aspen decline and decay are *Hypoxylon mammatum* and *Phellinus igniarius*.

SPRUCE BUDWORM INFESTATION IN SASKATCHEWAN PROVINCIAL FORESTS

Madan Pandila
Saskatchewan Parks and Renewable Resources
Prince Albert, Saskatchewan

INTRODUCTION:

In the mid 1950's, there were two infestations of Spruce Budworm in the province, one near Namew Lake, north of The Pas, Manitoba, and the other along the Birch River, south of Cumberland House. At its peak it covered about 8,400 km^2 of forest area and resulted in up to 30% of white spruce mortality, in some areas. At that time no action was taken on the Namew Lake outbreak as it was isolated, but timber harvesting was conducted along the Birch River as the timber was over-mature and mortality would have been severe. The harvesting also helped in the control of the infestation.

CURRENT STATUS:

The current outbreak of Spruce Budworm infestation was first detected south of Hudson Bay in 1982. In 1983, another infestation was discovered east of Nipawin and southeast of the Red Earth Indian Reserve. In early 1984 another spot infestation was detected along the Torch River, north of the Squaw Rapids Power Development. In 1985 three smaller areas in the Hudson Bay area near Tall Pines, Tennant Lake and the Woody Tower were detected.

The aerial survey, done by staff of Forestry Division and the Canadian Forestry Service (CFS), reported no new outbreak this year and all infestations remained moderate to severe.

No prediction for 1987 has yet been reported by CFS.

CONTROL STRATEGY:

With the discovery of Red Earth infestation in 1983, Forestry Division initiated timber harvesting and salvage operations through Saskatchewan Forest Products Corporation (SFPC) in Red Earth area and in the Torch River block.

Since 1985, Simpson Timber Company (STC) have been harvesting severely infected areas in the Tall Pines and Swan River areas in the Porcupine Forest.

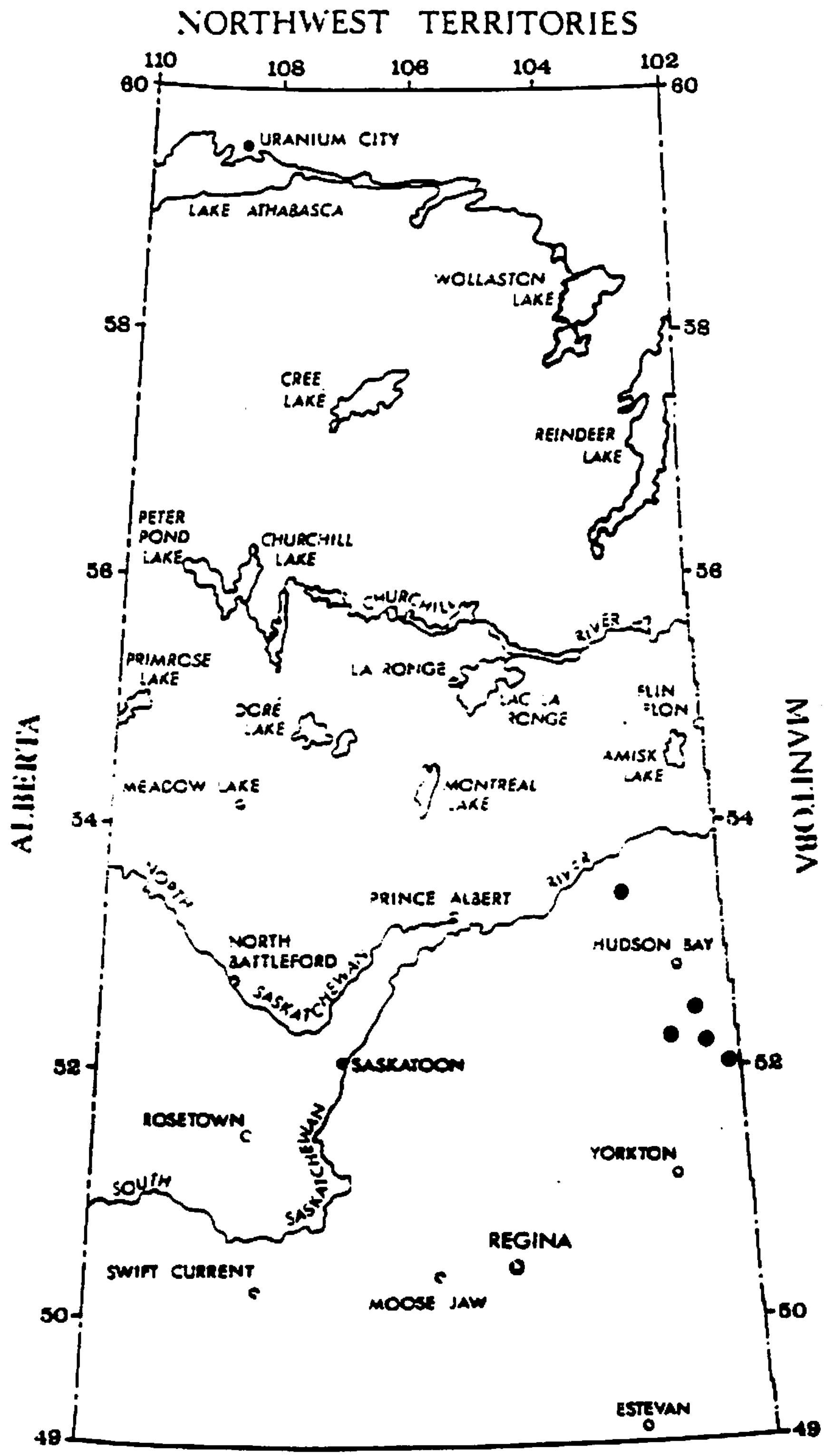
As a result of these operations, the infestation has been practically eliminated from the Torch River area. Annual harvesting programs will continue in the rest of the area as a control measure.

Forestry Division will continue to monitor the infestation through use of color infrared photography combined with aerial reconnaissance.

REQUIRED ACTION:

The infestation will continue to be monitored by both SPRR and CFS.

SFPC will continue the harvesting of heavily infested timber in the Red Earth and Nipawin areas in 1987. STC will continue harvesting infested timber in the Tall Pines area in 1987.



SASKATCHEWAN

● ------ 1986 - SPRUCE BUDWORM INFESTATION
IN SASKATCHEWAN

THE ROLE AND MANDATE OF THE NATIONAL FOREST PEST CONTROL FORUM

by B. H. McGauley

The National Forest Pest Control Forum has been in existence since 1973 and represents the only national meeting when all forest pest management and pesticide specialists can meet to exchange information and discuss issues concerning their current year and forecast programs. The Forum replaced the long-standing Interdepartmental Committee on Forest Spraying Operations which carried out a similar function but with little or no provincial representation. The Interdepartmental Committee was originally formed to review and recommend federal involvement in and funding of pest control operations carried out in the late 1950's and 1960's.

In recent years, the Forum has permitted an exchange of information concerning pest management operations and research. This has been the principal function of the Forum.

At the Forum meeting at Ottawa, November 19-21, 1985, a Forum Mandate Review Committee was proposed because there were several attendees who felt that the Forum could and should be more than an information exchange session. The committee, consisting of B. H. McGauley (OMNR), G. Munro (MDNR), L. Dorais (QMER), G. M. Howse (CFS) and E. Kettela (CFS) was subsequently endorsed by the Director General, Research and Technical Services. The terms of reference for the committee as outlined in a letter dated December 17, 1985 from the FIDS Program Manager, Protection, to the Director General were as follows:

i) examine the mandate of the Annual Forest Pest Control Forum,

ii) consider a change in the mandate of the Forum,

iii) if a change to the mandate is considered necessary, make recommendations for implementation of a change,

iv) discuss and make recommendations for broadening of the Forum to include vegetation management research.

The committee met in May and August 1986 to address the terms of reference and prepare a proposed goal and mandate statement for presentation at the 1986 Forum. The proposal was debated at length and modified to take into consideration the comments of the attendees. The modified role and mandate as agreed upon at the 1986 National Forest Pest Control Forum are outlined in this paper.

1.0 National Forest Pest Control Forum:

A National Forest Pest Control Forum will be conducted each year under the aegis of the Canadian Forestry Service.

2.0 Goal:

The goal of the Forum is to review significant pest conditions, pest control operations and pest management/pesticide related issues.

The word "pest" is interpreted in its broader context and includes insects, diseases and weeds. Pesticides include insecticides, fungicides and herbicides.

3.0 Activities of the Forum:

The National Forest Pest Control Forum will undertake the following activities:

1. exchange information on significant insect and disease distribution and forecast spread in Canada;
2. review the pest management activities, environmental monitoring, assessment of current year insect and disease control programs, overview of the herbicide program and outline of issues relating to any pesticides;
3. outline pest control operations proposed for the next calendar year;
4. apprise of current research relating to pesticide application, pesticide and silvicultural or other research which would reduce future pest outbreak potential;
5. receive an annual update on forestry pesticides which are registered and pending registration and discuss product by product the gaps preventing full registration by Agriculture Canada;
6. gather statistical information from each province in a standardized format (to be developed federally and agreed to by the provinces) on the operational forest pesticide use (ground and aerial);
7. debate specific pest management/pesticide issues and present recommendations in an Executive Summary.

4.0 Membership:

A significant change in the activity of the Forum is point #7 in Section 3.0. A Steering Committee will be needed to prepare issue statements for discussion. The Forum attendees will debate the issues openly and then vote. Motions which are carried will constitute recommendations which will be included in the Executive Summary which attendees can subsequently use as they see fit.

4.1 STEERING COMMITTEE MEMBERS:

Provincial forestry representatives:	. 1 from each of 10 provinces
Canadian Forestry Service:	. 1 from each of 2 institutes . 1 from each of 6 regional establishments . 2 from CFS Headquarters
Executive Secretary:	. FIDS - CFS Headquarters

5.0 Attendance at the Forum:

The following will be invited:

- provincial pest control staff
- provincial and federal government health, wildlife, fisheries and oceans, and environment staff
- border-state and federal U.S. pesticide/pest control staff
- federal government survey, research and pesticide regulatory staff
- representatives of the forest industry, both at the organizational and company level
- researchers - provincial government
  - private research labs
  - universities and colleges
- others as approved by the voting membership (e.g. Eastern Spruce Budworm Council representative, forestry consultants).

The following will not be invited:

- media
- environmentalist groups
- pesticide industry representatives.

6.0 Forum Outputs:

6.1 Annual Report:

The Forum provides an opportunity for information exchange and as such, will continue to produce an Annual Report. The Annual Report will contain detailed written submissions by participants, a list of attendees and addresses and an executive summary with recommendations (see below). Each member of the steering committee will receive 2 copies of the Annual Report (one copy catalogued in a library and the other retained by the member) and one copy will be sent to each attendee. Those who are absent but entitled to an invitation (see Section 5.0) will receive a copy if a written request is received.

6.2 Executive Summary:

An executive summary (2-3 pages) will be prepared each year by the steering committee and include a brief overview of insect/disease distribution, pest management programs, and proposed pest management programs, plus a significant treatment of issue statements with recommendations. The executive summary will be distributed to Forum attendees and be included in the Annual Report.

7.0 Modus Operandi:

The Forum program will be chaired cooperatively by the federal and provincial program assistants (see Section 8.0).

8.0 Program:

Detailed reports of pest control programs and research will be required for the Annual Report. However, the Forum program will be streamlined to permit additional time for discussion. The existing time frame of 3 days of reports and workshops will be retained. The 3-day program will include a half-day on operational pest control reports, half-day on pest distribution, half-day on research, environmental monitoring and health concerns, and a half-day on issue debate and preparation of recommendations. With this tight time frame, it will be necessary for speakers to be focused and brief. Speakers will touch on highlights and identify issues which could be discussed during the issue debate period.

The program will be prepared by the Executive Secretary with assistance from the provincial representative and corresponding CFS representative. It is recognized that some CFS organizations span several provinces and may be called upon more frequently than others. The Ontario Ministry of Natural Resources and Great Lakes Forestry Centre will assist the Executive Secretary in 1987. Future program organizers are proposed as follows:

YEAR	ORGANIZERS	CFS
1	Ontario	Sault Ste. Marie
2	British Columbia	Victoria
3	Quebec	Quebec
4	Alberta	Edmonton
5	New Brunswick/P.E.I.	Fredericton
6	Saskatchewan	Edmonton
7	Nova Scotia	Fredericton
8	Manitoba	Edmonton
9	Newfoundland	St. John's

9.0 Location:

The Forum will remain in Ottawa in 1987 and 1988. However, in 1988 serious consideration should be given to holding the Forum in other provinces on an annual basis beginning in 1989.

10.0 Date:

The Forum should continue to be held during the third week of November.

11.0 Budget:

The Forum will continue to function under the aegis of the Canadian Forestry Service and incidental expenses (e.g. postage, publication of proceedings, meeting room) will be covered by the Federal government.

ADDITION TO THE 1986 REPORT OF THE FOURTEENTH ANNUAL FOREST PEST CONTROL FORUM

Government of Canada | Gouvernement du Canada

MEMORANDUM | **NOTE DE SERVICE**

TO / À: Distribution List
Forest Pest Control Forum

SECURITY - CLASSIFICATION - DE SÉCURITÉ: R & TS/B.H. Moody/RC

OUR FILE — N / RÉFÉRENCE:

YOUR FILE — V / RÉFÉRENCE:

FROM / DE: B.H. Moody
Secretary, Forest Pest Control Forum

DATE: May 5, 1987

SUBJECT / OBJET: Forest Pest Control Forum Report

Please find enclosed a copy of Helson, McFarlane, and Comba Forum report. It was not included in the Report of the Fourteenth Annual Forest Pest Control Forum - 1986.

B.H. Moody

B.H. Moody

c.c. Dr. Blair Helson

GC 177 7540-21-798-8998

LABORATORY EVALUATION OF THE TOXICITY OF INSECTICIDES TO FOREST INSECT PESTS AND NON-TARGET INSECTS IN 1986

[Project No. FP-50 - Insecticide Toxicology]

Report to The 14th Annual Forest Pest Control Forum

B.V. Helson
J.W. McFarlane
D.R. Comba

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November 1986

Laboratory Evaluation of the Toxicity of Insecticides to Forest Insect Pests and Non-Target Insects in 1986

Introduction

During the past year major studies conducted by the FPMI insecticide toxicology project have included the evaluation of a new insecticide, SAN 811-I for forest insect control, factors affecting the residual toxicity of aminocarb, and the toxicity of aqueous mixes of new formulations of MATACIL, Zectran and Sumithion to jackpine budworm, eastern hemlock looper, Douglas fir tussock moth and *Choristoneura orae* larvae. We have continued studies to identify potential insecticides for the control of black army cutworm and white pine weevil and initiated a new study with the debarking weevil, *Hylobius congener*. Finally, research has been initiated to determine the persistence of a new insect growth regulator, UC 84572 in aquatic systems.

Results

SAN-811-I

This new insecticide, also known as ethofenprox, from Zoecon is believed to have insecticidal properties similar to the photostable pyrethroids but has low fish toxicity compared with them. Its toxicity to mammals and birds is also low. To date we have examined its contact toxicity, residual toxicity and the toxicity of foliar deposits to spruce budworm larvae compared with permethrin. Contact toxicity tests have also been conducted with black army cutworm and mountain ash sawfly larvae. Ethofenprox has exhibited very good activity against these insects and its residual activity on weathered foliage in initial tests was high. Generally this insecticide appears to be slightly less toxic than permethrin. These promising results indicate that this new insecticide warrants further evaluation for its potential against these and additional forest insect pests including spruce budmoth larvae. Investigations are also planned to assess its toxicity to aquatic invertebrates.

Residual Toxicity of Aminocarb

The residual toxicity of an aqueous mix of MATACIL 180F on potted trees of white spruce and balsam fir .to spruce budworm larvae was compared at 6 different dosages under natural weathering conditions. Previous tests with single dosages on potted trees indicated that the residual toxicity of MATACIL was higher on balsam fir several days after treatment. However the toxicity of foliar deposits on balsam fir and white spruce foliage in laboratory tests appeared to be similar. The present experiment was conducted to determine if and when differences in toxicity on these 2 tree species become evident during the weathering period. The toxicity of MATACIL appeared to be only slightly higher on balsam fir than on white spruce immediately after treatment and after 1 or 3 days of weathering. However after 5 and 7 days of weathering the residual toxicity of MATACIL on balsam fir was substantially higher than on white spruce. The cause or significance of these differences are not known at this time.

A second experiment with MATACIL on potted white spruce trees was conducted during another weathering period to determine if any differences in residual toxicity between the 2 experiments could be correlated with weather conditions during the experiments. Weather parameters were monitored continuously on site with a Campbell Scientific 21X Portable Weather Station. Although the data has not been analysed in depth, the most notable difference in weather was 84 mm of rain on the 2nd and 3rd day after treatment in the second experiment compared to 0 in the first. This rain did not appear to reduce the residual toxicity of MATACIL at this time.

Jackpine Budworm

Aqueous mixes of MATACIL 180F, Zectran UCZF 19, Sumithion 20F and technical fenitrothion with Triton X114 were extensively tested on laboratory-reared fifth instar larvae to determine their contact toxicity and the toxicity of foliar deposits on jackpine buds. MATACIL and Zectran were similar in toxicity by both exposure routes and more toxic than the fenitrothion formulations with one apparent exception. The toxicity of Sumithion 20F was almost comparable to the carbamates on treated foliage. In previous tests with field-collected larvae it was 2-3 X less toxic than the carbamates by this exposure route. A preliminary residual toxicity test with MATACIL 180F was also conducted on potted jackpine trees at 100 g AI/ha under natural weathering conditions. Mortality remained high until one day after treatment and then declined sharply after 3 days of weathering.

Eastern Hemlock Looper

Aqueous mixes of the above insecticide formulations were tested on third instar laboratory-reared larvae to determine their contact toxicity and toxicity of deposits on balsam fir foliage. By both exposure routes Zectran was the most toxic insecticide and appears to be a good candidate for field tests. It was 2.5-3X more toxic than either technical fenitrothion or MATACIL 180F which were similar in toxicity. Sumithion 20 Flowable also appears to be a promising formulation being more toxic than the technical fenitrothion emulsion, particularly on treated foliage. All materials were ca 3-4X more toxic on treated foliage than by direct contact.

Choristoneura orae

As larvae of this western species were available from the FPMI rearing section, preliminary contact toxicity tests with aqueous mixes of MATACIL 180F, Zectran UCZF 19, Sumithion 20F and a technical fenitrothion emulsion were conducted on fifth instars to obtain some basic information in case control of this species needs to be considered in the future. The toxicity of these formulations to C. orae was generally similar to spruce budworm.

Douglas Fir Tussock Moth

Likewise, preliminary contact toxicity tests with these insecticide formulations were conducted on fourth instar tussock moth larvae available from the FPMI rearing section. Zectran and MATACIL appeared to be similar in toxicity and both were more toxic than the fenitrothion formulations. All compounds were less toxic to Douglas fir tussock moth larvae than to 5th instar spruce budworm.

Black Army Cutworm

Further contact toxicity tests with several insecticides on 4th instar larvae confirmed that this species is very tolerant to most insecticides except permethrin and other pyrethroids. These other pyrethroids, particularly deltamethrin, were found to be very toxic to larvae. Diazinon was moderately toxic compared to other non-pyrethroid insecticides tested to date while trichlorfon and malathion exhibited very low toxicity. Sumithion 20F appeared to be ca 3X more toxic than a comparable technical fenitrothion emulsion.

White Pine Weevil

A large collection of white pine weevil adults was made and experiments are currently in progress to determine the toxicity of several pyrethroid insecticides to adults by direct contact and on treated white pine foliage. Methoxychlor which is the insecticide currently registered for control is being tested as a standard. Extremely high dosages of methoxychlor have been required to obtain mortality. Permethrin appears to be 1-2 orders of magnitude more toxic than methoxychlor by either exposure route.

Debarking Weevil - *Hylobius congener*

Debarking weevil adults were provided by Bruce Pendrel, FIDS, MFC. In preliminary tests, these adults were exposed to branches of white pine or white spruce dipped in 0.001, 0.01, 0.1 or 1.0% aqueous solutions of several selected insecticides. Dursban, lindane and Sumithion 20F all provided 100% mortality at 0.1%. Methoxychlor gave no mortality at any concentration while the results with permethrin were inconclusive.

UC 84572

This new insect growth regulator is being considered by Union Carbide for development for forest insect control. They also wished to have some initial information on the persistence of this compound, particularly in aquatic systems. Since methodologies are not yet available for measuring residues of this compound in various substrates, the approach we have taken is to measure its biological persistence with bioassays using mosquito larvae in comparison with Dimilin. Both insect growth regulators are highly toxic to mosquito larvae with detectable limits in the order of 0.1 ppb. An experiment is currently in progress in outdoor, sod-lined, wading pools treated with a range of concentrations of UC 84572 and Dimilin. Water samples are being taken at 3-4 day intervals from these pools and bioassayed with mosquito larvae.