THE 1971 SPRUCE BUDWORM SITUATION IN ONTARIO

PART A: DAMAGE AND FORECASTS

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PART B: AERIAL SPRAYING OPERATIONS

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GREAT LAKES FOREST RESEARCH CENTRE

SAULT STE. MARIE, ONTARIO

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To an even greater extent, the authors acknowledge the contributions of the Forest Research Technicians, the field personnel of the Forest Insect and Disease Survey Unit who are primarily responsible for the acquisition of the information and data in this report. Their cooperation and assistance are sincerely appreciated and in a very real sense all of the following should be considered coauthors of this budworm report.

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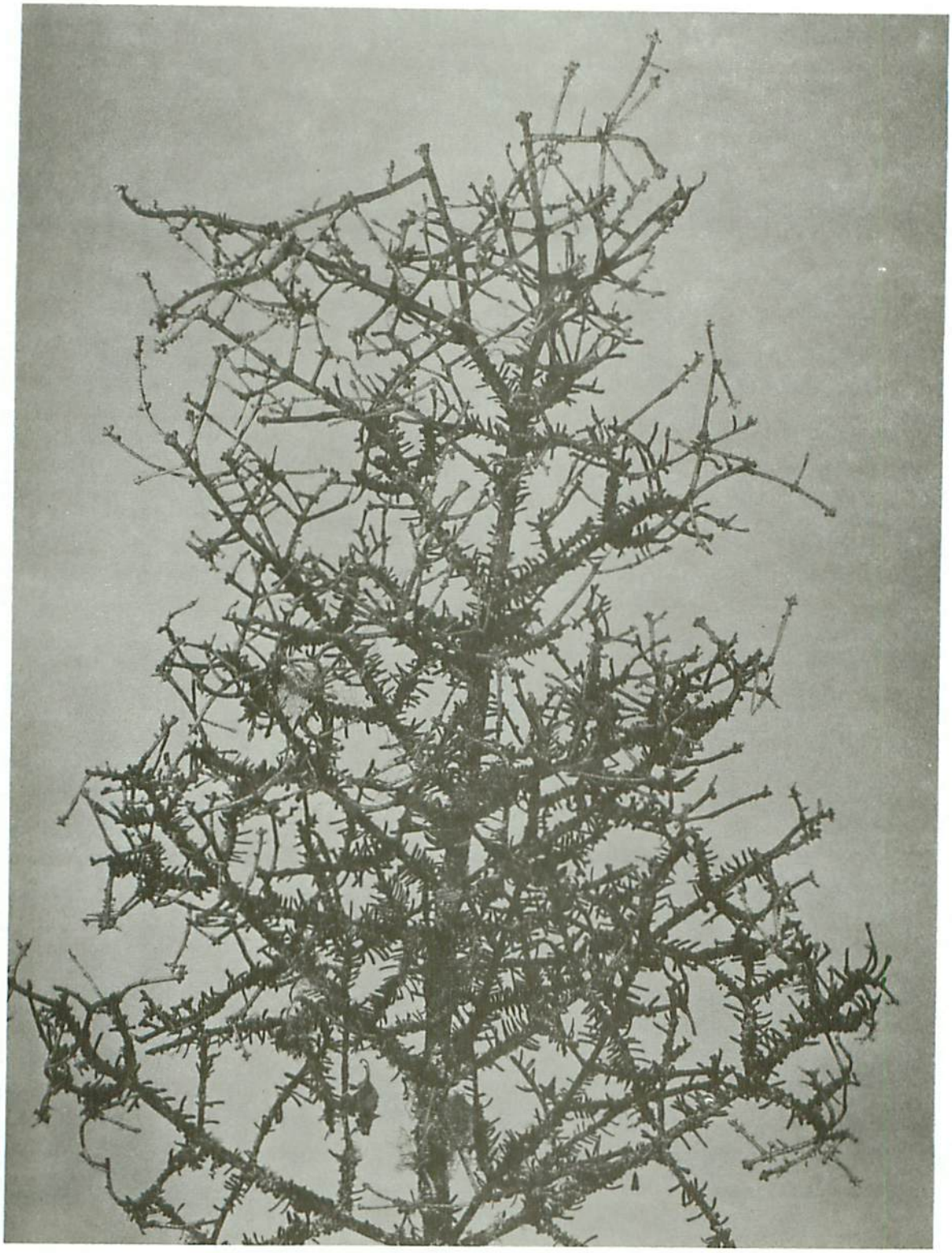
Western Survey Region:	M. J. Thomson, C. A. Barnes and C. N. Davis

In addition, the authors wish to remind all management or unit foresters (private or provincial) that if they require more specific information about spruce budworm conditions in their districts then they should contact the appropriate Forest Research Technician.



Frontispiece. Accumulative severe defoliation of balsam fir by the spruce budworm over a period of 4 years.

ABSTRACT

The spruce budworm situation in Ontario continued to worsen in 1971 and the amount of damage will likely increase considerably in 1972. Part A of this report describes, in some detail, changes in the boundaries of infestation and the pattern of outbreak in 1971 in three major sectors of the Province where the spruce budworm is causing concern; and it forecasts, in cartographic and tabular form, the damage liable to occur in 1972. Part B describes aerial spraying operations covering 81,000 acres which were conducted against the spruce budworm in Ontario in 1971 as part of a joint strategy developed by the Insect and Disease Survey Unit of the Canadian Forestry Service and the Environmental Protection Branch of the Ontario Ministry of Natural Resources.

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Cover photograph shows operational spraying using Fenitrothion against the spruce budworm in Northwestern Ontario. Spray aircraft in the photograph are Stearman.

PART A: DAMAGE AND FORECASTS

INTRODUCTION

One of the main functions of the Insect and Disease Survey Unit, Great Lakes Forest Research Centre, Canadian Forestry Service, is to detect and evaluate insect and disease problems occurring in the forests of Ontario. Furthermore, the Unit is responsible for informing forest management about dangerous or potentially dangerous situations and helping to find appropriate solutions to these problems. The Survey Unit has devoted considerable attention to the spruce budworm, *Choristoneura fumiferana* (Clem.), since 1967, when precursory incipient populations became evident in three widely separated parts of the Province. The subsequent development of these outbreaks has been described in the Annual Report of the Forest Insect and Disease Survey (1967, 1968, 1969, 1970 and 1971 (in press)), in the Annual District Reports prepared by the Forest Research Technicians (1967, 1968 and 1969), in periodic bulletins issued by the Survey Unit each field season and in various Information Reports originating in the group. By 1970, the spruce budworm situation in Ontario had worsened considerably and a fully integrated report became necessary in which the entire problem was dealt with on a yearly Province-wide basis. This report, which is a sequel to Information Report O-X-147 issued 1 year ago, describes infestations in 1971 and the probable extent of damage in 1972.

OVERALL SITUATION - 1971

In general, the overall situation in 1971 resembled that of 1970 in that the outbreaks which had developed in three distinct regions within the Province since 1967 remained confined to these regions, i.e., southeastern Ontario, northeastern Ontario and northwestern Ontario (Fig. 1). However, considerable expansion of infested areas over 1970 occurred within the first two regions as shown by the following comparison of areas infested in 1970 and 1971.

	Area within which moderate to severe defoliation occurred	
Outbreak segment	*1970*	*1971*
Southeastern Ontario	1.6 million acres	4.5 million acres
Northeastern Ontario	5.2	8.6
Northwestern Ontario	0.1	0.1
	6.9	13.2

The authors are, respectively, Research Officer and the Senior Entomology Technician, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

Northwestern Ontario continues to remain the one relatively bright spot in the overall picture. Undoubtedly the aerial spraying operations conducted for the past 4 years in the Fort Frances and Thunder Bay districts have beneficially altered the outbreak pattern in this part of Ontario. However, infestations totalling 2,000,000 acres exist in northern Minnesota (1971 Forest Pest Report, Minnesota, Department of Agriculture) and threaten to invade vulnerable stands north of the International Border (Fig. 1).

SOUTHEASTERN ONTARIO

Situation in 1971

The total area within which moderate to severe defoliation of the current foliage of balsam fir [*Abies balsamea* (L.) Mill.] and white spruce [*Picea glauca* (Moench) Voss] occurred in southeastern Ontario almost tripled from 1,600,000 acres in 1970 to 4,500,000 acres in 1971 (Fig. 2).

Major increases in the extent of infestation occurred in the central and southern parts of the Pembroke District and the northern part of the Tweed District, so that virtually all stands susceptible to budworm in the eastern two-thirds of the Pembroke District and in the northern third of the Tweed District were damaged. This large infestation now extends from Ottawa in the east almost to Mattawa in the northwest and to Haliburton in the southwest, including the eastern half of Algonquin Park. "Hot spots" in the park were recorded at Lone Creek in Stratton Township and in the vicinity of Annie Bay (Opeongo Lake) in Preston Township where exceptionally high larval populations caused complete defoliation of new shoots of fir and spruce. In some of the areas infested longest in the Ottawa Valley, the intensity of damage declined somewhat because of lower population levels.

Although a considerable increase in the infested area occurred in the Tweed District, very little expansion occurred in the two major infestations in the Kemptville District, one located to the north of Carleton Place in Fitzroy, Pakenham, Huntley and March townships and the other to the east of Carleton Place in Goulbourn Township. Small scattered pockets of moderate to severe defoliation occurred in Dalhousie, Clarence and Matilda townships in Kemptville District. In the Tweed District, new infestations ranging up to 20,000 acres in size were found in Barrie, Clarendon, Palmerston and Kingston townships in Frontenac County, in Camden Township in Lennox and Addington County, in Wollaston and Limerick townships of Hastings County and Hallowell Township of Prince Edward County. An overall increase in populations and severe defoliation occurred in the Lindsay District, particularly in Harvey, Galway and Anstruther townships in Peterborough County and in Clyde, Bruton, Monmouth and Glamorgan townships in Haliburton County

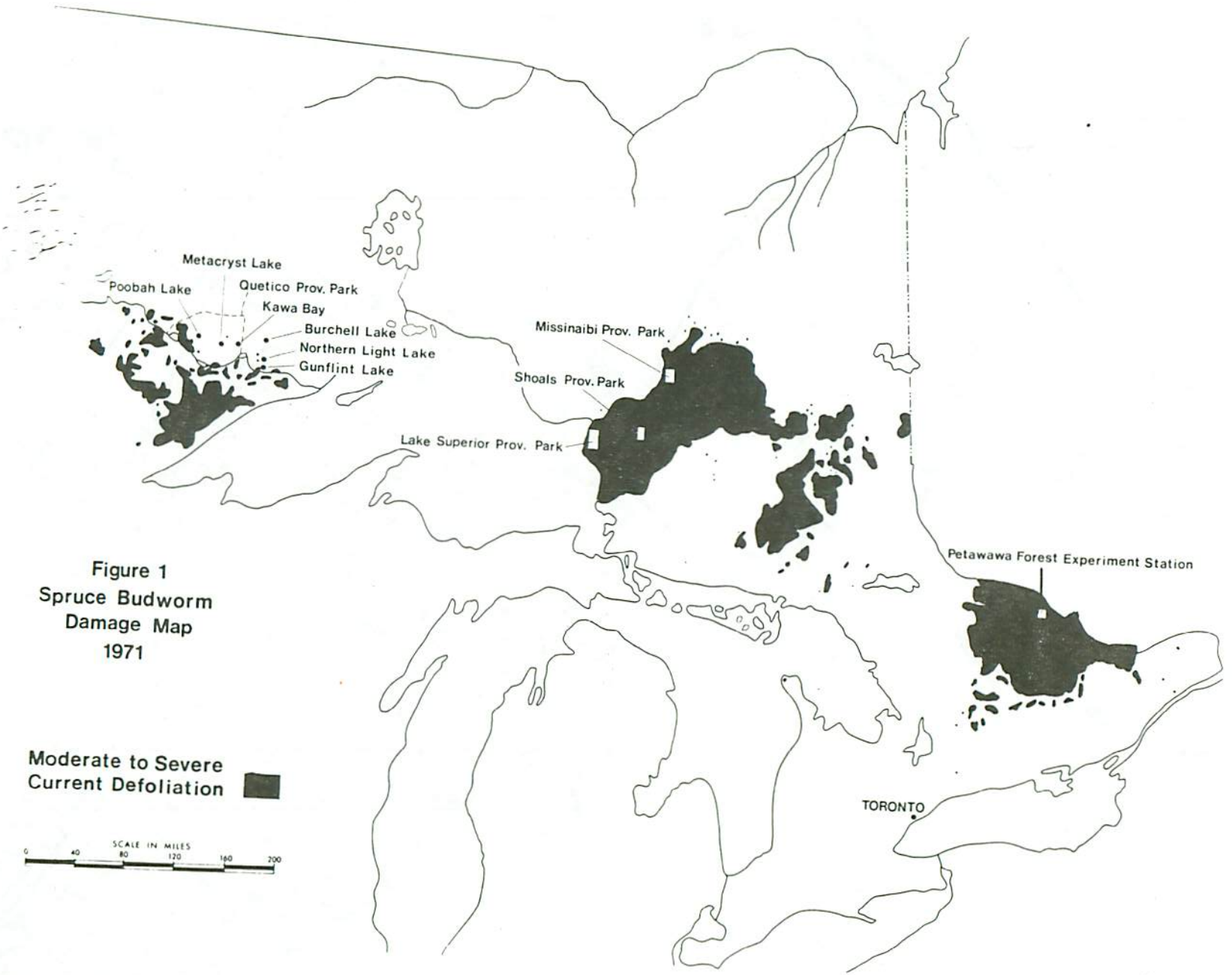


Figure 1
Spruce Budworm
Damage Map
1971

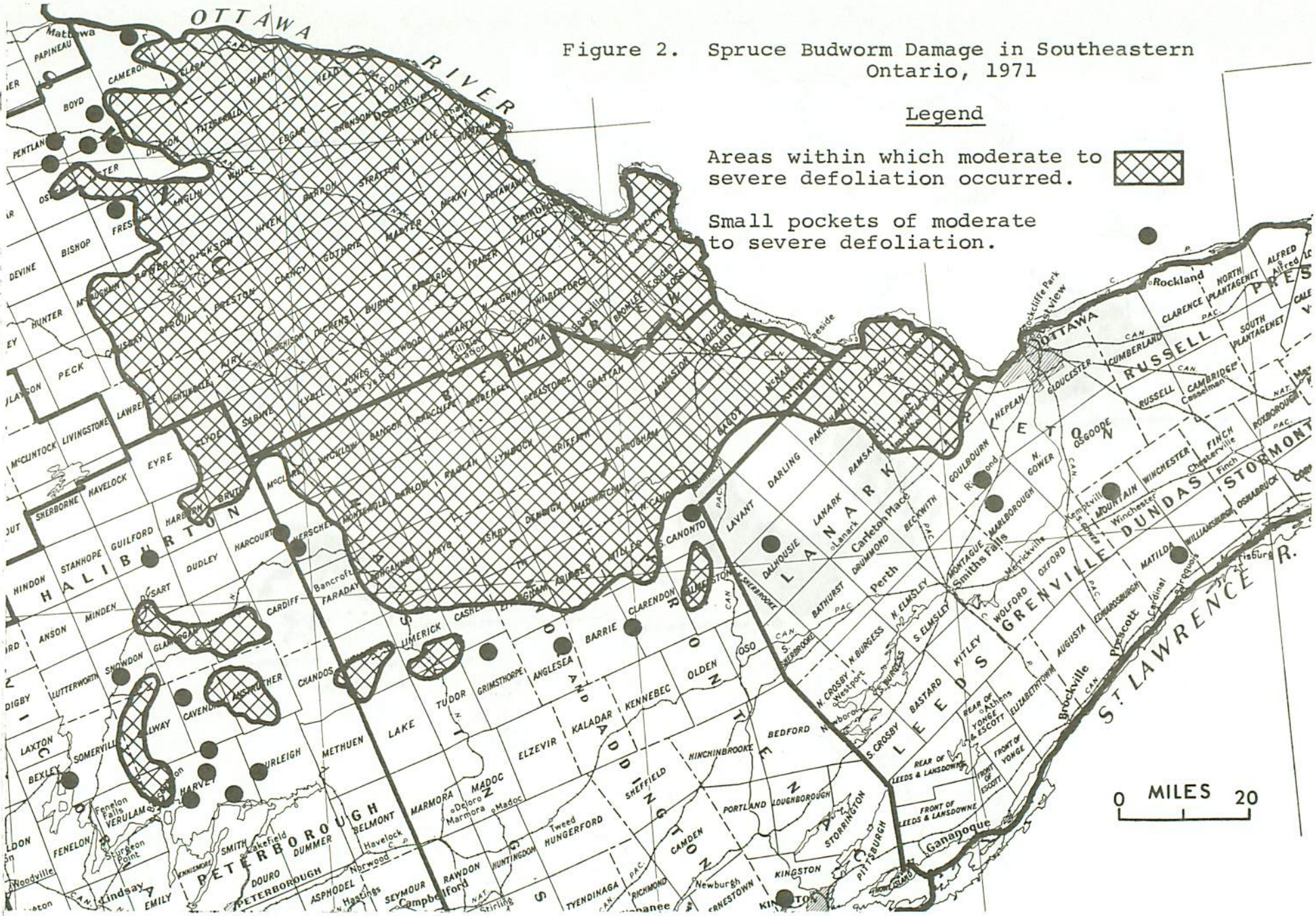


Figure 2. Spruce Budworm Damage in Southeastern Ontario, 1971

where many small, scattered infestations enlarged considerably. Trace or light infestations were observed generally throughout the remainder of southeastern Ontario.

Elsewhere throughout southern Ontario, the insect was more widespread than in recent years, though numbers of budworm larvae were generally low. Notable infestations occurred in Whitchurch and Uxbridge townships in the Lake Simcoe District and throughout the northern part of the Bruce Peninsula, which includes most of St. Edmunds Township and part of Lindsay Township in the Lake Huron District. Population levels were also low throughout the Lake Erie and Parry Sound districts with no known infestations above the trace or light levels.

Extensive moth flights occurred throughout southern Ontario in the latter part of July. These moth flights, which are a natural phenomenon, sometimes occur during the course of massive outbreaks like those presently sweeping eastern North America. Considerable public attention was focused on these moth flights and the reasons for their occurrence when cities such as Ottawa and Toronto were inundated. The most likely source of these moths was the Algonquin Park-Ottawa Valley infestation or the much larger infestation that exists north of the Ottawa River in Quebec.

Significant amounts of mortality and top-killing of balsam fir and white spruce trees have occurred between Pembroke and Renfrew, with the highest mortality occurring in the Bonnechere Valley where up to 56% of the balsam fir and 43% of the white spruce have died. Several years of defoliation by the spruce budworm and the balsam fir sawfly, *Neodiprion abietis* (Harris), were undoubtedly a major factor in this mortality, but other factors may also be involved. It is expected that further mortality will occur in the Bonnechere Valley.

The only aerial spraying operation in southeastern Ontario was carried out at the Petawawa Forest Experiment Station to protect high-value research stands. For further details, please refer to Part B of this report.

Damage Forecast for 1972

Population trends of spruce budworm are primarily based on year-to-year changes in the density of egg masses on branches collected from the mid-crowns of balsam fir and white spruce (see Table 1, p. 18). Thus egg-mass surveys in August provide a means of forecasting the damage to be expected from larval feeding in the following year. The results of an egg-mass survey conducted in southeastern Ontario in 1971 forecast a continuance of high damage levels in areas currently infested, accompanied by further enlargements of the outbreak in 1972 (Fig. 3 and Table 1). Most of the balsam fir and white spruce in the Pembroke

Figure 3. Spruce Budworm Damage Forecasts for 1972 in Southeastern Ontario.

District, particularly Algonquin Park and the Ottawa Valley, in the north parts of the Tweed and Lindsay districts and the west part of the Kemptville District will be moderately to severely damaged in 1972. Other than areas mentioned, budworm damage will occur throughout most of southern Ontario at a trace or light level, including the Toronto area which received a massive moth flight in July, 1971. Host trees in the northern tip of the Bruce Peninsula (St. Edmunds Township) are expected to be moderately to severely damaged in 1972 (see p. 11, Fig. 5).

Generally speaking, egg-mass densities within infested areas were much higher in 1971 than 1970. As a result if weather conditions favor budworm survival, a greater degree of damage will occur over a wider area.

The infestation in Larose Forest, Clarence Township in the Kemptville District, was sprayed in 1970 and declined to light intensity in 1971. The majority of the white spruce trees have recovered from past defoliation. However, egg-mass counts indicate that moderate defoliation will occur there in 1972.

It is expected that the only operational aerial spraying in southeastern Ontario against spruce budworm in 1972 will be an operation to protect the research stands at the Petawawa Forest Experiment Station.

NORTHEASTERN ONTARIO

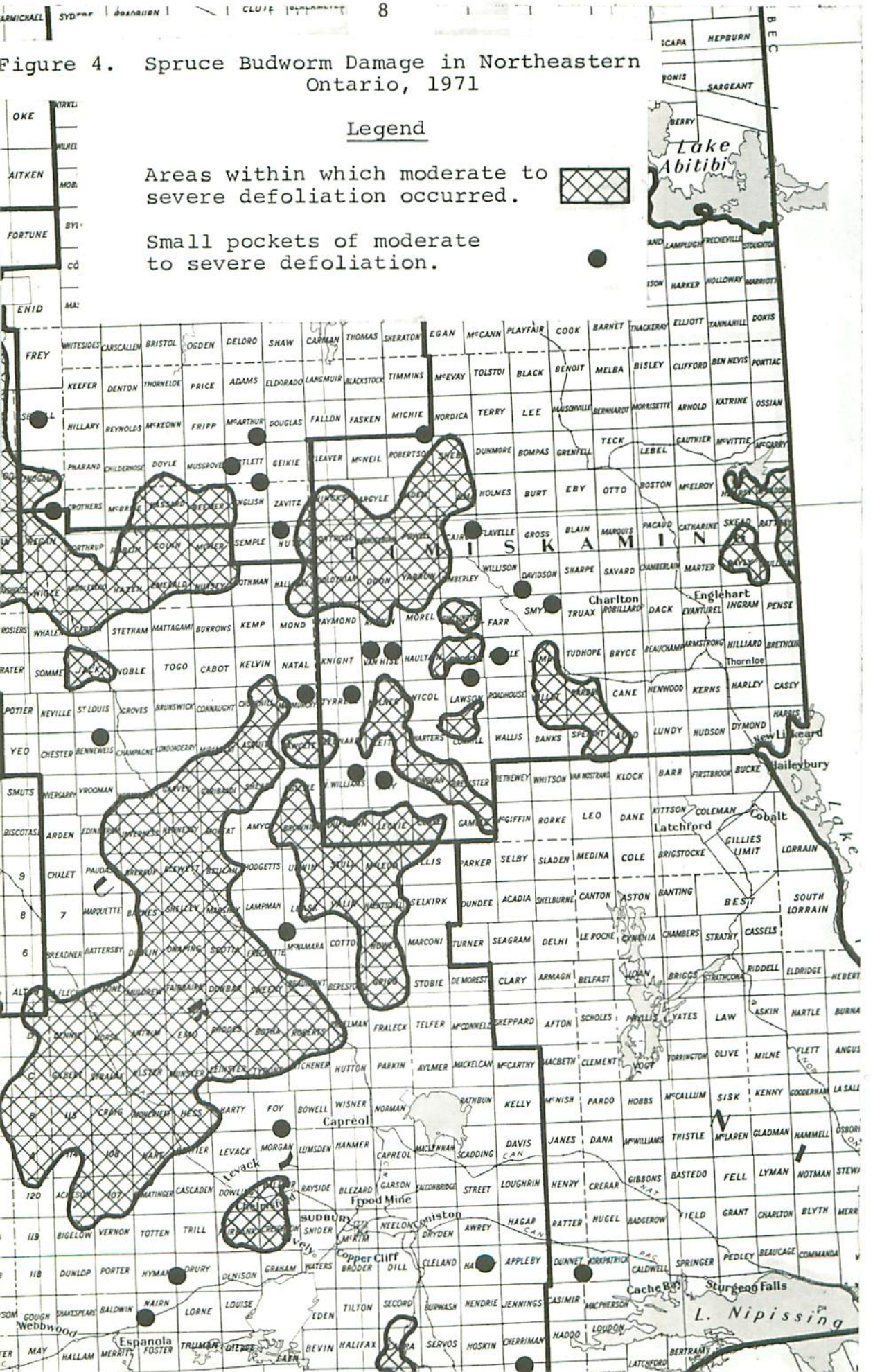
Situation in 1971

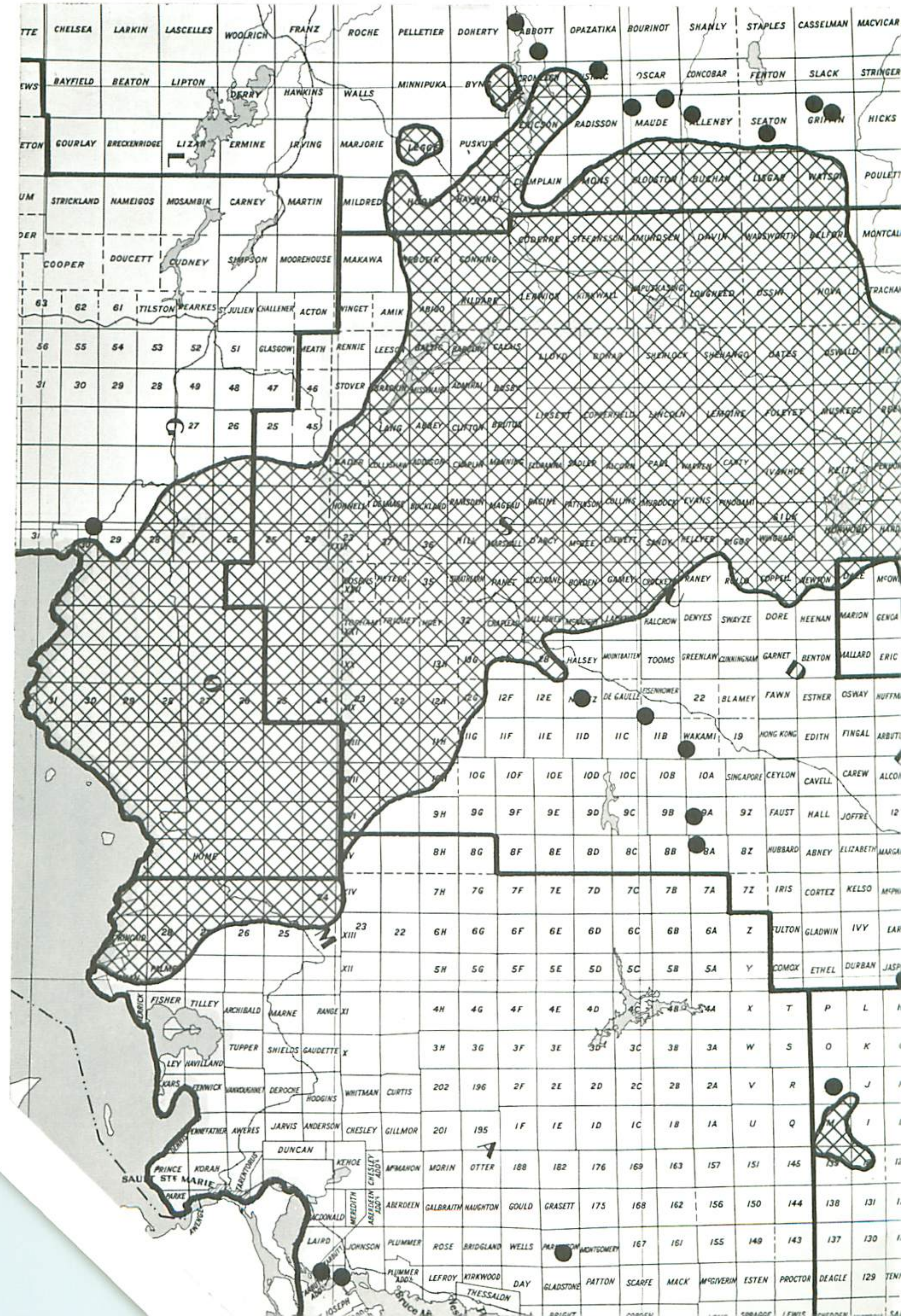
Figure 4 shows the location of moderate to severe defoliation by the budworm in northeastern Ontario in 1971. Most of the infestations enlarged, so that the area within which defoliation was recorded totalled 8.6 million acres compared to the 5.2 million acres damaged in 1970.

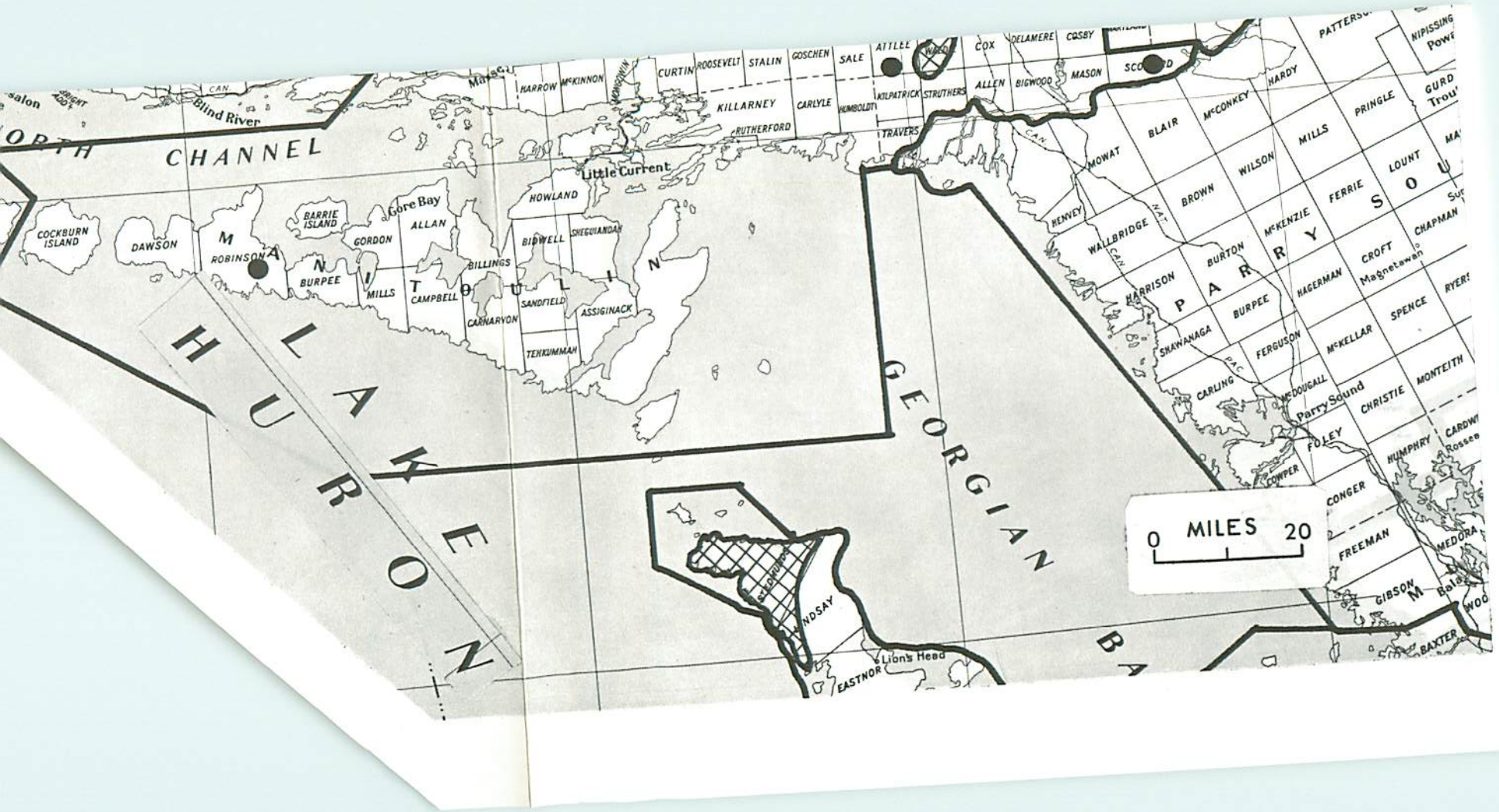
The major infestation in this region is a massive outbreak centered in the Chapleau District; it now extends from the shores of Lake Superior, the western limits of Lake Superior Provincial Park (White River District), in a northeasterly direction through much of the Chapleau District into the southern part of the Kapuskasing District, to the western edge of Cochrane District and the northern end of the Sudbury District. The dimensions of this single outbreak are roughly 145 miles long and about 75 miles wide encompassing over 6.5 million acres.

The major change in this infestation from 1970 was a major extension to the south and west resulting in moderate to severe damage to balsam fir and white spruce throughout all of Lake Superior

Figure 4. Spruce Budworm Damage in Northeastern Ontario, 1971




CHELSEA
LARKIN
LASCELLES
WOOLRICH
FRANZ
ROCHE
PELLETIER
DOHERTY
ABBOTT
OPAZATIKA
BOURINOT
SHANLY
STAPLES
CASSELMAN
MACVICAR
BAYFIELD
BEATON
LIPTON
DERRY
HAWKINS
WALLS
MINNIPUKA
OSCAR
CONCOBAR
FENTON
SLACK
GOURLAY
BRECKENRIDGE
LIZAR
ERMINE
IRVING
MARJORIE
LEGGE
PUSKUTA
RADISSON
MAUDE
ALLENBY
SEATON
HICKS
STRICKLAND
NAMEIGOS
MOSAMBIK
CARNEY
MARTIN
MILDRED
CHAMPLAIN
MONS
BUCHAN
POULETT
COOPER
DOUCETT
CUDNEY
SIMPSON
MOOREHOUSE
MAKAWA
COUDERRE
STEFANSSON
AMUNDSEN
DAVIN
WADSWORTH
MONTCALM
TILSTON
PEARKES
ST. JULIEN
CHALLENER
ACTON
WINGET
AMIK
KILDARE
LOUGHEED
NOVA
RENNIE
LEESON
GLASGOW
HEATH
LLOYD
SHERLOCK
OATES
OSWALD
STOVER
LINCOLN
LEMOINE
MUSKEGO
LANG
ABBEY
CLIFTON
BRUTUS
ALCORN
PAUL
WARREN
IVANHOE
KEITH
BUCKLAND
RACINE
PATTINSON
COLLINS
EVANS
GILL
HONWOOD
MARSHALL
D'ARCY
McGEE
SANDY
RIGGS
PETERS
PANET
BORDEN
GAMEY
RANEY
KEMBALL
NEWTON
McOWEN
DENYES
SWAYZE
DORE
HEENAN
MARION
HALSEY
MOUNTBATTEN
TOOMS
GREENLAW
CUNNINGHAM
GARNET
BENTON
MALLARD
ERIC
DE GAULLE
EISENHOWER
BLAMEY
FAWN
ESTHER
OSWAY
WAKAMI
HONG KONG
EDITH
FINGAL
SINGAPORE
CEYLON
CAVELL
CAREW
FAUST
HALL
JOFFRE
HUBBARD
ABNEY
ELIZABETH
IRIS
CORTEZ
KELSO
FULTON
GLADWIN
IVY
COMOX
ETHEL
DURBAN
HOME
FISHER
TILLEY
ARCHIBALD
MARNE
TUPPER
SHIELDS
GAUDETTE
LEY
HAVILLAND
FENWICK
DEROCHE
HODGINS
WHITMAN
CURTIS
AWERES
JARVIS
ANDERSON
CHESLEY
GILLMOR
DUNCAN
KEHOE
PRINCE
KORAH
SAULT STE MARIE
McMAHON
MORIN
OTTER
ABERDEEN
GALBRAITH
NAUGHTON
GOULD
GRASETT
LAIRD
JOHNSON
PLUMMER
ROSE
BRIDGLAND
WELLS
MONTGOMERY
LEFROY
KIRKWOOD
DAY
GLADSTONE
PATTON
SCARFE
MACK
McGIVERIN
ESTEN
PROCTOR
DEAGLE
THESSALON


CHANNEL
Blind River
Little Current
Gore Bay
COCKBURN ISLAND
DAWSON
ROBINSON
BARRIE ISLAND
GORDON
ALLAN
BURPEE
MILLS
CAMPBELL
BILLINGS
SANDFIELD
CARNARVON
BIDWELL
SHEGUIANDAH
HOWLAND
ASSIGINACK
TEHKUMMAH
MANITOULIN
HURON
LAKE
GEORGIAN
HARROW
McKINNON
CURTIN
ROOSEVELT
STALIN
GOSCHEN
SALE
ATTLEE
COX
DELAMERE
CASBY
KILLARNEY
CARLYLE
HUMBOLDT
KILPATRICK
STRUTHERS
ALLEN
BIGWOOD
MASON
TRAVERS
RUTHERFORD
HARDY
McCONKEY
BLAIR
MOWAT
BROWN
WILSON
MILLS
PRINGLE
HENVEY
WALLBRIDGE
McKENZIE
FERRIE
LOUNT
CHAPMAN
HARRISON
BURTON
PARRY SOUND
CROFT
HAGERMAN
BURPEE
SPENCE
SHAWANAGA
FERGUSON
McKELLAR
MONTEITH
CARLING
McDOUGALL
Parry Sound
CHRISTIE
FOLEY
HUMPHRY
COWPER
CONGER
FREEMAN
MEDORA
GIBSON
BAXTER
LINDSAY
Lion's Head
EASTNOR
0 MILES 20

Provincial Park and into the northern part of the Sault Ste. Marie District. Other extensions occurred on the eastern side where the main infestation merged with the smaller outbreaks in the northern part of the Sudbury District. Further spread occurred on the northern edge of the main outbreak along the Kapuskasing border in Hook and Hayward townships, northeast from Hayward Township to Opasatika Lake in Usnac Township, and in Buchan, Clouston and Lisgar townships.

In the Sudbury District, the total area within which moderate to severe defoliation occurred enlarged to approximately 1.3 million acres, an increase of 25% over 1970. Major increases occurred in the large infestation centered on Onaping Lake, in an infestation lying to the east of the Onaping infestation and to the north of Lake Wanapetei. An infestation north of the Village of Gogama in upper Sudbury District also enlarged and merged with the Chapleau infestations. Several new pockets of heavy infestation were detected at widely scattered locations in the district; three of the largest being in Township M south of Lac aux Sables, in Laura and Waldie townships in the vicinity of Burwash, and in Fawcett and Leonard townships surrounding Shining Tree Lake on the Sudbury-Swastika District boundary.

In the Swastika District, numerous infestations located in the southwest part of the District generally expanded. A sizeable new infestation of about 50,000 acres was detected south of and surrounding Larder Lake in the townships of Hearst, McFadden, Rattray, Skead and Bayly. This infestation extends for some distance eastward into the Province of Quebec.

The only defoliation detected in the North Bay District was a small pocket in Dunnet Township, in the same location as 1970 although larval population levels were slightly higher in 1971 than in 1970.

In the Sault Ste. Marie District, other than the area engulfed by the Chapleau outbreak in the northwest corner of the District, the only reported infestations were in Parkinson Township on white spruce and in Tarbutt Additional and Laird townships on balsam fir with little change from 1970 in population levels or infestation boundaries.

Although not detectable from the air, ground surveys revealed a sizeable area of trace or light defoliation on balsam fir and white spruce in the southeastern corner of Geraldton and the northwestern corner of the White River districts. Numbers of budworm larvae were generally low but were widespread throughout the area affected, which is bordered by Marathon on the west, White River on the east and Manitouwadge on the north.

Elsewhere in those parts of the Geraldton, White River, Cochrane and Kapuskasing districts which lie north of the main Chapleau outbreak, larval population levels were extremely low and defoliation

was nil or trace. Population levels within the main Chapleau infestation throughout northeastern Ontario were generally much higher in 1971 than 1970 and consequently the severity of damage was greater. In some locations, high larval populations caused even greater damage by consuming all of the current year's foliage and backfeeding on old foliage.

Population levels in undamaged areas lying south of these infestations or lying between scattered infestations in the Sault, Sudbury or North Bay districts were generally low but larvae were common and could be found wherever one searched.

Aerial spraying operations were carried out to prevent further damage in three provincial parks in northeastern Ontario in 1971. Please refer to Part B of this report for further details.

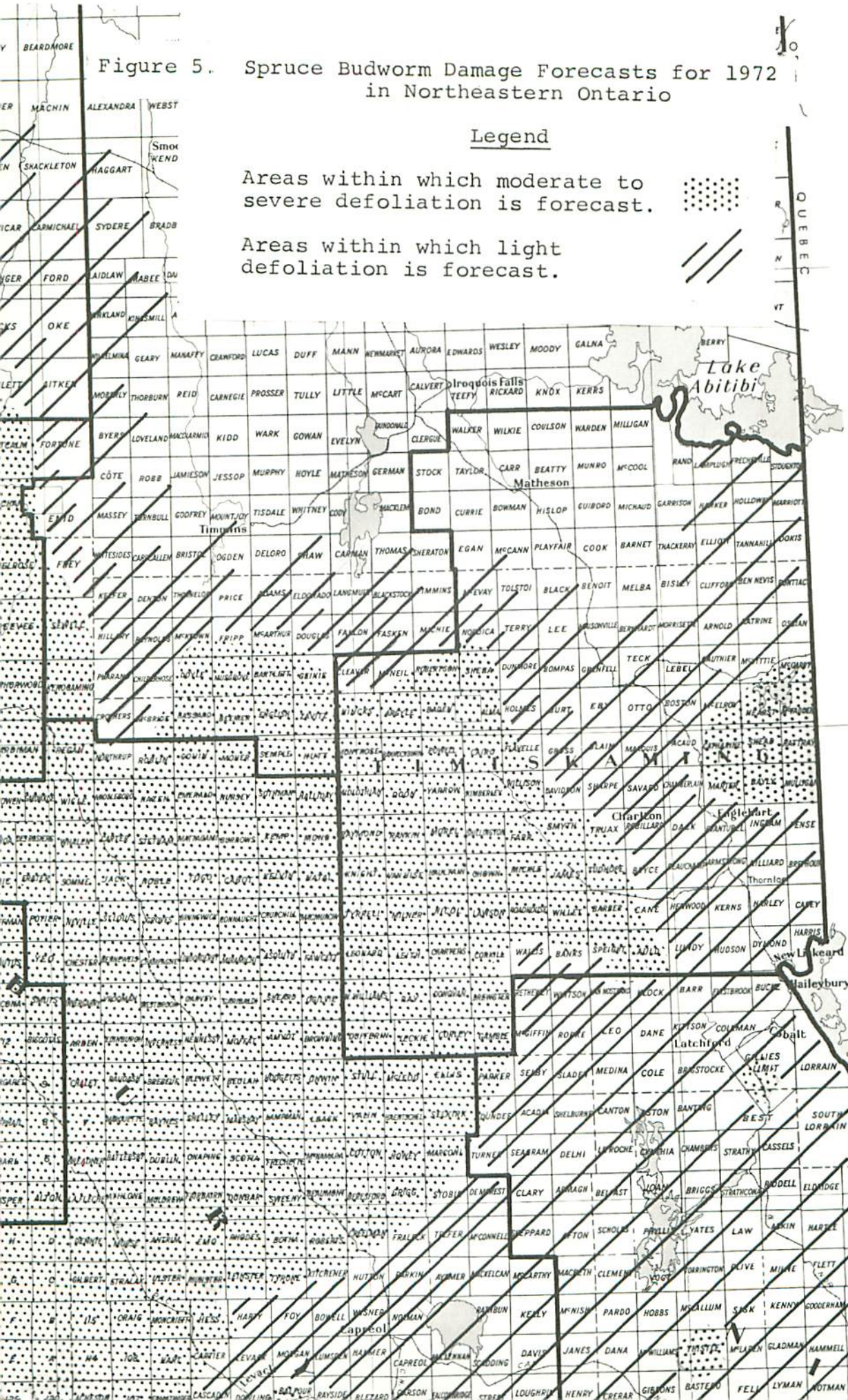
Damage Forecast for 1972

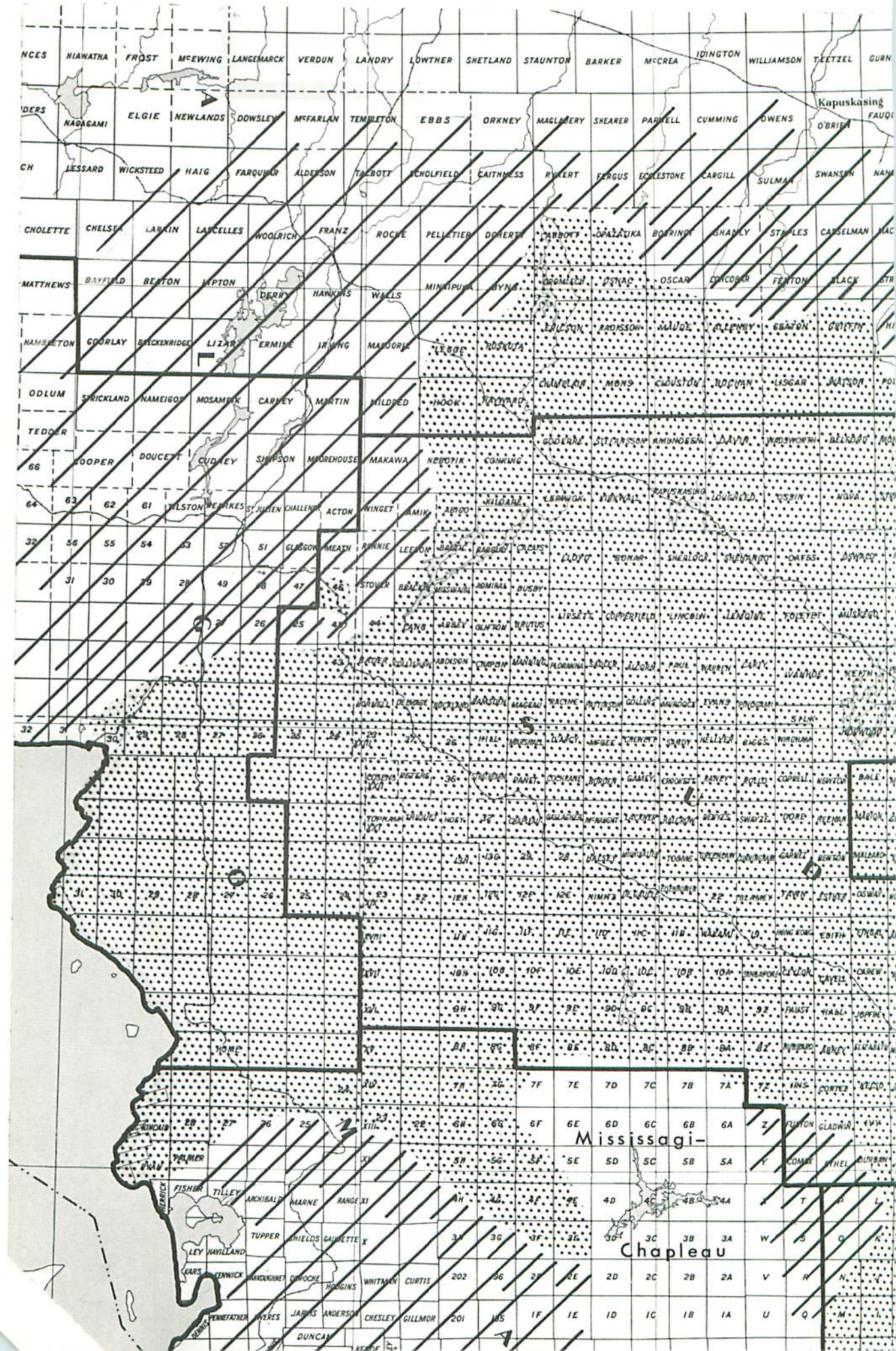
Spruce budworm egg-mass counts were obtained from 180 locations throughout northeastern Ontario (see Table 2, p. 22). Many of the locations sampled in 1971 had been sampled in 1970, thus by comparing egg-mass counts, a general population trend can be determined. Without exception, every district in northeastern Ontario that was infested with spruce budworm exhibited appreciable increases in egg-mass numbers over 1970. Population increases of up to tenfold have occurred, undoubtedly because of unusually favorable weather conditions for budworm survival during May, June and July of 1971.

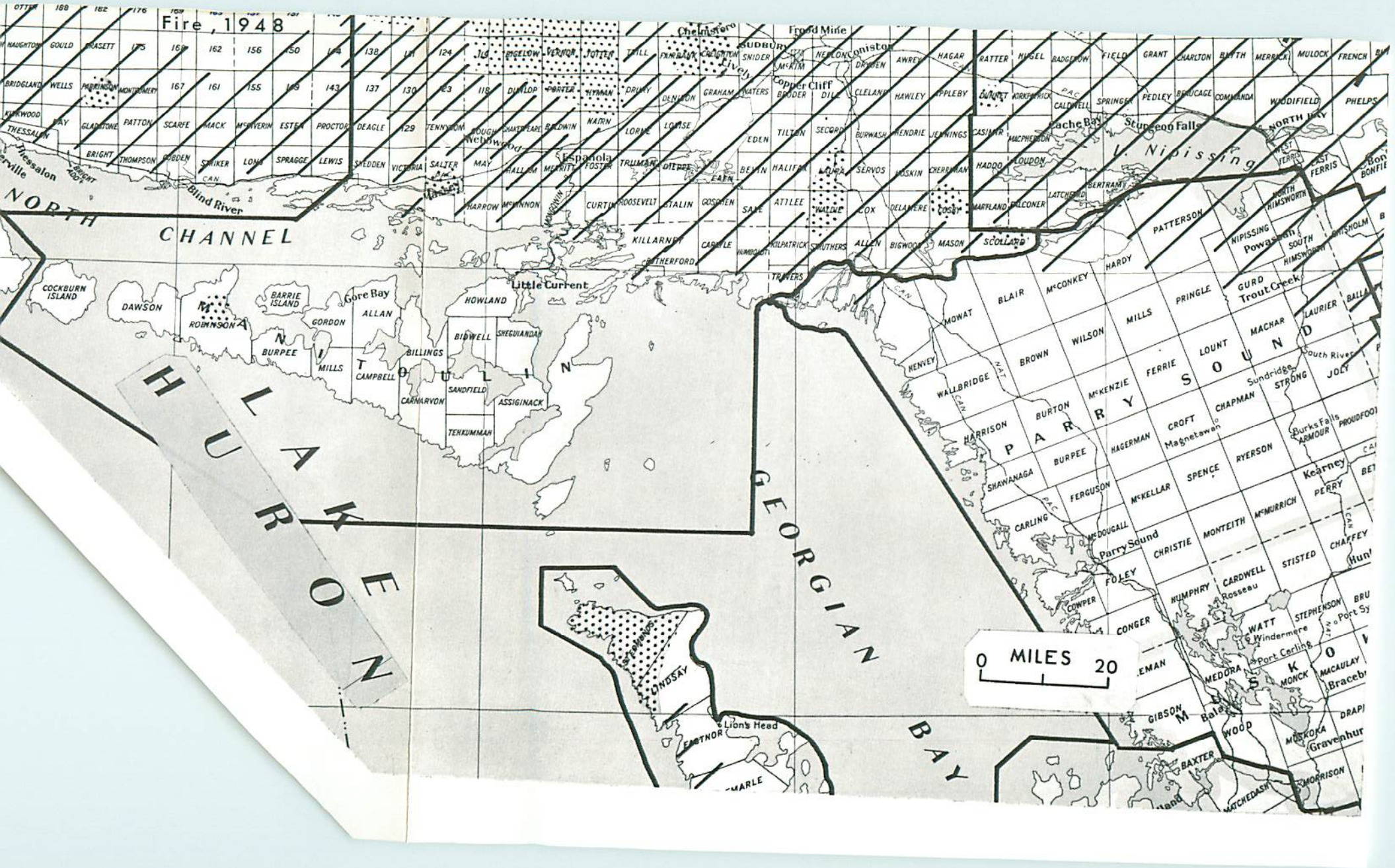
Thus, it is reasonable to expect widespread, severe damage, particularly throughout all areas infested to a moderate or high degree in 1971 (see Figures 4 and 5). The moderate to severe infestations that occurred in 1971 are expected to expand considerably and will probably merge into one massive infestation of at least 15 million acres engulfing all susceptible host stands of balsam fir and white spruce in the following areas (Figure 5): all of the Chapleau District; the southern half of White River District including the Lake Superior Provincial Park; Sault Ste. Marie District--the northwestern portion adjacent to the Chapleau and White River districts; Sudbury District--most of the District north and west of the city of Sudbury; Swastika District--the southwest portion plus a sizeable infestation surrounding Larder Lake on the Ontario-Quebec border; Cochrane District--a small portion of the southern part, south of Timmins; and Kapuskasing District--the south central part, extending north of the Chapleau District boundary as far as Opasatika Lake.

In addition to this one vast outbreak, smaller scattered infestations are expected to persist or occur in Parkinson, Laird, Tarbutt and Tarbutt Additonal townships in the Sault Ste. Marie District; in the following areas of the Sudbury District--Robinson Township on Manitoulin

Figure 5. Spruce Budworm Damage Forecasts for 1972 in Northeastern Ontario




Kapuskasing
Mississagi–
Chapleau


Fire, 1948
NORTH CHANNEL
LAKE HURON
GEORGIAN BAY
Blind River
Little Current
Gore Bay
Espanola
Webwood
Cache Bay
Sturgeon Falls
Lake Nipissing
Parry Sound
Trout Creek
Sundridge
Magnetawan
Burks Falls
Kearney
Port Carling
Windermere
Rosseau
Lion's Head
Baie
Gravenhurst
COCKBURN ISLAND
DAWSON
ROBINSON
BARRIE ISLAND
GORDON
ALLAN
BURPEE
MILLS
CAMPBELL
BILLINGS
CARNARVON
SANDFIELD
ASSIGINACK
HOWLAND
BIDWELL
SHEGUIANDAH
TEHKUMMAH
LINDSAY
EASTNOR
MARLE
0 MILES 20

sland, Waldie, Laura, Fairbank, Creighton, Balfour, and Cosby town-
ips; and in Dunnet, Thistle, Gillies Limit and Best townships in the
orth Bay District.

Light damage is expected to occur throughout the remainder of
ortheastern Ontario (Fig. 5) about as far north as the 49° 30' parallel
herever susceptible stands occur. The only significant exception to
his overall situation is a large area (about 700,000 acres) centered
round Rocky Island Lake in the northeast side of the Sault District, and
nown as the Mississagi-Chapleau Fire (1948); it will remain free of
amage since it is generally not vulnerable to budworm.

Elsewhere a sizeable area of trace and light defoliation on
ost trees was detected in the southeastern corner of Geraldton and the
orthwestern corner of the White River districts. The area affected
ies some distance (about 50 miles) from any major infestation and since
o evidence of moth influx exists, this light infestation could be the
tart of an independent outbreak. In view of the recently favorable
ituation for the budworm in Ontario, new outbreaks may be expected; but
n this area, namely, Marathon to White River, a full-blown outbreak
ould prove costly. Firstly, much of the affected area has a high balsam
ir content that would be suitable for harvesting in 30 years or less,
nd, secondly, the natural beauty of a portion, if not all, of the newly
esignated Pukaskwa National Park could be severely affected. Although
his infestation is in a very early stage of development and the 1971
gg-mass counts fail to indicate more than trace or light damage in
972, the situation will be carefully monitored.

In last year's report "The Spruce Budworm Situation in Ontario,
970, (Howse *et al.* 1971) Information Report O-X-147", it was mentioned
hat balsam fir mortality was expected in 1971, particularly in certain
arts of the Chapleau District. Intensive surveys did not detect any
ignificant amount of tree mortality, although many trees showed dead
ops and dead branch tips. The number of these is expected to increase
onsiderably in 1972 and the general condition of the balsam fir that
as been infested longest is expected to deteriorate further.

It is anticipated that aerial spraying operations in 1972 in
ortheastern Ontario will be confined to protecting trees in special
alue areas, primarily provincial parks. Parks such as Missinaibi,
vanhoe, Shoals, Lake Superior, Five Mile and Wakami Lake have received
pecial attention in terms of our surveys; and results and recommenda-
ions will be dealt with in greater detail in Part B of this report.

NORTHWESTERN ONTARIO

Situation in 1971

As mentioned in the description of the overall situation for 1971, the one relatively bright spot in the Ontario spruce budworm scene seems to be northwestern Ontario. Figure 6 depicts the location of moderate to severe defoliation that occurred in northwestern Ontario in 1971. Approximately 130,000 acres were damaged, about the same total as in 1970; in both years, most of the damage occurred in Quetico Park in the Fort Frances District. The extent of defoliation in 1971 would probably have been much greater if the Ontario Department of Lands and Forests had not carried out aerial spraying operations which are described in greater detail in Part B of this report.

However, it is necessary to backtrack somewhat in order to present a clear and complete picture leading up to the situation in 1971. During the 1970 field season, a new infestation was found around Poohbah and Tanner lakes in the south-central part of Quetico Provincial Park in the Fort Frances District. This new infestation was originally thought to be small in size but egg-mass surveys carried out in August and early September, 1970, provided evidence that additional areas were infested in the Fort Frances District. Subsequent surveys during the winter of 1970-71 revealed several infestations totalling about 130,000 acres. These infestations extended from Namakan Lake in the west to Bayley Bay in the east, with most of the infested acreage located in Quetico Park along the International Border. Two corridors of budworm-susceptible forest extend from the infestations in the south-central part of Quetico in a northeast direction to the Burchell Lake-Lac des Mille Lacs region. These corridors could provide avenues of access for the budworm into the western part of the Thunder Bay District. High budworm populations did exist in at least two locations in these corridors: at Kawa Bay on Kawnipi Lake and at Metacryst Lake which are 25 and 38 miles, respectively, southwest of Burchell Lake.

The management strategy developed to handle this particular situation is more fully described in Part B but essentially in 1971 it consisted of spraying all known pockets of infestation in the Thunder Bay District and of starting a program of abatement spraying in the Fort Frances District, beginning with the easternmost infestations closest to Burchell Lake and working westward.

Thus, following the spraying in May and June, 1971, the Forest Insect and Disease Survey conducted a series of pupal, defoliation and egg-mass surveys. The pupal counts and defoliation surveys revealed about 130,000 acres of moderate to severe defoliation, most of which was in the Fort Frances District and very little of which was in the sprayed areas. This represents little change from the situation in 1970. In the Fort Frances District, the 1971 defoliation again extended from

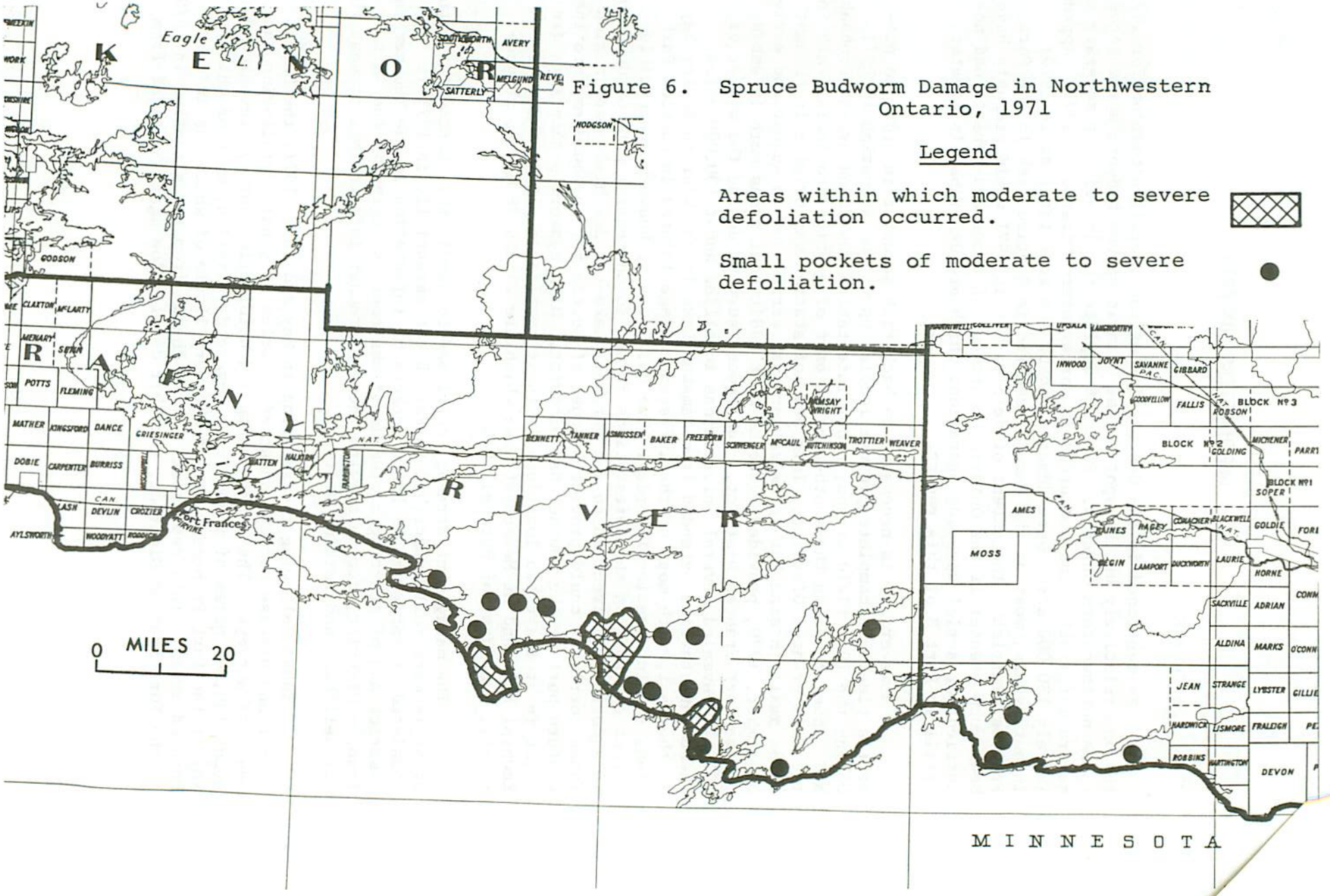


Figure 6. Spruce Budworm Damage in Northwestern Ontario, 1971

Namakan Lake to Bayley Bay along the International Border. Small scattered pockets of defoliation were found around sprayed areas at Kawa Bay and Poohbah and Tanner lakes.

In the Thunder Bay District, about 2,000 acres of current defoliation was recorded, most of which occurred in a new infestation found near Mountain Lake along the border. Small pockets of defoliation occurred in sprayed areas at Northern Light Lake, Granite Lake and Gunflint Lake and adjacent unsprayed areas of Gunflint Lake. These infestations in Thunder Bay and Fort Frances districts represent the northern edge of an extensive outbreak totalling some 2,000,000 acres which extends throughout central and northern Minnesota (see Fig. 1, p. 3) (1971 Forest Pest Report, Minnesota, Department of Agriculture).

In addition to the approximately 130,000 acres of infested acreage located mainly along the International Border, scattered trace and light defoliation was detected throughout an appreciable area near Atikokan north of Highway 11 and in a smaller area in Inwood Township near Upsala. These latter light infestations could possibly be incipient populations ready to break loose and may be similar to the situation described for the southeastern corner of the Geraldton and northwestern corner of the White River districts.

Damage Forecast for 1972

Egg-mass counts were obtained for 220 locations throughout northwestern Ontario, but concentrated in the Fort Frances and Thunder Bay districts (see Table 3, p. 29). Figure 7 illustrates the areas where moderate to severe defoliation (some 125,000 to 150,000 acres) is expected to occur in 1972.

Virtually all of the defoliation in 1972 will occur in the Fort Frances District in much the same areas as in 1971. Evidence obtained from assessments of the aerial spraying operations showed that there was no significant spread from infestation centers to uninfested areas to the north and east although a shift of population has been noted in the Poohbah Lake area. Populations are higher in the eastern part of this block and lower in the west compared with 1970. The egg-mass counts indicate that all sprayed areas except the Metacryst Lake area have been reinfested to levels that will cause moderate to severe defoliation in 1972.

In the Thunder Bay District, small pockets of defoliation are expected to occur in the vicinity of Gunflint, Granite, Northern Light and Mountain lakes in 1972. Much of the area in the Thunder Bay District which was sprayed in 1971 has been reinfested but egg-mass counts are lower and no evidence exists of any significant spread outward.

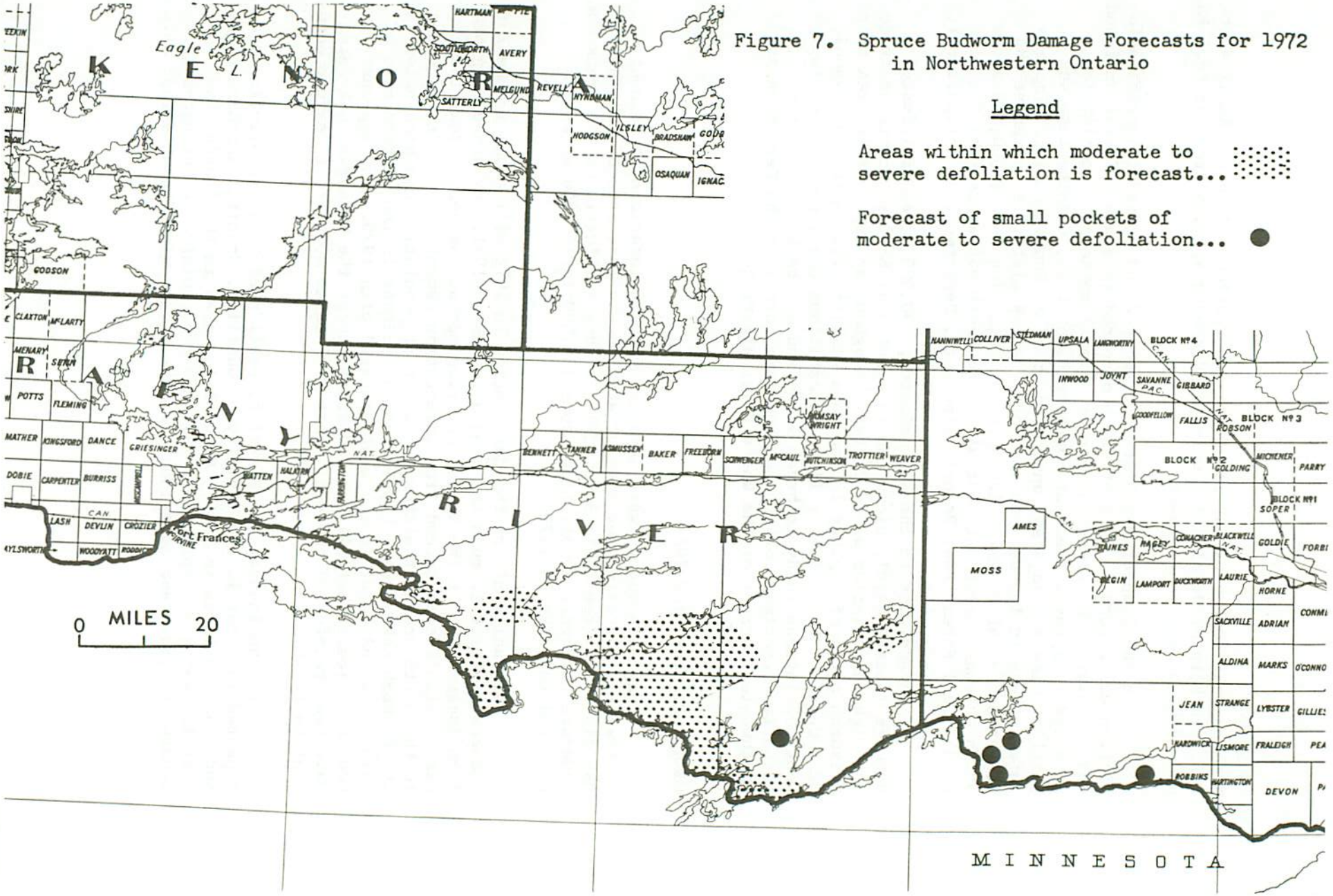


Figure 7. Spruce Budworm Damage Forecasts for 1972 in Northwestern Ontario

Legend

Areas within which moderate to severe defoliation is forecast...

Forecast of small pockets of moderate to severe defoliation...

Egg-mass counts from the Burchell Lake-Shebandowan Lakes-Lac des Mille Lacs region show that populations have remained low; in fact, the 1971 egg-mass counts are slightly lower than those for 1970 and are now at the lowest level that we have recorded since 1967. Therefore, no noticeable damage is expected to occur in this region in 1972. Egg-mass counts from the new infestations near Atikokan and Upsala were extremely variable, indicating that only trace and light defoliation would occur in 1972 in these areas. The possibility of new outbreaks appearing in these areas in the next year or two depends, however, on conditions developing that are suitable for budworm survival. Elsewhere, throughout northwestern Ontario, it is expected that numbers of budworm larvae will be low and damage levels negligible.

The extent of aerial spraying operations in northwestern Ontario in 1972 is likely to be similar to that of aerial spraying operations carried out in 1971 and described in Part B of this report.

SUMMARY

In 1971, as forecast for southeastern and northeastern Ontario, the spruce budworm outbreak continued to build up and covered more than 13 million acres, double that of 1970. In northwestern Ontario, the picture was unchanged from 1970, probably because of the program of abatement spraying.

Population build-up and development of the outbreak will continue in 1972 in southeastern and northeastern Ontario, with up to ten-fold increases in budworm numbers forecast in some districts of northeastern Ontario and noticeable damage to fir and spruce is expected over more than 20 million acres.

In northwestern Ontario, the situation is encouraging because the outbreak is expected to remain essentially unchanged from 1971. A continuation of the abatement spraying program may even help gain some ground and should continue to help prevent the reinfestation of the Burchell Lake-Lac des Mille Lacs region.

Table 1 Southeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Pembroke District (43 locations)				
Airy Twp - East Gate	wS	61	300	S*
Alice Twp	bF	85	442	S
Biggar Twp	bF	0	0	0
Bishop Twp	bF	2	6	L
Bower Twp - Penaish Lake	wS	63	517	S
Bromley Twp	wS	91	1815	S
Bronson Twp	wS	6	278	S
Cameron Twp - Rankin Creek	bF	0	16	L
Canisbay Twp	wS	45	1435	S
Clara Twp	bF	26	71	M
Deacon Twp	bF	21	43	M
Dickson Twp	bF	64	809	S
Guthrie Twp	wS	18	250	M-S
Head Twp	wS	75	448	S
Maria Twp	wS	25	271	S
McKay Twp	wS	40	157	M-S
Nightingale Twp	wS	21	442	S
Peck Twp	bF	3	8	L
Petawawa Twp	wS	60	268	S
Preston Twp	bF	97	744	S
Rolph Twp - Deep River	wS	65	369	S
" " - Rolphton	wS	65	803	S
Ross Twp - District boundary	wS	70	761	S
Ross Twp - Garage	wS	69	420	S
Sabine Twp - McCoy Lake	wS	10	90	M-S
Sherwood Twp	wS	6	432	S
Stafford Twp	wS	62	786	S
Stratton Twp				
2 Achray - Plot C	bF	70	193	S
2 Achray - Plot C	wS	62	450	S
Lone Creek #1	bF	100	122	M-S
Lone Creek #2	wS	100	663	S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

2 Aerial sprayed Pox Virus, 1971

Table 1 Southeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Pembroke Dist (cont'd)				
	Westmeath Twp	wS	52	792	S*
4	White Twp - A.R.O.	wS	3	235	S
	Wilberforce Twp - north of Rankin	wS	78	460	S
	Wilberforce Twp - north-west of Douglas	wS	93	754	S
	Wilkes Twp	bF	0	0	0
	Petawawa Forest Exp Sta - (Wylie and Buchanan Twp)				
	- Baseline	bF	62	184	S
3	- DeLuthier Road	wS	68	356	S
	- By-Pass Road	wS	84	1303	S
	- Orange Road	wS	63	458	S
1	- Spray #3	wS	88	613	S
1	- Spray #4	wS	69	573	S
1	- Thomas Lake	bF	47	302	S
	Parry Sound District (2 locations)				
	Sinclair Twp	bF	0	0	0
	South Himsworth Twp	bF	1	30	L-M
	Kemptville District (7 locations)				
	Cambridge Twp	wS	3	80	M
	Clarence Twp				
	- Larose Forest #1	wS	4	128	M-S
	- Larose Forest #2	wS	7	60	M
	Dalhousie Twp	bF	82	68	M
	Fitzroy Twp	wS	80	538	S
	Huntley Twp	wS	84	438	S
	Oxford Twp - Kemptville Nursery	wS	6	121	M-S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial Sprayed, Fenitrothion, 1971

3 Aerial Sprayed, N.P.V. Virus, 1971

4 Ground sprayed, Malathion, 1971

Table 1 Southeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Tweed District (11 locations)				
Admaston Twp				
- Bonnechere River	wS	91	715	S*
- Mt St Patrick Road	bF	42	152	M-S
Ashby Twp. - Hartsmere	bF	67	169	M-S
Brougham Twp	bF	82	253	S
Denbigh Twp	bF	58	235	S
Gratton Twp	wS	90	942	S
Griffith Twp	wS	82	771	S
Matawatchan Twp	bF	88	92	M
McNab Twp	wS	41	1391	S
Raglan Twp	wS	85	393	S
Wicklow Twp	bF	24	230	S
Lindsay District (11 locations)				
Bruton Twp	bF	1	16	L
Cardiff Twp	bF	1	53	M
Cartwright Twp	wS	17	68	M
Cavendish Twp - Pencil Lake	bF	5	69	M
Chandos Twp	bF	8	60	M
Clyde Twp	bF	87	205	S
Glamorgan Twp - Koshlong Lake	bF	0	0	0
Harvey Twp - Nogies Creek	bF	77	81	M-S
Havelock Twp. - Kennisis Lake	bF	0	18	L
Minden Twp.	bF	1	0	0
Somerville Twp.	bF	6	67	M
Lake Simcoe District (3 locations)				
Essa Twp.	wS	3	114	M-S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

Table 1 Southeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (concl'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Lake Simcoe Dist (cont'd)				
Uxbridge Twp.	wS	15	105	M-S*
Vespra Twp. - Midhurst	wS	3	44	M
Lake Huron District (2 locations)				
Glenelg Twp	wS	5	43	M
St. Edmunds Twp	wS	20	112	M-S

* S - severe, M - moderate, L - light, 0 - nil

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Chapleau District (41 locations)				
	Abney Twp Spanish Lake	bF	5	80	M*
	Amundsen Twp	wS	77	569	S
	Barclay Twp				
1	- Missinaibi Prov Park	wS	89	1116	S
1	- Missinaibi Prov Park	bF	42	448	S
	Borden Twp - Westover Lake	bF	100	226	S
	Carew Twp	bF	3	120	M-S
	Comox Twp - Comox Lake	bF	2	12	L
	Coppell Twp	bF	35	224	S
	Denyes Twp - Denyes Lake	bF	1	182	S
	Fawn Twp	bF	38	350	S
	Foleyet Twp	bF	88	257	S
	Halsey Twp - Nemegos Road	bF	81	1397	S
	Hill Twp	bF	99	1361	S
	Horwood Twp	bF	92	839	S
	Ivanhoe Twp				
	- Ivanhoe Prov Park	wS	68	2009	S
	- Ivanhoe Prov Park	bF	78	605	S
	Ivy Twp - Miniwaski Lake	bF	6	207	S
	Kapuskasing Twp				
	- Kapuskasing Lake	bF	96	169	M-S
	Leeson Twp	bF	9	16	L
	Lloyd Twp - Makonie Lake	bF	100	314	S
	Margaret Twp	bF	63	226	S
	Melrose Twp	bF	68	362	S
	Montcalm Twp - Elf Lake	bF	9	177	S
	Ossin Twp - Ossin Lake	bF	94	195	S
	Penhorwood Twp				
	- Kukatush Road	bF	76	878	S
	Peters Twp - Shoals Prov Park	bF	95	2480	S
	Sadler Twp - Robson Lake Road	bF	84	968	S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Chapleau Dist (cont'd)				
Twp 8B - N.W. corner	bF	14	82	M-S*
Twp 8F - Prairie Grass Lake	bF	0	46	M
Twp 9D - Highway 129	bF	10	279	S
Twp 9H - Verse Lake	bF	5	204	S
Twp 10F - Vezina Lake	bF	0	676	S
Twp 11B - Wakami Lake Prov Park	bF	40	502	S
Twp 11D - Five Mile Lake Prov Park	bF	15	569	S
Twp 12G - Sample Lake	bF	32	945	S
Twp 12H	bF	80	914	S
Twp 23 Rge 16 - Lineus Lake	bF	61	712	S
Twp 23 Rge 17 - Bulley Lake	bF	2	319	S
Twp 25 Rge 23	bF	87	509	S
Twp 43 - Ogasiwi River	bF	80	521	S
Twp 46 - Renabie Mine Road	bF	15	100	M
Cochrane District (6 locations)				
Bartlett Twp - Texmont Road	bF	70	294	S
English Twp - English Lake	bF	17	353	S
Hassard Twp	bF	80	400	S
McKeown Twp	bF	8	57	M
Sewell Twp - Lapierre Road	bF	47	237	S
Sydere Twp - Mi 8	bF	1	4	L
Kapuskasing District (20 locations)				
Bourinot Twp - Mi 33	bF	12	14	L

* S - severe, M - moderate, L - light, 0 - nil

(cont'd)

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Kapuskasing Dist (cont'd)				
Buchan Twp - Mi 6 west	bF	73	303	S*
Casselman Twp	bF	0	0	0
Cromlech Twp - Brunswick Lake	bF	0	59	M
Derry Twp - Cameron Lake	bF	0	0	0
Farquhar Twp	bF	1	7	L
Fenton Twp - Mi 23, Chain of Lakes Road	bF	30	16	L
Gourlay Twp - Gourlay Lake	bF	2	17	L
Griffin Twp - Griffin Lake	bF	1	61	M
Lisgar Twp - Chain of Lakes Road	bF	85	673	S
Mons Twp	bF	80	826	S
Mildred Twp	bF	8	0	0
Nansen Twp - Chain of Lakes Road	bF	1	3	L
Opasatika Twp - Opasatika Lake	bF	42	38	L-M
Poulett Twp	bF	0	17	L
Radisson Twp	bF	4	2	L
Seaton Twp - Mi 34, Chain of Lakes Road	bF	41	28	L-M
Shanly Twp - Camp 15, Groundhog River	bF	1	8	L
Stringer Twp - Groundhog River	bF	3	26	L-M
Wicksteed Twp - 1.2 mi south of Hornepayne	bF	0	0	0
North Bay District (7 locations)				
Aston Twp	wS	0	12	L

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
North Bay Dist (cont'd)				
Calvin Twp	bF	0	24	L-M*
Commanda Twp	bF	1	0	0
Dunnett Twp	bF	41	136	M-S
Gillies Limit	bF	9	62	M
Jocko Twp	bF	1	16	L
Thistle Twp	bF	2	121	M-S
Sault Ste. Marie District (11 locations)				
Herrick Twp - Pancake Bay Prov Park	bF	17	75	M
Parkinson Twp	wS	62	303	S
Ryan Twp - Mamainse Lake	bF	2	5	L
Tarbutt Additional Twp	bF	63	283	S
Whitman Twp	bF	0	0	0
Twp 3F	bF	16	96	M-S
Twp 5H	bF	6	120	M-S
Twp 7H, - Goulais Lake	bF	0	36	L-M
Twp 23 Rge 13 - Hanes Lake	bF	7	388	S
Twp 25 Rge 14	bF	2	164	M-S
Twp 26 Rge 12 - Harmony Road	bF	0	0	0
Sudbury District (49 locations)				
Antrim Twp	bF	47	344	S
Arden Twp	bF	10	76	M
Baldwin Twp	bF	1	7	L
Beaumont Twp	bF	40	208	S
Beulah Twp - Meteor Lake	bF	50	172	M-S
Botha Twp	bF	76	497	S
Carter Twp	bF	0	55	M
Creelman Twp	bF	2	53	M

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Sudbury Dist (cont'd)				
Craig Twp - Blue Water Lake	bF	33	292	S*
Drury Twp	bF	0	0	0
Edinborough Twp	bF	35	558	S
Fairbank Twp.	bF	13	126	M-S
Genoa Twp.	bF	0	102	M-S
Gilbert Twp	bF	85	922	S
Gough Twp	bF	0	9	L
Hazen Twp	bF	56	315	S
Hess Twp	bF	100	545	S
Howey Twp	bF	48	763	S
Hyman Twp	bF	24	89	M
Inverness Twp - Donnegana Lake	bF	40	313	S
Killarney Prov Park	bF	0	10	L
Leask Twp	bF	1	0	0
MacMurchy Twp	bF	98	347	S
Marquette Twp - Hwy 144	bF	42	188	S
Middleboro Twp	bF	33	87	M
Miramichi Twp	bF	94	614	S
Moncrieff Twp	bF	78	443	S
Muldrew Twp	bF	97	770	S
Potier Twp	bF	0	109	M
Regan Twp	bF	35	120	M-S
Scotia Twp	bF	98	613	S
Selkirk Twp	bF	0	59	M
Sheard Twp	bF	32	226	S
Shelley Twp	bF	99	1405	S
St. Louis Twp	bF	2	0	0
Stull Twp	bF	97	668	S
Togo Twp	bF	3	21	L
Tyrone Twp - Michaud Lake	bF	2	73	M
Waldie Twp	bF	88	743	S
Waldie Twp	wS	50	1470	S
Westbrook Twp	bF	1	124	M-S
Twp 107	bF	50	166	M-S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Sudbury Dist (cont'd)				
Twp 119	bF	23	276	S*
Twp 125	bF	1	13	L
Twp A	bF	90	1021	S
Twp B	bF	73	1483	S
Twp G	bF	61	645	S
Twp J	bF	1	45	L-M
Twp M	bF	17	48	L-M
Swastika District (20 locations)				
Alma Twp	bF	34	72	M
Ben Nevis Twp	bF	1	11	L
Catherine Twp	bF	1	85	M-S
Corkill Twp	bF	57	1003	S
Dufay Twp, P.Q.	bF	48	99	M
Eby Twp	bF	0	11	L
Gamble Twp	wS	51	530	S
Hearst Twp	bF	53	167	M-S
James Twp	bF	90	1062	S
Katrine Twp	bF	2	14	L
Lamplugh Twp	bF	0	0	0
Marriott Twp	bF	0	15	L
Milner Twp	bF	90	202	S
Montrose Twp	bF	88	533	S
Mulligan Twp	bF	0	0	0
Pacaud Twp	bF	15	16	L
Rattray Twp	bF	2	0	0
Truax Twp	bF	85	229	S
Tyrell Twp	bF	97	68	M
Yarrow Twp	bF	93	300	S
White River District (25 locations)				
Amwri - Manitouwadge Road	bF	2	0	0

* S - severe, M - moderate, L - light, 0 - nil

(cont'd)

Table 2 Northeastern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (concl'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
White River Dist (cont'd)				
Challener Twp	bF	-	0	0*
Gertrude Twp	bF	1	0	0
Home Twp	bF	-	490	S
Manitouwadge Road - Mi 1½	bF	20	30	L-M
Manitouwadge Road - MI 28	bF	3	0	0
Simpson Twp	bF	-	0	0
Twp 25 Rge 18	bF	-	4014	S
Twp 26 Rge 25 - Manitowik Lake	bF	-	300	S
Twp 28 Rge 15 - Crescent Lake	bF	40	23	L-M
Twp 28 Rge 18 - Callahan Lake	bF	70	158	M-S
Twp 28 Rge 20 - Sand Lake	bF	67	622	S
Twp 28 Rge 24	bF	-	144	M-S
1 Twp 29 Rge 16 - Agawa Bay Prov. Park	bF	75	339	S
Twp 30 Rge 18 - 2 mi N of Coldwater River	bF	-	205	S
Twp 30 Rge 19	bF	63	326	S
Twp 30 Rge 21 - Rabbit Blanket Prov Park	bF	-	538	S
Twp 30 Rge 21 - Rabbit Blanket Prov Park	wS	88	2140	S
Twp 30 Rge 24 - Black Trout Lake	bF	12	104	M-S
Twp 30 Rge 26 - Godin Lake	bF	-	0	0
Twp 32 Rge 27	bF	5	0	0
Twp 48 - Godin Lake	bF	-	11	L
Twp 66 - Hornepayne Road	bF	-	6	L
Twp 70 - Access Road	bF	15	3	L
Twp 74 - Rouse Lake	bF	4	0	0

* S - severe, M - moderate, L - light, 0 - nil

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Fort Frances District (118 locations)				
Agnes Lake - south end	bF	1	19	L*
Agnes Lake - middle, west side	bF	2	15	L
Airport Road - N.W. of strip	bF	3	5	L
Alice Lake	bF	0	18	L
1 Allan Lake	bF	1	43	M
Argo Lake - S.W. side	bF	5	15	L
Argo Lake - south end	bF	20	0	0
Batchewaung Lake	bF	0	11	L
Bayley Bay - Basswood Lake	bF	63	154	M-S
Bear Pass	bF	0	13	L
Bear Pelt Lake	bF	2	0	0
Beaverhouse	bF	5	37	L-M
Bentpine Lake	bF	0	4	L
Blackstone Lake	bF	2	0	0
Bottle Lake	bF	60	120	M-S
Buckingham Lake	bF	0	0	0
Burntside Lake	bF	1	0	0
Cache Lake	bF	0	0	0
Cache Bay	bF	0	6	L
1 Cairn Lake	bF	1	17	L
Camel Lake	bF	2	0	0
Canadian Point - Basswood L.	bF	8	80	M
Carp Lake	bF	10	10	L
Captain Tom Lake	bF	3	14	L
Clearwater Bay - Sand Point	bF	2	2	L
Clearwater Lake - 4 mi S	bF	1	0	0
Companion Lake	bF	1	0	0
Conmee Lake	bF	0	25	L-M
Dack Lake	bF	3	0	0
Darky Lake	bF	45	44	L-M
David Lake	bF	1	6	L
Delahey Lake	bF	1	35	L-M

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Fort Frances Dist (cont'd)				
	Duff Lake	bF	1	25	L-M*
	Emerald Lake	bF	0	20	L
	Eva Lake	bF	1	4	L
	Eye Lake	bF	0	0	0
	Factor Lake	bF	1	5	L
	Ferguson Lake	bF	0	8	L
	Findlayson Lake	bF	1	0	0
	Flanders Road	bF	5	0	0
	Fred Lake	bF	0	0	0
	French Lake	wS	3	14	L
	French Lake	bF	3	0	0
	French Lake Prov Park	bF	3	6	L
	Gehl	bF	0	2	L
	Goodier Lake	bF	1	8	L
	Hale Bay	bF	5	18	L
1	Heronshaw Lake	bF	0	0	0
	Hillyer Creek	bF	15	27	L-M
	Hydro Line	bF	1	0	0
	Joyce Lake	bF	0	7	L
1	Kawa Bay	bF	2	156	M-S
	Kawnipi Lake - S.W. of Rose Is.	bF	0	0	0
	Kawnipi Lake - S.E. Bay	bF	3	0	0
	King Point - Basswood Lake	bF	9	91	M-S
	Lac La Croix - Campbell's	bF	0	0	0
	Lac La Croix - I R 25D	bF	5	7	L
	Little Eva Lake	bF	2	0	0
	Little Grassy Bay	bF	1	6	L
	Little MacCaulay Lake	bF	5	0	0
	Loon Lake	bF	1	4	L
	Louisa Lake	bF	1	12	L
	Mack Lake	bF	1	0	0
	Maligne River - W of Tanner Lake	bF	80	389	S
1	Maligne River - Poobah Creek	bF	60	270	S

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Fort Frances Dist (cont'd)				
	Manion Creek	bF	1	0	0*
	Martin Bay - Lac La Croix	bF	80	693	S
	McAree Lake - Portage	bF	10	243	S
	McEwen Lake	bF	5	7	L
	McDougall	bF	0	0	0
1	McKenzie Lake - S.W. end	bF	2	28	L-M
	McKenzie - Tower	bF	0	0	0
	McNiece Lake	bF	0	0	0
	Melema Lake	bF	15	6	L
	Mercutio Lake	bF	0	0	0
	Minn Lake	bF	85	88	M
	Moose Bay	bF	3	10	L
	Namakan Lake - middle	bF	3	13	L
	Namakan Lake - east end	bF	0	26	L-M
	Namakan Lake - Moose Island	bF	2	29	L-M
	North Bay - Basswood Lake	bF	2	15	L
	Northland Gateway	bF	4	16	L
	Nydia Lake	bF	1	0	0
	Nym Lake	bF	0	0	0
	Olifaunt Lake	bF	0	0	0
	Orion Lake	bF	2	13	L
	Oriana Lake	bF	3	5	L
	Pickerel Lake	bF	0	0	0
	Pickerel River	bF	2	5	L
1	Poobah Lake - east end	bF	6	88	M
1	Poobah Lake - west end	bF	52	457	S
	Quetico Lake - east Bay	bF	0	0	0
	Rat River Bay	bF	1	12	L
	Red Horse Bay	bF	5	0	0
	Red Pine Lake	bF	0	0	0
	Saganagons Lake	bF	1	13	L
	Sarah Lake	bF	0	15	L
	Sark Lake	bF	1	0	0
	Sawbill Bay	bF	1	0	0
	Seine River - Hwy 11	bF	2	7	L

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Fort Frances Dist (cont'd)				
	Shade Lake	bF	5	73	M*
	Shoal Lake	bF	1	0	0
	Stokes Bay	bF	0	0	0
	Sturgeon Lake - west end	bF	1	50	M
1	Sturgeon Lake - S.W. side	bF	9	82	M
	Sturgeon Lake - east end	bF	0	15	L
1	Tanner Lake	bF	57	269	S
	Ted Lake - N of MacIntyre L	bF	0	0	0
	Thompson Lake	bF	2	6	L
	Tower - Hwy 11	bF	5	0	0
1	Trail Lake	bF	2	33	L-M
	Trout Lake	bF	3	12	L
	Tuck Lake - 1 mi N	bF	5	0	0
	Walter Lake	bF	0	0	0
	Whiskeyjack Lake	bF	2	0	0
	Wicksteed Lake	bF	3	21	L
	William Lake	bF	10	17	L
	Williamson Lake	bF	0	0	0
	Wolseley Lake	bF	1	0	0
	Thunder Bay District (87 locations)				
	Armstrong Road - Mi 7	bF	0	0	0
	Arrow Lake	bF	0	0	0
	Athelstane Lake	bF	0	0	0
	Baker Lake	bF	0	0	0
	Batwing Lake	bF	0	0	0
	Bedivere Lake	bF	0	0	0
	Bemar Lake	bF	0	0	0
	Black Sturgeon Lake	bF	0	0	0
	Black Sturgeon and Wolf Pup Roads	bF	0	0	0
	Blackwell Twp	bF	0	0	0
	Burchell Lake	bF	0	0	0

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Thunder Bay Dist (cont'd)				
Burchell Lake - south-east side	bF	0	0	0*
Canthook Lake	bF	0	0	0
Clovenhoof Lake	bF	1	6	L
Crayfish Lake	bF	0	6	L
Devil's Elbow	bF	5	11	L
Drift Lake	bF	0	0	0
Fountain Lake	bF	0	18	L
Graham	bF	0	0	0
1 Granite Lake - north	bF	3	6	L
1 Granite Lake - south	bF	3	67	M
Greenwater Lake - south side	bF	0	0	0
Greenwater Lake - Shelter Is	bF	0	0	0
Greenwood Lake	bF	0	0	0
Gunflint Lake - east end	bF	1	0	0
Gunflint Lake - west end	bF	55	53	M
Gunflint Lake - central	bF	8	25	L-M
Gunflint Lake - 4 mi north of east end	bF	0	0	0
Gunflint Lake 2 mi north	bF	0	0	0
Hagey Twp	bF	0	0	0
Haines Twp - Postans, (big broom)	bF	0	0	0
Hwy 11 - 2 mi west of Burchell Lake road	bF	0	0	0
Hood Lake	bF	0	0	0
Hoof Lake	bF	0	8	L
Huronian Lake	bF	0	0	0
Inwood Prov. Park	wS	25	13	L
Inwood Prov. Park	bF	12	6	L
Inwood Prov. Park Road - Mi ½	bF	3	0	0
Icarus Lake	bF	0	0	0
Joe Lake - Sibley Penin	bF	0	0	0
Kashabowie Lake - lower	bF	0	0	0
Kashabowie Lake - upper	bF	0	0	0

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

	Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
	Thunder Bay Dist (cont'd)				
	Kekebaub Lake	bF	1	0	0*
	Lac des Mille Lacs				
	- Baril Bay	bF	0	0	0
	- Blind Bay	bF	0	0	0
	- Bolton Bay	bF	0	0	0
	- Cushing Lake	bF	0	0	0
	- Lily Lake	bF	0	0	0
	- Pine Point	bF	0	9	L
	- Poplar Point - Ind Res	bF	0	0	0
	- Portage Bay	bF	0	0	0
	Marks Lake	bF	0	14	L
	Marks Lake Road	bF	0	8	L
	Max Lake - Spruce River Rd	bF	0	0	0
	McGinnis Lake	bF	1	20	L
	Melvin Lake - west	bF	0	13	L
	Moose Lake	bF	1	0	0
	Moss Lake	bF	0	0	0
	Mountain Lake - west	bF	68	131	M-S
	Mountain Lake - east	bF	35	37	L-M
	Mountain Lake - east	wS	60	169	M-S
	Nelson Lake	bF	0	0	0
	North Lake - north of Shekaka Lake	bF	1	0	0
	Northern Light Lake				
	- Curran Bay (Moose Bay)	bF	0	23	L-M
1	- East of weather Stn	bF	4	170	M-S
	- Savage Bay	bF	0	13	L
1	- South Shore (South Is)	bF	36	251	S
	- Trafalgar Bay	bF	0	0	0
	- Trout Bay - south	bF	2	20	L-M
1	- Weather Stn. (1970)	bF	7	14	L
	Pigeon River	bF	1	10	L
	Plummes Lake	bF	0	7	L
	Poshkokogan River	bF	0	0	0
	Powell Lake	bF	0	0	0

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

1 Aerial sprayed, Fenitrothion, 1971

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (cont'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Thunder Bay Dist (cont'd)				
Prelate Lake	bF	0	0	0*
Ross Lake	bF	0	6	L
Sandstone Lake	bF	0	0	0
Shebandowan Lake - lower	bF	0	0	0
Shebandowan Lake - upper	bF	0	0	0
Sleigh Lake	bF	1	0	0
Spruce River Road - Mi 26	bF	0	0	0
Squeers Lake	bF	0	0	0
Sunbow Lake	bF	1	12	L
Swallow Lake	bF	0	0	0
Tilly Lake	bF	0	0	0
Titmarsh Lake	bF	0	0	0
Whitefish Lake - east side	bF	0	9	L
Sioux Lookout District (5 locations)				
Gulliver Lake	bF	0	0	0
Norway Lake	bF	0	0	0
Old Man Lake	bF	0	0	0
Pyramid Lake	bF	0	0	0
Red Paint Lake	bF	0	7	L
Geraldton District (9 locations)				
Caramat Road - Mi 15	bF	0	0	0
Colter Twp - 3 mi west of Sturgeon River	bF	0	0	0
Jct of Industrial and Camp 5 roads	bF	2	0	0
Jct of Industrial and Camp 5 roads	wS	2	4	L
Ledger Twp - Gas line	bF	0	0	0

* S - severe, M - moderate, L - light, 0 - nil (cont'd)

Table 3 Northwestern Ontario - Spruce Budworm: Summary of defoliation estimates and egg-mass counts in 1971, and damage forecasts for 1972 (concl'd)

Location	Host	Estimated per cent of defoliation 1971	No. of egg-masses per 100 sq ft of foliage	Damage forecast for 1972
Geraldton Dist (cont'd)				
Marathon - ½ mi north of Hwy 17	bF	5	0	0*
Marathon - 2 mi north of Hwy. 17	bF	4	0	0
Marinet Lake	bF	2	0	0
Twp 86 - Rainbow Falls Park	bF	0	0	0

* S - severe, M - moderate, L - light, 0 - nil

PART B: SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS ONTARIO, 1971[1]

INTRODUCTION

Aerial spraying operations, covering some 81,000 acres were conducted against the spruce budworm in Ontario in 1971. One operation was in southeastern Ontario at the Petawawa Forest Experiement Station (PFES); three operations in provincial parks in northeastern Ontario--Missinaibi, Shoals and Lake Superior Provincial Parks; and two operations in northwestern Ontario--one in southwestern Thunder Bay District (Northern Light Lake, Granite Lake and Gunflint Lake) and one in Quetico Provincial Park of the Fort Frances District (Poohbah Lake, Metacryst Lake and Kawa Bay). The locations of these areas are shown in Figure 1 (p. 3). All operations, with the exception of the one at PFES, were carried out by the Ontario Department of Lands and Forests with the advice and assistance of the Canadian Forestry Service. The PFES operation was solely the responsibility of the Canadian Forestry Service. This statement describes each operation and the results obtained.

SOUTHEASTERN ONTARIO OPERATIONS

Background

At PFES, a total of 400 acres of high-value research forest, composed of some 23 white spruce [*Picea glauca* (Moench) Voss] plantations and three natural areas with high balsam fir [*Abies balsamea* (L.) Mill.] and white spruce components were sprayed to prevent or minimize damage from budworm feeding. The same areas had been sprayed in 1970 for the same purpose, with variable success. Egg-mass counts in the fall of 1970 forecast the presence of very high populations throughout the station in 1971.

Pre-spray Larval Surveys and Insect Development

Budworm emergence from overwintering hibernaculae started on May 7, 1971 and appeared to be complete by May 11, 1971. In April, before this emergence, foliage was collected from several locations on

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[1] This report was prepared by the Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario. K. B. Turner of the Environmental Protection Branch, of the Ontario Ministry of Natural Resources, Toronto, who had final responsibility for all operational decisions concerning provincial operations, provided operational details.

The authors are, respectively, a Research Officer and the Head of the Insect and Disease Survey Unit, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

the station and incubated. Numbers of emerging larvae were considerable, exceeding 100 per branch in some cases. Natural emergence confirmed the establishment of a high population throughout the Station.

Plans called for at least two applications by helicopter of fenitrothion, each of 3 oz per acre in fuel oil at a rate of 1 qt per acre. The first application was to be timed for the needle-mining stage (second instar) and the second application for third and fourth instar. A third application of 3 oz per acre was to be utilized, if necessary, 2 to 4 days following the second application. This strategy was based on recommendations of the Chemical Control Research Institute (CCRI), Canadian Forestry Service, Ottawa.

The timing of the spray applications was determined from observed insect development, host development and calculated accumulated heat units.

The Spraying Operations

A Hughes 269A helicopter equipped with a 32-ft boom and two spray tanks with a 55 gal (U.S.) capacity was contracted for the operation from Twinn Pest Control Aerial Ltd., Ottawa. The insecticide was formulated by Cyanamid of Canada and was Accothion dissolved in Aerotex 3134 at a concentration of 4 lb active ingredient per gallon of Aerotex. The formulated insecticide was diluted to the desired concentration at the spray site with #2 fuel oil (diesel oil).

On the evening of May 17, 1971 and morning of May 18, 1971, 400 acres on the Station received the initial application of 3 oz fenitrothion in 2 qt of spray mixture (diesel oil plus Aerotex 3134). Insect development was 98% second instar and 2% third instar.

The second application was carried out on the evening of May 28, 1971 when the insects had reached the peak of the third instar. The total area treated on May 28, 1971 was reduced to 325 acres because larval counts showed low population levels in two plantations of young trees totalling 75 acres. A third application was repeated over the 325 acres on the evening of May 31, 1971. The second and third applications were also at the rate of 3 oz of fenitrothion per 2 qt of diesel oil per acre. Generally speaking, weather conditions during all three applications were satisfactory.

Thus, in summary, 325 acres received three applications of 3 oz per acre for a total of 9 oz per acre and 75 acres received one application of 3 oz per acre.

Entomological Assessment

A full entomological assessment of the effectiveness of the operation was carried out, i.e., population densities of the budworm were determined in sprayed plots and unsprayed check plots before and after spraying. The results of this assessment are contained in Table 1.

Table 1. Results of entomological assessment at the Petawawa Forest Experiment Station, 1971

Treatment	% population reduction	
	wS	bF
Two applications of 3 oz each per acre (6 oz)	31.5	54.9
Three applications of 3 oz each per acre (9 oz)	35.2	56.6
	% defoliation	
	wS	bF
Spray Plots	77.3	41.2
Controls	92.3	95.7
	Post-spray pupal densities (Living budworm/18-in. tip)	
	wS	bF
Spray Plots	10.0	2.5
Control Plots	15.1	9.4

Thus, as these data indicate, a poor level of protection was achieved on an overall basis.

The amount of defoliation and the percent of population reduction varied considerably among plantations. In general, those plantations with initially high budworm levels eventually suffered the greatest damage. Aerial observation and ground work showed that one entire plantation was severely damaged, portions of six others were severely damaged and the remaining plantations received light or

moderate damage. A fairly good degree of protection was afforded to the sprayed balsam fir in natural stands, at least in comparison with white spruce.

A trace of damage was present in the two plantations that were sprayed only once during the second instar. However, population levels initially were not high enough to cause more than trace or light defoliation in any case.

The helicopter was calibrated to deliver 2 qt per acre with pump pressure at 40 lb psi and aircraft velocity of 60 mph. This provided an effective swath width of approximately 80 ft when the helicopter's altitude was just above tree top level. Spray coverage, where it could be monitored, appeared to be satisfactory. For example, the average droplet density deposited on spray cards at ground level across one 80-ft spray swath flown at an altitude of 50 ft and 60 mph was 11.3 droplets per square centimeter. The majority of the droplets, as recorded on spray cards, ranged in size from 100 to 500μ in diameter and averaged 250μ.

Conclusions

It had been concluded in 1970 that the primary causes of the poor level of protection achieved that year at PFES, when using a Stearman aircraft and higher rates of fenitrothion, were: "The unusually high initial levels of larval population, a delay in the arrival of the spray plane, a spell of poor flying weather, and the subsequent advanced stage of larval development beyond the fourth instar resulting from the lateness of spraying". The latter three suggested causes were not involved as factors in the 1971 operation, i.e., the optimum timing was achieved and no delays were experienced owing to weather or aircraft. As in 1970, larval population levels were generally very high. Population reduction figures show that not enough larvae were killed to provide a satisfactory degree of protection, and this, in turn, raises questions concerning the efficacy of fenitrothion and/or application techniques. The marked difference between the results obtained on balsam fir and white spruce is noteworthy.

Samples of the insecticide used were sent to CCRI. Bioassays were performed to compare the material used at PFES with laboratory stock. There appeared to be no difference in toxicity of the two batches of fenitrothion to spruce budworm larvae (personal communication from Dr. P. C. Nigam--CCRI).

Detailed forecasts of damage expected in 1972 for southeastern Ontario, based on egg-mass counts obtained in the fall of 1971, are given in Part A of this report. Egg-mass counts from several locations

throughout the Petawawa Forest Experiment Station support a forecast of severe defoliation on spruce and fir throughout the station in 1972. Therefore, a chemical control operation must again be considered to protect the experimental units on the station.

NORTHEASTERN ONTARIO OPERATIONS

Background

Spraying was carried out in three provincial parks in northeastern Ontario in 1971--Missinaibi and Shoals in Chapleau District and Lake Superior Provincial Park in the White River District. The purpose of spraying in these parks was primarily to preserve foliage and keep balsam fir and white spruce trees as green as possible throughout various high-use recreation areas and campgrounds.

The acreages sprayed in each park were: 6,000 in Missinaibi (this was a repeat of the 1970 spraying), 1,620 in the Shoals and 1,000 in Lake Superior. These sprayed acreages represent only a small portion of the total size of each park since Missinaibi is 176 square miles, Shoals is about 50 square miles and Lake Superior is 576 square miles.

Pre-spray Larval Surveys and Insect Development

The Canadian Forestry Service was responsible for obtaining data on insect and host development and for following the accumulation of heat units in determining the start of spraying, which was to be at the peak of fourth instar.

Observations and foliage collections for larval samples in each of the proposed spray sites during third instar confirmed the presence of substantial numbers of larvae (Table 2).

The Spraying Operations

Provincial personnel responsible for the operations were advised by the Canadian Forestry Service on June 7, 1971 (peak of third instar) that spraying should start about June 11 to June 12, 1971. A single Stearman aircraft on floats arrived in Chapleau on June 13, 1971 and spraying started that evening. All areas treated received a single application of 5.3 oz of fenitrothion in 1/5 gal of water per acre.

The Shoals was sprayed on the evening of June 13 and morning of June 14, Missinaibi was started on the evening of June 14 and finished on the morning of June 17 and Lake Superior was completed on the evening of June 19.

Entomological Assessment

The following data (Table 2) are pertinent to the assessment of these spraying operation.

Table 2. Pre-spray and post-spray population densities and percent defoliation from sprayed areas in the three provincial parks

Location	Host	Budworm density[a] Larvae pre-spray	Pupae post-spray	% Defoliation
Lake Superior	wS	27.2	9.8	60
		38.4	19.2	72
		15.0	1.0	2
	bF	21.0	1.5	7
		15.4	4.2	30
		8.0	.2	2
Shoals	bF	39.8	6.4	28
Missinaibi	wS	45.0	14.8	54
	bF	16.6	7.5	56
		9.0	2.8	50

[a] Average number of living budworm larvae per 18-in. branch tip.

Unsprayed control plots were not established in northeastern Ontario; however, if unsprayed survival curves for spruce budworm on white spruce and balsam fir at PFES are used to calculate the percent population reduction for the foregoing values, then a mean population reduction of 21% for sprayed white spruce and 36% for sprayed balsam fir can be obtained. Defoliation of white spruce in sprayed areas was not appreciably different from that recorded for unsprayed white spruce in the Chapleau District whereas sprayed balsam fir appeared to receive some protection compared to unsprayed balsam fir (Table 3). Pupal densities on sprayed balsam fir were considerably less than unsprayed balsam fir whereas pupal densities on sprayed white spruce were almost the same as unsprayed white spruce (Table 3).

Table 3. Pupal densities and defoliation for white spruce and balsam fir from sprayed and unsprayed areas in northeastern Ontario

		Pupal density[a]	% defoliation
Sprayed	wS	11.2	47
Not sprayed	wS	10.7	52
Sprayed	bF	3.8	29
Not sprayed	bF	10.4	88

[a] Number of living pupae per 18-in. branch tip.

Spray deposit could not be measured because little, if any, dye was placed in the spray mixture. Weather conditions were considered good.

Conclusions

The overall results cannot be considered as particularly satisfactory. The contrasting results on white spruce and balsam fir are similar to those noted for PFES. The weather conditions were suitable, no delays were experienced, the proper timing was achieved and larval populations were not excessively high. Therefore, the cause(s) of the poor results must be related to either the efficacy of the insecticide or to application techniques or to both.

Detailed forecasts of damage expected in 1972 for northeastern Ontario based on egg-mass counts obtained in the fall of 1971 are given in Part A of this report.

Anticipated spraying operations for 1972 potentially include every provincial park within the infestation that has an appreciable volume of balsam fir and/or white spruce.

Two provincial parks in the Chapleau District--Five Mile Provincial Park in Township 11D which suffered light defoliation in 1970 and 1971 and Wakami Lake Provincial Park, Township 11B, which was lightly defoliated in 1970 and moderately defoliated in 1971--show dramatic increases in budworm egg-mass populations in 1971 and the forecasts are for severe damage in 1971 (see Table 2, Part A). Presently, little interest is shown by the Province in protecting areas other than provincial parks or portions of parks in this region.

NORTHWESTERN ONTARIO OPERATIONS

Background

In 1968 and 1969, aerial spraying operations were carried out in the Burchell Lake region of northwestern Ontario in an effort to eliminate a spruce budworm infestation that was threatening a nearby area of 4.5 million acres of susceptible spruce-fir forest around Lac des Mille Lacs. This area had not been severely damaged by budworm for over 40 years. These operations combined with cool, wet weather were successful in eliminating the Burchell Lake outbreak. Budworm population densities have remained very low from 1969 to the present throughout the Burchell Lake and Lac des Mille Lacs regions.

However, in the fall of 1969, two small discrete infestations were discovered near the International Border, about 25 miles south of Burchell Lake. These infestations were located at Northern Light Lake and Granite Lake and were 2,800 and 1,200 acres in size, respectively. These two areas plus an additional small infestation on Gunflint Lake, discovered in May 1970, were sprayed in June 1970 with the objective of eliminating these infestations before they could increase and spread, particularly into the Burchell Lake region.

The origin of these infestations near the International Border is not certain, but they could have resulted either from lingering populations that carried over from an earlier outbreak or from moth flights from an extensive, prolonged outbreak in northern Minnesota.

The 1970 spraying at Northern Light, Granite and Gunflint lakes which are all located in the Thunder Bay District, 25 to 30 miles south of Burchell Lake, was not completely successful since these pockets of heavy infestation were not eliminated. Egg-mass counts in the fall of 1970 showed that infestation potential remained high for 1971.

Elsewhere, during the 1970 field season, a new infestation was found at Poohbah Lake in the south-central part of Quetico Provincial Park in the Fort Frances District. Poohbah Lake is located 50 miles to the southwest of Burchell Lake and 11 miles north of the International Border. Subsequent additional winter surveys in Fort Frances District revealed several infestations totalling 130,000 acres. These infestations extended from Namakan Lake in the west to Bayley Bay in the east, with most of the infested acreage located in Quetico Park along the International Border. Two corridors of budworm susceptible forest extended from the infestations in the south-central part of Quetico, in a northeast direction to the Burchell Lake-Lac des Mille Lacs region. These corridors could provide avenues of access for the budworm into the western part of the Thunder Bay District. High budworm populations existed in at least two locations in these corridors: Kawa Bay on Kawnipi Lake and Metacryst Lake, 25 and 38 miles, respectively, southwest of Burchell Lake.

A meeting was held in Sault Ste. Marie in early April 1971 between the Canadian Forestry Service and the Ontario Department of Lands and Forests to discuss the northwestern Ontario budworm situation. At this meeting, it was concluded:

(i) that the knock-out spraying approach used successfully in earlier operations was now largely out of the question except in a few scattered areas

and

(ii) that the approach should become one of abatement spraying concentrating on populations detected in the two major corridors threatening the large area of susceptible forest to the north and east.

Thus, it was decided to spray, in 1971, all known pockets of infestation in the Thunder Bay District to try again to eliminate them and to start a program of abatement spraying, starting with the easternmost infestations closest to Burchell Lake and working westward as far as resources would permit. At this time, it was apparent that the resources available would permit spraying about 70,000 acres in the Fort Frances District. Hopefully, this strategy would prevent the increase and spread of infestations threatening Burchell Lake. It was recognized that the procedure would have to be repeated perhaps annually until the infestations subsided naturally, even if the operation proved highly successful in 1971. The primary concern then was not protection, but to reduce the chances of the infestations along the border spreading to much larger susceptible areas containing uncut wood.

The operational plan for Quetico called for a single application (highest population areas to be sprayed twice) of 4 oz of fenitrothion in 1/5 gal of Aerotex per acre to be applied starting in the second instar or needle-mining stage. This was necessary because much of the cover type in infested areas consisted of an aspen overstory that would prevent adequate spray deposit on understory balsam fir if spraying was carried out after leafing of the aspen overstory had occurred. The Thunder Bay District operations were to be carried out at peak of fourth instar and each area was to be sprayed twice.

Pre-spray Surveys and Insect Development

The areas recommended by the Canadian Forestry Service for spraying were selected on a priority basis by using defoliation information, egg-mass sampling data, forest cover type information from type maps and aerial observations, a limited number of pre- and post-emergence larval counts and proximity to Burchell Lake. In Fort Frances District, the acreage was composed of three separate blocks; the first block and closest to Burchell Lake (about 25 miles) was approximately 13,000 acres

in size, located at Kawa Bay on Kawnipi Lake. The second block, which was about 9,000 acres, was located 13 miles west of Kawa Bay at Metacryst Lake. The third block was the eastern half of an 80,000 acre infestation surrounding Poohbah and Tanner lakes. Poohbah is about 12 miles west of Metacryst Lake.

Furthermore it was recommended that four blocks totalling 9,500 acres in the Thunder Bay District be sprayed. These four blocks were located at Northern Light Lake (5,000 acres), Granite Lake (2,000 acres), Gunflint Lake (2,000 acres), and 2 miles north of Granite Lake (500 acres).

Budworm emergence occurred on or before May 9 throughout Thunder Bay and Fort Frances districts and was generally complete by May 15, 1971. Field personnel of the Canadian Forestry Service followed insect development and host development and this information combined with accumulated heat units was used for the purpose of timing the various spray operations.

The Spraying Operations

It was recommended on May 13 that spraying should commence as soon as possible for the Quetico operations. Three Stearman aircraft (on wheels) and a Cessna guide plane arrived at Atikokan on May 14, 1971. Spraying did not commence until the morning of May 21, 1971 because of turbulent weather. The operation continued in Quetico until June 9, 1971 when 80% of the acreage had been covered. The aircraft then moved to an airstrip at Swallow Lake in the Thunder Bay District that had been especially constructed for the 1968 Burchell Lake operation. Spraying at Northern Light Lake started on June 11 and all four blocks were completed by June 15, 1971. Insect development during this time period had reached fourth and fifth instar. The aircraft returned to Atikokan on June 16 to resume the Quetico spraying which was completed by June 19, 1971. Insect development was advanced to fifth and sixth instar by this time.

Generally speaking, the northwestern Ontario operations were plagued with windy and turbulent weather conditions throughout the operation. This factor combined with the long hauls caused the spraying to extend over a longer period of time than was desirable.

All areas sprayed received a single application of 4 oz of fenitrothion in 1/5 gal of Aerotex per acre. There were no double applications as planned in Thunder Bay District. Table 4 lists the location, dates and acreages sprayed.

Measurement of spray deposit for these operations was virtually impossible because of the inaccessibility of the sprayed areas. However, one series of cards placed along a bush road at Northern Light Lake

showed the presence of spray droplets. Further analysis was not possible because no dye was present in the spray.

Table 4. Locations, acreages and dates sprayed in northwestern Ontario, 1971

Location	Acres	Date
Fort Frances - Quetico		
Block 1 - Kawa Bay	12,825	May 21, 22, 26, 27
Block 2 - Metacryst Lake	9,450	May 21, 27, 28, 31
Block 3 - Poohbah Lake-Tanner Lake	42,525	May 31, June 1, 2, 3, 4, 8, 9, 16, 17, 18, 19
Sub-total	64,800	
Thunder Bay		
Northern Light Lake	5,050	June 11, 14, 15
Granite Lake	1,680	June 15
Gunflint Lake	350	June 15
2 miles north of Granite Lake	500	June 15
Sub-total	7,580	
Grand Total	72,380	

Entomological Assessment

Owing to the general inaccessibility of the sprayed areas (except by water or aircraft), a conventional assessment involving pre- and post-spray population counts in sprayed and unsprayed areas was not attempted. However, it is possible to gain some general impressions of the effectiveness of the spraying through other ways such as pupal counts (Table 5), aerial defoliation surveys and egg-mass counts.

Aerial defoliation surveys showed that the sprayed areas were generally free of continuous defoliation but that they contained many, small, scattered pockets of moderate to severe damage.

Egg-mass counts indicate that all sprayed areas, except the Metacryst Lake block, have been reinfested to levels that will cause moderate or severe defoliation in 1972. The average egg-mass density however is about one-third lower this year than last year in the spray areas.

Table 5. Densities of living pupae in sprayed and unsprayed areas on balsam fir in Thunder Bay and Fort Frances Districts

Location	No. of living budworm pupae per 18-in. tip
Thunder Bay	
Sprayed	.36
Unsprayed (uninfested)	.04
Fort Frances	
Sprayed	.35
Unsprayed (infested)	.78
(uninfested)	.09

Conclusions

Pupal densites in sprayed areas were still quite high, though not as high as they would have been without treatment. Egg-mass counts indicate continuing infestations throughout most sprayed areas but at reduced levels compared to 1970. There is no evidence of any significant spread from infestation centers to uninfested areas to the north and east although a shift of population has been noted in the Poohbah Lake area. Populations are higher in the eastern part of this block and lower in the west compared with 1970. Forested areas near Burchell Lake and Lac des Mille Lacs are still uninfested by spruce budworm.

Thus, the situation is no worse now than it was 1 year ago. However, being able to maintain the status quo is a desirable objective, all things considered, in northwestern Ontario, and since this was apprently achieved, the spraying can be considered a qualified success.

Detailed forecasts of damage expected in 1972 for northwestern Ontario based on egg-mass counts obtained in the fall of 1971 are given in Part A of this report.

The need for aerial spraying operations in this region in 1972 remains similar to that of 1971, and it is expected that operations will be carried out in 1972 in much the same manner as those of 1971.

THE PROBLEM OF UNSATISFACTORY OPERATIONAL RESULTS WITH FENITROTHION IN ONTARIO

Fenitrothion has been employed as the chief chemical weapon for operational control projects in Ontario against spruce budworm for the past 4 years, i.e., 1968 to 1971. This insecticide has been applied in several different ways under a variety of conditions in several formulations and many different dosages to try to accomplish specific goals. It has provided a variety of results.

Following is a summary of results (Table 6) from all operations in Ontario that have been critically assessed over the last 4 years.

Table 6. Results of spruce budworm control operations with Fenitrothion in Ontario, 1968-1971

Operation	Host	Oz of fenitrothion/ acre (operational)	% population reduction	% defoliation
N.E. Ontario[a] - 1971	wS	5.3	21	47
PFES[b] - 1971	wS	6.0	32	77
PFES - 1971	wS	9.0	35	77
PFES - 1970	wS	10.2	36	94
PFES - 1970	wS	14.5	61	74
N.E. Ontario - 1971	bF	5.3	36	29
PFES - 1971	bF	6.0	55	41
Burchell Lake - 1968	bF	6.0	45	--
PFES - 1971	bF	9.0	57	41
PFES - 1970	bF	10.2	51	67
Burchell Lake - 1968	bF	12.0	89	--
PFES - 1970	bF	14.5	98	40

[a] Northeastern Ontario.

[b] Petawawa Forest Experiment Station.

Graphing these results (Fig. 8) illustrates the close relationship between the dosage of fenitrothion (ounces per acre) and the resulting population reduction. The difference in results on white spruce and balsam fir is striking.

Linear regressions were calculated for each group of data. The fit of each regression line to the corresponding data was tested and found to be significant at the .05 level for white spruce and at the .01 level for balsam fir. A further test showed that there was a significant difference at the .01 level between the two groups of data (regressions).

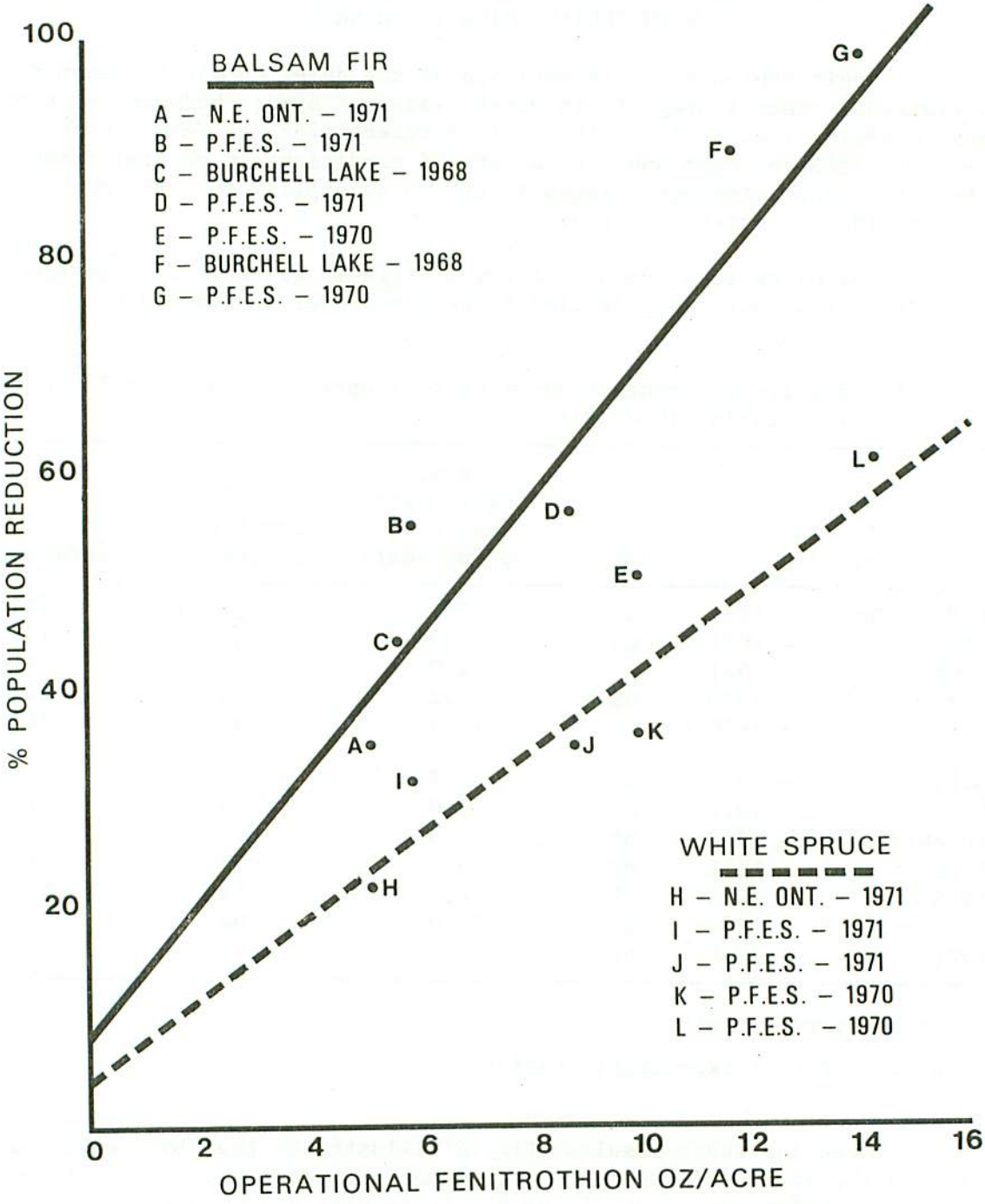

Figure 8. Different relationships on balsam fir and white spruce between population reduction and dosage when using fenitrothion operationally against the spruce budworm in Ontario. (N.E. Ontario--Northeastern Ontario; PFES--Petawawa Forest Experiment Station.)

Conclusions

1. Population reduction is lower on white spruce than on balsam fir when using the same dosage of fenitrothion. For example, where the two species are growing together, the population reduction is significantly lower on white spruce than on balsam fir but under these conditions, it is reasonable to assume that both species must, overall, receive exactly the same treatment.

2. It has not been possible to obtain a level of population reduction affording a satisfactory degree of foliage protection on white spruce in Ontario with less than 15 oz of fenitrothion per acre.

Proposals for 1972

These results were described and discussed as part of an internal review by the Canadian Forestry Service of spruce budworm control operations in 1971. Attending this meeting, held in Ottawa in mid-October 1971, were scientists intimately familiar with all operational aspects of aerial spraying in eastern Canada. The majority opinion among those present was that the problem was one relating to application technique, specifically an inadequate spray break-up. The spray cloud from Micronair equipped aircraft, for example, would be expected to be more effective since it would consist of smaller droplets.

Plans are underway at the time of writing for CCRI, Ottawa to conduct trials at PFES in 1972 that would show the operational feasibility and superiority of using Micronair equipment over the conventional boom and nozzle equipment that was used in 1971 operations.