

THE CURRENT SPRUCE BUDWORM
SITUATION IN
NORTHEASTERN ONTARIO

W. L. SIPPELL AND A. A. HARNDEN

FOREST RESEARCH LABORATORY
ONTARIO REGION
SAULT STE. MARIE, ONTARIO

INFORMATION REPORT O-X-135

CANADIAN FORESTRY SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY

JANUARY 1970

*Copies of this report may be obtained
from*

*Director, Ontario Region,
Canada Department of Fisheries and
Forestry,
Box 490, Sault Ste. Marie, Ontario.*

ACKNOWLEDGEMENTS

The assistance of the Northeastern Regional Forester, the District Foresters and their staffs in the districts concerned is gratefully acknowledged. Without the generous and timely provision of Ontario Department of Lands and Forests' aircraft and other facilities, aerial mapping of budworm defoliation would have been impossible.

ABSTRACT

A widespread and serious outbreak of the spruce budworm has developed in the spruce-fir forests of northeastern Ontario. This report is, in part, for use by the Ontario Department of Lands and Forests to answer inquiries and to advise companies concerning possible effects on their forest operation. Beginning with generalized accounts of the insect's life history and the probable impact on fir and spruce should the infestation continue for upwards of 10 years, the report describes the current situation by using defoliation maps of the Insect and Disease Survey Unit for 1968 and 1969, their forecasts for continued infestation and damage in 1970, and other background data.

Practising foresters in northeastern Ontario are requested to assist the Insect and Disease Survey Unit in compiling a complete and detailed history of budworm-caused defoliation in spruce and fir stands. Meanwhile, the Canadian Forestry Service and the Ontario Department of Lands and Forests are working together to devise a plan for control and protection which will minimize economic loss.

INTRODUCTION

The Insect and Disease Survey Unit of the Canadian Forestry Service, Ontario Region, conducts a continuing survey of the development, course, and impact of major insect and disease outbreaks. Since 1964 and particularly since 1967, the development of a potentially dangerous and widespread outbreak of the spruce budworm, *Choristoneura fumiferana* (Clem.), has been recognized. This report is by no means exhaustive of our knowledge of budworm, but it follows briefly the development and course of this outbreak up to 1969 and forecasts broad changes that may be expected in 1970.

REVIEW OF THE INSECT'S BIOLOGY

The spruce budworm, having caused widespread defoliation and tree mortality periodically in the past, is the most destructive insect pest of the Boreal Forest in Ontario. Its main food is the new needles of white spruce, *Picea glauca* (Moench) Voss, and balsam fir, *Abies balsamea* (L.) Mill., but when the preferred food is scarce it will feed on older foliage. Trees of other coniferous species including black spruce, *Picea mariana* (Mill.) BSP., are fed upon when growing in mixture with the two primary hosts.

The adult moth (Fig. 1) lays its eggs in masses in July on the needles of the host tree (Fig. 2). Eggs hatch in about 10 days and young larvae spin silken hibernaculae inside staminate flower cups or under bark scales where they overwinter. The larvae emerge from the hibernaculae in late April, or early May when as a general rule, they mine needles before entering buds. From that time on, until pupation occurs on the foliage in early July (Fig. 3) the larvae feed mainly on the buds or new shoots (Fig. 4 and 5). The adults emerge in a week to 10 days and so complete the life cycle.

THE IMPACT OF SPRUCE BUDWORM INFESTATIONS ON THE FOREST

Reduced diameter growth occurs during the first year of appreciable defoliation and continues in relation to the degree of defoliation and number of consecutive years of attack. As a general guideline, and based on studies of the impact of previous outbreaks on affected stands in northern Ontario, we may expect that some suppressed balsam fir trees will die in the third or fourth year of heavy attack. Top-killing of

Dr. Sippell is Head of the Insect and Disease Survey Unit and Mr. Harnden is the Senior Entomology Technician of the Insect and Disease Survey Unit, Forest Research Laboratory, Canadian Forestry Service, Sault Ste. Marie, Ontario.

balsam fir also begins at this time, especially on younger trees growing beneath an overstory of heavily infested white spruce and/or balsam fir. In the fifth year of heavy infestation, from 5 to 10 per cent of the merchantable balsam fir in susceptible stands can be expected to die with the rate of mortality increasing sharply with each additional year of damage. By the ninth or tenth year, stands with a high component of balsam fir will be considered inoperable by forest operators because of a deep and unmanageable layer of criss-crossed dead trees on the ground, the danger of falling trees or stubs, and a high fire hazard.

White and black spruce growing in mixture with balsam fir may also be killed, but they seem slightly more tolerant of defoliation than balsam fir. Spruce mortality, therefore, may be expected to resemble that of balsam fir but with a slight time lag. Pure stands of black spruce and isolated white spruce generally survive, but surviving spruce trees that come under severe attack suffer reduced radial and lineal growth and are predisposed to disease and bark beetle attack.

PREVIOUS OUTBREAKS

Suppression patterns typical of those caused by infestations of spruce budworm are found commonly among the annual growth rings of white spruce in northern Ontario. Some have been dated to 1704. This history and the fact that infestations have been active continuously somewhere in Ontario over the past 30 years suggest that the spruce budworm has been an indigenous and major influence on the development of our forests. This influence is exerted directly through the killing of balsam fir and spruce and indirectly through the close relationship between budworm-killed stands and major fires.

The last outbreak in northeastern Ontario, which terminated about 1950, covered a vast area from Lake Timiskaming in the east to White River in the west and from Kapuskasing south to the Ottawa Valley over a period of many years. A large proportion of the merchantable fir within this region was killed outright and in adjoining areas, such as in parts of the Kapuskasing and Cochrane districts, the fir component which was severely weakened by defoliation at the termination of the outbreak continued to die out over a period of at least 10 years.

THE CURRENT OUTBREAK

Beginning about 1964, a gradual but persistent increase in the low numbers of budworm present in northeastern Ontario was evidenced in Survey's data, expressed both in terms of an increased number of

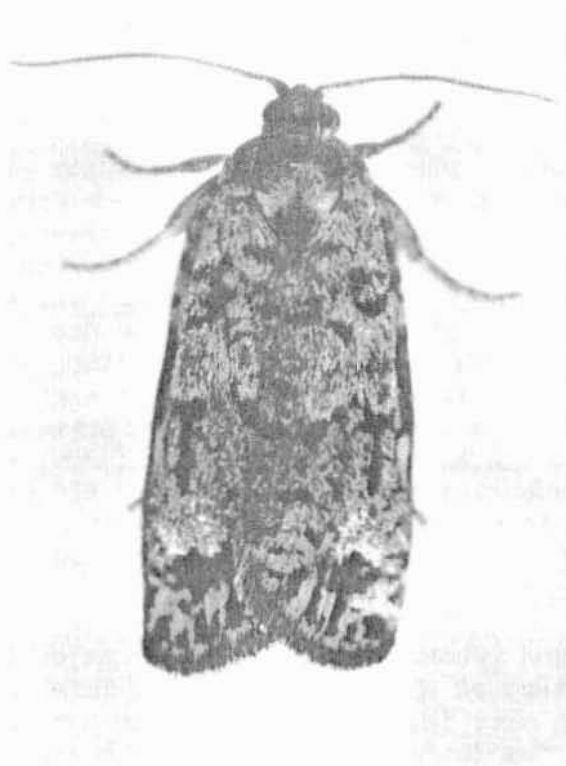


Fig.1 The adult moth.

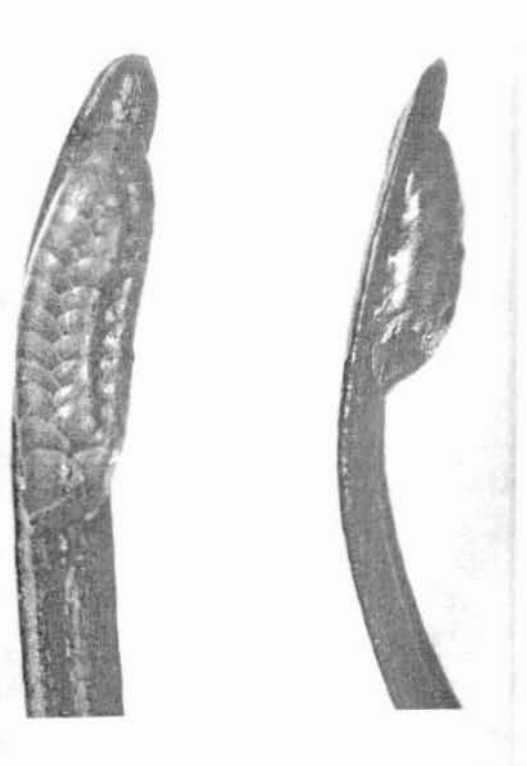


Fig.2 Egg masses on balsam fir needles.



Fig.3 The pupa



Fig.4 The fully grown larva.

positive collections from the general sampling from all species of host trees and in the results of a systematic survey of insects on spruce. However, above-endemic levels appeared and disappeared for several years before the first major build-up expressed itself in 1967 as a light infestation, extending over about 100 square miles, in and around Borden Township in the Chapleau District. This infestation developed mainly on mature white spruce, with balsam fir in the immediate vicinity becoming infested later. Little hope could be seen for early counteraction mainly because gradually increasing numbers also prevailed over such a massive area outside the main infestation, including parts of the Chapleau, Swastika, and Sudbury districts. Moreover, adequate budworm damage detection, which is possible only through aerial surveys, was complicated in 1967 by a heavy crop of cones; this masked the browning caused by defoliation.

In 1968, aerial and ground reconnaissance revealed major increases in the intensity and extent of the Borden Township infestation and a number of new infestations were detected over a large part of northeastern Ontario (Fig. 7). The Borden infestation northeast of Chapleau had increased to medium intensity and extended over approximately 300 square miles. New infestations extended over approximately 800 square miles in the northern parts of the Chapleau District and into the Kapuskasing District. Both first- and second-year infestations were largely of light or moderate intensity with pockets of severe defoliation in Borden, Conking, Ivanhoe, and Amundsen townships. New or enlarged infestations were also delineated in the Cochrane, Sudbury, Swastika, and Sault Ste. Marie districts. Elsewhere in northeastern Ontario, infestations were generally light, interspersed with small pockets of medium to heavy intensity, the most important of which were in Baden Township and Indian Reserve 72 in the Swastika District, in Fairbank Township in the Sudbury District and in Parkinson Township in the Sault Ste. Marie District.

In 1969, a further major development was evident. In the Chapleau District and the southern part of the Kapuskasing District, medium and heavy infestation extended over more than 2,000 square miles (Fig. 8). Stands within this area have obviously been changing from mixed woods, with a dense hardwood overstory that overtopped the fir at the time of the last outbreak, to a predominantly spruce-fir forest with scattered mature white spruce in the overstory and a dense semi-mature balsam fir understory (Fig. 6). In some stands the defoliation of balsam fir was particularly severe with upwards of 75 per cent of the old foliage removed in addition to all of the new needles. In the Sudbury District, a new medium to heavy infestation comprising approximately 400 square miles occurred in the area between Onaping Lake and the Canadian National Railway. Also, the light infestation of 1968 in Emerald and Gouin townships increased to heavy intensity, and two widely separated heavy infestations, in Fairbank and Asquith townships,

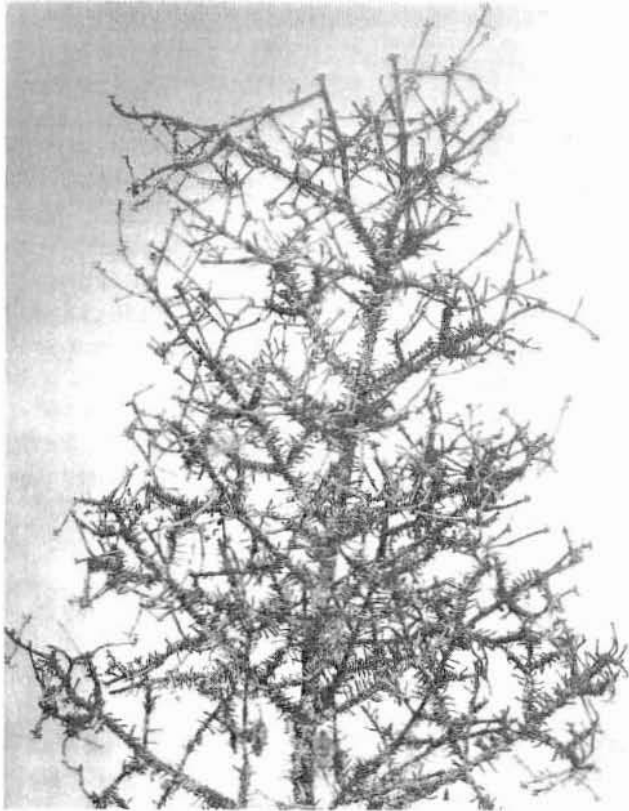


Fig. 5. Severe defoliation of a balsam fir branch caused over a 3 year period by the spruce budworm.



Fig. 6. A stand of balsam fir and white spruce typical of those heavily infested with spruce budworm. Note remnants of the hardwood component which apparently overtopped the fir during the outbreak which terminated about 20 years ago.

expanded. Eight additional, but smaller and widely separated infestations, ranging in size from 1 to 35 square miles, were observed in the district. In the Swastika District, an infestation in Yarrow Township enlarged and increased from medium to heavy intensity, and a new heavy infestation was found in Milner Township. Reductions in the extent of damage in the Cochrane District and the northern part of the Swastika District in 1969 compared with 1968 resulted from a severe frost in mid-June of 1968 that killed most of the new shoots of balsam fir, thus eliminating the food supply for the budworm. In Parkinson Township, Sault Ste. Marie District, a small, heavy infestation on white spruce recurred in 1969.

INFESTATION FORECASTS FOR 1970

Forecasts of levels of damage are made in the previous fall or winter through a sampling system based on the number of hatched egg masses on a measured amount of balsam fir foliage. The egg survey is, by necessity, planned around the defoliation map, with preference given to uninfested areas adjacent to known infestations. Six branch samples, one per tree, are removed from the mid-crowns of representative fir trees in each location. The foliage is closely examined and rechecked in the laboratory. Light, moderate, or severe damage is forecast by employing a well-known and widely used sequential sampling system developed in the Maritimes Region. Counts of egg masses are expressed finally in the number per hundred square feet of foliage (Table 1).

Forecasts arrived at in November 1969 revealed that moderate and severe defoliation can be expected again in 1970 providing, of course, that normal conditions prevail next spring (Fig. 8 and Table 1). A major extension of moderate and light defoliation is expected southward and southwestward of the largest infestation in the Chapleau District and probably beyond the points at which samples were taken. Similar extensions are forecast around Horwood Lake and Foleyet in the eastern part of the Chapleau District and again to the east and south of the large Onaping Lake infestation in Sudbury District. A sufficient number of nil returns were obtained from areas north and west of the infestations in the Kapuskasing District to suggest a static situation in this area for 1970.

Because this outbreak was widespread and the weather at the time of moth flight (July 15 to 28 at Chapleau) was bright, dry, and conducive to moth dispersal, new infestations will probably extend in 1970 beyond the 1969 borders of infestation.

Fig. 7

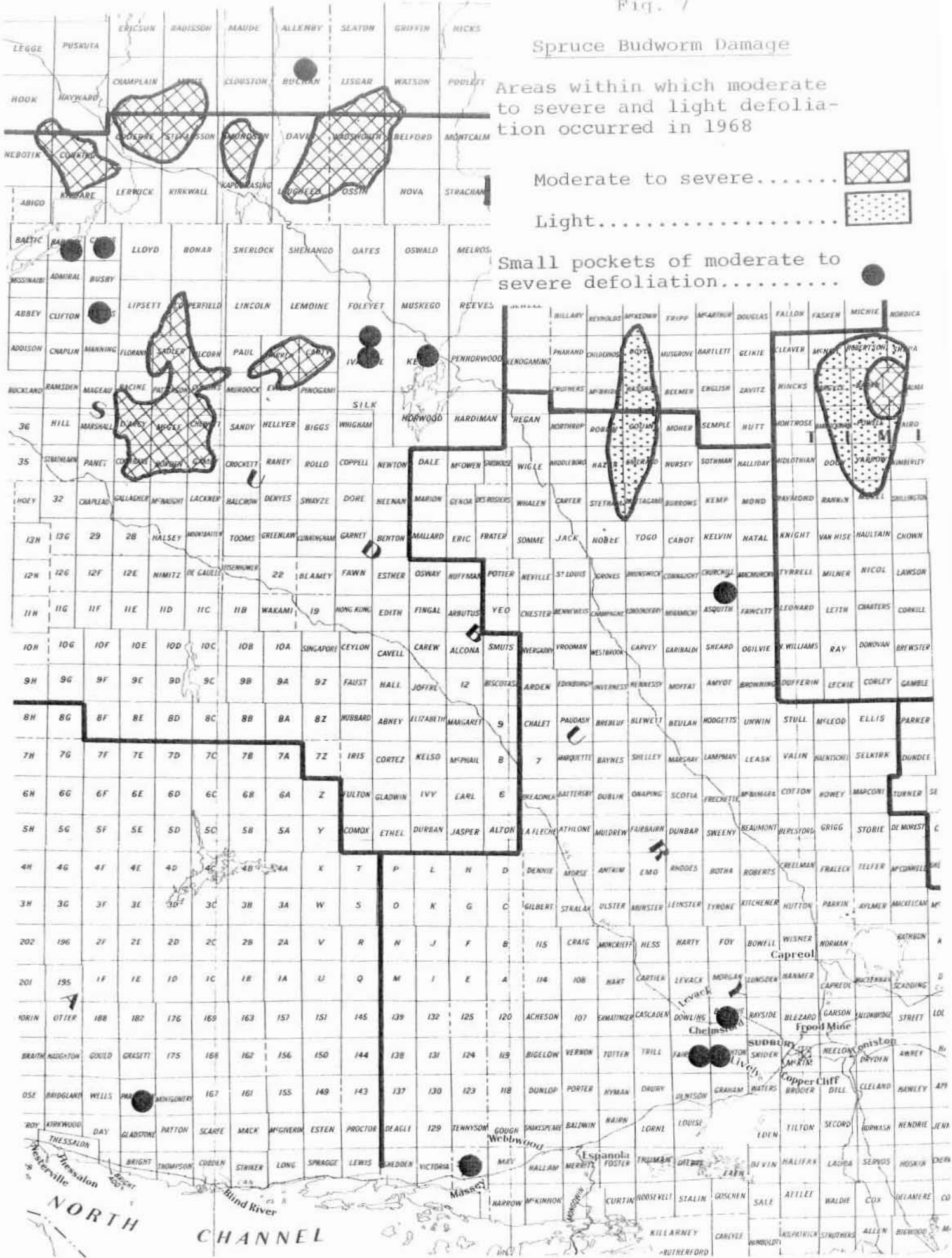
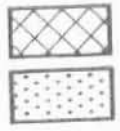
Spruce Budworm Damage

Areas within which moderate to severe and light defoliation occurred in 1968

Moderate to severe.....

Light.....

Small pockets of moderate to severe defoliation.....



GENERAL EVALUATION AND PROGNOSIS

A widespread and seemingly aggressive outbreak of the spruce budworm has become well established in the spruce-fir forests of northeastern Ontario, mainly in the districts of Chapleau and Sudbury. Balsam fir and white spruce trees over a large area have been partially defoliated for two consecutive years and an enlarged acreage will probably be affected in 1970. Although unfavourable spring weather could terminate the outbreak prematurely, it now has a biological momentum over such a massive area that its future continuation and development over at least the next 5 to 10 years seems assured.

The outbreak has developed mainly on mature white spruce but is now also affecting balsam fir in a general area where most mature fir was killed by the budworm some 20 years ago. It is evident from the number of stubs of poplar and birch in the area affected that the balsam fir now being attacked had survived the last outbreak as advanced growth beneath a dense canopy of hardwoods.

The following is a generalized guideline that can be applied broadly to anticipate the impact of continuous, heavy spruce budworm attack on the merchantable fir and spruce in susceptible stands: first and second years, an immediate reduction in growth increment; third and fourth years, some permanent injury to upper tree crowns and death of suppressed trees and trees suffering from severe budworm backfeeding; fifth year, death of 5 to 10 per cent or more of the volume; sixth, seventh, and eighth year, a sharp increase in the rate of annual mortality; and in the ninth or tenth year, virtually complete mortality, falling trees, and a difficult-to-control fire risk.

COOPERATION OF FORESTERS IN NORTHEASTERN ONTARIO

For a short period in July, heavily damaged trees appear reddish brown when viewed from the air because the dead needles which are cut off by the budworm during their feeding adhere to the twigs and branches. This permits our observers to map broadly the boundaries of infestation by aerial surveys. These damage maps constitute the most valuable series of records for use in determining outbreak patterns or following change in the extent and direction of spread from year to year and for ascertaining the outbreak history for specific areas at any future time. These damage maps, of course, also provide a basis for planning the scope and details of egg surveys used in forecasting and for planning the broad strategy of any protection measures to be undertaken. Because of the magnitude of this task, many stands understandably escape observation. In an attempt to maintain a detailed and

Fig. 8

Spruce Budworm Damage

Areas within which moderate to severe defoliation occurred in 1969.....



Small pockets of moderate to severe defoliation.....



Forecasts for 1970 Based on Egg Counts

Severe.....



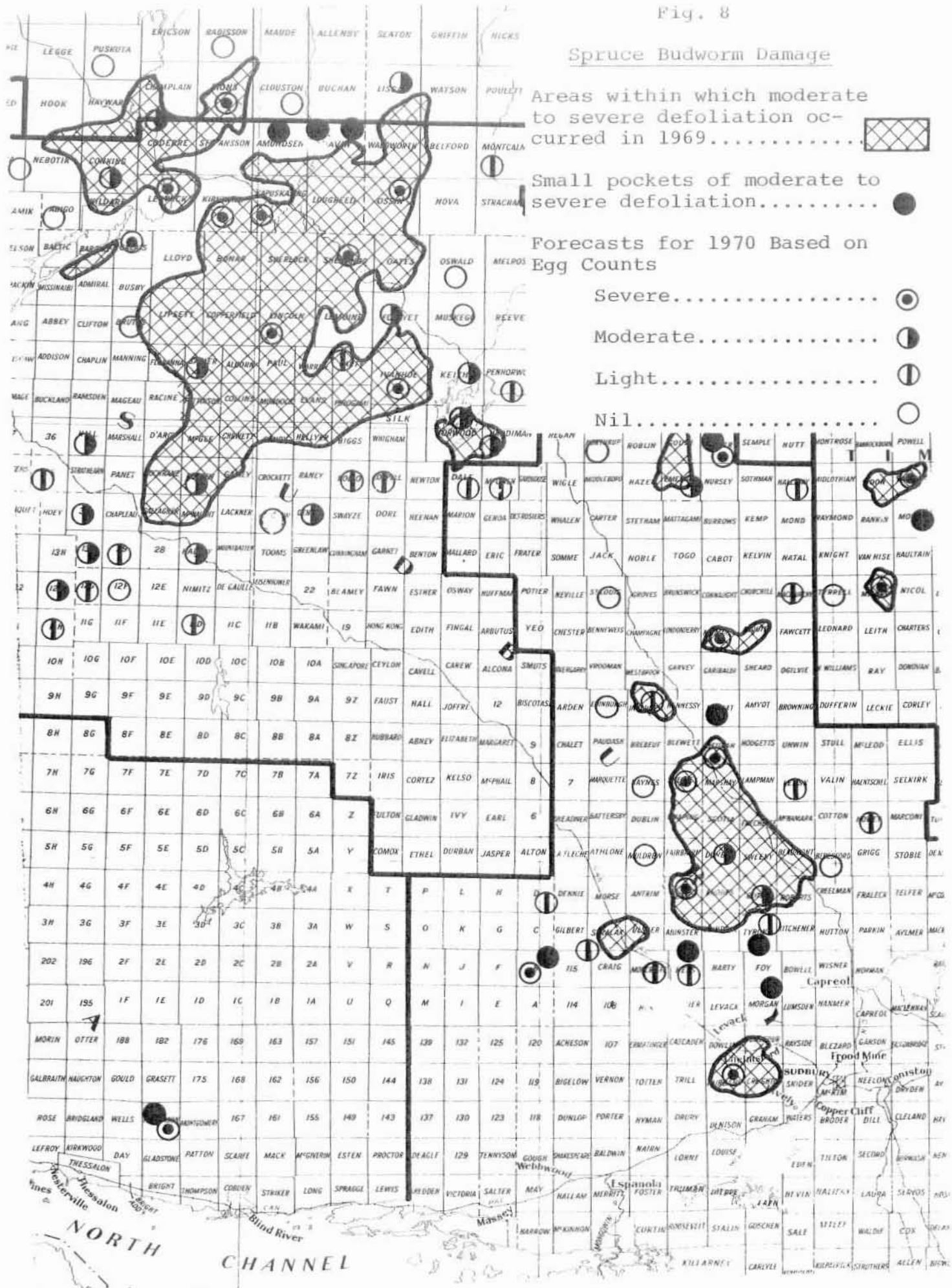
Moderate.....



Light.....



Nil.....



continuing account of the development and course of this important outbreak, the Insect and Disease Survey Unit herewith solicits the cooperation of foresters, especially those working in remote areas in the winter of 1969-70. Those who observe budworm defoliation on the new growth of fir or white spruce in areas other than those indicated as moderate to severe defoliation on Figure 8 are asked to submit four branch tips, each about 18 inches long, one per tree, with a slip enclosed giving the name and address of the collector, the exact location of the collection, the date, and if possible some indication of the extent of damage. Package and mail the samples promptly after collecting to the Insect and Disease Survey Unit, Canadian Forestry Service, Box 490, Sault Ste. Marie. These samples will be analyzed, rated for defoliation, and examined for the remains of hatched eggs. The results, which will be forwarded to the collector, will be used by the Survey Unit towards a more complete record and assessment of the outbreak.

Table 1. Spruce budworm: summary of balsam fir defoliation estimates and egg mass counts in 1969, and defoliation forecasts for 1970 in northeastern Ontario.

Location (township by district)	% defolia- tion of 1969 foliage	No. of egg masses/100 sq ft of foliage	Damage forecast for 1970
<u>Chapleau</u>			
Abigo	3	0	O *
Borden	60	68	M
Brutus	0	0	O
Calais (Missinaibi Prov. Park)	66	633	S
Carty	11	10	L
Conking	8	47	M
Coppell	4	22	L
Denyes	2	40	M
Foleyet	16	56	M
Halcrow	0	0	O
Halsey	3	48	M
Hardiman	8	68	M
Hill	5	84	M
Horwood	12	64	M
Ivanhoe (Ivanhoe Prov. Park)	60	309	S
Kapuskasung	71	860	S
Keith	32	89	M
Kirkwall	65	244	S
Lerwick	74	335	S
Lincoln	52	235	S
Makawa	1	0	O
Montcalm	6	20	L
Muskego	3	0	O
Ossin	33	185	S
Oswald	1	0	O
Penhorwood	2	12	L
Rollo	1	12	L
Saddler	3	83	M
Shenango	91	4008	S
11 D (Five Mile L. Prov. Park)	2	7	L
11 H	1	6	L
12 F	1	0	O
12 G	1	13	L
12 H	1	42	M
13 G	3	54	M
29	2	8	L
32	1	60	M
35	3	5	L

* S - severe, M - moderate, L - light, O - nil or very light.

(cont'd.)

Table 1. Spruce budworm: summary of balsam fir defoliation estimates and egg mass counts in 1969, and defoliation forecasts for 1970 in northeastern Ontario. (cont'd.)

Location (township by district)	% defolia- tion of 1969 foliage	No. of egg masses/100 sq ft of foliage	Damage forecast for 1970
<u>Cochrane</u>			
Hassard	8	16	L *
<u>Kapuskasing</u>			
Champlain	63	107	M-S
Clouston	3	0	0
Lisgar	7	76	M
Mons	71	160	S
Puskuta	3	0	0
Radisson	1	0	0
<u>North Bay</u>			
Badgerow	1	10	L
Dunnet	31	151	S
<u>Sault Ste. Marie</u>			
Parkinson (white spruce)	83	677	S
<u>Sudbury</u>			
B	35	476	S
Baynes	2	0	0
Beresford	1	0	0
Beulah	37	363	S
Botha	6	81	M
D	3	6	L
Dale	6	9	L
Dunbar	18	36	M
Edinburgh	1	0	0
Emerald	14	37	M
Emo	55	547	S
Fairbank	64	191	S
Halliday	2	3	L
Hess	2	12	L
Howey	8	31	M
Inverness	6	14	L
Leask	5	9	L
MacMurphy	3	9	L
McCowan	1	9	L
Miramichi	64	822	S

* S - severe, M - moderate, L - light, 0 - nil or very light.

(cont'd.)

Table 1. Spruce budworm: summary of balsam fir defoliation estimates and egg mass counts in 1969, and defoliation forecasts for 1970 in northeastern Ontario. (concluded)

Location (township by district)	% defolia- tion of 1969 foliage	No. of egg masses/100 sq ft of foliage	Damage forecast for 1970
<u>Sudbury (cont'd.)</u>			
Moher	50	466	S *
Moncrieff	16	14	L
Muldrew	2	0	0
Northrup	4	0	0
St. Louis	3	0	0
Shelly	51	475	S
Starlak	1	3	L
Tyrone	2	4	L
<u>Swastika</u>			
Milner	67	324	S
Tyrell	1	0	0
Yarrow	66	273	S

* S - severe, M - moderate, L - light, 0 - nil or very light.