JACK PINE BUDWORM
IN MANITOBA AND SASKATCHEWAN
1938-1967

by

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INTRODUCTION

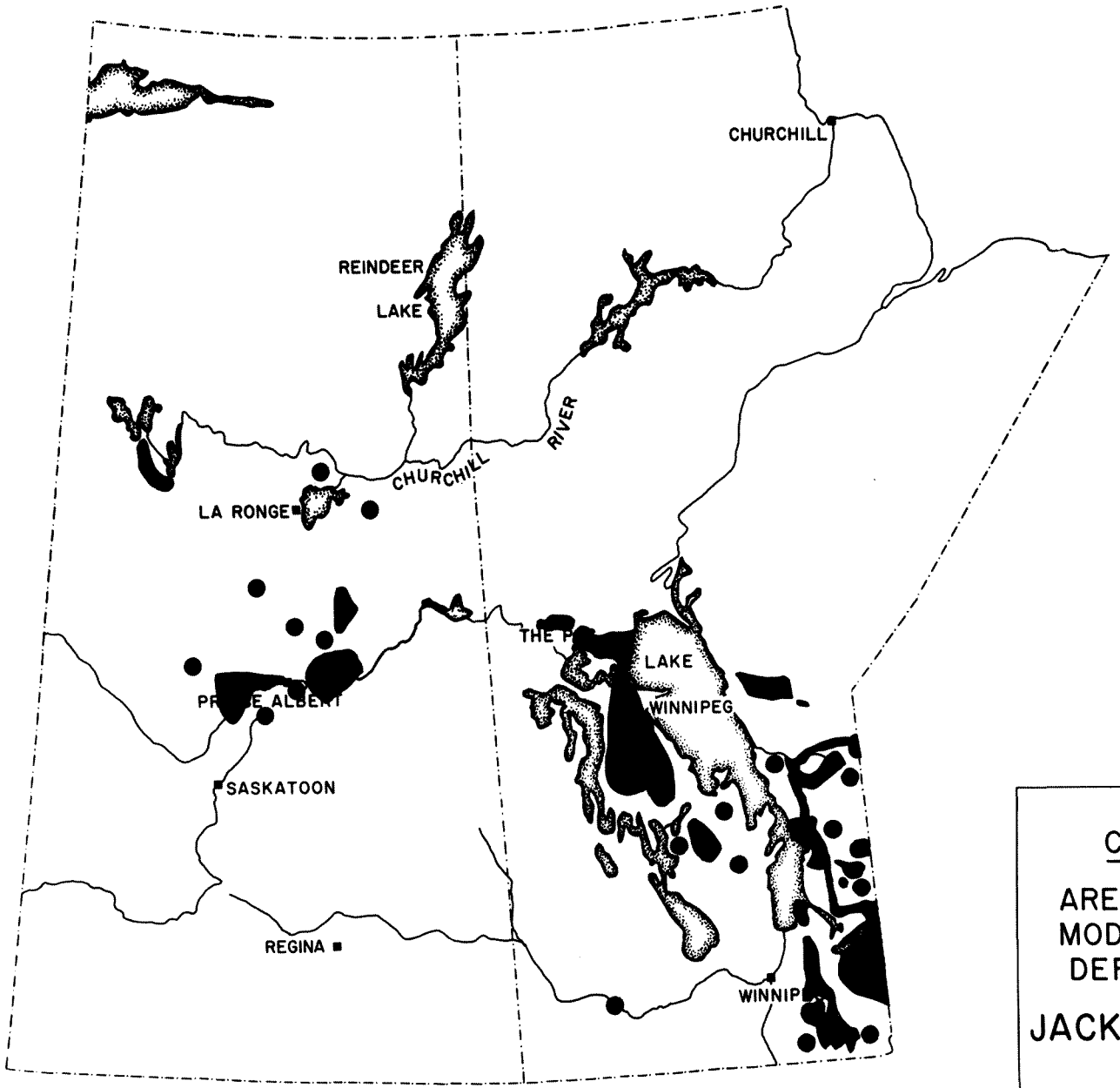
The jack-pine budworm, Choristoneura pinus pinus Free., has been a serious pest of jack pine and Scots pine as well as lodgepole pine in Manitoba and Saskatchewan for a number of years. Since this insect is of major importance, considerable scientific research has been devoted to it. Early observations on the life cycle of this pest, then known as Archips fumiferana, showed that there were differences between the forms on spruce and jack pine (Graham 1925), and that it could be considered a subspecies of the spruce budworm, if not a separate species (Brown and MacKay 1943). Pollen appeared to have a distinct and direct bearing on budworm numbers (Graham 1935) and larvae occupying staminate flowers developed more rapidly (Lejeune 1950). Scots pine, lodgepole pine, and jack pine are all susceptible to attack, and marked differences in defoliation were apparently attributable to the prevalence of male flowers (Heron and Prentice 1956), although there is some indication that Scots pine may be the preferred host (Reeks 1958).

Scots pine showed a striking reduction of increment in 1956, the first year of attack, indicating that this species is very sensitive to budworm defoliation (Prentice and Nairn 1958). Both light and moderate defoliation resulted in substantial increment loss, but moderate defoliation had much the more serious effects which persisted into the second year after defoliation (Jaquith et al 1958). Studies on the oviposition and feeding habits were completed in 1961 (Kulman and Hodson) and a method for larval rearing was developed (Heron 1961). Jack-pine budworm could severely damage red pine growing in a mixture with jack pine, and that the pest could survive independently of the latter when the two pines alternate in staminate flower production (Kulman and Hodson 1961). The biology and ecology of this defoliator was examined (Dixon 1961), and a sampling unit devised and thereby noted that the best time to sample for population estimates was at the beginning of the third instar, 20-30 days before heavy feeding by the fifth and sixth instars was due (Kulman and Hodson 1962).

Reasonably good records of this insect have been maintained by the Forest Insect and Disease Survey since 1938. Prior to 1938, however, very little information concerning its status and distribution is available. Most of the information within this report was obtained from Annual Ranger Reports (1946-66); prior to 1946, the necessary material was obtained from the Annual Forest Insect and Disease Survey Reports and from the Canadian Insect Pest Review. When the previously mentioned references were inadequate, Monthly Ranger Reports were consulted to obtain additional information.

JACK-PINE BUDWORM AREAS

A composite map of jack-pine budworm outbreaks in Manitoba and Saskatchewan is shown on page 2. The areas in which jack-pine budworm occurred are illustrated on the accompanying provincial map (page 3). It should be noted that the 'forest reserves' in Manitoba are now known as 'provincial forests'. The 'jack-pine budworm areas' have been summarized as follows:



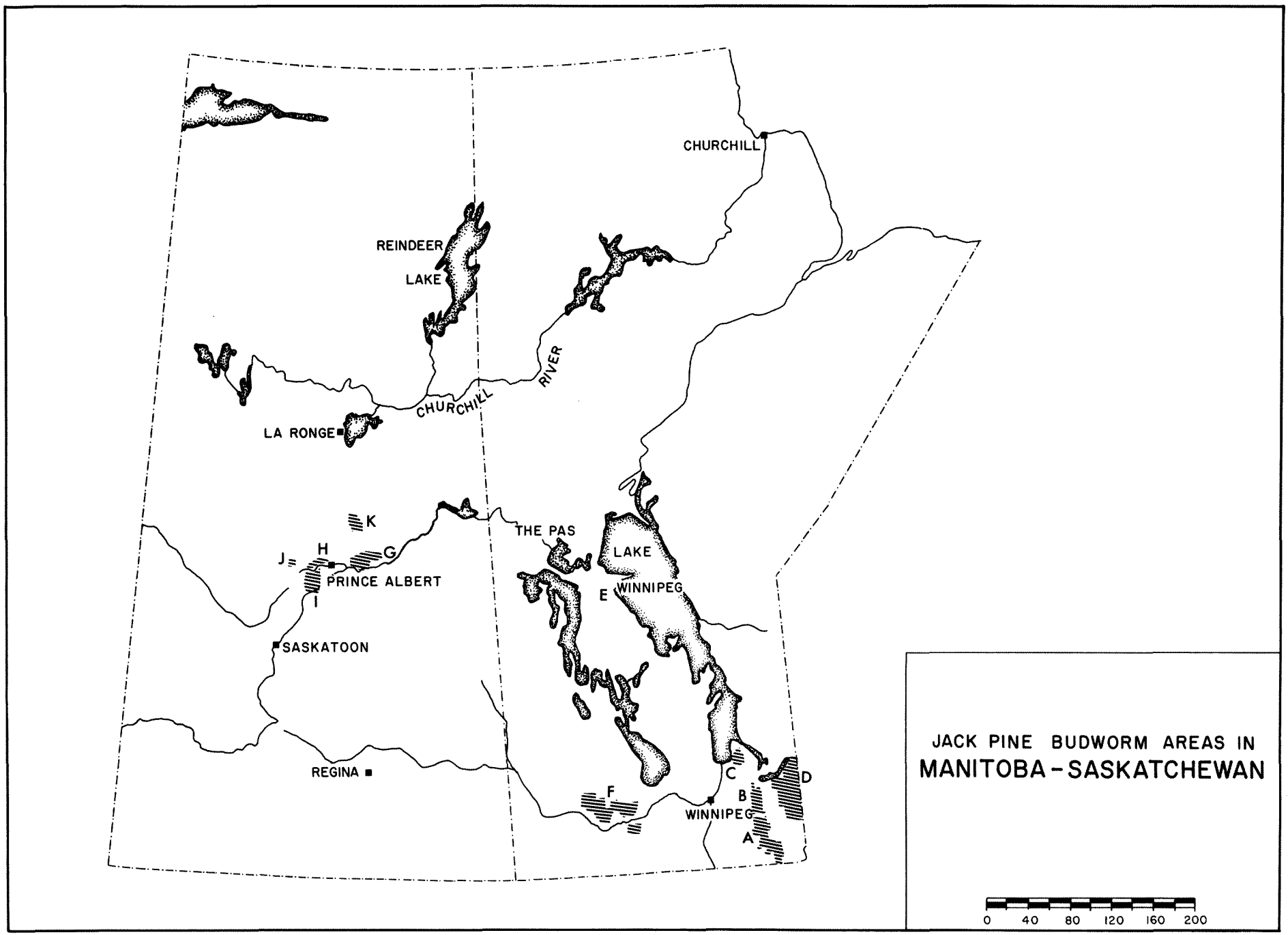
COMPOSITE MAP

AREAS AND POINTS OF MODERATE TO SEVERE DEFOLIATION BY THE

JACK-PINE BUDWORM

1945-1967

0 40 80 120 160 200


CHURCHILL
REINDEER
LAKE
RIVER
CHURCHILL
LA RONGE
K
J
H
G
PRINCE ALBERT
I
SASKATOON
REGINA
THE PAS
LAKE
WINNIPEG
E
C
D
F
B
WINNIPEG
A
JACK PINE BUDWORM AREAS IN
MANITOBA - SASKATCHEWAN
0 40 80 120 160 200

A. The Sandilands Provincial Forest
B. The Agassiz Provincial Forest
C. The Belair Provincial Forest
D. The Whiteshell Provincial Park and the Region East of Lake Winnipeg
E. The Interlake Region
F. The Spruce Woods Provincial Forest
G. Fort à La Corne Provincial Forest
H. Nisbet Provincial Forest
I. Pines Provincial Forest
J. Canwood Provincial Forest
K. Nipawin Provincial Park

A brief history of outbreaks in the above areas is outlined in the following pages.

THE SANDILANDS PROVINCIAL FOREST

This area has been the most severely attacked during the past 30 years. Stewart (1936) noted that 1850 acres of jack pine ranging from 20 to 30 feet in height were severely defoliated by 'spruce budworm' in 1935 and Richmond (1937) indicated that the infestation extended to the Eagle River in Ontario in 1936. This was the jack-pine budworm*. The infestation remained severe in 1937 and 1938, and possibly 1939, and declined to moderate in 1940 and to very light in 1941.

In 1942, populations were again at infestation levels and by the summer of 1943, the budworm was more abundant than in 1937. Severe defoliation was noted in the vicinity of Forest Service Headquarters and south for approximately 8 miles and in the southern portion of the provincial forest from 4 miles north of Badger to south of the provincial forest boundary. In 1944, severe defoliation persisted between Dawson Cabin and Forest Service Headquarters and extended throughout Sandilands and southeast to Sprague.

From 1945 to 1947, moderate to severe defoliation was recorded in the central portion of the provincial forest north and south of Forest Service Headquarters and in the vicinity of Dawson Cabin (Fig. 1). A large area was lightly defoliated in the northern portion. During 1948, several new pockets of moderate and severe defoliation became apparent, but damage in other areas of the infestation remained light. Although defoliation declined slightly in 1949, the area of infestation increased, but fire in the spring of 1949 destroyed 13,400 acres of jack pine in the southern portion of the infestation. Defoliation in 1950 was predominantly light except for a small moderate to severe pocket northeast of Dawson Cabin and only the occasional collection was taken from 1951 to 1953.

Populations began to increase in 1954, and in 1955 two separate infestations were noted in the northern portion of the provincial forest. The outbreak areas were subjected to severe burning from September 14 to 17. In 1956, in spite of the fire, substantial increases in populations and distribution of the jack-pine

*At that time, the jack-pine budworm was considered to be a 'race' or 'form' of the spruce budworm.

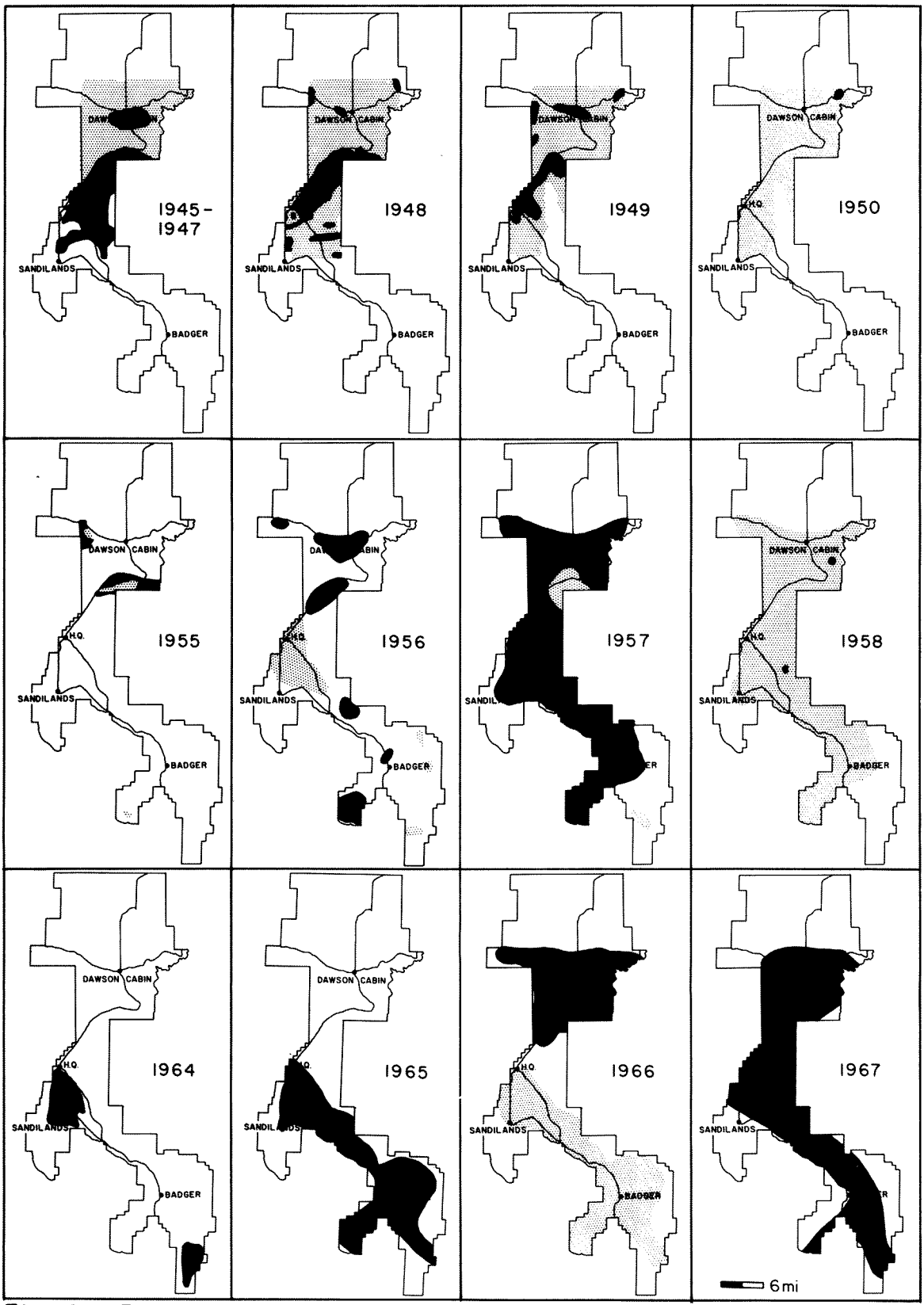


Fig. 1. Infestations of the jack-pine budworm in Sandilands Provincial Forest. Stippling denotes light defoliation and solid black moderate to severe defoliation.

budworm occurred. In the northern portion, moderate to severe defoliation occurred south and northwest of Dawson Cabin and in an area surrounding Dawson Cabin. Similar conditions existed in the southern portion northwest and southwest of Badger. An extensive area of light defoliation was observed immediately north of the town of Sandilands. A tremendous increase in populations occurred in 1957 and moderate to severe defoliation covered the greater portion of the Sandilands Provincial Forest. A general decrease followed in 1958 and only two small pockets of moderate to severe defoliation were recorded. Populations continued to abate in 1959 and remained very low from 1960 to 1962.

Two small areas of moderate to severe defoliation in 1963 expanded in 1964. Moderate to severe defoliation occurred immediately south of Forest Service Headquarters and in the extreme southern portion of the provincial forest. In 1965, the two infestations coalesced and formed one large area of moderate to severe defoliation. Although damage was mainly confined to jack pine, Scots pine plantations were also moderately defoliated. In 1966, the total area of light and moderate to severe defoliation increased from 135 to 285 square miles. A new infestation, possibly an extension of the old, was noted from Forest Service Headquarters north to the Trans Canada Highway. In 1967, defoliation was predominantly moderate to severe over most of the provincial forest.

THE AGASSIZ PROVINCIAL FOREST

The first recorded budworm infestation in this area was in 1944. Moderate to severe infestations occurred in the vicinity of Seddon's Corner (junction of Nos. 4 & 316 highways) and at Molson which is adjacent to the west boundary of the provincial forest. The infestation at Seddon's Corner continued in 1945, declined in 1946, and by 1947 was reduced to scattered pockets of light to moderate defoliation.

Populations remained low from 1948 to 1950, but in 1951 an infestation of light, occasionally moderate to severe defoliation, covered a large portion of the provincial forest (Fig. 2). With the exception of one small pocket of moderate to severe damage in 1952, defoliation decreased to light. From 1953 to 1965 populations were low within the provincial forest. In 1966, however, there was a major increase in the occurrence and distribution of jack-pine budworm. Moderate to severe defoliation covered approximately 150 square miles south of Milner Ridge. Populations decreased slightly in 1967, but a new area of moderate to severe damage was noted in the northern tip of the provincial forest.

THE BELAIR PROVINCIAL FOREST

A number of infestations have occurred in this area in the past 25 years. Generally light defoliation becoming moderate to severe occurred from Stead north to Victoria Beach and Elk Island in 1943. A complete report was not available in 1944 and from 1945 to 1947 no serious infestations were reported. Defoliation recorded as moderate in 1948 became moderate to severe in 1949 (Fig. 3). Populations remained at about the same levels in 1950 with the exception of the central and northern portions where light infestations were

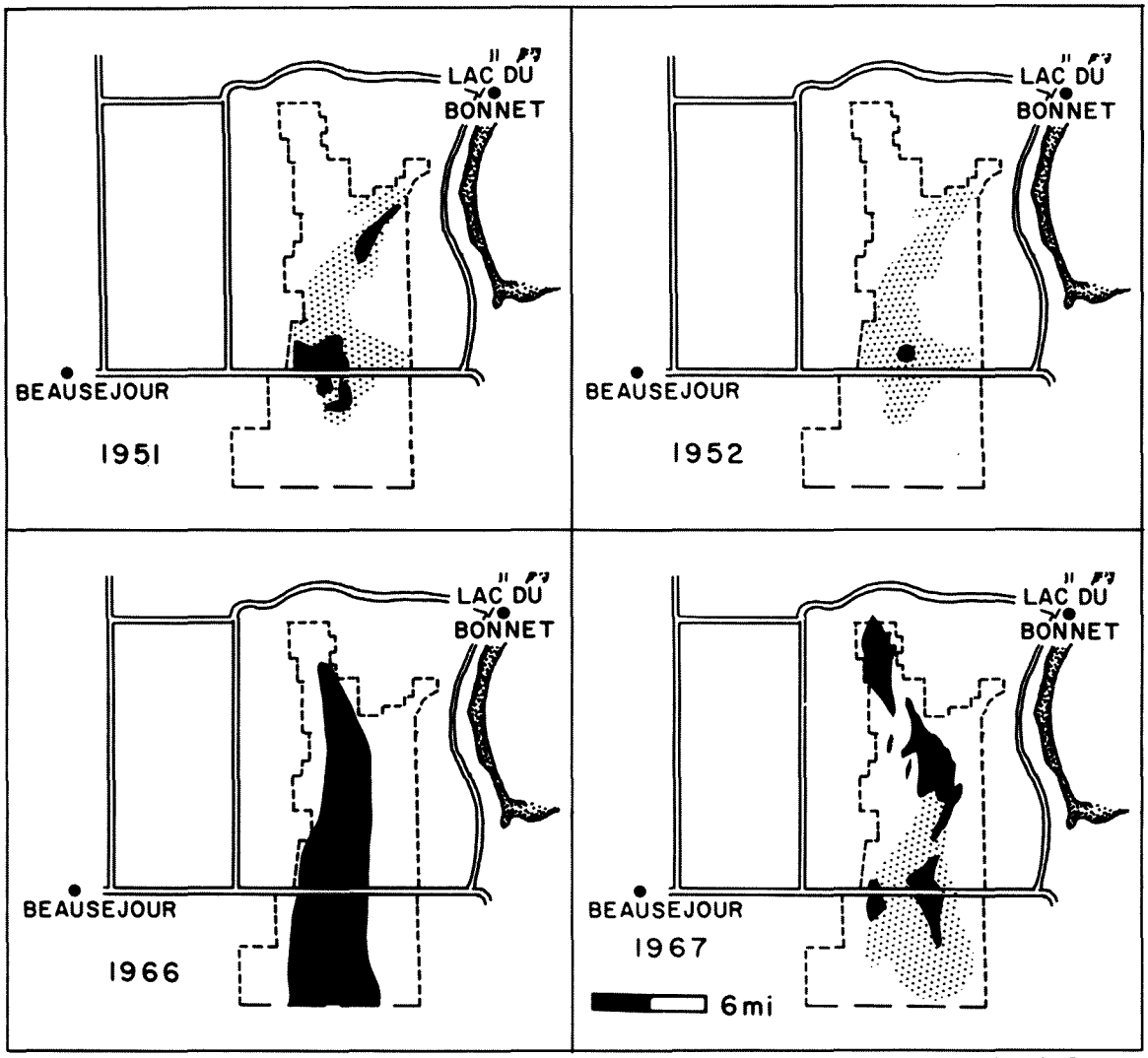


Fig. 2. Infestations of the jack-pine budworm in Agassiz Provincial Forest. Stippling denotes light defoliation and solid black moderate to severe defoliation.

noted. In 1951, a jack-pine ridge immediately north of Stead supporting poor to fair growth, suffered moderate to severe defoliation. The infestations in the central portion remained light, but defoliation became more severe in the northern sections. With the exception of a few scattered patches of moderate to severe damage in 1952, defoliation decreased to light. This was followed by a reverse trend in 1953; the infestations in the central portion did however disappear. Intensified activity was observed in 1954 and 1955, but in 1956, there was a marked reduction in larval populations which was partly attributed to the high incidence of larval and pupal parasites. Foliage discoloration was not conspicuous in 1956 except within a small light to moderate infestation southwest of Stead.

Populations remained low from 1956 to 1959, but in 1960, 11 and 7 square miles respectively, were moderately defoliated immediately north of Stead and in the Belair-Grand Beach areas. Very light defoliation occurred in the same areas in 1961. In 1963 and 1964 populations began to increase and in 1965 most stands from Stead north for about 10 miles were severely defoliated. Defoliation decreased in the northern portion. Numerous, scattered patches of moderate to severe defoliation occurred in 1967.

THE WHITESHELL PROVINCIAL PARK AND THE REGION EAST OF LAKE WINNIPEG

High populations of budworm were noted in the vicinity of Rennie in 1938. Populations were low from 1939 to 1943, but increases were noted in the provincial park in 1944 and in 1945 (Fig. 4). An extensive infestation was bounded on the south by No. 4 Highway, on the west by Mud Turtle Lake, and on the north by a line running southeast from Red Rock Lake through Nora Lake in Ontario. In 1946, the infestation declined in size and by 1947 only very light and occasionally moderate 'spot' infestations were detected. Moderate defoliation covered approximately 11,000 acres along the southeast shore of Aikens Lake in 1947 east of Lake Winnipeg and light defoliation occurred at a number of lakes (Moar, Dogskin, Wallace, Gem, and Oiseau) along the Manitoba-Ontario border.

The budworm crossed into Manitoba from Ontario in three different locations in 1948. Moderate to severe infestations were noted at Hobbs Lake (16 square miles), 4 miles north of Garner and south of Odd Lake (80 square miles), and south of McGregor Lake around Davidson Lake (25 square miles). Other infestation areas in 1948 were noted between Obukowin and Carrol lakes (2 square miles), south of Ryerson Lake (6 square miles), along the north shore of Oiseau Lake (1 square mile), between Aikens and Obukowin lakes (25 square miles), two miles southeast of Aikens Lake (4 square miles), southwest of Bissett (100 square miles), north of Bissett (30 square miles), northwest of Bissett (30 square miles), and at Sasaginnigak Lake. Moderate to severe defoliation occurred near Red Rock Lake in the provincial park in 1948.

Moderate to severe pocket infestations between the Winnipeg River and the Berens River merged into a single moderate infestation in 1949. Populations in the Whiteshell Provincial Park declined in 1949 and remained low from 1950 to 1965. There was a decrease in populations east of Lake Winnipeg in 1950 and from 1951 to 1964 light, occasionally moderate defoliation occurred at Flintstone, Aikens, Manigotogan, Maskwa, Dogskin, Obukowin, Wanipigow, and Sasaginnigak lakes.

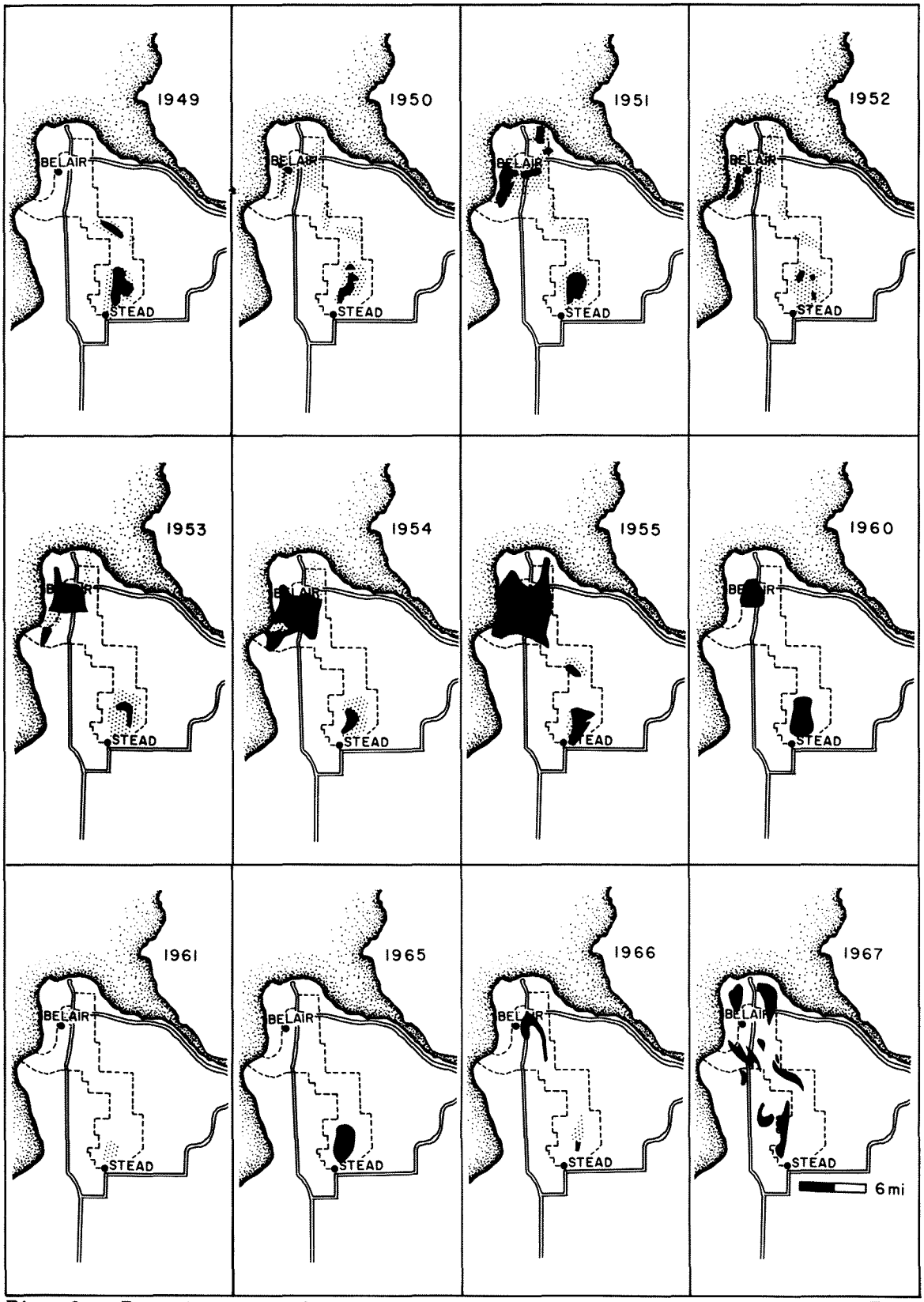


Fig. 3. Infestations of the jack-pine budworm in Belair Provincial Forest. Stippling denotes light defoliation and solid black moderate to severe defoliation.

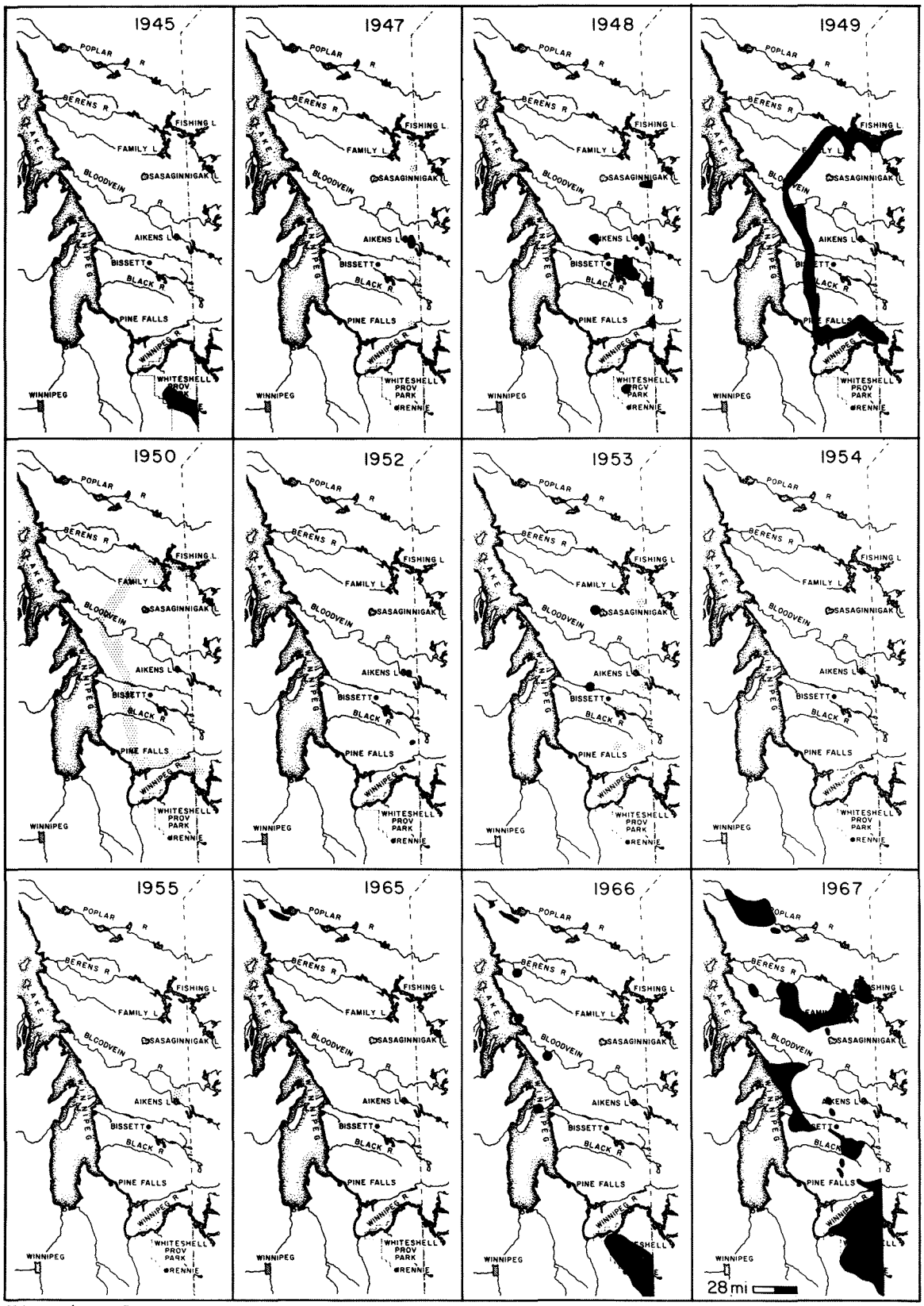


Fig. 4. Infestations of the jack-pine budworm east of Lake Winnipeg and in the Whiteshell Provincial Park. Stippling denotes light defoliation and solid black moderate to severe defoliation.

In 1965, a severe infestation encompassing 26 square miles was recorded between Weaver and Many Bays lakes east of Lake Winnipeg. Numerous pockets of moderate defoliation were noted along the east shore and on Black Island in Lake Winnipeg in 1966. In the Whiteshell Provincial Park, 430 square miles of jack pine suffered moderate to severe defoliation in 1966. In 1967, populations continued to increase in all areas. The largest area of moderate to severe defoliation extended from Falcon Lake northward along the Manitoba-Ontario border to Snowshoe Lake. Small patches of moderate to severe damage were noted in the vicinity of Cat Lake and between the Black and Manigotogan rivers, and, two small pockets of severe defoliation occurred between Manigotogan and Aikens lakes. Another area of moderate to severe damage was noted along the east shore of Lake Winnipeg from south of the Manigotogan River northward to the Bloodvein River. Small patches of light or moderate defoliation were detected on the northeast portion of Black Island and in the vicinity of Vickers, Viking, Family, Fishing, and Moar lakes.

THE INTERLAKE REGION

This region can be subdivided into two jack-pine budworm areas: the Rosenburg Area and the Gypsumville Area.

Rosenburg Area: This area is located north to northwest of Rosenburg and comprises approximately 25 square miles. The earliest recorded infestation was in 1941. Moderate to severe infestations have occurred in 1943, 1948-51, 1958-61, and 1964-66. Lighter infestations were noted in most other years.

Gypsumville Area: In the early 1940's, a severe infestation was observed from Moosehorn north to Fairford and in 1948 very light defoliation was noted 4/10 of a mile north of Gypsumville. Severe defoliation covered approximately 160 acres south of Gypsumville in 1949 but decreased to light in 1950. From 1951 to 1961, budworm activity in this area was minimal.

In 1962, however, 600 acres of jack pine between miles 45 and 46 along the Gypsumville-Grand Rapids Highway were lightly defoliated. It was estimated that the infestation had been present for two to three years. Populations increased between miles 45 and 49 in 1963 (Fig. 5) and encompassed approximately 230 square miles in 1964. The infestation continued to expand and in 1965 an area of 1,700 square miles suffered moderate to severe defoliation. In 1966, the entire infestation shifted northward and extended from Waterhen Lake to Grand Rapids covering approximately 1,730 square miles. Another northern extension occurred in 1967 and moderate to severe damage was noted north of Grand Rapids to the Cross, Cedar, Traders, and Driftwood lakes area. This latest infestation (1967) can be observed on the composite map.

THE SPRUCE WOODS PROVINCIAL FOREST

This plantation area has suffered severe damage by jack-pine budworm in the past. Light to moderate damage occurred in 1955, and in 1956 a number of jack, lodgepole, and Scots pine plantations were severely defoliated. Scots pine ranging in age from 16 to 35 years with moderate to heavy staminate

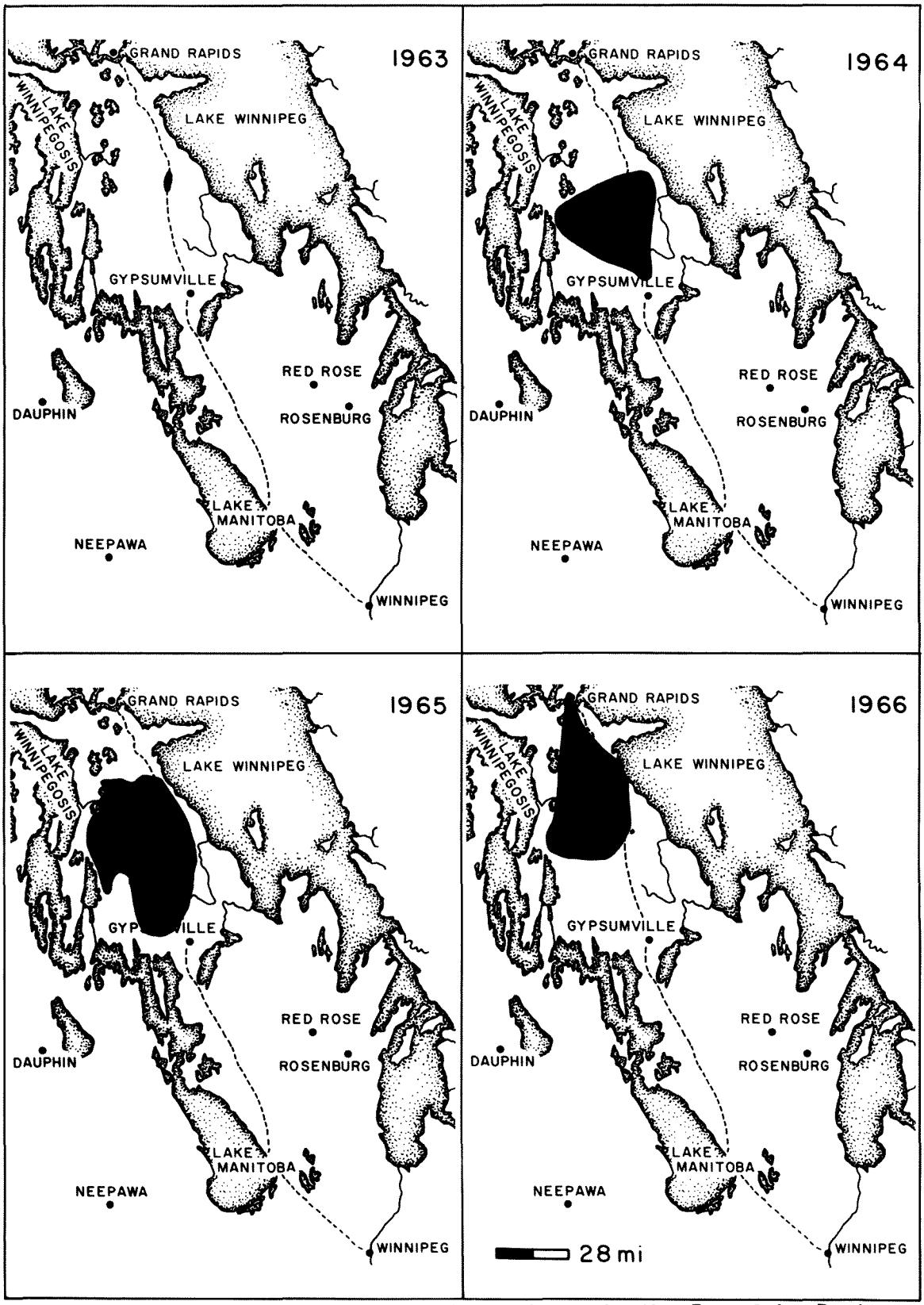


Fig. 5. Infestations of the jack-pine budworm in the Interlake Region. Stippling denotes light defoliation and solid black moderate to severe defoliation.

flower production were the most susceptible. Populations remained high in 1957 except on lodgepole pine where there was a lack of foliage and staminate flowers. The decline of budworm in 1958 was partially attributed to severe frosts in April which killed a high percentage of jack-pine terminals required for the early developmental stages of the larvae.

Populations were low from 1958 to 1963, but in 1964 an increase was noted in all pine plantations. Moderate to severe defoliation occurred in most jack and Scots pine plantations in 1965 and 1966 but chemical control measures in 1967 appear to have provided adequate control.

CENTRAL SASKATCHEWAN

This area includes the Nisbet, Fort à La Corne, Canwood, and Pines Provincial forests and the Nipawin Provincial Park. It was reported that moderate to severe infestations occurred in the Fort à La Corne Provincial Forest in 1939, 40 and 41. Populations decreased in 1942 and 1943 but moderate to severe damage was again noted in 1944 and 1945. The most severe defoliation was recorded from 7 miles east to 12 miles west of Twin Lake and east of English Cabin.

Populations were very low from 1947 to 1950 but began to build up from 1951 to 1955 in the Red Rock, Round Lake, Home, Holbein, and MacDowall blocks of the Nisbet Provincial Forest and in the Fort à La Corne Provincial Forest. Populations remained relatively the same in 1956, but declined sharply from 1957 to 1960.

In 1961, there was a general increase in the abundance and distribution of jack-pine budworm. Very light defoliation occurred in the Nisbet and Fort à La Corne Provincial forests in 1962 and 1963, but in 1964, moderate to severe defoliation was noted in the MacDowall (65 sq. mi.) and Holbein (27 sq. mi.) blocks of the Nisbet Provincial Forest and in the western portion of the Fort à La Corne Provincial Forest (176 sq. mi.) from Elk House on the west boundary east to English Cabin (Fig. 6). Defoliation was less severe throughout the Home and Red Rock blocks and in the northern half of the Steep Rock Block of the Nisbet Provincial Forest. Low populations were recorded north of Prince Albert.

Populations continued to increase in 1965 and the outbreak covered all of the Nisbet, Canwood, and Pines Provincial forests north of Township 45 and all jack-pine stands on both sides of the Saskatchewan River in the Fort à La Corne Provincial Forest. Moderate to severe defoliation also occurred in the Nipawin Provincial Park, south of Bittern (16 sq. mi.) and Candle lakes, and southwest of Pinehouse Lake. Populations decreased in 1966 but patches of moderate to severe defoliation persisted in the provincial forests, Nipawin Provincial Park, and in the Pinehouse Lake infestation. With the exception of a small pocket of moderate to severe defoliation south of Pinehouse Lake, light defoliation was recorded in all areas in 1967.

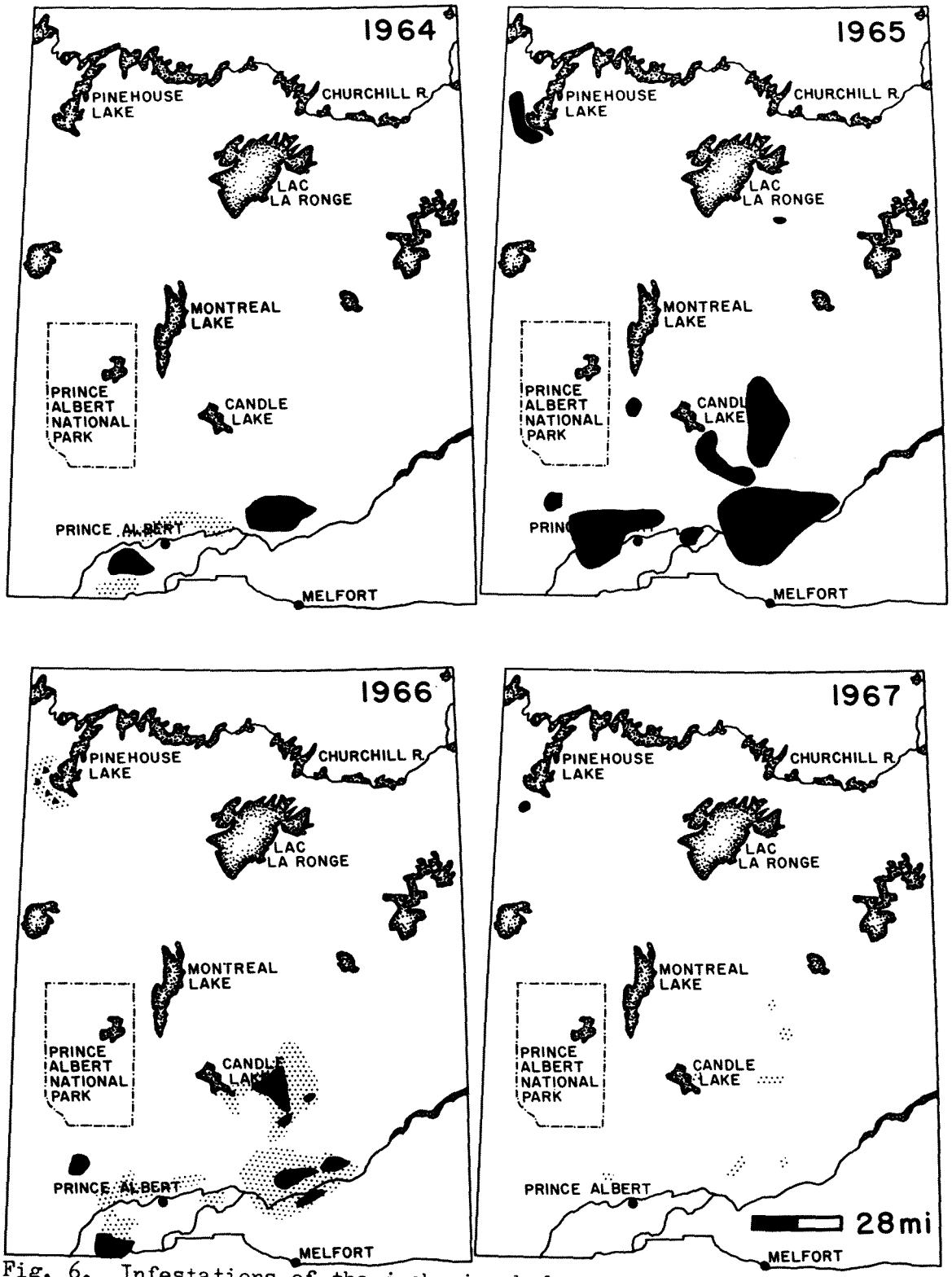


Fig. 6. Infestations of the jack-pine budworm in Central Saskatchewan. Stippling denotes light defoliation and solid black moderate to severe defoliation.

HOST TREE MORTALITY

Although mortality records have not been up-dated recently, considerable data has been accumulated from earlier infestations which indicate that jack-pine budworm is a serious pest.

In 1944, the killing of jack pine in the Sandilands Provincial Forest was generally light, but the occurrence of dead tops was quite high. In 24 quarter-acre random plots, the percentages of trees with dead tops varied from 12 to 60 per cent and the average length of dead tops ranged from 3 to 7½ feet.

The Sandilands Provincial Forest was thoroughly mapped for the percentage of dead-topped trees in 1947. At half-mile intervals, an estimate of average defoliation was made for 10 trees in each of two diameter classes at breast height. The diameter classes were: 5 inches and under, and over 5 inches to 10 inches. At each inspection point where dead tops were observed, the percentage of dead-topped trees in each diameter class represented was calculated. This was based on a count of 100 trees in each diameter class. The number of totally dead trees visible at each point was also recorded. A summary of the results in two diameter classes is shown in Table I.

Table I

Defoliation and dead top estimates for jack pine in two size classes in the Sandilands Provincial Forest

		Defoliation Estimates			Dead-Top Estimates		
Location	Total No. of inspection points	No. of inspection points	Average defoliation (%)	Max. defoliation observed (%)	No. of inspection points	Av. dead tops (%)	Max. dead tops (%)
Trees ≤5"							
South of boundary, between Tps. 6 & 7	168	151	16	75	149	<1	50
North of boundary, between Tps. 6 & 7	60	42	2	15	42	0	0
Entire Prov. For.	228	193	13	75	191	<1	50
5"< Trees <10"							
South of boundary, between Tps. 6 & 7	168	153	18	65	152	7	90
North of boundary, between Tps. 6 & 7	60	55	3	25	55	3	75
Entire Prov. For.	228	208	14	65	207	6	90

Results indicate that only 16 dead trees were recorded at 228 inspection points. Dead tops were more frequently observed in the 'over 5" class' and the maximum percentage of dead-topped trees was 90%. Damage was more severe in the southern portion of the provincial forest where dead tops were observed at 67 out of 168 inspection points. Similar investigations were conducted in Sandilands in 1948 and 1949.

Further mortality data was obtained north of Stead and in the Gypsumville area in 1949. Methods near Stead were similar to those in Sandilands except that instead of using average percentages for defoliation estimates, the categories light, medium and heavy were utilized. The results are shown below in Table II.

Table II

Defoliation classes and dead top estimates for jack pine north of Stead

No. of inspection points	Location Twsp.	Rge.	Defoliation by diameter class 5" and under	5" - 10"	Over 10"	Average % of dead top by diameter class 5" and under	5"- 10"	Over 10"	No. of dead trees
29	17	8	16L-10M-1H	15L-11M-1H	1H	1.67	2.83	0	23+
16	18	8	1L-4M-4H	1L-4M-4H	3M-4H	3.50	7.57	3.50	25

In the Gypsumville area, strips 1/2 chain wide by 10 chains in length were cruised in an east-west direction at 10 chain intervals throughout the stand. In each cruise strip, the trees were tallied according to the following diameter classes: (i) .5" to 1.4", (ii) 1.5" to 2.4", and up to 10" d.b.h. The trees were also tallied according to per cent defoliation of current foliage and old needles and defoliation was divided into the following categories: (i) 0 to 25%, (ii) 26 to 50%, (iii) 51 to 75% and (iv) 76 to 100%. The results are shown in Table III.

Table III

Defoliation and mortality of jack pine in the Gypsumville area

Cruise strip number	Total No. of trees	Range in d.b.h. inches	Mean d.b.h. inches	Defoliation Class Per cent		Per cent of dead trees
				New foliage	Old foliage	
1	161	.5 - 8.4	5.3	76 - 100	76 - 100	18.0
2	197	.5 - 8.4	5.1	76 - 100	76 - 100	17.2
3	247	.5 - 9.4	5.6	76 - 100	76 - 100	12.6
4	167	1.5 - 7.4	4.2	26 - 100	0 - 100	.6
5	93	1.5 - 9.4	5.0	0 - 50	0 - 25	7.5
6	150	1.5 - 9.4	6.0	76 - 100	76 - 100	6.7
7	123	1.5 - 8.4	5.5	0 - 25	0 - 25	6.5
8	71	1.5 - 9.4	6.3	76 - 100	76 - 100	5.6
9	124	1.5 - 9.4	5.6	76 - 100	76 - 100	12.9

The per cent of dead trees was calculated according to diameter class and crown class. The results are shown in Tables IV and V.

Table IV

Number of trees according to diameter classes and per cent dead in each class

Cruise strip no.	One inch		Two inch		Three inch		Four inch		Five inch		Six inch		Seven inch		Eight inch		Nine inch	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	2	100	17	71	20	10	32	16	31	0	37	16	15	0	7	0	-	-
2	1	100	10	80	32	62	26	15	57	2	43	0	23	0	5	0	-	-
3	2	100	6	100	22	68	41	10	59	3	71	1	34	3	9	0	3	0
4	-	-	7	14	33	0	57	0	55	0	13	0	2	0	-	-	-	0
5	-	-	13	15	12	33	15	7	16	0	19	0	9	0	8	0	1	0
6	-	-	2	50	7	57	13	23	34	3	47	2	33	0	11	0	2	0
7	-	-	3	66	9	44	21	10	30	0	30	0	24	0	6	0	-	-
8	-	-	1	100	2	50	9	22	13	0	13	8	20	0	7	0	6	0
9	-	-	4	75	15	73	22	9	27	0	30	0	17	0	7	0	2	0
Total	5	100	63	56	152	42	236	10	322	1	303	3	177	5	60	0	15	0

Table V

Dead Trees According to Crown Class

Diameter class	No. of trees tallied	No. of dead trees	Per cent Dead Trees by Crown Class (Per cent based on all trees)			
			dominant	codominant	Intermediate	Suppressed
1"	5	5	-	-	-	100
2"	63	35	-	2.0	4.8	49.2
3"	152	63	-	5.9	5.9	29.6
4"	236	23	.4	5.1	1.7	2.5
5"	322	4	-	1.2	-	-
6"	303	9	1.0	2.0	-	-
7"	177	1	-	.5	-	-
8"	60	0	-	-	-	-
9"	15	0	-	-	-	-

High mortality was evident in trees in the small diameters up to and including 3" d.b.h. In the remaining classes, mortality was very light and was non existent in the 8 and 9" d.b.h. classes. On the basis of mortality in relation to crown class, the highest rate of mortality occurred in the suppressed class followed by co-dominant, intermediate, and dominant.

Similar cruise strips were carried out in the Sandilands Provincial Forest in 1956. The results are shown in Table VI. Calculations indicate a maximum loss of 11.09% in the basal area of a stand.

Table VI

The loss of basal area attributable to jack-pine budworm

Cruise strip no.	D.B.H. Living		D.B.H. trees totally dead		Basal Area Stand			Defoliation history
	Range	Average	Range	Average	Living	Dead	Per cent loss	
1	1-10"	3.8"	1-6"	2.2"	86.69	1.319	1.48	1954: 1955: M 1956: H
2	1-11"	3.6"	1-10"	2.1"	76.43	6.095	7.38	1954: L 1955: M 1956: H
3	1-13"	7.8"	1-10"	3.0"	55.28	2.410	4.18	1954: L 1955: M 1956: M-S
4	1-13"	4.4"	1-11"	3.9"	57.49	7.171	11.09	1954: L 1955: M-S 1956: S
5*	1-10"	3.6"	1-6"	1.2"	62.47	.323	.514	1954: 1955: 1956: L

* Check

After the moderate to severe infestation in the Spruce Woods Provincial Forest in the mid 1950's, mortality counts were undertaken in Scots pine plantations in 1957 (McDowall et al) and in 1958.

A 'line count' method was utilized to determine tree mortality. One hundred trees were selected diagonally through each plantation and each tree was classified as healthy, dead, 1/3 crown dead, or dying leaders. The results are shown in Table VII.

Table VII

Tree Mortality of Scots Pine Based on Line

Counts of 100 Trees in Each Plantation

Plantation No.	Date planted	Acreage	Defoliation History			Per cent dead trees		Per cent with 1/3 or less of crown bare or dying		Per cent of trees with leader bare or dying	
			1956	1957	1958	1957	1958	1957	1958	1957	1958
87	1925	5.5	L	L	L	0	0	18	13	5	7
86	1925	1.0	M	M	L	4	0	21	11	20	6
84	1925	4.2	M	H	L	26	31	38*	55	3	12
83	1925	1.3	H	H	L	22	9	45*	65	0	12
8	1930	4.5	H	H	L	18	8	54*	90	1	19
4	1930	10.3	M	H	L	5	3	32	30	1	17
81	1925	10	L	M	L	5	2	26	14	7	12
2	1905	4.4	L	M	L	0	4	5	13	11	10
79	1925	2.0	L	M	L	8	4	24	34	6	18
3	1906	8.7	L	M	L	0	3	20	31	7	10
4	1907	9.5	L	M	L	2	0	12	11	3	9
8	1925	5	L	L	L	0	0	0	0	6	5
2	1927	15	L	M	L	8	10	40	27	11	22
2	1932	19.8	M	M	L	0	0	11	50	35	31
3	1932	14.7	H	H	L	1	0	6	46	29	39
26	1920	3.5	L	H	L	2	0	18	33	10	11
12	1916	7.6	L	M	L	0	2	7	12	5	9
8	1916	9.8	L	M	L	1	0	11	20	6	16

* A sample of these showed that most bare tops were actually dead. In all other Scots pine plantations, the majority of bare tops were living to the fall of 1957.
L. M. and H.: represent light, moderate and heavy.
Dead leaders, crowns and completely killed trees were common in plantations 27 to 32 years old; results showed that older plantations withstood defoliation of previous years.

DISCUSSION

Records indicate that jack-pine budworm outbreaks are of variable duration. Examples of 2 year outbreaks can be seen in the Agassiz Provincial Forest from 1951 to 1952 and 4 year outbreaks in the Sandilands Provincial Forest from 1955 to 1958 and from 1964 to 1967. The outbreak of longest duration occurred in the southern portion of the Belair Provincial Forest from 1948 to 1955, a total of eight years.

The ability of budworm to persist in a certain area appears to depend upon a number of factors. These can be summarized as follows: (i) rate of parasitism, (ii) condition of the host, and (iii) weather.

The rate of parasitism varies considerably in different locations and from year to year. In 1966, per cent parasitism varied from 6.9 to 36.3 in the Sandilands Provincial Forest in southeastern Manitoba and was as high as 20.9 and 29.3 in the Fort à La Corne and Nisbet Provincial forests respectively in central Saskatchewan. Larval parasitism was noted to be as high as 68.0% in northwest Wisconsin (Dixon and Benjamin 1963). More than 30 species of larval and pupal parasites have been reared from jack-pine budworm during the past 20 years in the Manitoba-Saskatchewan Region. Although complete egg parasite studies have not been attempted in this Region, parasitism as high as 62.6% has been recorded in Wisconsin.

It is also probably that the condition of the host plays a significant role in the regulation of population levels. Marked difference in the degree of defoliation in neighbouring plantations was apparently attributable to differences in the prevalence of male flowers (Heron and Prentice 1956), and populations fluctuated directly with pollen production (Fyfe and Lejeune 1946). Severe defoliation inhibited subsequent staminate flower production (Heron 1956). It is, therefore, reasonable to assume that three years of severe defoliation would drastically reduce the production of male flowers and hence larval populations. The scarcity of available foliage after severe damage had occurred would result in starvation and poor larval development. Increased defoliation of balsam fir resulted in decreased egg production by the spruce budworm (Blais 1953), and although not verified, perhaps the closely related jack-pine budworm would react in the same manner. This could also result in reduced populations after a number of years of moderate to severe damage.

Adverse weather conditions, particularly frost, can rapidly and seriously reduce budworm populations. In 1958, severe frosts in late April in the Spruce Woods Provincial Forest killed a high percentage of jack-pine terminals required for early larval development; thereby reducing budworm numbers. Cooler than normal temperatures in the Lower St. Lawrence and Gaspe regions greatly retarded spruce budworm development (Blais 1958). The analysis of the available weather data showed that the 1912 and 1949 outbreaks of spruce budworm in New Brunswick were preceded by several consecutive dry summers (Greenbank 1956).

Indications are that atmospheric currents play a significant role as a means of dispersal of jack-pine budworm. Examples of this phenomenon can be noted in the following maps: east of Lake Winnipeg (1948-49); central Saskatchewan (1964-65); and in the Sandilands Provincial Forest (1955-57

and 1964-66). This is further substantiated by the author who observed high populations of adults in Steinbach approximately 20 miles from heavily infested jack-pine stands. Newly-emerged spruce budworm larvae are photo-positive and proceed to the tip of the needle where overcrowding occurs (Wellington and Henson 1947); the larvae may drop to another twig or be caught in vertical air currents of low velocity to be borne above the level of the trees. Moths of the spruce budworm were carried by convective storms which precede typical cold fronts (Henson 1951), and furthermore, moth dispersal is a more effective agent of spread than larval dispersal (Greenbank 1957). In heavily populated areas where foliage is depleted, femals of the spruce budworm become more active in their search for oviposition sites, there being a definite tendency for females to oviposit on needles of the newer growth. Long range dispersal is thereby enhanced and a portion of the population may be transported to another area.

Although a number of these observations apply to the spruce budworm, further investigation is required to prove them applicable to the jack-pine budworm. In addition, mortality counts in the Sandilands Provincial Forest will be updated and published along with the historical aspects.

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