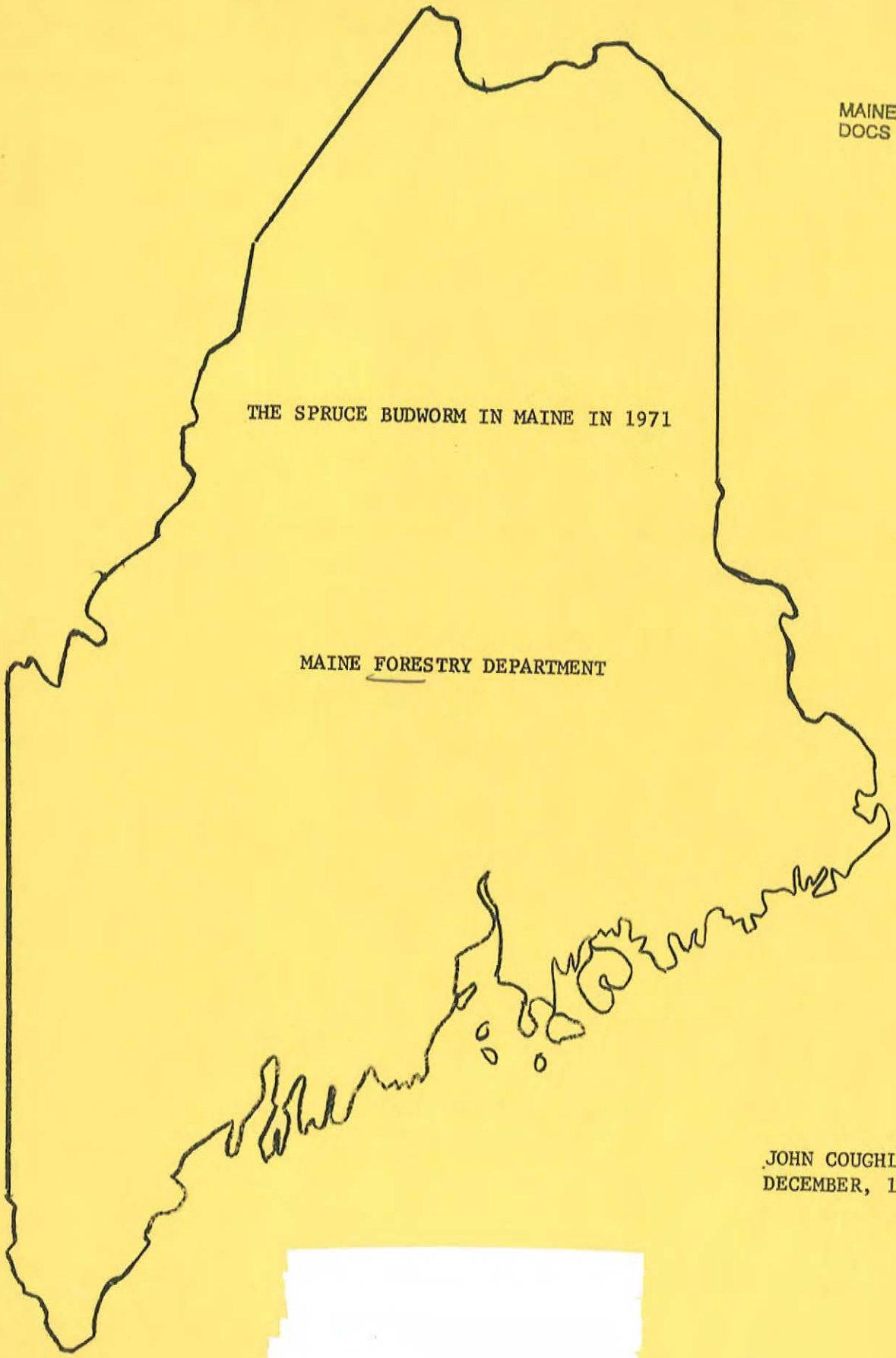
THE SPRUCE BUDWORM IN MAINE IN 1971



MAINE FORESTRY DEPARTMENT

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DECEMBER, 1971

1. INTRODUCTION

The most serious and destructive defoliator of the spruce-fir forests of North America, the spruce budworm, has existed in an "epidemic" or outbreak status for more than 20 years in Maine. During this period a series of insecticide treatments using DDT in 1954, 1958, 1960, 1961, 1963, 1964, and 1967 and using fenitrothion in 1970 have prevented the forest destruction historically associated with this insect. The spruce-fir country is still green and productive and tree loss has been minimal. At one point, around 1966, the "epidemic" infestation was confined to a relatively small area of less than 100,000 acres, centered on the town of Oxbow. All other areas then exhibited only light to negligible, or "endemic" infestations. The epidemic infestation has since enlarged again, mostly northeast of Mt. Katahdin and tree destruction has begun. Hope of controlling the insect sufficiently to prevent widespread destruction still exists, but the infestation has now spread over wide areas with new epicenters arising in Washington County, northwest of Mt. Katahdin, and in the country around and north of Allagash.

The neighboring provinces of Quebec and New Brunswick are also hard pressed to prevent serious forest destruction and in New Brunswick especially, efforts to control this insect through insecticide applications have involved millions of acres. Research in Canada and the U. S. has yet to provide a workable alternative.

Annual assessments of the spruce budworm situation in Maine have demanded the attention of a large part of the Maine Forestry Department entomology staff. In addition to the usual surveys, considerable support was provided to research activities of University of Maine scientists and to those of the U. S. Forest Service who conducted a pilot test of the insecticide "Zectran" during 1971.

With the loss of DDT, the only insecticide with demonstrate ability to reduce budworm populations to endemic levels, the search for substitutes has been intensified. Efforts in Maine had been directed unsuccessfully at increasing the spruce budworm parasite complex (1950-1958), the experimental application of Bacillus thuringiensis (1963), and the insecticides malathion (1964), Zectran (over 489 acres in 1967), and Sumithion[1] (fenitrothion) in 1968. Accothion (fenitrothion) has been used in a control operation over 210,000 acres in 1970. While results were satisfactory in protecting the 1970 spruce-fir foliage crop, budworm populations were not significantly reduced in terms of long range control. The affected forest was generally in better condition as a result of the foliage protection but was expected to be attacked again in 1971. No operational spray treatment was recommended for 1971, but further experimental work was recommended to meet the anticipated need for future treatment. This experimental work took the form of the pilot test of Zectran, by the U.S. Forest Service cooperatively with the Maine Forestry Department on four 2300 acre blocks of spruce-fir forests in the Oxbow area.

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1. The insecticide "fenitrothion" appears under a number of brand names: SUMITHION, ACCOTHION, NOVATHION, and others, depending on manufacturer. SUMITHION was tested in 1968 and ACCOTHION was applied operationally in 1970 but the material was essentially the same.

2. SURVEYS DURING 1971 SPRUCE BUDWORM LARVAL DEVELOPMENT

First priority for Maine Forestry Department biological survey teams and field laboratories at Portage and Cross Lake was given larval "development" samples in order to follow the seasonal development of the 1971 spruce budworm generation. Proper timing is essential in the various surveys and was critical for the test application of Zectran. Beginning in mid-May a series of representative fir foliage samples were taken, usually every day or two from the Oxbow area. The foliage was examined minutely in the Portage laboratory and the budworm larvae found were sorted according to their development stage or instar and counted. Development of the spruce budworm in 1971 is shown in Figure 1.

All of the laboratory work for the test of Zectran was carried out at the Maine Forestry Department field laboratory at Portage. Department personnel also handled a sizable share of the field work of foliage collections to determine pre- and post-spray budworm populations. Complete and detailed information on the Zectran test, the methods used, and the results should be obtained from the U. S. Forest Service.

Other foliage collections were made throughout the most seriously troubled region during the budworm larval development. These collections provided a check on the representativeness of the development samples, a check on the accuracy of the 1970 egg mass survey, and an opportunity to observe 1971 defoliation actually occurring at many widely separated locations. As expected, the 1970 egg mass survey accurately predicted the location and degree of the 1971 infestation. While a count of 279 or more budworm larvae on a sample of twenty-five 15-inch fir tips is classified as "heavy", many 1971 sample locations revealed 3, 4, or 5 times this number. A phenomenal count of 2120 larvae was found on one sample. With such numbers of budworm larvae attacking the trees, the serious damage that resulted came as no surprise.

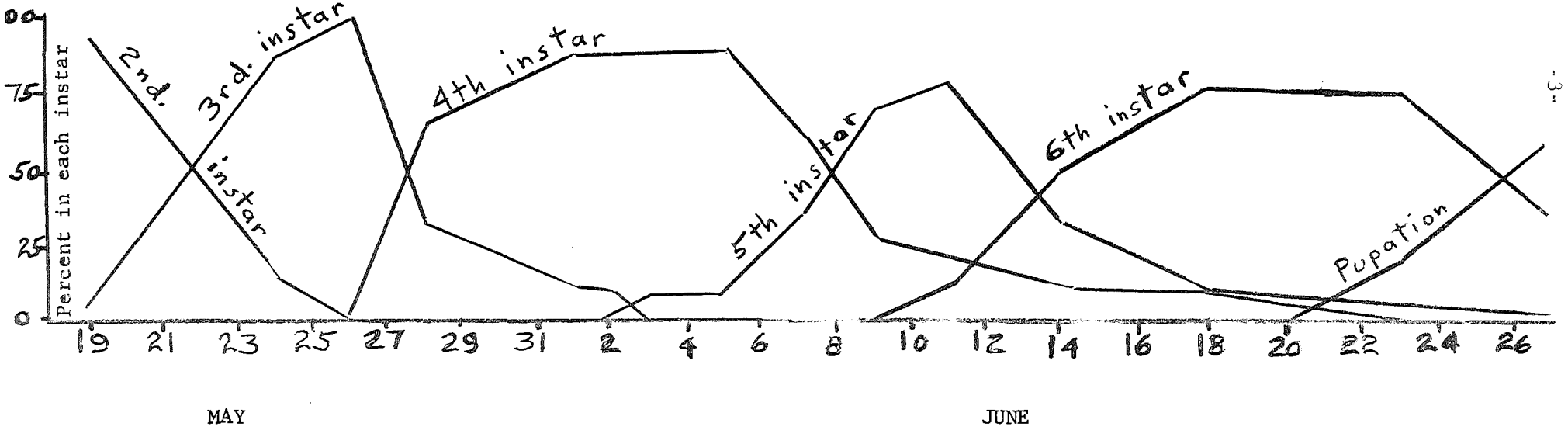
As part of their regular work, fire control personnel make insect survey collections throughout the state by the "tree beating" method. Collections sent regularly to Augusta reveal a variety of important forest insects, including the spruce budworm in those areas not readily accessible to those working out of Portage on the more intensive surveys. Figure 2 shows the locations where spruce budworm were found in this "Forest Insect Survey" during 1971.

3. DEFOLIATION BY SPRUCE BUDWORM IN 1971

The egg mass survey of August, 1970 (which located and sampled the eggs responsible for the 1971 infestation) indicated that there would be heavy and extensive defoliation of fir and spruce throughout the expanding Oxbow area infestation and around the newer infestation surrounding Cross and Madawaska Lakes.

Although spruce budworm larvae begin their destructive killing of buds in May and destroy current and some older foliage throughout most of June, the damage is most evident in early July. The dead needles are then a striking reddish-brown color, contrasting with the green of a normal spruce-fir forest. Later, these dead needles fall off, leaving only that

FIGURE 1. DEVELOPMENT OF SPRUCE BUDWORM IN 1971 (Data from Oxbow)



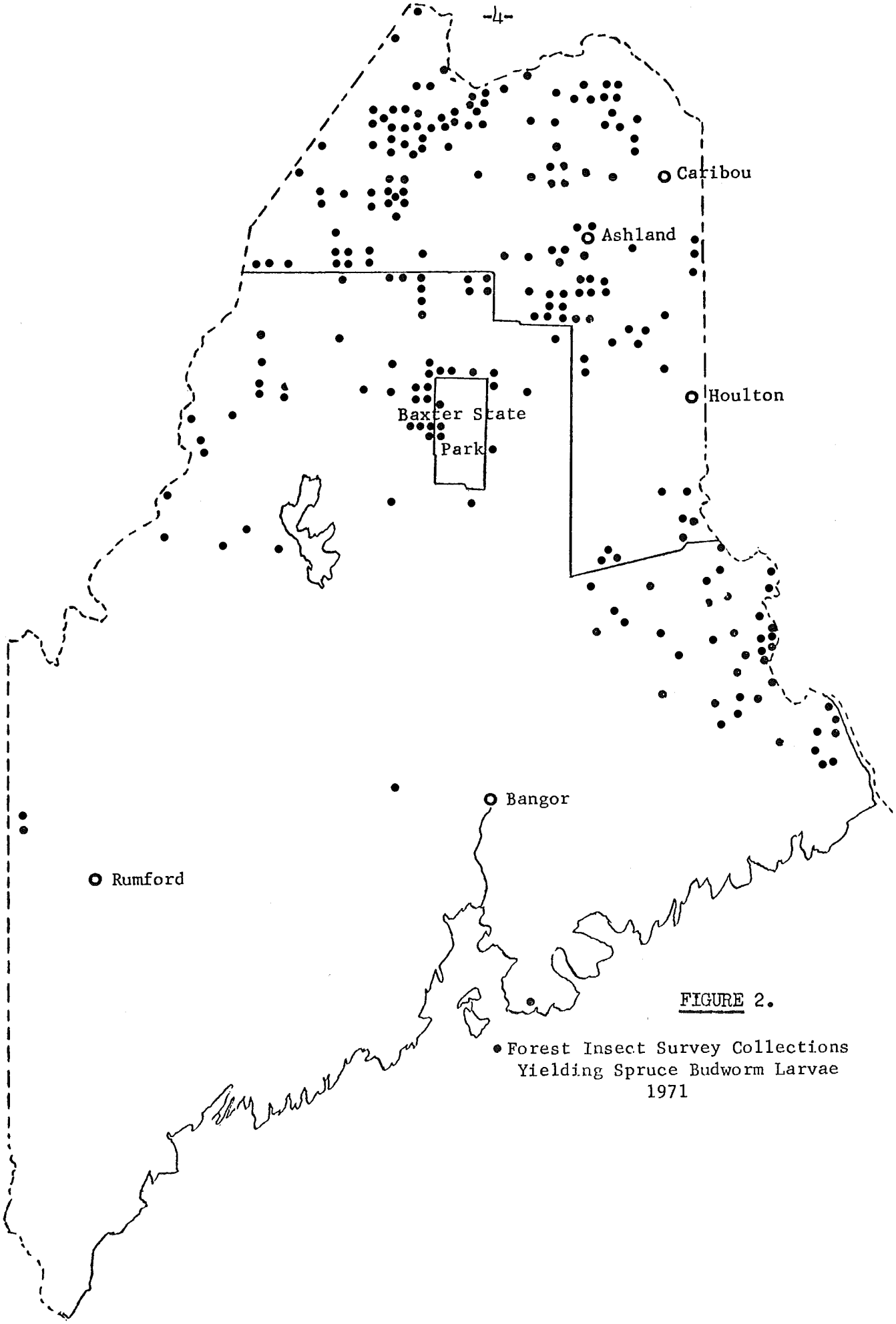


FIGURE 2.

• Forest Insect Survey Collections
Yielding Spruce Budworm Larvae
1971

part of the foliage which is still green, or in severe or prolonged infestations, the gray of defoliated and dying trees.

Travelers along Route 11 from Knowles Corner north to Ashland and especially along the road into Oxbow village noted the damage. Not only fir and spruce but larch also was damaged. In the Cross and Madawaska Lakes area the effect was especially striking from the height of land near Madawaska Lake. Woods workers, foresters, industry representatives, residents, and those scientists and technicians intimately concerned with the forest were impressed with the severity of the 1971 attack.

Normally some tree death is to be expected about the fifth year of serious defoliation and destruction of the stand may be virtually complete 2 or 3 years later. The severity of the 1971 attack was such that in the Cross Lake - Madawaska Lake area some tree death seems likely now after only 2 years of serious attack. Even small fir trees, less than 2-3 feet high were heavily fed upon by the continuous rain of larvae spinning down on silken threads from larger trees, seriously defoliated above them.

The effect could be appreciated properly only from the air. Aerial observations revealed extensive damage along St. Croix Stream, east of Route 11. The older infestations around Oxbow and the Cross Lake-Madawaska Lake area were striking in both extent and severity, but isolated defoliation was seen around St. Francis and further north in those townships surrounded on three sides by Quebec. A new center of defoliation was seen from the air northwest of Mt. Katahdin, south of Webster Lake in T6R10 and T6R11.

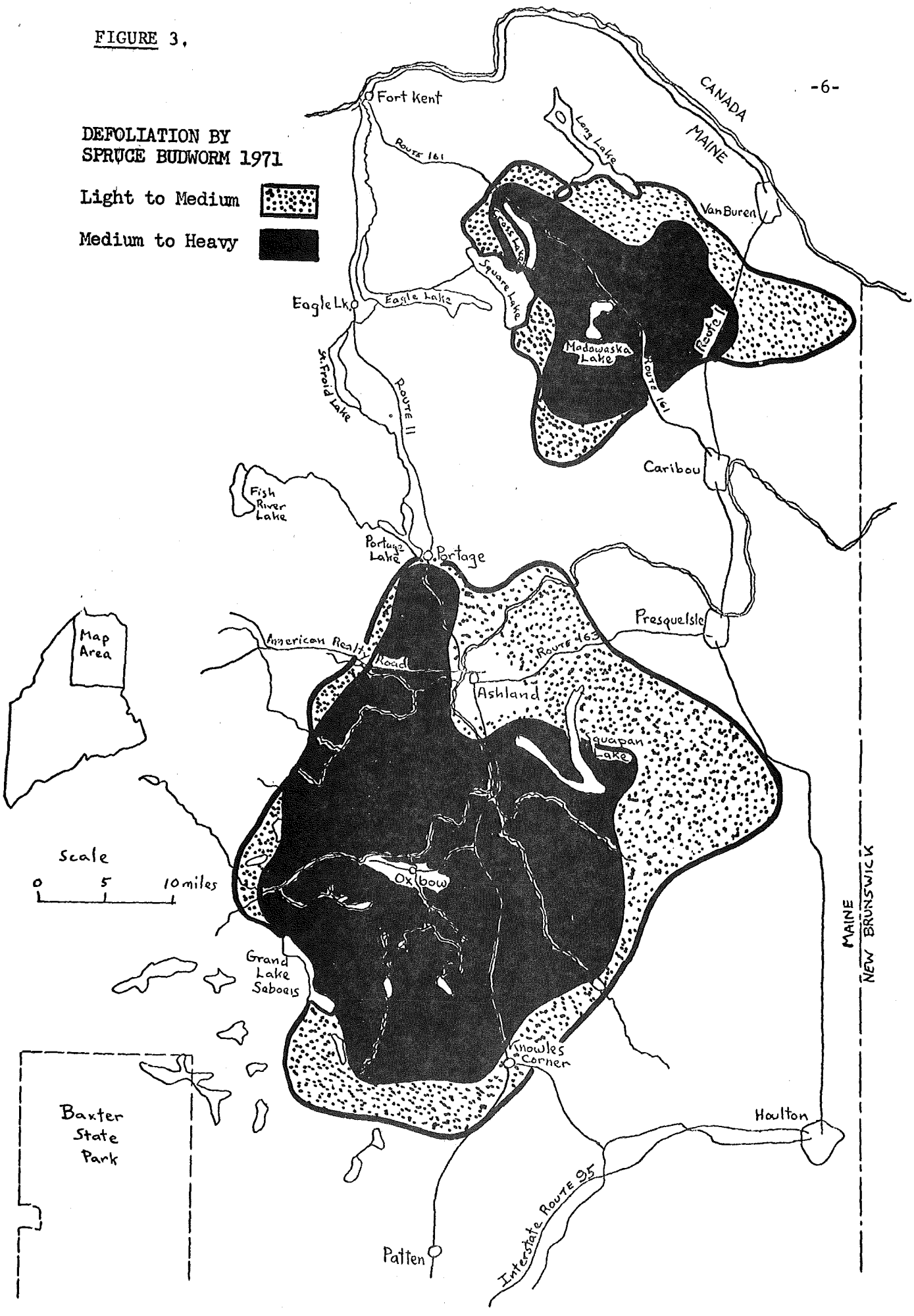
Scattered defoliation in Washington County seems to have coalesced into a new epicenter and more serious damage is occurring. At Fowler (T1R1) "Heavy" defoliation was noted where previously there had been "Light to Medium". "Medium to Heavy" defoliation was again found at Waite, this being the second year from this checkpoint. "Medium to Heavy" defoliation was also recorded at Lambert Lake where last year the survey crew found "Light to Medium". At Dyer (T1R2) defoliation was "Light to Medium". Over a wide area including Vanceboro, Codyville, Princeton, Plant. 21, T43MD-T27ED, Grand Lake Stream, Indian Twp., Talmadge, Forest (T10R3) and even as far west as Springfield trace and sometimes "light" defoliation was recorded. Although the damage is greater than recorded last year, tree condition at all locations was still classed as "good".

Defoliation in the Oxbow and Cross Lake-Madawaska Lake areas is shown in Figure 3. Elsewhere in the state tree death is not yet a threat.

4. SPRUCE BUDWORM MOTHS AT LIGHT TRAPS IN 1971

Every year a series of light traps are operated, primarily to detect spruce budworm moth flights. Much useful information is obtained on other species as well. The locations of the traps operated in 1971 are shown in Figure 4. These traps are operated each night during the period when moths are flying (principally July). Each night's catch is kept separately and later sent to the Augusta laboratory where the moth collections are sorted and counts made of all spruce budworm. A detailed tabulation of the number of spruce budworm moths caught is presented as Table 1.

FIGURE 3.


DEFOLIATION BY
SPRUCE BUDWORM 1971
Light to Medium
Medium to Heavy
Fort Kent
CANADA
MAINE
Long Lake
Route 161
Van Buren
Cross Lake
Square Lake
Eagle Lk
Eagle Lake
Madawaska Lake
Route 1
St. Froid Lake
Route 11
Caribou
Fish River Lake
Portage Lake
Portage
Presquelsle
Map Area
American Realty Road
Route 163
Ashland
Squapan Lake
Scale
0 5 10 miles
Oxbow
Grand Lake Seboeis
Knowles Corner
Houlton
MAINE
NEW BRUNSWICK
Baxter State Park
Patten
Interstate Route 95

SPRUCE BUDWORM MOTHS FROM LIGHT TRAPS - 1971

FIGURE 4.

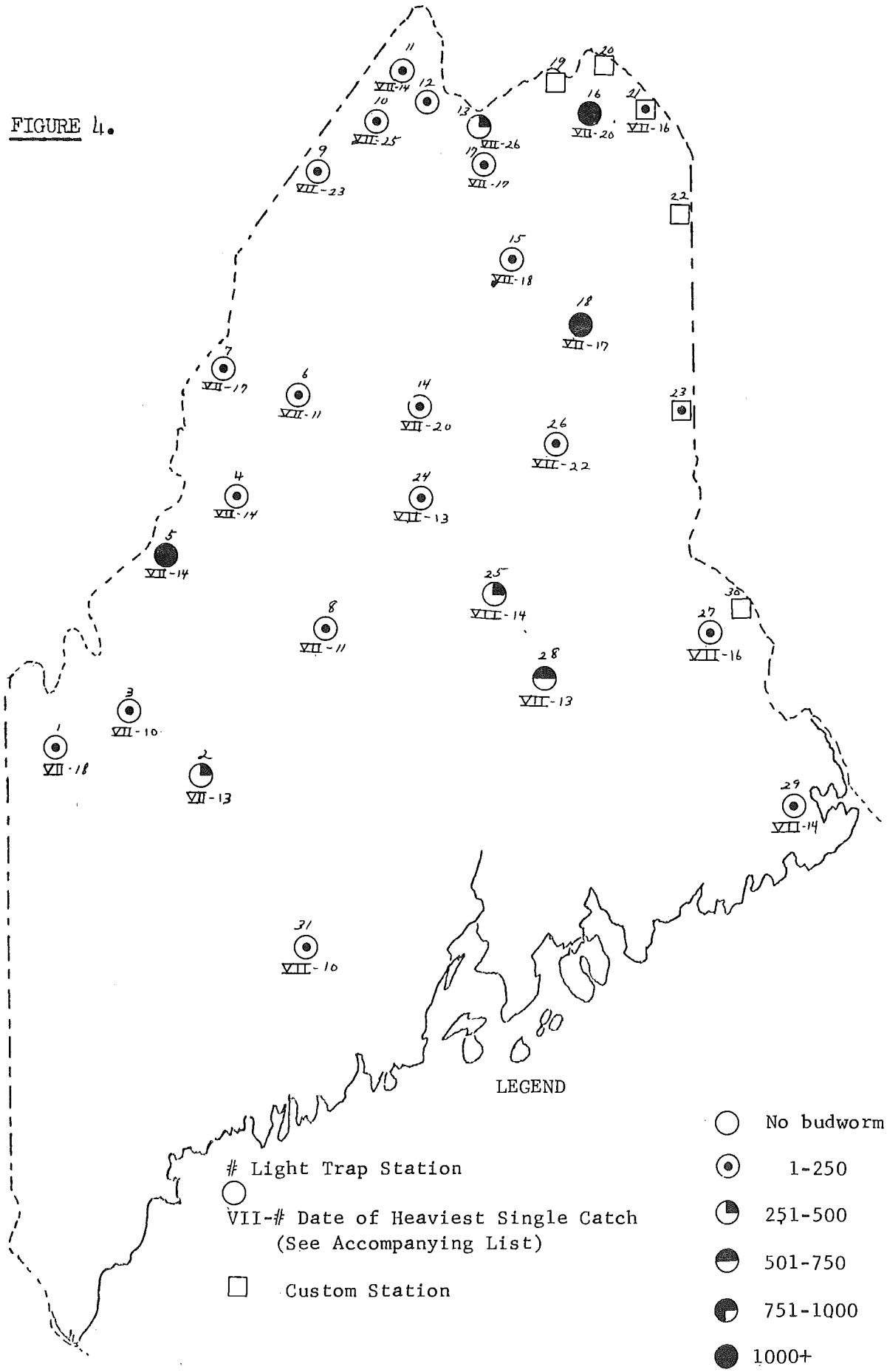


TABLE 1.

SPRUCE BUDWORM MOTHS IDENTIFIED FROM LIGHT TRAP COLLECTIONS DURING 1971

TRAP	DATES OF COLLECTIONS - - - - -JULY- - - - -																																		TOTAL
	1	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	AUGUST 1	2	3	4		
1. Cupsuptic(Rangeley)	3								6		5		3	2	3	25	14				4		4		3		1								73
2. Kingfield	1				1	1	4	3	56	6	171	7		33	8	3	3					1													298
3. Eustis					1	3	1	5	1	1	1	1	2	4																					20
4. Pittston Farm								5	7	3		61	10			16	10	9				1	1												123
5. Dennistown						6	20	62	117	47		194	23	141	167	69	53	23		8	29	107	47	5	14		3								1135
6. Caucomgomac									5				1		3																				9
7. T8R19(Somerset Co.)				3				4	6	1		17	1	1	49	2	1	3	6		6	12				2		1							115
8. Squaw Brook				1		7	2	12	52	2	1	43	2	5	39	2	2	1																	171
9. Depot Mt.(T14R16)									1				2			2	3				24				1	1									34
10. Chimenticook(T16R13)												4	7		2		2	4				1	11		5									36
11. Rocky Mtn.												23	1		12			13				1	3		5	1								59
12. Allagash(T17R11)																	1						1												2
13. St. Francis				1				2	1				3	6	2	6	6	31		19	26		33	72			3	25	20	1					257
14. Round Pond Telos(T6R11)			2	5	4		8	17	5	2		13	9	6	22	16	16	58	4	1	14	3	1	2							2	2		212
15. Round Mtn.(T11R8)												1				9		1	2		2													15
16. Cross Lake				9	86	35	111	151	122	1604	112	4	1044	966	1407	1352	671	4000±	365	57	660	404	886	54	158	67	10	13		8					14356
17. DeBoulie			5				1		1	1					65	5	21	17		3	21	11	19	30	13	4	1							218
18. Camp Dana (Oxbow)		8		4		2	13	18	357	2		96	363	40	1327	130	12	21	2		8	7	4	5			2								2421
19. Fort Kent Customs																																			0
20. Madawaska Customs																																			0
21. Van Buren Customs														4																					4
22. Fort Fairfield Customs																																			0
23. Houlton Customs			1											1	1																				3
24. Chesuncook Dam						1		2	1	7	13		1	6	1	3																			35
25. Long A						4		3	17	17	11	165	4	23	7	5	9	3				1		1											270
26. Shin Pond																				1															1
27. Topsfield					1				1	1		2	1	3																					9
28. Enfield			7	2	6	17	34	23	88	36	131	114	29	52	38	48	8	4																	637
29. Marion					1			1	14	15	12	19	8	14	3	1	5	1	1				1												96
30. Vanceboro Customs																																			0
31. Vassalboro			5			1	3	34	1			Stragglers thru Aug. 1																							44
TOTAL	4	8	20	25	100	77	197	342	859	1745	457	764	1514	1307	3156	1694	837	4189	380	89	794	549	1011	169	199	75	20	39	20	1	8	2	2		20653

The Cross Lake trap, No. 16, on the night of July 20 produced a phenomenal number of moths, estimated to be about 4000. This catch was a record for one night's catch in a single Maine trap. "Flights" of this sort have often had a decided effect on the trend of infestations, providing almost "instant epidemics" in limited locations. The light trap of course catches only a small fraction of the astronomical numbers that must be present in the area.

The heavy catch of trap No. 18, Camp Dana, is not surprising for it, like the Cross Lake trap, is surrounded by forests that were severely defoliated in 1970 and 1971. Trap No. 13, St. Francis is near a newly arisen epicenter along the St. John River.

The heavy catch at Dennistown, trap No. 5, is of concern. This trap caught higher numbers than surrounding traps last year also; yet no spruce budworm infestations have been detected otherwise in this region that has not seen a budworm epidemic for 50 years or more.

Collections from trap No. 25, Long A near Millinocket and No. 28, Enfield show how widespread the problem may become and suggest relationships to the new infestation west of Katahdin and to the Washington County area. The Kingfield trap, No. 2, provided a larger than usual catch.

Together with the Forest Insect Survey results, (Figure 2) these catches show how the budworm is to be found throughout the spruce-fir region of the state and point out areas that will require attention in future surveys.

5. THE 1971 EGG MASS SURVEY

Since the conditions to be expected in 1972 are predicted largely from the 1971 egg mass survey, the greatest effort was placed on this work. All indications throughout the 1971 season pointed to an explosion of the budworm problem. Older infestations had become more severe and new infestations, some quite distant, were becoming evident. Word from adjacent Quebec and New Brunswick gave additional cause for alarm.

The 1971 survey was intensified within the most seriously troubled regions and extended to include more recently discovered infestations. A total of 424 sites were visited, throughout Aroostook County and parts of Piscataquis, Penobscot, and Washington Counties. At each site the usual five 15-inch long balsam fir branches were taken from the mid-crown of each of five co-dominent trees. For most of the samples, all 25 sample branches were minutely searched for spruce budworm egg masses at the Portage or Cross Lake laboratory facilities. In less than 100 samples, largely those in remote or lightly infested areas, or taken late in the season, a sequential sampling system was used to identify the class of infestation without actually searching all 25 sample branches. The same system has been used with satisfactory results for many years.

The most extensive area of serious infestation is still that centered on Oxbow. Most of the survey effort in recent years has been spent in delineating the epidemic spruce budworm populations here and around Cross and Madawaska Lakes. A count of 34 egg masses per 25-twig sample at a particular location is sufficient to predict a heavy population, heavy defoliation, and serious tree damage at that site during the coming year. During the 1971 survey,

counts of 100 or more egg masses per sample were almost routine throughout much of this infested area. Counts of 200 were frequent and at one location, a few miles south of Squapan Lake in T9R4, 314 egg masses were found on the sample foliage. This count exceeds anything found during the experience of the present survey staff. These counts suggest that the 1972 damage will far exceed that of 1971. Samples taken at 314 locations within, between and surrounding the Oxbow and Cross Lake-Madawaska Lake areas averaged 55.500 egg masses per 25-twig sample. (These counts included light, negligible, and zero counts.) In the same area in 1970, 323 samples averaged only 16.875 budworm egg masses. In just one year the infestation has shown more than a three-fold increase. The Oxbow and Cross Lake-Madawaska Lake infestations, although both are larger than in 1970, have not yet coalesced. Only light to negligible budworm populations were found between the two areas.

The defoliation seen from the air south of Webster Lake was checked from the ground by crews making regular egg mass survey collections. This new infestation was found to be already quite extensive. Heavy budworm populations were revealed west of Telos Lake near the T6R11-T6R12 town line and just within Baxter Park in T5R10, east of Thissell Pond. Medium to heavy populations were found near the center of T5R11 and south of Nesowadnehunk Lake in T4R10 (Baxter Park). It would appear that while defoliation was quite limited in 1971 and tree damage was not serious, egg mass counts are now sufficiently high to predict noticeable defoliation over a wide area northwest of Mt. Katahdin in 1972. Light budworm populations connect this infestation to the Oxbow area and extend northerly through the Allagash to St. Francis and then north to Estcourt and Beau Lake.

A new epicenter arose in the Allagash-St. Francis area where heavy budworm populations were found along the St. John River. Further north, in those townships bounded on three sides by Quebec, only light to negligible egg mass deposits were found by ground survey crews although light defoliation was detected from the air early in July. In view of the infestations in adjacent Quebec, this area will be watched closely for further signs.

In Washington County a heavy egg mass collection came from Fowler (T1R1) where only "light" was found in 1970. Medium to heavy populations were found at Waite, medium at Lambert Lake, light to medium at Grand Lake Stream, and light populations at Vanceboro, Dyer, Codyville, Princeton, T43MD & T27ED, Indian Twp., Talmadge, and Forest (T10R3). More effort was expended on surveys in this area during 1971 because of the increased budworm populations and increasing concern. Even more effort will be required to follow the development of this infestation in the future.

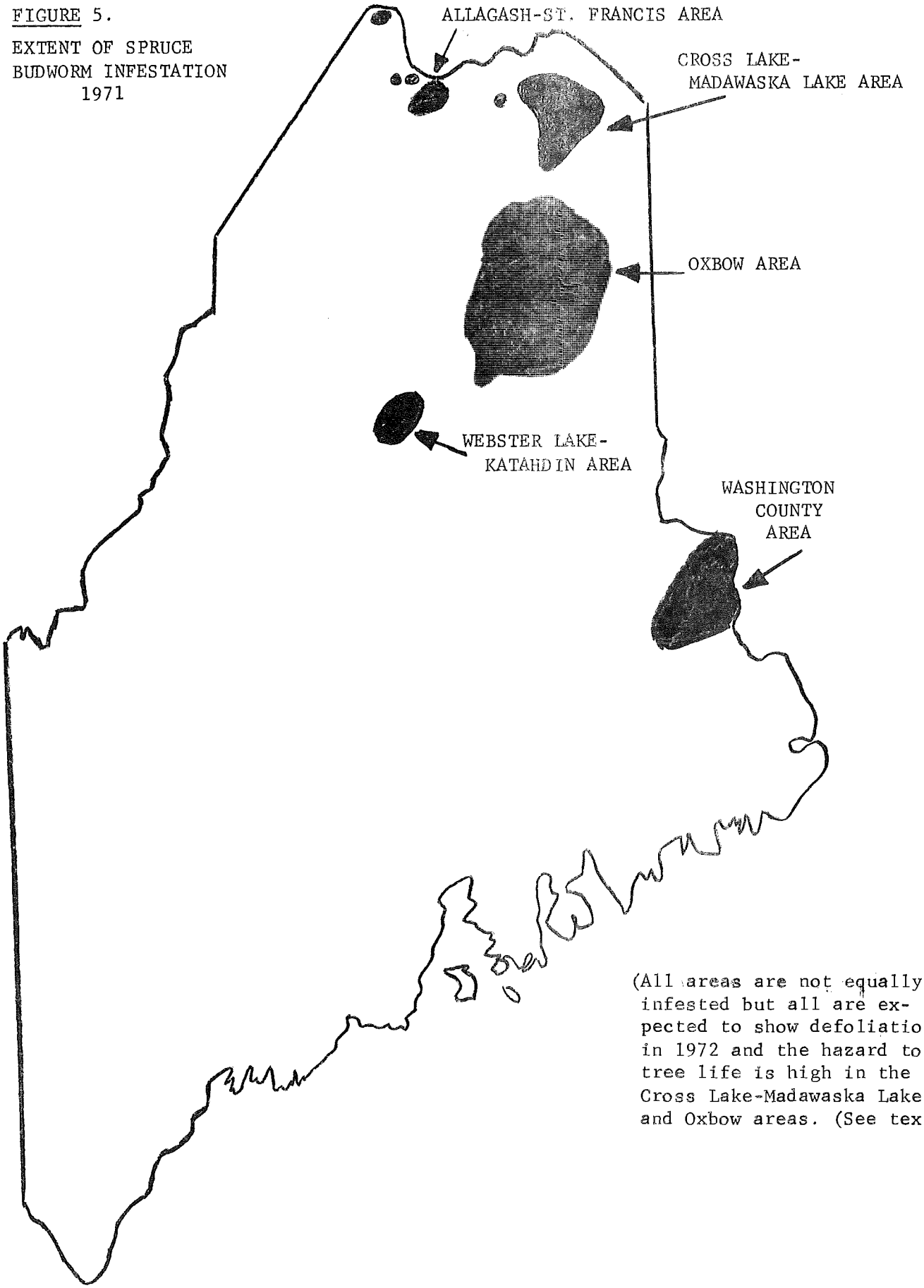
The various areas of concern are outlined in Figure 5.

6. EVALUATING THE THREAT

Studies here and elsewhere indicate that parasites and predators are probably important in endemic populations. However, in the present explosive rise of epidemic budworm populations they have been left far behind and are incapable of limiting the infestation. Nevertheless interest is high in the possibilities of biological control and more detailed studies of the spruce

FIGURE 5.

EXTENT OF SPRUCE BUDWORM INFESTATION 1971



(All areas are not equally infested but all are expected to show defoliation in 1972 and the hazard to tree life is high in the Cross Lake-Madawaska Lake and Oxbow areas. (See text.)

budworm parasite complex are being conducted by scientists of the University of Maine. Most of the efforts of the Maine Forestry Department laboratory at Cross Lake were in connection with this work during the 1971 larval stages of the budworm.

The accumulating tree damage is all too apparent to foresters and landowners. Large piles of pulpwood have already appeared along woods roads, out in fields, and along railway sidings. New roads are being pushed rapidly into affected areas. Many management plans are becoming obsolete as land managers are being forced to take second looks at what is happening to the land with which they are charged.

The better than three-fold increase in the egg mass numbers between the 1970 and 1971 surveys in the Oxbow and Cross Lake-Madawaska Lake areas suggests that 1972 damage will be three times as bad as 1971. Past history of such epidemic infestations suggests a further spread of the problem to new areas. Just as the St. Francis-Allagash and Webster Lake-Katahdin epicenters arose in unpredictable locations in 1971, new infestations surely await discovery in 1972. The rising infestation in eastern Washington County can reasonably be expected to become more serious especially in view of the infestation in adjacent New Brunswick.

The time is now past when Maine's budworm infestation could be restricted to limited areas. Yet, experience in 1970 in the Oxbow area of Maine and continuing demonstrations from adjacent Canadian provinces show that the widespread forest destruction historically associated with budworm epidemics can be prevented by currently available insecticides. Some have expressed optimism that the effect can be longer lasting or that budworm populations can be actually reduced. In view of the apparent lack of immediate climatic relief, ineffectiveness of natural enemies, inadaquacy of salvage efforts, and unavailability of alternatives, further insecticide control efforts, beginning with the most seriously affected trees seems to be the only acceptable option.

7. DELINEATION OF CONTROL AREAS

Technical limitations, economics, and policy dictate that insecticide treatments be limited to those areas where death of the affected trees is a real and imminent hazard. Insecticide control results are not satisfactory in light budworm populations but become increasingly better with higher budworm populations and when tree defoliation allows penetration of the insecticide throughout the forest canopy. The growing expense is another reason to keep control projects to the minimum size consistant with tree protection. It has long been the policy of the Maine Forestry Dept. to delay control efforts until extensive tree mortality is imminent in order to give natural agencies every chance to reduce the infestation and thus the need for treatment.

At the 314 locations sampled for egg masses in the Oxbow and Cross Lake-Madawaska Lake areas a "hazard index" was calculated. This index is simply a numerical value that can be assigned to each location and indicates the relative likelihood of tree mortality at that location.

The "hazard index" is based on four factors: 1. The egg masses found at that location, 2. The degree of current (1971) defoliation, 3. The degree of previous (cumulative) defoliation, and 4. The apparent chances for or against the sampled trees to survive (apparent vigor, bud condition, etc.). The first factor is determined from the results of the laboratory examination of foliage and the remaining three are results of judgement by the observer in the field at the time samples are collected. This person is in the best time and place to judge tree condition and is provided with a set of guidelines to aid in coming to a decision.

The availability of two department helicopters resulted in an opportunity to examine the forest closely from an ideal vantage point - just over the tree tops, and gave the observers unexcelled mobility. Supplementing and extending the observations made earlier by fixed wing aircraft, it was possible to sketch in areas where tree condition was so serious as to expect imminent mortality where trees were not already dead.

During egg mass survey each summer, sample collection locations, amount of observed defoliation, and number of egg masses found at each location are plotted with codes and symbols on a large wall map made up of U.S.G.S. topographic maps. Two transparent plastic overlays, one showing the hazard index for each location and one showing the results of the helicopter survey were superimposed on the egg mass survey base map. Areas of high hazard index and thus high liklihood of tree mortality were found to be confined to the Oxbow and Cross Lake-Madawaska Lake areas. Some 512,000 acres were included within the outer perimeter of these "high hazard" areas. Elimination of open areas and bodies of water bring the total area of most seriously threatened forest close to 500,000 acres. The high hazard areas are shown in Figure 6.

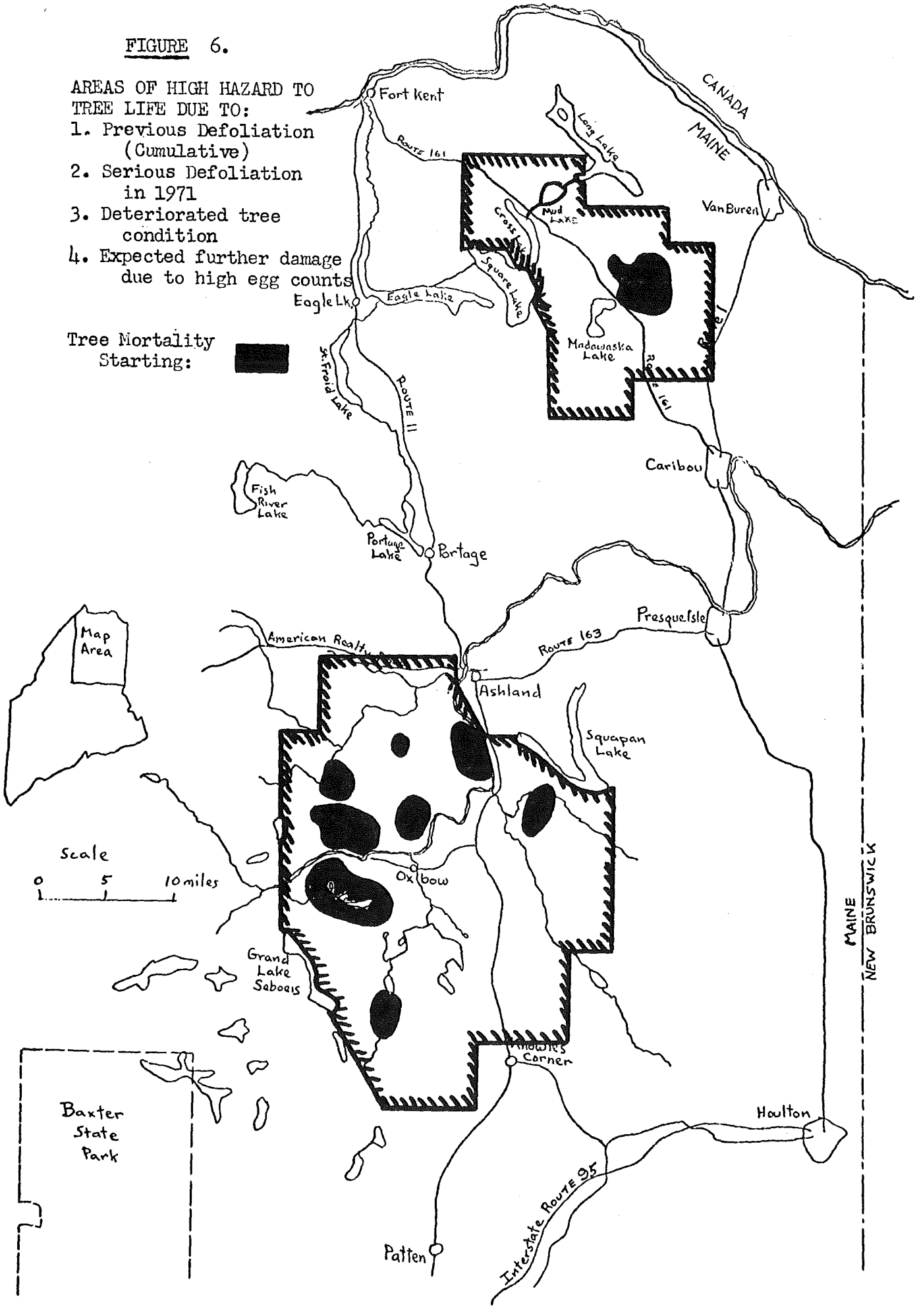
Although heavy spruce budworm populations are found over more extensive areas than delineated as above, and are found in the Allagash-St. Francis, Webster Lake-Katahdin, and Washington County areas (Figure 5.) the hazard to tree life in these areas is still low and they are not therefore included in any proposed control operations at this time.

8. PROPOSED 1972 CONTROL OPERATION

It is proposed to treat the 500,000 acres of "high hazard" in the Oxbow and Cross Lake-Madawaska Lake areas in 1972 with the insecticide "Zectran", applied as usual by air. Zectran is registered for use by the U. S. Government against the spruce budworm in the forest environment. Fenitrothion, as used operationally in Canada, is not registered. Other materials, including the biological agent Bacillus thuringiensis, are being proposed for testing but none have a proven operational capability for large scale control projects to protect trees and reduce spruce budworm populations. The need for action is immediate.

Although expensive, Zectran has a number of advantages. It is a carbamate insecticide tested by the manufacturer (Dow Chemical Co.) since about 1960 and by various federal and state agencies since 1965. It is considered less hazardous than the organophosphorus insecticides and far less persistent than the chlorinated hydrocarbons. Tests have shown that

FIGURE 6.


AREAS OF HIGH HAZARD TO TREE LIFE DUE TO:
1. Previous Defoliation (Cumulative)
2. Serious Defoliation in 1971
3. Deteriorated tree condition
4. Expected further damage due to high egg counts
Tree Mortality Starting:
Fort Kent
Long Lake
CANADA
MAINE
Route 161
Mud Lake
Cross Lake
Square Lake
Van Buren
Eagle Lk
Eagle Lake
Madawaska Lake
St. Froid Lake
Route 11
Caribou
Fish River Lake
Portage Lake
Portage
Presque Isle
Map Area
American Realty
Route 163
Ashland
Squapan Lake
Scale
0 5 10 miles
Oxbow
Grand Lake Seboeis
MAINE
NEW BRUNSWICK
Houlton
Baxter State Park
Patten
Interstate Route 95

Zectran breaks down rapidly, does not build up in food chains, and is probably one of the safest insecticides available for non-target species. At the low dosage planned for use, 2.4 ounces of actual material in one gallon of oil per acre, it is expected to have no effect on fish, birds, or mammals and minimal temporary effects on aquatic and other non-target insects.

Whenever a project of this sort is undertaken, the Maine Forestry Dept. has routinely contacted all residents in or near the spray area to look for "caution areas". These caution areas (to be avoided during spraying operations) include poultry and other animal farms (to avoid crowding and panic from low-flying aircraft), fish ponds, dairy farms, beehives, nature areas, organic gardens or any other possible problem.

Much time throughout the fall, winter, and spring has been taken by elaborate documentation of the problem to both state and federal agencies concerned with the environment. Although such projects have been closely monitored since the beginning, each year sees new restrictions and more elaborate checks and controls. It is anticipated that the 1972 project will be as close or more closely supervised than any previous project.

On the success of the 1972 control operations hangs the fate of very considerable areas of forest, now and in the future.

9. SUMMARY

1. The spruce budworm infestation expanded in both area and intensity during 1971 with the Oxbow and Cross Lake-Madawaska Lake areas hardest hit.

2. New "epicenters" of budworm infestation arose in the Allagash-St. Francis region and near Webster Lake, northwest of Mt. Katahdin. Light defoliation and scattered budworm populations previously noted in Washington County increased in area and intensity as another "epicenter" arose in this region.

3. Ground surveys, light traps, and other indicators reveal an explosive budworm situation for 1972.

4. A control operation over some 500,000 acres, using Zectran has been proposed for 1972 and preparations are underway.

10. CONDITIONS IN ADJACENT CANADIAN PROVINCES

QUEBEC[1].

Extensive ground and aerial surveys to evaluate the status of the spruce budworm, were carried out by the Laurentian Forest Research Centre and/or in cooperation with the Department of Lands and Forests, Quebec. The major infestation center is located in western Quebec. In 1971, this infestation increased to 12.9 million acres from 5 million acres recorded in 1970, encompassing the Dumoine, Noire, Coulonge, Gatineau, Lièvre, and Rouge watersheds and extending north beyond the Transcontinental Railway. In June 1971, 2 million acres were sprayed with the insecticide Fenitrothion to preserve the foliage and prevent mortality of balsam fir stands. Results were not as good as expected.

Aerial surveys of western Quebec in July, helped to delimit new centers of infestation. Two centers were found northwest of the main Dumoine-Gatineau area of infestation. To the north other small patches of light defoliation were found. To the southeast small to large patches of light to moderate infestation were found in the vicinity of Mont Tremblant, Terrebonne County.

Egg mass counts were rated as severe in 84% of the localities sampled forecasting a severe defoliation in the area in 1972. Reductions were however recorded in both sprayed and nearby unsprayed areas probably due to insecticide action. A decline in the number of eggs has also been noticed in unsprayed areas adjacent to the Ottawa River but the cause is not known. In new centers, away from the main infestation area, egg sampling was less intense, and populations varied between the localities. On the basis of ground and aerial defoliation surveys made in July and August approximately 3.7 million acres are considered as high hazard areas that is having suffered 2 years and more of severe defoliation, with a severe defoliation forecasted for 1972. In meetings held with provincial forest authorities it was decided that in western Quebec spraying operations should be undertaken only in high hazard areas.

In central Quebec, 21,000 acres of light to severe defoliation was observed again in 1971 in the previously known St. Maurice River infestation near Grand'Mère. Elsewhere in this region budworm populations are not cause of much concern at present although several new infestation areas were discovered. The small patches of light to moderate infestation recorded last year near Murray Bay were again active. Egg counts were high in 20% of the localities sampled in central Quebec.

In eastern Quebec, infestation areas of some importance were found only in Temiscouata County. The total infestation area increased more than 10 times, from 42,500 acres in 1970 to 470,000 in 1971. In an attempt to stop the infestation from spreading further, the area was sprayed in June 1971. The operation was not too successful but the population was lowered. The whole of Temiscouata Lake watershed, the area east

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1. Information from René Martineau, Forest Insect and Disease Survey. Laurentian Forest Research Centre, Ste. Foy, Quebec.

of that watershed up to New Brunswick boundary, the major part of Saint-Francois watershed and the upper portion of Trois-Pistoles watershed are now encompassed by the budworm outbreak. As yet, only light damage has been observed in the majority of the outbreak area but ground observations show sparsely distributed areas of up to 2 years of severe defoliation. Five major patches are well known, that is, north of Pohenegamook Lake, southwest of Cabano, along the road from Dégelis to Sinclair, east of Squatec Lake, and in areas adjacent to the New Brunswick boundary on the eastern side of Madawaska River. Fifteen percent of the localities sampled for eggs in eastern Quebec fell in the moderate to severe group and they were all in Temiscouata Valley. The trees being in good condition, no control operation is contemplated in the area in 1972.

MARITIMES[2].

In NEW BRUNSWICK, an aerial survey conducted by personnel of Forest Protection Limited and the Forest Insect and Disease Survey showed that defoliation (loss of new needles and shoots of balsam fir and spruce) was light over 1,047,000 acres, moderate over 1,945,300 acres and severe over 1,568,000 acres for a total of 4,560,900 acres. This represents an increase of 1,152,600 acres of all categories of defoliation over 1970. The two largest areas of severe defoliation were in north-central New Brunswick, 126,000 acres near Heath Steele Mines in Northumberland County, and 400,000 acres extending from McGraw Brook, Northumberland County in the east to Plaster Rock, Victoria County in the west. Severe defoliation was evident in smaller patches throughout the remainder of central and southern New Brunswick, particularly in the counties of Kent, Westmorland, Albert, Queen's, Charlotte, Sunbury, York, and Carleton. Small patches of defoliation were detected in Restigouche County for the first time in recent years. The infestation in Madawaska County, reported in 1970, continued, and that in Charlotte County increased in size and intensity.

Counts of egg masses at 1,100 locations in New Brunswick showed that the total area of infestation is 14.8 million acres, an increase of 2.0 million acres over 1970. Of this, 9.0 million acres were classified as high, 0.9 million acres medium and 4.9 million acres low. Except for one small patch just north of Edmundston, the areas of high infestation are south of a line between Jacquet River and Grand Falls. This increase continues the trend of the past 4 years. However, the area of high infestation in 1971 has a lower average population density than in 1970, and the areas of extreme infestation (400 + egg masses/100 ft^2 of foliage), are decidedly smaller. A 7.5-fold increase in egg densities was detected in Victoria, Madawaska, and Restigouche counties. Egg-mass infestations increased in intensity over 1970 in all other segments of the Province except the east coast area where populations decreased slightly. The largest areas of extreme egg mass populations (400 + egg masses/100 ft^2 of foliage) occurred:

1. in a wide band from Bathurst in the east to Grand Falls in the west - 1.3 million acres:

2. in the McGivney, Stanley, and Durham Bridge area - 115,000 acres:

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2. Information from Dr. R.S. Forbes and Mr. G.V. Moran, Maritimes Forest Research Centre, Fredericton, N.B.

3. south of Fredericton to the Bay of Funday and east to the St. John River - 937,000 acres.

4. the Kingston Peninsula and Stewarton area - 188,000 acres:

5. from Coles Island southeast to the Peticodiac River and Bay of Fundy - 889,000 acres:

6. from the north end of Grand Lake northeast to the Cains river - 250,000 acres.

7. in a band along the east coast from Dorchester, north to Chatham - 789,000 acres.

In NOVA SCOTIA, an aerial survey conducted by the Forest Insect and Disease Survey and the Nova Scotia Department of Lands and Forests delineated 398,400 acres of severe, 51,700 acres of moderate, and 112,600 acres of light defoliation. This defoliation was patchy because of the discontinuous nature of the forest. The main areas of severe defoliation were in western Cumberland County extending from Joggins in the north to Cape D' or in the southwest (110,600 acres), and on the North and South Mountains of Kings and Annapolis counties (287,800 acres). This represents a significant increase in damage over 1970. Elsewhere in Nova Scotia, no major increase in defoliation was noted.

Counts of egg masses at 30 locations, and of overwintering larvae at 178 locations showed that high infestations were more widespread than in 1970 in Cumberland, Kings, and Annapolis counties, and that medium to high infestations occurred in the northern quarter of Lunenburg County and at scattered locations in Digby, Shelburne, Queens, Hants, Colchester, Pictou, Antigonish, Inverness, and Victoria counties. Elsewhere, counts were low but they were significantly higher than in 1970. This upward trend is in keeping with the overall increase in budworm populations in northeastern North America. The average count of overwintering larvae for Nova Scotia in 1971 is 168 for 100 ft^2 of foliage as compared to 120 in 1970. Further, the average counts in Cumberland, Kings, and Annapolis counties are 946, 574, and 374 larvae per 100 ft^2 of foliage, respectively. Accordingly, moderate to severe defoliation is expected in many fir and spruce stands in these counties in 1972.

In PRINCE EDWARD ISLAND, defoliation was moderate to severe in patches in Prince County and trace to moderate at a few locations in Queens and Kings counties, representing a significant increase in infestation intensity from 1970. Counts of overwintering larvae at 44 locations showed a two-fold increase over 1970. The counts per 100 ft^2 of fir foliage for Prince, Queens, and Kings counties averaged 629, 377, and 312 compared to 470, 157, and 103 in 1970. This indicates that defoliation in 1972 will be generally severe in Prince County and moderate to severe in patches in Queens and Kings counties.