SPRUCE BUDWORM IN MAINE

Results of The 1982 Project, Biological Conditions in 1982

and

Expected Infestation Conditions for

1983

Entomology Division
Technical Report No. 19
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

SPRUCE BUDWORM IN MAINE: RESULTS OF THE 1982 PROJECT, BIOLOGICAL CONDITIONS IN 1982 AND EXPECTED INFESTATION CONDITIONS FOR 1983

I. INTRODUCTION

This report is a presentation of data gathered by the Budworm Survey and Assessment Unit (BSAU) of the Maine Forest Service (MFS). The BSAU annually conducts surveys of egg mass deposit, host tree condition, and overwintering larval population (L-II). The budworm unit cooperates with others in the MFS Entomology Division on surveys of budworm damaged trees. Complete 1982 results of these annual surveys are contained in this report.

In addition to annual surveys, this Unit determines proper timing of spray projects and evaluates the results of operational treatments and various operational-scale tests of insecticides and alternative spray regimes. Results of the 1982 operational evaluation are presented in this report and a summary of 1982 testing is provided.

A. Personnel Organization

During the 1982 spray project, the BSAU was assigned 59 project funded employees in addition to the year-round staff of thirteen. This large summer staff, totaling 72, was necessary because of the complicated nature of the 1982 project. The summer organization of the BSAU is shown on Figure 1.

The fall and winter staffing of the BSAU was somewhat reduced in 1982 compared to 1981 (Figure 2). The permanent staff of thirteen (13) was maintained, but fewer seasonal employees were needed for reduced egg mass and the fall-winter L-II surveys. These reductions were possible because of more precise evaluation of sampling needs in specific areas. Care was taken not to oversample areas where additional data would not add to final treatment decisions.

B. Survey Zones

Survey zones have been defined throughout the budworm infestation area to facilitate analysis and data presentation. These zones were established on the basis of similar infestation conditions and topography. Zones are shown in Figure 3 and described in Table 1.

FIGURE 1. MAINE FOREST SERVICE BUDWORM SURVEY AND ASSESSMENT UNIT SUMMER PROJECT ORGANIZATION

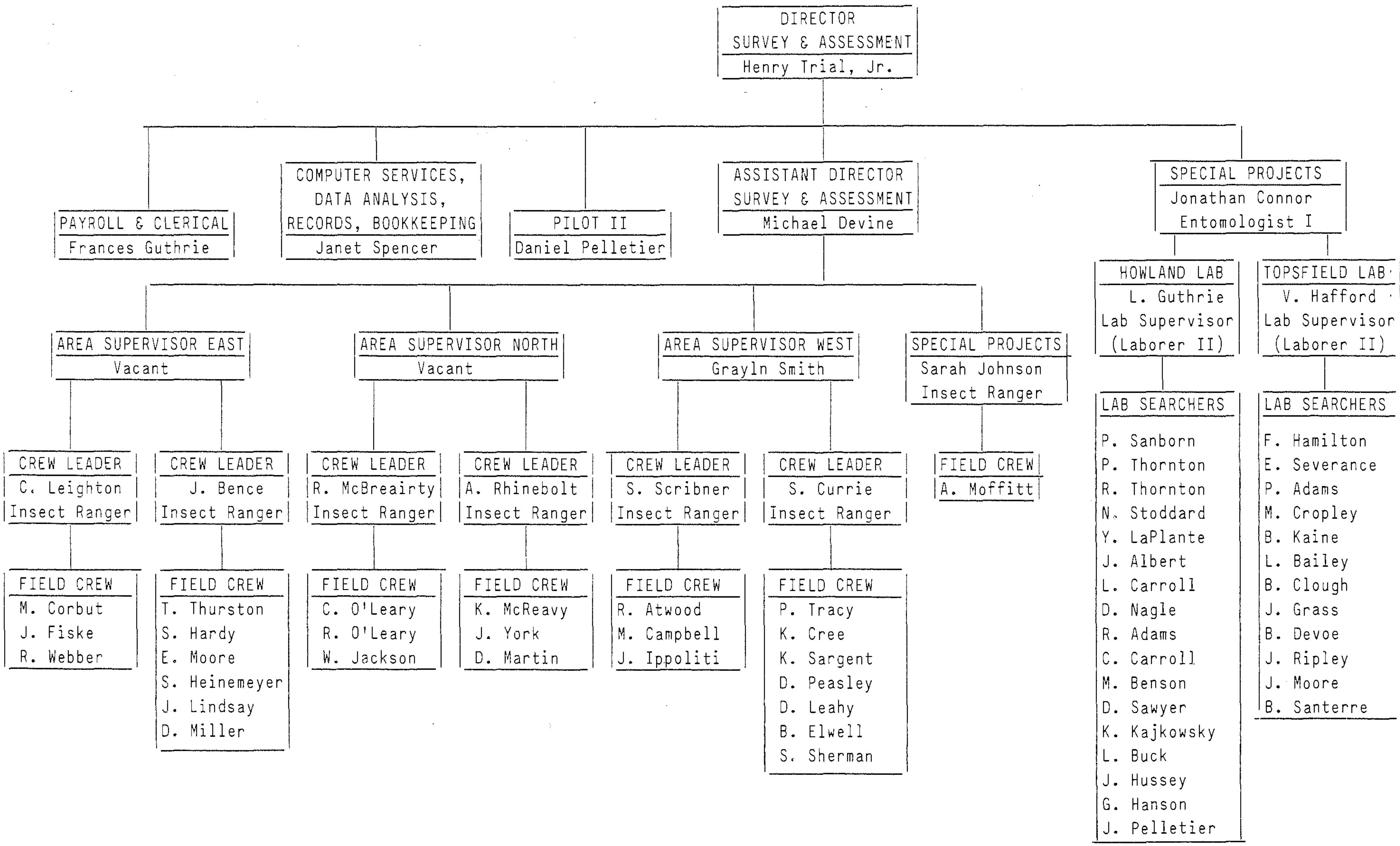


FIGURE 2.
MAINE FOREST SERVICE BUDWORM SURVEY & ASSESSMENT UNIT WINTER ORGANIZATION

- **DIRECTOR SURVEY & ASSESSMENT** — Henry Trial, Jr.
  - **COMPUTER SERVICES, DATA ANALYSIS, RECORDS & CLERICAL** — Janet Spencer
  - **ASSISTANT DIRECTOR SURVEY & ASSESSMENT** — Michael Devine
    - **PAYROLL, BOOKKEEPING RECORDS & CLERICAL** — Frances Guthrie
    - **STAFF ASSISTANT & SPECIAL PROJECTS** — Jonathan Connor
    - **FIELD ASSESSMENT**
      - Rex McBreairty
      - Grayln Smith
      - Christine Leighton
      - Stephen Currie
      - James Bence
      - F. Michael Skinner
    - **WINTER 1982-83 LABORATORY ASSESSMENT NOVEMBER - MARCH**
      - Everett Cram
      - Bonnie Milligan
      - Michael Ricci
      - Joseph Pelletier
  - **PILOT II** — Daniel Pelletier

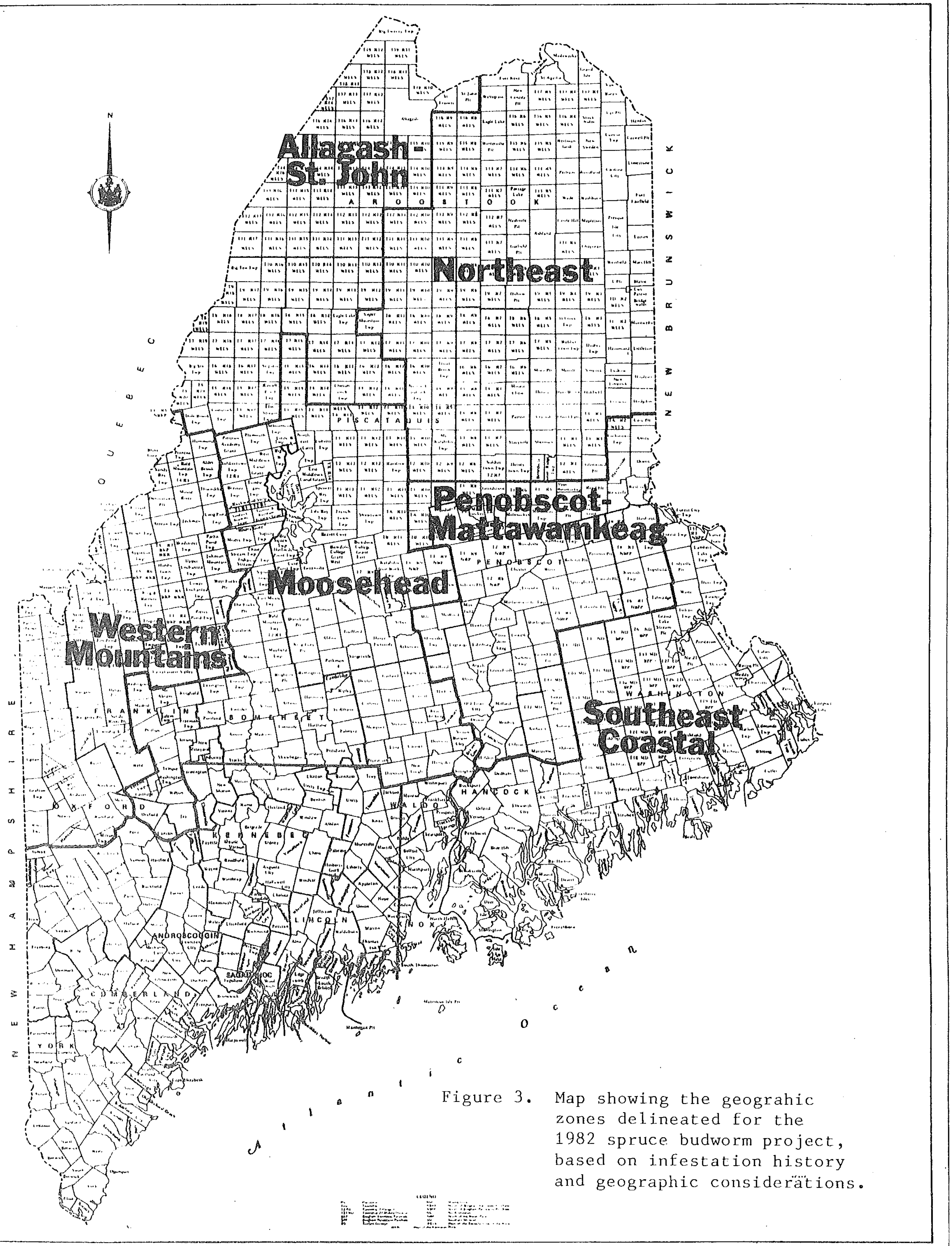


Figure 3. Map showing the geograhic zones delineated for the 1982 spruce budworm project, based on infestation history and geographic considerations.

TABLE 1. SPRUCE BUDWORM SURVEY ZONES

ZONE	GEOGRAPHIC	FOREST TYPE
Allagash-St. John Zone	Mostly flat with some rolling hills, two major river valleys, hilly in extreme north	Predominantly contiguous spruce-fir
Northeast Zone	Several hilly areas with two major river valleys	Few large areas of contiguous spruce-fir forest, predominantly mix wood areas, much cleared agricultural land
Penobscot-Mattawamkeag Zone	Most of the area low, flat, wetland	Flat wet areas heavy to soft-wood, ridges mostly hardwood
Southeast Coastal Zone	Mostly coastal influence, shallow rocky soil	Mixed softwood and scrub hard-wood; softwood, heavy to spruce with pockets of fir
Moosehead Zone	Softwood flats in the northern section of the zone; southern protion has many high mountains and rolling hills	Spruce-fir flats in north; mixed wood and hardwood in the south
Western Mountains Zone	Very hilly with several mountain ranges	Fir in the valleys with hardwood and spruce in the high areas, susceptible type broken into relatively small sections

II. BIOLOGICAL CONDITIONS IN 1982

The impact of budworm in a given season is highly dependent on a number of biological factors including health of the budworm population, host condition, and budworm parasitism. These factors are assessed or observed annually to provide a better understanding of feeding severity and host response.

A. Budworm Health in 1982

The 1982 season was generally favorable to budworm development and survival. Effective spray projects in the last several seasons and low 1981 populations in the southwest and central areas provided ample high quality food for the budworm. Also, the 1982 season was very dry and warm throughout much of the early instar period. Larvae seemed normal and vigorous throughout the State.

Favorable development conditions were reflected in higher than normal survival of budworm in many untreated areas.

In the northern third of Maine, survival in untreated check areas was a very unusual 30 to 60% on fir and an equally unusual 20 to 50% on spruce. This high larval survival caused increases in predicted population levels for the north. In the southwest, where increases in population are also predicted for 1982, survival rates ranged from 30 to 50% on fir and 10 to 30% on spruce. These rates, like in the north, are much higher than normal. High quality foliage was abundant in both areas.

The lowest survival rates for Maine in 1982, occurred in the southcentral and southeastern areas, with 10 to 30% on fir, 7 to 25% on spruce, and 10 to 15% on hemlock. These rates are considered normal when compared to those of recent years. Lower survival in the southeast area may be due to poor tree condition. Tree condition in the southcentral area is not generally critical, but populations in the area have been decreasing since 1980.

Another factor leading to good budworm survival in 1982 was a high occurrence of staminate flowers. Pollen from these flowers provide high quality food and sheltered feeding sites for early instar larvae.

B. Pre-Treatment Host Conditions in 1982

The condition of fir and spruce in the infested areas was noted prior to the 1982 spray operation. The general conditions by zone were as follows:

Allagash-St. John -- Much of the spruce-fir type in this zone has been continuously and effectively treated since 1978. As a result of this agressive intervention, much of the spray area in the zone has more than half it's normal foliage level for the last three seasons and trees are in fair or good condition. New areas added to the protection zone in 1982 were generally not protected in recent years and are in serious condition. Because the zone has been under continued budworm attack since 1978, trees in unsprayed areas or buffer zones are in critical condition or are dead.

During the winter of 1982 a sharp increase in spruce mortality in unsprayed areas became apparent. Spruce in the sprayed area is proceeding on a slow recovery from severe 1978 conditions.

Northeast -- Stand condition deterioriated in unsprayed portions of the northeast in 1981, however, most stands remain in fair condition. Exceptions occur in the western portion of the zone and in the far northeast where stands are in more serious condition. Most sprayed areas in the northeast are in fair or good condition.

Moosehead -- Defoliation was relatively light in most of this zone in 1981 and because of this, most stands were improved. However, most areas remained in fair condition or worse, because of past damage.

Western Mountains -- Low 1981 population resulted in low defoliation in this zone and thus improved tree condition. Heavy fir mortality is common in this zone, while most spruce is still alive. Even with good 1981 foliage, most surviving stands were only in fair condition or worse.

Penobscot-Mattawamkeag -- Little treatment has been done in this zone since 1978. Host type in this zone is not contiguous and stand condition is highly variable. Most host type was in fair or poor condition in 1981, and many stands have considerable tree mortality. Some stands in the zone have begun to recover. Small portions of this zone in the north were treated in 1981 and condition has improved somewhat.

Southeast Coastal -- The southeast portion of this zone represents some of the worst tree conditions in Maine. Much of the fir in this part of the zone died years ago. Hemlock is dying at a rapid rate, and spruce is in poor condition. Tree condition in the remainder of the zone is deteriorating rapidly and most stands are now in critical condition. Areas sprayed in 1981 in this zone improved markedly and some areas reached fair condition. Spruce is dying at a rapid rate in unprotected parts of this zone.

C. Parasitism Survey

For the fifth consecutive season, twelve plots (Figure 4) of five balsam fir trees were sampled to assess parasitism levels throughout the spruce-fir region of Maine. Relocation of the plots has been kept to a minimum over the last five years to provide a consistent basis for year-to-year comparisons of population trends. As in previous years, the spruce budworm populations were sampled at the peak 4 th instar, 6 th instar and pupation to assess levels of various parasites. Parasites were monitored in the egg stage of budworm development as part of the annual egg mass survey with the results reported elsewhere in this publication.

The 4 th instar budworm are dissected in water to determine levels of *Apanteles* sp. and *Glypta* sp.. The remaining collections are reared in shell vials to allow identification of adult parasites.

While the levels of parasitism have varied at a given point from year-to-year, the statewide mean seems to be fairly consistent for the last three years:

Year	$\bar{X}$ Statewide	Range
1982	33.8%	20.5 - 63.8
1981	31.4%	16.1 - 43.2
1980	33.6%	17.1 - 59.0

There is some question of the accuracy of the plots in Eustis and Shirley townships due to low populations of budworm which resulted in a small sample size. *Apanteles* sp. and *Glypta fumiferanae* were at levels of the last two years. The population level of *Meteorus* has been recorded from the 6 th instar collection, however, this year the pupal collection contained a much higher number of this species and these numbers were used. The results of all species collected appear in Table 2.

F.I.S. collections yielded very few budworm parasites which is a result of reductions in the number of scheduled collections on spruce and fir.

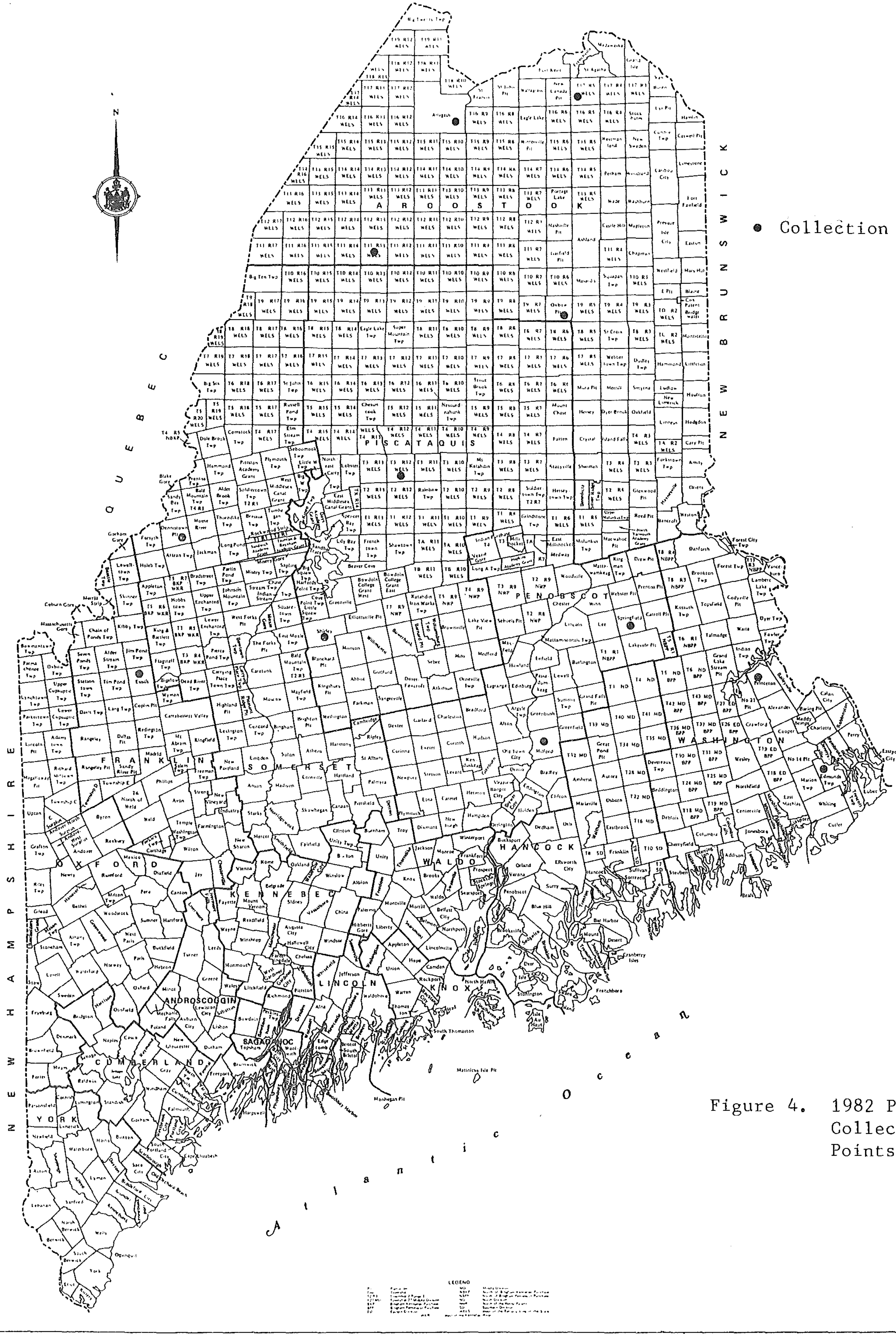


Figure 4. 1982 Parasite Collection Points.

Table 2 .
1982 Parasitism of Spruce Budworm (% by Species)

Location	*Apanteles*	*Glypta*	*Lypha*	*Meteorus*	*Omotoma*	*Phaeogenes*	*Itoplectis*	*Ephialtes*	Misc.	Total %[1] Mortality
Allagash Plt.	9.5	3.2	5.7	6.5	2.6	1.3	1.3	0.0	2.6	32.6
T11 R13	6.6	5.9	2.4	0.0	3.2	2.4	0.0	0.0	0.8	21.4
T17 R5	10.1	1.2	6.8	0.0	0.0	6.0	2.6	0.0	1.7	28.4
Oxbow Plt.	8.6	2.8	18.8	0.0	0.0	4.0	0.0	0.0	0.0	34.2
Edmunds	4.9	3.2	6.3	2.6	5.3	1.3	2.0	0.0	0.0	25.6
Springfield	3.2	1.6	7.6	6.6	4.6	1.0	4.6	0.5	0.5	30.3
Princeton	10.5	3.5	9.0	3.5	4.1	2.3	0.6	0.0	0.6	34.1
Bradley	5.1	7.4	9.1	1.9	1.9	5.8	0.0	0.0	1.0	32.2
T3 R12	6.4	2.8	13.4	9.7	0.0	0.0	0.0	0.0	0.0	32.3
Dennistown Plt.	3.1	1.9	4.1	6.5	0.0	1.6	1.6	0.0	1.6	20.5
Shirley[2]	15.8	0.0	26.3	14.5	0.0	7.2	0.0	0.0	0.0	63.8
Eustis[2]	5.7	0.0	10.9	33.4	0.0	0.0	0.0	0.0	0.0	50.0

[1]Parasitism rates allow only for previous losses to parasites and disregard other natural mortality factors.

[2]Results may not reflect true parasitism levels due to low budworm populations in these areas.

III. BIOLOGICAL ASPECTS OF THE 1982 SUPPRESSION PROJECT

ASSESSMENT OF THE 1982 SPRAY PROJECT AND EFFICACY EVALUATIONS OF INSECTICIDE VARIATIONS TESTED

The Budworm Survey and Assessment Unit timed and evaluated the 1982 spray project and conducted efficacy tests on numerous insecticides and treatment variations. Project activities included block timing and release and prespray population evaluations. Pre and post spray sampling provided data to evaluate general project success in terms of adjusted and unadjusted larval mortality and defoliation.

Several insecticides, formulations, and timing variations were evaluated intensively in 1982. These evaluations included experimental design, area setup, timing, and spray deposit assessment. Assessment areas were sampled several times in order to produce population reduction and defoliation curves. Unadjusted mortality, adjusted mortality, survival numbers, defoliation and foliage saved were also calculated in test areas.

A. Treatment Area

The 822,790 acre treatment area for 1982 was spread throughout the northern two thirds of the State (Figure 5). Most blocks in the Northwest and southeast were treated with a split application of Sevin-4-Oil. Single applications of Sevin were generally used in the west central area and the northeast. Sevin FR was used in the northeast. Orthene was used in the southeast and southwest. Bt was used on the southern and eastern fringes of the spray area in areas of human habitation.

B. Application Variations and Timing

Many application variations were used in 1982 (Table 3). Most split Sevin applications were timed for spruce protection with the first application in the late third instar and the second application as late as operationally possible in the fifth and sixth instars. This strategy also protects fir and hemlock. Two small split Sevin blocks had both applications sprayed before the peak of the fourth instar. All Orthene blocks were treated at the same rate, but timing varied from early applications before most insects entered the spruce buds to late applications in the fifth and sixth instars. Most Bt was applied in the fifth and early sixth instars to protect both fir and spruce.

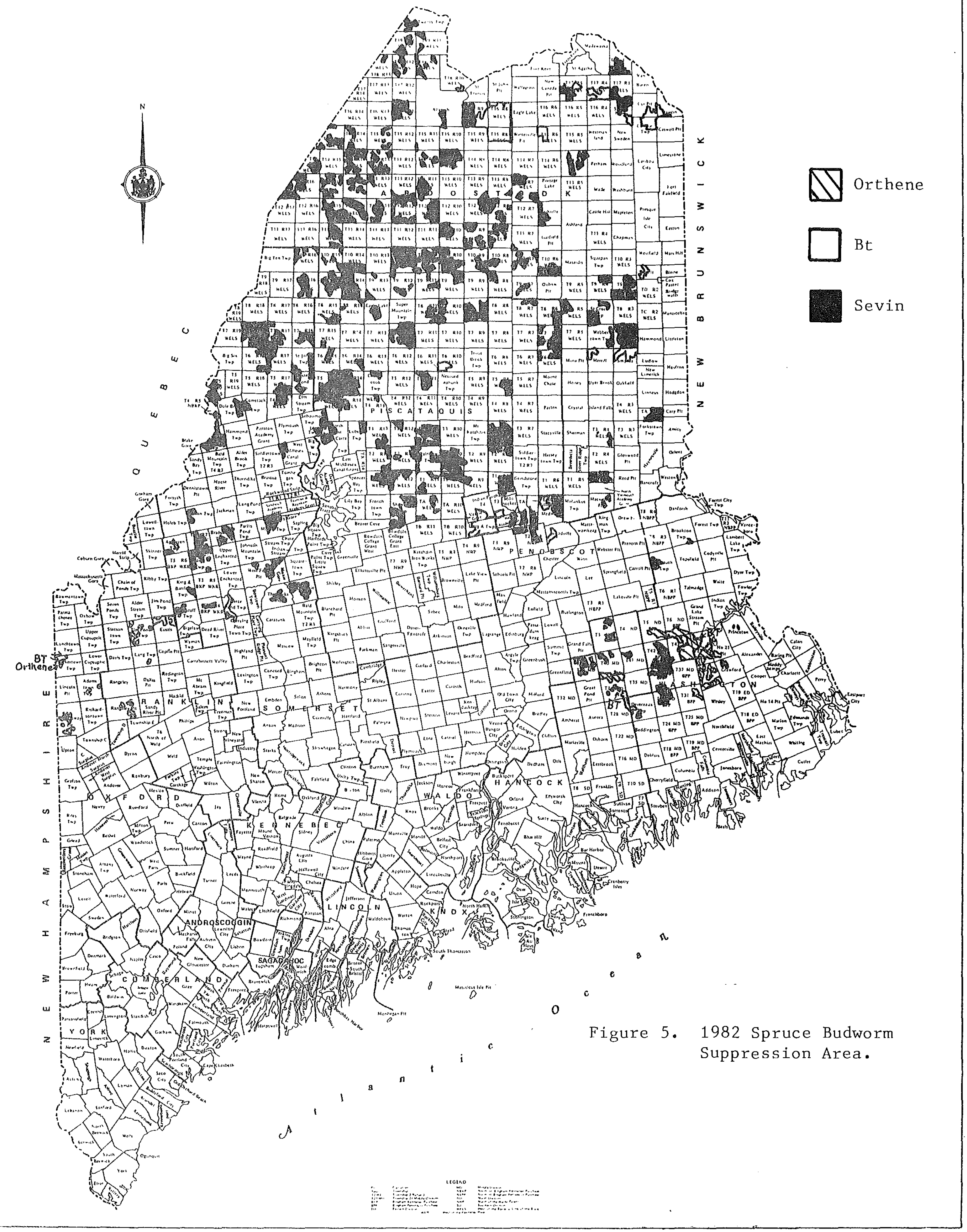


Figure 5. 1982 Spruce Budworm Suppression Area.

TABLE 3. TREATMENT VARIATIONS EVALUATED IN THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT INCLUDING PLANNED TREATMENT TIMING

INSECTICIDE	RATE ACTIVE INGREDIENT (Lbs.)	FINAL SPRAY VOLUME OZ.	AIRCRAFT	NUMBER OF APPLICATIONS	HOST*	Timing**
Sevin-4-Oil	0.46	30 oz.	C-54 Thrush Helicopter	2	1,2 4,5	1,2
	0.375	24 oz.	C-54 Thrush Helicopter	2	1,2 4,5	1
	0.75	30 oz.	C-54 Thrush Helicopter	1	1,3	3
Sevin FR	0.375	24 oz.	Thrush	2	1,3	1
	0.75	30 oz.	Thrush	1	1,3	3
Orthene	0.50	64 oz.	Helicopter	1	2	4
	0.50	64 oz.	Helicopter	1	2,4,5	3
Dipel 4L (Bt)	12 BIU	120 oz.	Helicopter	1	1,2,4	3
	12 BIU	96 oz.	Helicopter Thrush/Micronair	1	1,2,4	3
Thuricide 32LV	12 BIU	96 oz.	Helicopter Thrush/Micronair	1	1,2,4	3
***Thuricide 24B	12 BIU	96 oz.	Heli./Thrush	1	1,2,4,	3
Bactospiene	12 BIU	96 oz.	Helicopter	1	1,2,4	3

*Hosts: 1=Fir, 2=Spruce, 3=Fir priority and Spruce, 4=Spruce priority and Fir, 5=Fir, Spruce and Hemlock.

**Timing:

1. 1st application before larvae enter Spruce buds; 2nd application late 5th or early 6th instars.
2. Both applications before larvae enter Spruce buds.
3. Peak 4th instar and bud index near 4.
4. Before larvae enter Spruce buds.

*** Not evaluated in this report.

A comparison of Bt products (Dipel 4L and Thuricide 32 LV) was made in the Millinocket area. Also, Bt deposit and efficacy was compared for Helicopter vs. Micronair equipped Thrush aircraft. All Bt was applied at the 12 BIU rate at either 96 or 120 oz. finished volume per acre.

C. Larval Development

Synchronization of spray application with budworm development is necessary for the most effective results. Treatment should be applied as early in the season as possible to minimize defoliation, but not before the young larvae are exposed. Since changes in budworm feeding behavior occur concurrently with changes in larval instar, determination of the percentages of budworm in each instar can be used to plot their susceptibility to contact spray. In addition to insect development, an adequate spray target provided by the expansion of foliage is necessary. Bud and shoot development is also monitored and used in conjunction with insect development data.

Prior to the beginning of the budworm control project, permanent larval and shoot development sample plots were established adjacent to spray areas (Figure 6). Within these plots, dominant and codominant fir trees were periodically sampled to obtain foliage from the upper midcrown. A shoot expansion index was recorded for each of fifty shoots. Foliage was then taken to one of the field laboratories where it was searched for budworm larvae. These larvae were examined to determine percentage of insects in each instar. A development index curve was derived and plotted using a method developed in Quebec (Dorais, personal communication). Foliage flare was expressed as an index (Auger, personal communication) and plotted on the same graph as the larval index.

In addition to the permanent development plots, as the target stages approached, other samples were taken using the same method to check larval development at various locations within spray blocks. Desired timing for spray applications are shown in Table 3.

Conditions in 1982 were very unusual and changed frequently. Normal favorable conditions consist of a shoot index which is higher than the larval index. Generally, the more advanced shoot growth relative to larval development, the greater the chance for spray success. Luckily, the end result in 1982 was favorable spray conditions in early June and a favorable insect to host relationship during the spray period in most areas.

At the beginning of the 1982 season, bud development was slower than normal and insect development was well ahead. By the late third instar, bud development surged and soon was advanced compared to normal insect development. This change occurred because a cool, dry period apparently favored shoot development and retarded insect

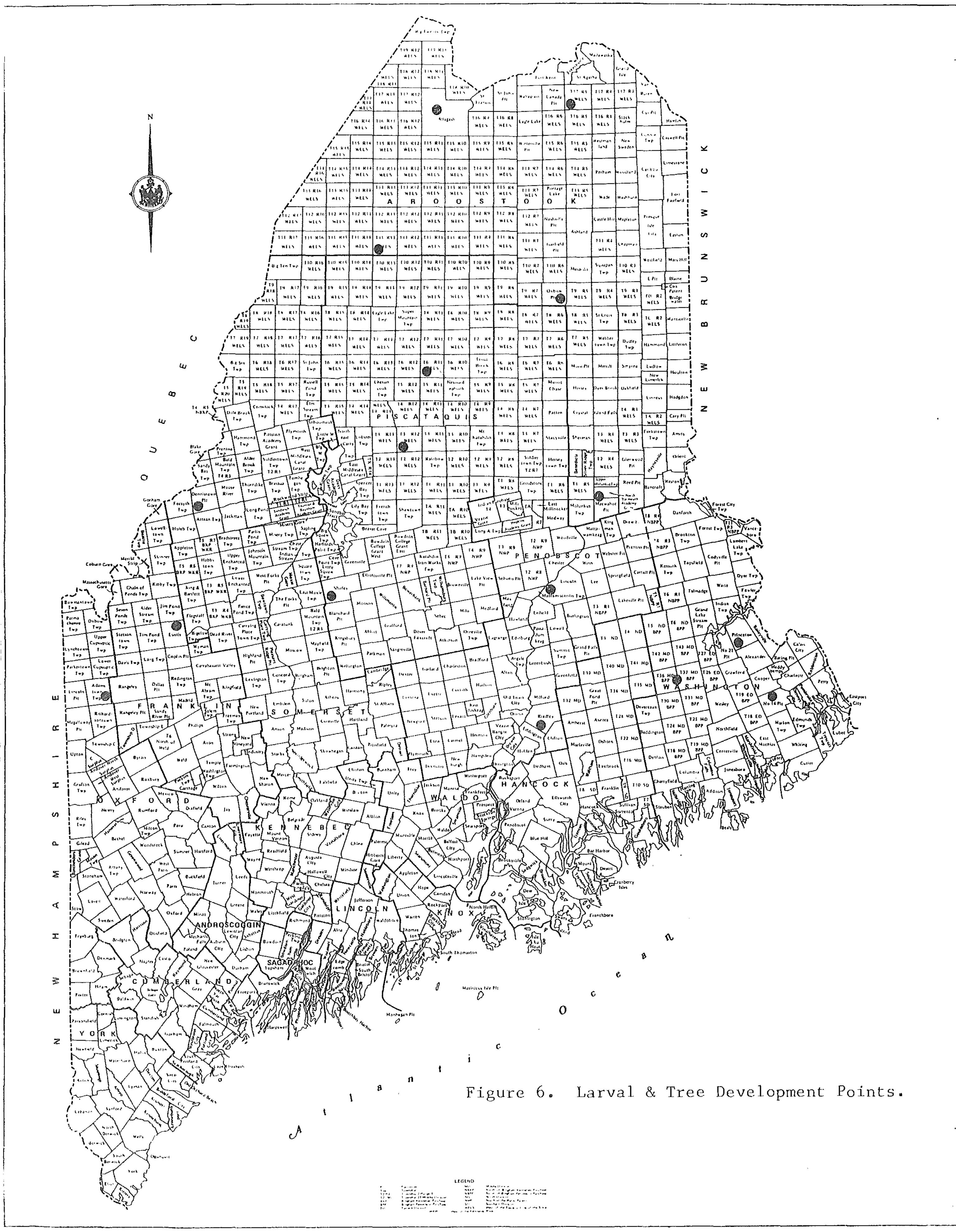


Figure 6. Larval & Tree Development Points.

development. During the middle instars, a very warm period began in northern Maine while the south remained cool.

High temperatures in the north resulted in very rapid development of insects and buds. By early June, development in the north was ahead of development in the southeast. The rapid advance in development in the north caused increased host damage, but ideal spray weather allowed rapid completion of the project thus holding defoliation to acceptable limits. Prespray damage in the north was greater than any other area, nevertheless prespray defoliation levels were acceptable. Most blocks were sprayed near the desired release date.

When an overall comparison is made between 1982 conditions and those seen in the prior three seasons, 1982 was probably the least favorable in terms of larval vs. foliage development in some cases.

The complexity of the 1982 operation extended to timing and block release. Many more spot developments were required than in the past because each application regime required different timing. For example, seven different timing assessments were required in one small cluster of spray blocks.

Another complicating factor was that spruce timing was based on behavior (feeding behavior and exposure of the insect) rather than on instar or shoot development. This type of timing required on-site inspection by a trained Entomologist.

D. Prespray Population Levels

Population levels in all spray areas were evaluated prior to spraying (Figure 7). These evaluations allow for deletion of low population areas and for finalization of block release timing based on spring populations.

Major features of the 1982 survey were very high populations (30 to 60 larvae per 18" branch) in the northwest and southeast and low (less than 10 larvae per 18" branch) populations in the central and southern portions of western Maine. Population levels in all these areas were comparable to 1981 levels. Populations in most other spray areas varied from 10 to 25 larvae.

As a direct result of the 1982 prespray evaluations, 12 blocks containing 31,028 acres in west central Maine and southern Aroostook were dropped from the project. These blocks were all found to have low populations. Prespray counts also caused adjustments in spray timing in Washington County and in western Maine. High counts in Washington County resulted in early release of some blocks to prevent damage. In the west, low counts delayed release to allow further shoot and insect development.

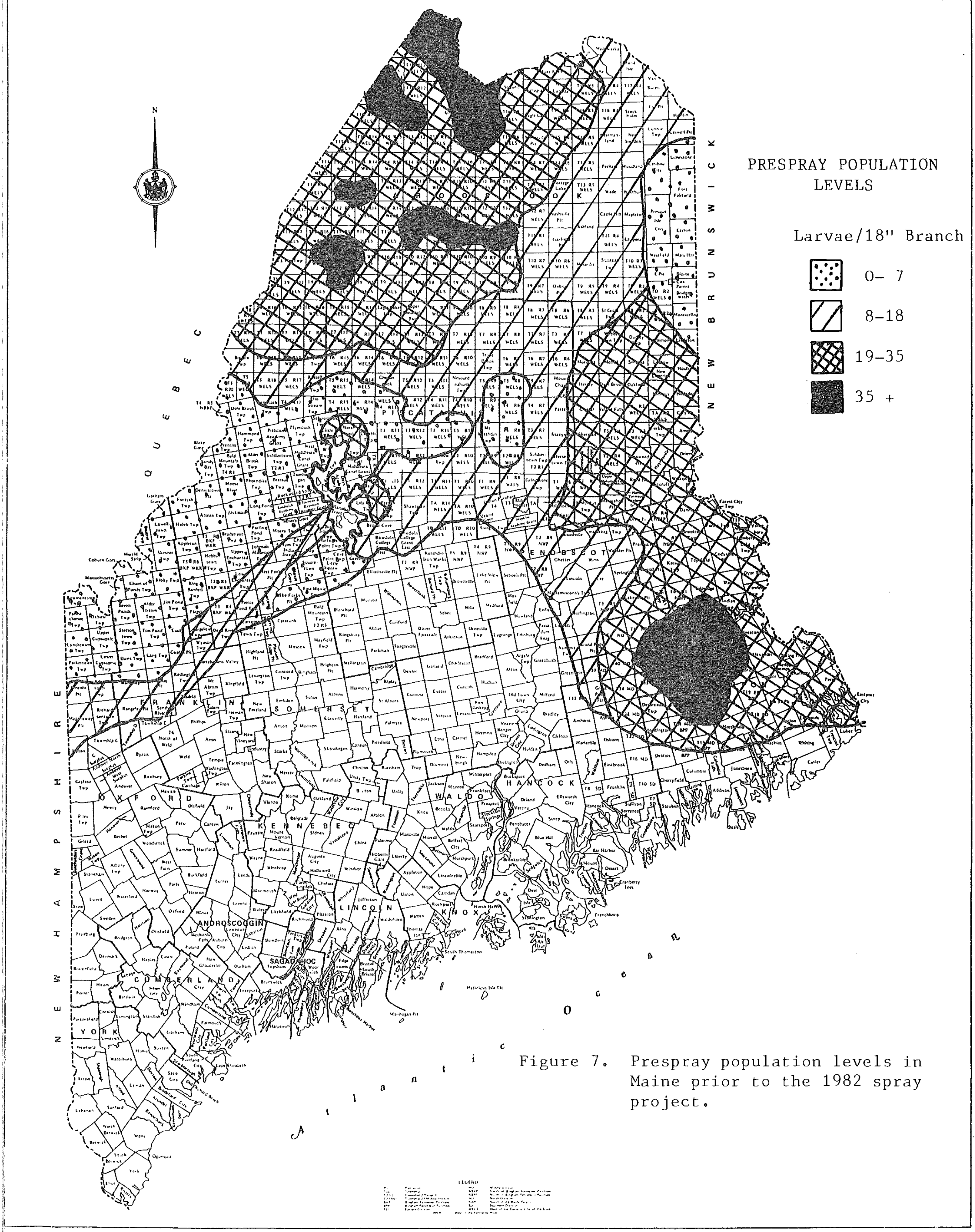


Figure 7. Prespray population levels in Maine prior to the 1982 spray project.

E. Spray Results

Spray results will be reported for each treatment variation employed in the 1982 operation. Many of the treatment variations used were evaluated in several areas and each area is listed separately. Table 4, 5, and 6 list spray results for Sevin, Orthene, and Bt respectively. Results are presented as the number of survivors per 18" tip, unadjusted mortality, adjusted mortality (Abbott's Formula), defoliation in sprayed areas, and foliage saved (defoliation in the unsprayed check minus defoliation in the spray blocks) for fir, spruce, and in some areas, hemlock.

Methods for efficacy determination of the 1982 project are shown in Sampling and Analysis Design For Experimental Insecticide Monitoring (Kemp, et. al., 1979) and the Maine Forest Service Spruce Budworm Survey and Assessment Manual (MFS Technical Report in preparation, Spring 1983).

F. Discussion

The 1982 spray project resulted in successful protection of foliage within most spray blocks with all materials used. Nearly all areas assessed showed population unadjusted reduction of at least 90 and many areas had reductions exceeding 95%. In general, the highest population reductions occurred in the high population areas of the northwest and southeast.

Defoliation in spray areas was generally less than half that in comparable unsprayed check areas. The highest defoliation levels in spray areas were observed in the northwest and southeast on fir. In the southeast area, high defoliation of fir was recorded in blocks treated with Orthene and timed for spruce protection. Heavily defoliated areas in the northwest resulted from early defoliation caused by extreme population pressure. Some northwestern blocks, as well as some in the southeast, were sprayed somewhat later than desired.

Results in areas of low to moderate populations in the central and southwestern areas were good, but population reductions were not generally as great as in high population areas. Larval survival is normally higher in low population areas thus making a high kill harder to attain. Defoliation in these areas was low due to the lower initial populations and the effects of spraying.

Results in Sevin-4-Oil treated areas were consistently excellent with high larval mortality and generally low defoliation. Defoliation in most Sevin areas was 60% less than defoliation in comparable unsprayed areas. Blocks sprayed with split applications of Sevin generally had higher populations and poorer tree conditions than blocks sprayed with a single application, thus direct comparisons of these regimes is difficult. However, split application

TABLE 4. RESULTS OF SEVIN-4-OIL AND SEVIN FR TREATMENT VARIATIONS BY AREA FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT

TREATMENT	AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	% DEF.	% FOL. SAVED
SEVIN-4-OIL							
Split Application 0.46 + 0.46 lbs. AI in 30 oz.							
Early/Early	M70, 71 Alligator Lake	F	0.71	94.2	82.3	46.3	42.3
		S	0.95	90.1	55.6	22.1	40.1
Early/Late	M2 Baskahegan Lake	S	1.10	94.9	80.4	38.0	23.5
	M77, 78 First Machias Area	F	0.55	98.1	94.0	30.7	65.1
		S	0.92	95.5	77.7	27.3	38.9
		H	0.30	97.7	87.0	12.7	30.8
	C54, 55 Long Lake, T12R14	F	0.73	97.0	94.5	46.7	43.0
		S	0.70	96.3	86.7	25.0	36.7
	A9, 12 Little Black River	F	0.95	97.0	92.7	52.7	42.6
		S	0.48	96.9	84.2	47.5	26.0
	J3, 8 Millinocket Area	F	0.15	97.6	91.5	19.0	18.6
		S	0.62	88.6	37.4	17.0	16.1
Split Application 0.375 + 0.375 Lbs. AI in 24 oz.	G33 Umcolcus Lake, T8R6	F	1.30	87.6	80.0	14.5	32.8
		S	1.85	85.5	40.7	13.5	25.8
	F23, 29 Mattagamon Lake Area	F	0.06	98.5	96.3	17.2	18.9
		S	0.54	88.0	45.3	15.4	14.6
	J1, 10 Millinocket Area	F	0.05	99.2	97.3	28.3	27.5
		S	0.33	94.6	70.1	18.3	12.6
	A42. 44 St. Pamphile Area	F	0.03	99.9	99.7	32.7	48.3
		S	0.07	99.6	98.4	16.7	42.1
	E46, 47 Loon Lake Area, T5R15	F	0.43	97.1	93.8	11.3	50.3
		S	0.38	97.0	89.1	9.5	29.5
Single Application 0.75 Lbs. AI in 30 oz.	G26 No. 9 Area, T9R3	F	1.42	89.6	83.6	17.3	30.0
		S	1.40	85.1	39.0	10.0	9.3
SEVIN FR							
Split Application 0.375 + 0.375 Lbs. AI in 24 oz.	G4, 8 T10R6	F	0.18	98.8	98.1	14.0	31.7
		S	0.28	98.0	91.9	9.0	10.3
Single Application 0.75 Lbs. AI in 30 oz.	G34. 36, 37 T8R5, St. Croix Lake Area	F	0.60	96.5	94.5	15.0	30.7
		S	1.03	90.4	60.8	9.7	9.6

TABLE 5. RESULTS OF ORTHENE TREATMENT VARIATIONS BY AREA
FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT

TREATMENT	AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	DEF.	FOL. SAVED
ORTHENE							
0.50 Lbs. in 64 oz.							
Early	M 81 Big Lake Area, T27 ED	F	0.10	97.6	91.9	70.0	29.5
		S	0.50	96.7	92.1	33.0	21.5
		H	0.10	99.8	98.7	24.0	19.0
	M 69 Eagle Lake, T40 MD	F	1.98	92.9	39.6	74.0	25.5
		S	2.18	82.9	15.6	32.5	22.0
		H	2.55	82.3	1.0	35.0	8.0
Late	M57,59 West Grand Lake Area	F	0.80	97.5	77.1	78.0	12.0
		S	1.57	88.0	71.5	43.5	11.0
		H	0.45	97.1	82.4	27.7	15.3
	K29, 33 Rangeley Plt.	F	0.35	94.9	81.0	6.5	33.5
		S	0.60	92.5	72.4	5.5	32.0

TABLE 6. RESULTS OF BT TREATMENT VARIATIONS BY AREA
FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT

TREATMENT	AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	% DEF.	% FOL. SAVED
DIPEL 4L							
12 BIU in 120 oz.							
Helicopter	M72, 73, 74 Narraguagus	F	1.00	95.3	85.0	36.0	44.1
	River Area, T34 MD	S	1.40	87.5	70.3	28.7	22.3
12 BIU in 96 oz.							
Thrush/Micro.	J5 Long A	F	0.05	98.0	96.3	10.7	25.1
		S	0.08	98.4	91.2	5.7	21.6
THURICIDE 32LV							
12 BIU in 96 oz.							
Thrush/Micro.	J5 Long A	F	0.07	98.7	95.5	17.3	18.5
		S	0.07	98.9	94.2	9.7	17.6
*BACTOSPIENE							
12 BIU in 96 oz.							
Helicopter	B13 Stockholm	F	0.30	91.3	72.2	12.0	22.8
		S	0.65	91.9	55.3	8.0	21.5

* This area received rain within 4 hours of application.

blocks seemed to receive significantly better foliage protection than single application areas.

Results in areas where both applications of a split treatment were made before larvae entered spruce buds were not significantly different from results in early/late blocks. Defoliation on fir was somewhat higher in the early/early area than in the early/late area. Defoliation on spruce was somewhat lower in the early/early area suggesting that this may be an effective spruce timing.

Efficacy of Sevin FR in both the split and single treatments was comparable to efficacy for Sevin-4-Oil. Overall evaluation of the FR blocks did reveal some inconsistency in terms of high defoliation which was not common in Sevin-4-Oil spray areas.

Defoliation of fir was high in areas treated with Orthene. Results on hemlock were fair and spruce results were fair to good. The same observations applied to the early and late timing for Orthene. Late spruce timing used on some blocks was not expected to protect fir and hemlock due to the amount of damage which occurred before spraying, but better results were predicted for the early timing blocks. Population reduction was lower in some early application Orthene blocks than the average for other treatments. All Orthene evaluations except the one made in the southwest were made on blocks with very high prespray larval counts and on blocks not treated in the recent past. These combined factors make a successful application very difficult.

Bt application at the 12 BIU rate was very effective in most areas. Population reduction and defoliation in most blocks was comparable to that seen in chemical areas. Blocks in the southeast and the Millinocket area had high kill and low defoliation. Some Bt blocks in the northeast showed inconsistent results, possibly due to late application or rain following treatment.

Dipel 4L and Thuricide 32 LV were both effective at the 12 BIU rate in 96 oz. volume. Final analysis is not likely to show any significant difference between the two products. Bactospiene was not applied under the same population and host conditions as the other two products, but did seem effective. A rain shower occurred shortly after application of the Bactospiene which seems to have reduced efficacy.

Bt application made with Micronair-equipped Thrushes seemed as effective as those made with jet helicopters. Spray deposit, in terms of droplets per square cm., was better with the Thrush than with the helicopter, but both aircraft gave excellent results.

G. Conclusions From The 1982 Testing Program

1. Low rate split applications of Sevin (.375 lb. in 24 oz. twice) were as effective on fir and spruce as high rate splits (.46 lbs. in 30 oz. twice).

2. Split application treatments of Sevin were much more effective on spruce than were single applications.

3. Sevin FR was effective, but less consistent than Sevin-4-Oil in the 1982 comparisons.

4. The early/early split applications of Sevin showed promise for protecting spruce.

5. Early application of Orthene was more effective on spruce than the late application.

6. Neither timing of Orthene was as effective as split or single applications of Sevin.

7. The 12 BIU applications of Bt were effective on all levels of population and host conditions evaluated.

8. No significant difference was seen in a test of Thuricide 32LV compared to Dipel 4L at 12 BIU in 96 oz. applied with Thrush aircraft equipped with Micronairs.

9. Test of Bt applied with jet helicopters compared with Micronair equipped Thrushes showed better deposit with the Thrush in terms of droplets per square cm.. Efficacy was good with both aircraft.

H. Future Testing Recommendations

1. Split applications with both applications occurring early (before larvae enter spruce buds) should be reevaluated for spruce protection.

2. Bt products should be evaluated with the 12 BIU rate, but at low volume (48 oz. or less) with atomizer equipped aircraft.

3. Registered chemicals other than those used in 1982 should be evaluated, especially in terms of spruce protection using split applications.

IV. FOREST CONDITION IN 1982 AND 1983 HAZARD FORECAST

This section contains survey results of defoliation, budworm moth occurrence, population prediction, tree damage, and specific L-II plans. Some of these results were used to formulate the hazard map presented in this section.

A. Defoliation, Aerial Survey

In July of 1982, an aerial defoliation survey was conducted and the entire spruce-fir region of Maine was mapped for current budworm defoliation. The survey began during the budworm pupal stage when most of the brownish budworm-clipped dead needles still adhered to the webbing and twigs. In 1982, conditions for the browning survey were good due to severe damage and weather conditions which allowed brown needle retention.

Trained observers surveyed the infested area from a Cessna 185 aircraft. The areas of defoliation were sketched on 1:62,500 topographic maps in the following categories: none, light, and moderate to severe.

The areas of moderate-severe defoliation are shown in Figure 8. The aerial defoliation survey was supplemented by ground observations within the sprayed areas and in questionable sections. A total of 3.8 million acres were classed as moderate to severe in 1982 which is a slight reduction from 4.0 million in 1981.

In 1982, "green" spray blocks showed up extremely well in the north and east. In many cases, buffer zone cut offs were very apparent. Unsprayed areas adjacent to spray blocks were readily discernable because of their browned foliage. Treatment blocks were not well defined in much of the central and western areas due to relatively light defoliation outside the spray blocks.

B. Forest Insect Survey Light Trap Program

Spruce budworm moth activity increased in 1982, with fourteen of the twenty light traps (Figure 9) exhibiting higher numbers of budworm than in 1981. Moth numbers were down in four of the five eastern traps, only the most eastern trap at Meddybemps showed an increase. A summary of the number of spruce budworm moths collected at light traps is shown in Table 7. While most of the moth activity can be attributed to local populations, the data indicates that the following dates and locations had inflights from surrounding areas:

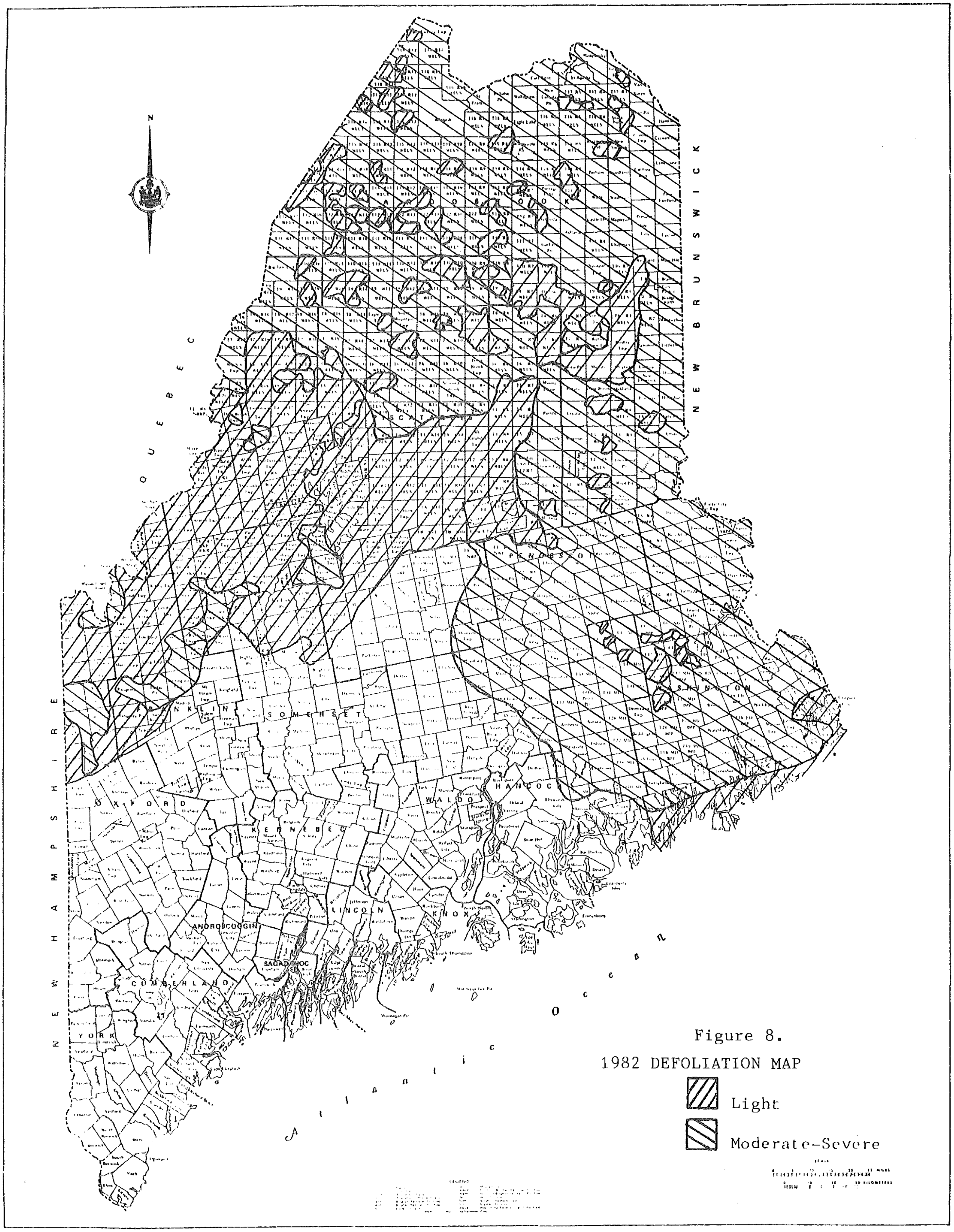


Figure 8.
1982 DEFOLIATION MAP

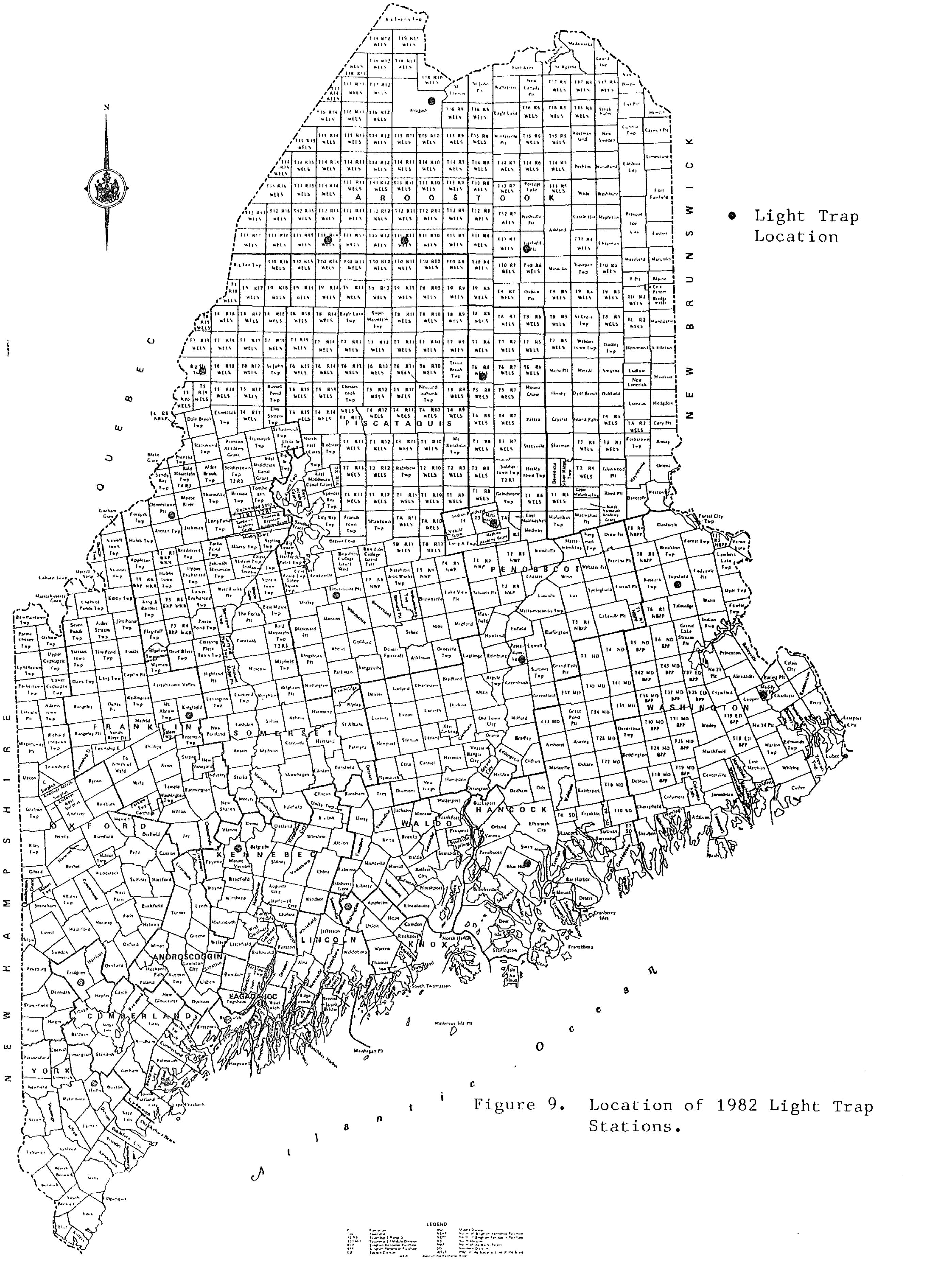


Figure 9. Location of 1982 Light Trap Stations.

Table 7.

Summary of the Number of Spruce Budworm Moths Collected at Light Traps
In Various Locations During June & July of 1982

Trap Location	June 27	28	29	30	July 1	2	3	4	5	6	7	8	9	10	11	12
Kingfield											3	3	1	11	7	9
Dennistown Plt.										1	2	1	16	1	15	29
Mt. Vernon												2	9	4	1	
Portland		1	1											1		
Meddybemps				2	1	16	6	6	25	285	675	1430	1670	794	900	950
Blue Hill								7			1	2	2	3	1	4
Passadumkeag	29*	27	19	13	6	4	1	2	69	250	500	440	1650	56	51	850
T6 R19										1	8	81	19		650	291
Clayton Lake											1	3		4	51	104
St. Francis			3						3	21	182	52		30	583	259
Garfield																2
Elliotsville	1*			1					1			9		23	16	700
Topsfield								11	7	6	73	60	56	92	43	28
Hay Lake	1*									1		3	15	14	89	98
Hollis Center										1						
North Bridgton						1					7	5	3	8	5	11
Washington													1	1		
Millinocket										2		3	1	9	12	18
Musquacook Gate										1	1	2	1		12	140
Brunswick	3*	2		1	1	1		2	1	1	1			11	8	5
Daily Totals	34*	30	23	17	8	22	7	24	106	570	1454	2096	3444	1062	2444	3498

Trap Location	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Totals	Trend***
Kingfield		1	24	20	11	1650	80	700	46	46	35	1350	180	3					4180	U
Dennistown Plt.	2	17	36	71	118	82	32	26	53	22	7	86	30	1					663	U
Mt. Vernon	2	1		3	3	5		2	37	10	9	38	9		5	5			145	U
Portland		2								1						1			7	D
Meddybemps	1250	1245	910	1610	625	651	118	120	94	4	8	47		16	30	3		2	13493	U
Blue Hill	3	1		6	9	16	13	11	11	19	8	3	5	5	5	4			139	U
Passadumkeag	4	135	295	142		114	25	1	190	31	6	125	3	8	3				5049	D
T6 R19	7	48	1210	470	2175	2075	525	3	1	3	1		1300	24					8892	U
Clayton Lake	1	18	681	121	1020	800	121	1	80	40	0	113	32	4	2				3196	U
St. Francis	14	4	34	44	2350	700	481	5	36	10	4	109	34	6	4	15			4983	U
Garfield	1				2			3	13	8		3	4						36	U
Elliotsville	11	35	46	100	41	100	25	75	625	85	31	1000	240	50					3215	U
Topsfield	200	200	244	75	9	2	25	3	7	4	5	3		1					1154	D
Hay Lake	10	3	450	9	125	50	53	84	250	5	3	16	5	2	1			6**	1292	D
Hollis Center		2						12	125	1	7	1	10	4	4				167	U
North Bridgton	3	4	1		1	19		2	8	4		3		2					87	D
Washington			3		3		2	1	89	26	12	25	55						218	U
Millinocket		2	85	35	12	4	12	4		4	2	255	10	3	2				475	D
Musquacook Gate	1		119	12	265	114		22	95	18	3	50	5	9					870	U
Brunswick	9	12	10	6	14	28	11	20	71	43	75	47	49	78	98	84	81	183**	956	U
Daily Totals	1518	1730	4148	2724	6783	6410	1523	1095	1831	384	216	3274	1971	216	154	112	81	191**	49200	U

*Summary of catches June 20 - 27.
**Summary of catches July 30 - August 4.
***Trend from 1981: U - up D - down.

July 12 - Passadumkeag, Elliotsville

July 15 - Hay Lake

July 18 - Kingfield

July 21 - Elliotsville, Hay Lake, Hollis Center, Washington

July 24 - Kingfield, Elliotsville, Millinocket

July 25 - T6 R19

Most of the flights were fairly short in duration again this year and while the total number of moths caught was higher than 1981, the number is significantly lower than in the late 1970's. There was one unconfirmed moth flight in Bar Harbor, but no confirmed reports were received at the Entomology Laboratory.

C. Population Prediction Survey

Format Changes - In the past the MFS has employed an egg mass survey as its primary means of early evaluation of predicted population. Overwintering larval surveys were used to confirm egg counts and to provide specific data from individual spray blocks throughout the winter.

Population prediction data from recent seasons have shown that egg mass estimates alone are often seriously inaccurate and that L-II estimates or combination of egg and L-II data have more predictive power. Also, the Budworm Survey and Assessment Unit was able to demonstrate advantages of L-II data in terms of permitting a longer survey period and reduced laboratory costs.

For these reasons, in 1982 the MFS decided to alter the general population prediction survey to include a combination of egg and L-II surveys. Egg mass was used in areas expected to have high or extreme populations as predicted through the aerial browning survey. The egg survey generally covered the northwest and southeast (Figure 10), and took place from July 26th and ended August 27th. The number of field crews was reduced from fourteen in 1981 to eight in 1982.

The general L-II survey covered the northeast, central and southwestern area. The L-II method was used in areas expected to be low, moderate, or undetermined. The survey began September 20th and ended October 31st.

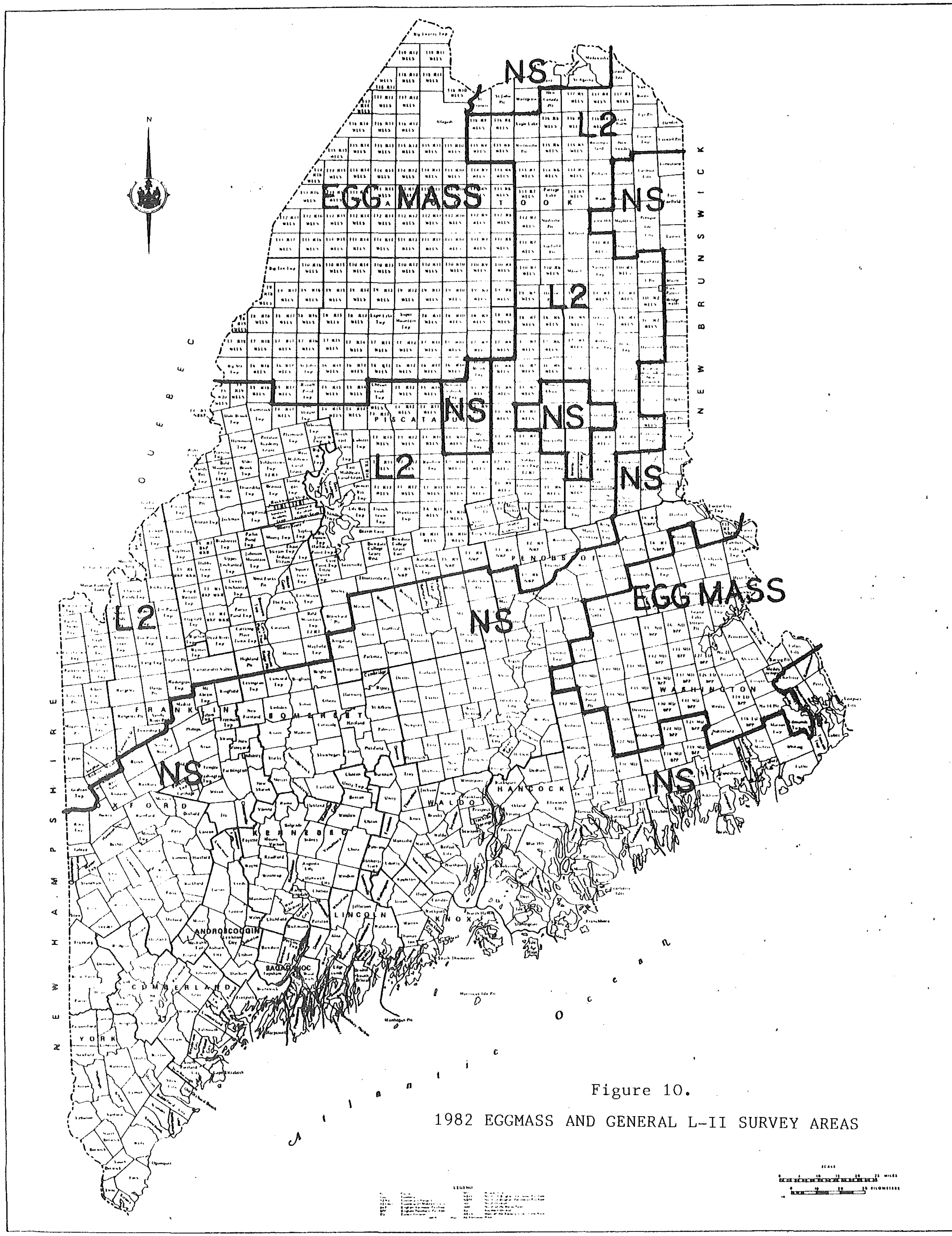


Figure 10.
1982 EGGMASS AND GENERAL L-II SURVEY AREAS

1. Population Prediction Methods

a. Survey Selection

Egg Mass - Areas chosen for the egg mass survey were those with current heavy to severe defoliation as delineated from the results of the aerial browning survey.

L-II -Areas of low 1982 defoliation and other areas of interest not evaluated with the egg survey were sampled with the L-II method.

No Ground Survey - Areas exist in the infested area where little interest is shown in early (by November 1) population prediction data. These areas were deliniated and eliminated from the general ground survey. Landowner requests for population information from these areas will be honored during mid-winter surveys. Current defoliation was also used in these areas as a prediction of 1983 population.

Final area selection for each method is shown in Figure 10.

b. Field Methods

The same field sampling procedure is used for the egg mass and L-II surveys. Sample density of the general population prediction survey is approximately one sample per 10,000 acres of relatively uniform stand type. In areas of variable stand type or treatment conditions, the density is often increased. Density of the general survey seldom exceeds one sample per 5,000 acres. Additional samples are taken in areas where specific requests are made by the major owners.

A general population sample consists of one upper mid-crown branch from each of three dominant or co-dominant fir and spruce trees. Dimensions of each branch; total length and width at the midpoint; are recorded. Each branch is cut into three to four inch segments and bagged separately in paper bags. Individual branch bags are then placed in larger bags for shipment to the laboratories.

Fir and spruce branches are separated into different container bags to allow easy sorting at the labs.

c. Laboratory Methods

Egg Mass - Egg mass laboratories were operated at Howland and Topsfield in 1982. Egg collections were sent to the closest lab where they were searched for egg masses by experienced lab workers. Needles with attached egg mass were separated from the branch and saved. Egg masses were classed in one of the following categories:

1. Old - from previous year's populations.

2. New - healthy.

3. New-parasitized - the majority of eggs in the egg mass parasitized.

4. New, dead of other causes - the majority of eggs in the egg mass damaged by predation, disease, etc., so as to prevent larval development.

The final determination of the egg mass category was made by an entomologist in the laboratory.

Following completion of the egg mass survey, an analysis was made of the viability (Table 8) of the egg masses.

The number of new, healthy egg masses per square foot of foliage was calculated separately for each branch of the sample and then converted to the number per 100 square feet for comparison with a sequential table. Searching of additional branches ceased when the cumulative egg mass count fell into a sequential category. The average number of egg masses per 100 square feet of foliage is then calculated by dividing total sound egg masses by total square footage searched and then converted to the number per 100 square feet. The infestation levels are defined as none, light, moderate, high, very high, and extreme (Table 9).

In areas where fir or both spruce and fir were considered important species, fir samples were searched first. If the fir sample was found to have a very high egg count, the spruce branches from the same area were not examined. It was thought that a very high count on fir would dictate a high count on spruce. Spruce is very difficult to count, and much time and money were saved with little decrease in sample reliability.

In areas where spruce was the species of interest or of special concern to the landowner, the spruce portion of the sample was automatically searched.

When counts on the fir portion of a sample were low or indeterminate the spruce portion of the sample was evaluated. This process either confirmed the low fir values or contradicted the fir count with a higher spruce value. Areas with low or inconsistent results were targeted for later assessment with the specific L-II method.

Table 8. Viability of Spruce Budworm Egg Masses, Including The Relative Abundance of Old Egg Masses Still Present on Fir, Spruce and Hemlock Foliage in 1982

	Fir	Spruce	Hemlock
Category*	Mean $\bar{X}$	Mean $\bar{X}$	Mean $\bar{X}$
% Parasitized	8.0	4.5	18.1
% Dead of Other CAuses	0.9	0.9	0.0
% Old Egg Masses	9.3	4.1	13.5
% New and Viable	82.7	90.7	70.8

* Percentage of parasitism and Dead of Other Causes was based on the number of new egg masses. Percentage of Old and New Egg Masses was based on the total number of egg masses encountered.

TABLE 9.
SPRUCE BUDWORM INFESTATION LEVELS BASED ON EGG MASSES PER 100 SQ. FT. OF FOLIAGE

No. Egg Masses Per 100 Sq. Ft.	Infestation Level
0	None
1- 99	Light
100-239	Moderate
240-399	High
400-999	Very High
1000 +	Extreme

L-II - The L-II method used is essentially the same as that described by Miller, et. al. (1971) and Miller and Kettela (1972). Several modifications in the method are being evaluated and will be described in a later report.

L-II samples are not searched sequentially as with egg samples, but use of the fir and spruce portions of the samples were similar to the method used for egg mass samples.

Infestation levels used for the L-II method are shown on Table 10.

2. Results

Final data for the general population prediction survey was provided to the landowners on November 2nd. The egg mass portion of the survey had been provided late in August. The November date compares to early to mid-September dates for providing data in recent years. The later date was necessary to employ the L-II method. In general, the landowners found the November date acceptable.

A total of 1,947 samples were collected during the 1982 survey. Of this total, 925 samples were egg samples, and 1,022 were L-II samples. A summary of statewide results is shown in Figure 11. More than 5.5 million acres were found to have high or extreme predicted population. This was approximately twice the 1981 acreage in these categories.

The most prominant feature of the survey was a large and general increase in population levels predicted for 1983 compared to the prediction for 1982. Nearly the entire northern third of the State was found to be heavily infested. These increases follow by one season similar increases in Quebec and New Brunswick. In addition, almost all of eastern Maine was high or extreme. Only the southwest and central portions of Maine remained relatively low in infestation level and even these areas had many small areas of moderate or high populations. A large area near Rangeley in southwestern Maine had high populations. Moderate and high areas in the west and central areas suggested future increases in these areas.

In the past, populations were compared annually by comparing mean egg mass deposit in six zones established for the infested area. Because part of the 1982 survey employed the L-II method, a direct comparison with 1981 data was not possible. Egg and L-II data are, however, correlated in terms of infestation levels, so comparison by use of an index is possible. Such a comparison of 1982 and 1981 data by zone is shown in Table 11. This table also shows egg mass data for the past five years.

TABLE 10. HAZARD RATING SYSTEM USED IN 1982

CURRENT DEFOLIATION

Category	Values	Hazard Values
Trace	0- 5	0
Light	6-20	1
Moderate	21-50	2
Heavy	51-80	4
Severe	81 +	6

PREVIOUS DEFOLIATION
(1981% Plus 1980%)

Trace	0-9	0
Light	10-49	3
Moderate	50-129	6
Heavy-Severe	130 +	9
Dead Tops		+3

EGG MASS & OVERWINTERING LARVAL DEPOSIT
BASED ON NO./100 SQ. FT. OF FOLIAGE

	Egg Mass	L-II	
Light	1- 99	1-175	1
Moderate	100-239	176-500	2
High	240-399	501-1100	3
Extreme	400 +	1101 +	4

TREE VIGOR

Good	0
Fair	1
Poor	2
Very Poor (No chance of recovery)	3

HAZARD

Hazard Rating	Range of Total Values
Low	0- 6
Moderate	7-15
High	16-22
Extreme	23-26

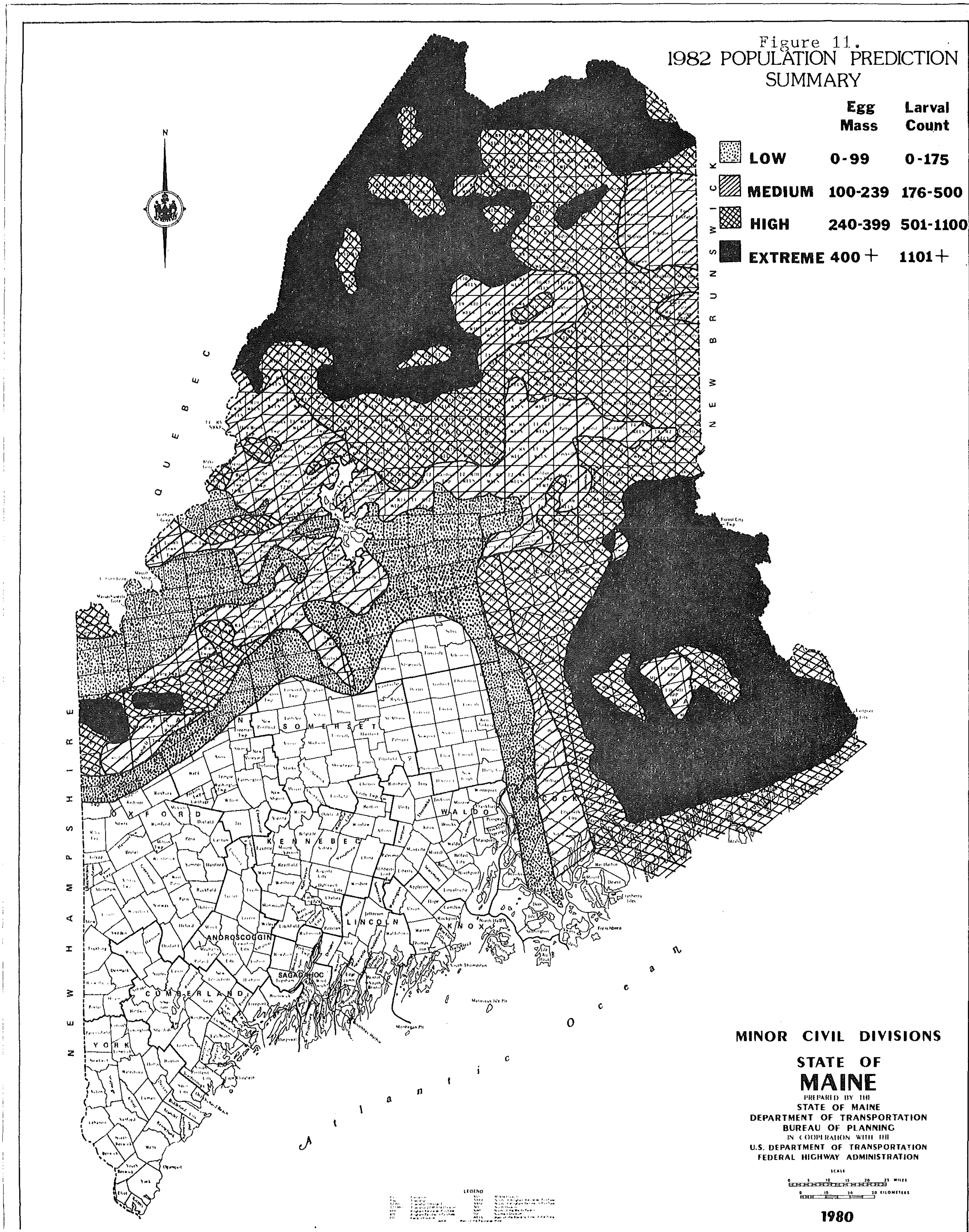


Figure 11.
1982 POPULATION PREDICTION SUMMARY

TABLE 11. POPULATION PREDICTION FOR 1983
AND POPULATION TRENDS BY ZONE

ZONE	EGG MASSES/100 SQ. FT. 1977	1978	1979	1980	1981	1981 POP. INDEX	1982 POP. INDEX EGG MASS & L-II	1981 TO 1982 TRENDS
Allagash-St. John	332	331	392	260	176	1.63	3.14	++
Northeast	312	824	374	254	109	1.41	3.08	++
Penobscot-Mattawamkeag	287	519	697	271	216	1.83	3.00	+
Southeast Coastal	155	469	292	493	331	2.15	3.09	+
Moosehead	110	210	287	185	43	1.14	2.26	+
Western Mountains	107	158	416	221	38	1.10	2.14	+

Predicted population by zone is shown in Figures 12 through 17. A discussion of population prediction by zone follows.

Allagash-St. John -- Extreme populations are predicted for nearly the entire zone for 1983. Areas near some 1982 treatment blocks were high as was much of the southern quarter of the zone. A small area in the southwest corner of the zone had moderate population levels. Predicted populations for the entire zone are higher than levels predicted for 1982.

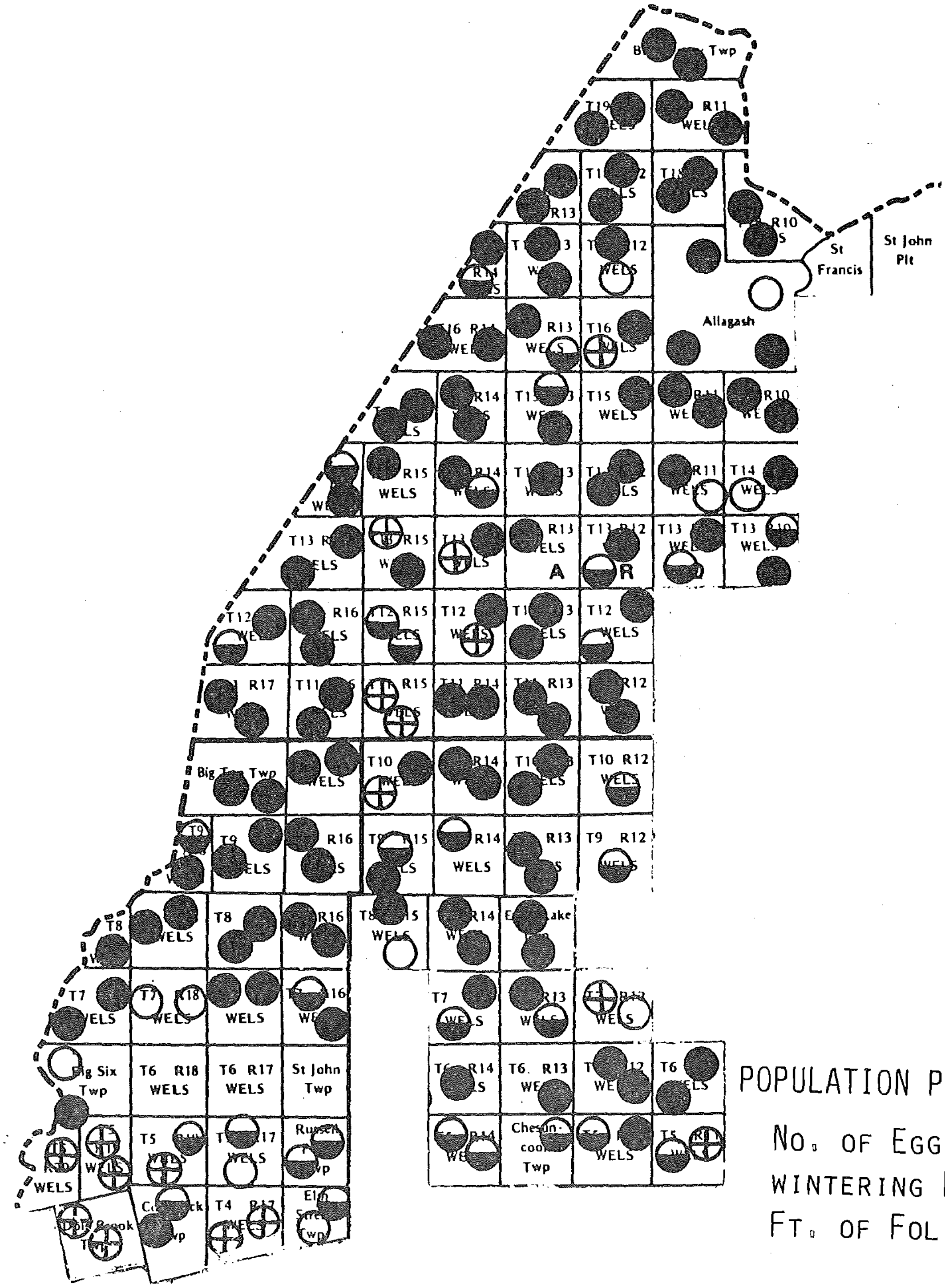
Northeast -- This zone also had a sharp increase in predicted population in 1983. Most of the zone was found to be high and the northern quarter was extreme. Moderate areas were found in the southeast portion of the zone, the westcentral area near Oxbow and in the farming areas near Presque Isle. Population levels for 1983 are expected to be twice 1982 levels or more.

Penobscot-Mattawamkeag -- The eastern half of this zone is entirely high or extreme. Levels in this portion of the zone are higher than those predicted for 1982; often twice as high. Some samples in the southwest portion of the zone were low or moderate. Most of these low areas were west of the Penobscot River. Another area of low and moderate population was found near Millinocket. This area was also low in 1982.

Southeast-Coastal -- Almost the entire zone was found to be extreme. Areas of high were mapped along the coast, near Calais, and near the 1982 spray blocks in the center of the zone. Spray blocks near First Machias Lake were the only moderate areas found in the entire zone. Spruce L-II samples taken within this zone produced some of the highest counts ever recorded in Maine.

Moosehead Zone -- Moderate populations are predicted for the Moosehead Zone in 1983. Areas in the southeast and southwest portions of the zone were found to be low. Many of these low areas are located near the southern limits of the infestation. The far northern portion of this zone, north of Moosehead Lake, is the only part of the zone predicted to be high in 1983. Populations in the Moosehead Zone are expected to be lower than much of the rest of Maine in 1983, but even this zone will have higher levels than 1982.

Western Mountains -- Large increases were found in this zone. Two areas of extreme and a large area of high populations were found near Rangeley. Other high areas were found near Bowmantown, Sandy Bay, and Jackman. The majority of the zone is expected to remain low or moderate in 1983, but the zone has generally experienced large increases in predicted populations.



POPULATION PREDICTION LEGEND

No. OF EGG MASSES & OVER-WINTERING LARVAE/100 SQ. FT. OF FOLIAGE

	Egg Masses	Overwintering Larvae
LOW	0 - 99	0 - 175
MEDIUM	100 - 239	176 - 500
HIGH	240 - 399	501 - 1100
EXTREME	400 +	1101 +

Figure 12. 1982 Spruce Budworm Population Prediction Map of the Allagash-St. John Zone.

POPULATION PREDICTION LEGEND

No. of Egg Masses & Overwintering Larvae/100 Sq. Ft. of Foliage

	Egg Masses	Overwintering Larvae
LOW	0 - 99	0 - 175
MEDIUM	100 - 239	176 - 500
HIGH	240 - 399	501 - 1100
EXTREME	400 +	1101 +

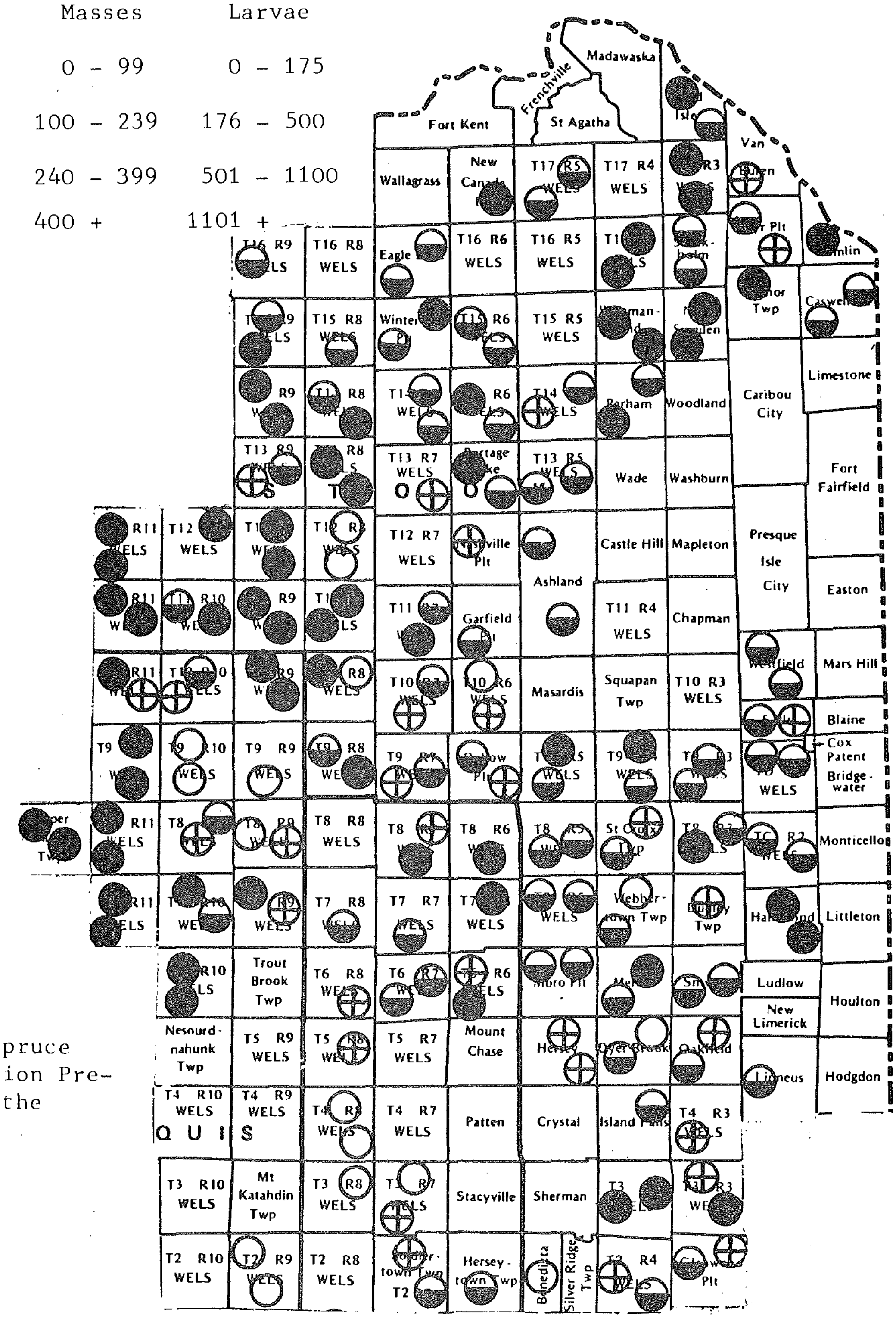


Figure 13. 1982 Spruce Budworm Population Prediction Map of the Northeast Zone.

POPULATION PREDICTION LEGEND

No. of Egg Masses & Over-wintering Larvae/100 Sq. Ft. of Foliage

		Egg Masses	Overwintering Larvae
LOW	○	0 - 99	0 - 175
MEDIUM	⊕	100 - 239	176 - 500
HIGH	◒	240 - 399	501 - 1100
EXTREME	●	400 +	1101 +

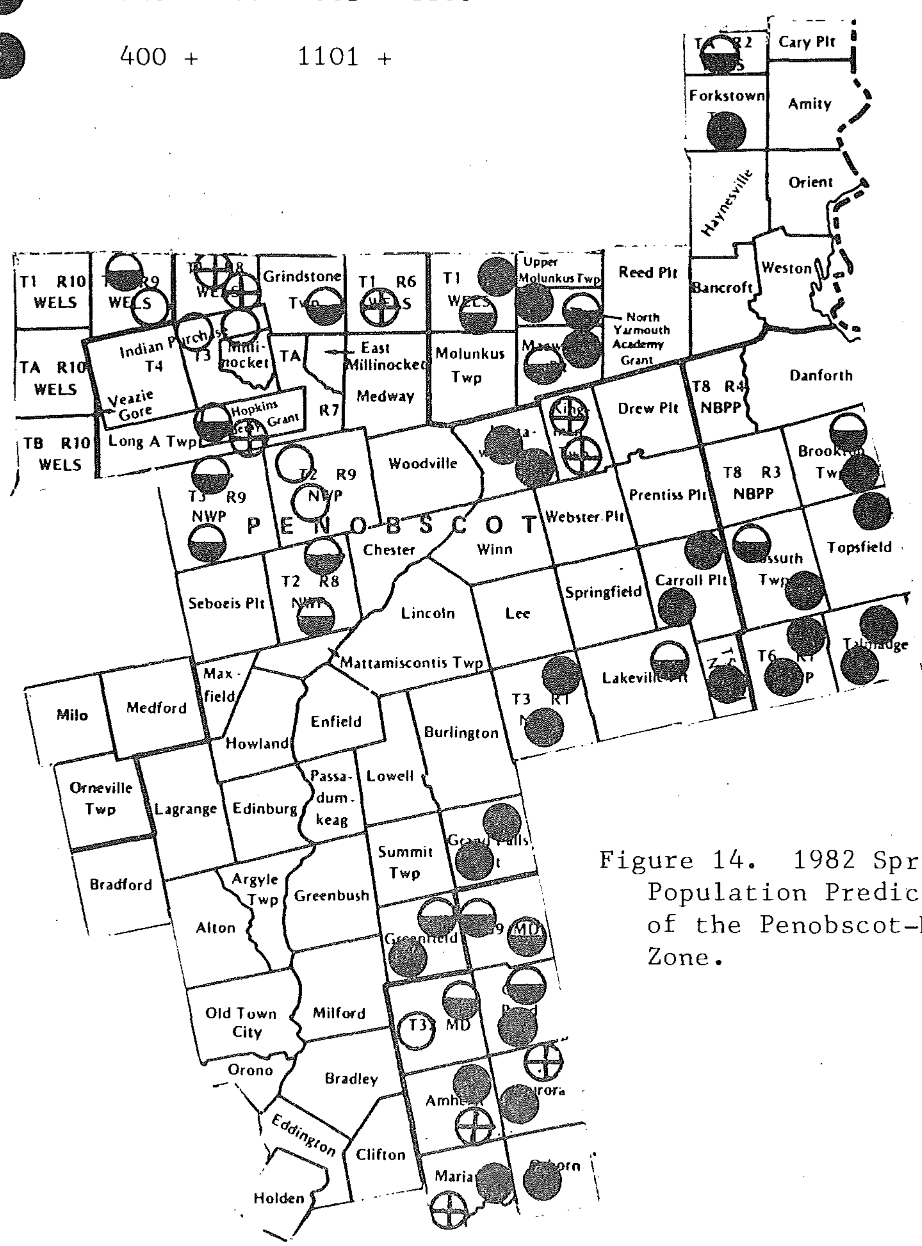


Figure 14. 1982 Spruce Budworm Population Prediction Map of the Penobscot-Mattawamkeag Zone.

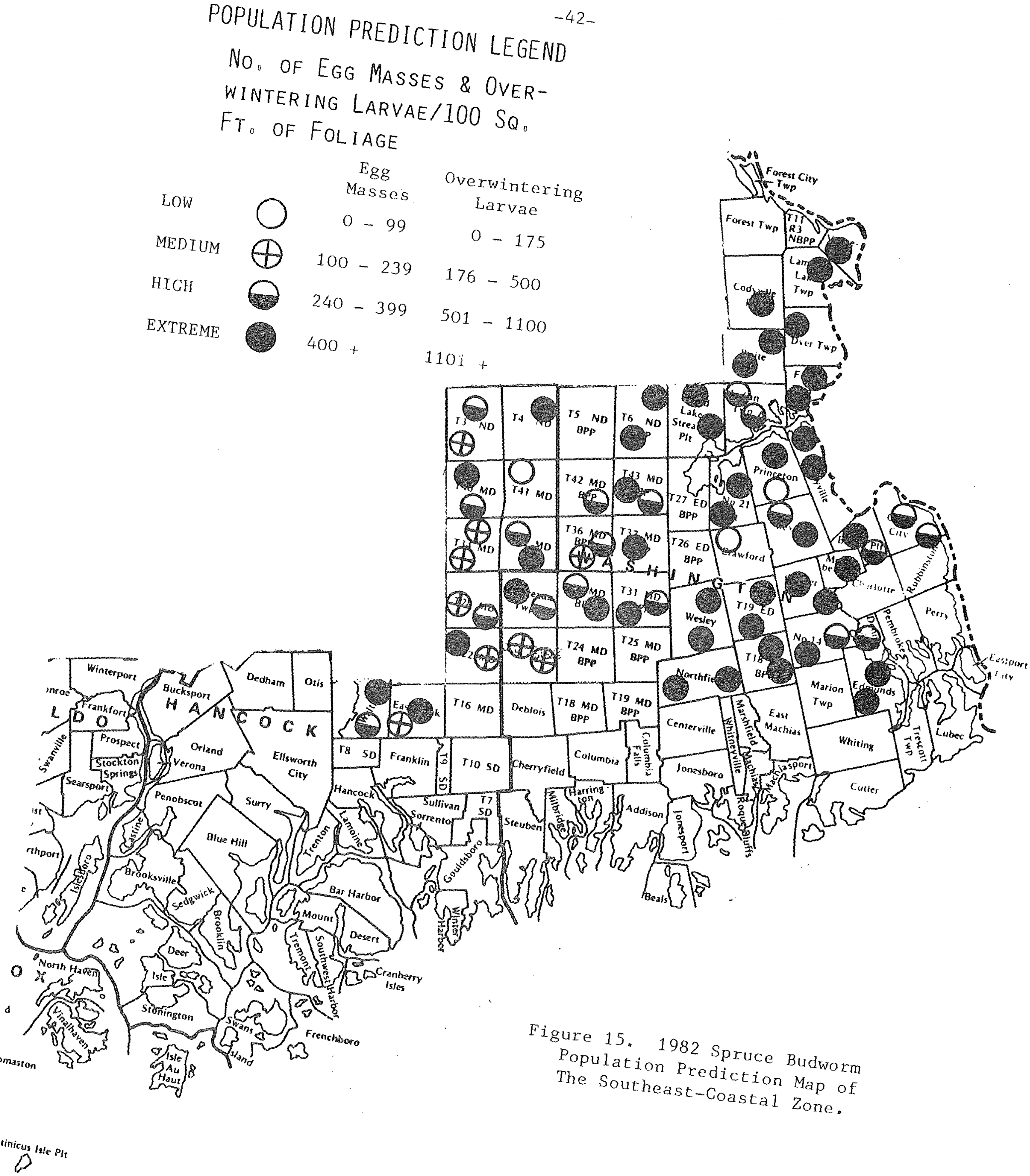


Figure 15. 1982 Spruce Budworm Population Prediction Map of The Southeast-Coastal Zone.

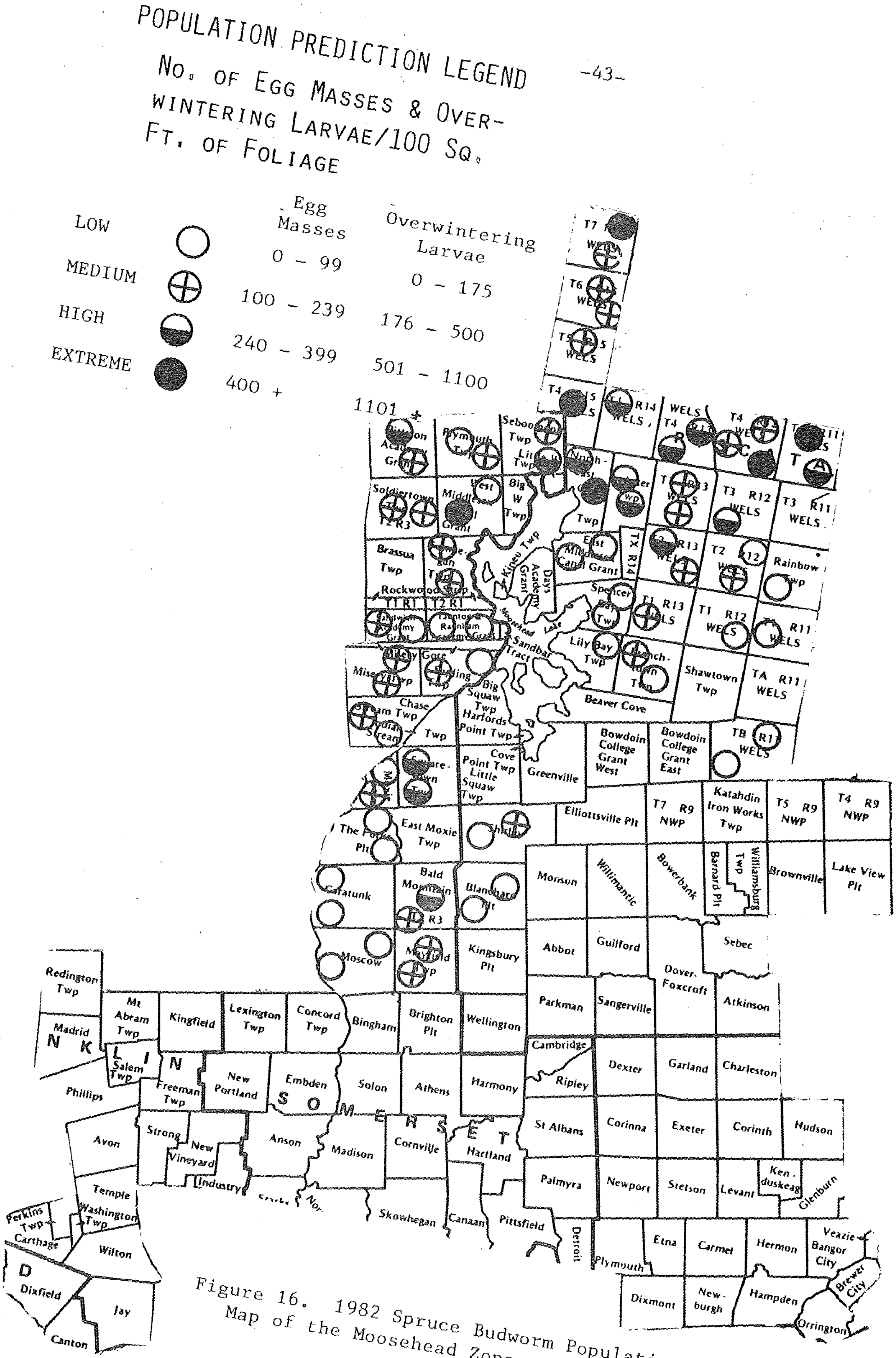


Figure 16. 1982 Spruce Budworm Population Prediction Map of the Moosehead Zone.

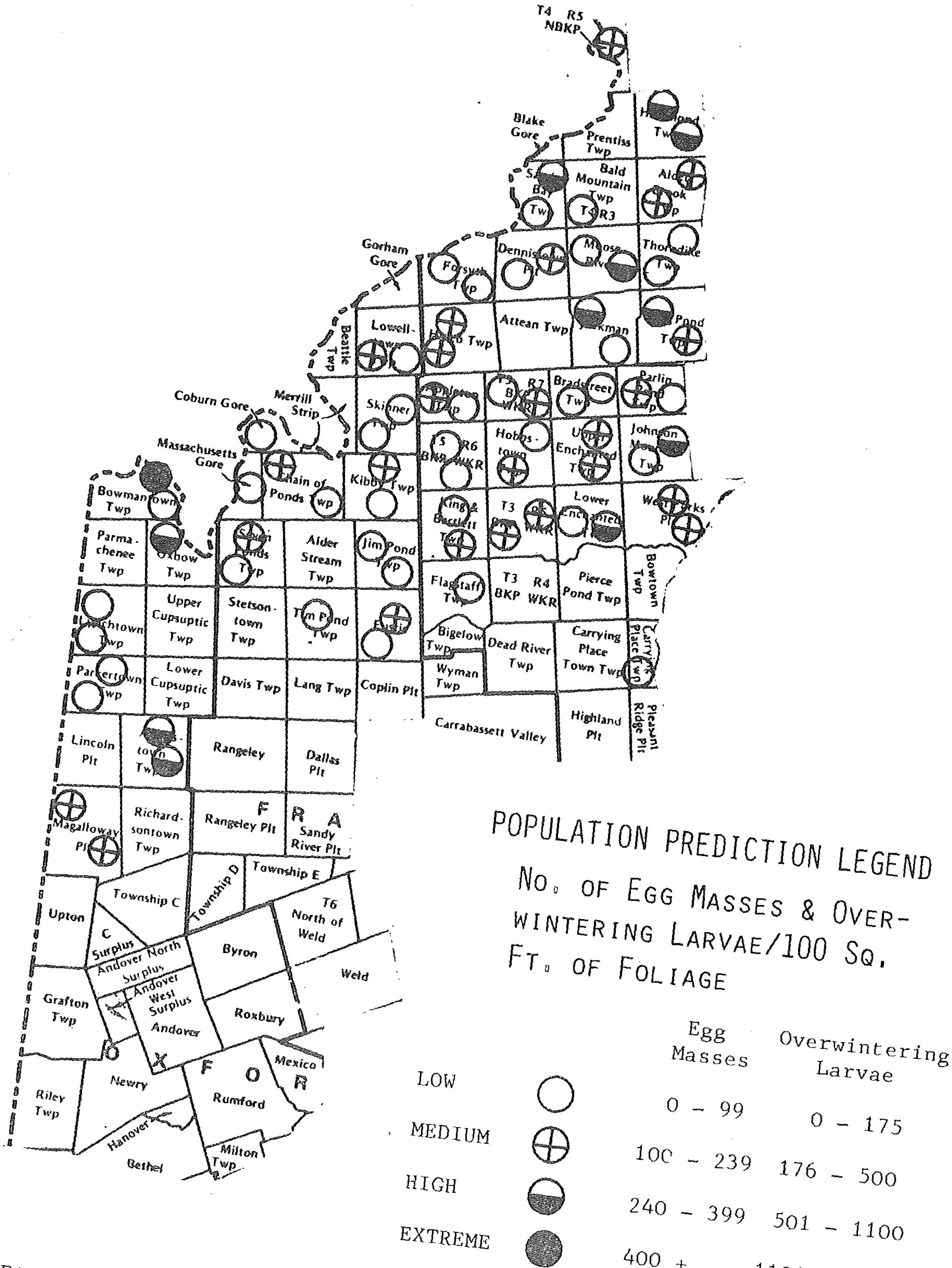


Figure 17. 1982 Spruce Budworm Population Prediction Map of the Western Mountains Zone.

D. Tree Damage Surveys

1. Ground Assessment

Concurrent with the collection of population prediction samples, a survey of tree condition in the infested areas was made. At each sample point the following data were taken from balsam fir and red spruce.

Percent defoliation of current year's growth.

Percent defoliation of 1980 and 1981 growth.

Tree Vigor

Presence of Dead Tops

Presence of Dead Trees

Presence of Balsam Woolly Aphid

Presence of Beetle attack

These data were used to determine the general condition of stands. Stand condition data in conjunction with predicted population data were then used to determine hazard values and potential damage to fir and spruce stands.

2. Aerial Assessment

The current MFS use of aerial damage assessment is less extensive than in the past and, in most cases, is specifically geared to landowner needs. Some aerial assessment time is used to validate a general hazard map prepared primarily with ground data. This map is provided to the landowners as a general starting point for their treatment area selection.

In 1982, aerial observations were used along with hazard data to develop a MFS treatment recommendation (Figure 18). Spray blocks treated in 1982, landowner requests, and areas of concern to the MFS were assessed.

As with the aerial browning survey, flying is done in a Cessna 185 aircraft on floats in the fall and skis in the winter. Maps used vary with the needs of the landowners.

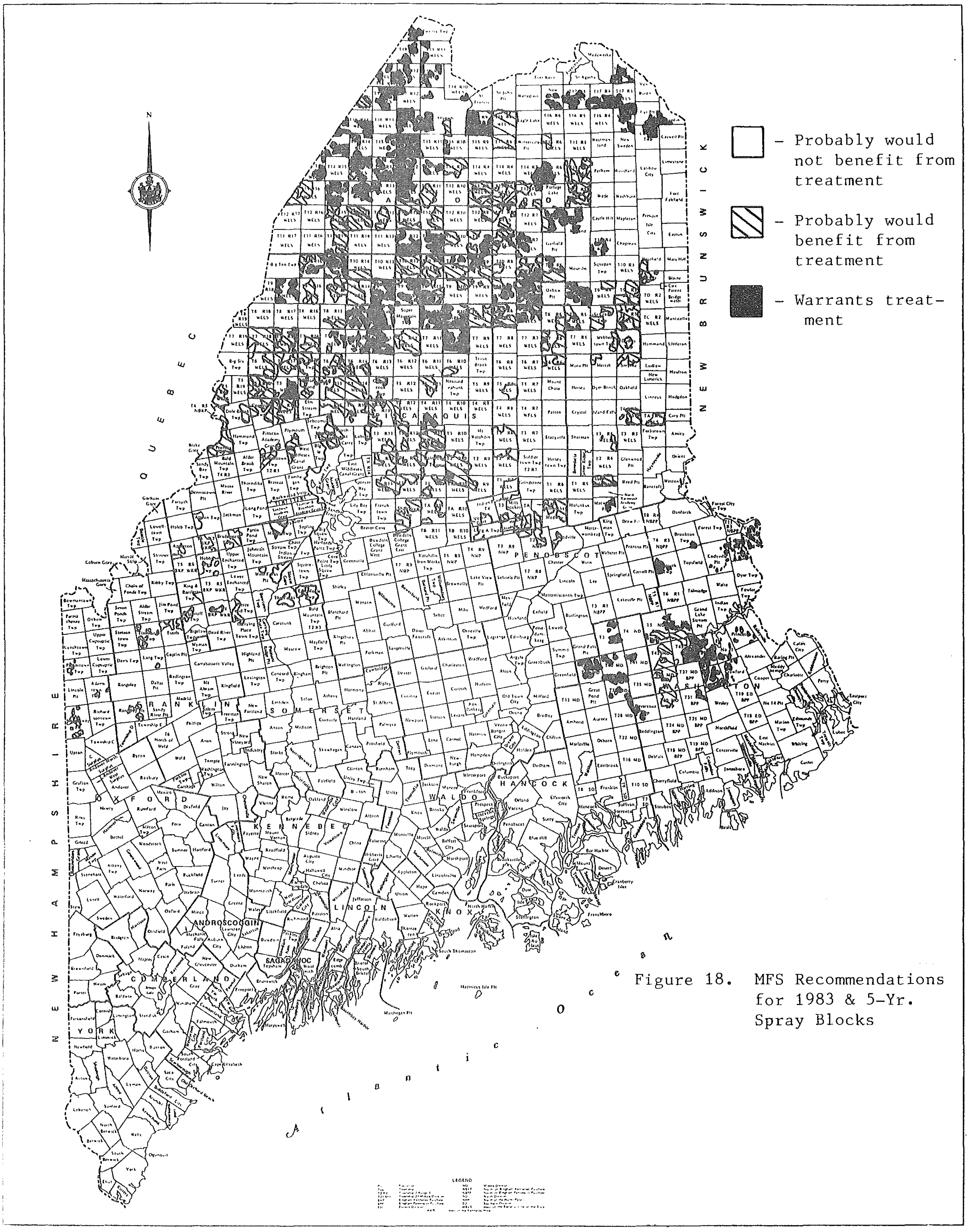


Figure 18. MFS Recommendations for 1983 & 5-Yr. Spray Blocks

E. Stand Mortality and Mortality Studies

No specific studies of host mortality were conducted in 1982. The 1981 mortality map was updated (Figure 19).

The status of host mortality in 1982 can be summarized as follows:

1. Areas treated as needed are still experiencing little mortality.

2. Fir mortality is at or near its peak in many long untreated portions of the State, especially in the southeast. Mortality rates of fir often exceed 80 percent.

3. Spruce mortality is increasing rapidly in the southeast and portions of northern Maine. Mortality as high as 40% was found, but most areas are 20% or less.

4. Spruce mortality continues to increase in areas even after fir is dead or removed.

5. Hemlock is dying at a rapid rate in eastern Maine with some areas exceeding 50% tree mortality and over 70% top mortality.

Mortality studies are planned for 1983. The Moosehorn Wildlife Refuge in Edmunds will be resurveyed to evaluate spruce mortality. In addition, mortality data was collected on ninety-six plots established in 1979.

F. Specific L-II Evaluations

Following completion of the general population prediction survey, questions about infestation levels remained in many areas. In many cases landowners felt they needed additional population data to formulate treatment decisions before the February 1 withdrawal deadline.

A sample system employing a modified L-II method was used to gather specific population data for areas where treatment decisions were in question.

1. Sample Areas

Only lands chosen for treatment in 1983 were surveyed with the specific L-II method. All samples were taken within block boundaries.

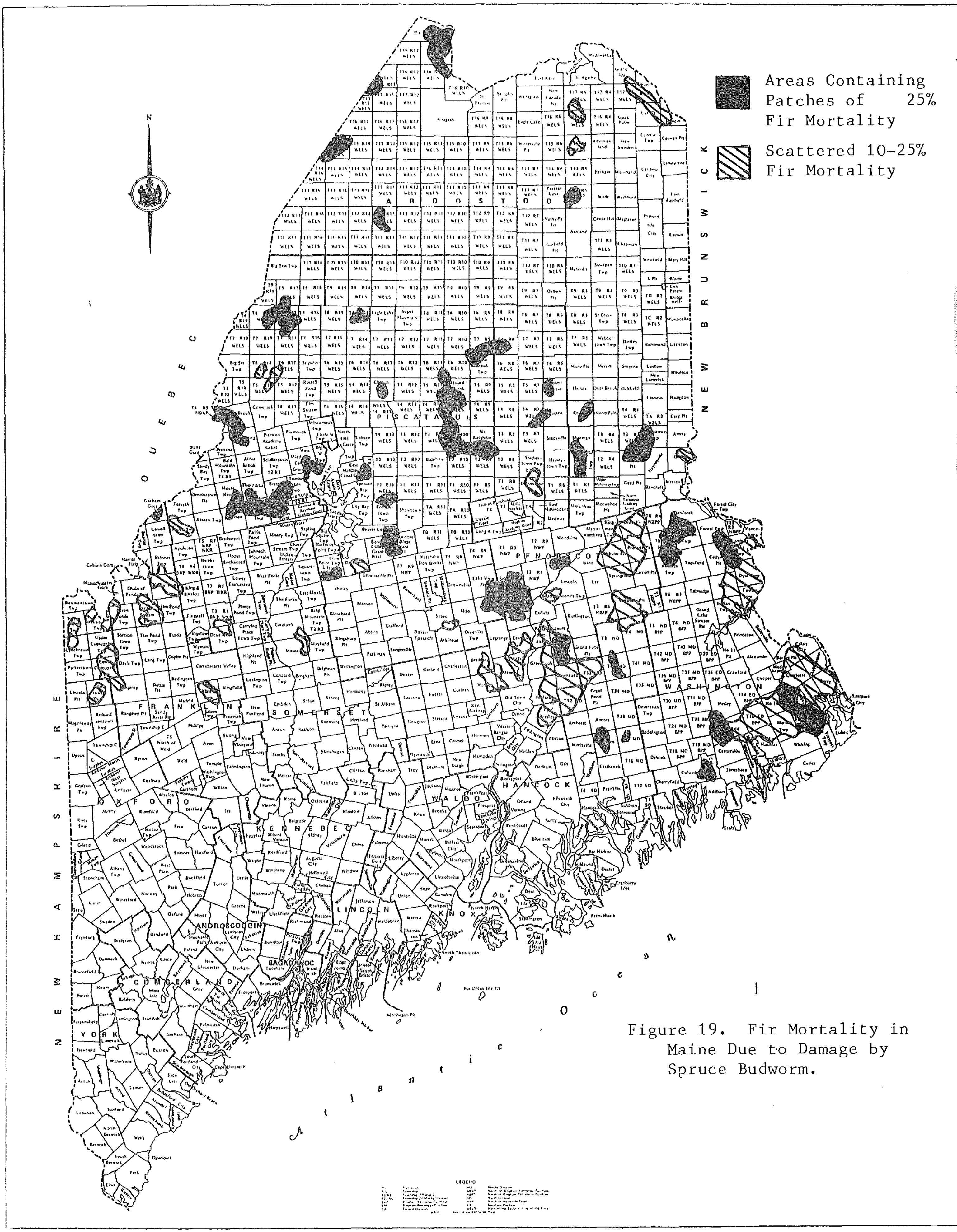


Figure 19. Fir Mortality in Maine Due to Damage by Spruce Budworm.

2. Timing

Samples were taken from December 1 to January 15.

3. Field Methods

Samples were collected near major roads and trails in suggested spray blocks. A sample consisted of three to fifteen points depending on the size of the block. Each point consisted of four trees; two fir and two spruce. One upper mid-crown branch was collected from each tree. Branches were treated as described for the general L-II method.

4. Laboratory Methods

Samples were processed using the same method as used for the general survey. All branches were processed and data averaged for the proposed block. Data was provided to the appropriate landowner.

G. Forecast of Tree Condition and Hazard for 1983

Data collected during ground surveys are quantified into a hazard rating using the system shown in Table 10. Approximately 4.5 million acres were classed as high or extreme hazard.

Hazard ratings were calculated for each sample point and mapped by zone (Figures 20 through 25). All hazard values are for fir. Generally, extreme values indicate that spruce needs protection.

The general hazard outlook by zone is as follows:

Allagash-St. John -- Conditions in this zone remain similar to those predicted for 1982. Persistently successful treatment of much of this zone has lowered hazard in spray areas. Some spray areas have recovered from extreme hazard to low or moderate levels, but due to high predicted populations for 1983, most of the 1982 spray areas are in the high category. Moderate hazard was predicted in sprayed portions in the central and southern portions of the zone. Extreme hazard is predicted for largely untreated areas in the northeast portion and for a large area in the southwest portion. The general trend of hazard in this zone is up for 1983 due mostly to high predicted populations.

Northeast -- This zone showed a sharp increase in hazard predicted for 1983. Most of this zone has not been treated recently, and hazard increases were due to heavy 1982 defoliation and high predicted populations. Much of the northern third of the zone is in extreme hazard. Moderate areas were found in the westcentral and southern portions of the zone where considerable spraying was done.

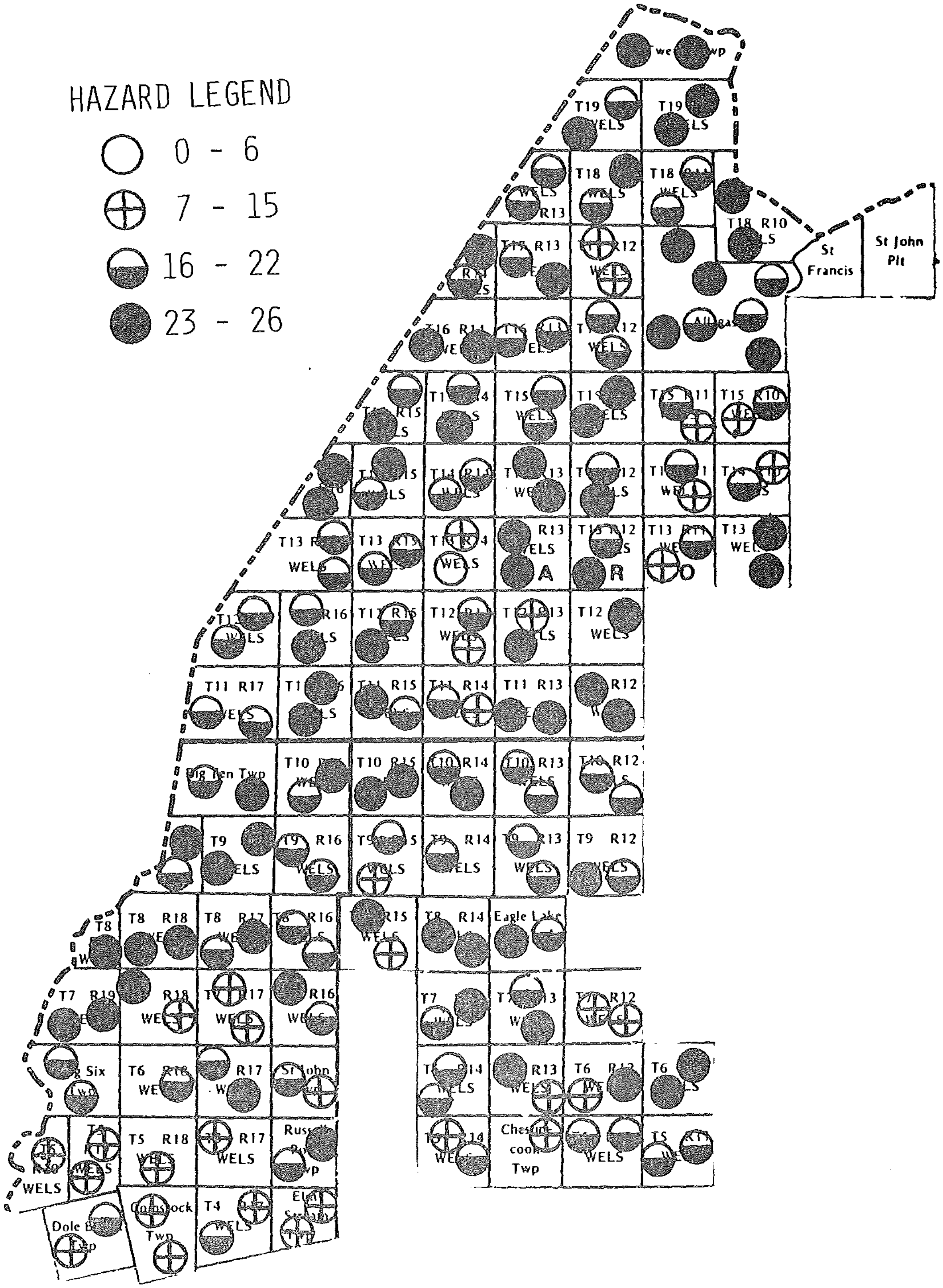
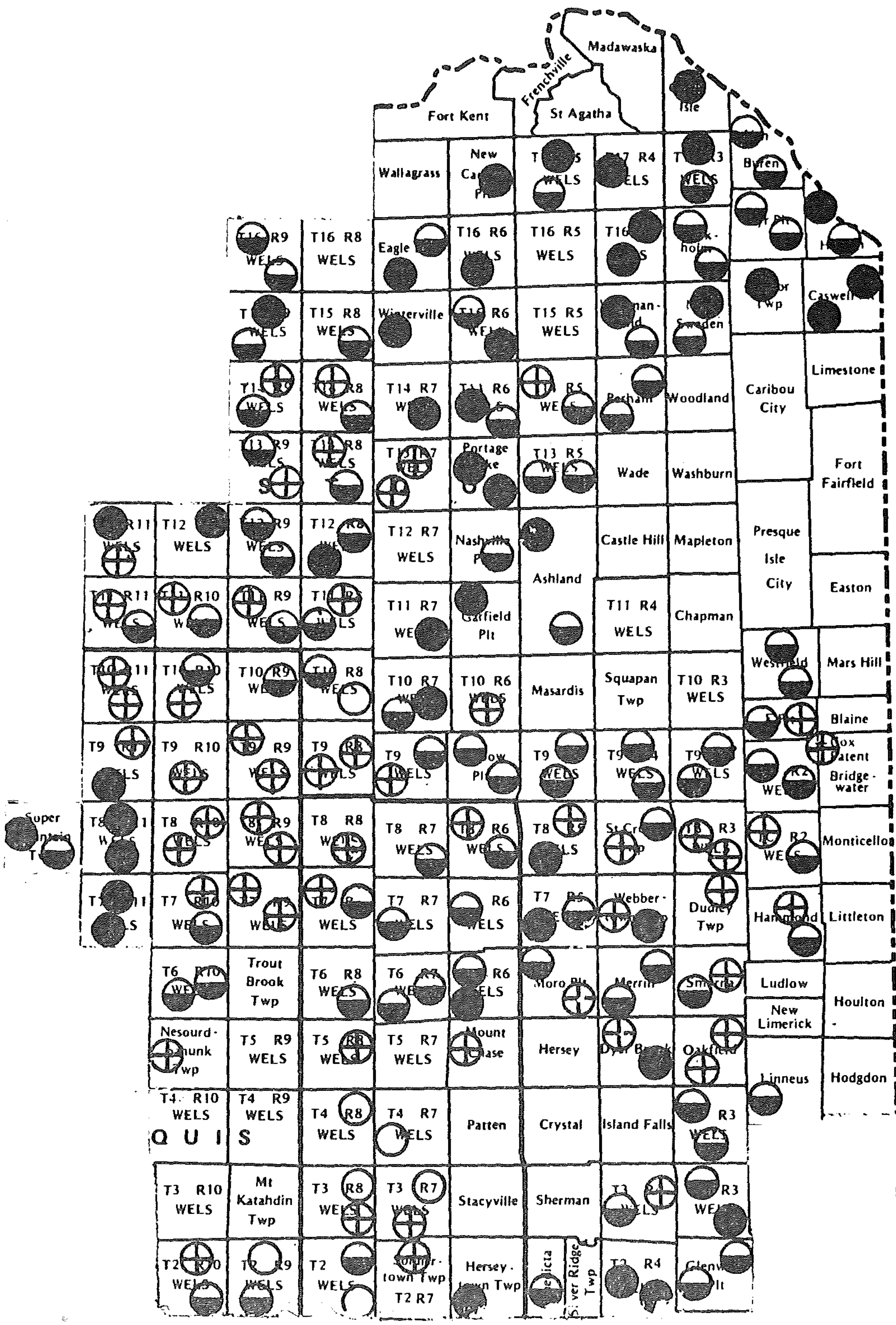


Figure 20. 1982 Spruce Budworm Hazard Appraisal Map of the Allagash-St. John Zone.



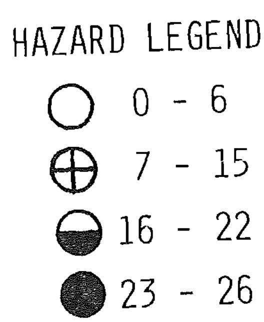


Figure 21. 1982 Spruce Budworm Hazard Appraisal Map of the Northeast Zone.

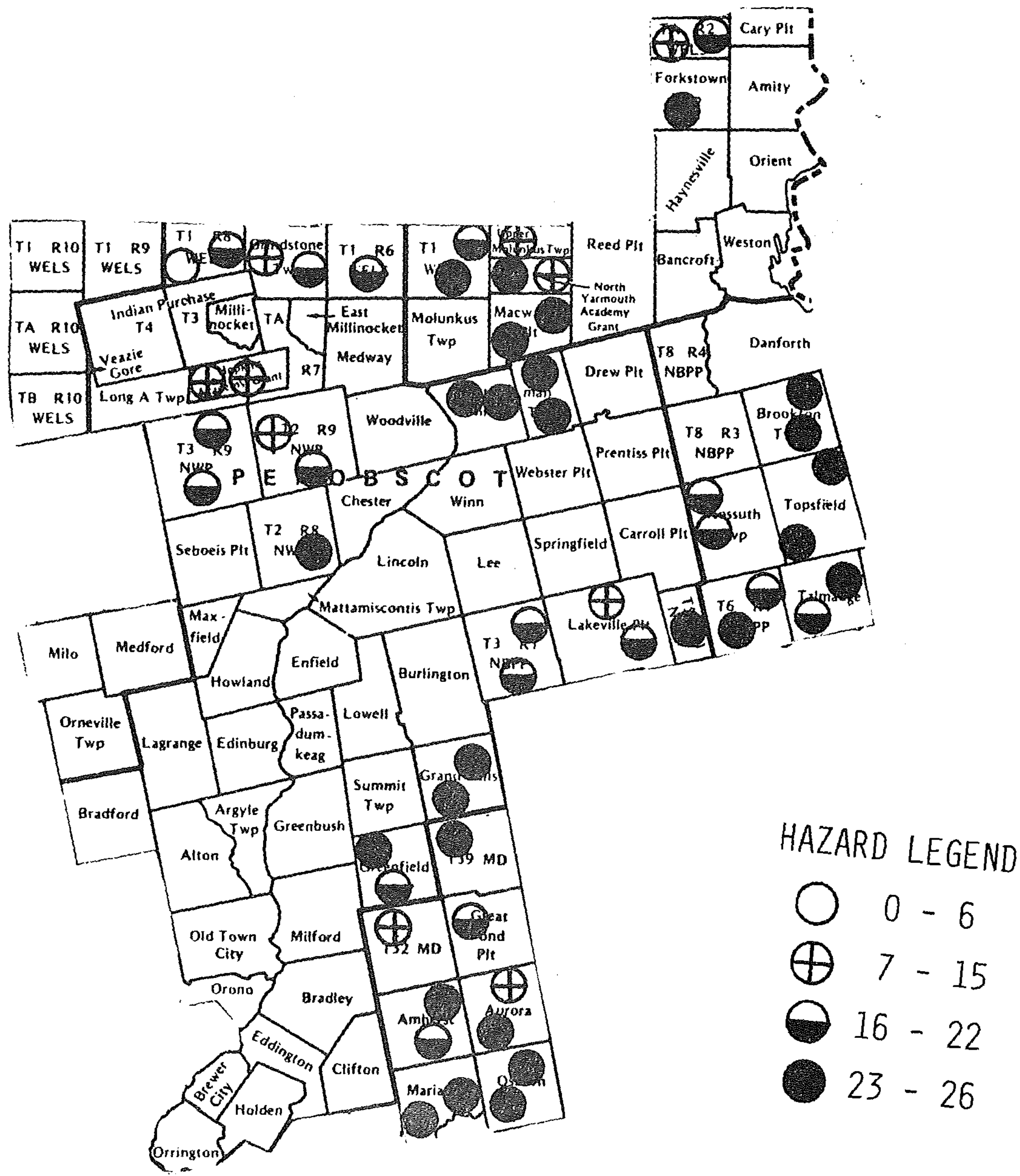


Figure 22. 1982 Spruce Budowrm Hazard Appraisal Map of the Penobscot-Mattawamkeag Zone.

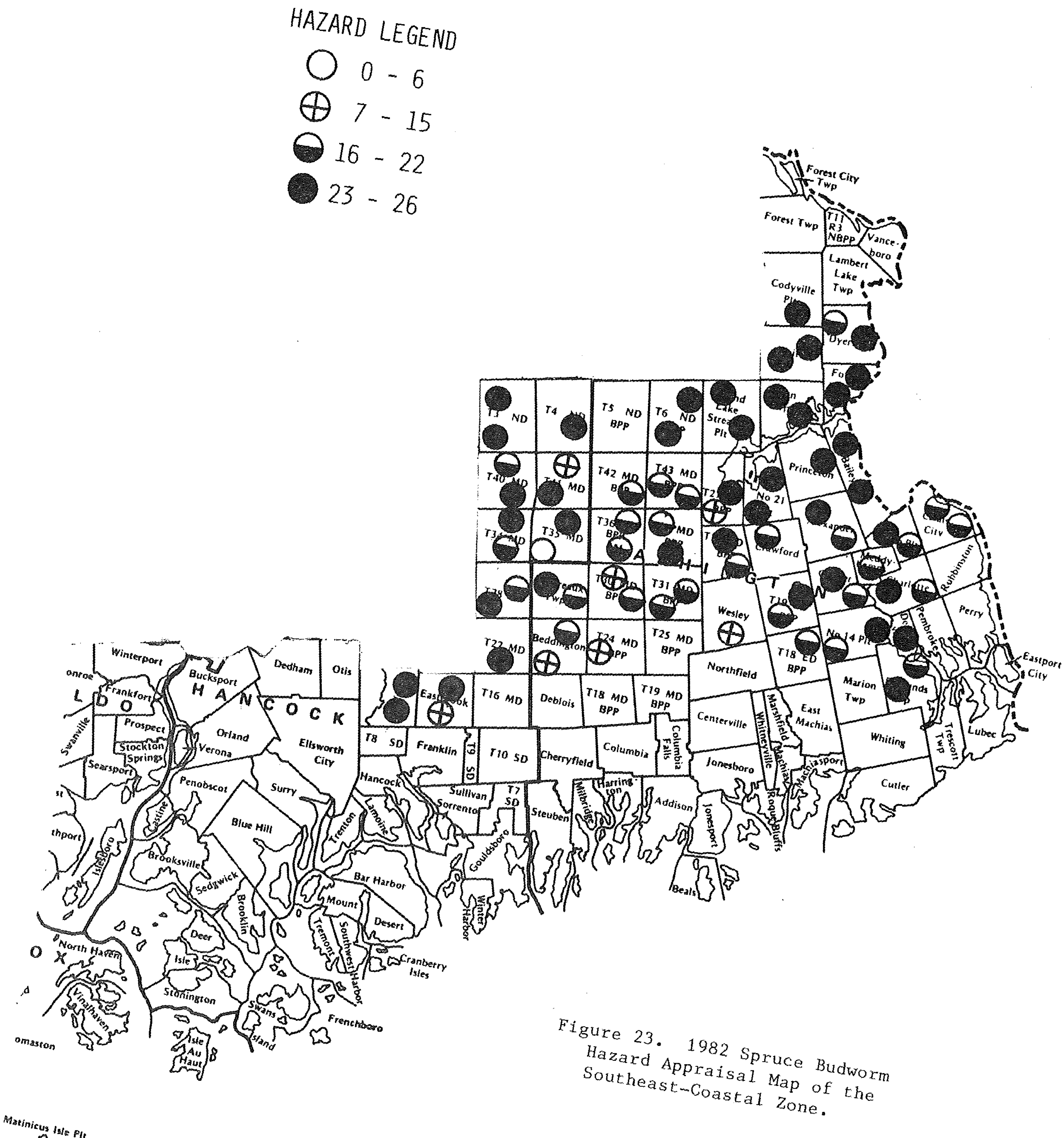


Figure 23. 1982 Spruce Budworm Hazard Appraisal Map of the Southeast-Coastal Zone.

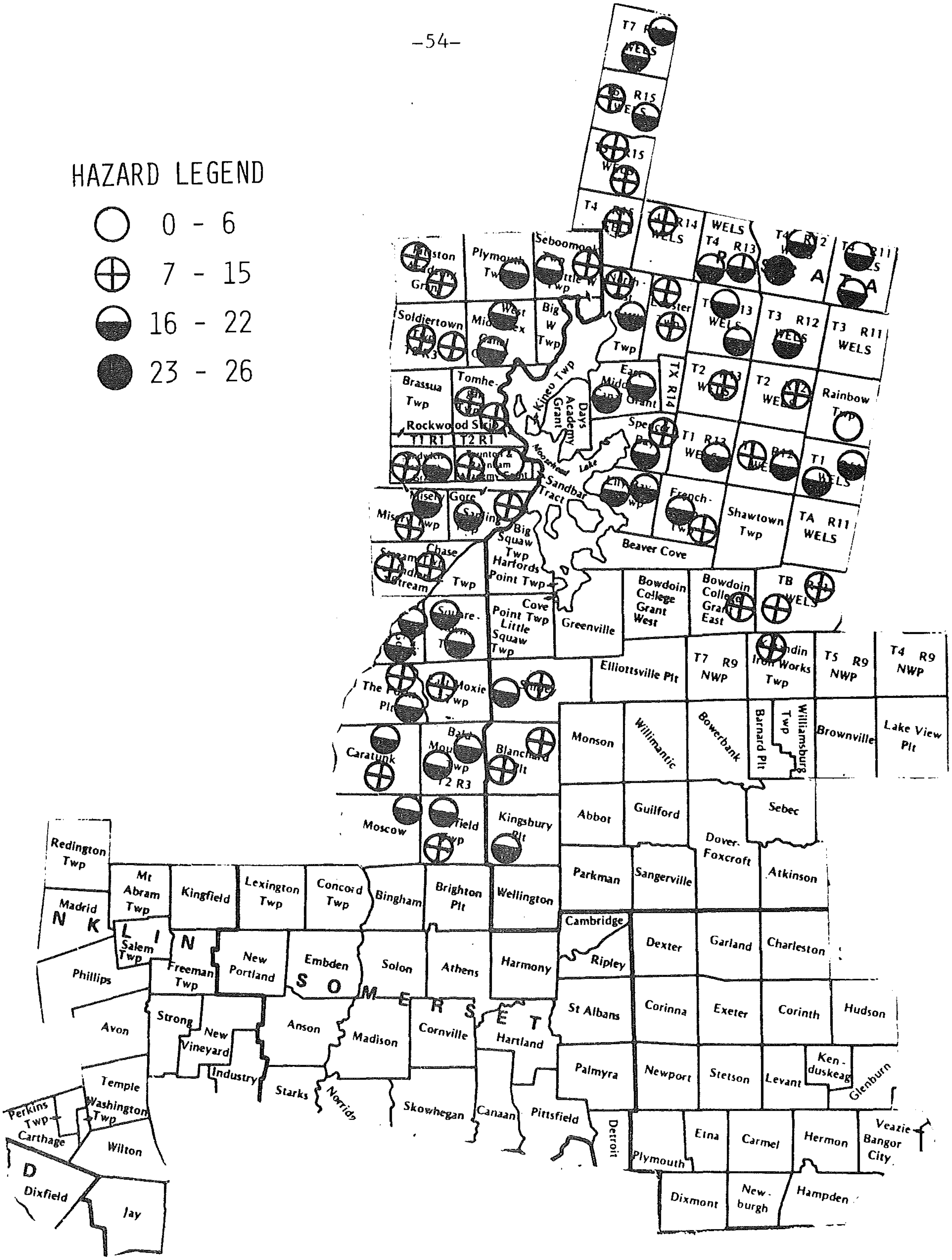


Figure 24. 1982 Spruce Budworm Hazard Appraisal Map of the Moosehead Zone.

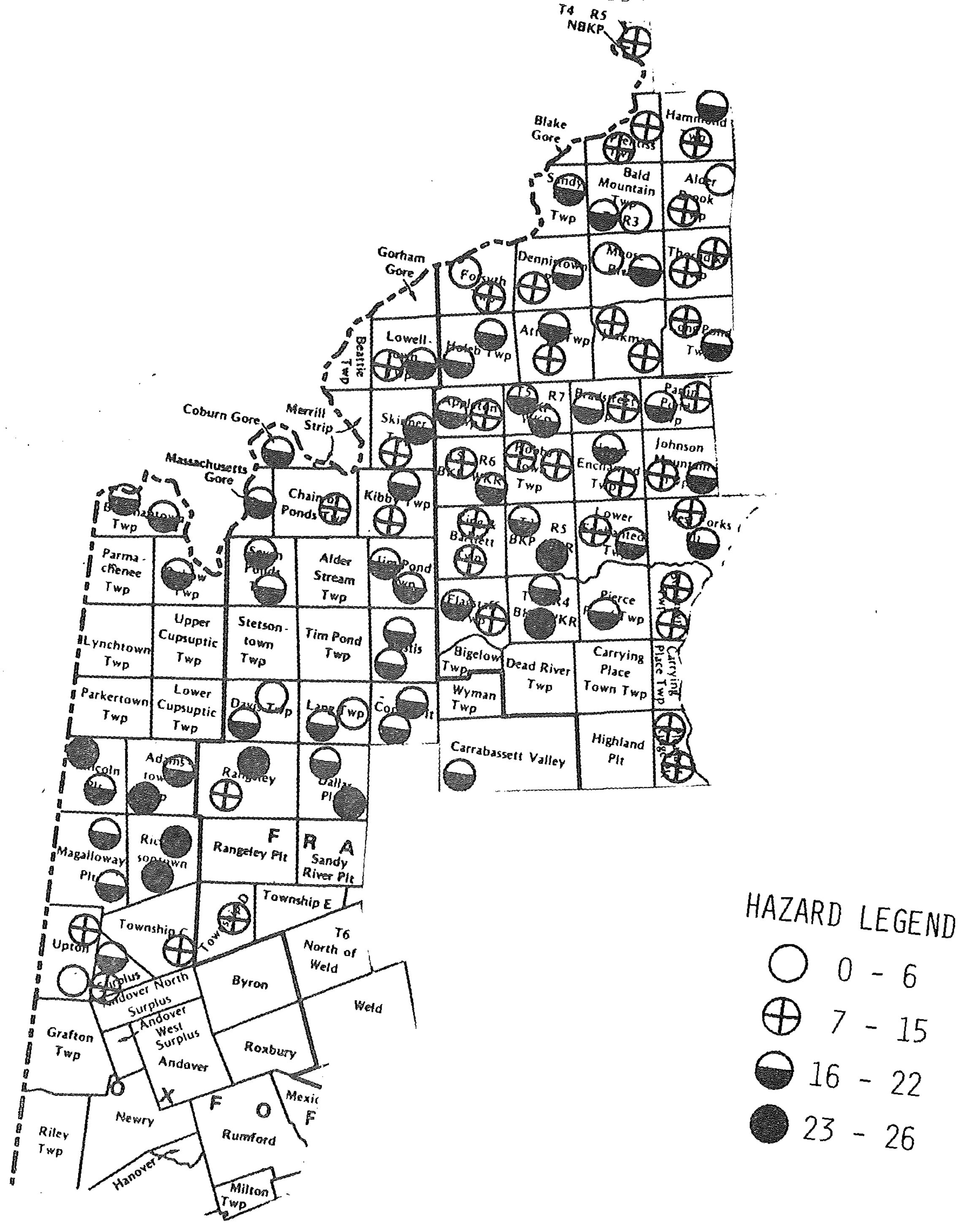


Figure 25. 1982 Spruce Budworm Hazard Appraisal Map of the Western Mountains Zone.

Agricultural areas on the east border of the zone were also found to be moderate. In the remainder of the zone, high hazard is predicted.

Penobscot-Mattawamkeag -- With the exception of the Millinocket area, which was moderate, all of this zone was found to be high or extreme. Extreme hazard was predicted near Mattawamkeag and in the eastern portion. Conditions in the zone for 1983 are expected to be worse than in 1982 due to heavy 1982 defoliation and prediction of high 1983 populations.

Southeast-Coastal -- Almost all of this zone was found to be extreme. High hazard was predicted for the coastal area and 1982 treatment areas. Extreme conditions persist in the zone because of critical tree condition and continued high populations. Improvements near spray areas were due to foliage saved by spraying and a slight lowering in predicted populations.

Moosehead Zone -- Conditions have improved in this zone due to relatively low populations for the last two seasons. High hazard was found around Moosehead Lake, but most of the zone was moderate. High areas were maintained largely by accumulated past damage. The general trend of the zone was toward a reduced hazard.

Western Mountains -- Northern and southern extremes of this zone are predicted to be in moderate hazard. The central portion of the zone is high. Moderate hazard in the northern portions of the zone were due to low populations in 1981 and 1982 resulting in improved tree conditions. Two areas of extreme hazard were found in the Rangeley area.

Ground surveys and aerial checks of questionable areas were used to prepare a general hazard map (Figure 26). This map shows approximately 4.5 million acres of high and extreme hazard.

H. Spray Area Selection

Some landowners spray stands with the sole goal of keeping trees alive for a short period until they can be harvested. Other landowners are more agressive and spray more often in an attempt to allow growth or at least keep trees in good condition. This more agressive strategy sometimes means treatment of trees in moderate hazard. The MFS has been receptive to both strategies in order to meet the needs of a variety of landowners.

Generally, spray areas are selected from the high and extreme hazard area shown in Figure 26.

Under conditions of the voluntary spray program, landowners make application for inclusion of various lands in the spray

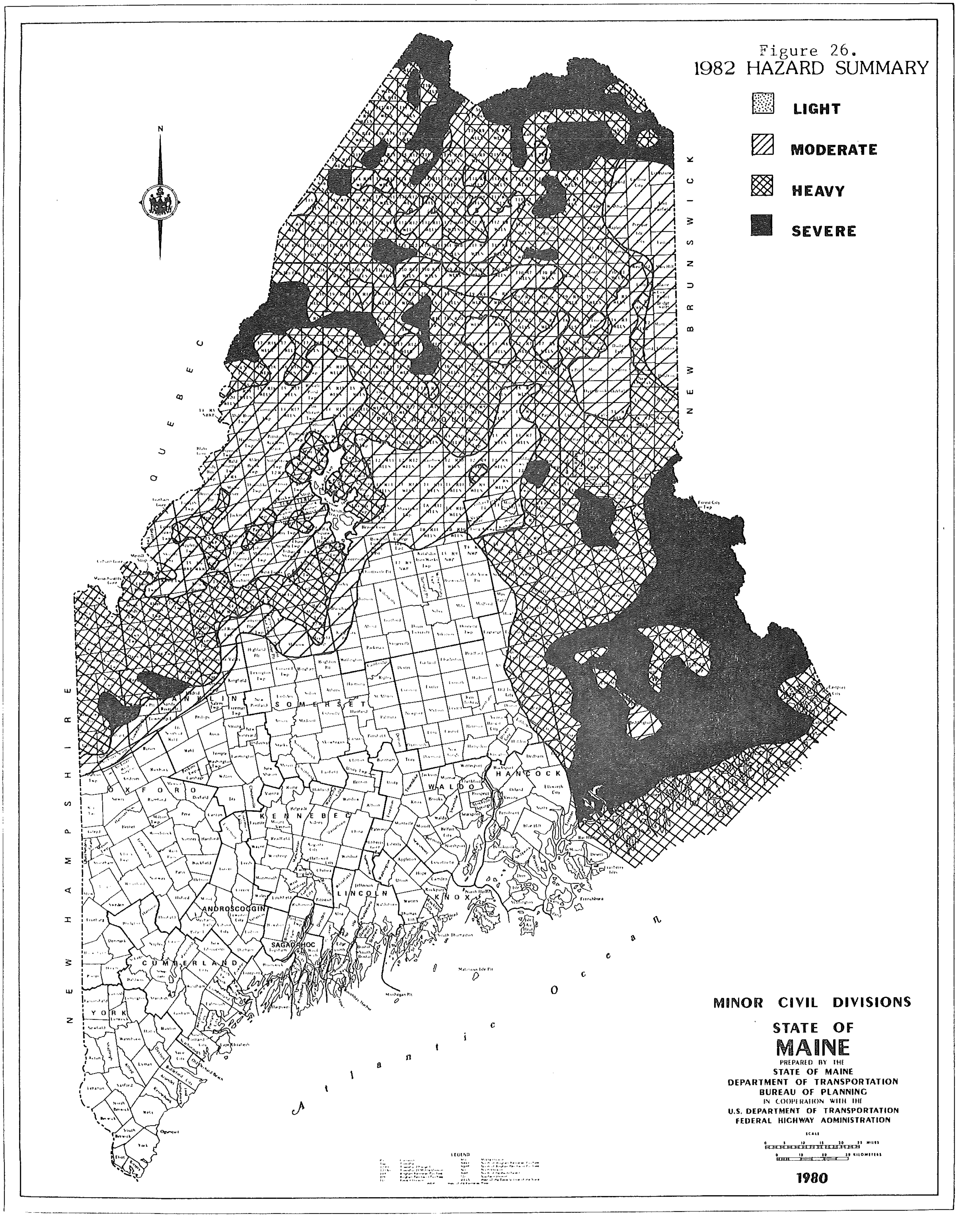


Figure 26.
1982 HAZARD SUMMARY

program. The MFS then evaluates these applications and specifies the final spray area.

The general spray area selection procedure is as follows:

1. MFS evaluates treatment results for the current year and provides data to the landowners (mid-summer).

2. MFS conducts general surveys to predict expected population and tree conditions and provides data to the landowners (November 1 completion).

3. Landowners review survey results for their lands, conduct their own evaluations of conditions, and examine company protection goals.

4. MFS provides general hazard maps and specific recommendations to the landowners (mid-November).

5. Joint MFS and landowner review of conditions on specific lands (prior to December 1).

6. Landowners submit proposed spray and 5 year acreage to MFS (December 1).

7. MFS review and approval of acreage (December 15).

8. Ongoing landowner and MFS evaluation of submitted lands including specific L-II sampling (December and January).

9. Final date for landowner withdrawal from next spray program (February 1).

V. 1982 EFFORTS AND FORECAST OF CONDITIONS IN QUEBEC AND NEW BRUNSWICK

The Province of Quebec conducted an aerial spray operation on 1,284,273 hectares in 1982. Split applications of Matacil or Fenitrothion were used on most of this area (1,256,302 hectares). Dipel 88 and Thuricide 32 LV were used on the remainder of the acreage. As in the past, most of the project was treated with four engine aircraft.

Matacil was applied in two applications of 3/4 oz. active ingredient in 20 oz. final volume per acre, and Fenitrothion was sprayed twice at the rate of 3 oz. active ingredient in 20 oz. final volume per acre. The first application was timed for bud flare with the second five days later. Bt was applied at the 8 B.I.U. rate in 64 oz. volume at bud flare.

The spray area was concentrated in the Lower St. Lawrence and Gaspé regions. Populations and results varied considerably between the two areas with the best results in the Lower St. Lawrence area. Prespray populations averaged 25 larvae per 45 cm. (18") branch tip; > 35 in the Gaspé. Larval mortality was near 90%. Foliage protection was good in 40% of the spray area and adequate on another 16% of the area. Bt results were as good as chemical results.

The summer egg mass survey conducted in Quebec, showed a sharp upturn in predicted population. Populations for 1983 should match high 1982 levels and severe defoliation is expected. A protection project, at least as large as the 1982 project, is expected.

In New Brunswick in 1982, about 1.69 million hectares were treated with either a single or split application of Fenitrothion. A small area was treated with Matacil 180 Flowable. Included in the operational acreage treated in 1982 was about 45,000 acres sprayed in small private woodlots in the former "one mile set back zone". Bt was tested on 4,000 acres. Protection was generally considered good with 65 to 75% foliage retained and budworm survival generally less than 15%. In general, results in 1982 were comparable to the good results seen over the past six years.

The 1982 egg mass survey showed a moderate to high infestation level throughout the Province. Egg deposit was higher in the protection areas then the buffer area. The 1982 infestation level in the central and southern areas of New Brunswick's protection zone was significantly higher than that seen in 1981. Levels were about the same in the north.

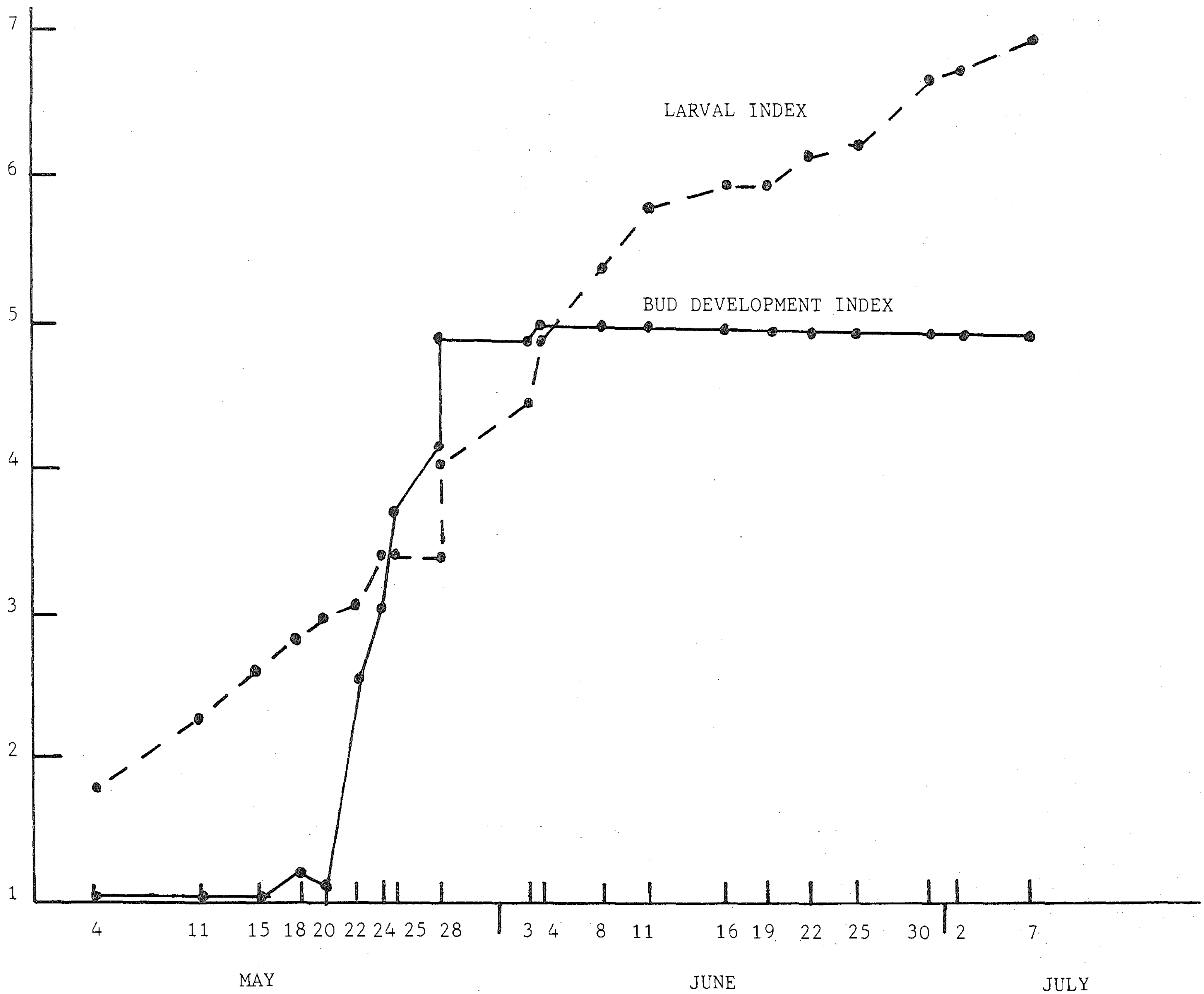
Most of the protection area in New Brunswick was classed as moderate to high hazard in 1982. The current situation suggests a program in 1983 similar in size to the 1982 program.

APPENDIX A

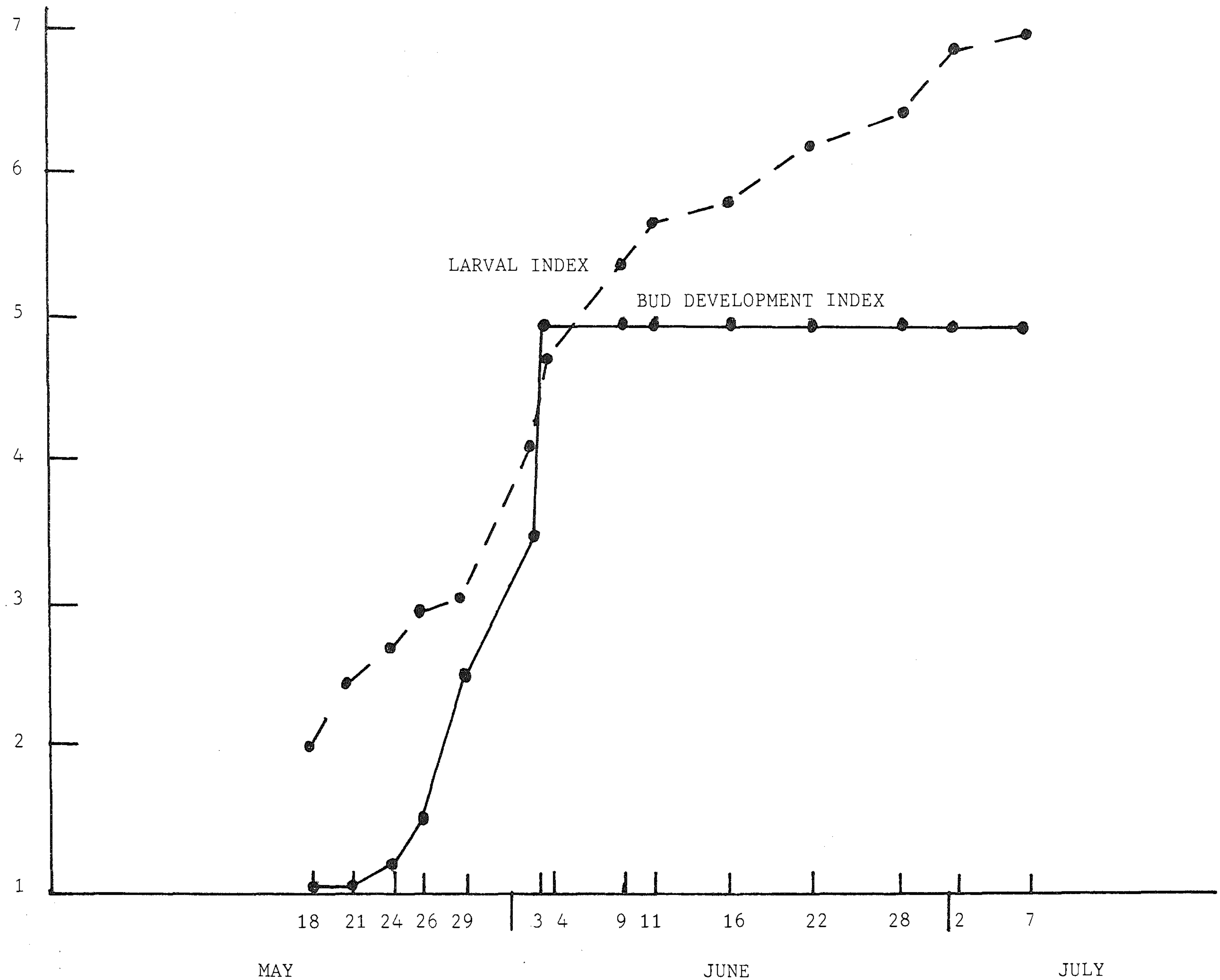
SPRUCE BUDWORM PROJECT 1982

DEVELOPMENT CHARTS

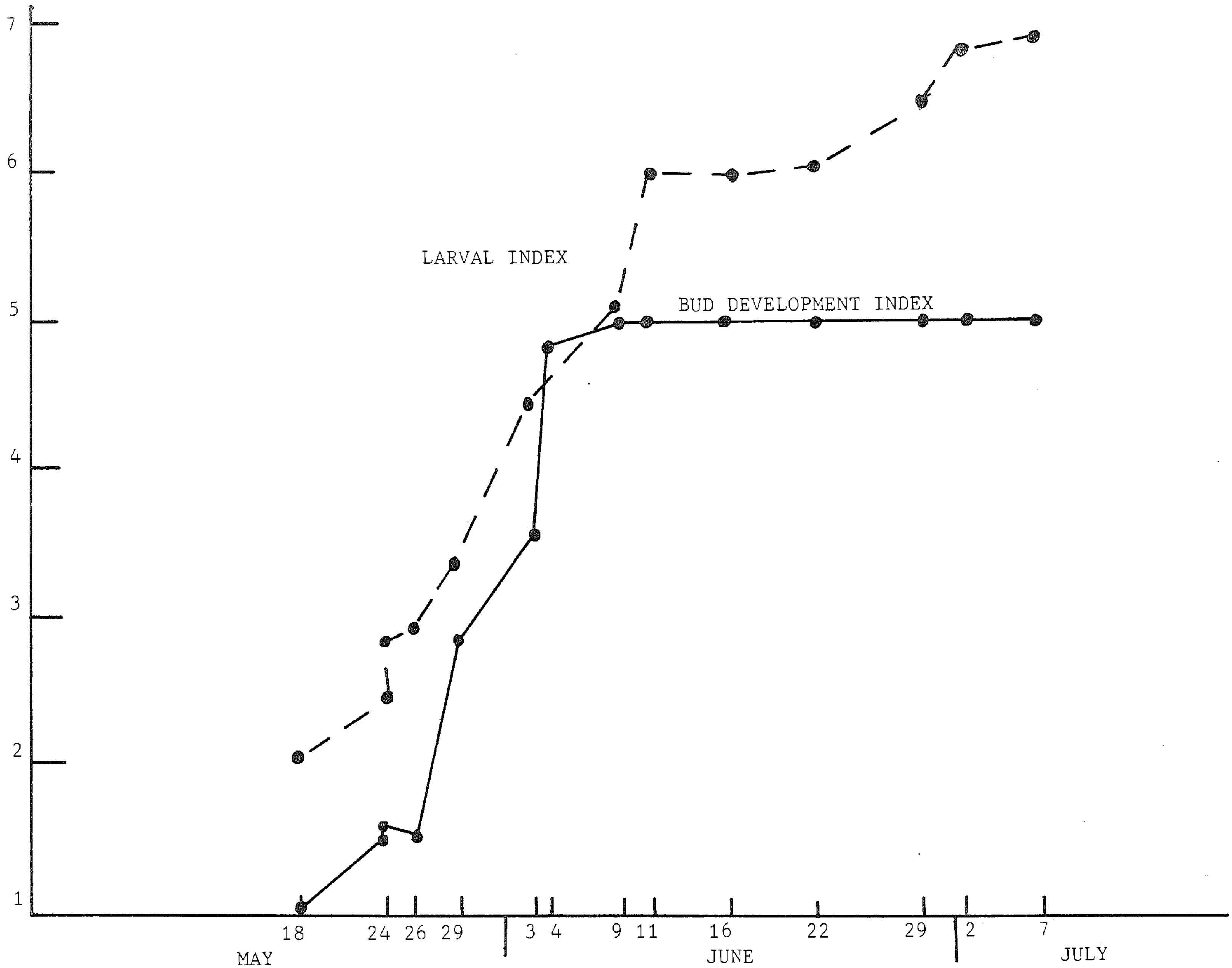
LARVAL AND BUD DEVELOPMENT IN 1982 AT PRINCETON



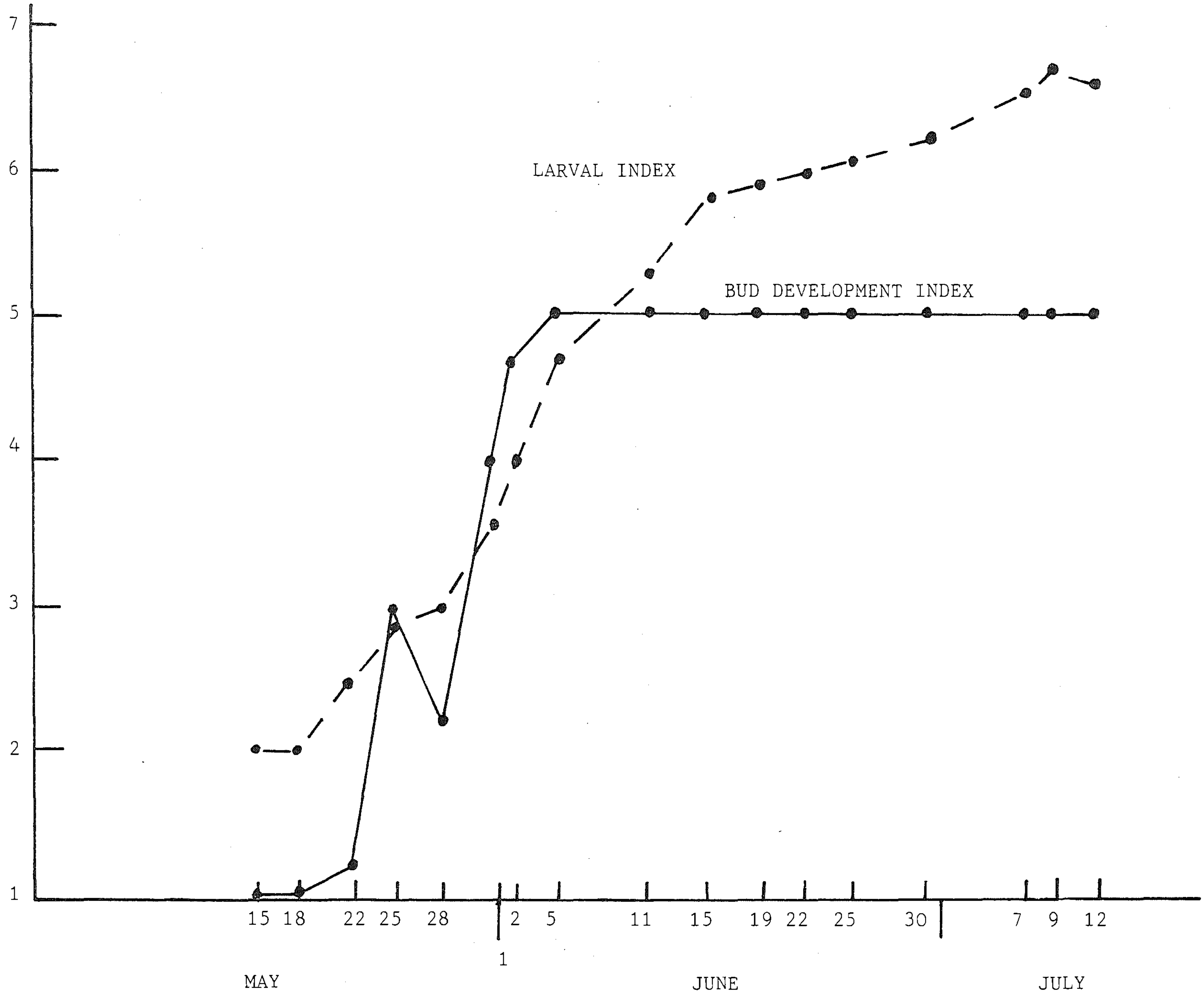
LARVAL AND BUD DEVELOPMENT IN 1982 AT UMSASKIS



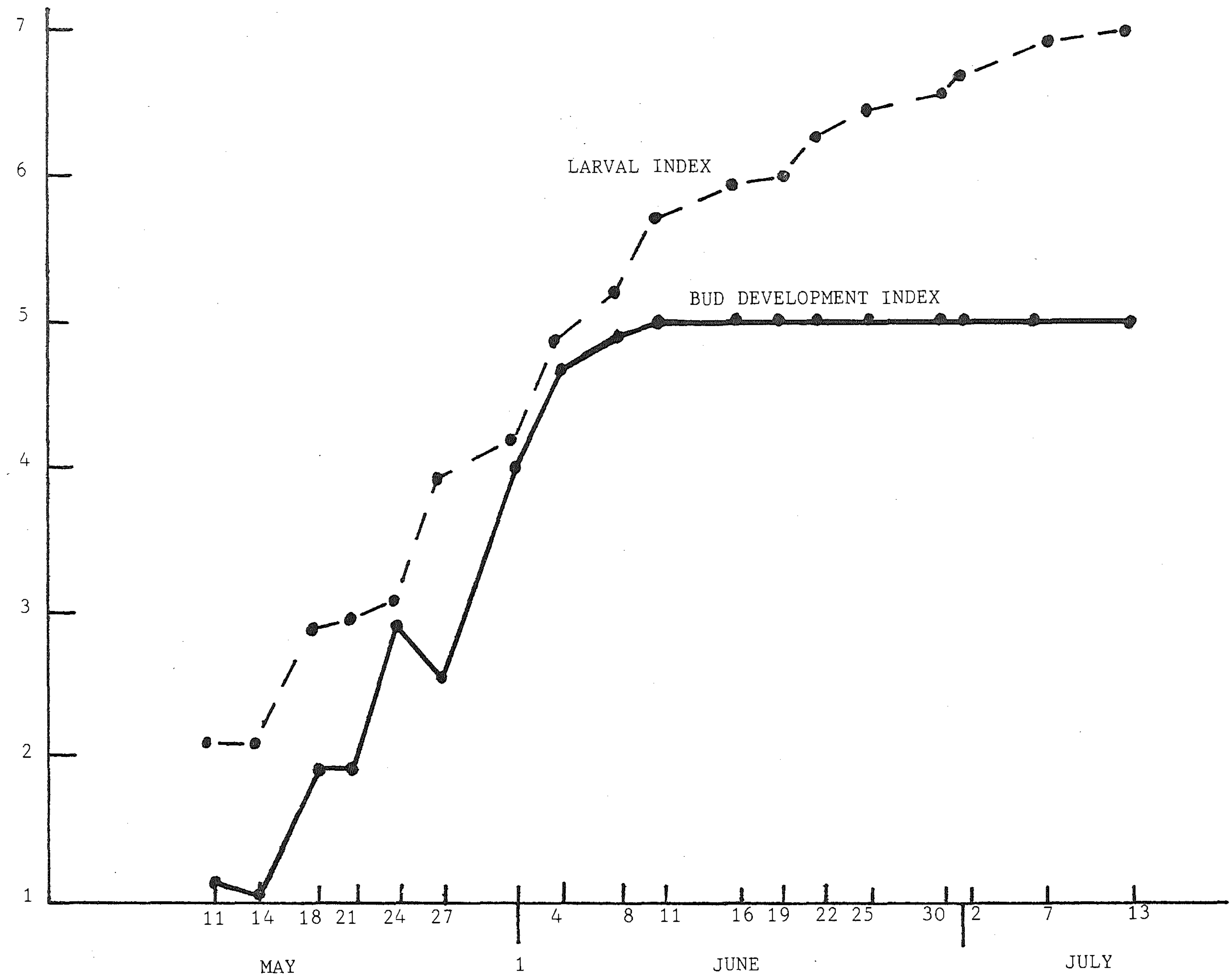
LARVAL AND BUD DEVELOPMENT IN 1982 AT ALLAGASH



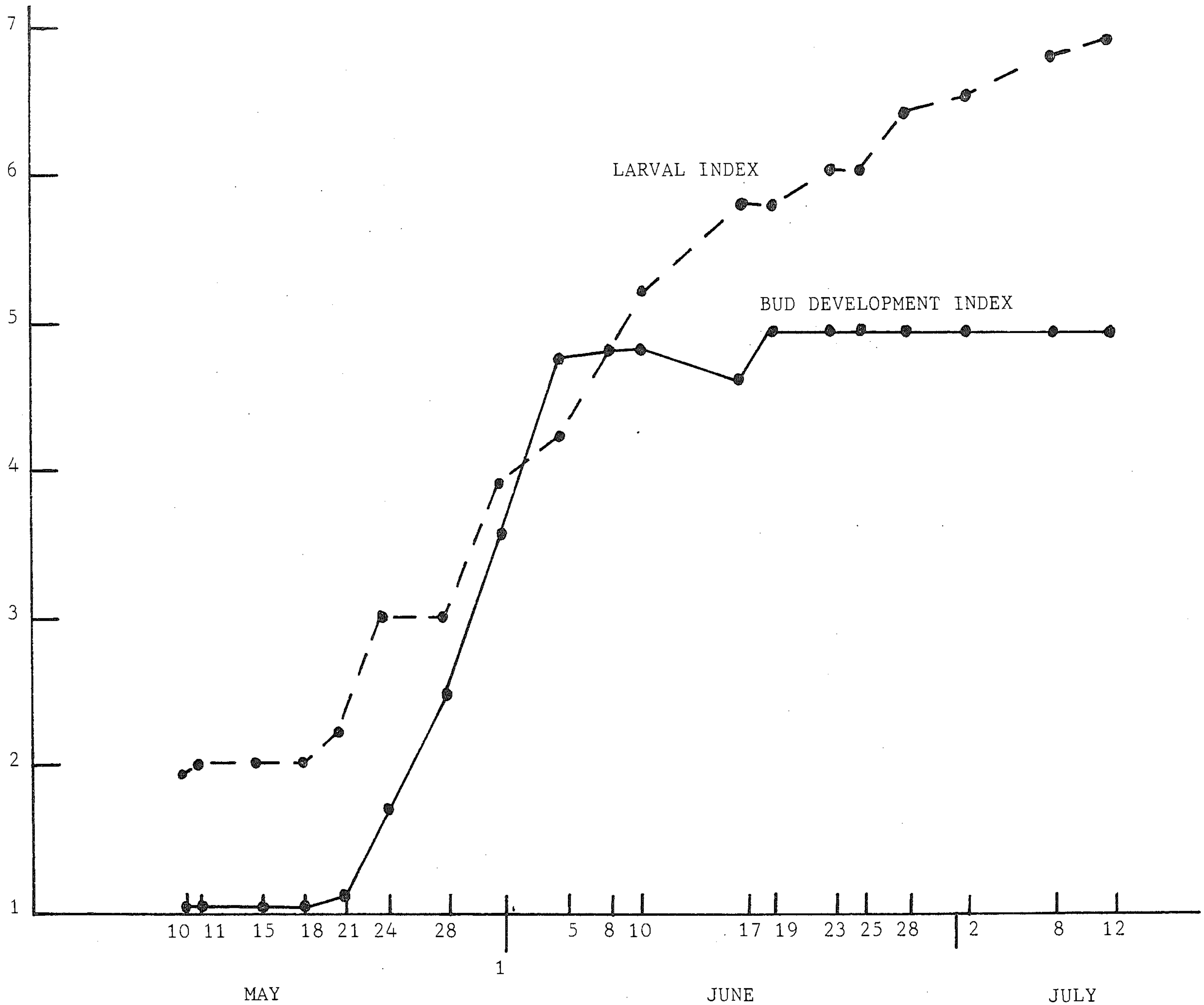
LARVAL AND BUD DEVELOPMENT IN 1982 AT DENNISTOWN



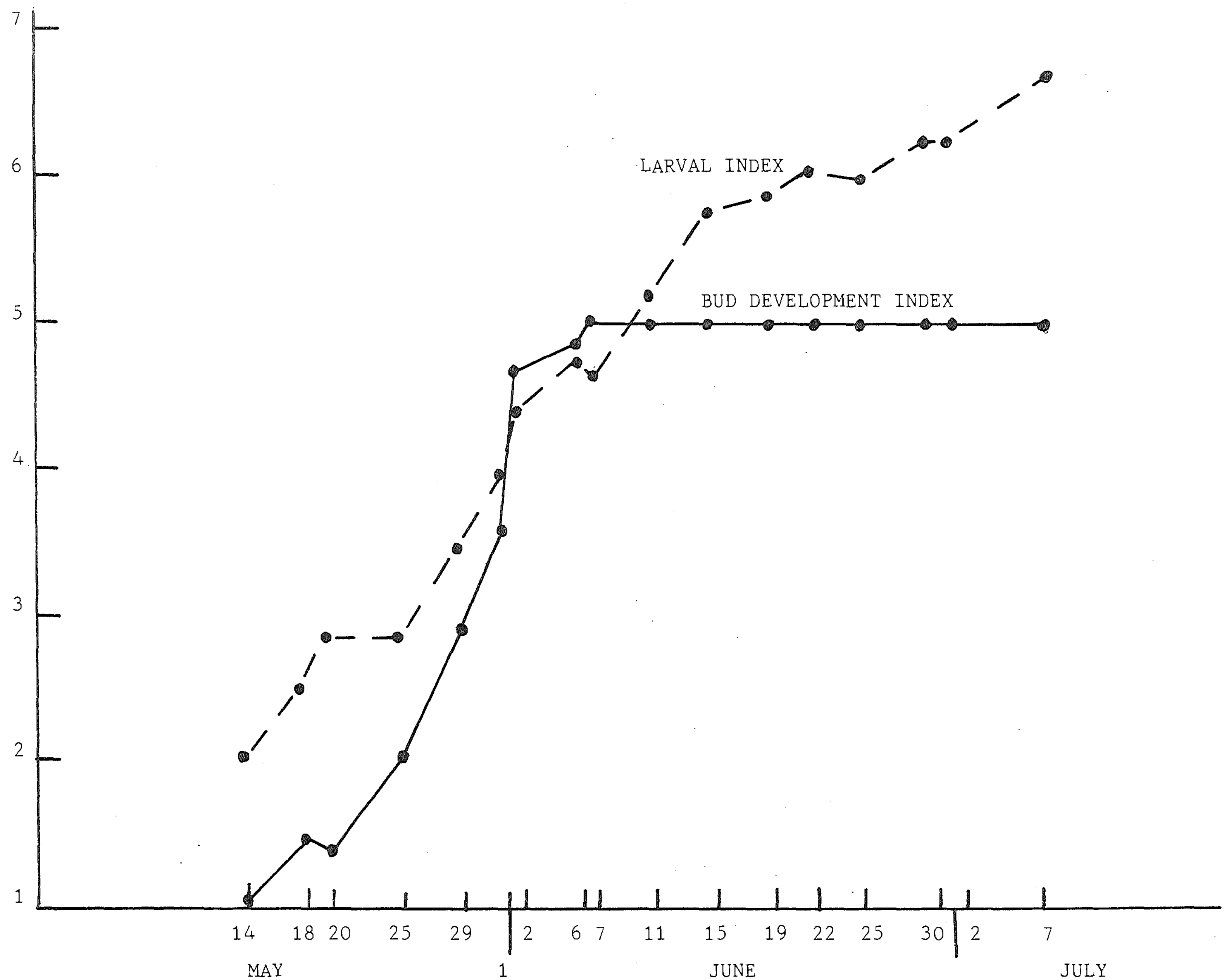
LARVAL AND BUD DEVELOPMENT IN 1982 AT T1 R4 (MACWAHOC)



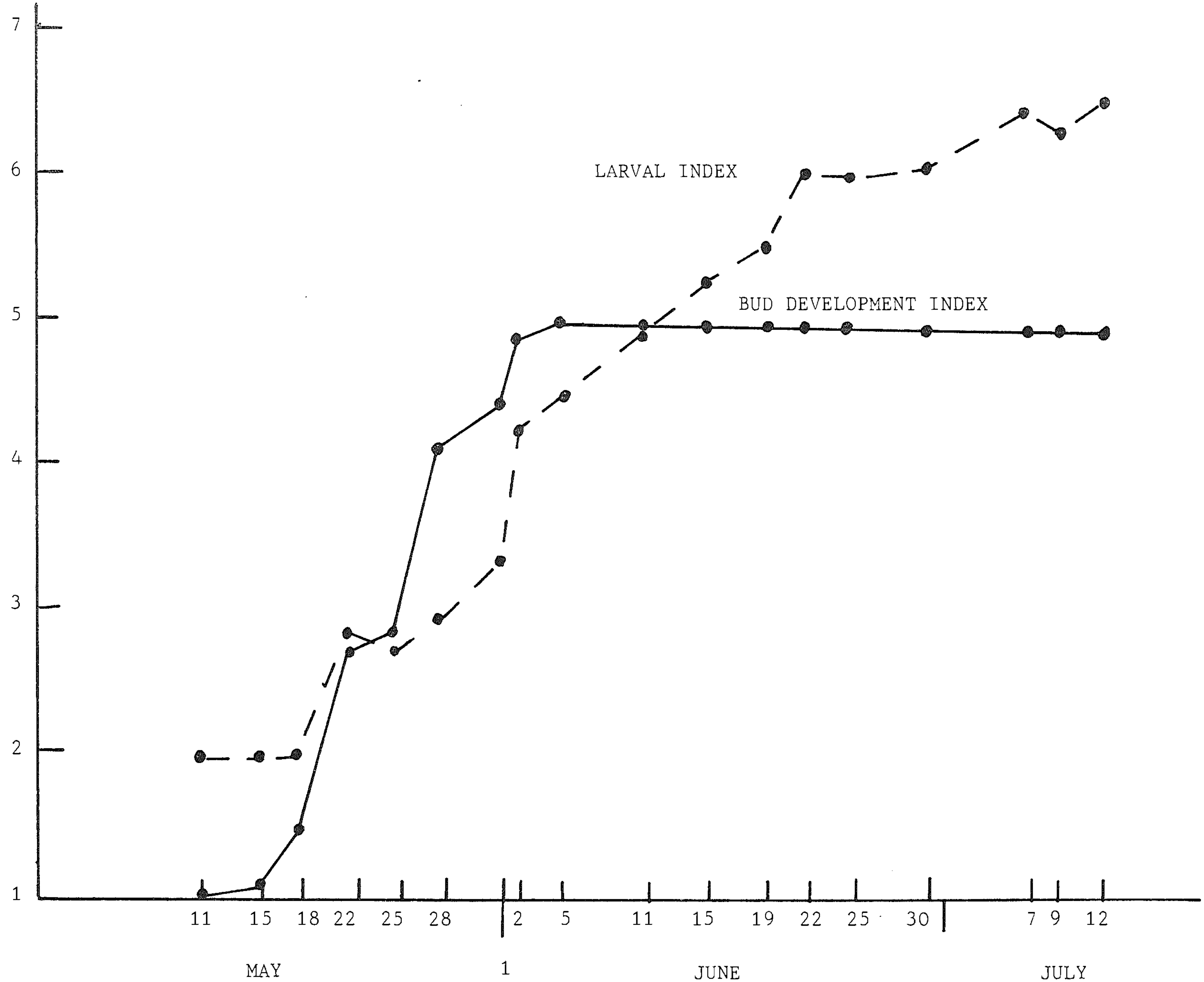
LARVAL AND BUD DEVELOPMENT IN 1982 AT T6 R11 (ROUND POND)



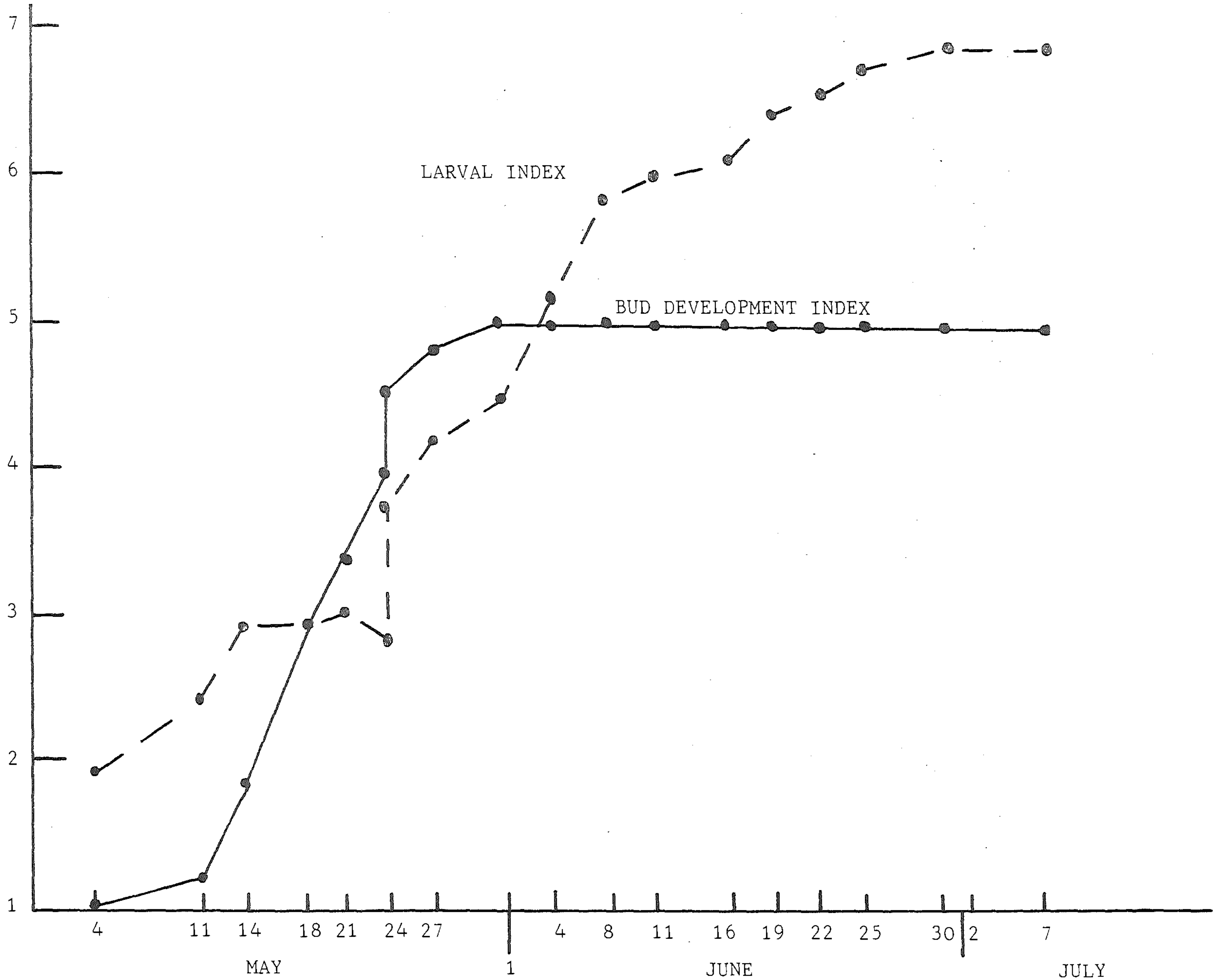
LARVAL AND BUD DEVELOPMENT IN 1982 AT EUSTIS



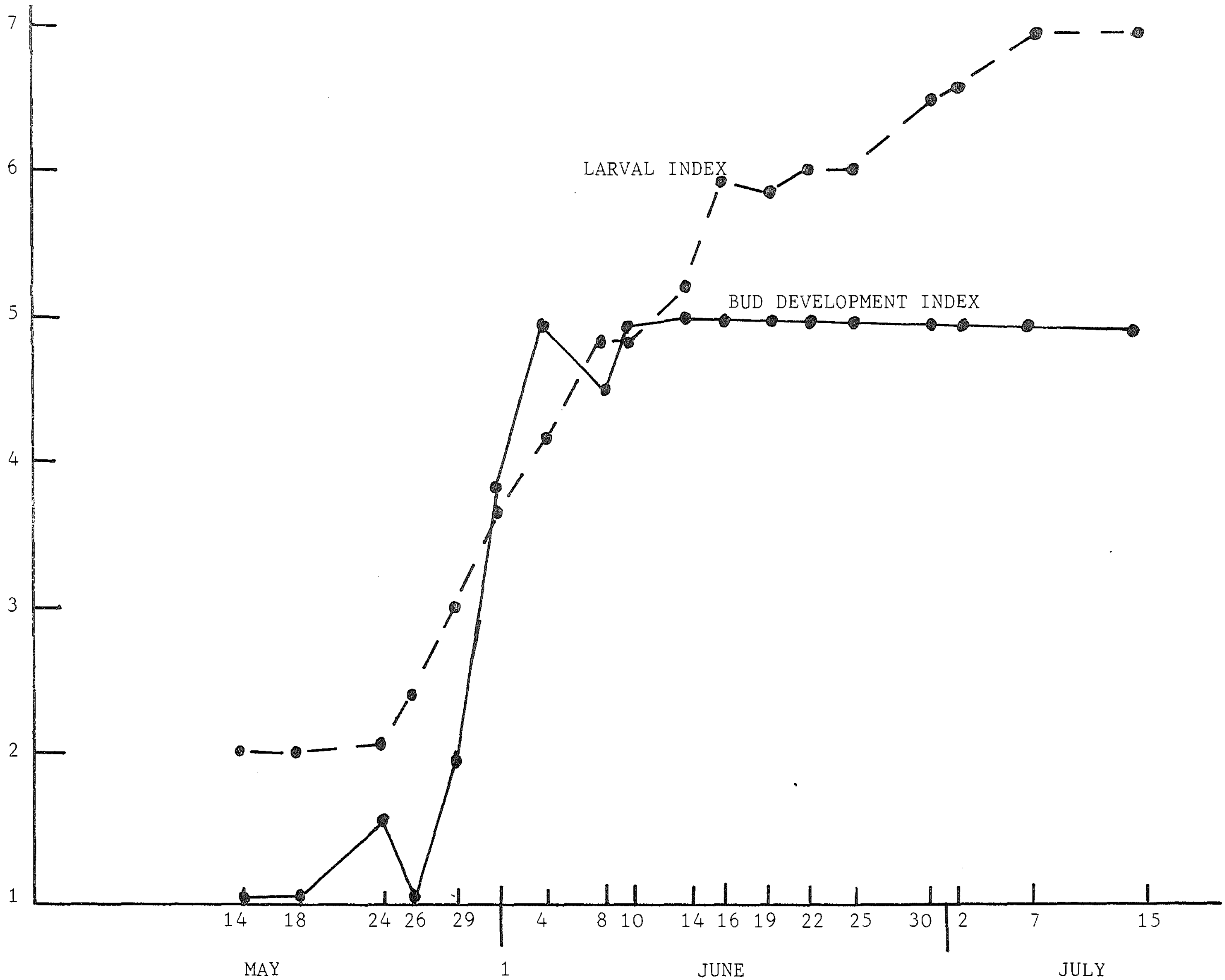
LARVAL AND BUD DEVELOPMENT IN 1982 AT SHIRLEY



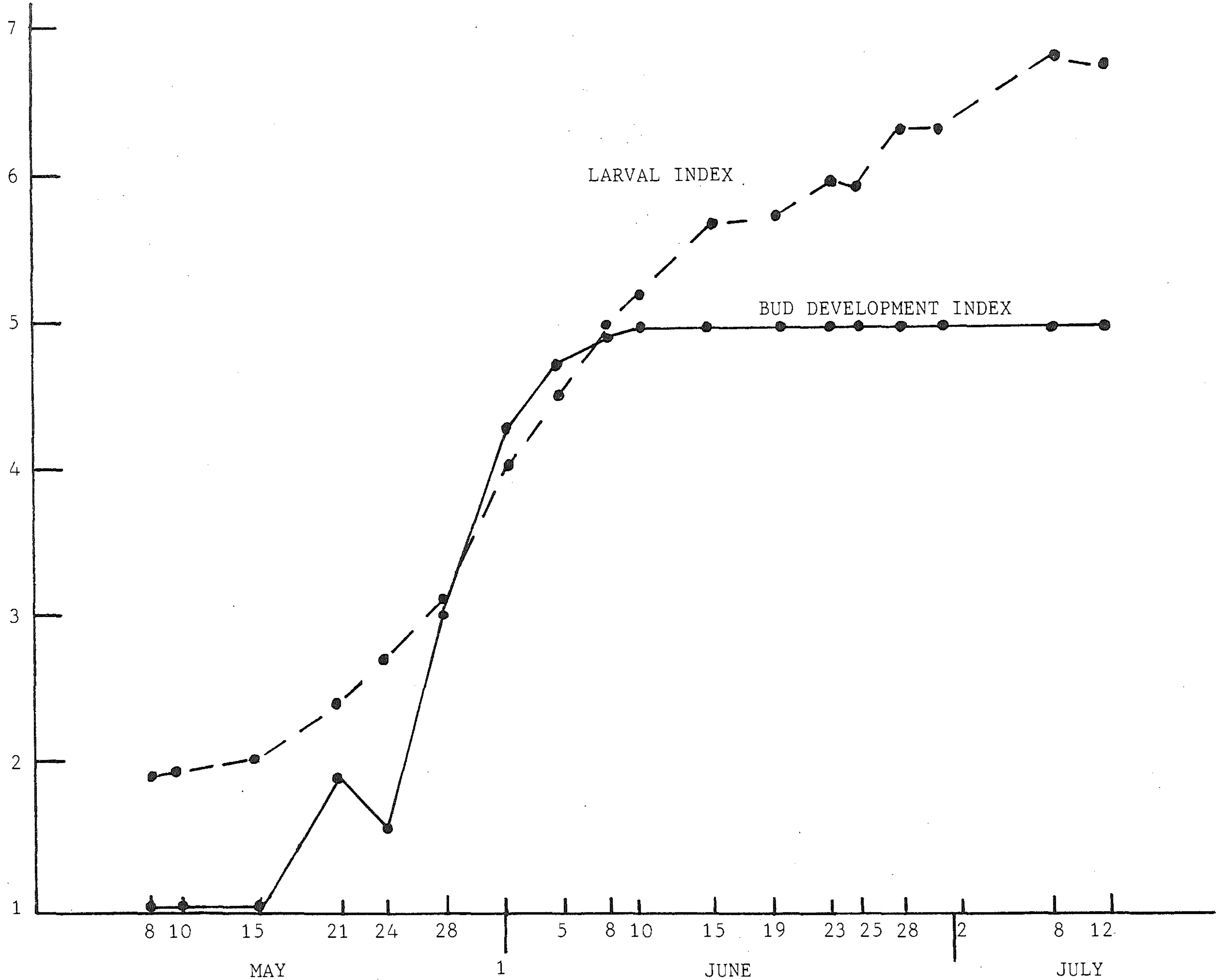
LARVAL AND BUD DEVELOPMENT IN 1982 AT LINCOLN



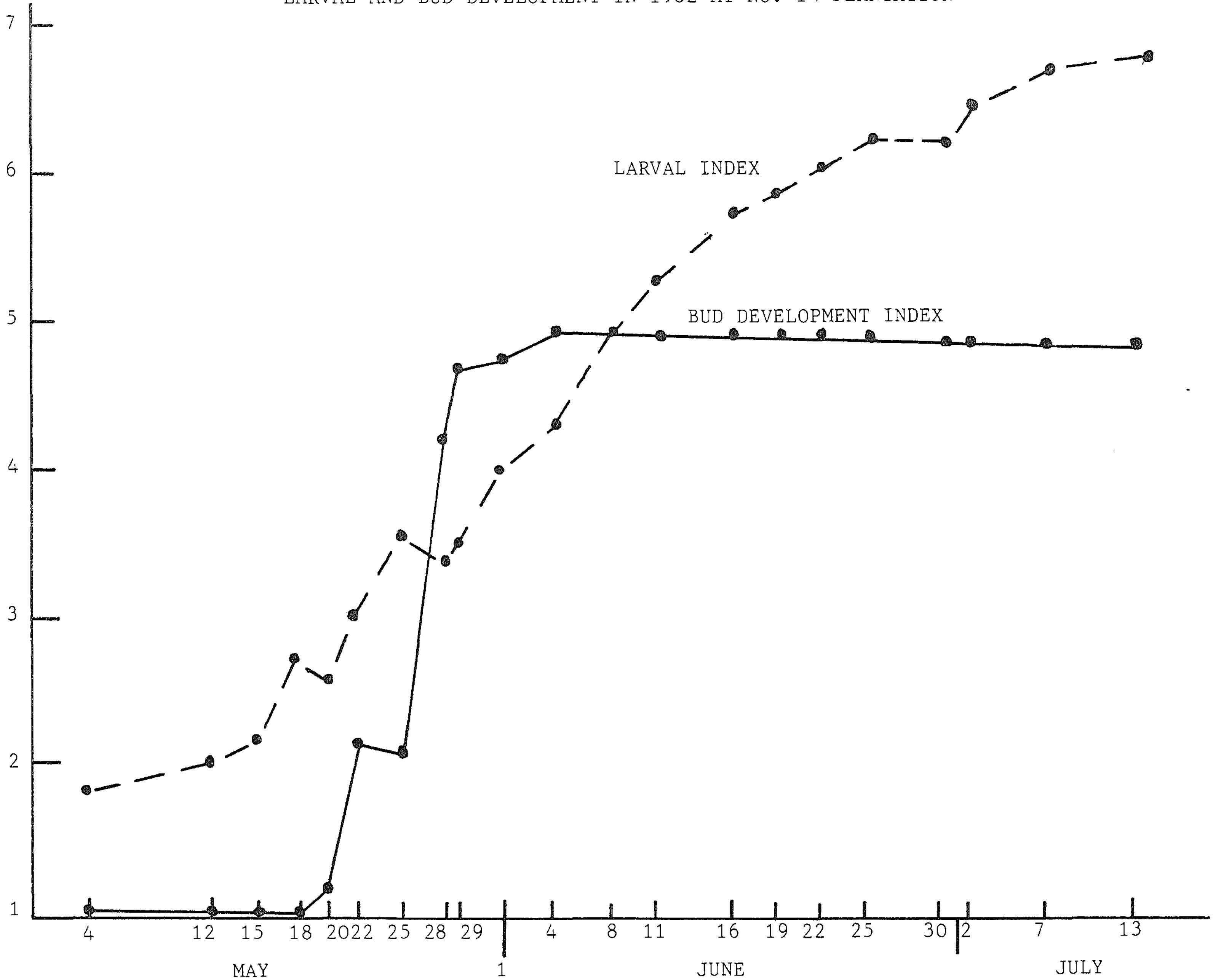
LARVAL AND BUD DEVELOPMENT IN 1982 AT T17 R5 (CROSS LAKE)



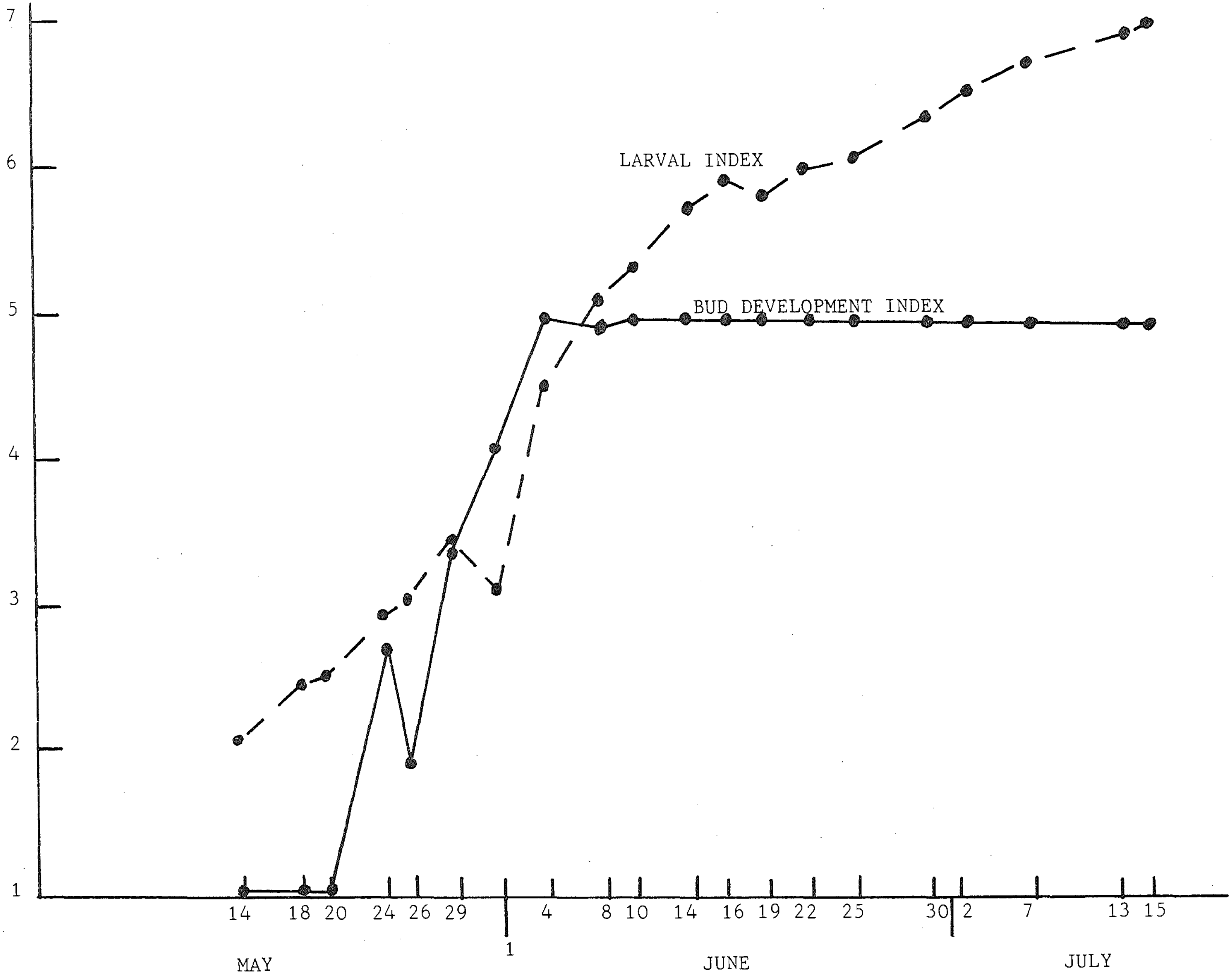
LARVAL AN BUD DEVELOPMENT IN 1982 AT T3 R12 (CHESUNCOOK)



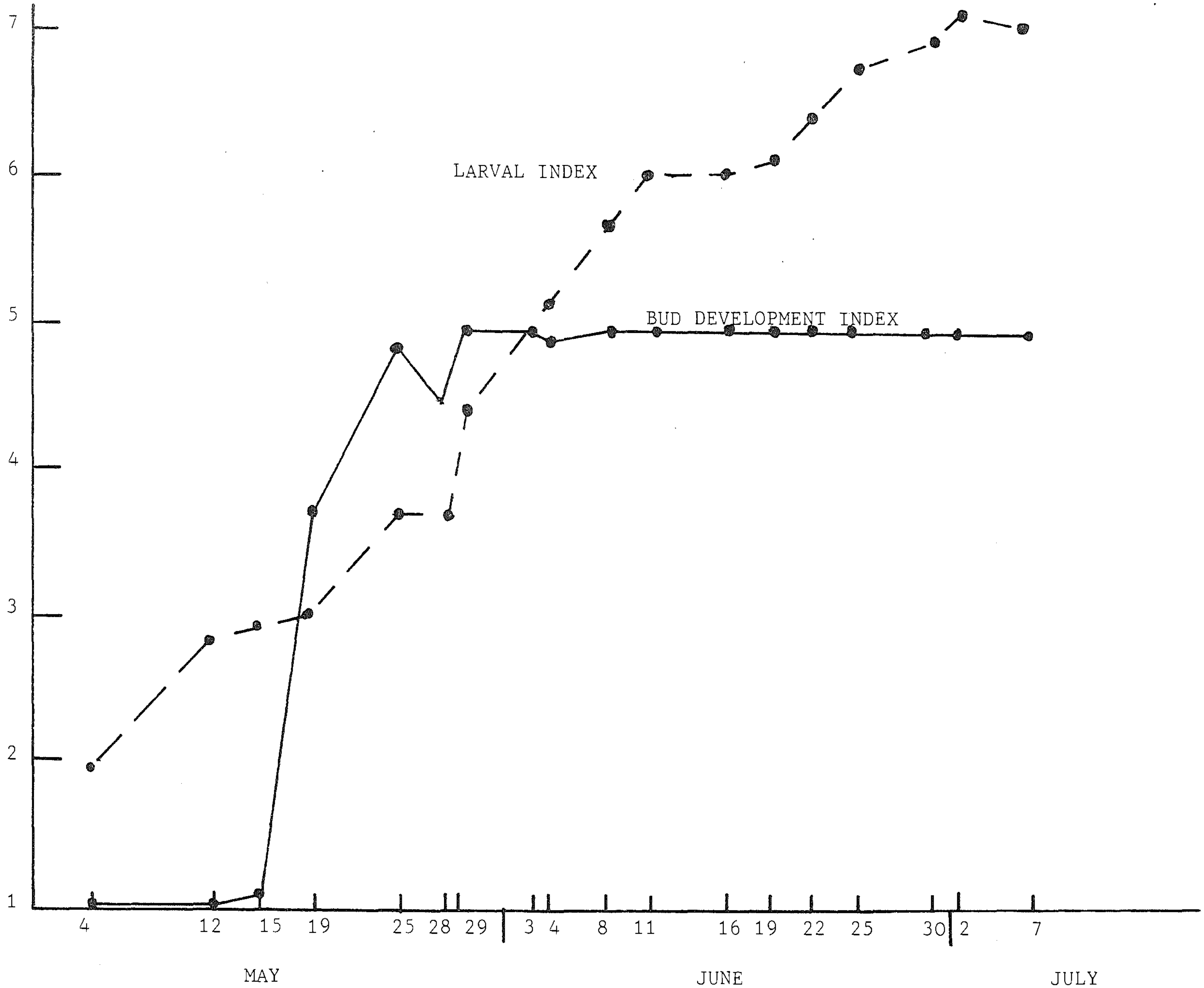
LARVAL AND BUD DEVELOPMENT IN 1982 AT NO. 14 PLANTATION



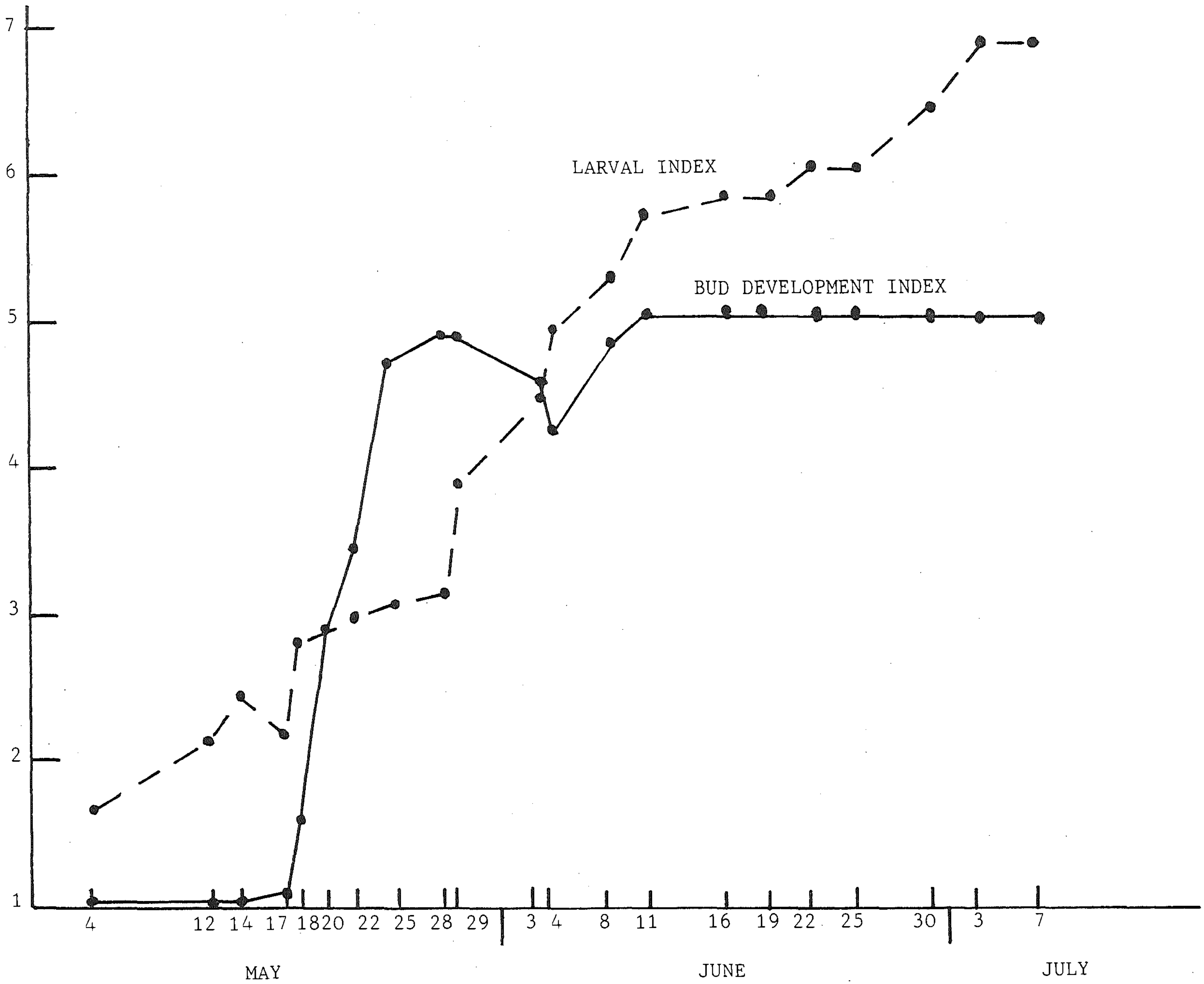
LARVAL AND BUD DEVELOPMENT IN 1982 AT OXBOW



LARVAL AND BUD DEVELOPMENT IN 1982 AT BRADLEY



LARVAL AND BUD DEVELOPMENT IN 1982 AT T36 MD



LARVAL AND BUD DEVELOPMENT IN 1982 AT ADAMSTOWN