SPRUCE BUDWORM IN MAINE

Results of The 1983 Project, Biological Conditions in 1983

and

Expected Infestation Conditions for

1984

Entomology Division
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SPRUCE BUDWORM IN MAINE: RESULTS OF THE 1983 PROJECT, BIOLOGICAL CONDITIONS IN 1983 AND EXPECTED INFESTATION CONDITIONS FOR 1984

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 conducts insect studies of budworm damaged stands and cooperates with others in the MFS Entomology Division on surveys of budworm damaged trees. Complete 1983 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. Results of the 1983 operational evaluation are presented in this report and a summary of 1983 testing is provided.

A. Personnel Organization

The BSAU has a year round staff of sixteen. The fall and winter staffing of the BSAU is shown in Figure 1. During the 1983 Spray Project, five of these permanent employees went into project funded positions in an acting capacity, and an additional thirty-eight project funded employees were added to the staff. The summer organization of the BSAU is shown on Figure 2.

B. Survey Zones

Survey zones have been defined for 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 descriptions are given in Table 1.

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

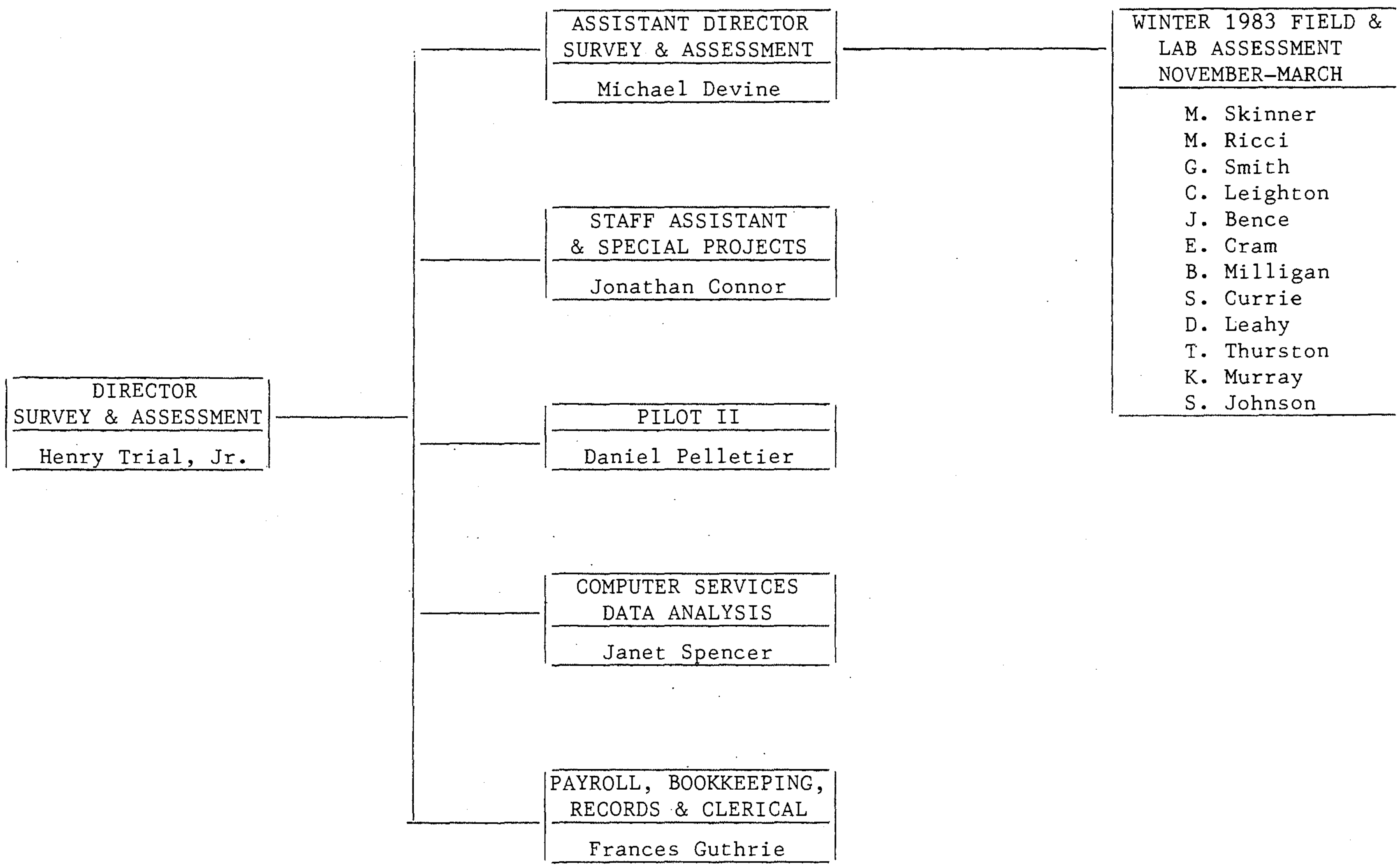
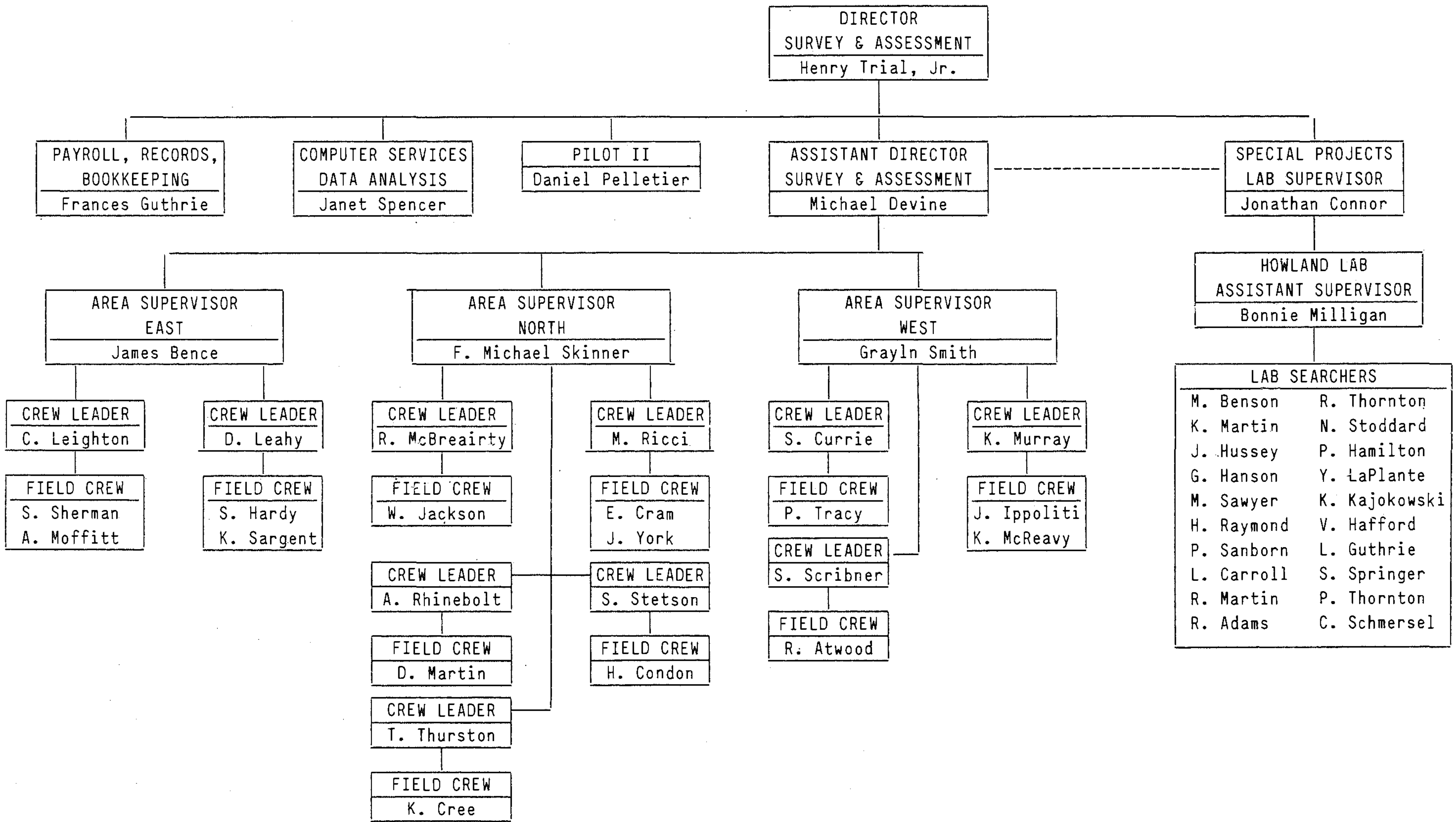


FIGURE 2.
MAINE FOREST SERVICE BUDWORM SURVEY AND ASSESSMENT UNIT SUMMER PROJECT ORGANIZATION



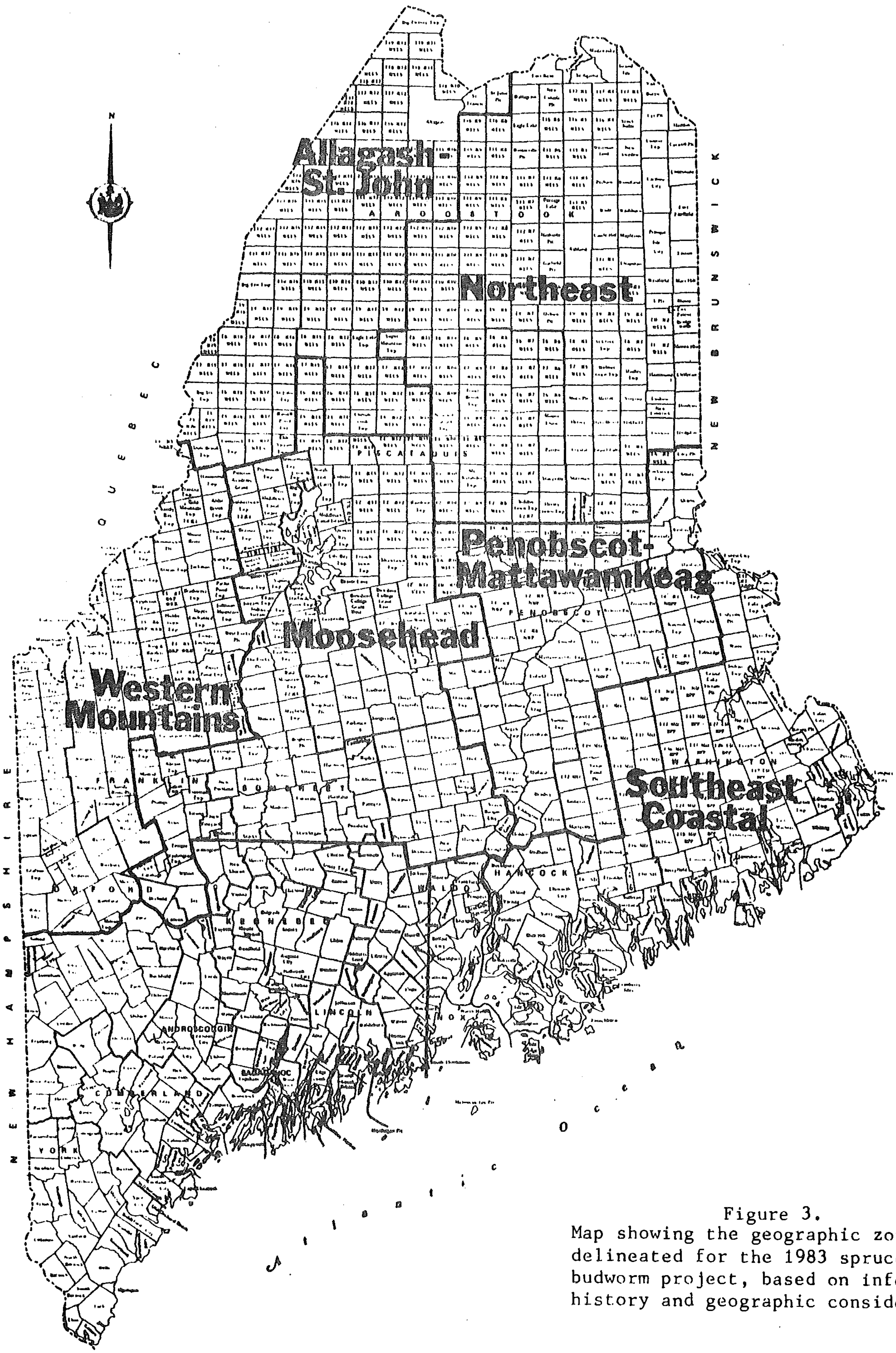


Figure 3.
Map showing the geographic zones delineated for the 1983 spruce budworm project, based on infestation history and geographic considerations.

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 softwood, ridges mostly hardwood or hemlock
Southeast Coastal Zone	Mostly coastal influence, shallow rocky soil	Mixed softwood and scrub hardwood; softwood, heavy to spruce and hemlock with pockets of fir
Moosehead Zone	Softwood flats in the northern section of the zone; southern portion 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 1983

The magnitude of budworm impact in a given season is highly dependent on several biological factors including budworm population health, host conditions, and budworm parasitism. These factors are assessed or observed annually and provide a more complete understanding of the severity of budworm feeding and the corresponding host response.

A. Budworm Health in 1983

Unusual weather in 1983, high populations, and unusual host development caused lower than normal budworm survival. Cool, wet weather in May caused larval reductions of 10 to 40% in some areas and probably stressed budworm throughout the life cycle. The effect of very hot humid weather in June and July are unknown, but moth activity may have been affected.

Larval survival rates in 1983 were near or slightly below normal, but extreme variability was noted. Larval mortality in untreated areas varied from 40 to 98% and often extreme variability was noted from check lines in close proximity. Survival in nearly all zones was lower than 1982 levels, but the high level of variability made comparisons difficult.

B. Pre-Treatment Host Conditions in 1983

The condition of fir and spruce in the infested areas was noted prior to the 1983 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 four seasons and trees are in fair or good condition. New areas added to the protection zone in 1982 were improved, but are still in serious condition. Because the zone has been under continued budworm attack since 1977, trees in unsprayed areas and buffer zones are in critical condition or are dead.

Northeast -- Stand condition deterioriated in unsprayed portions of the northeast in 1982, 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 improved in 1982 and are in fair or good condition.

Moosehead -- Defoliation was relatively light in most of this zone in 1982 and because of this, most stands were improved. Most areas are now in fair condition and some areas have improved to good.

Western Mountains -- Low 1981 and 1982 populations 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. With good 1981 and 1982 foliage, most surviving stands were in fair condition. Important exceptions are heavily damaged stands from Rangeley to Richardson Twp.

Penobscot-Mattawamkeag -- Little treatment has been done in this zone since 1979. Host type in this zone is not contiguous and stand condition is highly variable. Most host type was in fair or poor condition in 1982, and many stands have considerable tree mortality. Some stands in the zone have begun to recover. Small portions of this zone in the far north and southeast were treated in 1982 and tree condition has improved.

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. Spruce is dying at a rapid rate in unprotected parts of this zone. Tree condition in the remainder of the zone is deteriorating rapidly and most stands are now in critical condition. Areas sprayed in 1982 in this zone continued to improve and some areas reached fair condition.

C. Parasitism Survey

Parasitism of spruce budworm is monitored annually on twelve permanent study plots distributed over the spruce-fir region of Maine (Figure 4). Plots were established in 1978 to provide a consistent basis of data allowing year-to-year trends of parasite populations to be followed. Plots are located outside of treated areas and have only been relocated when tree mortality required it.

Samples are collected at peak 4th instar, peak 6th instar, and peak pupation. Third instar larvae are dissected alive in water to determine the number and species of parasites. Remaining samples are reared individually in shell vials to determine parasite levels.

The mean of total parasitism for all three sample stages was 31.7 (see Table 2) with a range of 19.1% - 59.7%. This figure is adjusted for loss within the budworm population to 4th and 6th instar parasites, but does not reflect budworm population losses to other natural mortality factors. *Apanteles* and *Glypta* caused 12.4% and 5.4% respectively of the total parasitism which is in the range of past years. It is interesting to note that one *Brachymeria* sp.

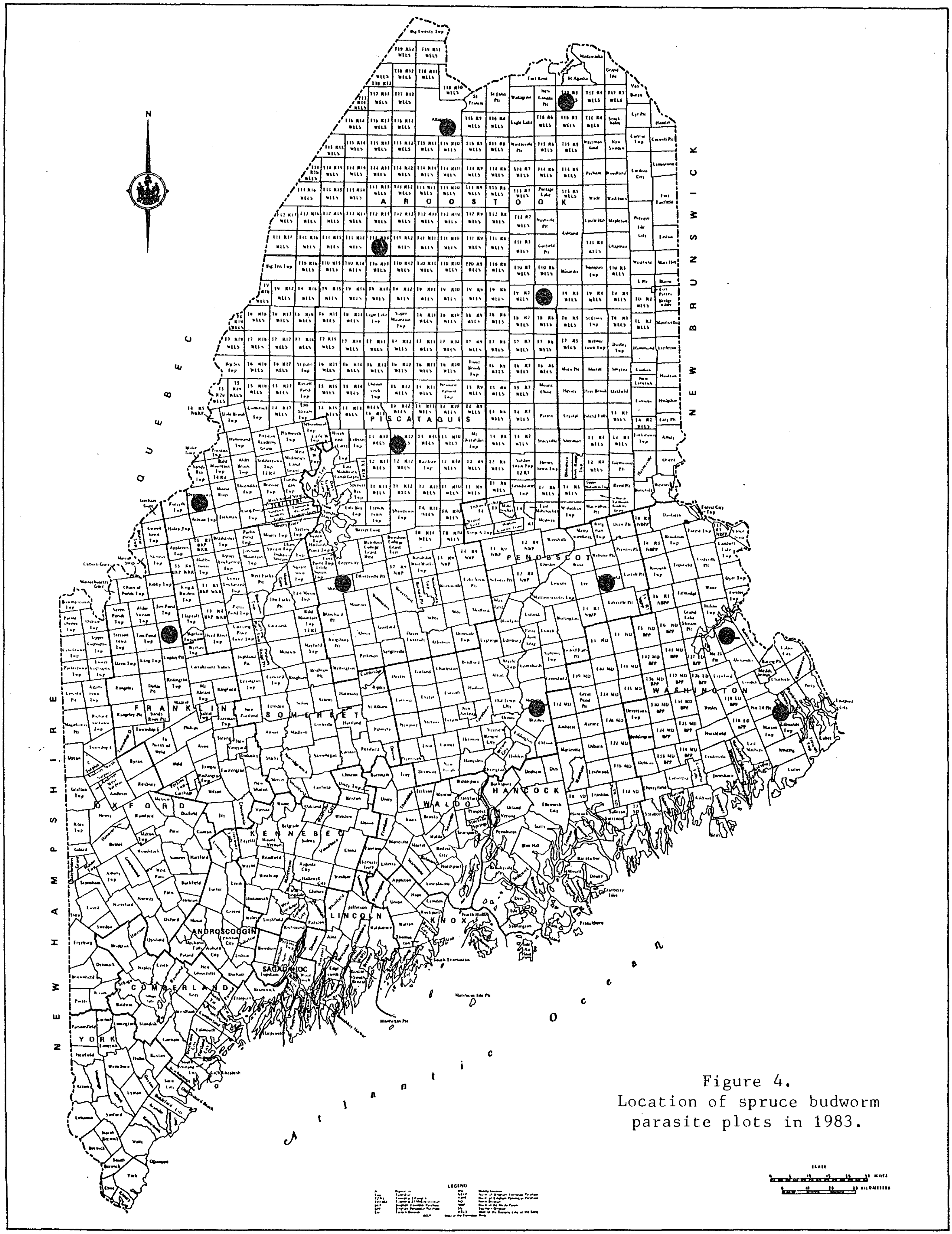


Figure 4.
Location of spruce budworm parasite plots in 1983.

Table 2.
1983 Percentage Parasitism of Spruce Budworm

Location	*Apanteles*	*Glypta*	*Lypha*	*Meteorus*	*Phaeogenes*	*Omotoma*	Miscellaneous Hymenopters	Miscellaneous Diptera	Total Apparent % Parasitism*
Shirley	29.0**	6.4**	8.1**	16.1**	← no data →				59.7
Dennistown Plt.	17.4	2.5	0.0	2.5	0.0	2.2	0.0	7.5	32.0
T3 R12	7.0	5.8	1.4	11.4	7.4	4.5	0.0	0.0	37.5
Bradley	3.1	7.0	0.0	9.6	0.0	1.2	1.2	0.0	22.1
Springfield	15.5	2.8	1.6	0.0	4.6	9.1	0.0	0.0	33.6
Princeton	3.6	3.6	0.0	3.7	0.0**	8.1**	0.0**	0.0**	19.1
Edmunds	16.5	9.2	5.5	1.3	3.9	5.1	1.3	1.3	44.4
Allagash Plt.	14.9	0.0	0.0	0.0	8.5**	8.5**	0.0**	0.0**	31.9
T11 R13	9.6	8.9	0.0	0.0	3.7	1.2	0.0	0.0	23.4
Oxbow Plt.	11.9	6.0	2.1	3.0	3.2	0.0	0.0	0.0	26.2
T17 R5	16.0	4.7	2.1	0.0	**	**	**	**	22.8
Eustis**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0

* Parasitism rates allow only for loss to earlier occurring parasites and do not account for other causes of natural mortality.

** Insufficient number of budworm in sample to provide reliable data.

(prob. *intermedia*) was reared from a pupae from Bradley. To date this is the first confirmed specimen of this introduced parasite our survey has collected.

Several of the 6th instar and pupal samples contained too few live budworm to provide reliable parasite information. This has been noted on Table 2 and was due to very high temperatures at the time of sampling, which resulted in the death of many larvae while being transported to Augusta.

III. BIOLOGICAL ASPECTS OF THE 1983 SUPPRESSION PROJECT

ASSESSMENT OF THE 1983 SPRAY PROJECT AND EFFICACY EVALUATIONS OF INSECTICIDE VARIATIONS TESTED

The Budworm Survey and Assessment Unit timed and evaluated the 1983 spray project and conducted efficacy tests on numerous insecticides and treatment variations. The Unit's project activities included spray timing, block release, prespray population checks, spray efficacy and population evaluations. The data provided by this pre and post spray sampling was the basis for evaluating general project success in terms of adjusted and unadjusted larval mortality and foliage saved by spraying.

Intensive evaluations of several insecticide formulations and timing variations were conducted in special assessment areas in 1983. Included in these evaluations were experimental design and setup, timing and spray deposit assessment. Periodic sampling in these assessment areas over the field season permitted the compilation of several types of data including: population reduction and defoliation curves, adjusted and unadjusted mortality, survival numbers, defoliation, and amount of foliage saved.

A. Treatment Area

The 848,624 acres sprayed in 1983 was spread throughout the northern two thirds of the State (Figure 5). A split application of Matacil was used on most blocks (635,331 acres). Sevin-4-Oil was used (89,441 acres) in a split application near Allagash and on selected blocks in the westcentral and eastcentral areas. Orthene (4,624 acres) was sprayed as a single application on one block south of Presque Isle. A total of five Bt products were used on 119,228 acres. All the Bt used was applied in a single application of 12 BIU's. Most Bt blocks were located in the eastern and southern portions of the treatment area.

B. Application Variations and Timing

Several application variations were used in 1983 (Table 3). Most of the project area was treated with split applications of Matacil or Sevin-4-Oil. Most splits were timed such that the first application occurred before larvae entered the spruce buds and the second application was planned for peak 5th instar or red spruce bud break, whichever occurred first. This timing was used in red spruce areas and where red spruce made up an important portion of the stand. In areas stocked predominantly with fir, the first

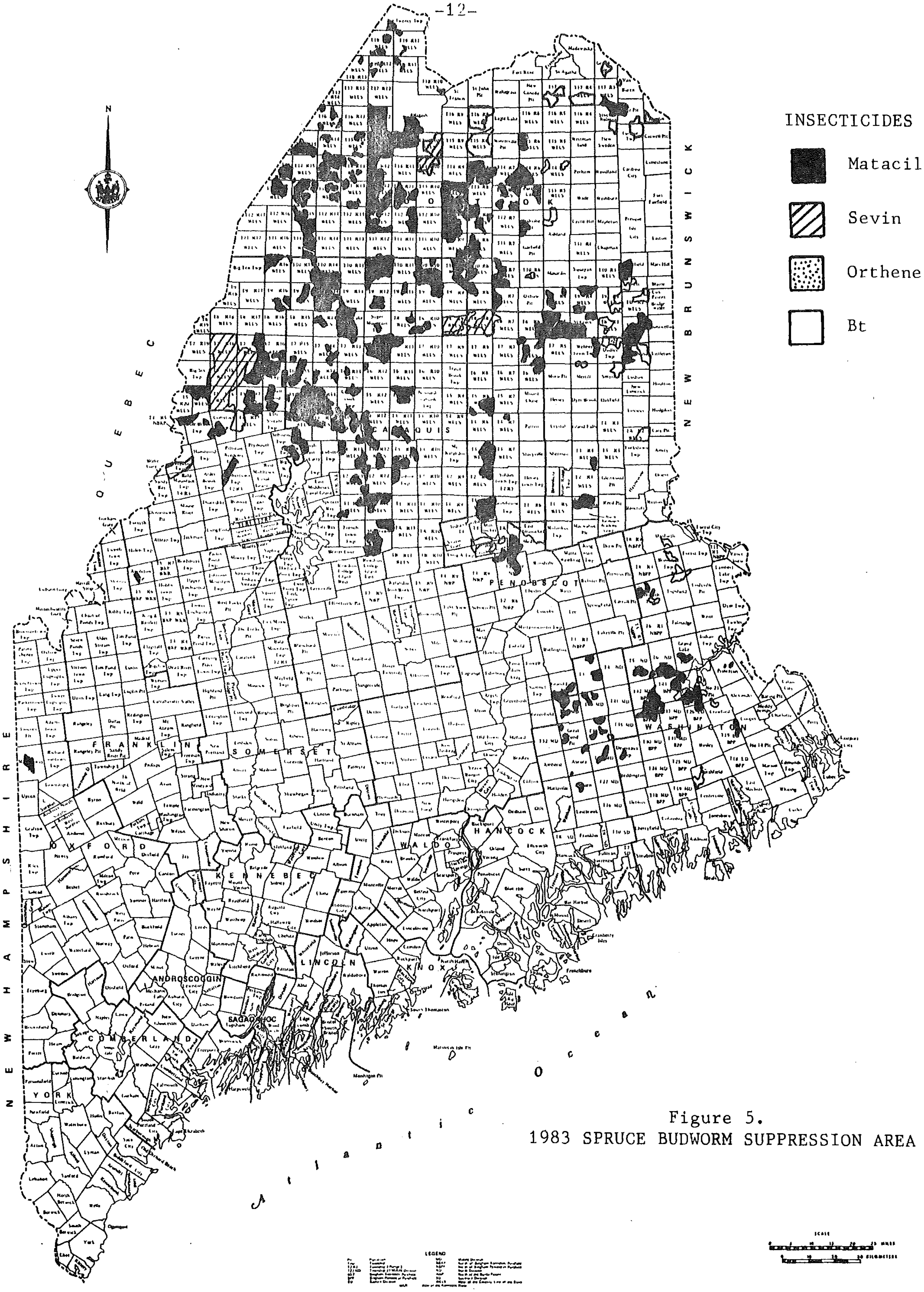


Figure 5.
1983 SPRUCE BUDWORM SUPPRESSION AREA

TABLE 3. TREATMENT VARIATIONS EVALUATED IN THE 1983 MAINE SPRUCE BUDWORM CONTROL PROJECT INCLUDING PLANNED TREATMENT TIMING

INSECTICIDE	RATE ACTIVE INGREDIENT (OZS.)	FINAL SPRAY VOLUME OZS.	AIRCRAFT	NUMBER OF APPLICATIONS	TIMING*
MATACIL	1.0	20	C-54 THRUSH M-18	2	1,2,3
SEVIN-4-OIL	6.0	24	C-54 THRUSH	2	1,2
ORTHENE	8.0	64	THRUSH	1	4
DIPEL 6L	12 B.I.U.	64 32	THRUSH M-18	1	4
DIPEL 4L	12 B.I.U.	48	THRUSH	1	4
THURICIDE 32LV	12 B.I.U.	64 48	THRUSH M-18	1	4
THURICIDE 24B	12 B.I.U.	96	M-18	1	4
BACTOSPIENE	12 B.I.U.	64	THRUSH	1	4

*TIMING:

1. 1st application before larvae enter spruce buds; 2nd application 5th or early 6th instar.
2. 1st application 50 to 70% 4th instar; 2nd application 5 to 7 days later.
3. Both applications before larvae enter spruce buds.
4. Peak 4th instar.

application was applied when 50 to 70 percent of the larvae were 4th instar (Index 3.4 to 3.7) and the second application was applied five to seven days later. Both variations were expected to provide good fir protection, but the later second application was expected to provide better spruce protection.

In 1983, first application release came at about the same time for both timing variations because larvae were slow to enter the spruce buds. Usually the two timing regimes differ by two to five days. Often larvae move from the needle to around spruce buds in the 3rd instar, but in 1983 the wet weather delayed the move until most larvae were in the 4th instar.

One small block was sprayed twice with Matacil before the larvae entered the spruce buds. This timing was used with Sevin-4-Oil in a similar test in 1982 with good results in terms of spruce protection.

All Orthene and Bt products were applied as a single application. Orthene was sprayed at the 8 ozs. A.I. per acre rate and all Bt at 12 B.I.U.'s per acre. Spray regimes used for the various Bt products varied considerably. Dipel 6L, Thuricide 32LV and Bactospiene were all applied at 64 ozs. final volume per acre. In addition, Dipel 4L, Dipel 6L, and Thuricide 32LV were applied undiluted at 48, 32 and 48 ozs. respectively. Thuricide 24B was applied at 96 ozs. per acre.

Orthene and all Bt products were timed for peak 4th instar. A well expanded fir bud target was also necessary for block release (Index 3.5 to 4.0).

C. Development, Spray Timing, And Weather

Larval instar development and the expansion of host tree buds were closely monitored in order to properly time the release of spray blocks. Data were collected every three days from sixteen permanent development locations throughout the State (Figure 6). Each sample provided a larval index and a bud index. When the index of a permanent point in the vicinity of treatment blocks approached the desired release timing, spot developments were initiated within the blocks for final timing. The desired timing for each treatment variation is shown in Table 3.

A large number of spot developments were taken in 1983 to properly time applications. Spot developments were especially important for timing the first applications in spruce stands. Timing in these areas required direct observations of the position of insects and the swelling of shoots.

The larval development season in 1983 was unusual, containing

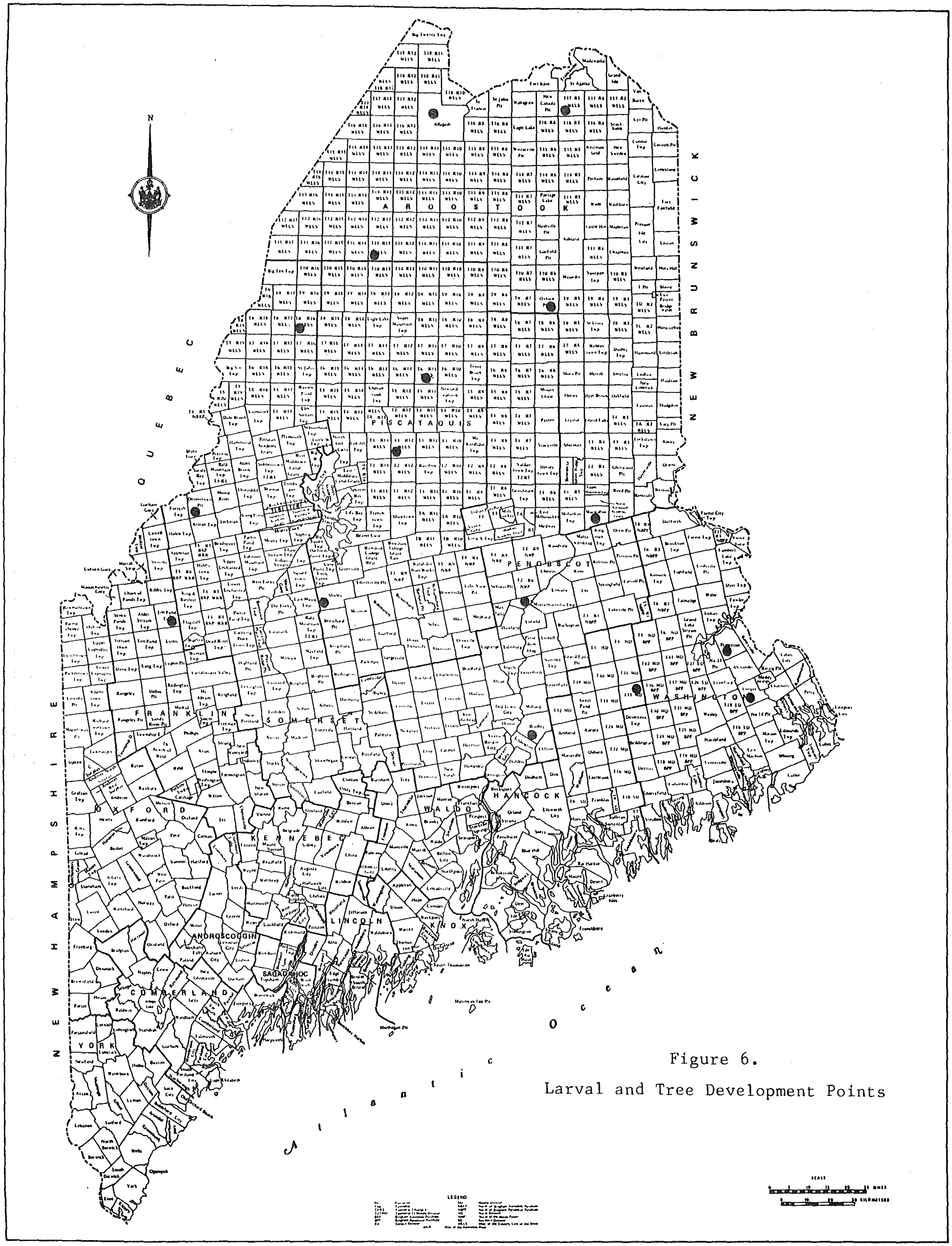


Figure 6.
Larval and Tree Development Points

two radically different and long lasting weather patterns. During the early instars in May and early June the weather was cool and wet. Rain fell nearly every day. In early June the weather changed to a very hot, dry pattern, which lasted through the remainder of the project. Temperatures were in the 80's for most of this period.

Larval development during the early wet weather was extremely slow. Larvae emerged at or slightly before normal, but quickly became retarded in their development. Larvae were very inactive during the cool, wet weather and fed very little. By the 4th instar, larval development was ten to fourteen days slower than normal.

Larval development was very fast during the hot, dry weather. After about two weeks of hot, dry weather development had quickened to a pace only slightly slower than normal.

Shoot development was also drastically affected by the unusual weather. The cool, wet weather seemed to be favorable for fir shoot development. By the late 3rd larval instar, fir shoots were well elongated with individual needle tips showing (Index 4). The shoot development index was advanced relative to the larval index.

Shoot development data is not kept for spruce, but observations suggest that spruce was not advanced as was fir. Red spruce buds broke at the normal time or later than normal in some areas. In 1983 red spruce buds broke in the northwest around June 15th, about two weeks after fir buds broke.

Wet weather in May and early June delayed first applications in some areas, but most treatments were delayed for five days or less. Very slow development during this period caused these delays to be insignificant in terms of defoliation. The second application on several blocks was also delayed by weather, however, these delays were caused by high temperatures, haze, and wind. Delays were generally less than seven days, but even four to five days under very hot, dry conditions resulted in measurable losses of foliage. Most notable losses were seen on fir in the northwest.

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 spray blocks and finalization of block release timing based on spring populations.

Extreme populations (26 to 70 larvae per 18 inch branch tip) were found in northwestern and northcentral Maine (Figure 7). High levels were found in the northeast, the Rangeley area, and in portions of the southeast. Other areas were found to be moderate with the exceptions of low counts in blocks treated for the last few

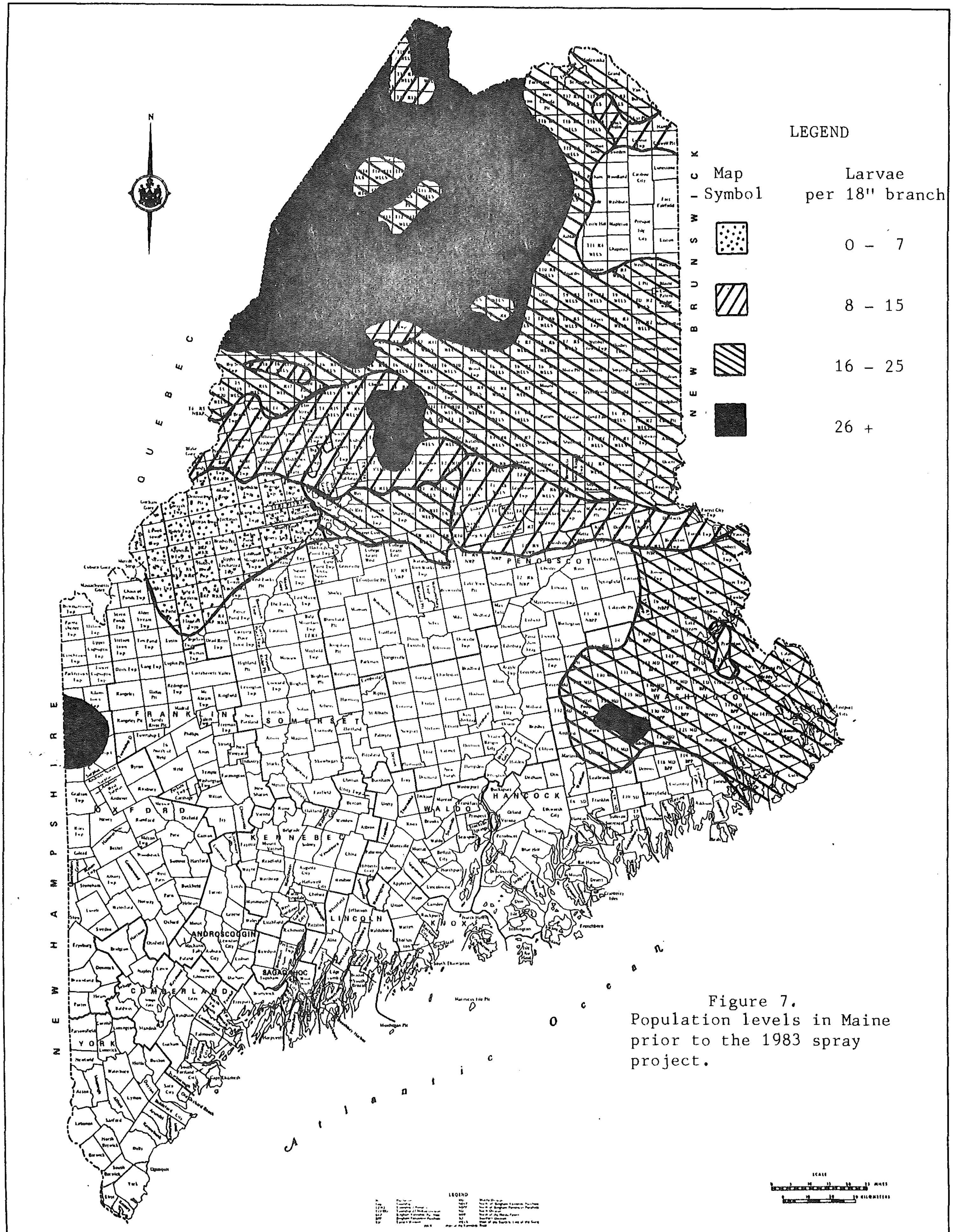


Figure 7.
Population levels in Maine prior to the 1983 spray project.

years in the west and some blocks in the Millinocket area.

In many areas, large variations were noted between fir and spruce counts. Extreme counts on spruce and low or moderate counts on fir were found in many areas. In most cases spruce had higher counts then fir. In some spruce survey lines, individual inter-tree counts varied as much as 200 larvae per 18" tip.

As a direct result of the 1983 prespray survey, six blocks containing about 16,501 acres in western and central Maine were dropped from the project. These blocks were all found to have low populations.

E. Spray Results

Spray results will be reported for each treatment variation employed in the 1983 operation. Many of the treatment variations used were evaluated in several areas and each area is listed separately. Tables 4 and 5 list spray results for chemical insecticides and Bt respectively. Results are presented as the number of survivors per 18 inch branch tip, unadjusted mortality, defoliation in sprayed areas, and foliage saved (defoliation in the unsprayed check minus defoliation in the blocks) for fir, spruce, and in some areas, hemlock.

Methods for efficacy determination of the 1983 project are shown in Sampling and Analysis Design For Experimental Insecticide Monitoring (Maine Forest Service Technical Report No. 12, Kemp, et. al., 1979) and the Maine Forest Service Spruce Budworm Survey and Assessment Manual (MFS Technical Report in preparation).

The 1983 spray project had variable results, with much of the treatment area showing more damage than had been seen in the 1979 through 1982 seasons. Despite this general observation of poorer results, most blocks showed acceptable foliage protection and population reduction compared to relevant untreated checks.

Unadjusted population reduction ranged from 82 to 99 percent with chemical insecticides and from 73 to 98 percent with Bt. The highest and most consistent reductions were in Sevin blocks. Generally, unadjusted mortality was extremely variable with Matacil and Bt products and the majority of lines evaluated showed higher survival than in years 1979 to 1982. Higher survival occurred in scattered blocks throughout the project area and on both fir and spruce. Areas of consistent high or low survival were not seen as was the case in 1982. The variability in survival seems to be related to inconsistent spray results due to unusual weather conditions.

Natural mortality in untreated areas was also extremely variable, probably due to weather. Mortality in checks ranged from

TABLE 4. RESULTS OF CHEMICAL INSECTICIDE TREATMENT
VARIATIONS BY AREA FOR THE 1983 MAINE SPRUCE BUDWORM CONTROL PROJECT

Treatment	Area	Host	No. Sur. Per 18" Tip	% Red. Unadj.	% Def.	% Fol. Saved
MATACIL Split Application 1.0 oz. + 1.0 oz. A.I. in 20 oz.						
Early/Late Small Aircraft	A48, A50 T15R14	F	3.45	81.8	78.0	19.6
		S	1.05	93.7	66.6	22.2
	M48, M49 T28 MD	F	2.93	82.7	58.8	23.9
		S	4.07	83.6	31.1	31.0
		H	3.65	85.9	25.8	36.7
	B10, Stockholm	F	0.13	99.7	64.8	30.6
		S	0.40	98.8	44.3	41.4
	C63, T10R16	F	0.50	98.8	70.7	26.9
		S	0.47	98.6	49.9	39.7
	M57, M59, M84 Princeton Area	F	1.78	89.4	33.8	22.5
		S	0.67	97.0	53.4	31.8
		H	1.48	91.1	25.4	25.0
Early/Late Large Aircraft	A30, T16R12	F	4.33	85.2	94.1	3.5
		S	2.33	90.3	78.5	10.3
	F 1, T8R13	F	0.40	97.7	14.6	63.9
		S	0.70	95.1	47.4	39.0
	G 1, G12 ,T10R7	F	0.67	97.6	19.7	46.2
		S	0.70	97.3	47.6	32.9
	B18, T14R7	F	1.13	96.5	67.9	27.5
		S	0.67	97.9	35.9	49.8
	D10, T12R9	F	1.27	97.3	89.3	8.3
		S	0.87	97.8	68.7	20.1
	D25, T10R12	F	0.27	97.4	17.6	72.4
		S	0.07	99.5	45.0	43.8
	E46, E10, Russell Pd. Area	F	4.49	75.5	69.4	28.2
		S	1.85	92.1	40.5	48.3
Early/Early	M70, Alligator Lk.	F	2.93	85.7	20.0	26.9
		S	0.80	97.6	28.4	25.1
		H	3.56	77.9	28.7	28.4

TABLE 4 (CONTINUED). RESULTS OF CHEMICAL INSECTICIDE TREATMENT VARIATIONS BY AREA FOR THE 1983 MAINE SPRUCE BUDWORM CONTROL PROJECT

Treatment	Area	Host	No. Sur. Per 18" Tip	% Red. Unadj.	% Def.	% Fol. Saved
SEVIN-4-OIL 6.0 oz. + 6.0 oz A.I. in 24 oz. Early/Late	F18, F21; T8R8	F	0.48	98.1	28.7	43.0
		S	0.18	99.3	39.1	36.1
	A59 T15R10	F	0.40	98.9	84.5	13.1
		S	0.67	99.0	20.4	68.4
	E 8, T6R18	F	1.33	95.6	58.5	39.1
		S	0.13	99.3	26.1	62.7

TABLE 5. RESULTS OF BT INSECTICIDE TREATMENT
VARIATIONS BY AREA FOR THE 1983 MAINE SPRUCE BUDWORM CONTROL PROJECT

Treatment	Area	Host	No. Sur. Per 18" Tip	% Red. Unadj.	% Def.	% Fol. Saved
DIPEL 6L 12 B.I.U.'s in 64 ozs.	G 46, Smyrna	F	2.20	73.0	47.1	25.7
		S	2.05	85.5	58.7	13.5
	M82, M111; T26ED	F	2.12	93.6	44.6	43.6
		S	0.80	97.4	26.0	45.3
		H	2.27	89.3	34.1	33.8
	M72, M73; T34MD	F	0.80	81.3	12.3	18.1
	SMALL TREES	S	0.73	90.4	13.8	16.6
	M121	F	3.67	78.7	26.1	33.4
		S	3.47	79.7	20.0	41.6
		H	0.33	97.8	6.3	26.4
DIPEL 4L 12 B.I.U.'s in 48 oz. Undiluted	M 5; Danforth	F	0.83	94.5	15.1	36.1
		S	0.55	96.4	16.4	16.4
DIPEL 6L 12 B.I.U.'s in 32 oz. Undiluted	M 10; Topsfield	F	0.95	87.5	28.4	22.8
		S	0.52	86.6	20.9	11.9
THURICIDE 32LV 12 B.I.U.'s IN 64 Ozs.	G 26; T9R3	F	0.75	91.3	52.2	20.6
		S	0.35	97.4	34.1	38.1
	B 5; T17R5	F	2.80	88.6	45.6	27.0
		S	1.53	93.7	59.1	13.1
THURICIDE 32LV 12 B.I.U.'s IN 48 oz. Undiluted	B 13; Stockholm	F	2.10	85.4	56.9	34.3
		S	0.43	96.9	24.3	47.9
THURICIDE 24B 12 B.I.U.'s in 96 ozs.	J12; Medway	F	1.40	91.2	33.4	45.6
		S	1.27	91.8	13.1	38.0
BACTOSPIENE 12 B.I.U.'s in 64 ozs.	G 27; T8R3	F	1.01	86.7	45.6	27.2
		S	1.63	81.9	42.8	29.4

98 to 40 percent. Mortality was generally higher on spruce than on fir, but variability was seen with both species. Variability occurred within areas and even within assessment lines.

Untreated survival is used to calculate mortality adjusted by the Abbott's formula. However, the variability of survival in checks meant that the Abbott's formula correction was meaningless and thus not used.

Defoliation was generally heavier in 1983 than has been seen in the last few seasons, but treated areas had much less defoliation than untreated checks. Distinguishing treated and untreated areas during the aerial survey was extremely easy.

In the years 1979 to 1982 defoliation in sprayed areas was 30 to 50 percent of the expected defoliation (based on unsprayed checks). Figures in 1983 showed less foliage saved than past years. Defoliation was 40 to 70 percent of the expected. Foliage saved figures in the northwest were very low in some blocks due to high larvae counts. If larval feeding on one year old foliage (backfeeding) had been considered (added to the defoliation level in check areas), foliage saved would be much higher. Little backfeeding was observed in spray areas.

Mean defoliation to fir in sprayed areas ranged from 94 to 17 percent with the highest defoliation occurring in the northwest. Fir defoliation in most blocks was an acceptable 40 to 60 percent compared to near 100 percent defoliation in many untreated areas.

Fir defoliation was low in spray blocks with more moderate population and in areas receiving the optimum spray coverage. Fir defoliation in some of the large aircraft areas was high due to very high larval counts and delays in the second application due to bad weather.

Fir in spray blocks generally appeared to have less defoliation when observed during the aerial survey than when observed from the ground. This variation was due to less defoliation on tree tops than on lower and middle crowns as confirmed by occular estimates taken for each crown segment. Less upper crown defoliation was probably due to much better spray deposit on tree tops. The advanced flush and rapid growth of fir foliage probably resulted in much of the spray being intercepted by upper crown foliage, thus not reaching the lower and middle crowns. Another factor which may have resulted in more low crown defoliation was insecticide induced evacuation of the upper crown. Evacuation (knock down) of this type often occurs with a contact insecticide such as Matacil.

Mean defoliation to spruce range from 78 to 12 percent, again with the highest levels in the northwest. Most blocks were 30 to 60 percent defoliated in 1983 compared to 25 to 50 percent levels in past seasons. Spruce defoliation in untreated checks was much higher than normal with most areas 60 to 90 percent defoliated.

In general, spruce defoliation in both treated and untreated areas was far heavier than normal in 1983. Differences between 1983 and past years may include; heavier than normal larval population, unusual larvae/host synchrony, or less effective spray results on spruce.

In many treated blocks a portion of the spruce had moderate or even heavy defoliation, but the remainder of the spruce and the fir in the block would have only light defoliation. This "spotty" defoliation on spruce was not due to spray misses, but rather to extreme variability of population and variation of bud flush between spruce trees.

Hemlock defoliation was lower than in past years, in most cases 20 to 30 percent. This is probably due to lower counts in the southeast where most hemlock is found.

The best and most consistent foliage protection was seen in areas sprayed with Sevin. With the exception of high fir defoliation on block A59 due to late application, all Sevin areas showed a high percentage of foliage saved. Good Sevin results were probably due to the long residual of the material and good deposit under marginal weather conditions.

Results with Matacil varied from very good to unacceptable. Nearly all blocks with unacceptable results had application problems with one or both applications, or in a few cases, were treated late due to weather delays or unusual development. Most Matacil blocks were acceptable or good relative to untreated areas. Some unacceptable blocks would be acceptable if backfeeding on one year old foliage was considered. In some northwest blocks less than 20 percent of the 1983 foliage was saved, but in untreated areas nearby 100 percent of the 1983 foliage plus 50 to 80 percent of the 1982 foliage was lost due to backfeeding.

Large aircraft Matacil blocks seem to have inconsistent results probably due to unusual weather which adversely affected deposit with larger planes.

Bt was generally sprayed in areas of high to moderate population pressure and was not used under extreme conditions such as in the northwest. Most Bt treatments were good or acceptable in terms of foliage saved. Undiluted treatments with Dipel and Thuricide were as good or better than higher volume diluted applications. Nearly all Bt treatments were as effective on spruce as they were on fir. This was not true in many Matacil blocks where spruce was more heavily defoliated than fir.

Five Bt blocks in the Princeton area, treated with Dipel 6L at 64 ozs., were sprayed during the long rainy period when larvae were very inactive. Post treatment checks of these blocks gave no indication of adequate treatment. All five blocks were retreated with Thuricide 32LV at 48 ozs. in an attempt to achieve adequate results. Results on these blocks show adequate results despite the loss of significant foliage prior to the second treatment.

F. Conclusions From The 1983 Testing Program

1. Split applications of Sevin-4-Oil were generally more effective in protecting fir and spruce than were split Matacil or Bt products under 1983 conditions.

2. All Bt materials used were found to be effective at the rate employed and results with all materials were similar.

3. Results with Neat (undiluted) applications of Dipel 4L, Dipel 6L, and Thuricide 32LV were similar to each other and not significantly different from diluted applications.

4. Bt results on spruce were comparable to results obtained with Matacil and Sevin-4-Oil.

5. Split applications of Matacil where both applications were done early did not work well on spruce in 1983, probably because of larval inactivity under cool, wet conditions.

IV. FOREST CONDITION IN 1983 AND 1984 HAZARD FORECAST

This section contains survey results of defoliation, budworm moth occurrence, population prediction, tree damage, and plans for evaluation of overwintering larvae in specific areas. Some of these results were used to formulate the hazard map presented in this section.

A. Defoliation, Aerial Survey

In July of 1983, 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 1983, 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 4.0 million acres were classed as moderate to severe in 1983 which is a slight increase from 3.8 million in 1982.

In 1983 spray results were not dramatic and the contrast between treated and untreated areas was not as obvious as in 1982. Trained observers were, however, able to identify successfully treated areas. Even marginally treated areas appeared significantly different than severely browned, unsprayed areas. Untreated areas in the north and southeast showed a severe degree of browning not seen in recent seasons.

B. Forest Insect Survey Light Trap Program

Eighteen light traps were operated throughout Maine (see Figure 9) during the period of major moth activity in 1983. A summary of spruce budworm moths collected in the State is shown in Table 6.

While budworm moths can be active from mid-June to early August, the data for this year exhibits two major periods of moth activity that may be the result of inflights from

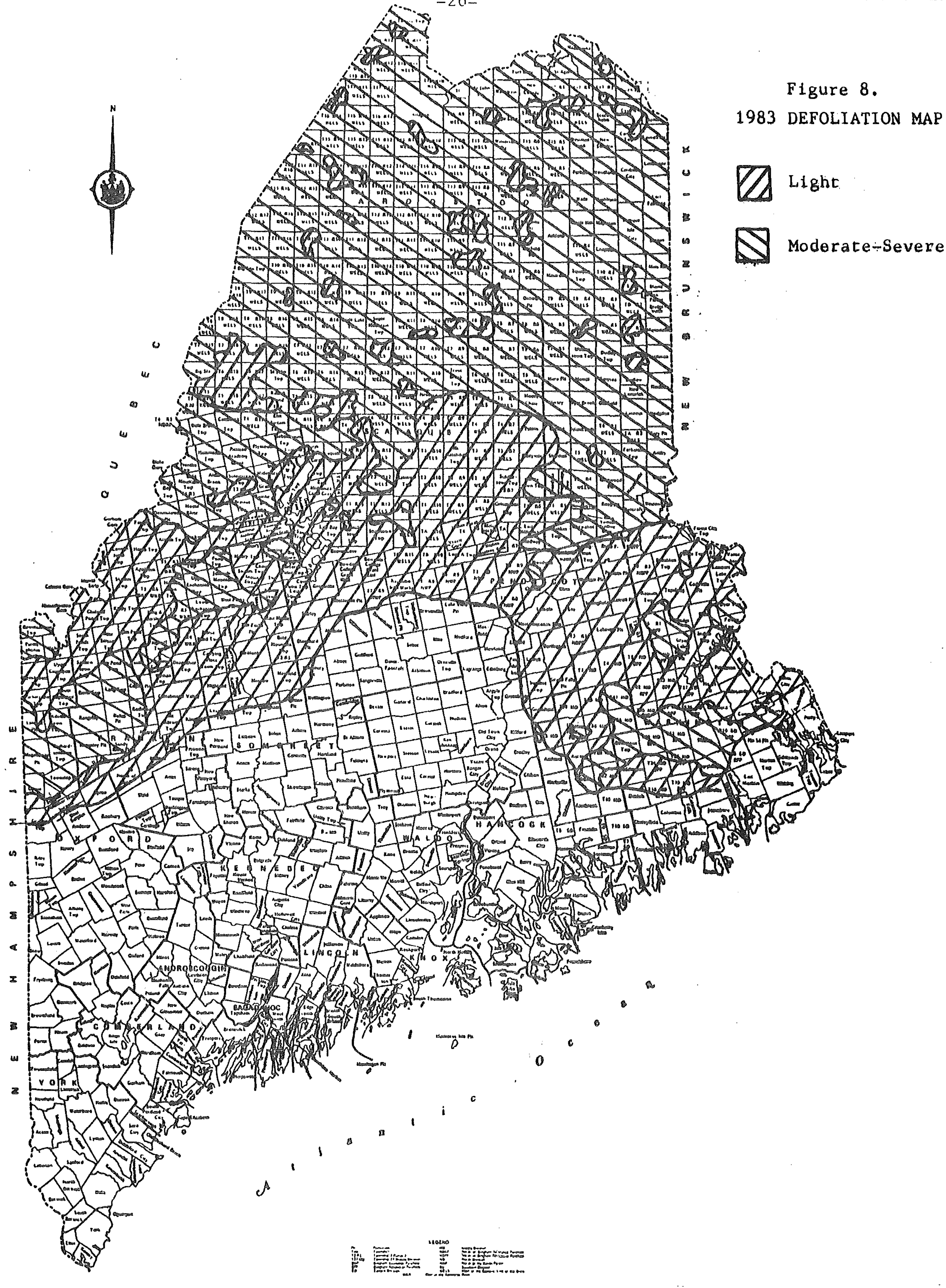


Figure 8.
1983 DEFOLIATION MAP

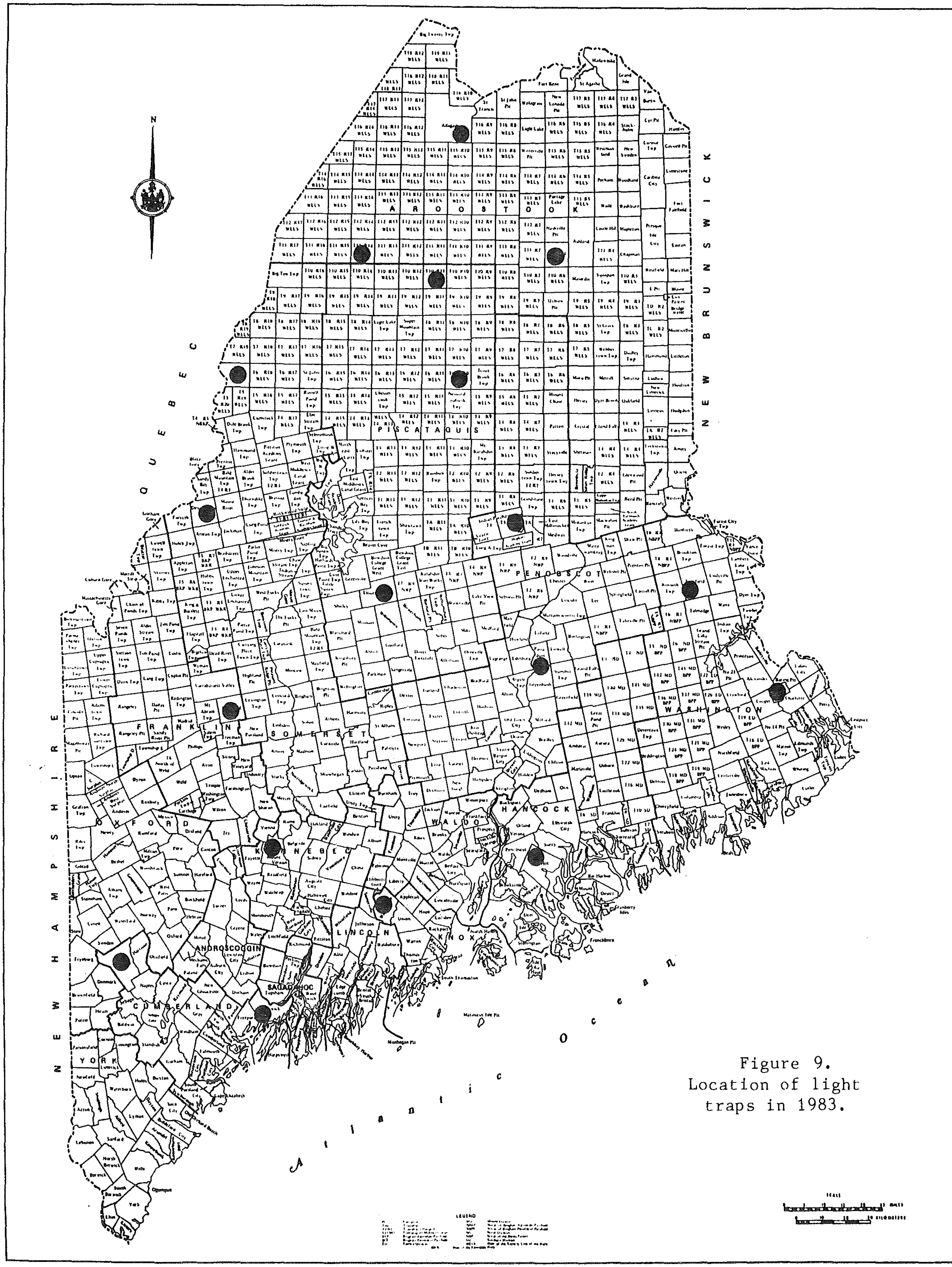


Figure 9.
Location of light traps in 1983.

Table 6.

SUMMARY OF THE NUMBER OF SPRUCE BUDWORM MOTHS COLLECTED AT LIGHT TRAPS IN VARIOUS LOCATIONS DURING JUNE & JULY OF 1983

TRAP LOCATION	JUNE 27*	28	29	30	JULY 1	2	3	4	5	6	7	8	9	10	11	12
Kingfield	1		1	1	6		7	3				16			10	52
Dennistown Plt.	2			1	19	22	40	189	13		3	51		24	114	402
Mt. Vernon									1							
Meddybemps	4			13	370	124	750	1000	1125	250	350	1836	900	54	1080	2607
Passadumkeag	132	28	125	175	200		1900		336	13	11	350	6	7	80	176
Blue Hill					1		1			2	1	7	1			2
T6 R19						16		192							335	315
Clayton Lake		1							4		4	20		32	137	1600
St. Francis	2			19	535	111	577	1450	1022	1	41	885	14	13	450	1240
Garfield	No Moths															
Elliotsville				2	7	10	4	12	10	1		20	3	11	3	69
Topsfield				42	16	55	85	4800	350	48	23	1000	18	1	123	1
Hay Lake				3								230		19		47
North Bridgton	1				9	3	8	3	7			3		4	3	11
Washington													4	1		
Millinocket								2							1	
Musquacook Gate				1				1		1	1				3	
Brunswick	2	3	2	1	2		7	7	4	5	10		7	40	108	45
Daily Totals	144	32	128	258	1165	341	3379	7659	2872	321	444	4418	953	206	2447	6567

TRAP LOCATION	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30**
Kingfield	110	75	75	350	1150	375	400	106	67	20	14	300	33	23	230			
Dennistown Plt.		136	120	110	197	135	327	35	13	63	11	28	12	125				
Mt. Vernon	3	4		15	79		48	45	8		7	2	4					
Meddybemps	3600	1792	1176	734	920	648	1128	592	118	142	44	38	14	19	64			
Passadumkeag	117		29	70	114	17	9	2	26	11	4	8						
Blue Hill	10	41	33	48	53	20	24	42	46	18	6	5	8	2				
T6 R19	375	1500		160		11	1400	200	15	4		5			36	155	131	76
Clayton Lake	2000	707	84	161	105	410	3	4	3	5		1		1				
St. Francis	19000	18000	24000	2321	20	692	360	24	230	26	23	132	90	8	297	147		
Garfield																		
Elliotsville	196	258	365	663	500	12320	265	68	112	40	32	2	65	74	93			
Topsfield	123	116	307	259	191	28	149	104	103	193	20		24	4	9	5		
Hay Lake	105	92	81	95	221	325	120	2	10	11	3	10	2	2	2	25	3	40
North Bridgton	116	120	56	250	1113	550	460	62	37	58	104	138	14	26				
Washington	140	7	23	40	28	31	4	6	25	3		1	1					
Millinocket				57	200	49	17	3	3	9	3	1	1					
Musquacook Gate	3	54	2	11	12	8	12	11					1					
Brunswick	50	47	150	425	560	500	331											
Daily Totals	25948	22949	26501	5769	5463	16119	5057	1306	816	603	271	671	269	284	731	332	134	116

*Summary of catches June 12 - 27

**Summary of catches July 30 - August 9

infestations from within or outside of the State. The two periods were as follow:

July 3 through July 9 - Meddybemps, Passadumkeag, St. Francis, and Topsfield

July 11 through July 19 - Clayton Lake, Meddybemps, and St. Francis

During both periods of above normal moth catches, weather fronts moved across the State which could account for the sudden increases in the number of moths caught.

Local moth flights were scattered throughout the season, one interesting one appears to have taken place far outside of the spruce-fir region in Brunswick and North Bridgton on July 16th and 17th. Another seemed to develop suddenly in Elliotsville on July 17th and 18th.

The total moth catch for 1983 was 144,673 moths which is a substantial increase from 49,200 caught in 1982, but is more in the range of catches prior to 1981.

C. Population Prediction Survey

Format Changes - Previous budworm population prediction work indicated that egg mass data is often insufficient information on which to base budworm population predictions. Subsequently, the MFS in 1982 altered its general population prediction survey to include a combination of egg mass and L-II surveys. This new combination of egg mass and L-II was utilized again in 1983. Egg mass was used in areas expected to have high or extreme populations as predicted through the aerial browning survey. Figure 10 shows the 1983 locations of egg mass and L-II surveys.

The egg mass survey started August 1st and ended September 3rd with eight field crews surveying in the northwest and southeast.

The general L-II survey covered the northeast, central and southwestern area. L-II surveying was conducted in areas expected to be low, moderate or undetermined. This survey started September 5th and ended November 4th.

1. Population Prediction Methods

a. Survey Selection

Egg Mass - An egg mass survey was conducted in 1983 in those areas that were rated during the aerial browning survey as having suffered moderate to severe defoliation

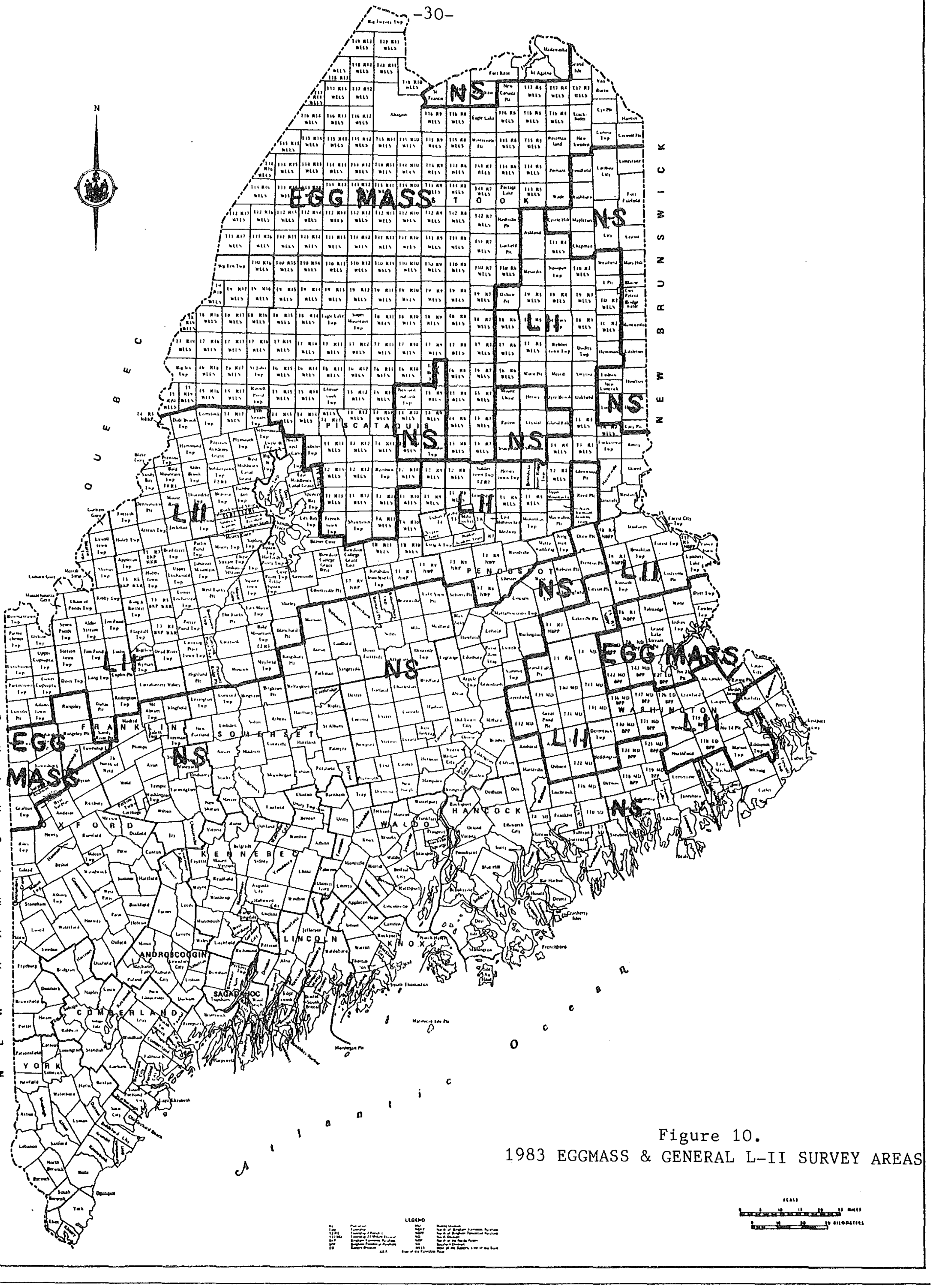


Figure 10.
1983 EGGMASS & GENERAL L-II SURVEY AREAS

during the summer of 1983.

L-II - L-II (overwintering second instar larvae) surveying was conducted in areas of low 1983 defoliation and in other areas of interest that were not evaluated with the egg mass survey in 1983.

No Ground Survey - There are several areas within the infestation where little interest is shown in having an early population prediction work done. These areas were deliniated and eliminated from the general ground survey. Any landowner requests from these areas were honored during mid-winter surveys. Ratings of current defoliation in these areas served as the basis for predicting 1984 population.

b. Field Methods

The field collecting procedure for both egg mass and L-II sampling is similar. One sample per 10,000 acres is the usual sample density of the general population prediction survey. Sample density in areas of variable stand type or that have special treatment requirements is usually heavier at one sample per 5,000 acres.

A general population sample consists of one upper midcrown branch from each of three dominant or co-dominant fir, spruce, and hemlock trees. Dimensions of each branch; total length and width at midpoint; are recorded. Each branch is cut into segments (eggmass 4 to 6 inches, L-II 1 to 3 inches) and bagged separately in paper bags. Collection site information is placed on each bag. Individual branch bags are then placed in larger bags for shipment to the laboratory for processing. Fir and spruce branches are separated into different container bags to ease sorting at the labs.

c. Laboratory Methods

Egg Mass - Egg mass samples collected during the 1983 survey were processed at the Howland Lab. Lab workers searched the foliage of each sample for egg masses and classified them into the following categories:

1. Old - deposited in 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 egg development.

An entomologist constantly checked egg mass workers to insure proper identification of egg mass type.

Results of an analysis of 1983 egg mass viability are shown in Table 7.

A calculation of sound (parasitized egg masses and masses dead from other causes excluded) egg masses per 100 square foot of foliage is made for each branch searched 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. This number is then converted into an infestation level; light, moderate, high, and extreme (Table 8).

Fir egg mass samples from a given area were always searched first. If the count found on the fir was very high, the matching spruce portion of the sample was not searched. If the number of egg masses on the fir was either in the light or moderate categories then the matching spruce was searched. The procedure of not searching spruce if the fir was high was instituted because a high egg mass count on fir usually means a high count on spruce. Spruce is difficult to search and this policy saved both time and money during searching. Areas with low or inconsistent results were targeted for later assessment with the specific L-II method.

L-II - The L-II caustic soda spruce budworm larval extraction method was developed by Miller et. al, 1971. The MFS has used this method with some modifications since the early 70's.

Infestation levels for the L-II method are shown on Table 9.

2. Results

Final data for the general L-II population prediction survey was provided to landowners on November 4th. Egg mass data had been provided in early September.

A total of 2,031 samples were collected during the 1983 survey. Of this total, 999 samples were egg samples, and 1,032 were L-II samples. A summary of statewide results is shown in Figure 11.

Table 7. Viability of Spruce Budworm Egg Masses, Including the Relative Abundance of Old Egg Masses Still Present On Fir, Spruce and Hemlock Foliage in 1983

	Fir	Spruce
Category*	Mean X	Mean X
% Parasitized	8.8	4.8
% Dead of Other Causes	1.5	0.9
% Old Egg Masses	23.8	8.9
% New and Viable	68.3	85.9

* 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 8.
Spruce Budworm Infestation Levels Based On Egg Masses Per 100 Sq. Ft. of Foliage

No. Egg Masses Per 100 Sq. Ft.	Infestation Level
0 - 99	Light
100 - 239	Moderate
240 - 399	High
400 +	Extreme

TABLE 9.
MAINE FOREST SERVICE HAZARD RATING SYSTEM USED IN 1983

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
(1982% Plus 1981%)

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	23-25

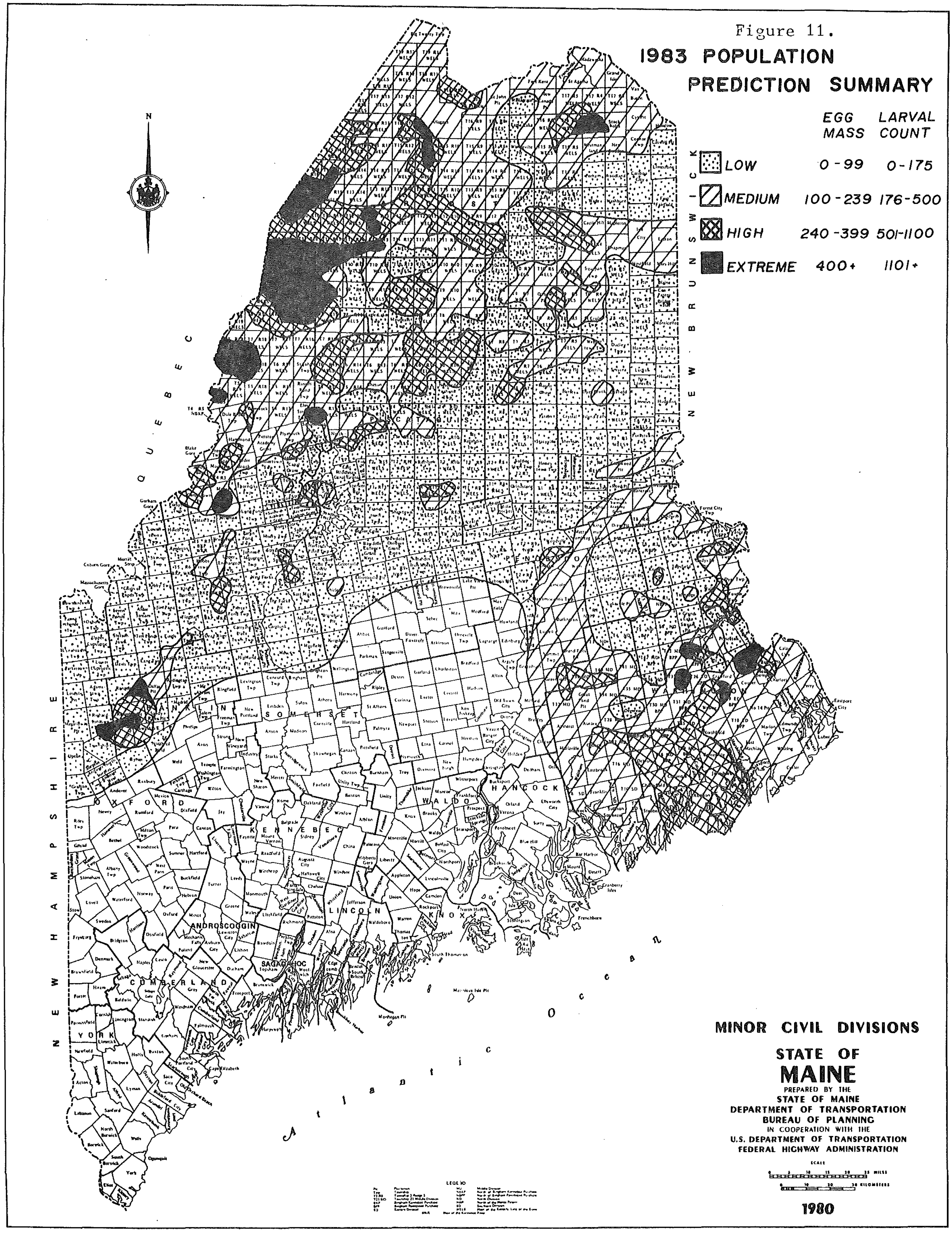


Figure 11.
1983 POPULATION PREDICTION SUMMARY
EGG MASS
LARVAL COUNT
LOW 0-99 0-175
MEDIUM 100-239 176-500
HIGH 240-399 501-1100
EXTREME 400+ 1101+
N
QUEBEC
NEW BRUNSWICK
NEW HAMPSHIRE
OXFORD
FRANKLIN
SOMERSET
PISCATAQUIS
PENOBSCOT
KENNEBEC
WALDO
HANCOCK
LINCOLN
KNOX
ANDROSCOGGIN
SAGADAHOC
CUMBERLAND
YORK
Atlantic Ocean
MINOR CIVIL DIVISIONS
STATE OF
MAINE
PREPARED BY THE
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1980

Results of the 1983 population survey show large decreases over much of the infested area; 3.0 million acres of high and extreme predicted for 1984 compared to 5.5 million acres predicted for 1983. Nearly all of Northern Maine had high or extreme populations in 1983, but 1983 predictive surveys show much of the area to be moderate or low. Mean 1983 predicted population levels for the north were less than half the 1982 predicted level, but several areas of high and extreme population remain in the northwest.

Population levels were found to be very low in much of the southwest and central portions of the infestation. An area of high and extreme population was again found near Rangeley. In the southeast, predicted population showed a decrease from uniform high and extreme to variable moderate and high levels. Smaller low and extreme areas were also found in the southeast.

Results of the 1983 survey are compared to 1982 results by the survey zones described earlier (Table 10). As in 1982, the general survey employed both egg and L-II sampling and comparisons were done as an index. Table 10 also shows egg mass data for the past five years.

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

Allagash-St. John -- Predicted populations for this zone have declined significantly from uniform high and exteme levels last year. Most of the central portion of the zone is predicted to be high and extreme again in 1984, but most of the northern and southern portions were found to be moderate. Areas where populations seem low can not be correlated to 1983 spray areas.

Northeast -- This zone showed a sharp reduction in predicted population. A small area of extreme population was found in the north and scattered areas of high remain in the central and westcentral areas. Much of the remaining northern and central area was moderate. Large areas of low population were found near Presque Isle and in the southern portion of the zone.

Penobscot-Mattawamkeag -- Two small areas of high population remain in Chester and near Greenfield, but the remainder of the zone was found to be moderate or low. This zone and the northeast showed the largest population reductions in 1983.

Southeast-Coastal -- Nearly all of this zone was predicted to be extreme in the 1982 survey, but the 1983 survey showed high variability. Small areas of extreme population remain south of Princeton and a large area of high was found in the southwest part of the zone. Small high areas remain south of Vanceboro. The southeastern and northwestern portions of the zone are predicted to be moderate or low.

TABLE 10. POPULATION PREDICTION FOR 1984 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	1983 POP. INDEX EGG MASS & L-II	1982 TO 1983 TRENDS
Allagash-St. John	332	331	392	260	176	1.63	3.14	2.31	-
Northeast	312	824	374	254	109	1.41	3.08	1.58	- -
Penobscot-Mattawamkeag	287	519	697	271	216	1.83	3.00	1.43	- -
Southeast Coastal	155	469	292	493	331	2.15	3.09	1.91	-
Moosehead	110	210	287	185	43	1.14	2.26	1.37	-
Western Mountains	107	158	416	221	38	1.10	2.14	1.43	-

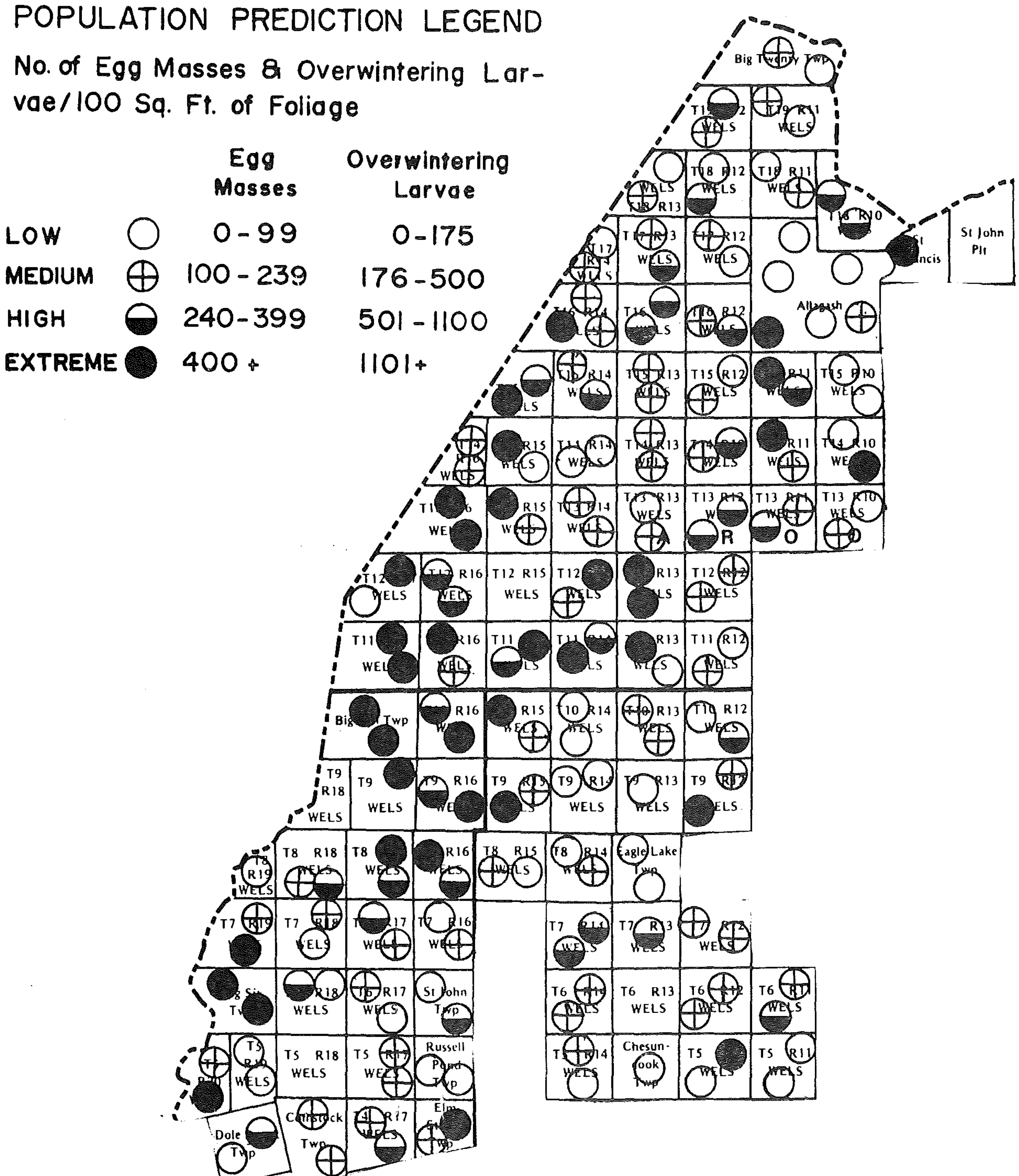


Figure 12. 1983 Spruce Budworm Population Prediction Map of the Allagash-St. John Zone.

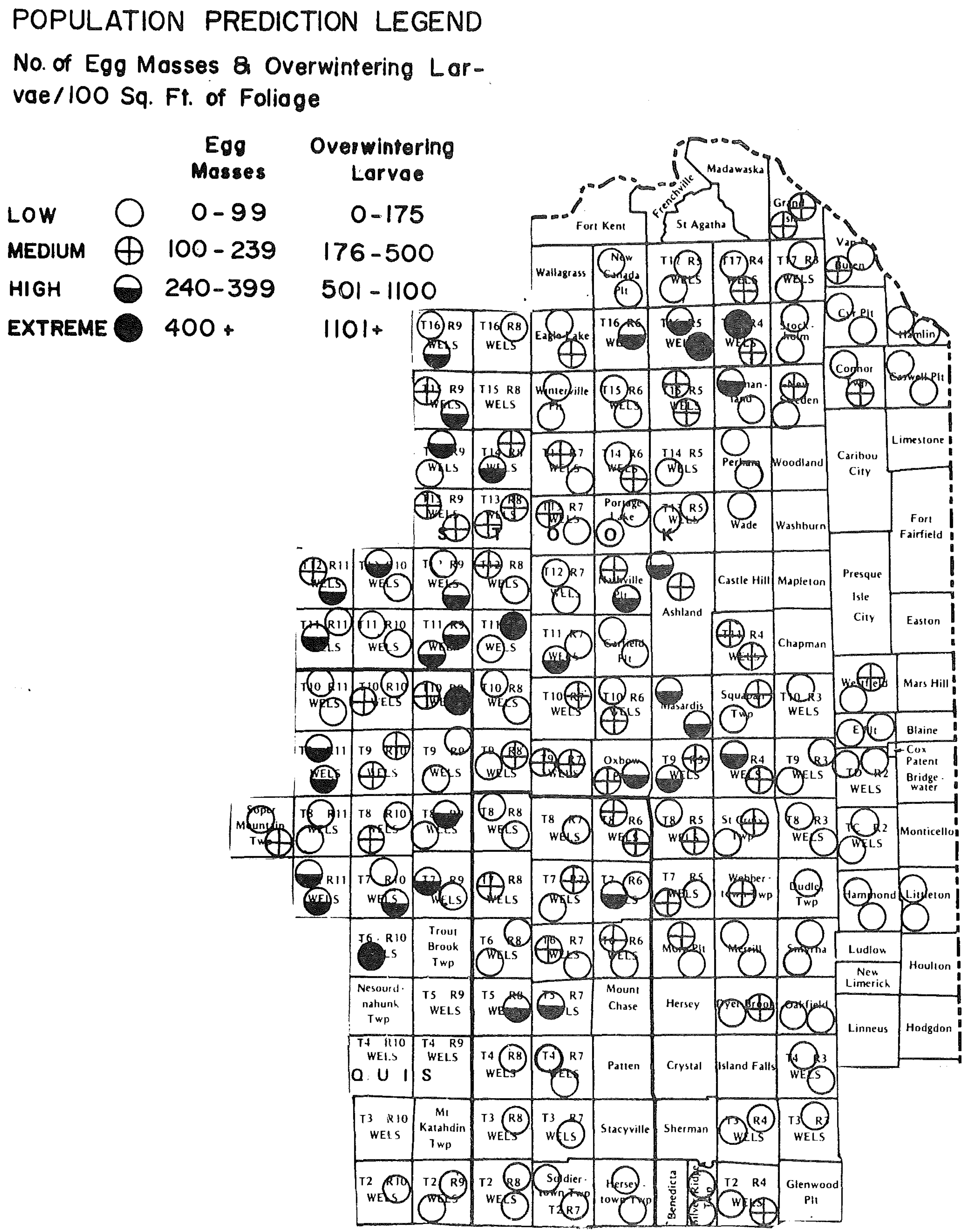


Figure 13. 1983 Spruce Budworm Population Prediction Map of the Northeast Zone.

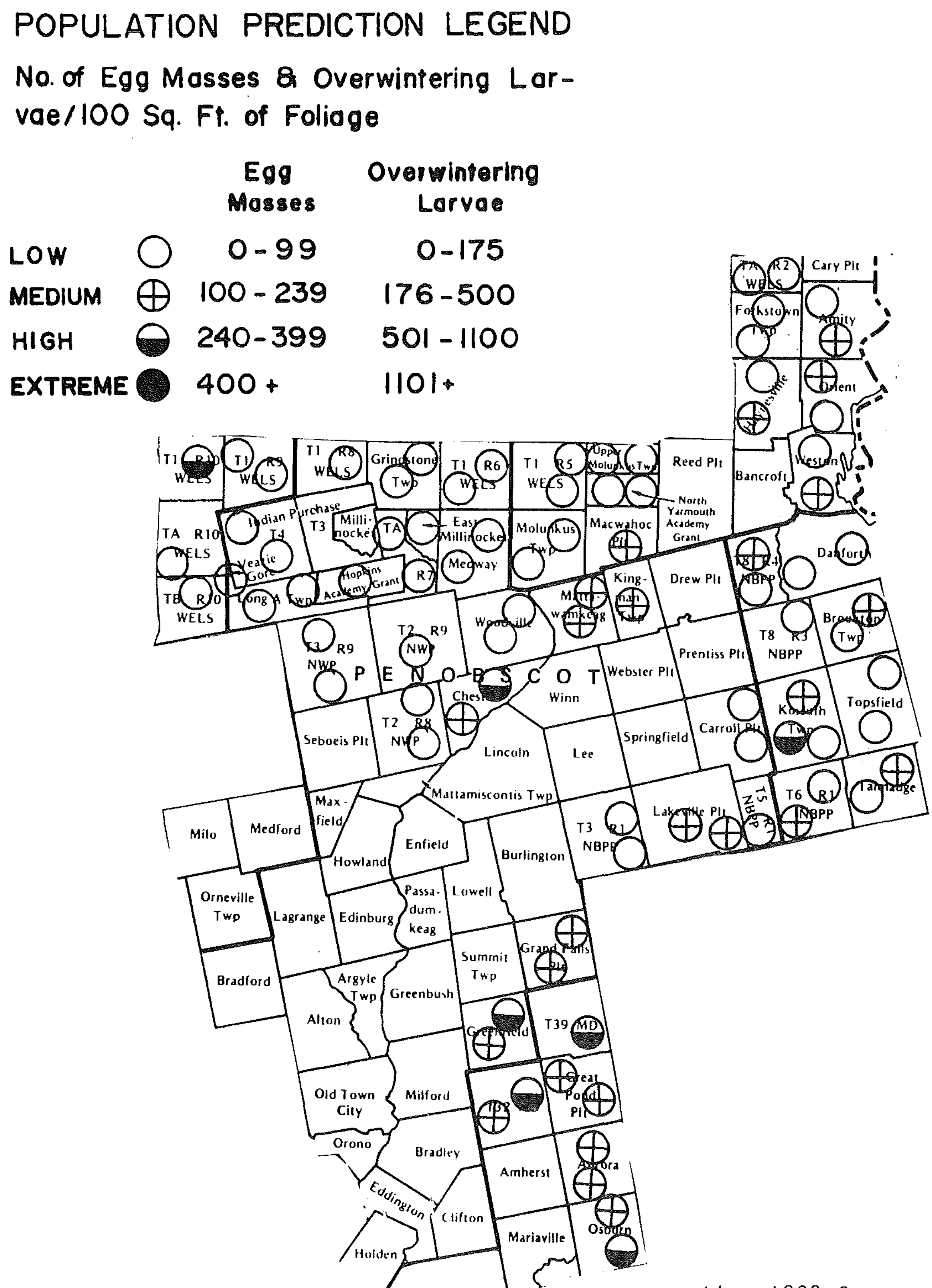


Figure 14. 1983 Spruce Budworm Population Prediction Map of the Penobscot-Mattawamkeag Zone.

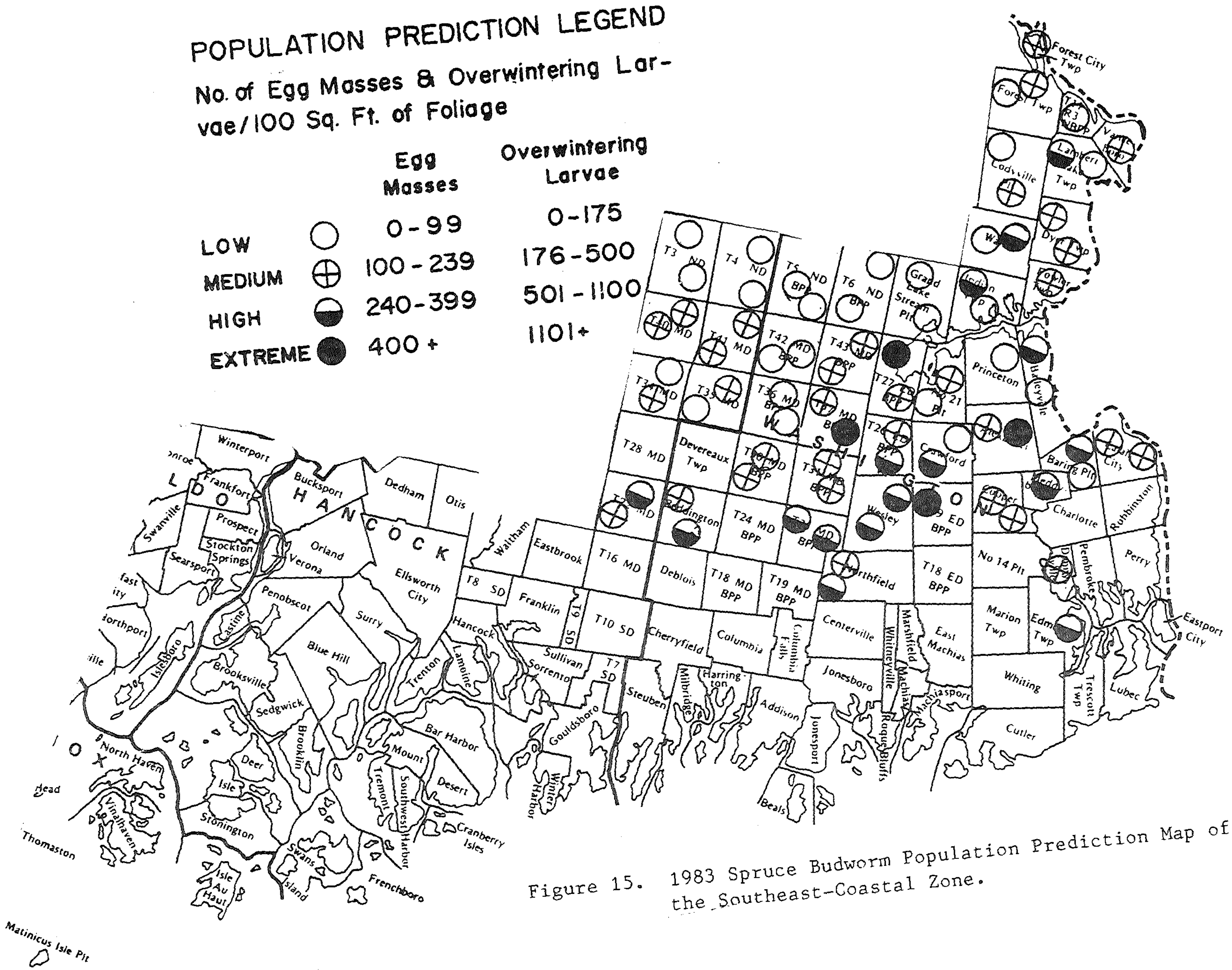


Figure 15. 1983 Spruce Budworm Population Prediction Map of the Southeast-Coastal Zone.

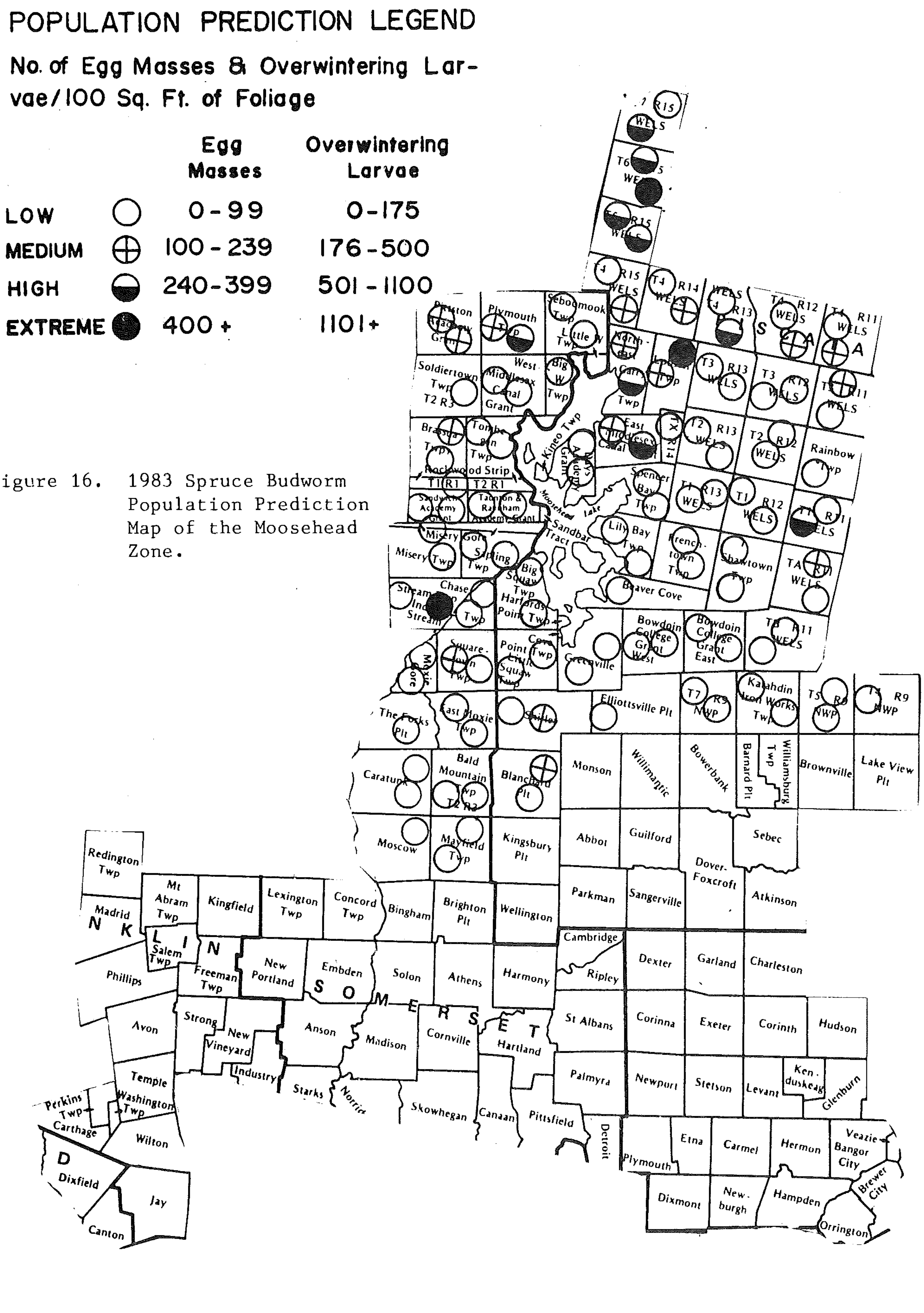


Figure 16. 1983 Spruce Budworm Population Prediction Map of the Moosehead Zone.

POPULATION PREDICTION LEGEND

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

		Egg Masses	Overwintering Larvae
LOW	[open circle]	0-99	0-175
MEDIUM	[circle with cross]	100-239	176-500
HIGH	[half-filled circle]	240-399	501-1100
EXTREME	[filled circle]	400+	1101+

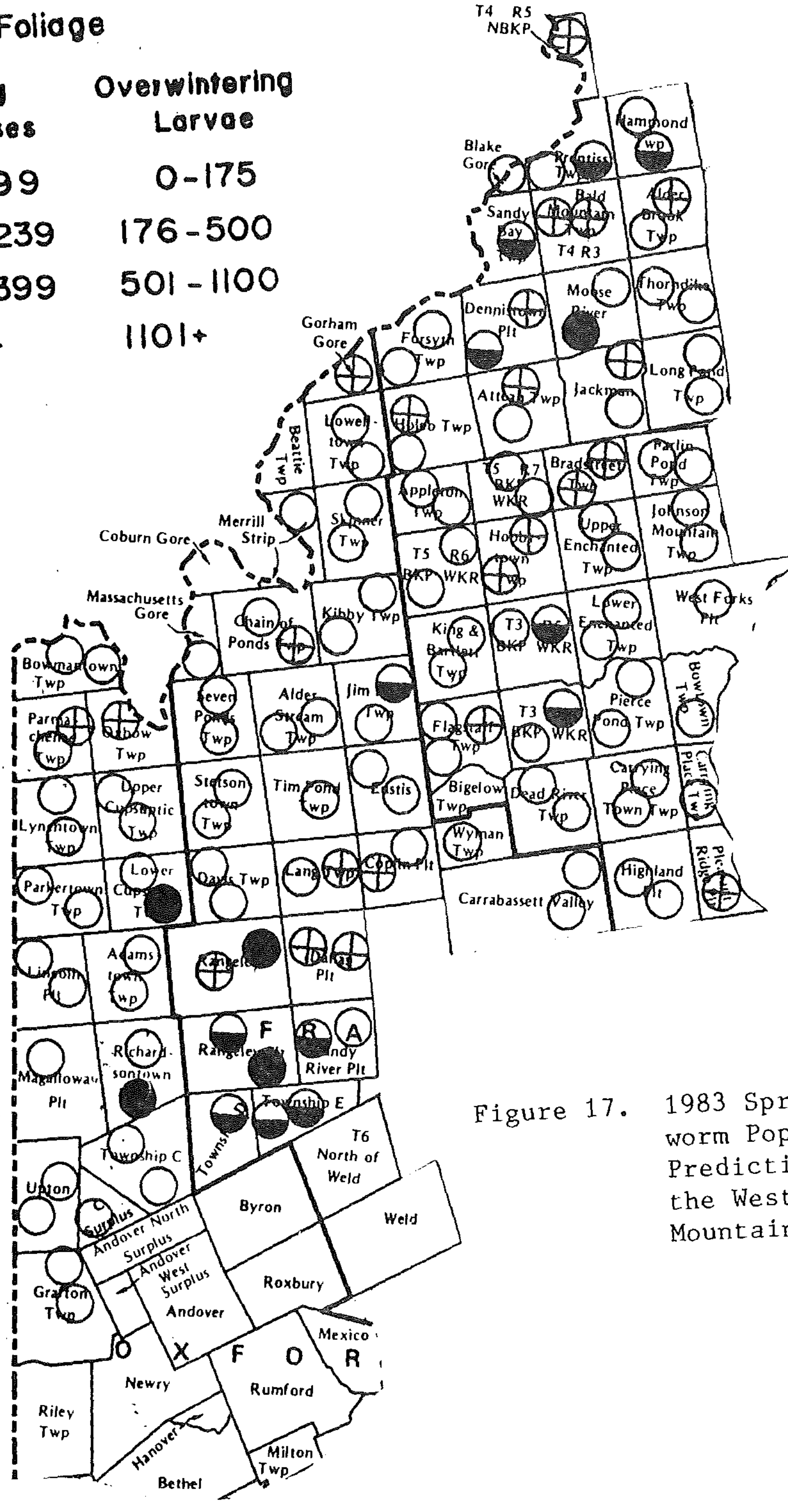


Figure 17. 1983 Spruce Budworm Population Prediction Map of the Western Mountains Zone.

TABLE 11. MORTALITY OF FIR AND SPRUCE ON PERMANENT PLOTS
ASSESSED IN CONNECTION WITH THE MAINE SURVEY OF SECONDARY INSECTS IN
BUDWORM DAMAGED STANDS

MORTALITY PERCENTAGE BY SPECIES AND YEAR

	FIR					SPRUCE				
SURVEY AREAS	1979	1980	1981	1982	1983	1979	1980	1981	1982	1983
Northwest	38.6(515)*	45.5(472)	66.2(465)	74.9(430)	69.9(196)	9.4(85)	10.5(78)	10.7(75)	17.1(70)	25.0(36)
Northeast	22.5(315)	38.1(315)	53.2(301)	66.0(315)	73.9(218)	8.6(35)	20.0(35)	20.0(35)	42.9(35)	47.1(17)
Southern Aroostook	10.2(303)	15.2(302)	27.6(291)	37.6(351)	47.4(287)	0.0(47)	0.0(47)	6.7(45)	8.2(49)	3.0(33)
Musquacook	20.2(257)	27.7(252)	40.9(245)	62.0(253)	62.6(99)	9.3(43)	11.6(43)	20.9(43)	31.9(44)	29.4(17)
Baker Lake	41.2(85)	23.8(185)	38.5(183)	58.4(149)	56.5(85)	6.7(15)	3.1(65)	4.6(65)	7.0(43)	7.5(40)
Telos	24.5(188)	36.2(258)	44.8(227)	60.0(200)	66.5(188)	1.8(112)	2.8(142)	4.2(121)	8.0(100)	13.4(97)
Moosehead	---	8.6(382)	23.4(351)	37.3(415)	50.5(297)	---	0.5(267)	0.0(248)	0.9(227)	2.5(163)
Western Mountains	11.9(379)	18.7(377)	23.4(339)	34.1(302)	42.3(300)	0.8(121)	2.5(121)	2.7(111)	5.4(93)	7.6(92)
Penobscot	10.1(512)	23.5(540)	35.9(498)	56.0(461)	71.6(328)	0.0(88)	1.1(288)	3.0(100)	3.4(89)	19.3(57)
Northern Washington	55.6(115)	45.0(148)	52.6(107)	59.0(122)	64.0(111)	2.4(35)	2.4(42)	3.6(28)	7.1(28)	4.0(25)
Southern Washington	28.5(449)	47.8(449)	55.4(443)	71.3(414)	59.0(205)	2.1(100)	5.5(100)	8.5(100)	11.6(86)	16.7(42)

* The number in parentheses indicate the number of trees assessed in a category in the year specified.

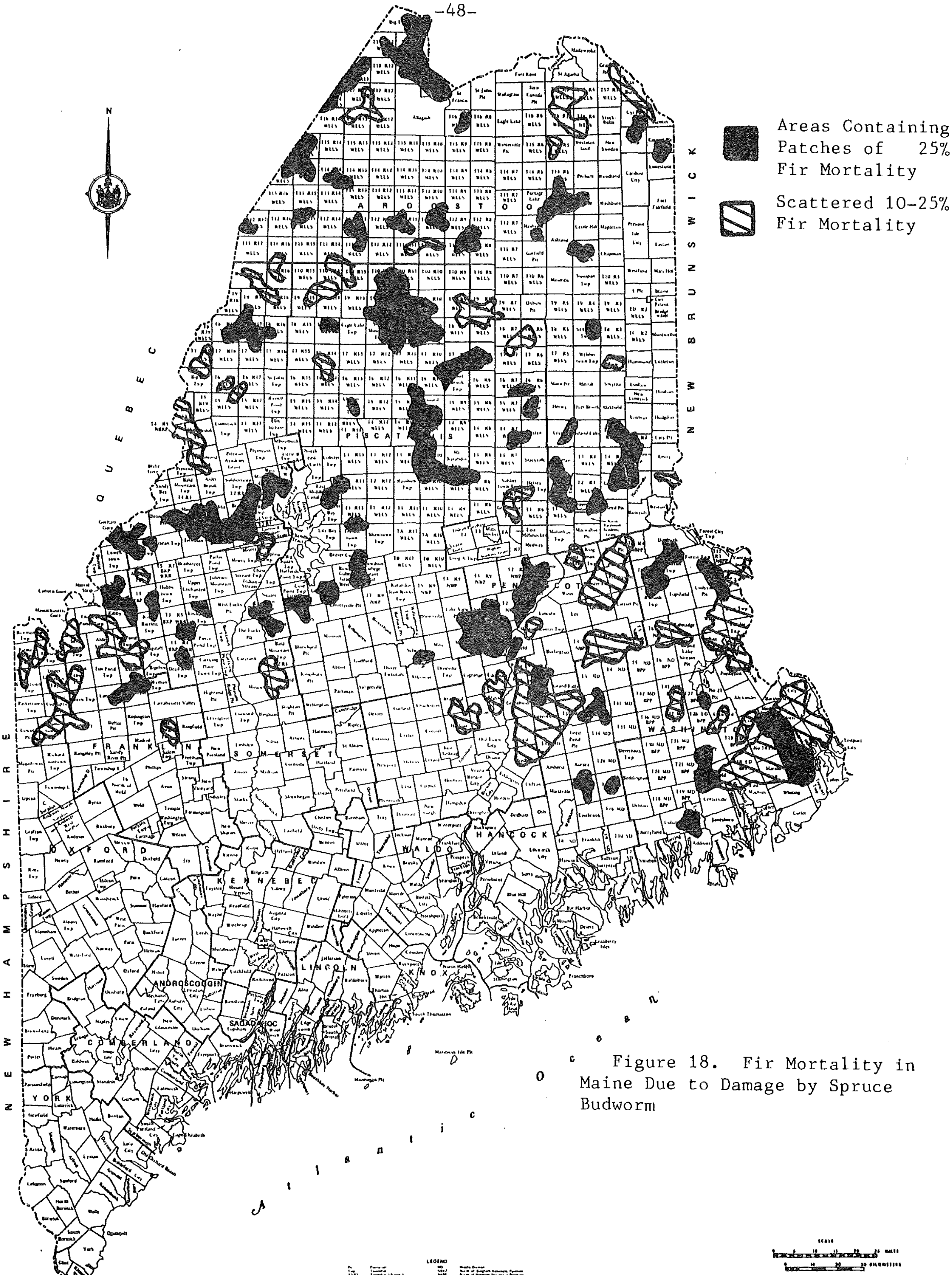


Figure 18. Fir Mortality in Maine Due to Damage by Spruce Budworm

acres that are in the five year suppression program.

The field sampling method used to gather specific population data is a modified version of the general L-II sampling techniques.

Samples are collected and processed between November 1 and January 20.

1. Field Methods

Samples are collected within tentative treatment areas for the upcoming spray program. A sample point consists of one upper mid-crown branch (2.5 - 3.5 feet in length) from each of two fir and two spruce trees. The number of sample points taken in each five year acreage area depends upon the size and accessibility of the area. Usually at least three sample points are taken, but as many as ten may be required in larger tentative treatment areas. Branches collected from these sample points are treated as described for the general L-II method.

2. Laboratory Methods

Samples are processed using the same method as used for the general L-II survey. All branches are processed and the number of larvae extracted from each sample point by the species collected are pooled and an average population level for each proposed treatment area is determined. This data is provided to the appropriate landowner or manager.

G. Forecast of Tree Condition and Hazard for 1984

Data collected during ground surveys are quantified into a hazard rating using the system shown in Table 9.

The portion of the budworm area in high or extreme hazard is somewhat smaller than the 1982 area (4.5 million acres in 1982 compared to 4.4 million acres in 1983). Hazard intensity has decreased in several areas due mainly to lower predicted populations. High levels of 1983 defoliation kept hazard at relatively high levels in northwestern and southeastern Maine.

Hazard ratings were calculated for each sample point and mapped by zone (Figures 19 through 24). All hazard values are for fir, but high or extreme values for fir generally indicate spruce is also in need of protection.

The general hazard outlook by zone is as follows:

Allagash-St. John -- Conditions in this zone are predicted to be very similar to predicted 1983 conditions. Nearly the entire

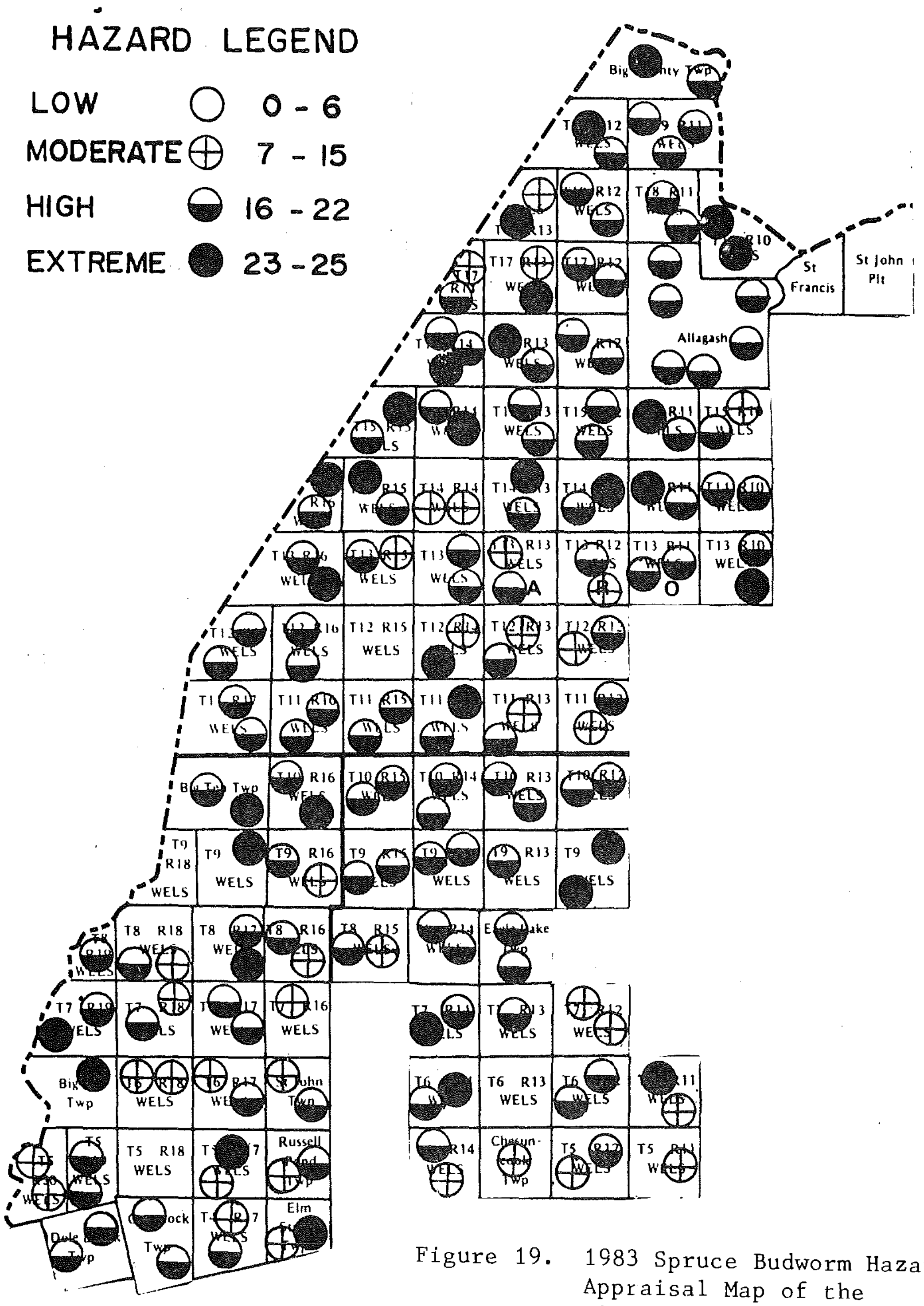


Figure 19. 1983 Spruce Budworm Hazard Appraisal Map of the Allagash-St. John Zone.

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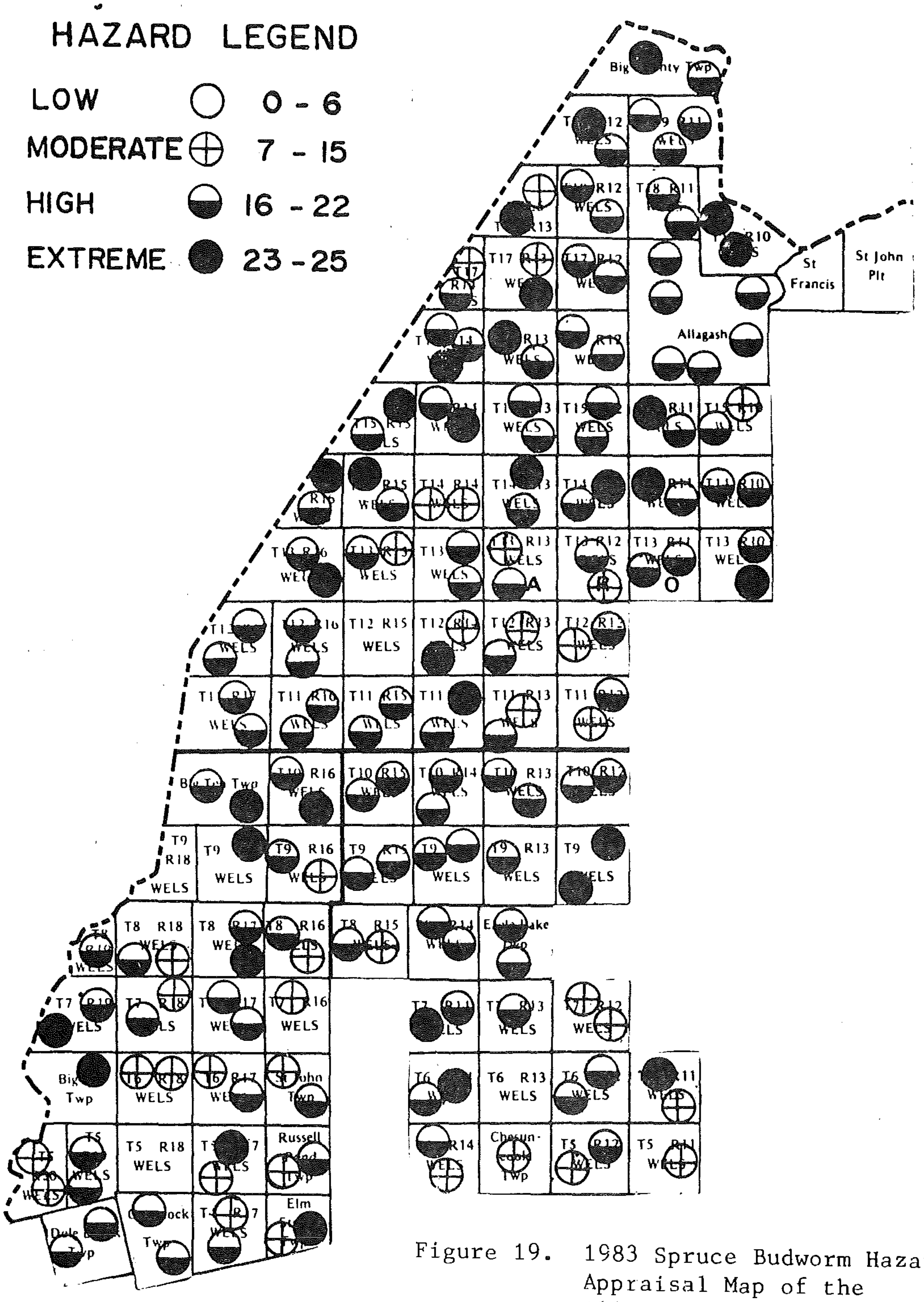


Figure 19. 1983 Spruce Budworm Hazard Appraisal Map of the Allagash-St. John Zone.

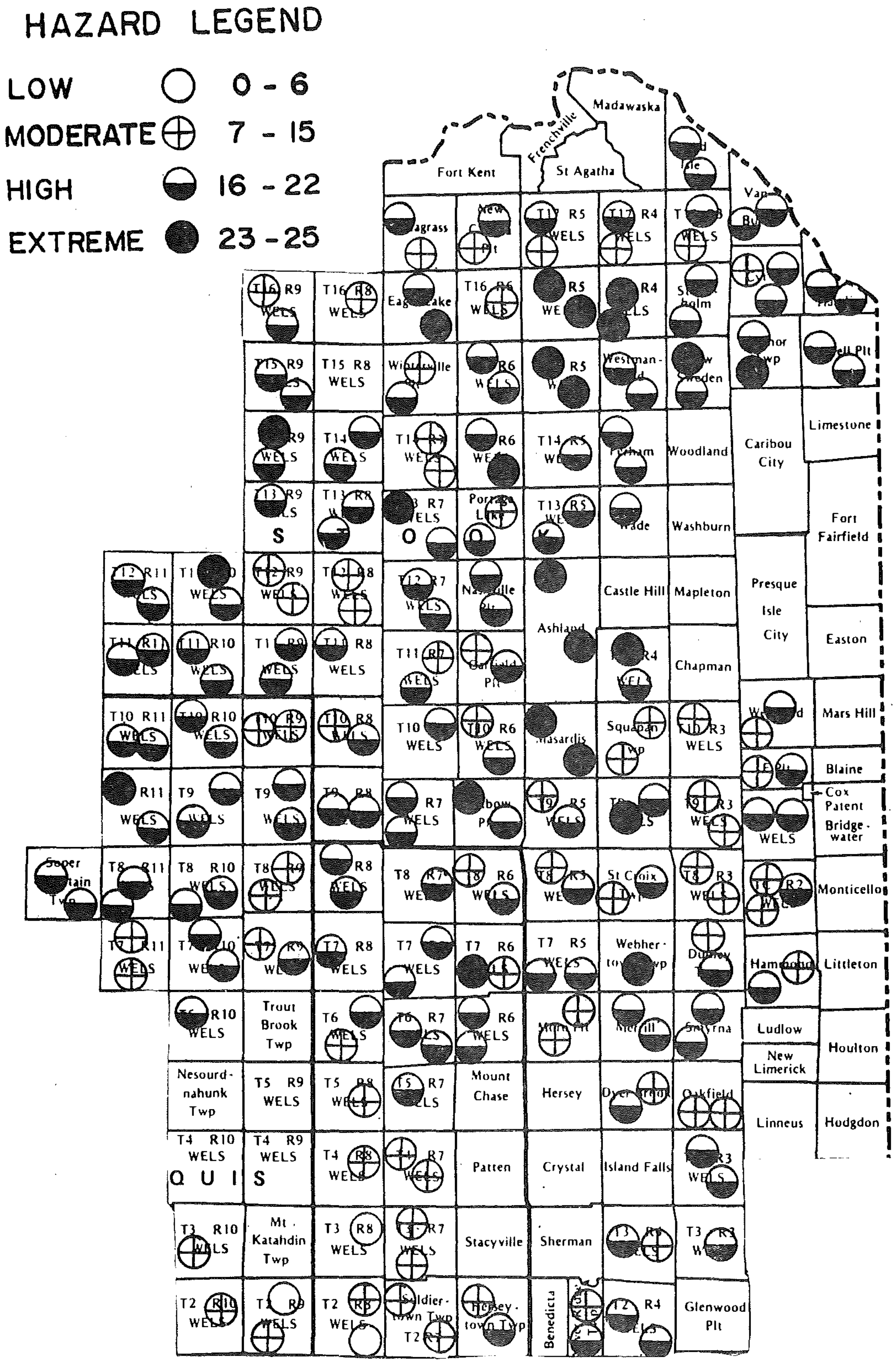


Figure 20. 1983 Spruce Budworm Hazard Appraisal Map of the Northeast Zone.

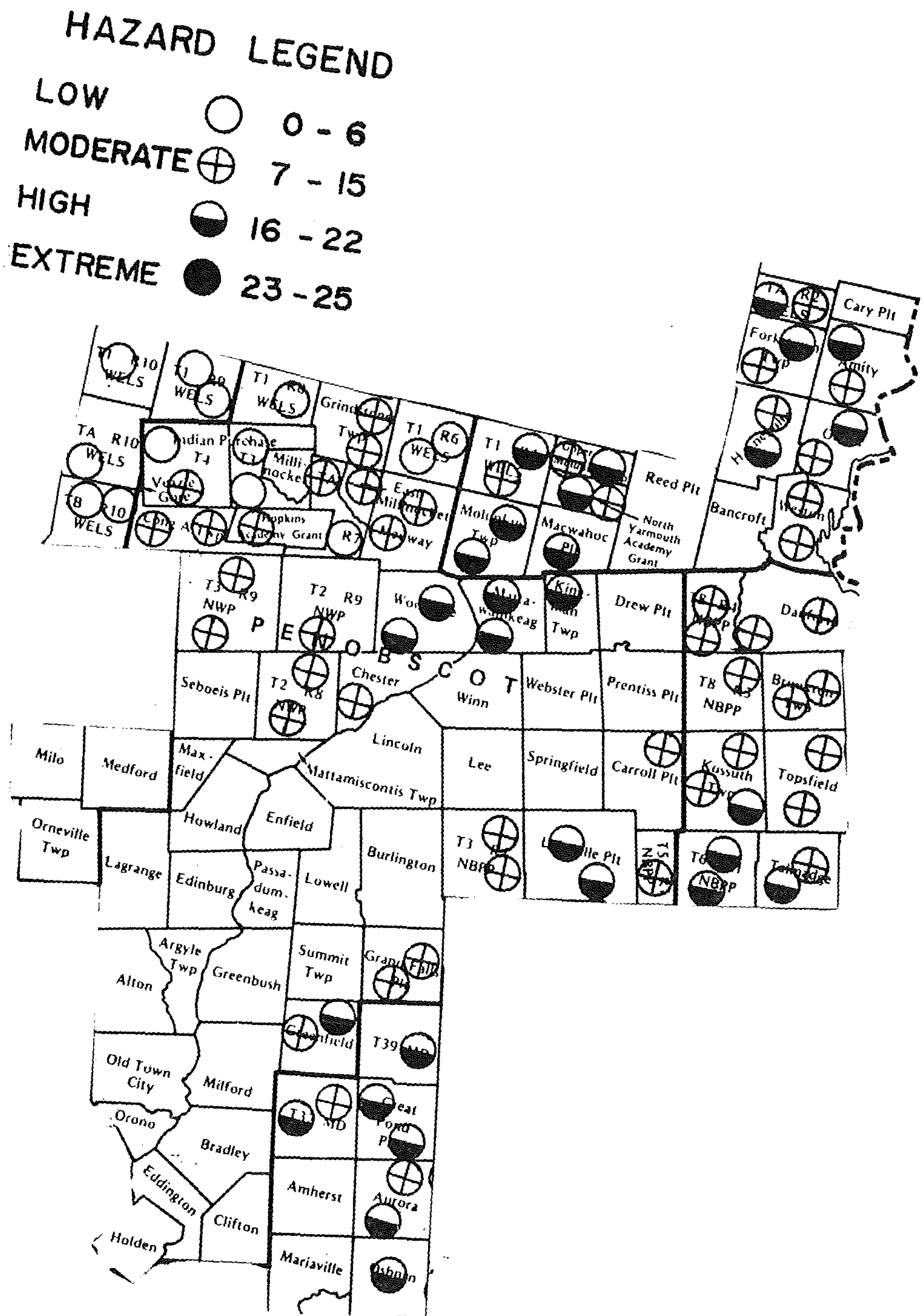


Figure 21. 1983 Spruce Budworm Hazard Appraisal Map of the Penobscot-Mattawamkeag Zone.

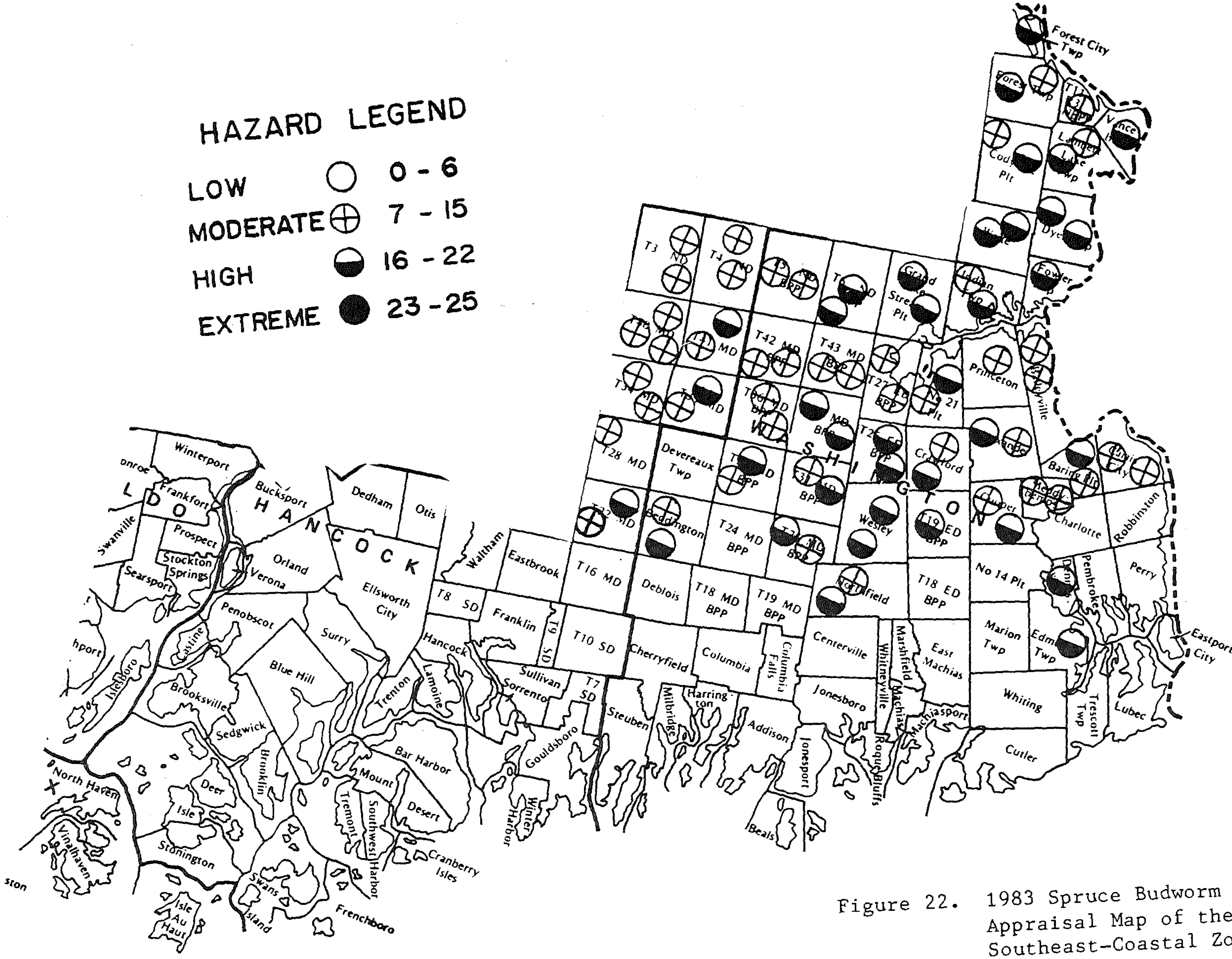


Figure 22. 1983 Spruce Budworm Hazard Appraisal Map of the Southeast-Coastal Zone.

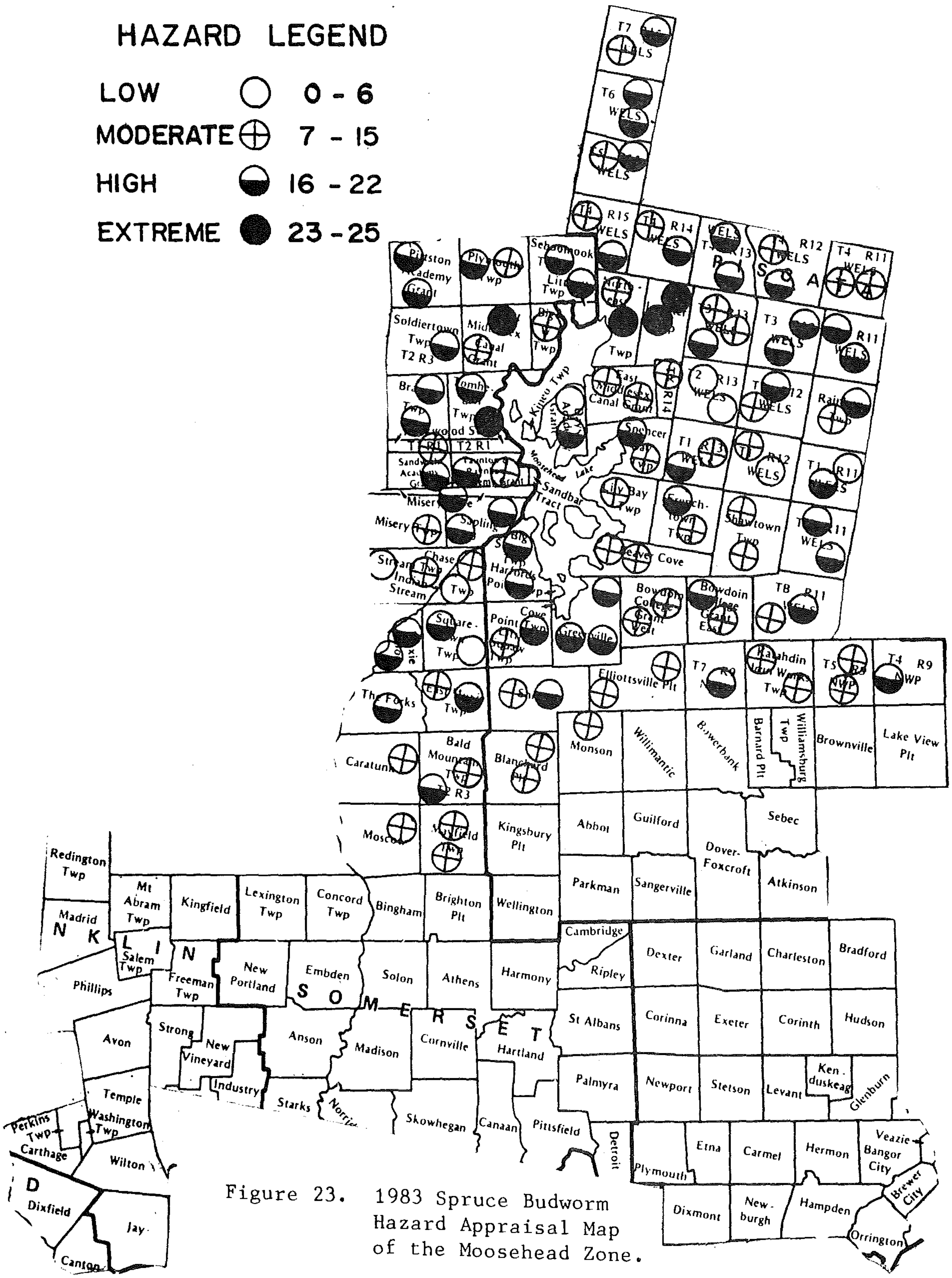


Figure 23. 1983 Spruce Budworm Hazard Appraisal Map of the Moosehead Zone.

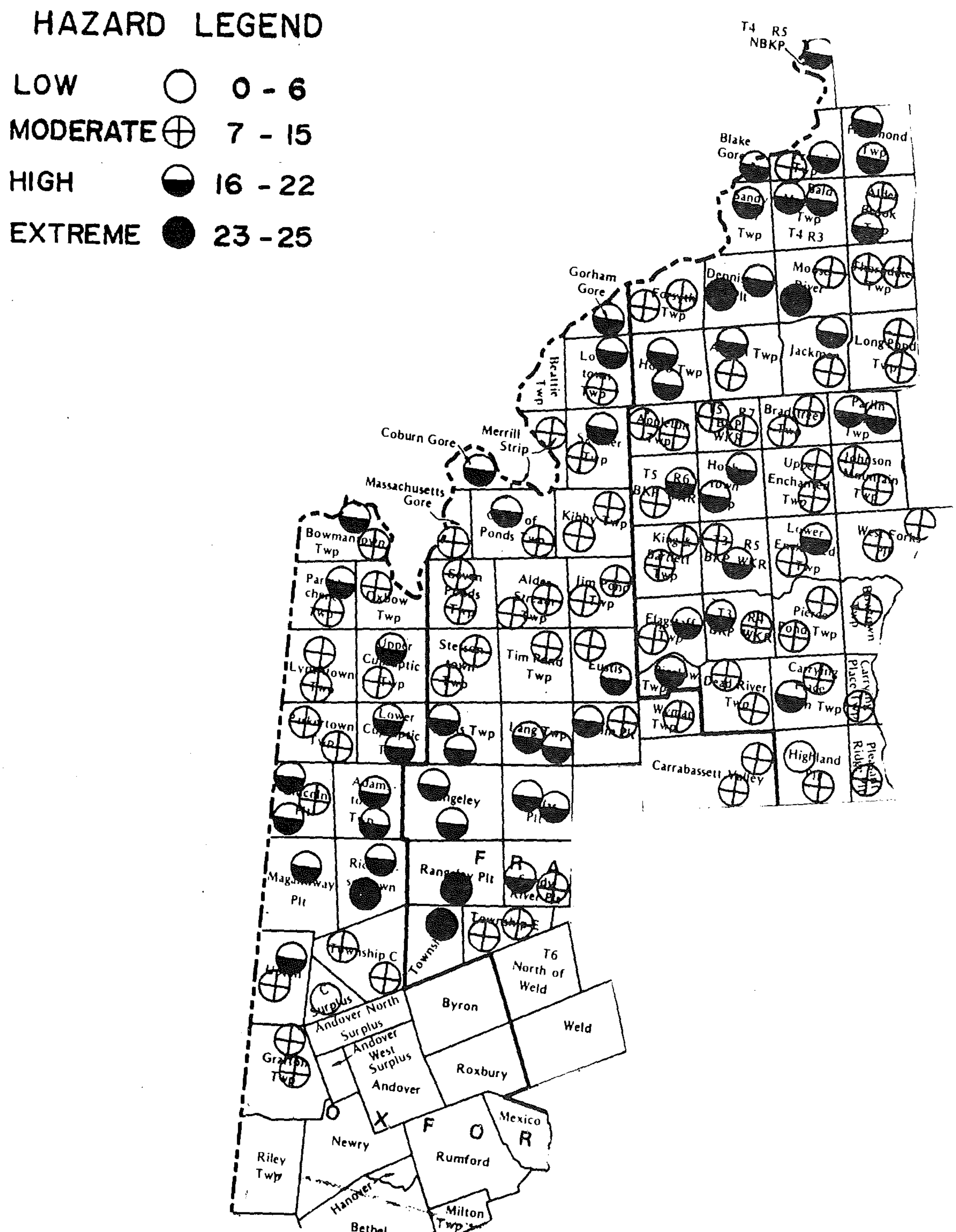


Figure 24. 1983 Spruce Budworm Hazard Appraisal Map of the Western Mountains Zone.

zone is in high hazard. Small areas of extreme and moderate hazard are scattered throughout the zone. Hazard in this zone has lowered in the years 1980 to 1982, but in 1983 heavy defoliations caused a hazard increase in some areas. Lower predicted 1984 populations moderated the hazard increase.

Northeast -- Predicted hazard for this zone is substantially lower than that predicted for 1983. Most of the zone is predicted to be high hazard for 1984. Two areas of extreme hazard remain in the central and northern portions of the zone. The southern portion of the zone, south of Presque Isle, has a large area of moderate hazard. Most of the hazard decrease in this zone is due to lower predicted populations, and because defoliation was lower in the southern portion of the zone in 1983.

Penobscot-Mattawamkeag -- This zone shows a substantial hazard reduction compared to 1983 levels. Most of the zone had been high in 1983, but only the area around Mattawamkeag remain high for 1984. The Millinocket area has improved to low hazard. The remainder of the zone was found to be moderate. Hazard reduction in this zone is due to low predicted populations and lower 1983 defoliation.

Southeast-Coastal -- The southeastern and northeastern portions of this zone are in high hazard for 1984. Much of the zone was extreme in 1983. Sprayed areas in the central portion of the zone have improved to moderate due to lower defoliation. Populations in much of the zone are sharply reduced for 1984 accounting for much of the hazard improvement.

Moosehead Zone -- Most of the Moosehead Zone was predicted to be moderate for 1984. Scattered areas of high hazard remain west of Moosehead Lake, and small areas of extreme hazard was found in the north; hazard values in this zone have declined for the last three years due to lower populations and resulting improvements in foliage complement.

Western Mountains -- Most of this zone has improved to moderate after several years of low populations. A large area of high hazard near Rangeley remains. Small areas of high hazard also remain in the northern part of the zone. As with the Moosehead Zone, hazard improvement is due to lower populations since 1980.

Ground surveys and aerial checks of questionable areas were used to prepare a general hazard map (Figure 25). This map shows approximately 4.5 million acres of high and extreme hazard.

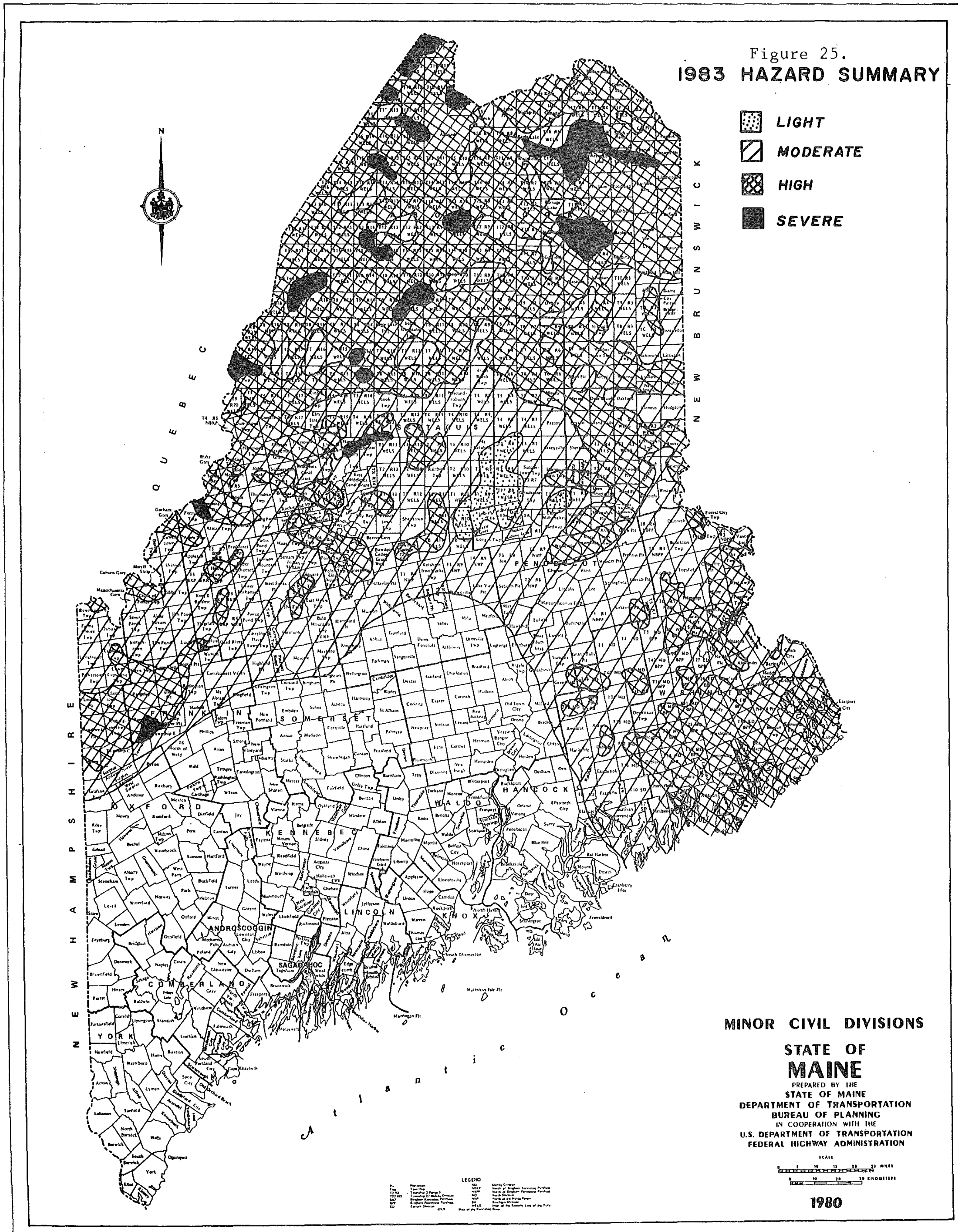


Figure 25.
1983 HAZARD SUMMARY

V. 1983 SPRAY OPERATIONS AND FORECAST OF CONDITIONS IN QUEBEC AND NEW BRUNSWICK

The 1983 spray project in New Brunswick conducted by Forest Protection Limited covered 1,495,000 hectares of susceptible spruce-fir forest. An additional 200,000 hectares was treated by J. D. Irving Limited. Forest Protection Limited's spraying began on May 21st and was completed on June 19th. All areas were treated as planned.

Most of the area was treated with Fenitrothion. Matacil was used on 101,000 hectares and Bt on 10,300 hectares.

The majority of the area was treated with TBM and DC-6 aircraft. Small woodlot areas were sprayed with an assortment of small aircraft including M18, AgCat, and Cessna 188.

Measurable defoliation was mapped in 26.5% of the sprayed area compared to defoliation on 21.5% of the area in 1982. The 1983 project was considered a success.

The 1983 egg mass showed a reduction in the area expected to receive moderate to high defoliation in 1984. Points with low egg counts increased from 26% of total points in 1982 to 48% of the total in 1983. The predicted decrease in the area of infestation is largely due to a decline in budworm populations in much of Southern New Brunswick.

In Quebec, a total of 1,186,104 hectares of forest were treated in 1983. Most of the area was located in the Lower St. Lawrence and Gaspe' regions. About 1,156,103 hectares were treated with chemicals and 30,001 hectares were treated with Bt. Two applications of Matacil were used on 85% of the chemical areas in 1983 and two applications of Fenitrothion used on the remaining chemical acres. The Bt product used was Novabae 3.

Spraying was done with fourteen DC-4's, three DC-6's, two L-749 Constellations, and three AgCat B aircraft.

The 1983 project met objectives with regard to foliage protection and population reduction. An average of 30% foliage reduction was achieved and 78% of the total spray area was held in the low defoliation category. Quebec Bt treatments in 1984 were termed as effective as chemical treatments.

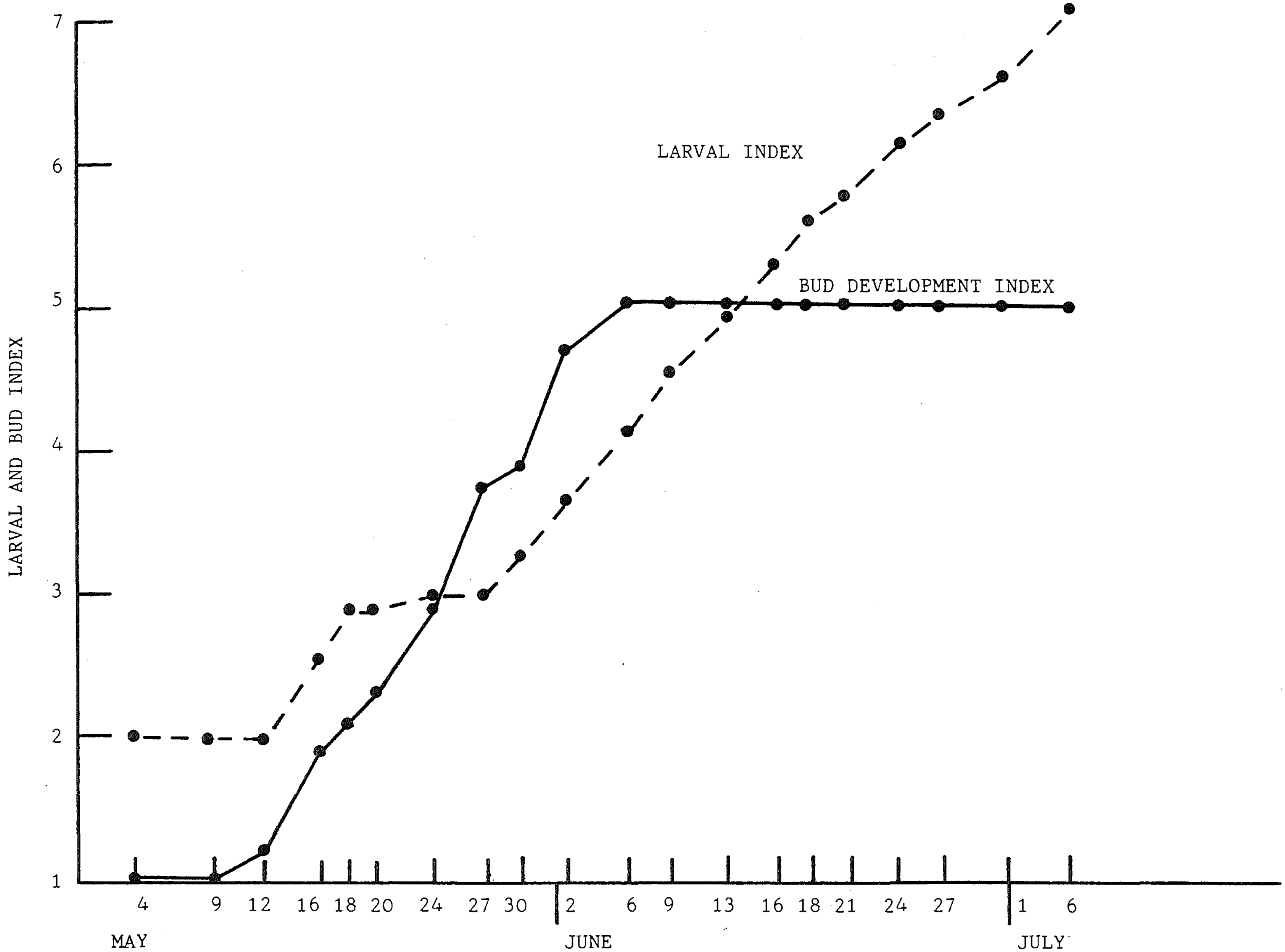
Population prediction surveys conducted in 1983 indicate Province wide reduction in population for 1984. Reductions in population are expected in the Gaspe' and Lower St. Lawrence region, while the area north of Quebec City and the north shore region should show population increases. Populations in other portions of Quebec remain similar to 1982 predictions.

APPENDIX A

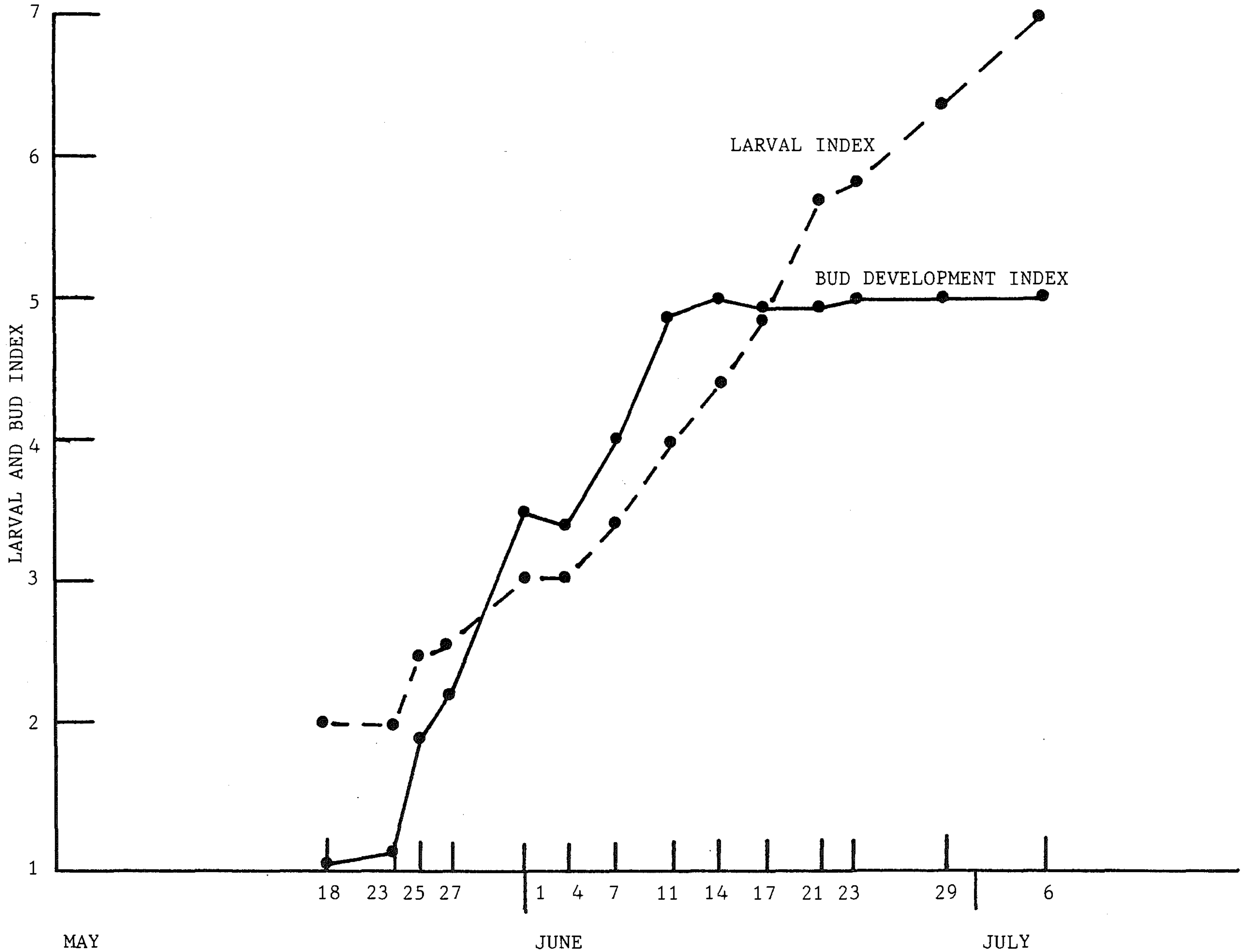
SPRUCE BUDWORM PROJECT 1983

DEVELOPMENT CHARTS

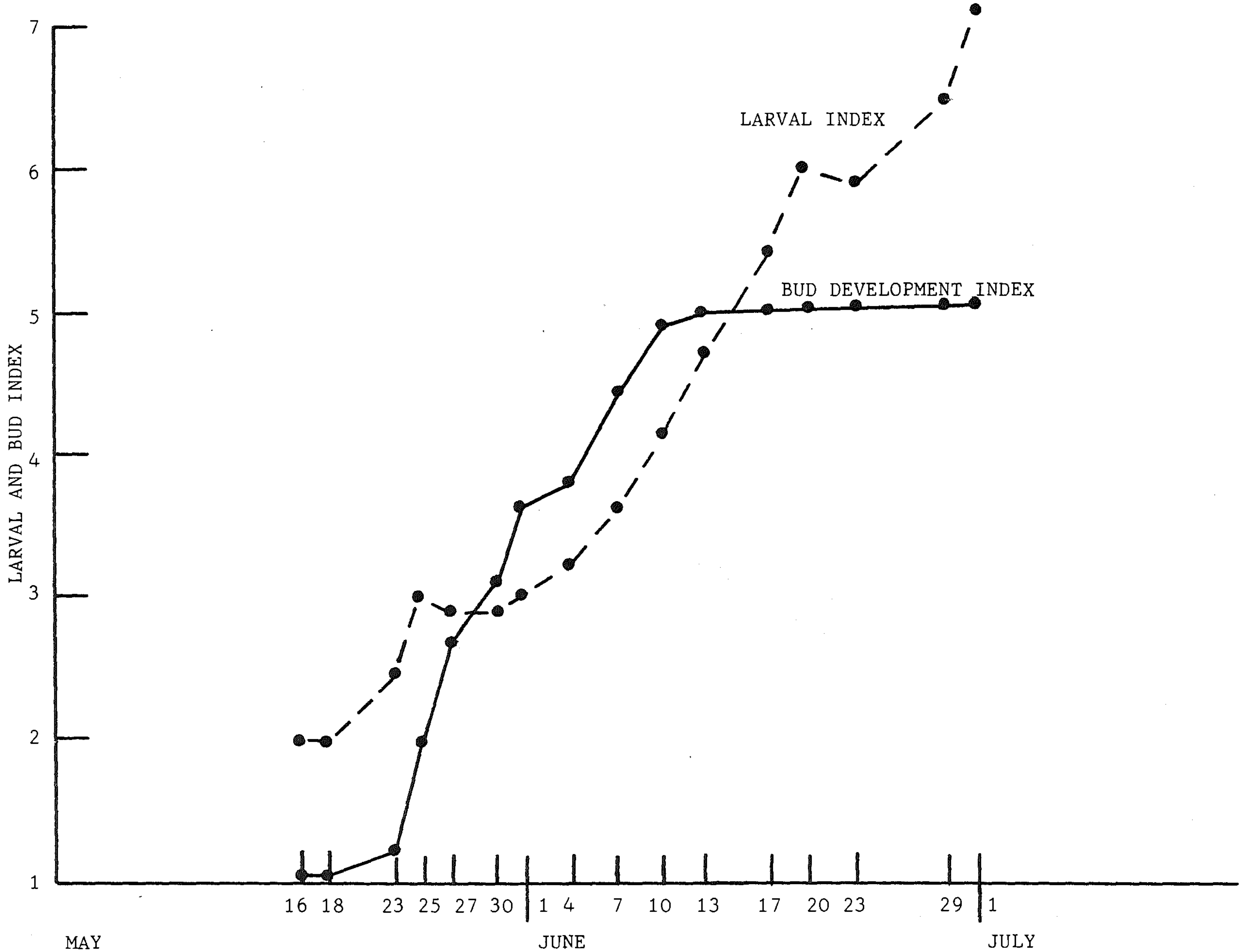
LARVAL AND BUD DEVELOPMENT IN 1983 AT PRINCETON



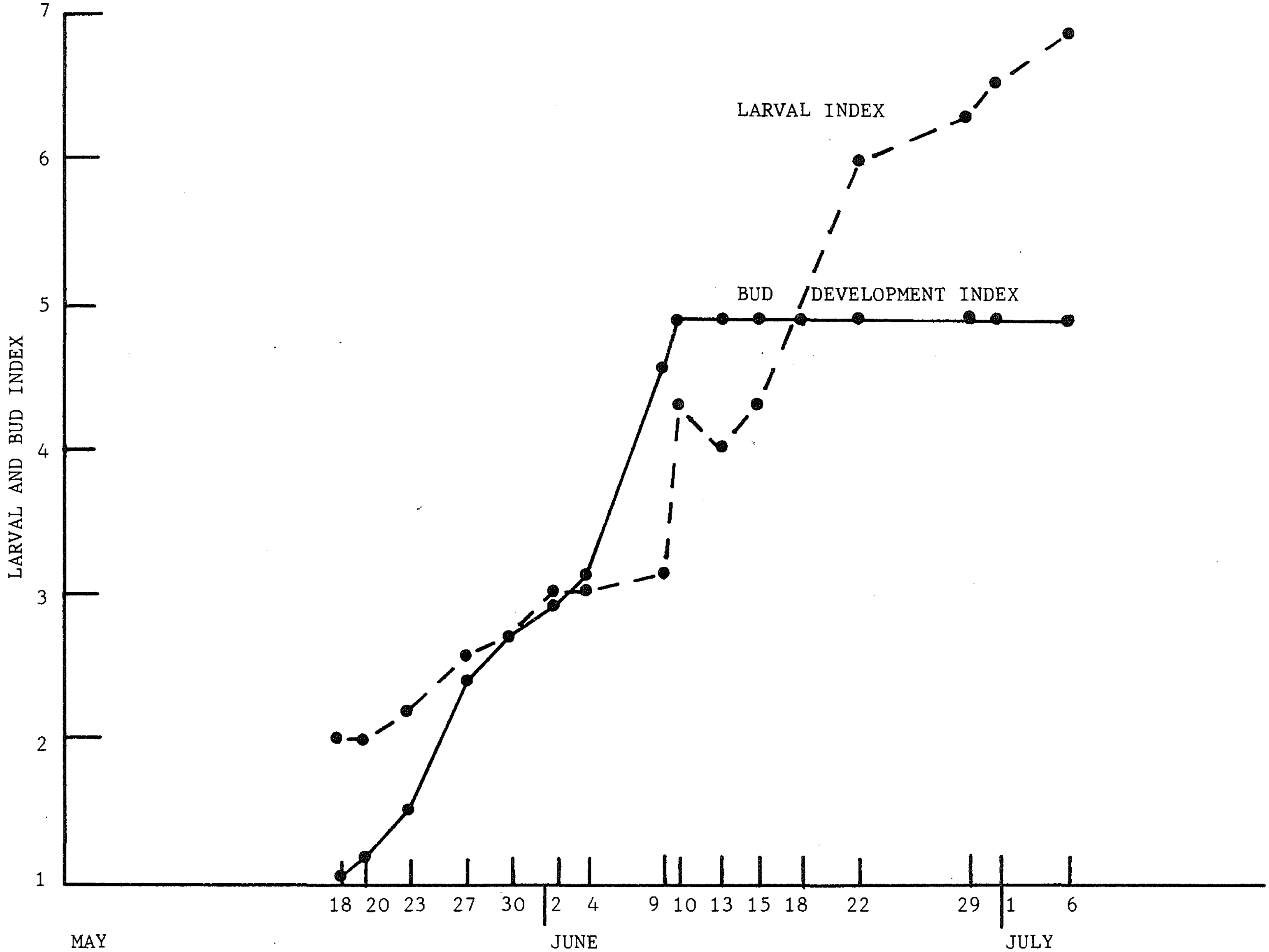
LARVAL AND BUD DEVELOPMENT IN 1983 AT UMSASKIS (T11R13)



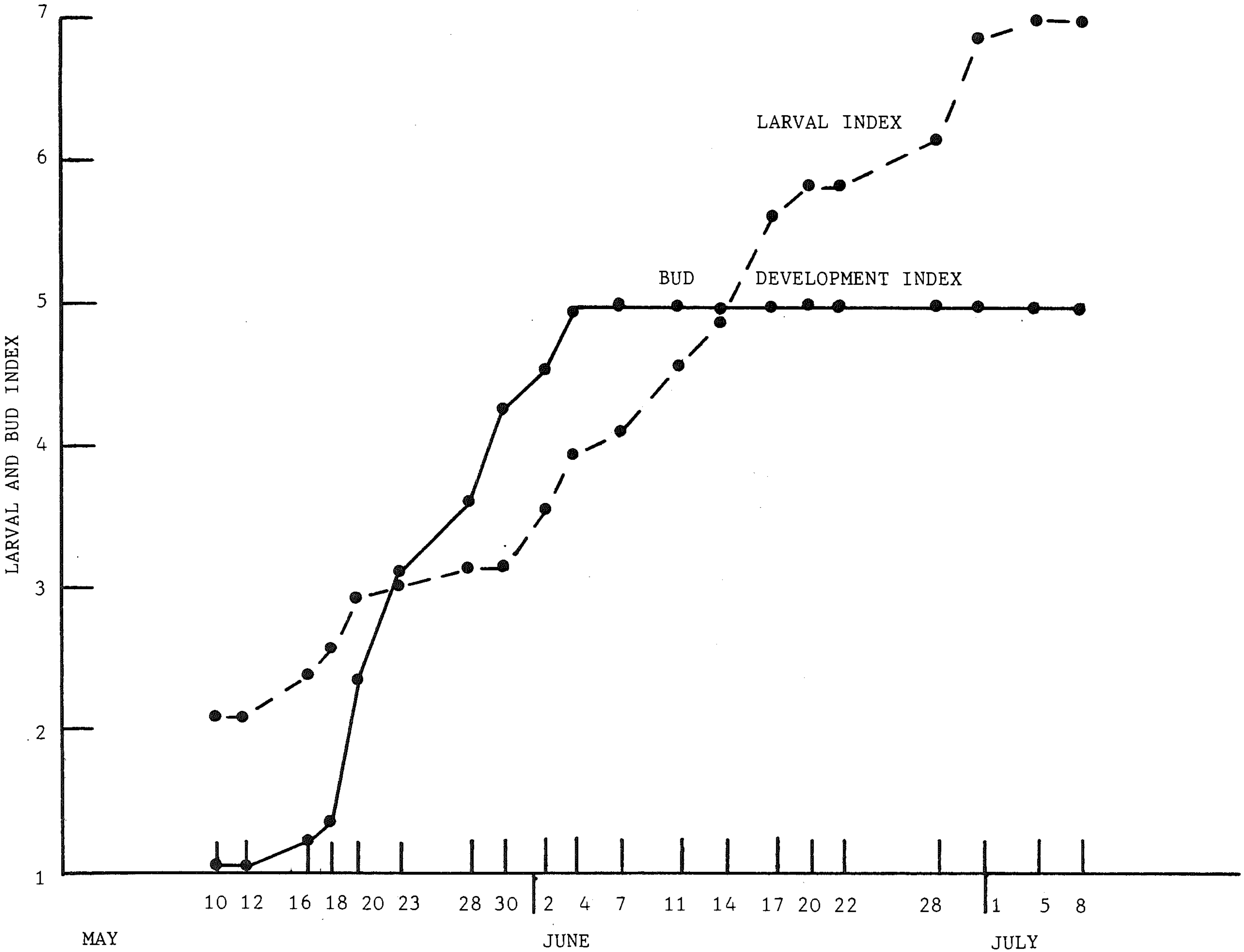
LARVAL AND BUD DEVELOPMENT IN 1983 AT ALLAGASH



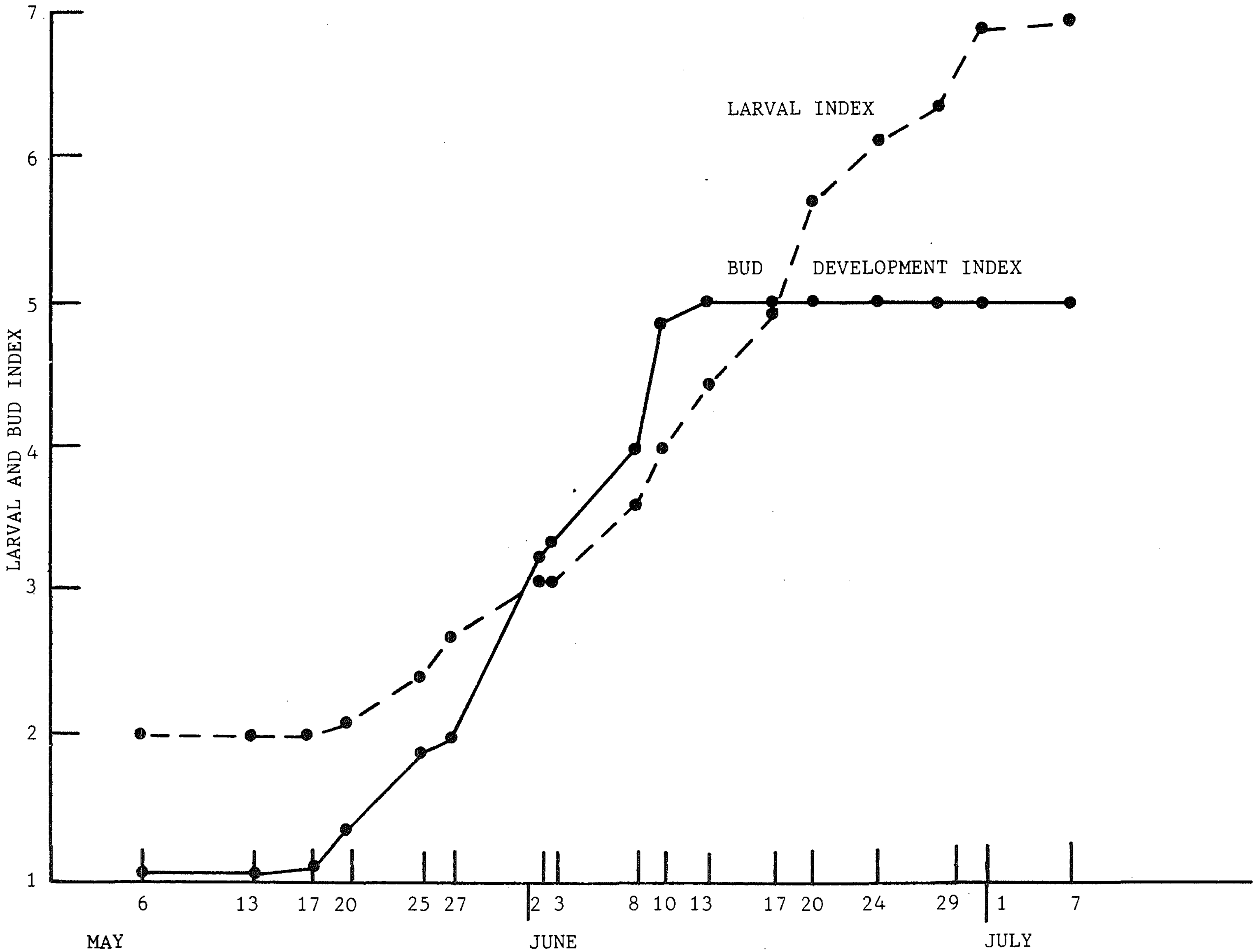
LARVAL AND BUD DEVELOPMENT IN 1983 AT DENNISTOWN



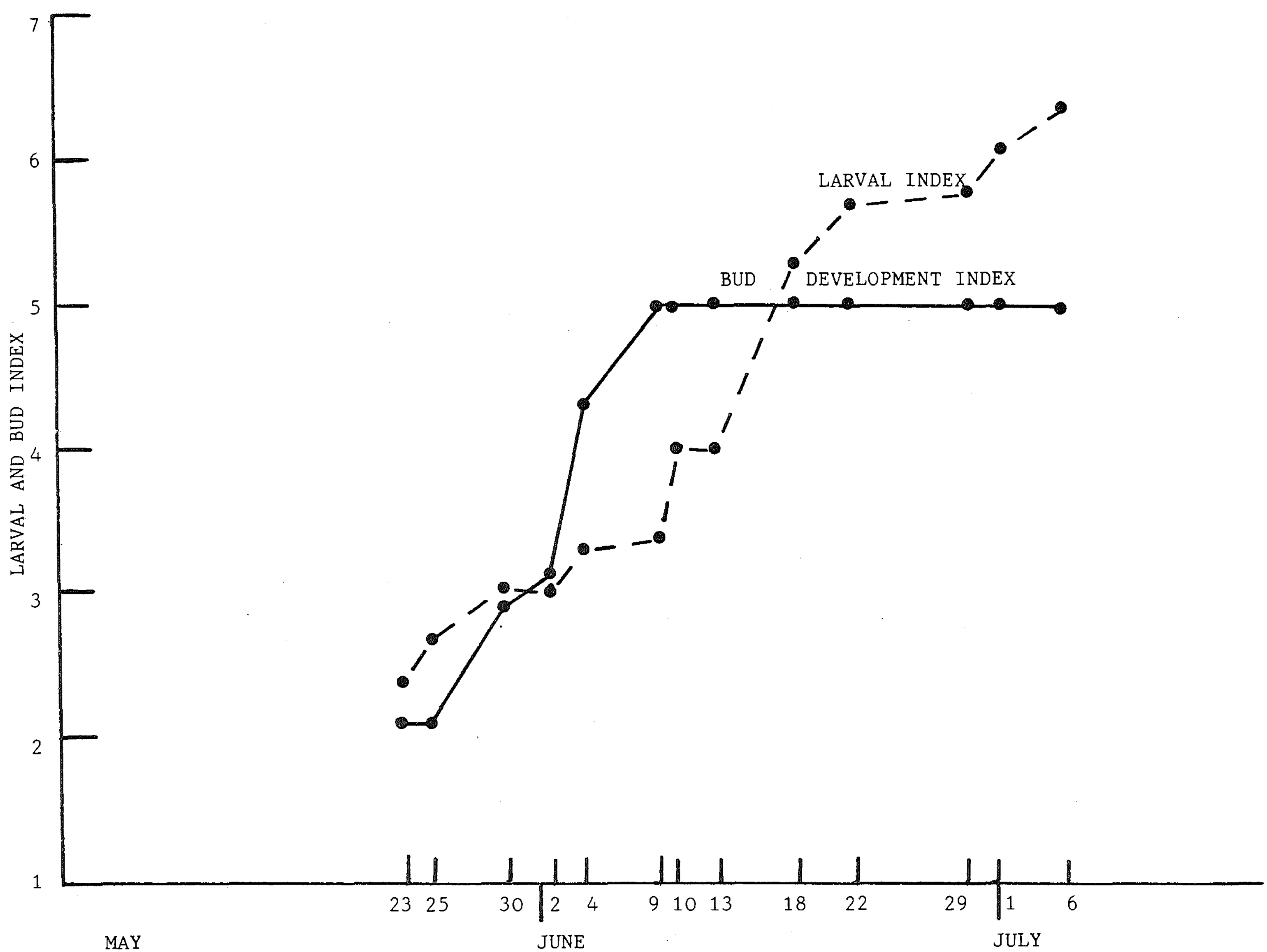
LARVAL AND BUD DEVELOPMENT IN 1983 AT MACWAHOC (T1R4)



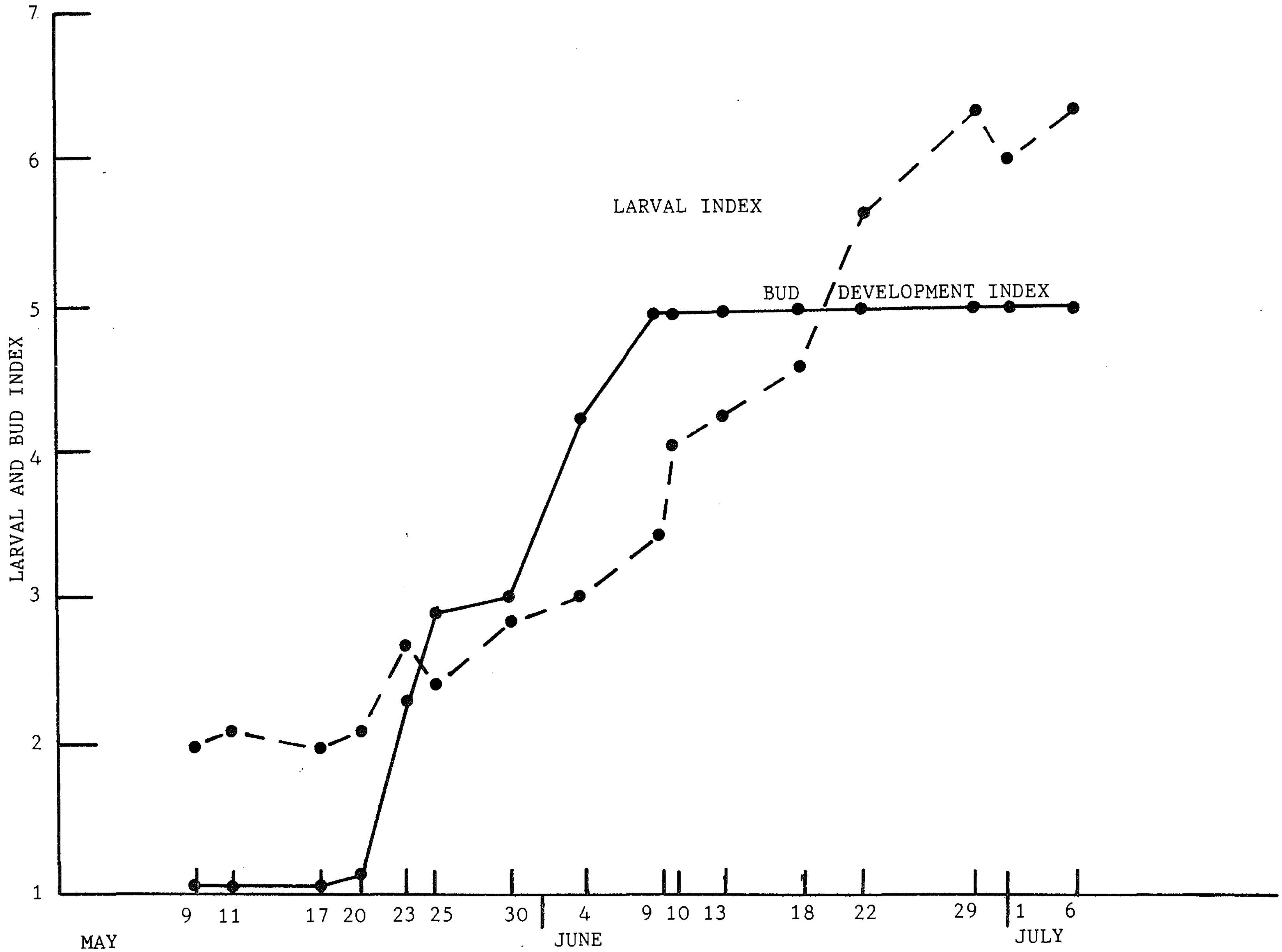
LARVAL AND BUD DEVELOPMENT IN 1983 AT ROUND POND (T6R11)



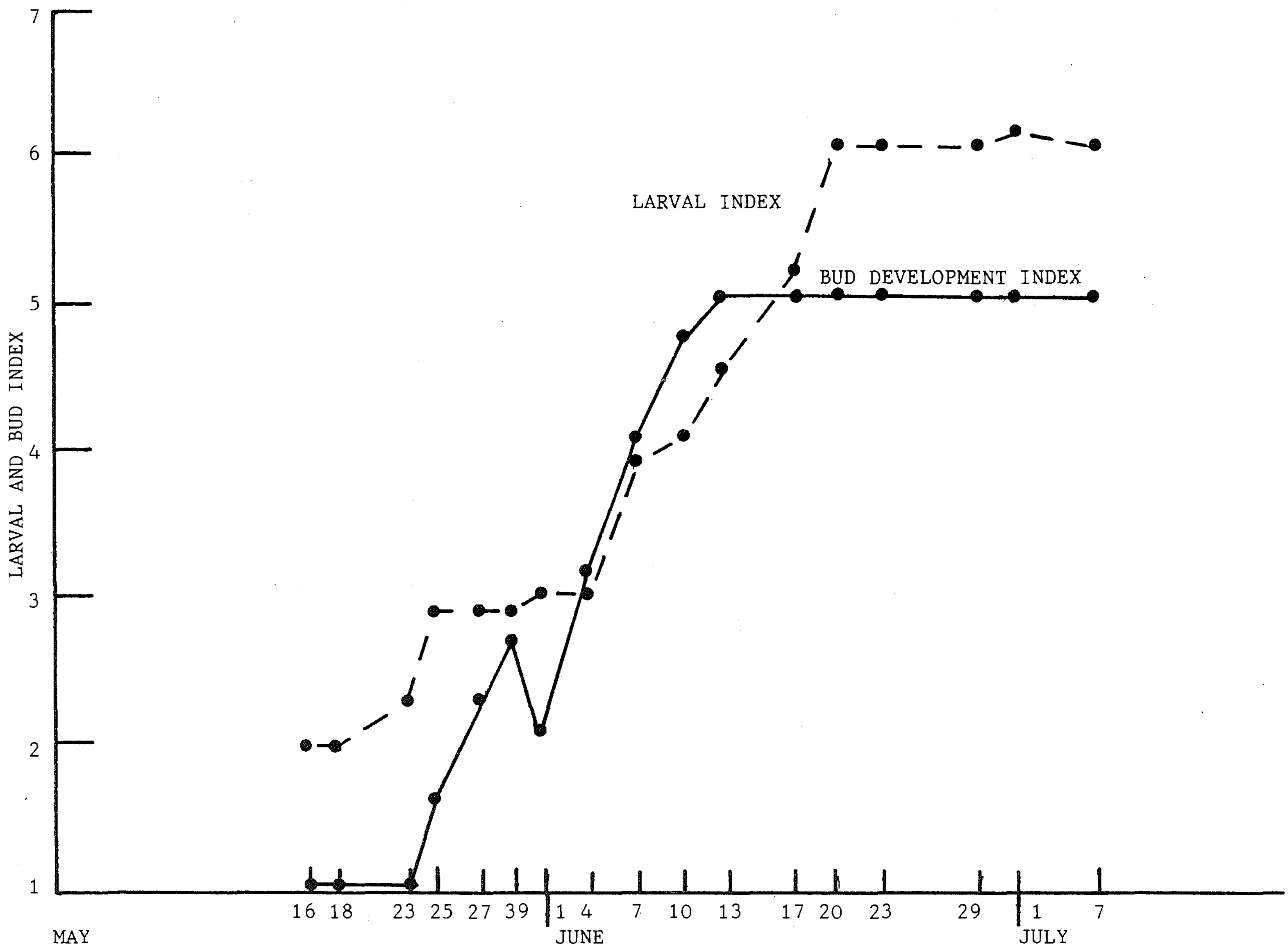
LARVAL AND BUD DEVELOPMENT IN 1983 AT JIM POND



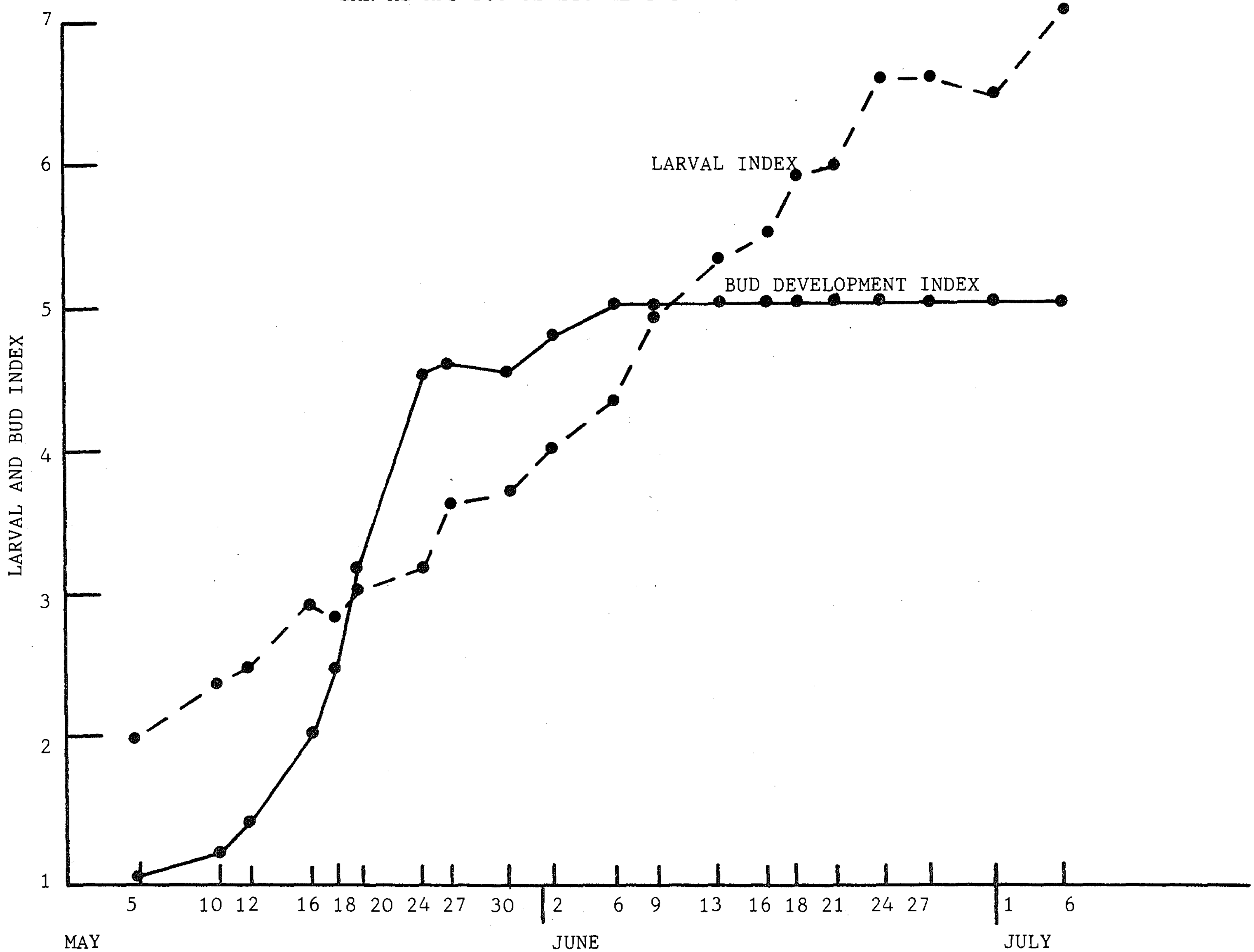
LARVAL AND BUD DEVELOPMENT IN 1983 AT SHIRLEY



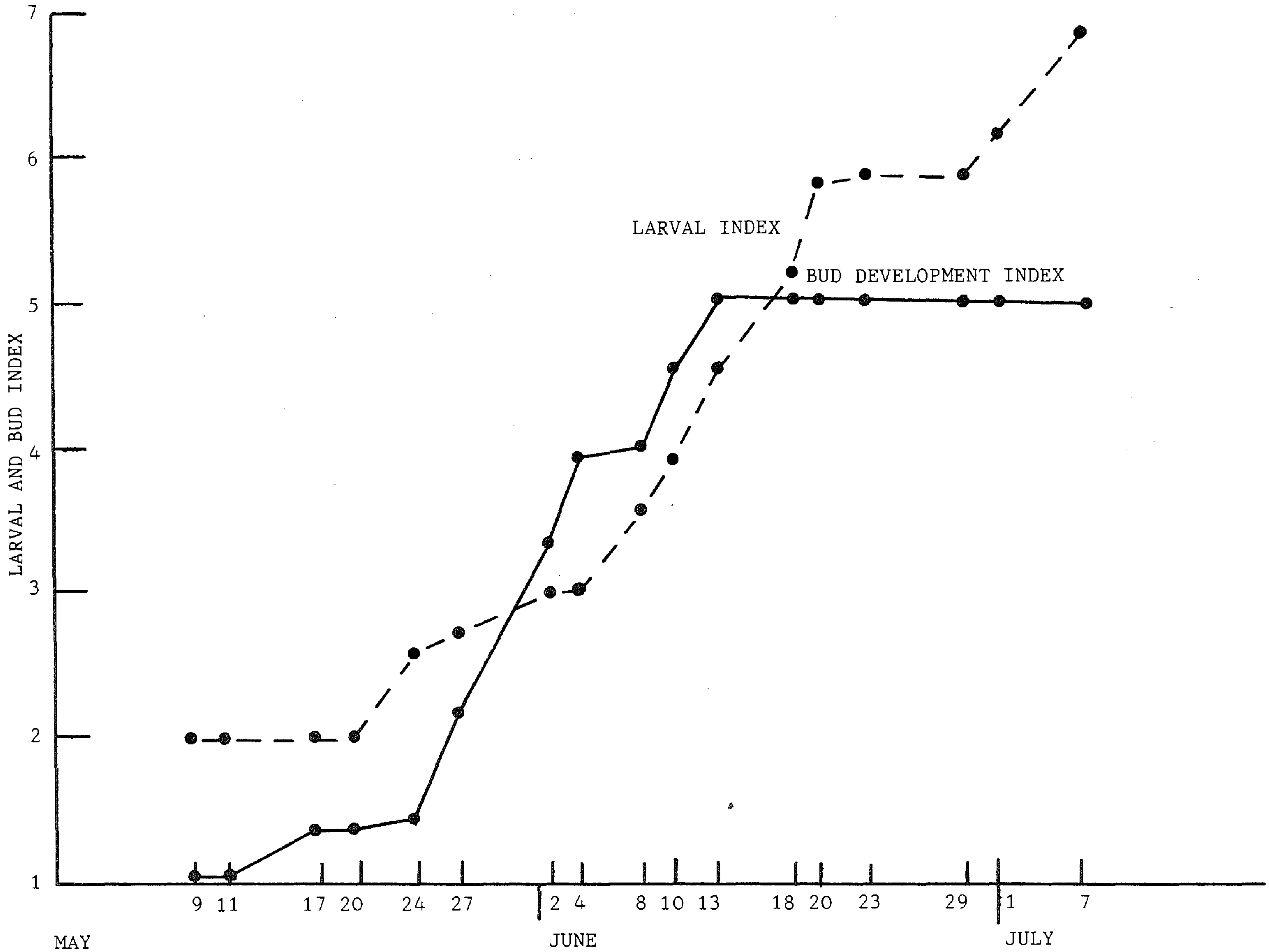
LARVAL AND BUD DEVELOPMENT IN 1983 AT CROSS LAKE (T17 R5)



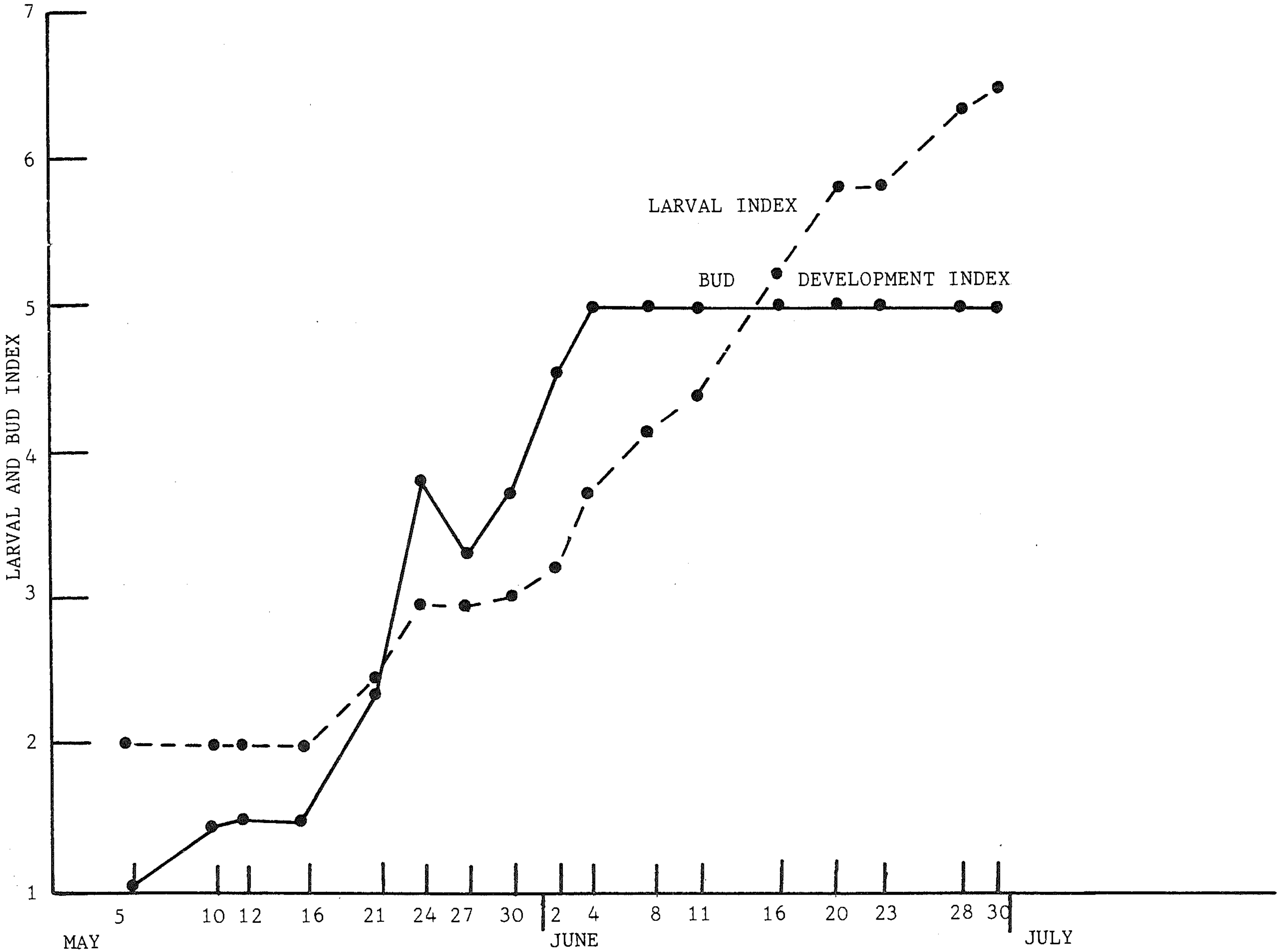
LARVAL AND BUD DEVELOPMENT IN 1983 AT MATTAMISCONTIS

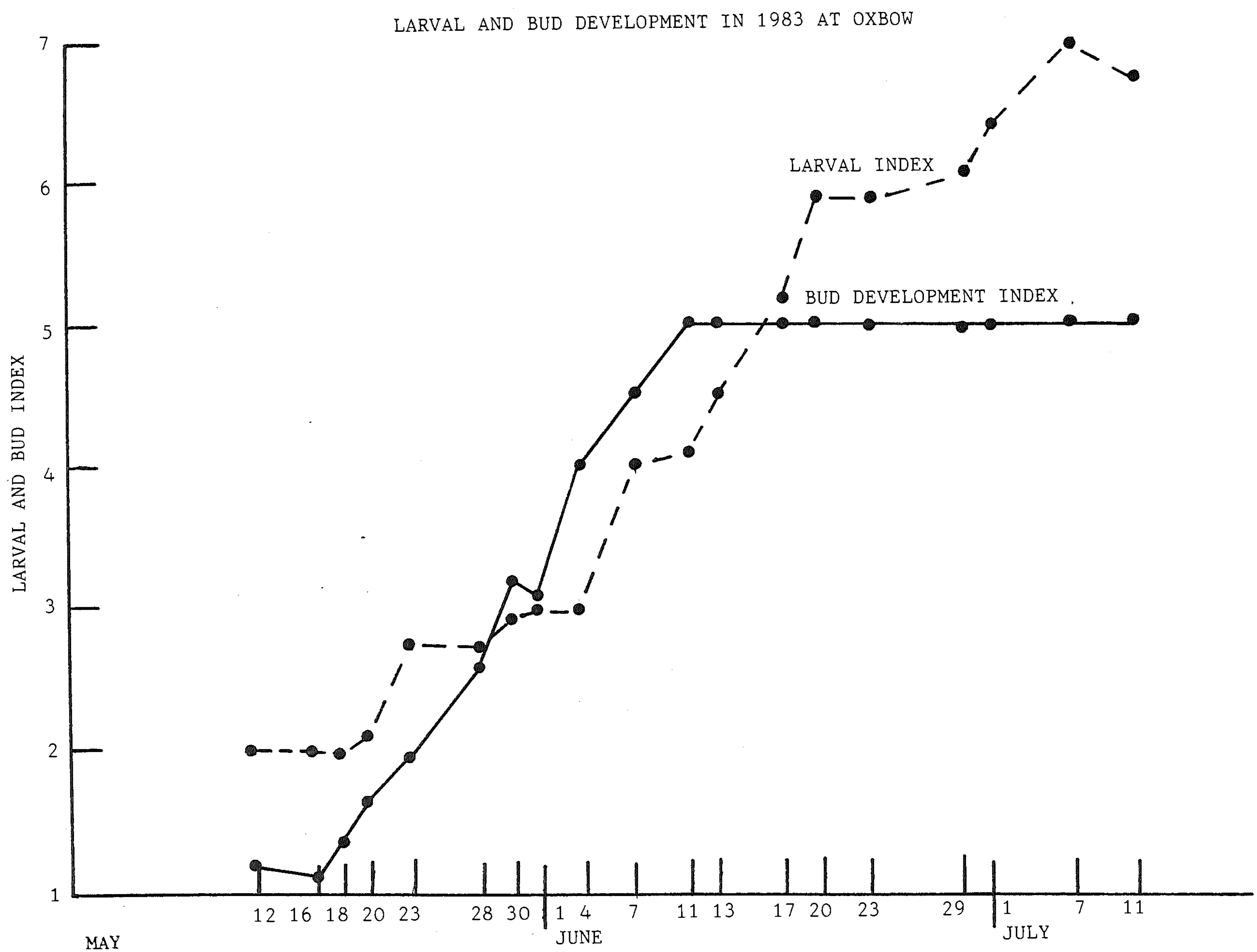


LARVAL AND BUD DEVELOPMENT IN 1983 AT CHESUNCOOK (T3 R12)



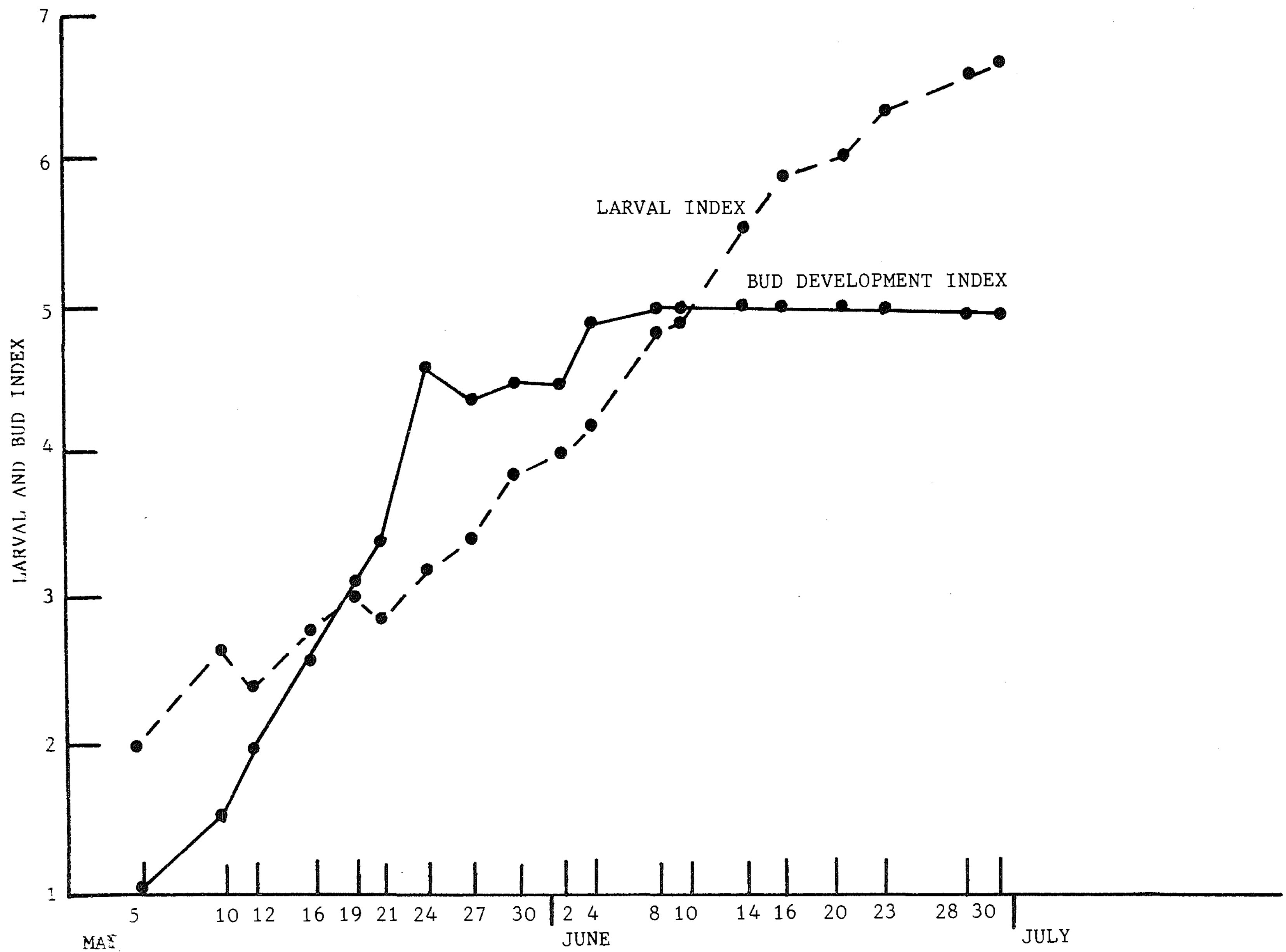
LARVAL AND BUD DEVELOPMENT IN 1983 AT COOPER

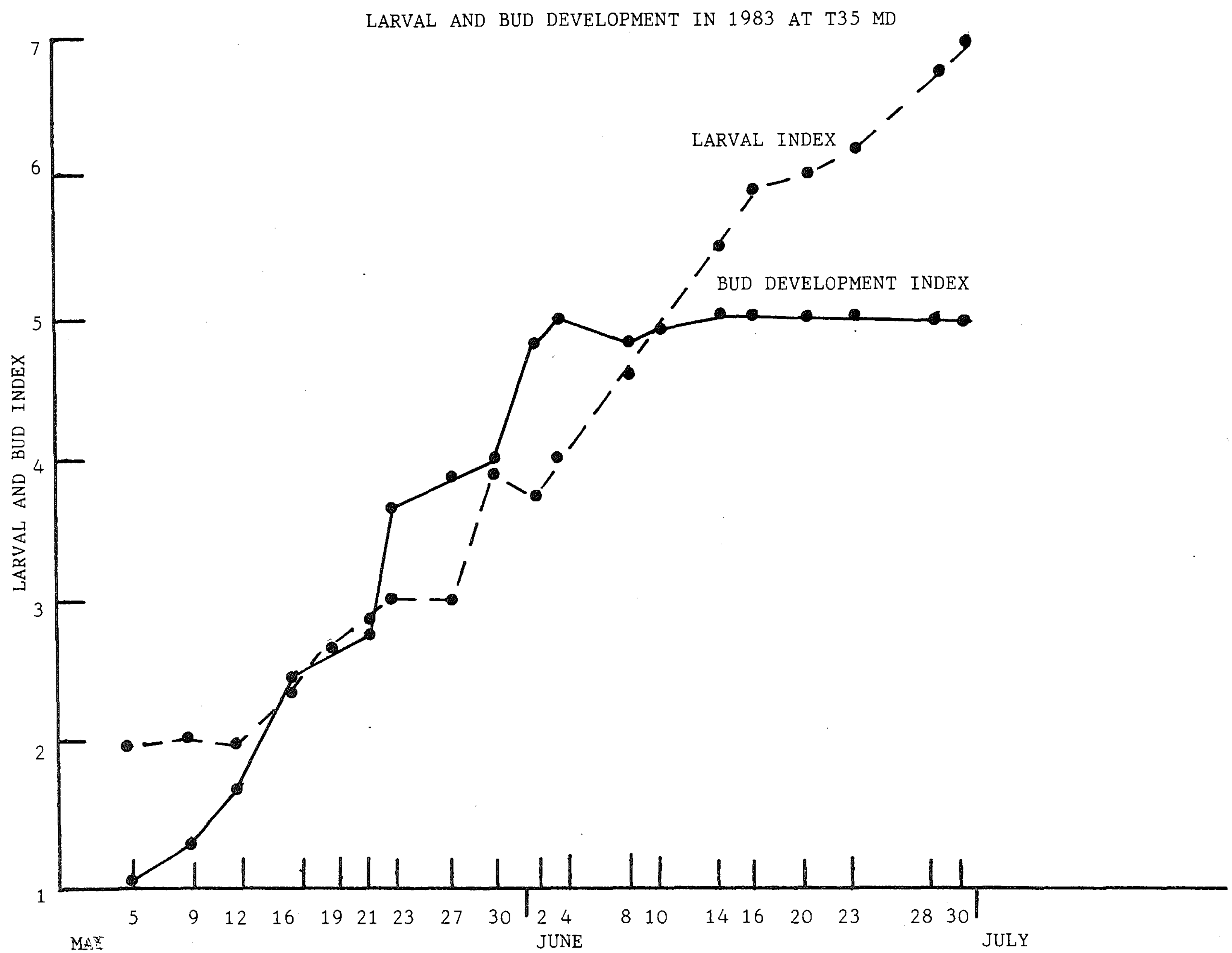




LARVAL AND BUD DEVELOPMENT IN 1983 AT OXBOW
LARVAL AND BUD INDEX
7
6
5
4
3
2
1
LARVAL INDEX
BUD DEVELOPMENT INDEX
12 16 18 20 23 28 30
1 4 7 11 13 17 20 23 29
1 7 11
MAY
JUNE
JULY

LARVAL AND BUD DEVELOPMENT IN 1983 AT BRADLEY





LARVAL AND BUD DEVELOPMENT IN 1983 AT T35 MD
LARVAL AND BUD INDEX
1
2
3
4
5
6
7
LARVAL INDEX
BUD DEVELOPMENT INDEX
5 9 12 16 19 21 23 27 30 2 4 8 10 14 16 20 23 28 30
MAY
JUNE
JULY

LARVAL AND BUD DEVELOPMENT IN 1983 AT ST. FRANCIS LAKE (T8 R16)