1979

FOREST INSECT AND DISEASE REPORT

Minnesota Department of
Natural Resources
Division of Forestry

Rochester Region
Division of Forestry

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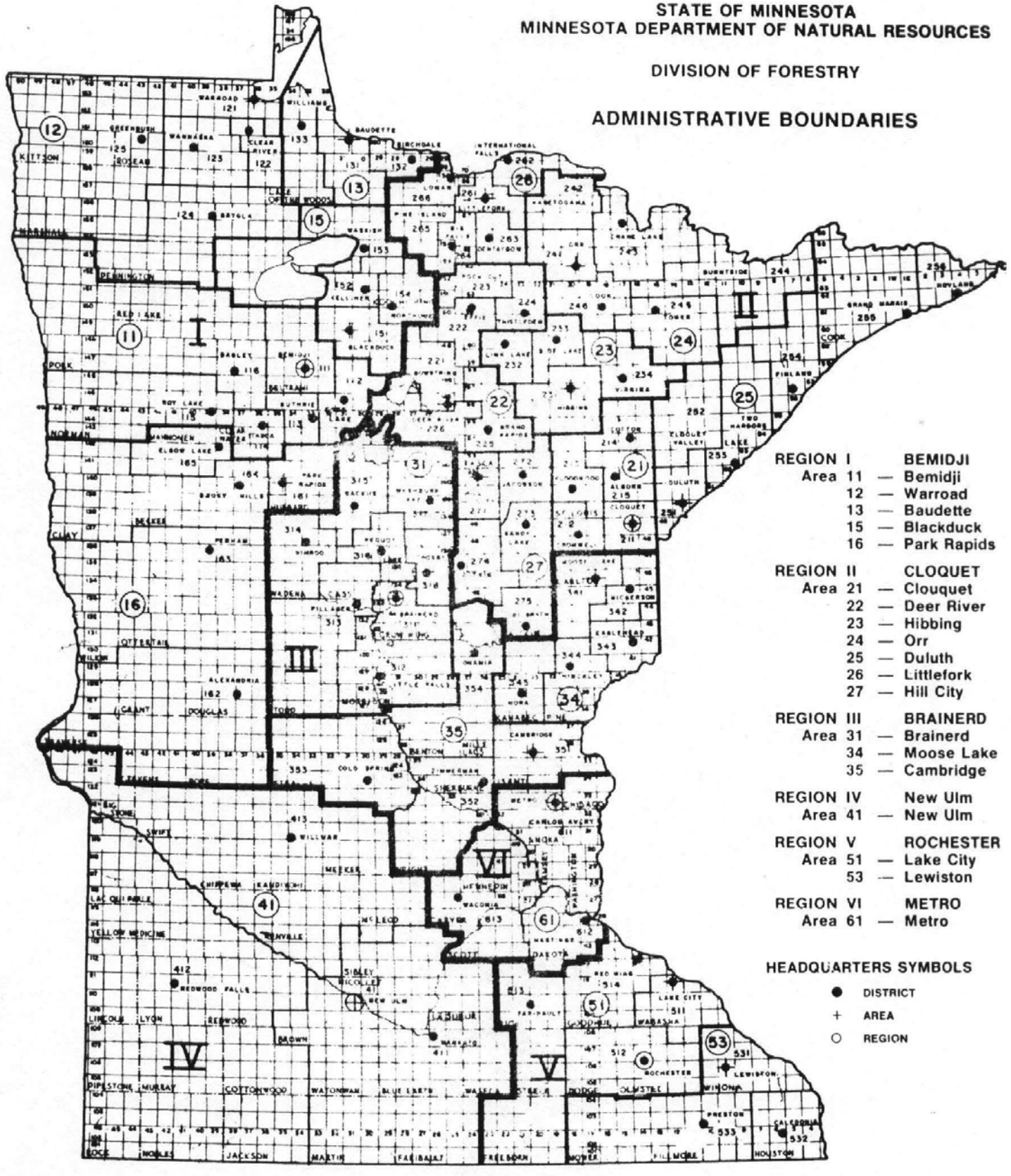
SPECIAL PROJECTS

FIGURE 1


STATE OF MINNESOTA
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FORESTRY
ADMINISTRATIVE BOUNDARIES
REGION I BEMIDJI
Area 11 — Bemidji
12 — Warroad
13 — Baudette
15 — Blackduck
16 — Park Rapids
REGION II CLOQUET
Area 21 — Clouquet
22 — Deer River
23 — Hibbing
24 — Orr
25 — Duluth
26 — Littlefork
27 — Hill City
REGION III BRAINERD
Area 31 — Brainerd
34 — Moose Lake
35 — Cambridge
REGION IV New Ulm
Area 41 — New Ulm
REGION V ROCHESTER
Area 51 — Lake City
53 — Lewiston
REGION VI METRO
Area 61 — Metro
HEADQUARTERS SYMBOLS
DISTRICT
AREA
REGION

INTRODUCTION

There are approximately 16.5 million acres of forest land within the State of Minnesota. Over one-half of the commercial forest land within the State is publicly owned. These forests support a 1.2 billion dollar forest industry, which is the third largest industry within the State. The Minnesota Department of Natural Resources (MN-DNR) has been charged by the legislature with management efforts and/or support on Minnesota's state, county, and private forest lands.

Minnesota's Forest Insect and Disease Management Unit is contained within the Forest Management Section of MN-DNR Forestry Division. Field activities within this Division have been regionalized into six regional administrative units (see Figure 1). The insect and disease unit consists of a Forest Insect and Disease Supervisor, one Field Coordinator, four Regional Forest Insect and Disease Specialists and six seasonal Plant Health Specialists. The four Specialists and the six seasonal Plant Health Specialists have regional responsibilities. The Field Coordinator is assigned to the Central Office staff.

The responsibility of Minnesota's Forest Insect and Disease Management Unit includes surveillance, detection, and control efforts associated with forest insect and disease activity on state, county, and/or private land. The objective of the Forest Pest Unit is to reduce or eliminate the impact of forest pests on Minnesota's forest resources. The unit provides input on sivicultural management and direct control techniques to forest land managers. Twenty-four (24) major, and more than one hundred minor, insect and disease agents contribute to the economic or aesthetic drain on Minnesota's forest resources.

1979 FOREST INSECT AND DISEASE HIGHLIGHTS

Pine tussock moth populations expanded in east-central Minnesota during 1979 to the point that a severe outbreak may be experienced in 1980. Egg mass and overwintering larval surveys indicate that over two thousand acres may experience heavy defoliation. Jack pine stands in north-central and northwestern Minnesota again suffered from widespread attack by jack pine budworm. Infestations of the insect covered 53 thousand acres with heavy defoliation occurring on 20 thousand acres during 1979. The yellow-headed spruce sawfly continued to attack scattered stands of spruce in northeastern Minnesota. Plantation damage was not heavy enough to warrant widespread control activities.

The forest tent caterpillar (FTC) was again the major defoliator of hardwoods during 1979. Approximately 4.4 million acres experienced heavy defoliation. Aspen blotch miner, a common pest of aspen, experienced reduced population levels which were probably the result of FTC defoliation. Two male gypsy moths were trapped in Minnesota during 1979. They were collected in Dakota and Hennepin counties, which are in the metropolitan area of the Twin Cities. Intensified trapping in this area during 1980 will be established by the USDA Animal and Plant Health Inspection Service.

Dutch elm disease (DED) continued to kill trees in both urban and forested locations throughout Minnesota. Dutch elm disease control on state land continued to be a major source of activity during 1979. A total of 3,663 dead and dying elm trees were removed from public lands during 1979. An infestation of Dutch elm disease was reported for the first time in Lake of the Woods county.

Dieback of walnut seedlings and saplings in plantations was a problem in southeastern Minnesota. Studies are being conducted to determine the pathogen(s) involved. Butternut canker continues to cause dieback and decline of butternut trees throughout their range in Minnesota.

A general decline of hard maple has been reported throughout south central and southeastern Minnesota. Oak mortality resulting from a variety of causes (i.e., oak wilt, two-lined chestnut borer, construction damage, etc.) was a widespread problem again in 1979.

Special projects were conducted on a wide variety of subjects during 1979. Shelterbelt studies examined insect and disease activity in the south. A dwarf mistletoe control project was instituted as was a study of Diplodia tip blight control. White pine blister rust studies were instituted to develop geographical and sivicultural guidelines for future white pine plantings.

INSECTS

Insects Infesting Softwoods

Pine Tussock Moth — *Dasychira pinicola* **(Dyar)**

In Region III (see Figure 1) a low population

existed in Mission Township of Crow Wing County during 1979. High larval populations and noticeable defoliation of jack pine occurred on 360 acres in the General Andrews State Forest (see Map 1).

Population density, feeding damage, and distribution were monitored carefully in 1979 based on the 1977-78 buildup in S½ of Section 25, Township 45 N, Range 20 W, and in Section 36, Township 45 N, Range 20 W. Based upon the history of the 1959-63 and 1969-71 outbreak trends and subsequent controls, it was determined that current population densities were at a potentially explosive level. Chemical control was considered to be the best method of suppression while the infestation was still localized within state-owned forests.

Two helicopter spray control programs were subsequently attempted. These are summarized in the following tabulation.

Date	*Chemical*	*Area Sprayed*	*Cost*
June 29	Sevimol	360 acres	$2,661.30
July 12	Orthene	360 acres	$3,690.00

Scattered thunderstorms developed the evening of June 29 with 0.24 inch of precipitation recorded (at Willow River Nursery) in the spray area. Heavy rains also occurred in the early part of the following week, July 2-3. After field checks of larval numbers, it was obvious the 360 acre spraying of state land had not been effective. It was decided that an additional spray should be applied July 12 in order to reduce the population to non-economic numbers and restrict its distribution in 1980.

Post-spray field checks of larval numbers and an egg mass survey showed that the second spraying was not effective in reducing the population or restricting its spread.

An egg mass survey was conducted near General Andrews Nursery to determine density and distribution of the population in 1980. The results are listed in the following table. It is believed that seven or more egg masses per tree represent an economic population level (see Map 1).

Egg masses were also found in some of the nursery beds in the General Andrews Nursery. These beds were sprayed twice with Malathion after egg hatch.

Table 1
Pine Tussock Moth Egg Mass Survey Results

Plot #	*Location*	*Egg Masses/Tree* Tree 1*	*2*	*3*	*Average Number Egg Mass/Tree for Plot*
1	SE-SE 25-45-20	19	10	29	19
2	SE-SW 25-45-20	7	16	7	10
3	NE-NE 25-45-20	31	17	7	18
4	SW-NE 25-45-20	7	7	10	8
5	SW-SW 19-45-19	15	40	20	25
6	NW-NE 36-45-20	19	6	11	12
7	SW-SW 30-45-19	8	2	4	5
8	NW-NE 36-45-20	4	8	12	8
9	none taken				
10	NW-SE 19-45-19	0	1	0	0
11	SW-SW 19-45-19	10	12	8	10
12	SE-SE 18-45-19	4	0	0	1
13	SW-SW 25-45-20	0	0	0	0
14	SW-SW 24-45-20	17	13	17	16
15	NE-NE 2-44-20	0	0	0	0
16	SE-SE 35-45-20	1	0	0	0
17	SE-NW 36-45-20	3	5	4	4
18	SW-NE 30-45-19	2	2	2	2
19	NE-SE 13-45-20	3	7	13	8
20	SE-SE 30-45-19	9	11	3	8
21	SE-SW 29-45-19	2	2	0	1
22	SE-NW 31-45-19	1	3	4	3
23	SE-SW 36-45-20	1	1	0	1
24	SW-NE 1-44-20	31	33	10	25
25	SW-NW 5-44-19	1	0	0	0
26	NE-NE 12-44-20	1	0	0	0
27	NE-NW 8-44-19	2	1	0	1
28	NW-SW 8-44-19	0	2	1	1

*Seven or more egg masses per tree represent an economic population level.

On December 13, cones were randomly collected from jack pines on plots 1, 2, 3, 4, 5, 8, 14, and 20 and examined for overwintering 2nd instar larvae in hibernacula. Two hundred cones produced 250 viable overwintering larvae. Several larvae per cone are indicative of the possibility for heavy defoliation the following spring.

Outlook for 1980

The tussock moth population and distribution will be greatly expanded from that in 1979!

Egg mass surveys indicate population levels in the General Andrews State Forest and surrounding townships have the potential to cause heavy defoliation and top kill in jack pine on several thousand acres. The overwintering larval survey indicates populations may not be as high as

PINE TUSSOCK MOTH SPRAY PROJECT

1979 AREA

PROJECTED 1980 PROJECT AREA

MAP 1

indicated by the egg mass survey. An early larval survey will more accurately determine population levels and outbreak boundaries.

Phenological Notes on the Pine Tussock Moth

June 11	— Mostly 2nd instar larvae. No feeding damage noted on jack pine.
June 16	— Mostly 3rd instar larvae. Slight feeding damage becoming evident on jack pine.
June 22	— Mostly 4th instar larvae. Some top defoliation. Some tops turning brown.
June 29	— Sprayed with Sevimol. (0.24 inch rain)
July 2-3	— Rain.
July 4	— Mostly 4th to 6th instar larvae.
July 8	— One pupa noted.
July 9	— Three pupa noted.
July 12	— Sprayed with Orthene.
July 28	— Adults emerging in collections.
August 7-8	— Egg mass survey conducted.

Jack Pine Budworm — *Choristoneura pinus* Freeman

The jack pine budworm continued to be the major insect pest in the northcentral and northwestern parts of the state. Budworm infestation occurred within a 55,000 acre area located in Cass, Wadena, Crow Wing, Hubbard, Becker, Clearwater, and Mahnomen Counties (see Map 2).

The area infested is comparable in size to that infested during 1978. The area of heavy budworm feeding, however, was reduced considerably during 1979. Heavy budworm activity during 1979 covered approximately 20,000 acres while the area affected in 1978 was approximately 53,000 acres. There was a significant reduction in budworm activity in southern Hubbard County and in southern Beltrami County during 1979.

There were several areas in which jack pine stands had been heavily defoliated during 1977 and 1978 and in which dead tops and tree mortality became evident during 1979. The largest area was in Wadena County where 7,410 acres showed some degree of damage. Of this total acreage, 6,458 acres were on private land, and the remainder was state-owned land. Damage was severe on 5,026 acres in Wadena County, and salvage operations on both state and private lands were started during the fall of 1979. Salvaging will continue during the winter of 1980 to reduce the threat of a major bark beetle epidemic in 1980.

Approximately 100 acres of state-owned land in Hubbard County (Section 4, Township 143N, Range 34W) were damaged in the 1978 infestation. Prism plots taken throughout the stand during 1979 indicated that 20% of the trees were dead. Another 32% of the living trees had experienced top kill. Dieback ranged in length from 2 feet to 35 feet and averaged 10 feet. Mortality was variable with some prism plots showing 100% of the trees on the plot dead while other plots did not include dead trees. Salvaging of this stand also started in the fall of 1979 and should be completed by the start of the 1980 growing season.

A Potlatch Corporation-owned jack pine area in Becker County (Section 25, Township 139N, Range 36W) was also severely damaged. Damage occurred during 1978, and salvaging started that fall.

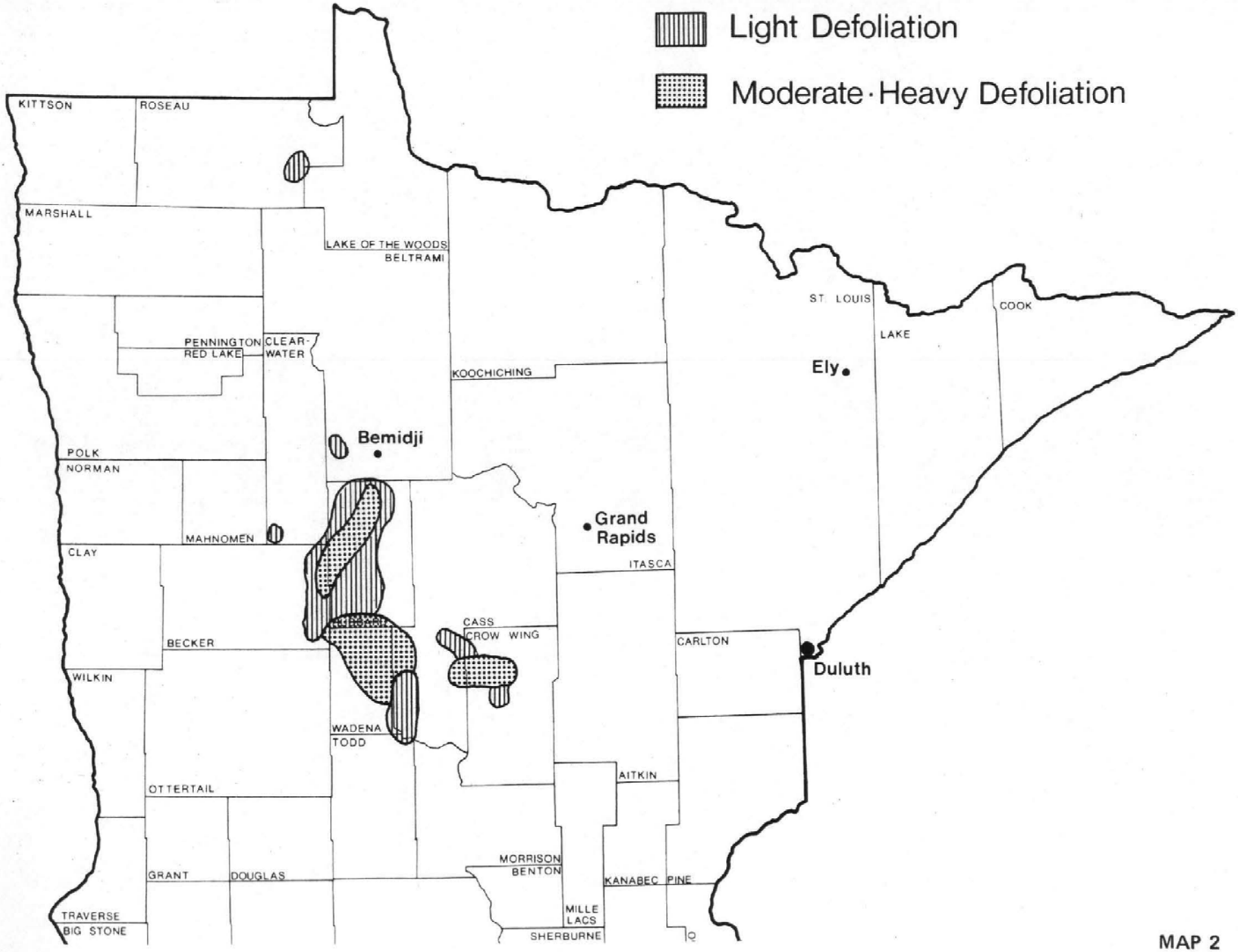
It seemed that the heavily damaged jack pine stands in Wadena, Becker, and Hubbard Counties had been predisposed to damage by other factors. Surrounding stands of jack pine had been fed upon with a similar intensity but suffered little permanent damage. Both the Wadena County jack pine areas and the stand in Becker County had been severely stressed during the drought of 1976-77. Budworm feeding during the growing season immediately after the end of the drought apparently caused enough additional stress to result in damage. Without the drought, damage would not have been as severe and widespread.

The Hubbard County stand was also stressed by the drought, but the soils were not as droughty as those in Wadena and Becker Counties. Also the major infestation in Hubbard County occurred in 1978, the second growing season after the drought had ended. The heavily damaged stand in Hubbard County was different from surrounding stands because in the past it had undergone some partial harvests, and the stand was opened up. The more open-grown nature of the trees in the damaged stands probably produced a greater abundance of staminate cones. This apparently allowed the early larval instars to survive more successfully and a greater population to build up. This larger population consumed more foliage which resulted in the heavier damage.

Surveys

Three major surveys were conducted during 1979. The first of these was the early larval

JACK PINE BUDWORM DEFOLIATION · 1979



MAP 2

survey conducted from early to mid-June to predict areas of heavy activity during 1979. Preliminary plans had been formulated in Wadena County to carry out a direct control operation if the population appeared to be high enough. From the early larval survey results, the decision was made not to carry out any direct control program. This decision was based on the following two situations: early larval populations were below the threshold established for spraying, and/or stands were so heavily damaged that salvaging, not spraying, was the recommended treatment.

The second survey was a pupal survey in which 50 pupae were collected at each collection site. Each pupa was individually placed into a gelatin capsule to record moth emergence. Survey results are listed in Table 2. Moth emergence ranged between 20% and 63% which appears to be a high enough emergence to carry over the population. The major cause of emergence failure was disease, while insect parasitism was a minor component.

Table 2

Jack Pine Budworm Pupal Survey Results

County	*Description*	*Emergence*	*Wasp Parasitized*
Hubbard	9-143-35	63%	4%
	12-143-35	63%	8%
	24-145-34	35%	6%
	1-139-32	35%	2%
Becker	35-140-36	62%	0
	15-139-36	45%	6%
	15-139-36	26%	2%
Wadena	2-138-35	49%	4%
	6-138-33	38%	No Data
	7-138-34	30%	No Data
	33-137-34	40%	No Data
	19-136-33	28%	No Data
	10-136-34	40%	No Data
	10-136-33	40%	No Data
Cass	35-138-32	36%	No Data
Crow Wing	14-136-29	20%	No Data

The third survey was an egg mass (EM) survey started in August and completed in October. Two hundred and thirty-five egg mass plots were established throughout the major jack pine type in north central and northwestern Minnesota irrespective of budworm activity during 1979. The survey was conducted by collecting two branches from each of three trees on the plot. On each branch, 15 inches of needle-bearing surface were inspected for egg masses. The results of the survey are summarized in Table 3. Those plots which contained at least four egg masses on the branch samples are listed under the heading, "EM's — Heavy Activity". Plots with four or more egg masses are considered to have potential for moderate to heavy defoliation.

Only 44 of the 235 egg mass plots predict a potential for moderate to heavy defoliation during 1980 (see Map 3). One township in Wadena County, four townships in Hubbard County and two townships in Becker County contain areas with high egg mass counts. Generally high egg mass counts were obtained where heavy defoliation had occurred in 1979. It has been observed that areas of heavy defoliation are not fed upon to any appreciable degree the second consecutive year. The lack of staminate cones and scarcity of needles may cause a reduction in the following year's early larval survival, thereby reducing, noticeably, the amount of defoliation.

Outlook for 1980

Jack pine stands in the townships where four or more egg masses per plot were found will have the potential for noticeable defoliation. It is anticipated, however, that larval mortality will be high in these areas and, therefore, heavy defoliation will not be widespread. Areas of high egg mass counts will be watched closely, and salvaging recommendations will be made if needed.

Except for scattered "hot-spots", there should be a general reduction in the budworm population throughout the major jack pine areas of the state during 1980.

Phenological Notes on the Jack Pine Budworm

June 5 — In Hubbard County, larvae ranging in length up to 2.5mm were found in the staminate cone clusters.

June 7 — In southern Beltrami County, larvae ranged in length from 1 to 2mm and were actively feeding in the staminate cone clusters.

June 19 — In southern Hubbard County, larvae ranged up to 8mm in length and appeared to be darkening in their coloration. The first shoots webbed together were noticed at this time.

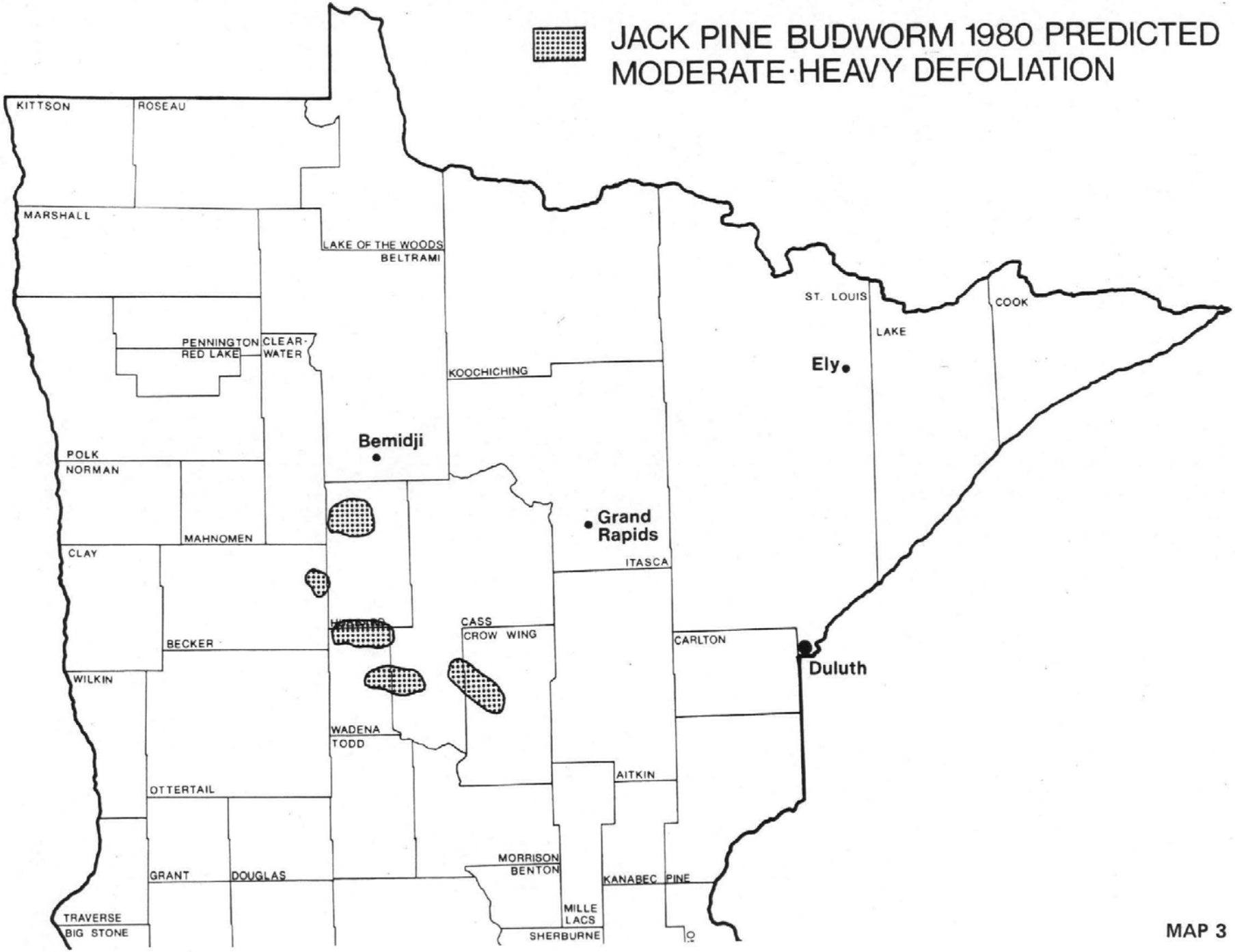
July 5 — Larvae had reached the 5th and 6th instars in southern Hubbard County. Feeding was confined to current year foliage.

July 10 — Pupae and late instar larvae were present on some branches in southern Hubbard County.

Table 3

Jackpine Budworm Egg Mass Survey Results

County	*Township*	*Plot Defoliation (%)*	*Number of Plots with:* No EM's	EM's = Light Activity	EM's = Heavy Activity
Crow Wing	136-29	25-35	1	0	1
	137-29	20	0	1	0
	136-27	5-35	3	0	0
	135-27	5-10	0	1	1
Cass	138-30	20	0	1	0
	138-32	20-75	1	3	0
	137-32	20	1	1	0
	136-32	30-45	0	2	0
	135-32	5-15	1	2	0
	134-32	5	1	0	0
Wadena	138-35	5-55	3	2	6
	138-34	5-80	7	1	1
	138-33	10-40	4	6	0
	137-34	5-55	5	4	0
	137-33	10-40	6	2	0
	136-34	10-35	2	3	0
	136-33	10-35	6	4	1
	135-34	5	0	1	0
	135-33	10-90	4	2	0
	134-33	15	1	0	0
Hubbard	139-32	0-15	3	4	0
	139-33	0-15	1	3	0
	139-34	10-40	2	2	1
	139-35	0-20	2	7	0
	140-32	0-20	5	5	0
	140-34	20	0	1	0
	143-34	0-60	4	9	6
	143-35	0-15	1	2	6
	144-34	0-40	2	6	9
	144-35	10-25	0	1	4
	145-33	0	0	1	0
	145-34	0-20	1	7	2
	145-35	0-20	9	1	0
Becker	138-36	15	1	0	0
	139-36	0-30	1	5	3
	140-36	15-20	0	0	3
	141-36	0-20	1	4	0
Clearwater	143-37	0-10	2	2	0
Lake of the Woods	161-34	0	0	3	0
Roseau	161-35	0-10	1	1	0
	161-30	0-10	1	4	0
	161-37	0-10	0	2	0
	160-33	0-10	0	2	0
		TOTALS	**83**	**108**	**44**
		% of TOTALS	**35%**	**46%**	**19%**


JACK PINE BUDWORM 1980 PREDICTED
MODERATE·HEAVY DEFOLIATION
KITTSON
ROSEAU
MARSHALL
LAKE OF THE WOODS
BELTRAMI
PENNINGTON
RED LAKE
CLEAR-
WATER
KOOCHICHING
ST. LOUIS
LAKE
COOK
Ely
Bemidji
POLK
NORMAN
MAHNOMEN
Grand
Rapids
ITASCA
CLAY
HUBBARD
CASS
CROW WING
CARLTON
Duluth
BECKER
WILKIN
WADENA
TODD
AITKIN
OTTERTAIL
MORRISON
BENTON
GRANT
DOUGLAS
KANABEC
PINE
MILLE
LACS
TRAVERSE
BIG STONE
SHERBURNE

MAP 3

July 18 — Approximately 2% of the pupae sampled in central Hubbard County had emerged; some late instar larvae were still observed feeding.

August 9 — Approximately 50% of the egg masses collected in southern Hubbard County had hatched.

Spruce Budworm — *Choristoneura fumiferana* (Clemens)

In Region II, populations of this pest increased over 1978 populations. Aerial and ground surveys indicated expanded defoliation in southern and southwestern St. Louis County. The incidence of defoliation decreased in western Lake County. Approximately 150,000 acres of spruce fir type suffered light to moderate defoliation (see Map 4).

Cooperative Projects

Cooperation with the U.S. Forest Service was undertaken in an attempt to determine an economical and accurate method for assessing losses of commercial timber caused by spruce budworm attack. A cooperative study with the University of Minnesota College of Forestry was also conducted to explore the economics of utilizing and marketing spruce budworm-threatened or damaged timber.

Outlook for 1980

Continued low level populations with scattered light to heavy defoliation in southern St. Louis County can be expected.

Phenological Notes on the Spruce Budworm

June 8 — Mostly 2nd instars; slight webbing of new shoots and light feeding were evident on edges of new needles. (southern St. Louis County)

June 15 — Mostly 3rd instar; larvae started to spin down when disturbed. Dandelions were going to seed. (southern St. Louis County)

July 10 — Pupae evident. (southern St. Louis County)

July 15 — Adults emerging. (southern St. Louis County)

Yellowheaded Spruce Sawfly — *Pikonema alaskensis* (Rohwer)

In Region I, populations continued to be light, but because this sawfly often attacks ornamental spruce, phone calls expressing concern were common. The Blackduck Area and the Bemidji, Cass Lake and Guthrie Districts contained the general area of sawfly infestation in the Region. No plantations experienced heavy enough feeding to warrant control activities.

Table 4

Plantation Survey for the Yellowheaded Spruce Sawfly (Region 1)

County	*Description*	*No. of Trees Inspected*	*No. of Trees Infested*
Beltrami	2-152-30	200	4
	12-152-30	400	1
	11-152-30	300	0
	2-153-30	150	0
	10-153-29	50	17
Itasca	13-147-29	40	1
	7-148-28	100	2
	17-148-29	100	2
Koochiching	11-151-27	200	6
	36-152-27	200	9
	32-152-29	40	9
	25-152-29	200	0

Sawfly populations were again at high levels in some white spruce plantations and roadside plantings in Regions II and III. Moderate to heavy feeding damage could be seen by mid-July.

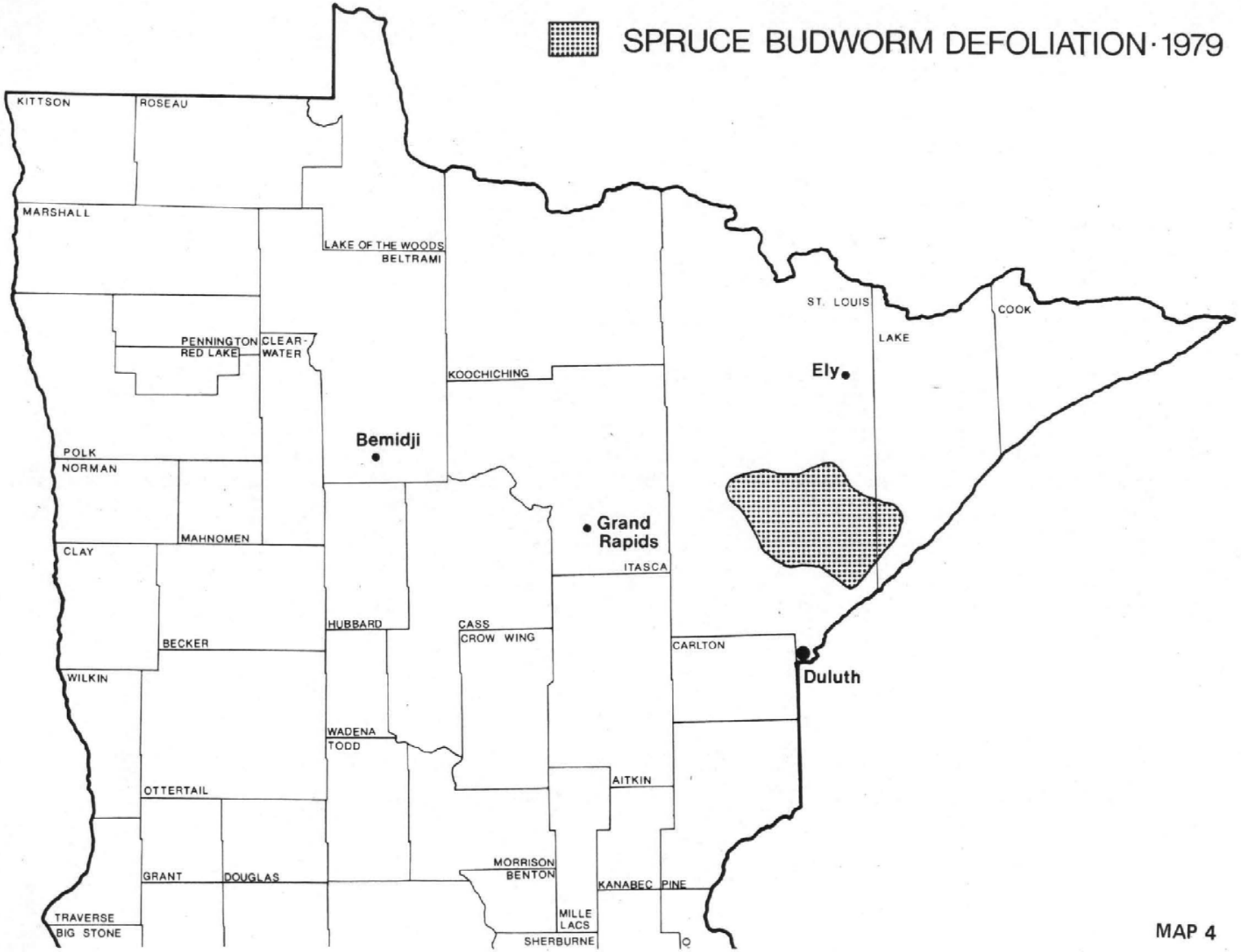
Spraying was recommended only in plantations where tree mortality could be expected without chemical control. Where practical, only pockets of infestations were sprayed. Malathion (57% E.C.) was applied in these areas using mist blowers during the first week of July. Malathion was mixed at a concentration of 1.5 gal./100 gal. of water and applied at the rate of 4.8 gal. of solution per acre.

Two acres of a 16-acre plantation (No. 111-14) in International Falls District were spot sprayed.

In the Bowstring District, a 16-acre plantation (No. 25522) located in Section 33, Township 147N, Range 25W, was sprayed. This plantation had been hand released in 1977 and 1978. A white spruce seed orchard located west of Sturgeon Lake (Section 16, Township 45N, Range 2W) supported damaging numbers of sawflies on high value scion stock and was also sprayed.

Recommendations were made to several private plantation owners that they should spray for sawflies in order to avoid mortality.

On state-owned land, sivicultural release operations on several white spruce plantations were


SPRUCE BUDWORM DEFOLIATION · 1979
KITTSON
ROSEAU
MARSHALL
LAKE OF THE WOODS
BELTRAMI
PENNINGTON
RED LAKE
CLEAR-
WATER
KOOCHICHING
ST. LOUIS
LAKE
COOK
Ely
Bemidji
POLK
NORMAN
MAHNOMEN
CLAY
Grand
Rapids
ITASCA
HUBBARD
CASS
CROW WING
CARLTON
Duluth
BECKER
WILKIN
WADENA
TODD
AITKIN
OTTERTAIL
GRANT
DOUGLAS
MORRISON
BENTON
KANABEC
PINE
TRAVERSE
BIG STONE
MILLE
LACS
SHERBURNE
MAP 4

delayed. This allows spruce to grow to a larger size in order to reduce susceptibility to damage by the sawflies upon release.

Effectiveness of 1978 Spraying

In Region II, spraying of 95 acres of white spruce plantations in 1978 was successful in reducing the infestation levels in 1979 and preventing tree mortality. Additional spraying was not necessary in these plantations even though sawfly populations were high in other plantations scattered throughout the Region.

Outlook for 1980

It is likely the sawflies will be at high levels in some plantations again in 1980. Some of these plantations, especially young, open-grown plantations, may require spraying to avoid tree mortality. Plantations should be checked early in June so control operations can be planned. Spraying must be done when the majority of the larvae are in the 3rd instar (mid to late June, depending on the weather).

Phenological Notes on the Yellowheaded Spruce Sawfly

June 7 — Most white spruce shoots had lost the bud scales and shoots were 1-3 cm long. Adults were noted but no larvae were observed. (Carlton County)

June 13 — Mostly adults and eggs were observed, but a few 1st instar larvae were present. (Aitkin County)

June 18 — Mostly 1st instar larvae observed. Slight browning of needles with minor feeding damage was noted. White spruce shoots were almost fully expanded. (Aitkin and St. Louis Counties)

June 22 — Mostly 2nd instar larvae present. (Itasca and Pine County)

June 28 — Mostly 3rd instar larvae. (At this time the FTC started to spin cocoons.) (Itasca, Carlton, and Beltrami Counties)

July 2 — Mostly 4th instar larvae. (Carlton County)

July 8 — Mostly 5th instar larvae. (Carlton County)

July 14 — Many larvae had completed feeding with 4th and 5th instars still present. (Carlton and Cass Counties)

The sawflies were one to two weeks late in developing in comparison with 1978. Adult emergence was late and sporadic. This led to late feeding damage and differing larval age groups in varying localities.

Larch Sawfly — *Pristiphora erichsonii* (Hartig)

Populations of this sawfly continued to be at low levels in northern Minnesota.

In Region II, low population levels were noted in Aitkin, St. Louis, Koochiching and Carlton Counties. A stand of tamarack near Washburn Lake, Aitkin County, suffered moderate defoliation.

In Region I, a two-acre upland plantation of tamarack located just north of the Badoura Nursery, which had experienced heavy defoliation during 1977 and 1978, suffered only light defoliation during 1979.

Tamarack stands in northern Beltrami, southern Lake of the Woods, southwestern Koochiching and eastern Roseau Counties were sampled for larch sawfly activity. Sawfly larvae were found in only one stand and at a very low population level. The infested stand was in an upland area and contained a mixture of red and jack pines with the tamarack. A summary of sample areas is included in Table 5.

Table 5
Larch Sawfly Survey Results

County	*Description*	*Stand Status*	*Sawfly Activity*
Beltrami	27-153-20	swamp	none
Koochiching	29-158-29	upland	light
Lake of the Woods	36-157-31	swamp	none
	3-158-32	swamp	none
	21-159-32	swamp	none
	26-160-32	swamp	none
	33-160-32	swamp	none
	34-160-32	swamp	none
Roseau	17-161-35	upland	none
	19-161-35	upland	none

Phenological Notes on the Larch Sawfly

July 6 — Larvae in 2nd and 3rd instars. (Carlton County)

July 13 — Larvae in 3rd to 5th instar with some completed feeding. (Aitkin County)

Introduced Pine Sawfly—*Diprion similis* (Hartig)

Populations in Region I remained at low levels during 1979. An area in the Chippewa National Forest in Cass County (Sections 19 and 30, Township 145N, Range 30W) which had experienced heavy defoliation during late summer in 1978 showed only light larval activity during 1979. A few scattered white pine seedlings (less than 10 feet in height) were heavily stripped of foilage. However, feeding was generally light and scattered. Introduced pine sawfly larvae were occasionally observed in jack pine during jack pine budworm surveys in central and northern Hubbard County.

Populations were fairly low but infestations were very common in Region II. During September, numerous calls were received from private landowners and district foresters who observed the larvae dropping from white pine and crawling around yards.

In Region III second generation larvae caused noticeable defoliation on white pine along the Mississippi drainage in Crow Wing and Morrison Counties. Heavy defoliation was reported in the Camp Ripley Military Reserve. Numerous calls were also received from homeowners in the central lakes districts of Cass and Crow Wing Counties during September. White and red pine in plantations and windbreaks in Todd and Morrison Counties supported light to heavy defoliation. A detailed survey was not conducted.

Large scale control operations were not undertaken. Individual homeowners with small (<12'), heavily defoliated (>50%), ornamental pines supporting actively feeding colonies of II, III, or IV instar larvae used Malathion (57% E.C.) and a mist blower for control.

Outlook for 1980

Scattered stands and plantations in Region III with infestation histories will be monitored to record first and second generation population levels in 1980. Present data is insufficient to predict future population level. Control is normally economically feasible only in young plantations and windbreaks.

Bark Beetles — *Ips spp.*

Bark beetle populations were generally low in 1979 due to the wet growing season. There were a few areas where abnormal circumstances caused populations to reach outbreak proportions.

An extensive area of jack pine budworm defoliation has occurred for the last three to four years in central Minnesota (Wadena and Hubbard Counties). This has predisposed a number of stands to the point that bark beetles are becoming established and causing further losses. In some cases populations have expanded to the point of causing losses in understory and adjacent stands. Removal of breeding material in many of these stands as well as the favorable growing conditions during 1979 should have reduced this buildup.

A pocket of dead red pine was discovered during a routine fire detection flight (Section 19, Township 144N, Range 37W). Field examination revealed approximately 30 trees containing 5,000 board feet of timber had been killed by bark beetles. This was attributed to a population buildup in slash left after thinning the previous year. Bark beetles also killed an area of advance jack pine reproduction and residual red pine on Blueberry Island (Section 20 and 21, Township 40N, Range 20W) in Pine County. This was due to a population buildup in wind-thrown jack pine, red pine slash, and 1976 drought-stressed trees.

Outlook for 1980

Continued high beetle populations can be expected in the budworm stressed areas of Wadena, Hubbard, eastern Becker and southern Clearwater Counties. Another moist growing season with continued salvage operations and directed cuts should serve to reduce population levels.

Only removal of heavy slash and/or more timely cutting operations will reduce sporadic outbreaks in regular timber sale areas or thinning operations.

Red Pine Needle Midge — *Thecodiplosis piniresinosae* Kearby

Damage by the red pine needle midge was common in Region II. One of the most heavily infested stands was in a Lake County plantation (Section 16, Township 53N, Range 10W). Evidence of this insect is a swelling of the current year's needle bases where an orange larvae feeds and later bores an exit hole. Infested needles are about 40 percent shorter than normal, turn yellow, and then brown in October.

Outlook for 1980

Outbreaks are weather related so there is a good chance the midge will not do much damage. However, since repeated heavy attack can produce crooks and forks in the terminals and laterals, stands infested in 1979 will be checked in 1980.

Spittlebugs — *Aphrophora spp.*

Pine spittlebug, *Aphrophora parallela* (Say), populations apparently declined in northwestern Minnesota while they increased in Aitkin, southern Carlton and northern Pine Counties. Spittle masses were most common on jack pine and Scots pine.

Phenological note: Spittle masses were first observed June 5th in southern Hubbard County.

Saratoga spittlebug, *Aphrophora saratogensis* (Fitch), populations were found to be high in two plantations in Region II. Spittlebugs were causing some stunting and flagging in a red pine plantation (Section 36, Township 60N, Range 24W). This plantation will be evaluated in 1980 to determine population levels and whether control is necessary.

A private plantation of 150 acres (Section 12, Township 143N, Range 30W) was reported destroyed by spittlebugs.

Insects Infesting Hardwoods

Aspen Defoliators

The forest tent caterpillar, *Malacosoma disstria* Hubner, was again the major defoliator of many hardwood throughout a large portion of northern Minnesota (see Map 5). In many areas foliage on all broad-leaved trees, except red maple, as well as the understory vegetation was completely consumed. Tamarack was also completely defoliated in several areas, and in the Cotton District a young white spruce seed orchard was sprayed in order to protect the trees. Heaviest populations in Region I were found throughout Lake of the Woods County, western Koochiching County, eastern Roseau County, and Becker County. Large portions of southern Lake, south and central St. Louis, and eastern Carlton County in Region II were heavily defoliated. Lighter defoliation was scattered throughout the region. In Region III, defoliation was generally localized south of a line from Remer to Walker. Numerous caterpillars were reported in the Nemadji State Forest in northern Pine County. Approximately 4.4 million acres statewide were heavily defoliated. In a few areas, the refoliation of aspen and birch was not complete. Leaves were reduced in size and not uniformly distributed throughout the crowns.

Outlook for 1980

Based upon the 1979 egg mass survey, defoliation in 1980 will cover an area similar to that of 1979 but will probably be less severe. Scattered areas of heavy defoliation may occur outside of the area shown on the map (see Map 6).

It should be remembered that this is only an estimate based on the egg mass survey. Results can be extremely variable due to adverse weather during spring hatching, high rates of egg parasitism (which was not examined), and the starvation of late instar larvae in 1979 which resulted in small sizes of egg masses.

Table 6
Forest Tent Caterpillar
Pupal Parasitism[1] Survey

Location	*Parasitized*	*Adults Emerged*
North of Biwabik	78	22
Bear Island Lake	58	42
One Pine Island	74	26
Virginia	80	20
Arrowhead Rd., N. Duluth	92	8
N. Island Lake on #4	97	3
Cloquet	98	2
Junction #33 and #2	92	8
Cotton, St. Louis County	88	12
TOTALS	**757**	**143**
% OF TOTALS	**84%**	**16%**

1. Most parasitism was apparently due to Sarcophagid flies. Survey was conducted during July, 1979, in Region II.

Phenological Notes on the Forest Tent Caterpillar

May 16 — Aspen produced catkins in Carlton County.

May 17 — Egg masses were hatching in southern Cass County.

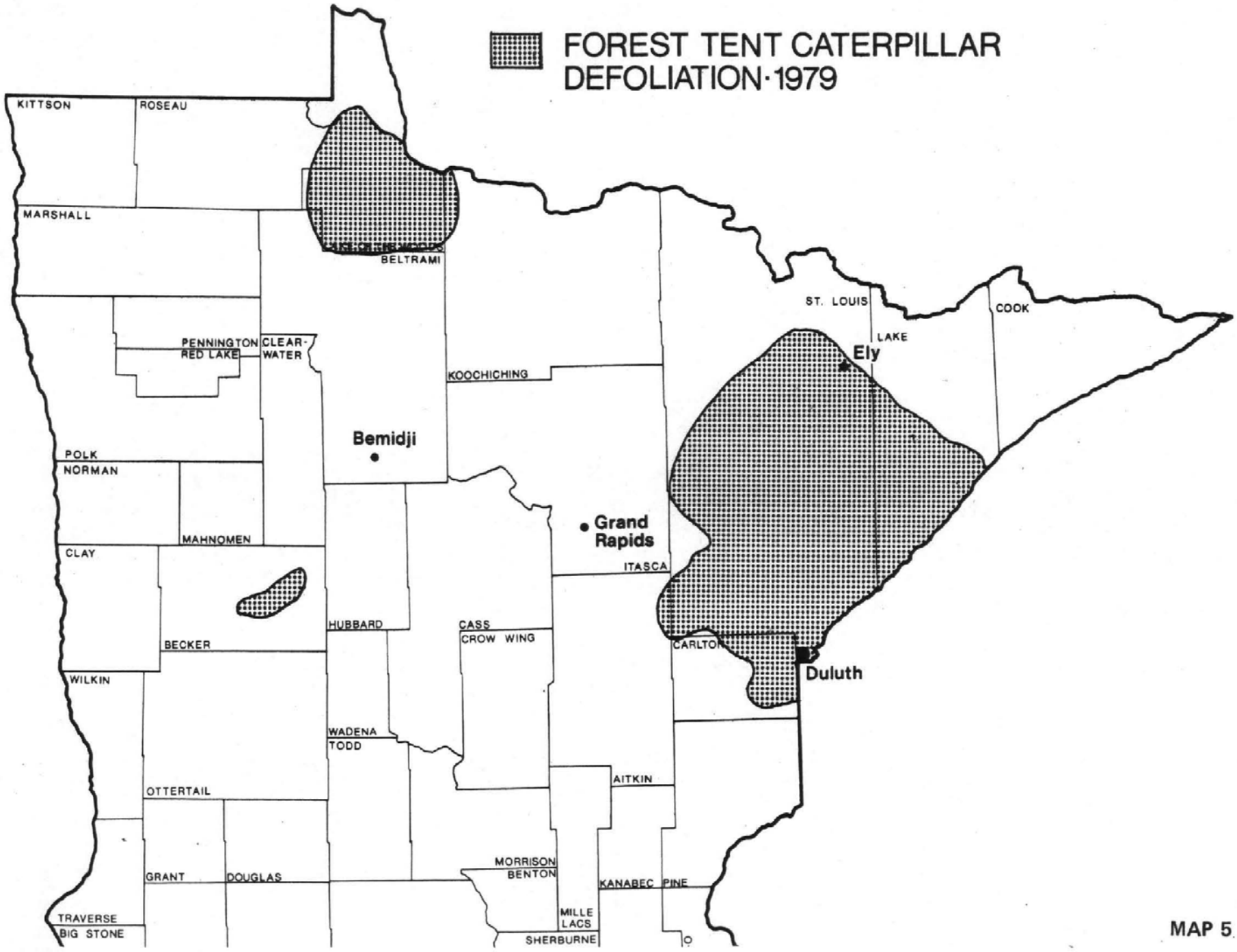
May 17-21 — Most egg masses were hatched, and the aspen buds were beginning to break in Carlton County.

May 18 — Hatching was continuing in Hubbard and southern Beltrami Counties.

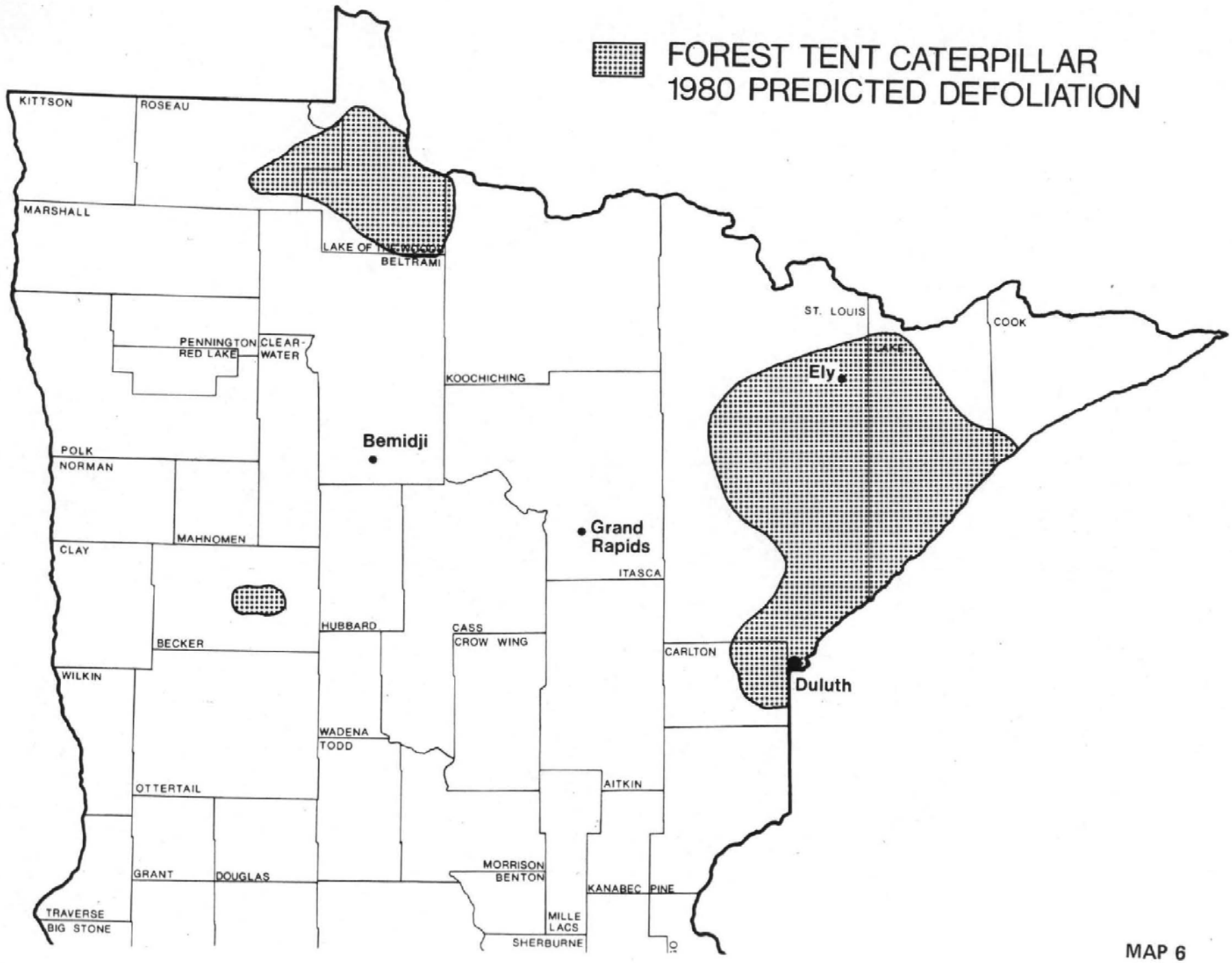
May 24 — Egg masses were still partially hatched with the hatched larvae only 2mm in length; aspen buds showed green tips in Hubbard County.

May 25 — Larvae were 5 to 6mm in length in Carlton County.

May 29 — Larvae ranged up to 5mm in length in Lake of the Woods County. The aspen buds ranged from tight to green tips to leaves


FOREST TENT CATERPILLAR
DEFOLIATION·1979
KITTSON
ROSEAU
MARSHALL
BELTRAMI
PENNINGTON
RED LAKE
CLEAR-
WATER
KOOCHICHING
ST. LOUIS
LAKE
COOK
Ely
Bemidji
POLK
NORMAN
MAHNOMEN
CLAY
Grand
Rapids
ITASCA
HUBBARD
CASS
CROW WING
CARLTON
Duluth
BECKER
WILKIN
WADENA
TODD
AITKIN
OTTERTAIL
GRANT
DOUGLAS
MORRISON
BENTON
KANABEC
PINE
TRAVERSE
BIG STONE
MILLE
LACS
SHERBURNE

MAP 5


FOREST TENT CATERPILLAR
1980 PREDICTED DEFOLIATION
KITTSON
ROSEAU
MARSHALL
LAKE OF THE WOODS
BELTRAMI
PENNINGTON
RED LAKE
CLEAR-
WATER
KOOCHICHING
Bemidji
POLK
NORMAN
MAHNOMEN
CLAY
BECKER
WILKIN
HUBBARD
CASS
CROW WING
Grand
Rapids
ITASCA
ST. LOUIS
COOK
LAKE
Ely
CARLTON
Duluth
WADENA
TODD
OTTERTAIL
AITKIN
GRANT
DOUGLAS
MORRISON
BENTON
KANABEC
PINE
TRAVERSE
BIG STONE
MILLE
LACS
SHERBURNE

MAP 6

showing. In Roseau County along the Canadian border, hatching and bud break had not started.

June 1 — Larvae were 7 to 8mm in length (3rd instar) in Carlton and St. Louis Counties.

June 3 — Defoliation was noticeable in Lake of the Woods County.

June 5 — Larvae ranged in length from 5 to 7mm's; aspen leaves were 1/2 to 3/4's expanded with no feeding damage apparent in Hubbard County.

June 10 — Larvae ranged in size from 20 to 25mm in length (3rd and 4th instars); migration across roads was beginning; and Sarcophagid flies were common in Carlton and St. Louis Counties.

June 19 — In Carlton County, larvae were 40mm long (4th instar), and understory shrubs were being defoliated. In Hubbard County larvae ranged in size up to 33mm and high numbers of ground beetles were feeding on the larvae.

June 20 — Larvae were actively defoliating a commercial strawberry field in Carlton County. In Lake of the Woods County, larvae ranged up to 50mm in length, were feeding on understory vegetation, and the first cocoons were observed.

June 21 — Tamarack was being defoliated near Nickerson in Pine County.

June 25 — A white spruce seed orchard in St. Louis County was being defoliated.

June 27 — Larvae began to spin cocoons in St. Louis and Carlton Counties. Cocoons were common in Lake of the Woods County, and Sarcophagid flies were very bothersome.

July 2 — Most larvae had spun cocoons, but feeding larvae could still be found in Carlton County.

July 5 — Defoliated aspen trees were beginning to break new buds in Carlton County.

July 10 — Sarcophagid flies were still active in St. Louis County.

July 11-21 — Adult moths were emerging in St. Louis and Carlton Counties.

Although the forest tent caterpillar was the most important defoliator in aspen forests, there were a number of other insects observed feeding on aspen and other associated hardwoods.

The aspen blotch miner, *Lithocolletis tremuloidiella* Braun, population was reduced probably as a result of the severe forest tent caterpillar defoliation. Miner activity was a minor factor in aspen defoliation in northern Aitkin County but was very common in Lake County north of the area of heavy FTC defoliation. It was also found in a localized area in Lake of the Woods County (Section 26, Township 158N, Range 30W).

The aspen leaf roller, *Anacampsis innocuella* (Zeller), was present in localized areas in Carlton and St. Louis Counties, causing minor defoliation. It was, however, the most common cause of defoliation to sapling aspen in northern Aitkin and eastern Itasca Counties. Leaf roller activity was noticeable in central Beltrami County and in southern Lake of the Woods County in the Baudette, Waskish and Kelliher Districts. This is the approximate area of heavy leaf roller activity experienced during 1978 although the intensity of activity was reduced. Minor leaf roller activity was observed in the southern part of Hubbard County.

Aspen leaf tier, *Enargia decolor* (Walker), populations were apparently reduced from those of 1977-78 but did cause minor defoliation in northern Aitkin, southeastern Itasca and Carlton Counties.

The eastern tent caterpillar, *Malacosoma americanum* (Fabricius), was abundant in Carlton, Pine, Aitkin, and St. Louis Counties where it defoliated apple, cherry, plum, and Juneberry. It was often seen defoliating aspen and mountain ash in association with forest tent caterpillars.

Miscellaneous Insects of Aspen Sprouts

An area of aspen sprouts approximately 3 to 5 feet tall located in Lake of the Woods County (Section 26, Township 158N, Range 30W) was inspected for insect pests. Two leaf mining insects were observed. The more obvious insect was the aspen blotch miner, *Lithocolletis tremuloidiella,* which was causing large oval light green spots between the major veins of the leaves. The other mining insect was the aspen leaf miner, *Phyllocnistis populiella* Chamb., causing spiral, serpentine

mines in the leaves. The occurrence of the blotch miner was spotty, but where it did occur it was heavy, often 80% of the leaves on the sprouts were infested. The leaf miner was observed only occasionally, and its activity was very light when observed.

Gypsy Moth — *Lymantria dispar* (L.)

Gypsy Moth phermone traps were placed throughout most of southeastern and central Minnesota by the Animal and Plant Health Inspection Service (APHIS) of the USDA. This trapping resulted in moths being trapped in two metropolitan areas, Dakota and Hennepin Counties. Follow-up field checking resulted in no egg masses being found. Traps placed by DNR personnel in northeastern Minnesota resulted in one chickadee being caught.

Outlook for 1980

The continued presence of Gypsy Moth in eastern Wisconsin indicates the potential for this pest to "hitchhike" into Minnesota. There is a need to continue setting out survey traps and making contingency plans should an infestation break out.

DISEASES

Infectious Diseases — Softwoods

Scleroderris Canker and Dieback — *Gremmeniella abietina* (Lagerb.)

The North American strain of Scleroderris canker was found in two new locations in 1980. The disease was found in Lake County (Section 36, Township 58N, Range 7W), Plantation #189-17. The heaviest infection was in 21 acres of the plantation which had been aerially seeded in 1965. It appears that the source of infection was nursery stock planted in the remainder of the plantation. No control was recommended since the disease occurs in other plantations in the vicinity. Also, most trees in the plantation are over six feet in height and are now too tall to be killed by the disease. However, future red pine plantations should not be established within one-half mile of this source of infection.

The North American strain was found in a nursery on the University of Minnesota Cloquet Forestry Center. The nearest known source of infection is in the Finland District approximately 80 miles to the northeast. No local source of infection has been found. Possibly infected seedlings were brought in. The infected seedlings on the Forestry Center were burned so they wouldn't act as a source of infection.

The European strain of Scleroderris canker has not been found west of New York.

Outlook for 1980

The North American strain will continue to be a minor problem in Minnesota. No accurate prediction of the spread of the European strain of Scleroderris out of the northeast United States can be made at this time.

Diplodia Tip Blight — *Diplodia pinea* (Desm.) Kick.

There was very little incidence of Diplodia tip blight throughout the state during 1979.

Red pine seedlings in General Andrews nursery infected by Diplodia in 1978 when showed symptoms of infection were culled by the nursery crews when lifted in the spring of 1979.

Very little new infection of seedlings in General Andrews nursery occurred in 1979.

Outlook for 1980

This disease is not expected to be a major problem as long as precipitation patterns remain normal.

Spruce Needle Rust — *Chrysomyxa ledicola* Lagerb.

Black and white spruces were both very heavily infected with spruce needle rust in Koochiching County. In one roadside planting of white spruce (20-25 feet in height), the trees were so heavily infected that they looked tan in color. This was due to the heavy production of spores on the current year's needles. Forty percent of the current year's needles were infected.

Spore pustules were evident on August 2nd in an infected white spruce plantation (Section 17, Township 158N, Range 32W) in Lake of the Woods County.

A privately owned natural white spruce stand (trees 30 feet tall) in Beltrami County (Section 17, Township 144N, Range 34W) was also heavily infected with the disease.

Outlook for 1980

Intensity of infection varies greatly from year

to year depending on the weather so a tree seldom is defoliated and killed. Rust infection will probably not be very common in 1980.

Pine Needle Rust — *Coleosporium asterum* (Diet.) Syd.

This foliage disease was common in northern Minnesota on young red pine growing in plantations. A 60-acre plantation in Koochiching County (Section 29, Township 158N, Range 29W) had 90 percent of the trees infected by this fungus. The trees averaged about seven feet tall, and the heaviest infections occurred on the lower one-third of the crown. A 10-acre private plantation located in Hubbard County (Section 22, Township 141N, Range 33W) also was infected by this foliage disease. Approximately 50 percent of the 5 foot tall red pine seedlings were infected. A Beltrami County (Section 35, Township 154N, Range 30W) plantation was infected with this disease.

Sweet Fern Rust — *Cronartium comptoniae* Arth.

A 44-year old jack pine plantation in Itasca County (Section 27, Township 59N, Range 23W) had approximately 25% of the stems infected with sweet fern rust. After a tree has reached a basal diameter of 3 inches, it is relatively safe from mortality. In this plantation the average DBH was 7.0 inches.

Outlook for 1980

The trees will remain infected with sweet fern rust which may slightly reduce height growth and quality. Little additional mortality should occur.

Shoestring Root Rot — *Armillariella mellea* (Vahl. ex Fr.) Karst

This disease continued to be present and noticeable in red pine plantations under 10 years of age in Region I. A number of plantations in the northern part of the Region were inspected for insect and disease problems by walking through the plantations and by picking out at random 50 to 100 trees which were closely inspected. In 36% of the plantations, shoestring root rot was observed, and the percentage of infected trees ranged between 1% and 10%.

In one red pine plantation in the Warroad Area (Section 4, Township 161N, Range 35W) root rot pockets had been identified and flagged during the summer of 1978. In 1979, this plantation was reinspected. The pockets that had been flagged did not enlarge. The only change was that trees that had appeared yellow-green during August of 1978 were dead in 1979. Despite the pockets not enlarging, new infection centers that were not present in 1978 were noticed in 1979. Tree mortality was spotty but may range up to 10%. Monitoring of this plantation as well as others with shoestring root rot present will continue during 1980.

Pine Wilt Disease — *Bursaphelenchus lignicolus* Mamiya and Kiyohara

A wilting disease of pine caused by the pine wilt nematode may be established in Minnesota. The nematode kills pines by multiplying in the sapwood of branches and the main bole to the extent of blocking the transport vessels. Mortality normally occurs in one growing season. Needle discoloration, wilting, and browning of the entire crown with decreased resin flow are symptoms of the disease. The small nematodes (less than 1mm long) are transported from infested to healthy trees inside pine sawyers of the long horned beetle family (Cerambycids).

Trees can be sampled using an increment borer to obtain a sapwood core. Cores are immersed in water overnight to extract the nematodes which are then preserved using a glycerin, formaldehyde and water solution. Live nematodes and cores from suspect trees should not be transported. Suspect dead or wilted pines should be reported to the regional insect and disease specialists.

Pine wilt nematode has been confirmed in 13 states as of January, 1980. These states include Arkansas, Florida, Illinois, Iowa, Kansas, Kentucky, Louisiana, Missouri, Nebraska, New York, Pennsylvania, South Carolina, and Tennessee. In addition, a nematode of the same genus has been isolated from dying pine in Minnesota. Efforts are underway to identify the species of the nematode found.

The host range of this nematode in the United States includes the following: white pine (*P. strobus*), red pine (*P. resinosa*), jack pine (*P. banksiana*), loblolly pine (*P. taeda*), shortleaf pine (*P. echinata*), slash pine (*P. elliotti*), Austrian pine (*P. nigra*), Virginia pine (*P. virginiana*), ponderosa pine (*P. ponderosa*), mugo pine (*P. mugo*), Scots pine (*P. sylvestris*), Swiss stone pine (*P. cembra*), and Japanese black pine (*P. thunbergiana*).

Infectious Diseases – Hardwoods

Dutch Elm Disease – *Ceratocystis ulmi* (Buism)

Dutch elm disease continued to kill trees in both urban and forested locations throughout Minnesota. In Region I, disease incidence was the most severe in the southern part of the Region in Grant and Douglas Counties. Elms in these counties are considered high risk trees. Timber sales on private lands are being set up to harvest the elm resource before it is lost.

In Maplewood State Park, 60 dead and diseased elms were marked for removal in midsummer. They were cut down and disposed of in September and October. Temporary employees who would have been laid off at the end of August were used to do the sanitational work. Average cost per tree for removal and disposal was $34.34.

This is the third consecutive year for elm removals from Maplewood State Park. The first year, 47 elms were removed and the second year, 23 elms were disposed of. The outlook for 1980 would be for more diseased elms to be found in Maplewood State Park, although the number should not be as great as that encountered during 1979.

A new county was added to the list of counties in which Dutch elm disease had been found. That county is Lake of the Woods County, where the disease was positively identified on several trees within the city limits of Baudette, along the Rapid River, and in the Clementson area.

In Region III, diseased elms were removed by hot shot crews in the following state parks: Interstate, 200 trees; Crow Wing, 35 trees; and Lindberg, 25 trees. In addition, hot shot crews removed dead and dying elms from the St. Croix and Father Hennepin State Parks.

In the Metro Region (VI), a special Dutch elm disease crew was hired to remove and dispose of dead and dying elms. During 1979, this crew disposed of 2,963 trees with an average cost of $20.58 per tree. This average cost included labor, clean up, supplies, and equipment repair costs. Removals occurred on the following DNS properties:

Fort Snelling State Park	1,047 elms
William O'Brien State Park	807 elms
Afton State Park	63 elms
Minnesota Valley Trail Site 2	129 elms
Rush River Trail Site	95 elms
Lawrence Wayside	306 elms
Luce Line State Trail	231 elms
Lotus Lake Fisheries Control Site	146 elms
Bayport Wildlife Management Area	15 elms
Schmidt Wildlife Management Area	9 elms
Carlos Avery Wildlife Management Area	340 elms
Public Accesses	15 elms
TOTAL	**2,963 elms**

In southern Minnesota, all work was done by private contractors. Contracts were awarded on a lump sum, sealed bid basis. In Region IV, a total of 292 trees were removed at an average cost of $37.21 per tree. In Revion V, 304 trees were removed at a cost of $37.87 per tree.

Region IV

Camden State Park	46 elms
Fisheries Station at Waterville	4 elms
Flandrau State Park	117 elms
Fort Ridgely State Park (Plus hazardous limbs removed from three trees)	38 elms
Lake Shetek State Park	38 elms
Minneopa State Park	20 elms
Split Rock Creek State Park	29 elms
TOTAL	**292 elms**

Region V

Beaver Creek Valley State Park	41 elms
Forestville State Park	28 elms
Kruger State Forest Campground	10 elms
Lake Louise State Park	30 elms
Rice Lake State Park	23 elms
Whitewater & Carley State Park	36 elms
Sakatah Lake State Park	102 elms
Crystal Springs Fisheries Station	13 elms
O.L. Kipp State Park	21 elms
TOTAL	**304 elms**

In addition, 104 trees were removed from state-administered Public Access Areas in Region IV, at a cost of $50.14 per tree.

Lake Sarah and Bloody Lake (Murray Co.)	16 elms
School Grove Lake (Lyon Co.) and Curtis Lake (Yellow Medicine Co.)	28 elms
Lake Francis, Roemhildts Lake, Lake Jefferson, Lake Washington, and Gorman Lake (Le Sueur Co.)	26 elms
Lake Elysian, Goose Lake, and Buffalo Lake (Waseca Co.)	9 elms
Minnesota River at Granite Falls (Chippewa Co.)	5 elms
Lake Hook, Round Grove Lake, and Silver Lake (McLeod Co.), Bear Lake, Wolf Lake, and Lake Minnie Bell (Meeker Co.)	16 elms

Minnesota River at North Redwood (Redwood Co.)	4 elms
TOTAL	**104 elms**

Outlook for 1980

In areas where the disease is present harvesting in managed hardwood stands should be directed toward elm removal. The regeneration of other hardwood species should be favored. Operations will be continued statewide to mark and remove diseased trees from state lands in areas contiguous to control zones or areas of high public use. Continued losses are expected.

Butternut Canker — *Sirococcus clavigigneti — juglandacerun* Nair, Kostichka, and Kuntz.

Decline of butternut continued to occur throughout southeastern Minnesota. Since samples collected and sent for culture in both 1978 and 1979 were not processed properly, the only positive diagnosis of butternut canker west of the six counties verified in 1976 came from Brown County on the extreme western edge of the butternut range in Minnesota. However, butternut dieback and mortality has been observed in the field very extensively throughout the areas of Dakota, Hennepin, LeSueur, Nicollet, Rice, Sibley, and Scott Counties.

It is apparent that butternut canker is a disease which is capable of spreading throughout the butternut range in Minnesota and has the potential of greatly reducing this tree in our forests.

One of the Forest Insect and Disease Management personnel objectives in 1980 will be to obtain and culture samples for positive identification throughout the northern portions of the butternut range.

Walnut Dieback

Insect and Disease personnel are currently investigating a walnut dieback in the southeast. Samples were collected from a Fillmore County plantation (Section 13, Township 103N, Range 9W) and sent to the University of Wisconsin. Cultures yielded several fungi including one unknown fungus that has been shown to be pathogenic to walnut seedlings growing under greenhouse conditions. At this time efforts are being made to identify the pathogen involved.

Symptoms include dieback of branches, stem cankers which usually occur in association with pruning wounds, and basal sprouting.

Similar symptoms have been found in a walnut planting in Goodhue County (Section 13, Township 112N, Range 15W). Samples are currently being cultured to see if this is the same disease complex. In contrast to the Fillmore County planting this is an upland site.

Plans for next year include continued survey and evaluation of this problem in the southeast.

Non-Infectious Diseases

Maple Decline

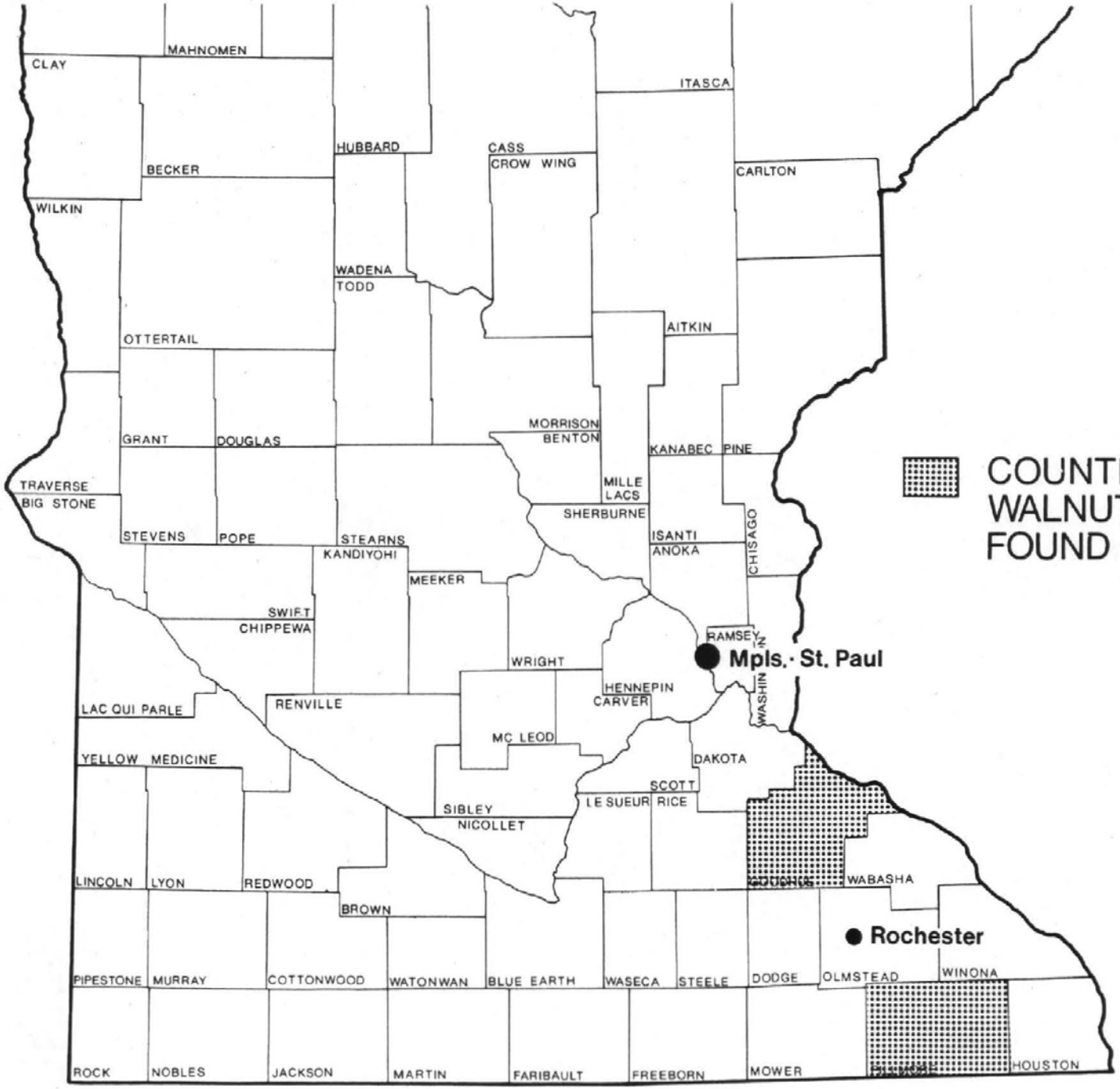
A general decline of hard maple *Acer saccharum* has been reported throughout south central and southeastern Minnesota. Symptoms include crown dieback, death of a portion of the crown or complete mortality.

It is suspected that this decline is the result of the 1976 drought. With hard maple having a preference for moist sites, it would follow that during severe drought, loss of soil moisture would result in feeder root mortality. In succeeding years, the tree crown would die back in proportion to the degree of feeder root mortality. Trees in this condition become susceptible to attack by a number of insect and disease pests. An example would be Verticillium Wilt caused by the fungus *Verticillium albo-atrum.* Those trees that become successfully colonized by *Verticillium* die rapidly while other trees may continue to decline progressively.

Since this decline has been reported almost exclusively as an urban problem, several community tree inspectors were contacted throughout south central and southeastern Minnesota. The information gathered through these inspectors indicated the main impact of maple decline is in the southeast. In 1979, throughout the southeast, symptom severity continued to increase. No individual instances of apparent recovery were reported, and all contacted inspectors reported increased numbers of hard maple removed.

Herbicide Damage to Pines

In Regions I and II herbicide damage to pine plantations became apparent during late summer. Jack pine was damaged in Beltrami and Hubbard Counties in Region I. In Beltrami County (Sections 3 and 4, Township 153N, Range 30W), jack pine foliage had yellowed by late August. When inspected in October, the foliage was still yellow but buds and shoots appeared green and healthy. Jack pine in Hubbard County (Section 31,



COUNTIES WHERE WALNUT DIEBACK WAS FOUND IN PLANTINGS·1979

MAP 7

Township 140N, Range 32W) also showed yellow foliage by the end of the summer. During the fall it became apparent that the younger trees had been killed. In Region II, herbicide damage was observed in red pine plantations and seemed to be common. In some plantations, up to 75% of the trees were affected.

Herbicide damage can cause a loss of the current year's needles and buds may be killed. When the terminal bud is damaged, the tree will take on a bush-like appearance until a side branch establishes dominance.

Damage to these stands may have been the result of the late growing season. Since spraying contracts are let some months prior to the beginning of the growing season, little flexibility for spray dates is achieved. Due to cold weather, the growing season was retarded, and the pines may not have been hardened off enough to withstand the herbicide.

Winter Injury

Widespread winter injury occurred to conifers throughout Minnesota. Damage was more severe and noticeable late in the winter due to the fact that the winter of 1978-1979 was the most severe on record for Minnesota. Injury was most pronounced on white, red, Scots, and jack pines growing along roadsides. Exposed conifers such as those along edges of stands and in windbreaks also suffered winter injury.

Stands of Scots pine, which had normally experienced foliage burning during winter but then flushed green in the spring, experienced tree mortality when foliage, buds, and branches were killed. In a Christmas tree plantation of Scots pine in Olmsted County, 90 percent of the trees were burned with 50 percent of these trees experiencing some degree of mortality. Scots pine mortality in Christmas tree plantations was heavy in southern Hubbard County.

Oak Mortality

Oak Wilt – *Ceratocystis fagacearum* (Bretz) Hunt

Shoestring Root Rot – *Armillariella mellea* (Vahl. ex Fr.) Karst

Two-Lined Chestnut Borer – *Agrilus bilineatus* (Web.)

Red Oaks in Ottertail and Douglas Counties of Region I continued to experience top kill and complete tree mortality. Emergence holes in the bark, characteristic of the two-lined chestnut borer, were noticed on most of the dead trees. The mushrooms of *Armellariella mellea* have not been observed, but it is thought that red oak mortality is being caused by both two-lined chestnut borer and shoestring root rot getting established in trees weakened by the drought of 1976-77.

Oak mortality in woodlot and yard situations continued to be a widespread problem in the Metro Region. A fixed wing aerial survey in October 1979 mapped pockets of oak mortality in Anoka County. Oak wilt, construction damage, two-lined chestnut borer and shoestring root rot are contributing causes. Case-by-case evaluations are needed to determine the primary agent, the extent of the problem and treatment alternatives. Additional private forest management activity in the Region coupled with high fuelwood demand should serve to increase public awareness and understanding of these problems, and promote the proper removal and utilization of infested material.

Shoestring root rot was observed in declining oak stands in the Metro Region and in Region III. In the Metro Region it was found within several oak wilt pockets. In Region III it was present in stands where two-lined chestnut borer was contributing to oak mortality. The range of diagnosed two-lined chestnut borer activity was expanded to include Todd County in 1979.

In southeastern Minnesota scattered pockets of oak mortality continued to occur. The primary causes appeared to be oak wilt disease and the effects of the 1976 drought.

Two-lined chestnut borer was found in association with oak wilt infected northern red oaks in one infection center in the Whitewater State Park (Section 20, Township 107N, Range 10W). A salvage-control timber sale in this area was conducted by the forestry office at Lewiston.

In 1979, there was no detected additional spread of oak wilt west of the established range in Region V. Several cases of burr oak mortality initially thought to be new cases of oak wilt were diagnosed as drought related. These occurred in Faribault County east of the Town of Wells.

Outlook for 1980

Oak wilt disease will continue as a major mortality inducing factor in oak stands of the six-county Metro Region. The occurrence of two-lined

chestnut borer will continue to be tied to stressed oak stands with unthrifty tops.

SPECIAL PROJECTS

Shelterbelt Insect and Disease Survey

Early in 1979, a letter indicating the availability of DNR personnel for shelterbelt insect and disease problem analysis was sent to all Region IV Soil and Water Conservation Districts. The objective of this program is to provide technical assistance to district technicians and landowners concerning insect and disease problems in shelterbelts and windbreaks. The program will also give DNR insect and disease management personnel information concerning the extent and severity of insect and disease problems. In addition, the need for special cultural practices or species composition, and other management problems in shelterbelts and windbreaks can be determined. Fifteen southwestern Minnesota counties responded to the letter.

The majority of the work was done in plantings from one to four years of age. The most commonly planted species were Amur Maple, Caragana, Canadian Red and Tartarian Honeysuckle, Lilac and Russian Olive, shrub species, which were used in the first and second rows of the plantings. Norway and Robusta poplar, Hackberry, green ash, silver maple, and Colorado Blue and Black Hills spruce are tree species used for the inside rows.

Of these species, the poplars with an unknown canker disease, and ash with a severe aphid problem were the most insect and disease prone. Cultural practices such as improper planting, poor timing of planting, poor care of stock, and poor species selection were the most important problems observed. Lack of post-planting weed control and herbicide drift were also problems.

Most of the trees and shrubs planted in shelterbelts had one or more specific insect and/or disease problems. Many of these caused little noticeable damage while other severely injured foliage, twigs, branches, stems, or roots causing stunting or mortality.

The following are some of the more important insect and disease problems found:

- Ash Borer – *Podesia syringae fraxini* (Lugger)

  Caused breakage of limbs; occurred sporadically throughout the region; was found mainly on younger trees.

- Eastern Tent Caterpillar – *Malacosoma americanum* (F.)

  Variable amounts of defoliation damage on a variety of tree and shrub species, was sporadic throughout the region.

- Aphids

  Stunting and curling of leaves and deformation of shoots were found mainly on ash throughout the region.

- Ash Flower Gall Mite – *Eriophyes fraxinflora* (Felt)

  Caused deformation of staminate flowers of ash throughout the region.

- Phomopsis Canker of Russian Olive – *Phomopsis elaeagni* (Linder)

  Produced cankers which girdled tree causing wilting and death. Found in McLeod County only.

- Cytospora Canker of Spruce – *Cytospora kunzei* (Sacc.)

  Was a common occurrence on Norway and Colorado blue spruce primarily on stressed older trees.

- Verticillium Wilt – *Verticillium albo-atrum* (Reinke and Berth)

  This dieback causing disease was found on ash, catalpa, elm basswood, black locust, maple, plum, Russian olive and others, throughout the region. Some scattered mortality was noted.

- Fire Blight – *Erwinia amylovora* (Burr.)

  Was of minor importance in windbreaks and shelterbelts, but very important in orchards and other shelterbelts utilizing apple and pear (*Rosaceous sp.*) plantings.

- Cedar-Apple Rust – *Gymnosporangium juniperi-virginiana* (Sachw.)

  Was of minor importance.

- Anthracnose Leaf Disease

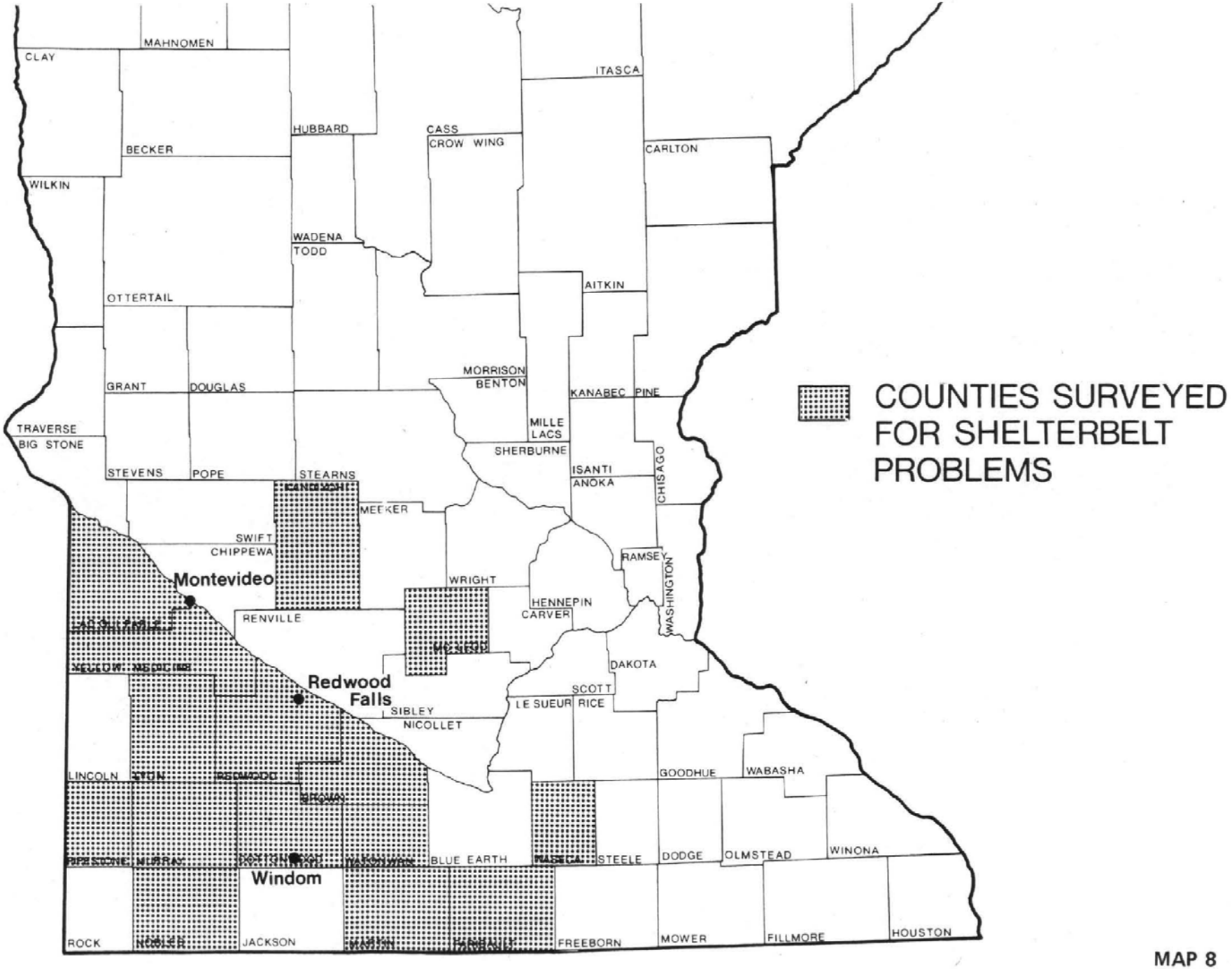
  Was a minor problem but may cause premature defoliation during wet seasons,

- Chemical Injury

  Was a fairly common problem due to herbicide drift.

- Winter Burn of Conifers

  Was a very extensive problem throughout region due to severe winter of 1978-79.


MAHNOMEN
CLAY
BECKER
HUBBARD
CASS
CROW WING
ITASCA
CARLTON
WILKIN
WADENA
TODD
AITKIN
OTTERTAIL
GRANT
DOUGLAS
MORRISON
BENTON
KANABEC
PINE
TRAVERSE
BIG STONE
MILLE LACS
SHERBURNE
ISANTI
ANOKA
CHISAGO
STEVENS
POPE
STEARNS
MEEKER
SWIFT
CHIPPEWA
RAMSEY
WASHINGTON
Montevideo
WRIGHT
HENNEPIN
CARVER
RENVILLE
DAKOTA
Redwood Falls
SCOTT
SIBLEY
LE SUEUR
RICE
NICOLLET
GOODHUE
WABASHA
LINCOLN
LYON
REDWOOD
BROWN
MURRAY
COTTONWOOD
BLUE EARTH
STEELE
DODGE
OLMSTEAD
WINONA
Windom
ROCK
NOBLES
JACKSON
FREEBORN
MOWER
FILLMORE
HOUSTON
COUNTIES SURVEYED FOR SHELTERBELT PROBLEMS

MAP 8

White Pine Blister Rust Survey

A blister rust survey, based upon Dr. Eugene Van Arsdale's work in the 1960's was developed in order to evaluate a wide range of environmental conditions and sites for hazard rating. It is hoped that a determination of conditions under which white pine can be planted to minimize losses from the blister rust disease can be made. The survey procedure was to find stands of white pine; evaluate factors such as overstory, aspect, proximity to bodies of water and the presence of Ribes; and pick at random 50 trees to evaluate disease severity. White pine weevil damage was also assessed on these sample trees.

So far, ten stands have been evaluated, and the results are listed in Table 7. Fatal cankers are those cankers which are on the main stem or within 4 inches of the main stem and would likely result in tree death.

The first four stands listed in the Table were plantations established during the 1940's and generally could be considered open-grown even though the 3rd and 4th stands grew under a light, scattered overstory of jack pine and aspen. The remaining six stands were natural, understory stands in the Paul Bunyan State Forest. The infection and the weeviling pattern follow closely what has been recorded in the literature. Understory stands appear to have less of a chance of being damaged by the blister rust disease and by the white pine weevil.

All stands sampled were in Van Arsdale's hazard zone 3, which he describes as areas in which the white pine stands will require "modified standard controls." His controls for this zone include: *Ribes* eradication within the stand of white pine as well as within 600 feet of the stand, basal pruning of the live crown portions, pruning out any cankers in the upper portions of the live crown, and underplanting with complete release not coming until the trees are 35 feet tall (personal communication with Van Arsdale, November, 1979).

Obviously, there has not been enough data collected to draw any conclusions. It is hoped that approximately 200 white pine stands can be evaluated, and these stands will provide a wide range of stand and environmental conditions to evaluate. Through this evaluation, areas can be defined in which white pine can be raised successfully, even in the high hazard zones (zones 3 and 4). For example, survey results so far would indicate that white pine can be grown with a low disease incidence under conditions such as those experienced in the Paul Bunyan State Forest. Unsuccessful white pine stands result when planted under conditions in which the first four stands grew. Both areas of white pine fall under the same hazard zone rating, but infection rate is quite different.

Dwarf Mistletoe of Black Spruce — *Arceuthobium pusillum* Peck

The key to reducing mistletoe damage is preharvest planning. After the site is harvested, it may be too late or too costly to treat the site. It must be decided before harvesting how to eliminate almost all of the black spruce in the harvest area. In many cases, this is now done by including a clause in the timber sale contract which states that the logger must cut or kill all black spruce trees five (5) or more feet in height. If it is unreasonable to expect the logger to kill all the trees, a crew with a chain saw is sometimes sent in after the site is harvested.

Another method of killing the residual trees is by burning the site after harvesting. In the International Falls District (Section 36, Township 69N, Range 24W), a state-owned skidder was used to knock down a stand of trees which were unmerchantable due to mistletoe and which bordered a sale area. This area will have to be burned to remove the slash and to kill the smaller (less than 10 feet tall) trees. Rock Cut District used a state skidder in January 1980 to knock down residual trees and create a fire break around a 90-acre harvested area. This area will then be burned and aerially seeded.

Mistletoe Studies:

A. Insect and disease personnel in Region I and Region II are continuing a study to determine the effectiveness of the five (5) foot cutting rule in controlling dwarf mistletoe. Plots are established in mistletoe sites before logging. Data are collected to determine the amount of mistletoe infection and numbers of black spruce stems on the site before and after logging.

Two plots that had been established in December of 1977 in the Roy Lake District in Clearwater County were inspected. These plots were logged during the winter of 1977-78. When the plots were established in 1977, there was a total of 10 live infected black spruce trees over 5 feet tall on both of the prism plots. In 1979, those trees were gone. In 1977, no trees under 5 feet

Table 7
White Pine Stand Evaluation for Blister Rust Damage

Description	Hazard Zone	Average Height	Overstory	Aspect	Distance to Nearest Lake	Position on Slope	Ribes Present	Percent of Trees Non-infected	Percent of Trees Dead	Percent of Live Trees Infected w/ Fatal Cankers	Height of Fatal Cankers		Percent of Live Trees Weeviled
											< 9′	> 9′	
31-161-36	3	> 30′	None	Level	> 1 mile	Top	No	6	0	38	32	68	100
19-158-34	3	> 30′	None	Level	> 1 mile	Top	Yes	2	10	49	32	68	84
10-159-34	3	10-20′	Yes	East	> 1 mile	Mid-slope	Yes	6	18	66	96	4	90
10-159-34	3	10-20′	Yes	North	> 1 mile	Mid-slope	Yes	4	34	64	90	10	91
17-141-32	3	20-30′	Yes	South	> 1 mile	Bottom	No	74	13	4	100	0	59
17-141-32	3	10-20′	Yes	Level	> 1 mile	Top	No	88	4	2	0	0	4
34-142-33	3	10-20′	Yes	Level	> 1 mile	Top	Yes	84	4	0	0	0	8
23-142-33	3	10-20′	Yes	Level	> 1 mile	Top	Yes	96	0	2	100	0	10
14-142-33	3	< 10′	Yes	South	> 1 mile	Mid-slope	Yes	92	0	0	0	0	0
11-142-33	3	< 10′	Yes	West	> 1 mile	Mid-slope	Yes	100	0	0	0	0	0

tall were found, but in 1979, 45 trees were found. None of these young trees were infected.

When the plots were established, there was approximately 3 feet of snow on the ground and the seedlings were hidden under the snow cover. The snow accounted for the seedling count discrepancy. It is interesting to note, however, that the deep snow also protected the seedlings from the logging activity. If those seedlings had been infected, logging activity would not have destroyed them and their potential for infecting the new stand would have been great.

B. Use of a herbicide to kill residual black spruce on harvested sites.

MN-DNR and the University of Minnesota are cooperating on a study to examine the effectiveness of using a herbicide to kill residual black spruce on harvested sites. Three sites in the Littlefork area were sprayed with the herbicide Sodium-TCA. The three sites all contained several mistletoe infected residual black spruce standing in the cut-over area. The three sites were each bordered on one or more sides by unmerchantable spruce (unproductive site) heavily infected with mistletoe which had not been cut. The unmerchantable infected spruce is a serious threat to the next rotation of spruce on the cut-over area. The cut-over area of each site plus a one to two chain strip of unmerchantable spruce bordering the cut-over area were sprayed.

Sites Sprayed

Section 18, Township 65N, Range 26W (45 acres sprayed)

Cut-over area had residual black spruce which varied from trees less than 1 foot in height to trees 5.5 inches DBH. Trees in the unmerchantable edge varied from less than 1 foot in height to 20 feet in height.

Section 1, Township 156N, Range 25W (30 acres sprayed)

Residual black spruce in cut-over area varied from trees less than 1 foot in height to trees of 5.0 inches DBH. Trees in the unmerchantable edge varied from trees less than 1 foot in height to trees of 6.7 inches DBH.

Section 27, Township 69N, Range 23W (23 acres sprayed)

Residual black spruce in cut-over area varied from trees less than 1 foot in height up to 5 feet in height. Trees in the unmerchantable edge varied from trees less than 1 foot in height to trees of 8.9 inches DBH.

Data collected on the sites included: density of trees, size of trees, presence or absence of dwarf mistletoe, number of woody stems (excluding Labrador tea, leatherleaf, and bog laurel for which presence and abundance of stems were estimated), percent moss cover, and percent grass coverage.

On July 13, 1977, sodium TCA (Sodium Trichloroacetic acid, Hopkins Chemical Company, Minneapolis, Minnesota) was applied at 12 gallons of mix per acre or 32.4 pounds of sodium trichloracetic acid per acre. Application was made by a Hiller 12E helicopter operated by a commercial applicator.

Survival of trees, other woody vegetation, mosses and grasses on the sites will be determined in 1980.

Cost – only one contractor bid on the contract for spraying, which resulted in a cost of $60 per acre. The cost of herbicide was $9.75 per acre and was included in the $60 figure.

Water Monitoring

At each spray site, three water samples were collected from the following locations: (#1) within the spray area, (#2) two chains outside the spray area, and (#3) five chains outside the spray area.

The samples were analyzed at the Carlos Avery Chemical Lab for TCA residue. Analysis of the water samples showed that trichloroacetic acid (TCA) occurred in these sites before spraying at concentrations which varied from 0.5 to 4.5 ppm (see Table 8). Apparently there was no movement of the spray material out of the spray area since water samples collected two and five chains outside the spray area never contained more than 4.5 ppm TCA after spraying. The TCA applied was either broken down, diluted or in some way tied up in the plants or plant material on the spray sites since all of the water samples collected seven weeks after spraying contained 1.0 ppm or less TCA.

Diplodia Studies Conducted or Started in 1979

A. Study to develop chemical control for nurseries.

North Central Forest Experiment Station (NCFES) and MN-DNR worked together to determine the effectiveness of several chemicals to prevent infection of nursery stock by *Diplodia pinea.* Unfortunately, no infection by Diplodia occurred in the study area in either the control or treated beds; therefore, no results were obtained in

Table 8
Water Sample Results from the Dwarf Mistletoe Project

Site 27-69-23

Location of Sample (See above)	*Prior to Spray Collected [7/6/79]*	*4 Days After Spray Collected [7/17/79]*	*7 Weeks After Spray Collected [8/31/79]*	*3 Months After Spray Collected [10/25/79]*
	ppm TCA	**ppm TCA**	**ppm TCA**	**ppm TCA**
#1	4.5	17.5	< 0.5	< 0.5
#2	3.0	0.5	< 0.5	not sampled
#3	4.5	< 0.5	< 0.5	< 0.5

Site 18-65-26

Sample Location (See above)	*Prior to Spray Collected [7/6/79]*	*4 Days After Spray Collected [7/17/79]*	*7 Weeks After Spray Collected [8/31/79]*
	ppm TCA	**ppm TCA**	**ppm TCA**
#1	3.0	3.0	< 0.5
#2	2.0	4.5	< 0.5
#3	3.5	4.5	< 0.5

Site 1-156-25

Sample Location (See above)	*Prior to Spray Collected [7/6/79]*	*4 Days After Spray Collected [7/17/79]*	*7 Weeks After Spray Collected [8/31/79]*
	ppm TCA	**ppm TCA**	**ppm TCA**
#1	2.0	15.8	1.0
#2	0.5	3.0	< 0.5
#3	1.0	1.0	< 0.5

Minnesota. Similar studies were conducted by NCFES and the Wisconsin DNR. NCFES plans on publishing a report on the results.

B. Study on growth and survival of *Diplodia pinea* infected red pine seedlings upon outplanting.

Three-year-old red pine seedlings infected by Diplodia and seedlings showing no symptoms of infection were mixed together and planted on two sites in the Fond du Lac State Forest in Carlton County. Height of the seedlings, as well as the location of the Diplodia infection (terminal leader or side branch) on the infected seedlings, were recorded. Height growth and survival of infected and non-infected seedlings will be compared after one and two years to determine if the Diplodia infection causes much damage to seedlings upon outplanting.

STUDIES ON YELLOWHEADED SPRUCE SAWFLY

By: Dr. Herbert M. Kulman
Department of Entomology,
Fisheries and Wildlife
University of Minnesota

The yellowheaded spruce sawfly, *Pikonema alaskensis*, is being studied in the Grand Rapids area with support from the Blandin Foundation and the University of Minnesota. Dr. H.M. Kulman and students (Department of Entomology, Fisheries and Wildlife) have found that 66% of overwintering cocoons are destroyed by predatory insects and small mammals, and from 1 to 20% of the late stage feeding larvae are destroyed by parasitic wasps and flies. Natural agents are causing very little mortality to the egg and small larval stages. Therefore, a search is being made for parasites that attack eggs and all feeding larval stages as there is enough room for additional natural controls in these stages without causing serious competition with the natural control agents already in the biological system.

Chemical sex attractants (pheromones) have been identified and should prove useful for survey purposes by placing minute quantities of the material in sticky traps hung in the trees. The number of males captured would be an index to the sawfly population and thereby serve as a warning to watch for defoliation and anticipate control needs. The methods are still being tested and are not yet available for general use.

Studies on a parasitic fly, *Bessa harveyi*, have shown that the fly is greatly limited as a control agent, in spite of its abundance, because: (1) the eggs fail to hatch or are lost when larvae shed their skin, (2) substantial numbers of small maggots after penetrating the sawfly, are encapsulated by tissue that kills the maggot, and (3) many flies emerge for a second generation in late summer. They often fail to reproduce as sawfly hosts are scarce late in the season. The size of this "wasted" second generation varies greatly year to year, making the fly also an undependable control agent.

Studies on this parasitic fly are a continuation of similar studies of its association with the larch sawfly – part of a study supported by the DNR concerning importation of parasites for control of that defoliator pest of tamarack.