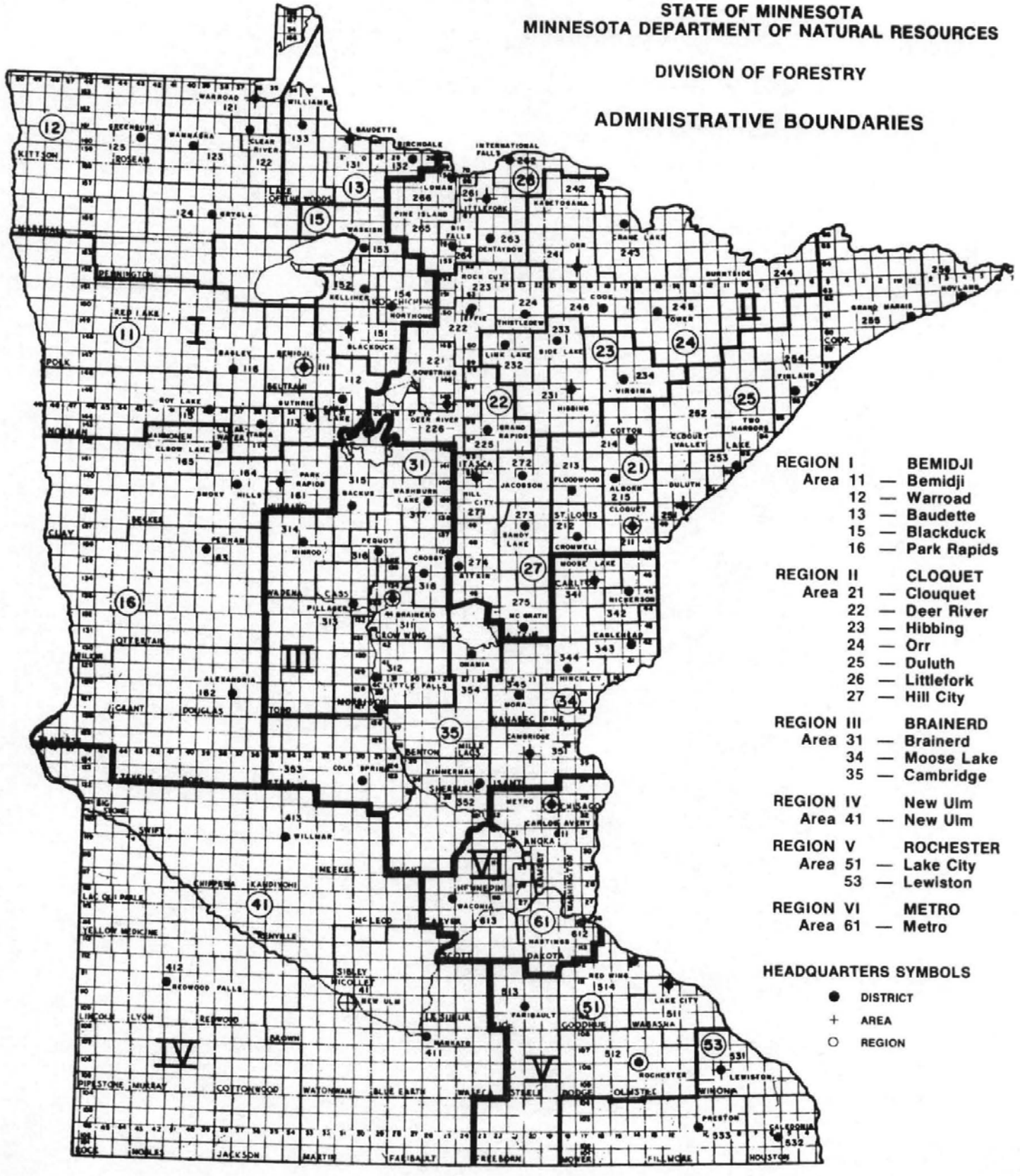
1978
FOREST INSECT AND DISEASE REPORT

MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

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

TABLE OF CONTENTS

THE MINNESOTA FOREST INSECT AND DISEASE MANAGEMENT PROGRAM

There are approximately 16,000,000 acres of commercial forest land in the State of Minnesota. Responsibilities for dealing with the insect and disease problems on these forested lands have largely been up to the local land managers of the county, state and federal governmental agencies involved with forestry in Minnesota. To assist these land managers, in the past, one to three Pest Specialists located in St. Paul were available, and during June and July, Seasonal Plant Health Specialists in the regions also provided assistance.

In 1977, a Forest Insect and Disease Management Program was started, and this program expanded the compliment of Specialists to include a supervisor, a staff entomologist and a pathologist all located in St. Paul, and four full time Regional Forest Insect and Disease Management Specialists. Through modifications in the program and through position and personnel attrition, during 1978 this program included Jim Brooks in St. Paul as the Supervisor, Jerry Hecht in Grand Rapids as the Field Coordinator, and the 4 Regional Specialists: Alice Clark in the Rochester and New Ulm Regions, Raph Miller in the Brainerd and Metro Regions, Mike Albers in the Cloquet Region, and Alan Jones in the Bemidji Region. Assisting these Regional Specialists were the Seasonal Plant Health Specialists: Roger Hannigan in Bemidji, Gene Schmidt in Virginia, Ray Dolan Cloquet, Bob Tiplady in Brainerd, and Mark Wurdeman in Mankato.

The Minnesota FIDM unit works cooperatively with the State and Private FIDM and the North Central Forest Experiment Station of the U.S. Forest Service, and with the University of Minnesota. This report, then, is a collection and summary of surveys and observations made during 1978 by all personnel involved in forest insect and disease work in Minnesota.

1978 FOREST INSECT AND DISEASE HIGHLIGHTS

The two insect problems which affected the largest areas of commercial forest land were the forest tent caterpillar and the jack pine budworm. The forest tent caterpillar caused severe defoliation over a wide area of northern Minnesota and in scattered areas throughout Central Minnesota. The population of jack pine budworm, which was primarily located in 1977 in a 6,500 acre area west of Bemidji and in isolated pockets in southern Hubbard County and into Wadena County, literally exploded and infested an area of about 68,000 acres. Defoliation was so severe in some areas that continguency salvaging plans were formulated.

Of concern, too, during 1978 was a build up of tussock moth populations on jack pine in the Brainerd Region. The yellowheaded spruce sawfly continued to be a nuisance in white spruce plantations in both the Bemidji and Cloquet Regions, and direct control measures were undertaken on the more heavily defoliated state plantations in the Cloquet Region. There was an increase statewide of pine spittlebug populations, while populations of bark beetles declined. Except for small, localized outbreaks, both the larch sawfly and the introduced pine sawfly created minor problems during 1978.

Diplodia tip blight disease, a serious problem during 1977 particularly in the Brainerd Region, was significantly reduced in incidence and severity, and its occurrence was thought to be drought-related. Naemacyclus needlecast disease on Scotch pine was identified for the first time in the State in the Brainerd Region. Dutch elm disease continued to be the major urban tree problem in Minnesota. On DNR-owned lands in high use areas approximately 3300 diseased or dead elms were removed and disposed of. Butternut canker disease was visually diagnosed throughout nearly the entire butternut range in Minnesota, and it was positively identified in Brown County which placed this disease at the western edge of the butternut range. Oak mortality continued to be a problem in central and southern Minnesota and this oak dieback seemed to be a combination of oak wilt, two-lined chestnut borer, and oak anthracnose.

During 1978, some lingering effects of the 1976-77 drought were still evident, but the significant weather influences were snow and frost. In the Bemidji Region, an early November 1977 snowstorm caused widespread tree damage, and in the Warroad Area approximately 20% of the 5 to 20 year old pine in plantations were lost to snow loading. A late frost in June caused widespread tip dieback of white spruce and balsam fir throughout much of northern Minnesota.

Finally, a white pine pruning study which was started in 1971 in southern Hubbard County was inspected for the fourth time since its establishment. Preliminary observations seemed to indicate that pruning of white pine did reduce blister rust incidence. More significantly, growing white pine as an understory tree seemed to reduce the infection level to the point that a white pine stand can be grown without significant blister rust losses.

INSECTS INFESTING SOFTWOODS

Jack pine budworm — *Choristoneura pinus* Freeman

During 1977 the jack pine budworm caused serious defoliation to approximately 6,500 acres of jack pine west of Bemidji, and isolated incidences of defoliation were observed in Hubbard and Wadena Counties. Because of this, in 1978 an early larval survey was conducted throughout the major jack pine areas in the Bemidji Region. This survey was undertaken to identify areas which would experience defoliation. The greatest and most consistent larval find was in southern and central Hubbard County. Early instar larvae were also found in Beltrami County around the 1977 defoliated area, as well as in Clearwater, Mahnomen and Roseau Counties.

Jack pine defoliation, as predicted by the early larval survey, involved nearly 100% of the major jack pine types south of Red Lake. The heavier defoliated areas covered approximately 53,000 acres with about one-half of the area being in private ownership (see Table 1). No signs of defoliation could be observed from the air in Mahnomen and Roseau Counties, although defoliation had been predicted by the early larval survey. Heaviest defoliation was located in Hubbard County in T. 144 N, R. 34 W; T. 143 N, R. 34 W, and T. 140 N, R. 32 W; in Becker County in T. 142 N, R. 36 W; and in Beltrami County in T. 147 N, R. 34 W.

Moderate to heavy jack pine defoliation also extended into the Brainerd Region. A gross area of about 15,000 acres of 30 to 65 year old jack pine showed signs of budworm infestation. Heaviest defoliation occurred in western Cass County, Wadena County, and parts of Crow Wing County.

In the Cloquet Region, no budworm activity was detected from a general aerial survey of the Region in late June. A follow-up ground survey was also conducted, and jack pine budworm was found at only two survey points. These were at the intersection of State Highways 11 and 1 in Koochiching County, section 31, T. 70 N, R. 26 W and southwest of Perch Lake in St. Louis County, section 21, T. 60 N, R. 21 W. Only incidental populations of budworm were present at these two locations.

TABLE 1

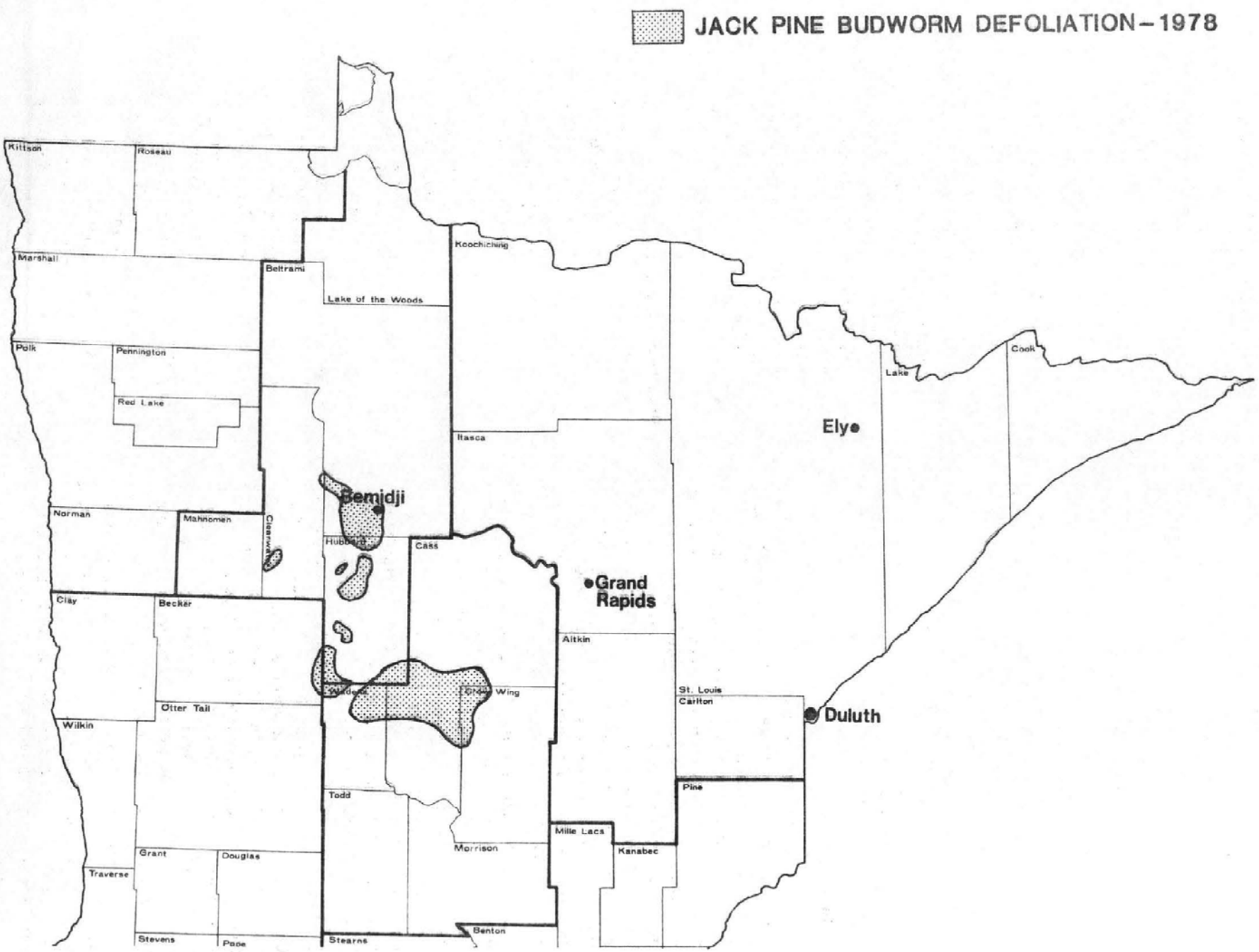
DEFOLIATED JACK PINE ACREAGE IN THE BEMIDJI REGION BY COUNTY AND LAND OWNERSHIP

				Private	
County	Total	State	County	Industry	Non-Industry
Becker	6,200	2,440	380	380	3,000
% of Total	—	39	6	6	49
Hubbard	24,250	2,650	6,900	6,080	8,620
% of Total	—	11	28	25	35
Clearwater	1,250	—	410	790	50
% of Total	—	—	33	64	3
Beltrami	21,300	3,000	11,450	220	6,630
% of Total	—	14	54	1	31
TOTALS:	**53,000**	**8,090**	**19,120**	**7,450**	**18,290**
% of Total	**—**	**15**	**36**	**14**	**35**

Effects of the 1977 Defoliation

In Beltrami County where heavy defoliation was experienced during 1977 (T. 147 N, R. 34 W), only very light defoliation was observed during 1978. Some top-killing was observed and dead branch tips were common, but tree mortality was rare.

There may have been 3 contributing factors to this decrease in budworm activity and absence of tree damage. These factors included a lack of staminate flowers, harvesting of budworm-infested stands, and an abundance of moisture during the growing season. Staminate bud surveys conducted during March of 1978 revealed that staminate buds were


JACK PINE BUDWORM DEFOLIATION – 1978
Kittson
Roseau
Marshall
Beltrami
Lake of the Woods
Koochiching
Polk
Pennington
Red Lake
Itasca
Lake
Cook
Ely
Bemidji
Norman
Mahnomen
Clearwater
Hubbard
Cass
Grand Rapids
Clay
Becker
Aitkin
Wilkin
Otter Tail
Crow Wing
St. Louis
Carlton
Duluth
Pine
Todd
Mille Lacs
Kanabec
Morrison
Grant
Douglas
Traverse
Stevens
Pope
Stearns
Benton

rare in the defoliated areas but common in the lighter to non-defoliated surrounding fringe areas. Defoliation patterns during 1978 seemed to follow closely staminate bud patterns; additional and heavier defoliation occured in the fringe areas where buds were found, but minimal additional defoliation occured where buds were difficult to find.

Harvesting of approximately 300 acres of budworm infested jack pine during the winter months of 1978 was centered in the more severely defoliated areas and may have reduced the amount of heavily defoliated trees in the area. The residual trees which had experienced lighter defoliation could have better tolerated the stress of defoliation without showing signs of dieback. Finally, the abundance of moisture, especially early in the growing season, created ideal survival and growing conditions for the defoliated trees.

Outlook for 1979:

During late summer and fall, egg mass and staminate bud surveys were conducted in the major jack pine types throughout the Bemidji and Brainerd Regions. These surveys were designed to help determine if and where egg masses were being deposited, and to help predict budworm activity during 1979. From the results of these surveys, the number of staminate buds found was minimal indicating a scarcity of primary food for the early instar larvae. Despite these findings, the presence of egg masses indicate that jack pine budworm activity will once again be noticeable in both regions.

Defoliation should involve a similar area in Beltrami County as that defoliated during 1978, but the intensity of defoliation should be diminished. Heavy defoliation is again predicted in Hubbard County, particularly in the Guthrie District. New defoliation should be apparent along the Hubbard-Beltrami County line, and in the Park Rapids District in southern Hubbard County the infestation should spread westward to where lakes and hardwoods break up the jack pine types. In Becker and Clearwater Counties budworm activity should be less than during 1978, but in Becker County jack pine stands ranging between 50 and 65 years of age may experience top-kill and mortality from any additional defoliation. These more susceptible, overmature stands will perpetuate conditions favorable for reoccurring budworm outbreaks.

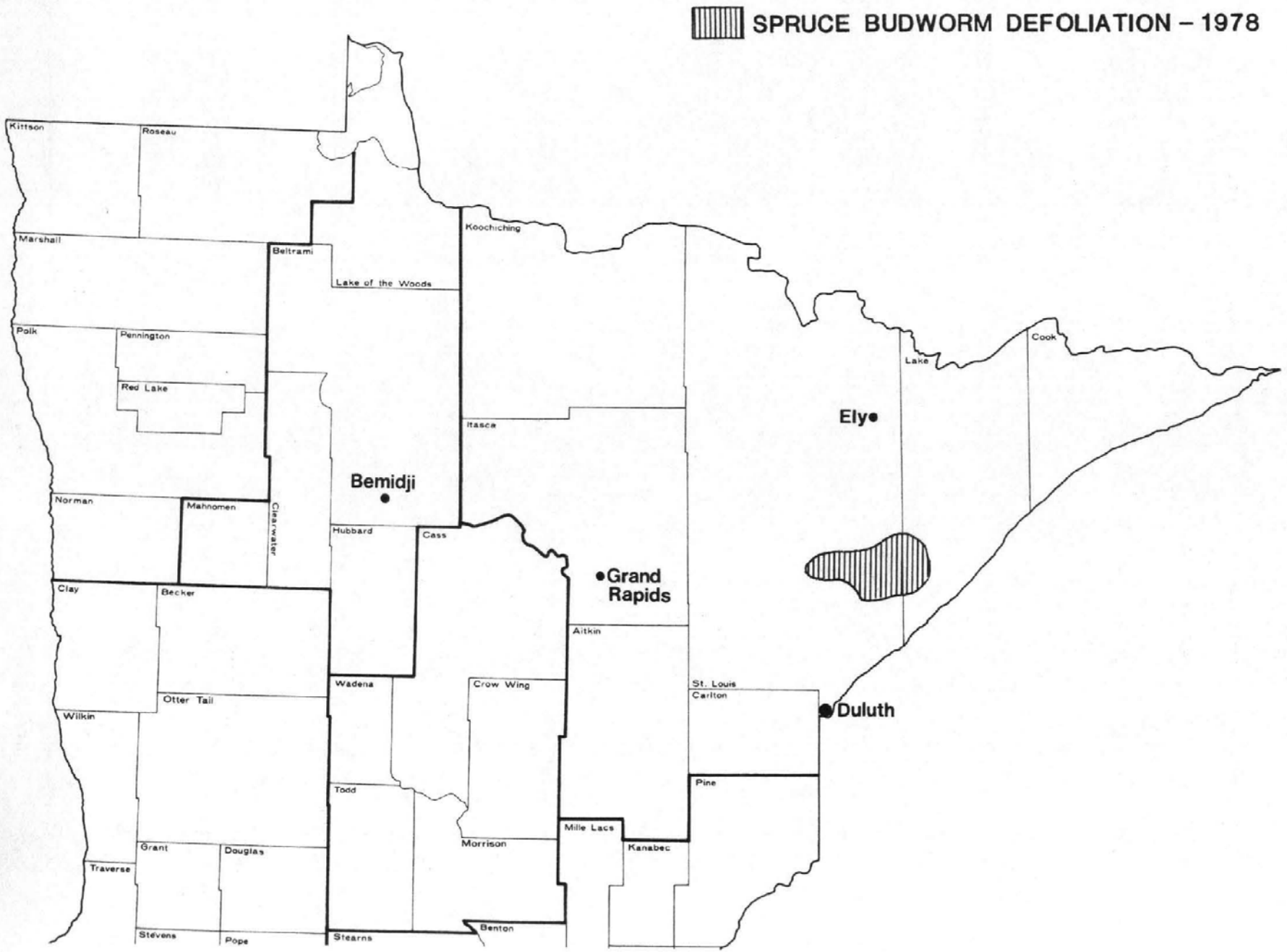
There were two areas in Roseau and Lake of the Woods Counties, T. 161 N, R. 34 W and T. 161 N, R. 36 W, in which the jack pine were found to be bearing heavy staminate bud crops, and jack pine budworm egg masses were present. The occurrence of both staminate buds and egg masses create an ideal condition for a budworm population to build up, and it is predicted that in these two areas noticeable defoliation could occur during 1979.

In the Brainerd Region, egg mass survey results indicate that budworm activity will be less than that experienced during 1978. Jack pine areas in northern Wadena and western Cass Counties should still support high enough populations to cause noticeable defoliation during 1979. Jack pine areas in southern Wadena and Crow Wing Counties will probably experience only light and scattered defoliation. In one area in Crow Wing County, however, egg mass concentrations were heavy enough to indicate moderate to heavy defoliation during 1979. This area centers around sections 9 and 10, T. 136 N, R. 27 W.

In the Cloquet Region, jack pine budworm activity is thought to be on the upswing. The outbreaks in the other two regions and the low level populations of budworm detected in Koochiching and St. Louis Counties indicate a potential for increased budworm activity.

Phenological Notes:

May 23	—	Ninety percent of the staminate flowers were being mined by early instar larvae in numbers ranging from 2 to 20 per staminate shoot (Beltrami County, T. 147 N. R. 34 W).
June 5	—	Larvae were 5 — 6 mm long and were mining new needle fascicles (southern Beltrami County).
June 7	—	Larvae were 5 — 12 mm in length (northern Hubbard County).
June 2—		Larvae ranged in length up to 20 mm (northern Hubbard County).
June 29	—	Larvae had pupated (Becker County).
July 6	—	Infested jack pine areas appeared red from the air.
July 17	—	Fifty percent of the pupae had emerged (southern Hubbard County.)
July 24	—	Both hatched and unhatched egg masses were found (southern Beltrami County).


SPRUCE BUDWORM DEFOLIATION – 1978
Kittson
Roseau
Marshall
Beltrami
Lake of the Woods
Koochiching
Polk
Pennington
Red Lake
Itasca
Cook
Lake
Ely
Bemidji
Norman
Mahnomen
Clearwater
Hubbard
Cass
Grand Rapids
Clay
Becker
Aitkin
Wadena
Crow Wing
St. Louis
Carlton
Duluth
Otter Tail
Wilkin
Todd
Pine
Mille Lacs
Morrison
Kanabec
Grant
Douglas
Traverse
Stevens
Pope
Stearns
Benton

Spruce budworm — *Choristoneura fumiferana* (Clemens)

Defoliation by the spruce budworm was mapped in an aerial survey on June 27, and the majority of the current year feeding was again confined to the Cloquet Valley State Forest. Population levels were rather low, similar to 1977 levels. The defoliation was generally light to moderate but scattered.

Current year feeding damage was noted in a white spruce plantation (section 36, T. 56 N, R. 12 W) in St. Louis County.

Phenological Notes:

June 2 — Larvae were 4 — 10 mm in length and were feeding in newly developed shoots (southern St. Louis County).

June 8 — Larvae were in the 4th and 5th instarts (Cotton District).

July 5 — Both pupae and moths were present (southern St. Louis County).

July 1— Moths were observed still flying (southern St. Louis County).

Outlook for 1979:

Continued low level populations with scattered light to heavy defoliation in the Cloquet Valley State Forest is predicted.

Yellowheaded spruce sawfly — *Pikonema alaskensis* (Rohwer)

Population levels throughout the Bemidji Region were generally at a low level, but in the Cloquet Region high level sawfly populations were present in white spruce plantations having a history of infestations. A white spruce plantation survey conducted in the Blackduck Area in the Bemidji Region showed that in plantations where sawfly defoliation could be detected, numbers of trees showing defoliation ranged between 5% and 80%, although in most plantations the degree of defoliation was low enough to be inconsequential. One Boise Cascade plantation, however, in the Northome District, Section 35, T. 152 N. R. 27 W, Koochiching County, experienced heavy defoliation on at least 50% of the trees. Plans for the 1979 season include expansion of this survey.

In the Cloquet Region, 12 plantations (95 acres total) were sprayed during the week of June 18 — 24 to control the sawfly. Malathion 57% E.C. was applied using mist blowers and hydraulic sprayers. Spraying was recommended only in plantations where mortality of trees could be expected if no control was done, and where practical, only pockets of infestation were sprayed.

Table 2. Plantations sprayed for Yellowheaded Spruce Sawfly in 1978.

District & Location	Date Sprayed	Acres Sprayed	Plantation Size	Year Planted
Sandy Lake				
6-50-23	June 26	6	28	1966
4-50-23	June 26	2	6	1966
23-50-22	June 22,23	24	28	1966
26-50-22	June 23	10	20	1966
McGrath				
4-45-22	June 19	10	31	1966
6-44-22	June 21	2	166	1966
Jacobson				
12-52-22	June 21	12	12	1969-70
Hill City				
36-26-52	June 22,23	12		
Floodwood				
16-54-21		1	19	1967
Cotton				
30-56-16	June 22,23	11	12	1977-78
Int'l Falls				
11-69-24		4	16	1963-65
13-69-23		1	10	1963-68
	Total	**95 Acres**		

After spraying, 100 trees were examined in selected plantations to determine the distribution of sawflies and spray coverage. Trees which were missed during spraying might provide breeding populations in 1979 for possible re-infestation of the plantation.

Table 3.

District	Location	% of trees infested with sawflies in 1978	% of trees infested with live sawflies after spraying
Sandy Lake	26-50-22	66	5
Sandy Lake	23-50-22	82	9
Sandy Lake	4-50-23	88	19
Sandy Lake	6-50-23	82	12
Jacobson	12-52-22	73	14
McGrath	4-45-22	82	2
Hill City	36-26-52	94	15

Data were recorded in several plantations to determine what percent of the trees which were infested this year had both live and dead sawflies on them after spraying.

Table 4

District	Location	Percent of trees infested in 1978 which had both live and dead larvae after spraying
Sandy Lake	26-50-22	0
Sandy Lake	23-50-22	4
Sandy Lake	4-50-23	4
Jacobson	12-52-22	1

It appears that the major carry-over population of sawflies in 1979 will be from trees missed entirely in the spraying, rather than from trees on which part of the sawflies were killed by spraying and part were not killed.

Selected plantations were sampled to determine the damage being done by the sawflies. The drought of 1976 made it difficult to determine the exact cause of death since the drought and sawflies were undoubtedly both involved. Tree mortality varied from 0% to 54%.

Outlook for 1979:

It is very likely sawflies will be at high levels in some plantations again in 1979. Some of these plantations, especially young, open-grown plantations may require spraying to prevent 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).

Sawfly distribution was determined by examining the trees after spraying for presence of dead larvae or for feeding damage. Distribution was probably underestimated because it was easy to overlook feeding damage from a small number of larvae.

Phenological Notes:

May 12 — White spruce buds were just beginning to swell.

May 18 — White spruce buds were still swelling, but they were mostly covered by scales.

May 23 — Yellowheaded spruce sawfly adults were emerging and were ovipositing on spruce needles (Jacobson District).

May 27 — This was the last date adult sawflies were observed ovipositing near Grand Rapids.

June 4 — Some adults were still noted near Jacobson. First instar larvae were also present, but most hatching had not yet occurred.

June 6 — White spruce defoliation was evident in the Bemidji Area.

June 16 — Mostly 3rd instar larvae were found with some 2nd and 4th instars also present (Jacobson District).

June 18-24 — Sprayed for sawflies.

July 14 — Mostly larvae were cocooned, but some 5th instar larvae were still feeding.

July 19 — Incidental 5th instar larvae were still found.

Introduced pine sawfly — *Diprion similis* Hartig

Populations of this sawfly remained at a low level throughout Minnesota during 1978. A few larvae were collected in Aitkin and northern Pine Counties, but no defoliation was observed. An occasional sawfly larva was observed in Hubbard and Beltrami Counties on jack pine while conducting jack pine budworm surveys. Low numbers of cocoons were found in a natural understory stand of white pine in section 7, T. 141 N, R. 32 W, Hubbard County, but little defoliation was detected. Heavy defoliation was reported by USFS Foresters working out of the Cass Lake District on the Chippewa National Forest. They reported moderate to heavy defoliation in a natural white pine stand growing on the north shore of Leech Lake in Cass County. A few larvae were found on October 30th, and cocoons were common.

Outlook for 1979:

Visible defoliation should occur again in the Cass Lake area. Elsewhere in the State, scattered low level populations causing very light defoliation should occur.

Larch sawfly — *Pristiphora erichsonii* (Hartig)

Light infestations were noted in northwestern Aitkin County and Central St. Louis County in the Cloquet Region, but populations were low enough to cause little concern. In the Bemidji Region, the only observed defoliation was to a two acre planting of tamarack on high ground just north of the Badoura Nursery in Hubbard County, section 9, T. 139 N, R. 32 W. Larch sawfly caused nearly 100% defoliation of this stand for the second consecutive year. On July 26th cocoons were collected from under the trees, and at that time the trees were beginning to refoliate.

Outlook for 1979:

Continued low level populations throughout the State are expected, but heavy defoliation will again occur in the Badoura Nursery area.

Pine tussock moth — *Dasychira plagiata* (Walker)

For the first time, tussock moth larvae were found in the Bemidji Region northwest of Bemidji in T. 147 N, R. 34 W. In mid-July a cocoon was found in section 29 T. 148 N, R. 35 W. Although these finds represent a very low population, its presence in northwestern Minnesota is somewhat unusual and bares closer scrutiny during the 1979 growing season.

In the Brainerd Region, populations of the pine tussock moth increased greatly with light defoliation noted in jack pine in the S1/2 of section 25, T. 45 N, R. 20 W and in section 36, T. 45 N, R. 20 W in the General Andrews State Forest in northern Pine County.

An egg mass survey was conducted in August to predict population levels in 1979. At each sample plot three trees were examined and the number of tussock moth egg masses in an "arm sweep area" of each tree was recorded.

Plot Location	No. of Egg Masses/Tree "(Arm Sweep Area)"
SESW, 25-45-20	4.3
W1/2NE, 25-45-20	0.0
I35 Wayside, 25-45-20	0.3
SESE, 25-45-20	0.0
NWSW, 19-45-19	1.6
SE, 18-45-19	0.0
NENE, 24-45-20	0.3
Dago Lake Campsite, 30-45-19	0.3
SE, 30-45-19	0.0
SW, 29-45-19	0.0
1-44-20	0.3
6-44-19	0.0
SW, 12-45-20	0.3

Outlook for 1979:

Although few egg masses were found, the possibility exists of the population developing to the point where localized top killing of jack pine is possible.

Phenological Notes:

July 18 — Cocoons were common, but some later instars were observed still feeding. (Pine County)

July 2— Moths were beginning to emerge from collected cocoons. (Pine County)

Pine Engravers — *Ips Sp.*

Bark beetle activity throughout the state was generally at a low level during 1978. The above average rainfall received during the growing season was probably the major contributing factor to the lack of bark beetle signs. No bark beetle signs were observed in the defoliated jack pine west of Bemidji, but a private campground in Becker County did continue to lose sawlog-size red pine to beetle attacks. The normal campground activities occurring on the ground around the trees may well have disposed the trees to beetle attacks for the second year.

In the Cloquet Region bark beetle activity was also low after a build up of activity in 1977. The build up had occurred in jack pine which had been killed by the drought of 1976. The area affected covered from R11 W to 19W, and from T64N north to the Canadian border. The dead trees occurred in scattered pockets over the area and commonly occurred on rocky hilltops. Fifteen to 30% of the jack pine in these pockets were dead. Late in 1977 some bark beetles started to move from the dead trees to living trees.

Plots were established to monitor additional mortality caused by bark beetles moving into the living jack pine. Three percent additional mortality occurred during the 1978 growing season. Bark beetle populations were greatly reduced when compared to the 1977 levels, although wood borers were still very active in the dead trees.

Outlook for 1979:

Continued low level bark beetle activity throughout the State; however, no additional tree mortality due to this activity should be experienced in drought affected jack pine stands in the Cloquet Region.

Pine spittlebug — *Aphrophora parallela* **(Say)**

High levels of nymphs were noted on jack pine in both the Bemidji and Cloquet Regions, but no branch flagging was observed. In the Rochester Region, a 100 acre, 20 year old Scotch pine plantation in Winona County was infested with this spittlebug. In late June in both thinned and unthinned areas of the stand, there was noticeable dripping of spittle from branches with 10 to 15 spittle masses per 2-foot branch sample. By mid-July adult spittlebugs were feeding, and flagging had become noticeable in the lower half of the crowns. In late September adults had ceased their feeding. The amount of flagging at this time had increased, but it did not appear great enough to cause tree mortality. This spittlebug population may have built up in response to the preceding drought years.

Outlook for 1979:

No predictive surveys were conducted; hence, no estimation of population trends were made.

INSECTS INFESTING HARDWOODS

Aspen Defoliation

During 1978, approximately 5 million acres of aspen were defoliated to some degree in the State of Minnesota. Widespread severe defoliation was caused by the forest tent caterpillar, and the aspen leaf roller caused lighter defoliation also over a large area. Minor, localized defoliation was caused by the aspen leaf tier and the large aspen tortrix.

Forest tent caterpillar — *Malacosoma disstria* **Hubner**

In the Bemidji and Cloquet Regions severe defoliation was experienced over a large area as shown on the map. Except for red maple, complete stripping of all trees, understory shrubs, and herbaceous plants had occurred by the second week in June. Heavy populations of larvae in these severely defoliated areas were particularly bothersome to homeowners, both rural and urban, when FTC larvae stripped ornamental trees and shrubs, fed upon garden plants, and dropped on cars, houses and people. In the Bemidji Area which experienced only scattered, light defoliation, FTC preference seemed to be hardwoods other than aspen with red oak, green ash and sugar maple being fed upon.

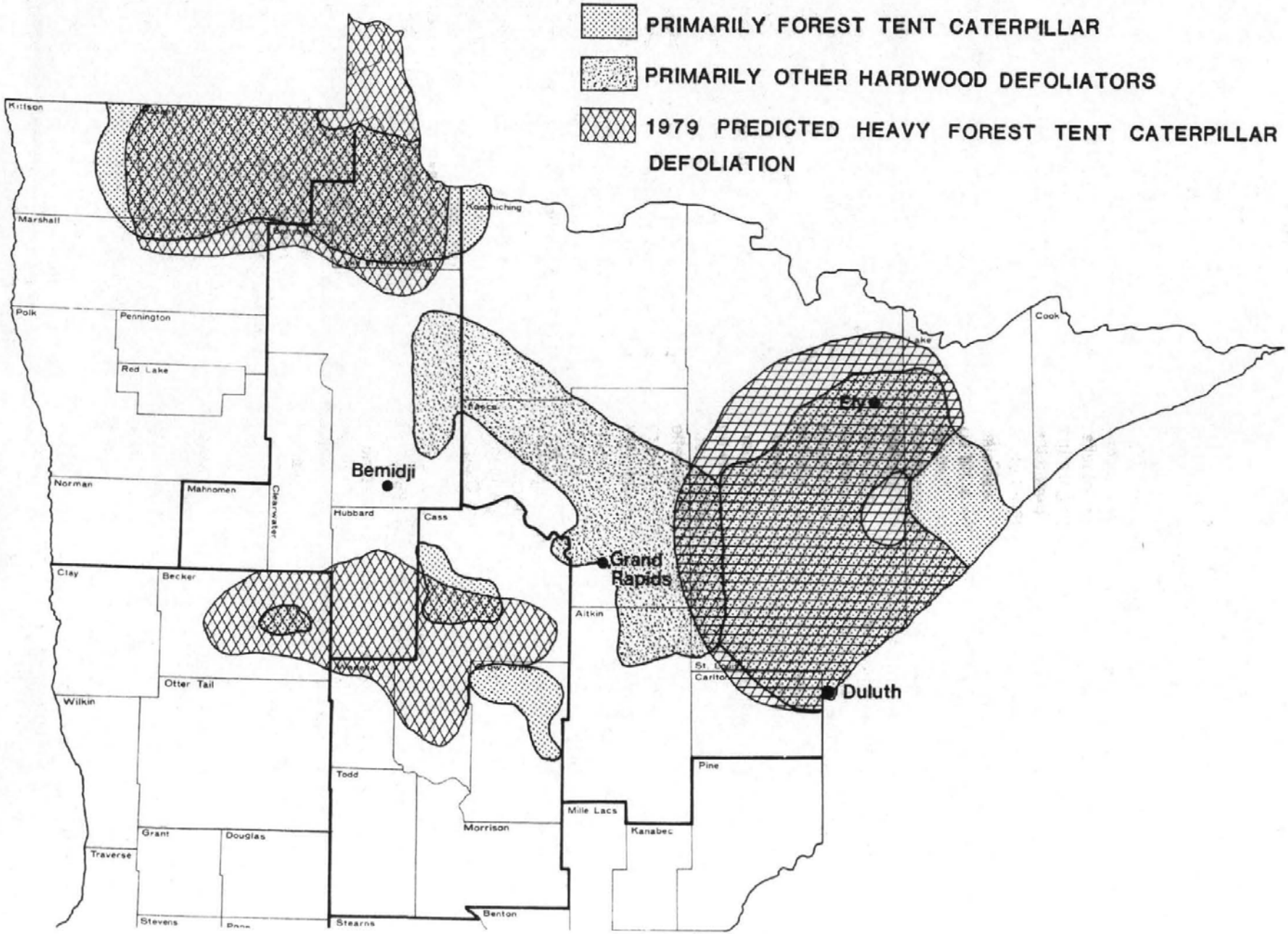
In the Brainerd Region, FTC populations increased over the population levels of 1977, and this increase resulted in areas of localized defoliation throughout the Region. There was one area north of Walker which experienced defoliation as severe as that experienced in the northern two regions. An area from Cross Lake to Crosby was affected by large numbers of caterpillars, but defoliation was not heavy for the most part.

Outlook for 1979:

Areas predicted by an egg mass survey to experience severe defoliation are outlined on the map. It must be remembered, however, predictions based solely on egg masses can be drastically altered by weather, parasites and larval diseases. The longer a population is active in an area, the greater the chances are for parasite and disease build up to occur. Therefore, it takes a greater number of egg masses each year to support the same population level as the previous year. Also, it has been observed in the past that the percentage of egg masses hatching in the spring decreases as previous winter temperatures approach -40°F (communication with Harold Batzer, Entomologist with the North Central Forest Experiment Station, St. Paul).

ASPEN DEFOLIATION 1978

MODERATE-HEAVY DEFOLIATION OF ASPEN AND OTHER HARDWOODS



Phenological Notes:

April 29	—	Aspen flowering (Cloquet).
May 10	—	Aspen buds were beginning to break, and larvae were beginning to emerge from egg masses (Cloquet).
May 18	—	Larvae were mostly 5 mm long at Cloquet, but egg masses were just beginning to hatch in Roseau County.
May 22	—	Larvae were mostly 8 mm long at Cloquet.
May 26	—	Larvae were mostly 10 to 12 mm in length at Cloquet. Defoliation was becoming apparent in Becker County.
May 30	—	Defoliation by FTC was becoming quite apparent with some aspen showing complete defoliation. Larvae were approaching 2 cm in length in the Cloquet Valley State Forest.
June 5	—	Larvae were moving across roads looking for new food sources at Cloquet.
June 10	—	First larvae were spinning cocoons, but most were still feeding (Cloquet).
June 30	—	Most larvae were in the pupation stage, but some feeding late instar larvae were observed.
July 5	—	First moths were observed. Aspen was beginning to refoliate in the Cloquet Valley State Forest.
July 11-13	—	Major moth emergence was occurring.
July 19	—	Moth flight was subsiding with many egg masses observed (Cloquet).

Aspen leaf roller — *Anacampsis innocuella* **(Zeller)**

In the Cloquet Region, the increased population of leaf rollers accounted for much of the defoliation to aspen in Aitkin, Itasca, and western St. Louis Counties but was a minor aspect of defoliation in Carlton County. Leaf rollers were also present in Cook County, though at a very low level causing minor defoliation.

In the Bemidji Region, a high incidence of leaf rollers was observed in Beltrami, Cass, Hubbard, and Becker Counties with heavy populations occuring in a north-south band of Townships from T. 156 N to T. 148 N, and from R. 30 W to R. 32 W. Sixty to 80 percent of the aspen observed along roadsides showed rolled leaves. Despite this high incidence of leaf rollers, very few leaves actually dropped, and little damage to the trees was observed. There was a definite line between the major forest tent caterpillar defoliation area and the area of leaf roller activity. This line was the approximate boundary between Beltrami and Lake of the Woods Counties.

Aspen leaf tier — *Enargia decolor* **Walker**

Populations and distribution of this defoliator increased from 1977 in northern Aitkin, Carlton, southeastern Itasca, and southern St. Louis Counties in the Cloquet Region. Damage was insignificant, however.

Large aspen tortrix — *Choristoneura conflictana* **(Walker)**

Low populations were observed in the Cloquet Region, but not elsewhere in the State. It was collected only occasionally in Cook County.

Outlook for these 3 defoliators during 1979:

No predictive surveys were conducted; hence, no estimation of population trends were made.

Gypsy Moth — *Lymantria dispar* (L).

The gypsy moth is an introduced insect that has become one of the most destructive forest pests in the country. Though it's worst damages are concentrated in the New England states, the gypsy moth has become established in small pockets in Michigan and Wisconsin in recent years. It becomes increasingly is more likely that this insect will move into Minnesota. The gypsy moth is often carried long distances by hitchhiking on the exterior and undersides of motor homes and trailers. The larvae of the gypsy moth feed on the foliage of both hardwoods and conifers, but hardwoods are more preferred.

A cooperative effort to monitor this insect in Minnesota is conducted each summer by the USDA, Minnesota Department of Agriculture and the DNR, with aid from the National Campers and Hikers Association. Small, cardboard traps, containing a pheromone which attracts the moths, are placed in wooded areas throughout the state. Approximately 11,000 traps were placed in Minnesota this year. One gypsy moth was collected near Mantorville in Dodge County in a trap set by the USDA Animal and Plant Health Inspection Service. They believe this one moth was a "hitchhicker" but will be following up with intensive local trapping for the next three years at a rate of 1 trap per 3 square miles.

Outlook for 1979:

Only a few rare hitchhiking moths are expected in the state.

INFECTIOUS DISEASES

Softwood Diseases

Scleroderris canker and dieback — *Gremmeniella abietina* (Lagerb.)

The occurrence of this disease was again confined to the Cloquet Region, primarily along the north shore area of Lake Superior. In addition to Scleroderris-infected plantations identified in 1977, a plantation located in section 19, T. 65 N, R. 13 W., was also found to have this disease present. It is believed, however, that the less virulent North American strain of the fungus is the pathogen causing infection in all of these plantations.

Scleroderris canker continued to cause concern in the northeastern United States and in south eastern Canada where the more virulent European strain is present. In New York this disease has been found in 12 counties, and approximately 50,000 acres of red and Scotch pine have been affected. In 1977 there were 3 plantations in Vermont infected with Scleroderris, but during 1978, 35 plantations in 9 counties were identified despite eradication measures undertaken in 1977. A plantation in Quebec and one in New Hampshire were also newly diagnosed as being infected during 1978. Since this disease can be disseminated on nursery stock, quarantines have been enforced in New York, Vermont, Canada, and by the United States Department of Agriculture (1, 2).

Outlook for 1979:

The North American strain should continue to be of minor importance in the Cloquet Region. The introduction of the European strain into Minnesota is always possible and may eventually be inevitable. Continued vigilance by the FIDM personnel and the local land managers is imperative, and reducing the percentage of red pine being planted is strongly recommended.

(1) Nicholls, T.H. Scleroderris canker in conifers. Amer. Christmas Tree J. 23 (1): 23-26. 1979.

(2) Skilling, D.D. Tree diseases-Scleroderris canker-a threat to pines. McGraw-Hill Yearbook of Science and Technology. 1978. p. 367-369.

Diplodia tip blight — *Diplodia pinea* (Desm.) Kickx

Incidences of this disease in the Bemidji Region were less than during 1977, and disease occurrence seemed to be drought related. Plantation surveys conducted in Roseau and Lake of the Woods Counties did detect this disease, but it was of minor importance. Damage was confined to a few lower branches and scattered dead buds and shoots.

Many red pine plantations in the Cloquet Region were infected with this tip blight fungus with a stunting and browning of shoots occurring in pockets within the plantations. The disease often appears to be most severe on young trees planted near large old red or jack pines left standing on the site. Very little mortality was observed during 1978, but stunting and killing of shoots were common.

In 1977 in the Brainerd Region, this fungus was found infecting red pine plantations in Cass, Wadena and Crow Wing Counties. Permanent plots were established to measure the spread of the disease. In the heavily infected plantations, *very little* new infection was found which was a similar observation to other states where Diplodia had been a problem during the drought of 1976-77. Thus, the assessment made by the U.S. Forest Service pathologists that Diplodia outbreaks were related to stress situations appeared to be accurate.

Diplodia tip blight was found on nursery stock in both state nurseries. The 2-2 transplants were the most heavily infected stock, but 2-0 and 3-0 seedlings also showed some infections at the General Andrews State Nursery. Researchers at the North Central Forest Experiment Station are working with the DNR in evaluating the disease and developing chemical control techniques.

Outlook for 1979:

It is anticipated that this disease will continue to decline in importance as precipitation patterns remain normal. This disease still remains as a potential problem on nursery stock and may be a problem until chemical controls are developed.

Rhizosphaera needlecast — *Rhizosphaera kalkhoffii* Bub.

Rhizosphaera needlecast was found damaging the lower branches of blue and white spruce in a Christmas tree plantation in the New Ulm Region, in Martin County, section 13, T. 102 N, R. 31 W. Samples were cultured by the North Central Forest Experiment Station personnel and positively identified. Needles infected the previous year had a purple cast, and the fruiting bodies of this fungus appeared in the normally white stomata as black, fuzzy dots.

Outlook for 1979:

Isolated incidences of this disease will continue to be encountered throughout the State, and this disease can be a minor nuisance to Christmas tree growers.

Naemacyclus needlecast — *Naemacyclus sp.*

Two Christmas tree plantations near Sunrise, Minnesota in the Brainerd Region were found to be infected with this disease. Scotch Highland and some

of the other long-needled Scotch pine varieties are susceptible to *Naemacyclus* infection while showing resistance to Lophodermium needlecast. Symptoms of Naemacylus needlecast are similar to those of *Lophodermium* infection, but disease development is less severe. Fruiting bodies of the fungus form on the lower sides of the needles and are elliptical, waxy and brown to white in color.

Outlook for 1979:

Since the longer needled varieties of Scotch pine are more resistant to winter burning, increased plantings of these varieties can be expected thereby creating a possible increase in the incidence of this disease.

Shoestring root rot — *Armillariella mellae* (Vahl. ex Fr.) Karst

This disease was observed killing pine and spruce in plantations throughout the state although the numbers of tree being killed were small. In the Bemidji Region, this disease continued to be present in most red pine plantations under 6 feet in height and was the leading cause of tree mortality. Similar to the other two regions, however, mortality was generally less than 5% of the trees in the plantations, and it is anticipated that disease incidence will lessen as the trees grow taller. Permanent plots were established in root rot centers to monitor the spread of the disease.

Outlook for 1979:

This disease will continue to be evident in young plantations, particularly on former hardwood sites which have been treated with herbicides. Disease incidence also is associated with stress conditions, and therefore normal precipitation patterns should reduce disease incidence.

Dwarf mistletoe — *Arceuthobium pusillum* Peck

During fiscal year 1978, $8,000 was spent for the control of dwarf mistletoe on selected black spruce timber sales in the Cloquet Region. This money was used to cut down residual spruce after harvesting was completed. The following is a summary of this control program:

Total Acres Treated	339
Total Number of Sites Treated	16
Average Cost per Acre	$22.93
Average Number of Acres per Site	21

Most black spruce timber sale contracts in both the Bemidji and Cloquet Regions now include a clause which states that the logger must cut down or kill all trees five or more feet in height. This practice eliminates almost all of the infected stems which should enable a commercial stand of spruce to develop on sites that might have otherwise been lost due to mistletoe.

In some cases of heavy mistletoe infection, it will be necessary to use other control methods such as fire. It is just as important to make sure that a dense stand of black spruce is regenerated as it is to eliminate mistletoe infected trees. The key to reducing mistletoe damage is preharvest planning because after the site is harvested, it may be too late or too costly to treat the site.

The effects of logging on mistletoe control continued to be monitored through the establishment of permanent plots in mistletoe infected pockets of black spruce designated for harvest. During 1978, 2 plots were established in Roseau County and one plot in Koochiching County in the Bemidji Region, and 3 additional plots in Koochiching County in the Cloquet Region were established.

Outlook for 1979:

Little change in disease incidence and severity due to the long rotational ages of black spruce and the slow spread of the disease. A long range trend should be for a decrease in this disease as management intensifies through proper harvesting and use of prescribed burning.

Dutch elm disease — *Ceratocystis ulmi:* (Buism)

Dutch elm disease continued to be the major shade tree problem in many urban areas throughout Minnesota. The DNR's involvement with this disease included removal and disposal of infected elms on high use areas of DNR—owned lands. The following table summarizes the diseased tree removals in the New Ulm and Rochester Regions on DNR lands by private contractors.

REGION	TREES REMOVED	COST	COST/ TREE
New Ulm	760	$19,522	$26
Rochester	1,076	$31,778	$29

In addition to the contracted removals in the New Ulm Region, diseased elms were also removed through timber sales in two state parks and two public access areas. The total revenue from these sales was $2,358.90, and total sale volumes were 71.13 MBF.

In the Brainerd Region, 1,470 elms were removed in the following areas:

LOCATION	No. of TREES REMOVED
Father Hennepin State Park	566
Kathio State Park	160
Lindberg State Park	150
St. Croix State Park	70
Banning State Park	54
Wild River State Park	37
Interstate State Park	125
Region 3 Wildlife Management Areas	200
Region 3 Public Access Sites	108

The average cost of removing and disposing of these elms was $35.37 per tree which was a slight increase over 1977's costs.

In addition to these removals, 47 diseased elms in Lake Carlos and 10 diseased elms in Itasca State Parks were removed and disposed of during the late winter—early spring period of 1978. Twenty-three new cases of DED were identified in Lake Carlos State Park, and $2,000 of Shade Tree Disease money was transferred to the Division of Parks to remove and dispose of these trees.

Outlook for 1979:

Continued increase in this disease will occur Statewide.

Butternut canker — *Siroccus* sp.

A decline of butternut has been observed in Minnesota for several years. The symptoms of this decline include extensive trunk and branch cankering with a resulting dieback of the crown. Trees succumb after several years of progressive deterioration. The organism responsible for this disease has been identified as a fungus in the genus *Sirococcus,* but the species has not yet been identified.

A survey of this disease in 1976 had found the disease to be present in six southeastern counties, but in 1978 the disease was visually diagnosed throughout most of the southern range of butternut in Minnesota. Samples from an infected stand in Brown County, section 28, T. 111 N, R. 32 W, were analyzed by the Department of Plant Pathology, University of Wisconsin and found to contain the *Sirococcus* fungus. Therefore, the *Sirococcus* fungus had reached the western edge of the butternut range in Minnesota. Additional samples had been obtained from diseased stands in Mower, LeSeur and Blue Earth Counties and were being analyzed for *Sirococcus.*

Black walnut is closely related to butternut, and there is concern that the disease will also infect black walnut. Thus far this has not been the case even when black walnut was found growing in among diseased butternuts. However, artificial inoculations have produced progressive and fatal cankers on black walnut saplings especially when under stress.

Outlook for 1979:

Continued butternut mortality is expected to occur over the entire range of butternut in Minnesota.

NON-INFECTIOUS DISEASES

Maple Decline

Sugar maples showed a general decline throughout southern Minnesota. Crown dieback, death of an entire portion of the crown, and complete tree mortality were observed in ornamental sugar maple plantings in virtually every city and town. These symptoms may have been drought related as maples prefer a moist site and react strongly to drought, or the trees may have been infected by the Verticillium wilt fungus, *Verticillium albo-atrum* Reinke & Berth. Sugar maples in campgrounds and picnic areas were showing the same symptoms as the urban trees. These symptoms were normally not observed in forested areas. However, in Helmer Myre State Park near Albert Lea, the maples in both the picnic and adjacent forested areas showed the same dieback symptoms.

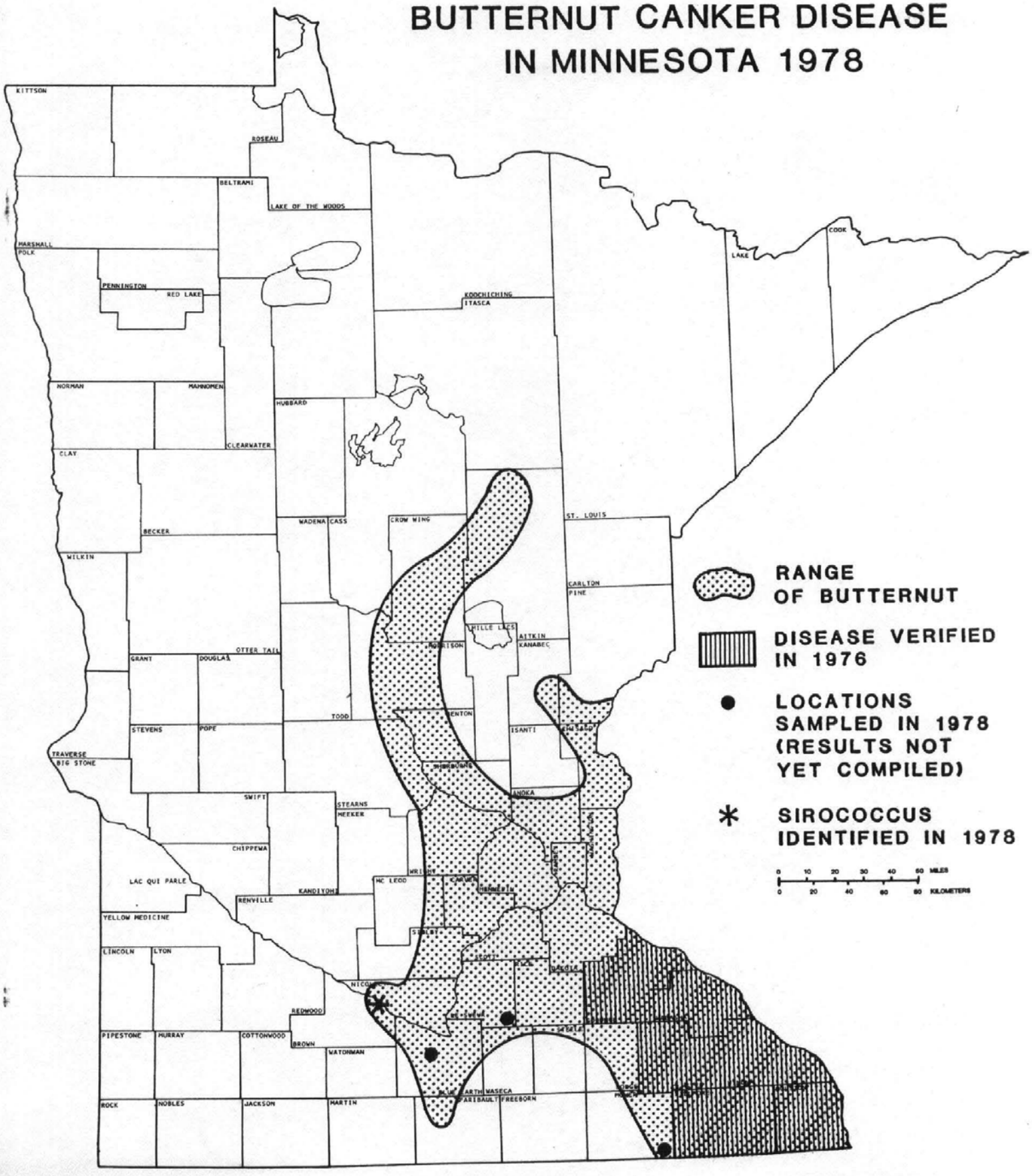
Outlook for 1979:

Continued decline symptoms on maples planted off site such as those sites encountered in urban situations will occur.

Snow Damage

In the early part of November 1977, a severe snowstorm with heavy, wet snows and high winds blanketed northern and central Minnesota. The effects of this storm became evident after the snow had melted. The weight of the snow combined with the high winds permanently bent over many pines in both planted and natural stands. Most trees continued growing during 1978, and at the end of the growing season the trees remained bent over but with upturned leaders. Heaviest damage seemed to be in the Beltrami Island State Forest in Roseau, Lake of the Woods and Beltrami Counties, although similar damage was noted throughout the Bemidji Region. The Warroad Area Forester estimated that at least 20% of the 5 to 20 year old trees in red and jack pine plantations were lost to snow loading. Losses, however, were not confined to these age classes; mature timber also went down under the weight of the heavy snow.

BUTTERNUT CANKER DISEASE IN MINNESOTA 1978



Frost Damage

On June 8th, early morning temperatures dipped into the 20's north of a line running from Blackduck to Hibbing. In July the current year shoots of white spruce began to droop, turn purple, and later turn brown. In some plantations 100% of the trees showed these symptoms although, generally, trees with drooping terminals were found to be scattered throughout the plantations. In the Bemidji Region, this frost damage was observed as far south and east as Cass Lake, but heaviest damage occurred in Roseau and Lake of the Woods Counties where nearly 100% of the white spruce plantations were affected. In the Cloquet Region, tip dieback on balsam fir as well as white spruce occurred, particularly north of Hibbing.

MISCELLANEOUS

Oak Mortality

Oak wilt disease — *Ceratocystis fagacearum (Bretz) Hunt*
Two-lined chestnut borer — *Agrilis bilineatus (Web.)*
Oak anthracnose — *Gnomonia quercina Kleb.*

Oak wilt has been a perennial problem throughout the oak areas of southern and central Minnesota, but in the Brainerd and Metro Regions during 1978, this disease did not appear to account for much of the oak mortality experienced. No new infections were found north of Minnesota Highway 95. South of this highway, the two-lined chestnut borer and the oak anthracnose fungus were found, and these two pests seemed to be the source of the oak problems rather than oak wilt disease. Abundant rainfall and humidity in June resulted in widespread occurrence of anthracnose on white oak. Disease severity ranged from minor leaf spotting to complete defoliation in Sherburne, Morrison, and Benton Counties.

In Southern Minnesota, scattered pockets of oak mortality continued to occur. The primary cause appeared to be oak wilt and the severe drought of 1976—1977. From data based on forest inventory plots, it was concluded that 16% of the plots in the oak forest type showed cluster-type oak mortality similar to the mortality patterns caused by oak wilt disease.

There did not appear to be any significant spread of oak wilt west of its established range in south central Minnesota. Two cases of interest occurred in Faribault County, an area in which oak wilt was not previously known. A positive culture result was returned by the University of Minnesota Plant Disease Clinic from bur oaks sampled in Pilot Grove Township, W1/2SE1/4 of section 3, T. 101 N, R. 28 W. Another site in Faribault County south of Winnebago, section 11, T. 103 N, R. 28 W, had several acres of dying bur oak. Symptom range included varying degrees of crown dieback to complete mortality. Isolations made from this stand did not yield the oak wilt fungus. The conclusion was that mortality resulted from drought and attack by the two-lined chestnut borer which had been found working in the main trunks.

Oak anthracnose was also very common on white oaks in southeastern Minnesota, again related to the abundant precipitation received in May and June. Some pockets of oak were observed severely defoliated, but most trees were able to reflush with a replacement set of leaves by mid-summer.

In the Cloquet Region, 5 northern red oaks northeast of Sandy Lake in Aitkin County were found to be infested with the chestnut borer, and mortality is expected by the summer of 1979. There were many oaks in the Sandy Lake area with unthrifty tops. It was possible that stress due to drought and human activity predisposed the trees to attack by the two-lined chestnut borer.

Phenological Notes:

June 9 — Larvae were present under the bark in Aitkin County.
June 14 — 28: Adults were active in Aitkin County.

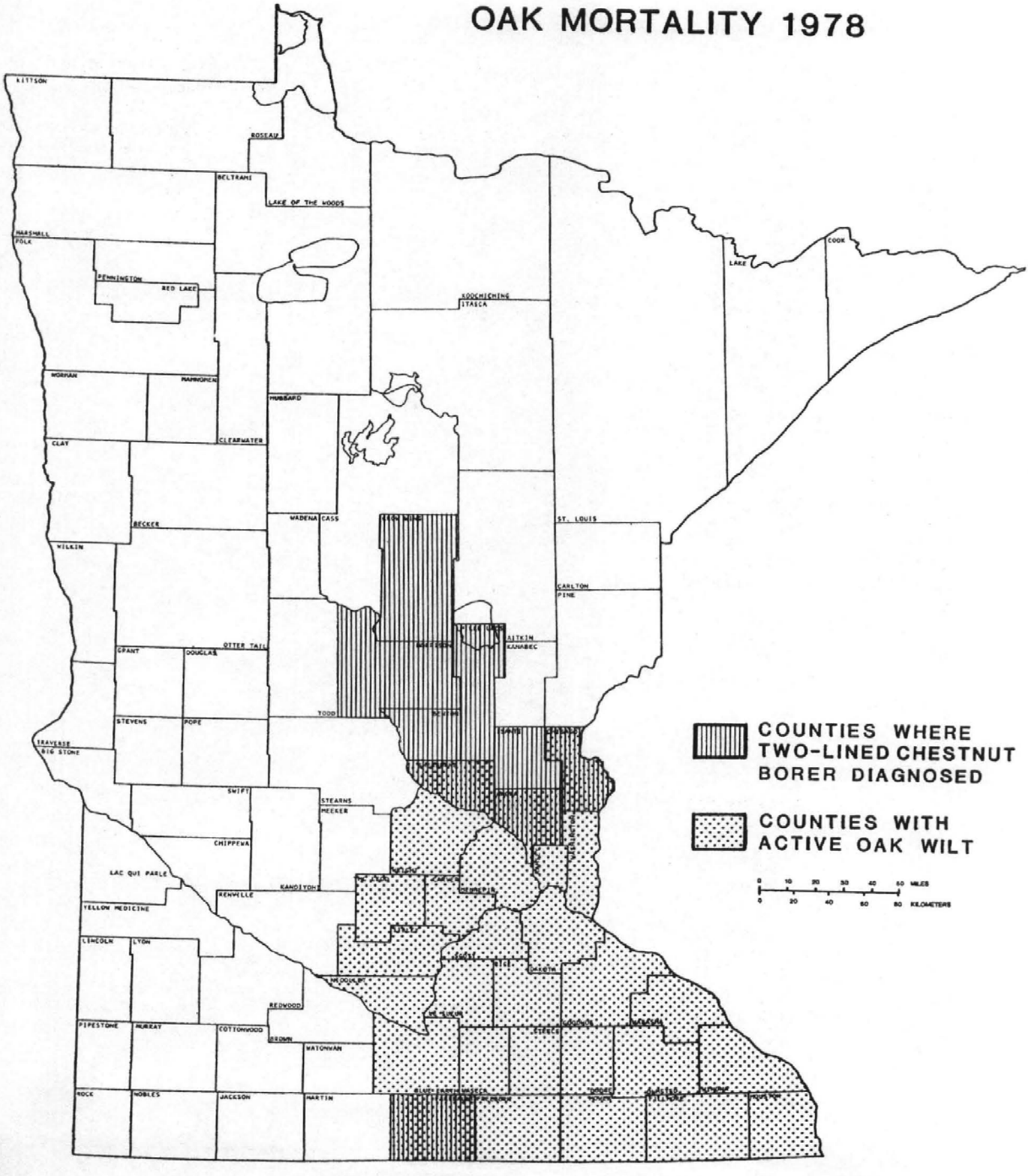
Outlook for 1979:

Oak wilt will continue as a major mortality—inducing factor in oak stands in southeastern Minnesota. The occurrence of two-lined chestnut borer should decrease as the effects of the 1976—77 drought diminish. Oak anthracnose will again be present during 1979 and should be common if moisture is abundant early in the growing season.

White Pine Pruning Study

In 1971 an area of natural growth, understory white pine located in the Paul Bunyan State Forest, section 7, T. 141N, R. 32W, was included in a study to evaluate the effects of pruning on white pine blister rust incidence and severity. Two areas were laid out in which trees were permanently marked and numbered, with the two areas separated by a "buffer" zone in which no trees were involved in the study. One area contained 877 trees ranging in DBH from .5 inch to 5.8 inches with the majority of the trees in the 1 to 3 inch diameter range. This was the pruned area in which the basal one-third to one-half of the live crowns were removed from each of the 877 trees during the fall of 1971. The other area, the unpruned area, contained 756 trees of similar diameter classes. When a branch canker was discovered in

OAK MORTALITY 1978



the pruned area, it was generally removed. No pruning or other cultural work were carried out in the unpruned area.

The stands were inspected for new canker infections, canker growth, canker death and tree mortality in 1971, 1973, 1975, and 1978. Cumulative results up to and including 1978 are listed in Table: 5.

The study will continue with readings scheduled to take place every 2 years. The results so far indicated that a difference did exist between the pruned and the unpruned areas. The yearly loss from blister rust in the pruned area was approximately 40% of the loss in the unpruned area, and the percentage of trees in the pruned area with cankers was slightly more than 50% of the number in the unpruned area. Since both areas were close to each other and influenced by the same biotic and nonbiotic factors, it was concluded these differences resulted from pruning.

The yearly mortality rate from blister rust was very low in both the pruned and unpruned areas, and this yearly loss rate should decline as the trees grow in height. Height growth will cause the lower branches to die from suppression thereby reducing the target area for new infections since "most blister rust cankers in the Lake States occur within 9 feet of the ground. . ."(1).

Preliminary observations from this study seem to indicate that in northwestern and central Minnesota growing white pine on similar sites as the study area and as an understory tree should be a fairly safe practice from a blister rust standpoint. Suppression, however, does seem to be the leading cause of non-blister rust mortality. Cultural recommendations would have to be refined so that the trees are released before suppression losses occur but still maintain the protective microenvironment against blister rust and white pine weevil which an overstory seems to provide.

(1) Nicholls, Thomas H., and Robert L. Anderson,1977. How to identify white pine blister rust and remove cankers. North Central For. Exp. Sta., For. Serv., USDA. 8p.

Table 5 — Summary of the White Pine Pruning Study

	Unpruned	Pruned
No. trees dying from all causes, 1971—78	96	89
% mortality	12.7%	10.1%
No. trees dying from blister rust, 71—78	78	54
% dead trees dying from blister rust	81.3%	60.7%
% of all trees sampled dying from blister rust	10.3%	6.2%
Yearly % loss from blister rust over 7 years	1.5%	0.9%
No.of live trees with cankers	477	276
% of sample trees with cankers	63.1%	31.5%

PLANTATION SURVEY

Conifer plantations were surveyed for insect and disease problems in the Cloquet Region during the 1978 growing season. Table 6 is a summary of that survey:

LOCATION	YEAR PLANTED	SPECIES	PEST PROBLEM	% OF TOTAL PLANTATION
29-46N-25W	1963	Red pine	Diplodia tip blight	5
14-50N-17W	1966	Red & Scots p.	NONE	—
16-61N-22W	1967	Red pine	Needle droop= herbicide & drought	5
16-61N-22W	1966	Red pine White spruce	Needle droop	10
16-61N-22W	1967	Red pine White spruce	NONE	—
26-62N-23W	1958	Red pine	NONE	—
26 & 27-62N-23W	1964	Red pine	Diplodia tip blight	20
27-62N-23W	1963	Red pine	Diplodia tip blight	10
26 & 27-62N-23W	1962	Red pine	Diplodia tip blight	10
26-68N-21W	1969	Red pine White Spruce	NONE	—
26-68N-21W	1971	White Spruce	NONE	—
15 & 22-67N-21W	1972	Red pine White Spruce	Diplodia tip blight	25
15 & 16-67N-21W	1970	Red pine Black Spruce	Diplodia tip blight	20
33-147N-25W	1972	White Spruce	Yellowheaded spruce sawfly	75
11-146N-26W	——	———	Yellowheaded spruce sawfly	5
15-146N-26W	1965	White & Bl. Spruce	NONE	—
17 & 20-146N-26W	1967	Red pine White spruce	Armillaria root rot	1
24-147N-27W	1971	Red pine White spruce	Diplodia tip blight	35
4-147N-27W	1966	Red pine	Diplodia tip blight	25
5-147N-27W	1966	Red pine	Diplodia tip blight	25