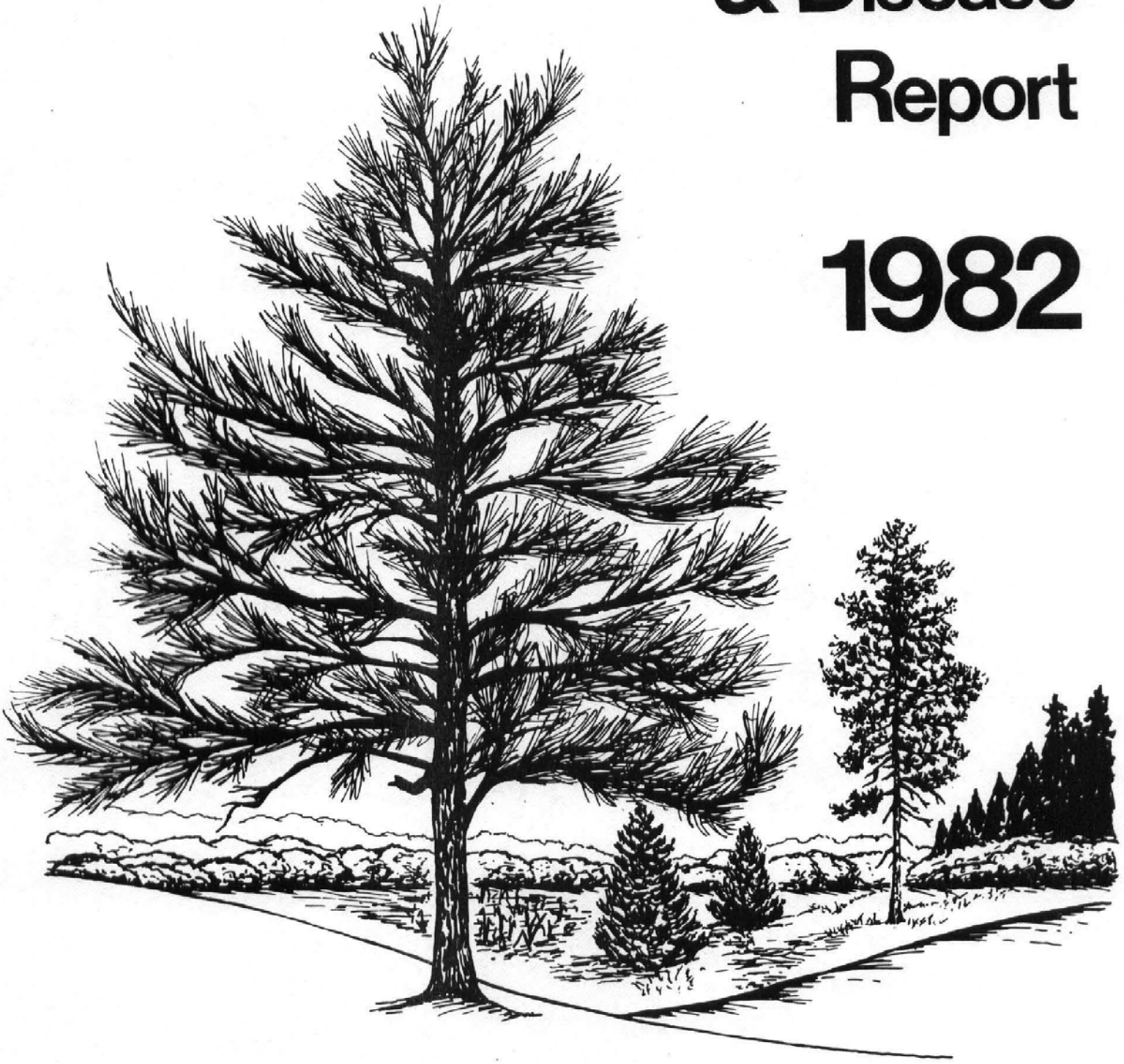
Forest Insect & Disease Report

1982



Division of Forestry
Minnesota Department of Natural Resources

1982 FOREST INSECT AND DISEASE ANNUAL REPORT

BY

Minnesota Department of Natural Resources

Division of Forestry

St. Paul, Minnesota

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FORESTRY

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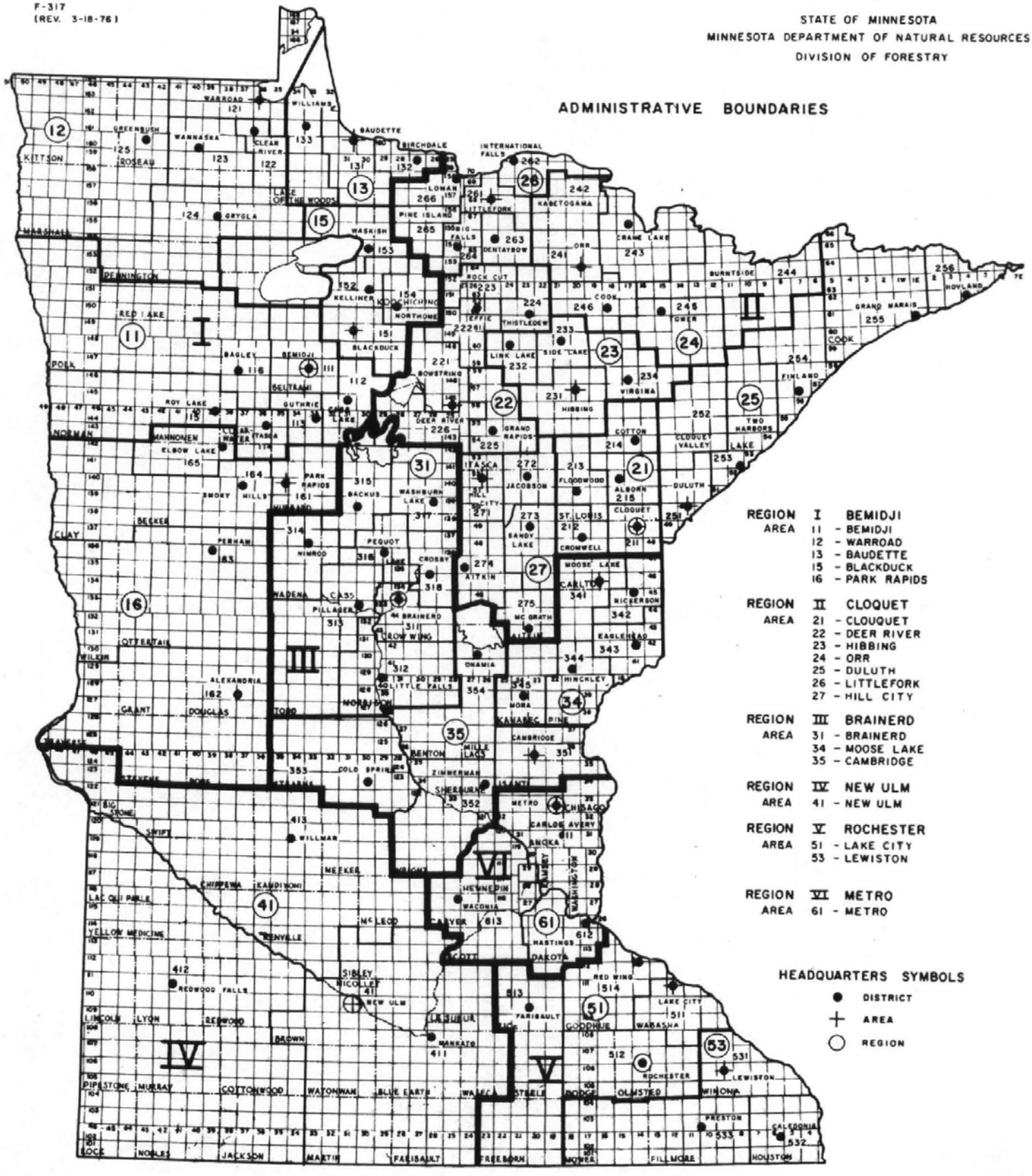

INTRODUCTION

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.

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1982 FOREST INSECT AND DISEASE HIGHLIGHTS

Total 1982 Insect and Disease accomplishments were greatly reduced in 1982 due to approximately two-thirds of available manhours having been spent administering the Division of Forestry's Herbicide Program. This time demand is expected to continue in the near future.

Actually, 1982 was a fairly quiet year for Insects and Diseases. Most pests were at low levels with the exception of an expanding fall defoliator complex and a very localized Jack Pine Budworm outbreak. 1982 was significant, however, in that it was the first year that the Gypsy moth has been proven to have overwintered in Minnesota. In addition, a number of special and cooperative projects were conducted.

Spruce Budworm populations were slightly increased in both incidence and severity of defoliation from 1981. Another interesting problem called physiological needle droop occurred in two small areas. Special project work included a Spruce Budworm Loss Assessment Survey in cooperation with State and private Forestry, a study of the larval parasites and diseases of the Pine Tussock Moth, a cooperative Oak Wilt Chemical Control Project with the University of Minnesota, a trial of chemicals to control White Spruce Cone Insects, an analysis of the Mycorrhizal Fungi endemic to Badoura State Nursery and a small project involving weed control in Black Walnut plantations.

SPRUCE BUDWORM - Choristoneura fumiferana (Clemens)

Since 1973, spruce budworm populations have been defoliating mature and overmature balsam fir and white spruce in the Finland and Cloquet Valley State Forests. In 1982 both the incidence and severity of defoliation increased over the defoliation experienced during 1981.

The map indicates the areas of defoliation in 1982. The following indicates categories on the map:

HEAVY:	50-100% of the current year foliage was missing, or host trees had red-brown crowns.
MODERATE:	20-49% of the current year foliage was missing.
LIGHT:	1-19% of the current year foliage was missing.

The acreage defoliated by defoliation category was:

HEAVY:	48,400 acres
MODERATE:	47,700 acres
LIGHT:	30,600 acres
TOTAL:	126,700 acres

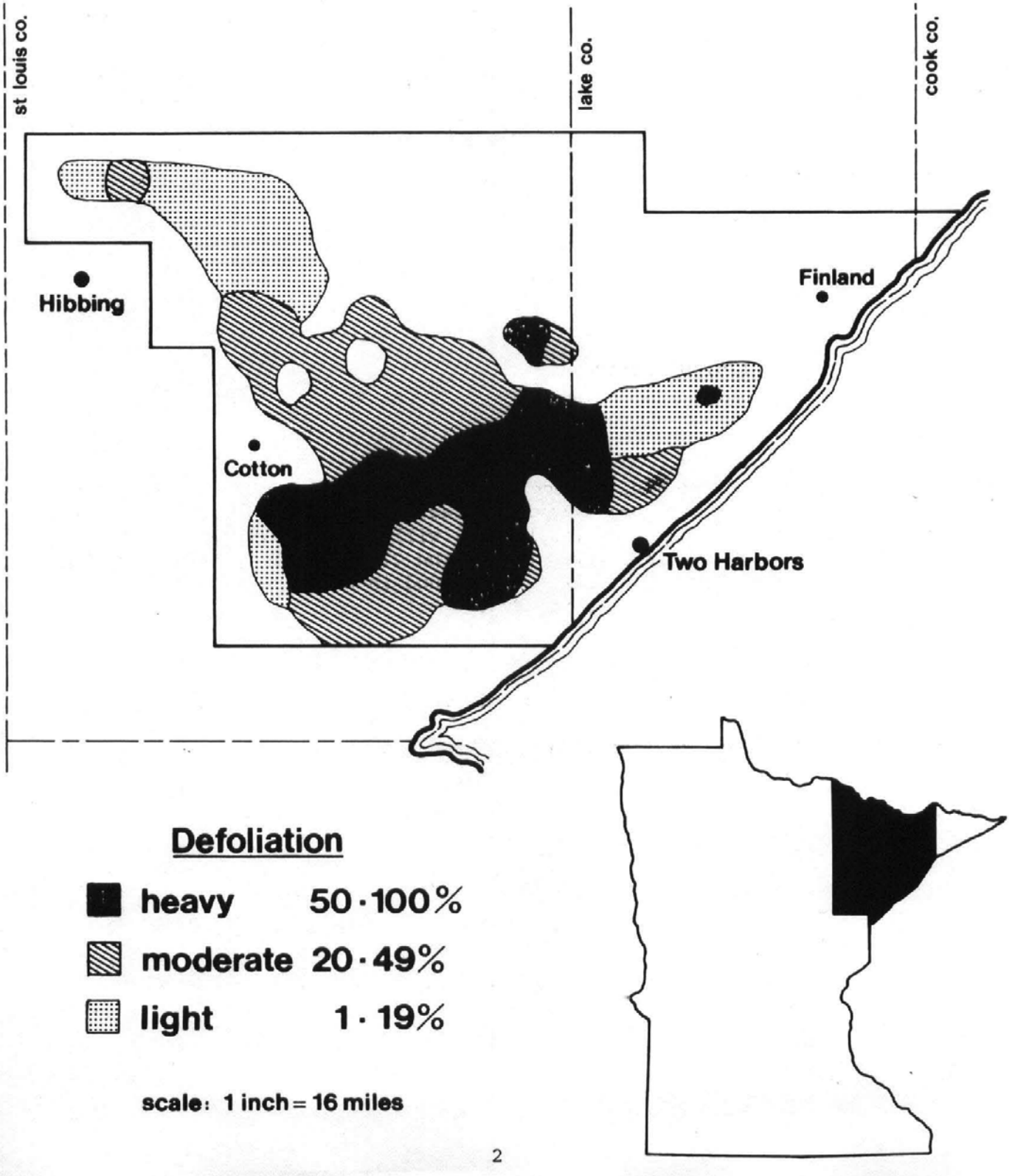
Outlook

During September and October, 20 egg mass plots were established in both the outbreak area and adjacent forest lands. Predictions based on this survey would indicate that light to moderate defoliation will continue in areas affected in 1982 while heavy defoliation is expected in the Cloquet Valley State Forest (see map). For the first time, egg masses were found in the Fond du Lac State Forest indicating a potential population buildup.

Phenological Notes

May 14	-	Third instar larvae found in Carlton County.
June 9	-	Larvae were mostly in their 4th and 5th instars in southern St. Louis County.
June 17	-	Primarily 5th instars were found in the Cloquet Valley State Forest in St. Louis County.
June 21	-	About 20% of the population had pupated near Central Lakes, St. Louis County.
June 28	-	A few 6th instar larvae present, but mostly pupae present. Many larvae were observed "sacked out" apparently from disease. Very few Diptera and Hymenoptera adults observed parasitizing budworm during 1982. Observations made near Cotton, St. Louis County.
July 6	-	Adult emerging but pupae and a few 6th instar larvae were found north of Two Harbors in heavily defoliated area of St. Louis County.

MAP 1. **1982 Map of current defoliation of balsam fir and white spruce in NE Minnesota caused by the spruce budworm, Choristoneura fumiferana (Clemens)**



JACK PINE BUDWORM - Choristoneura pinus Freeman

Except for a single localized outbreak, jack pine budworm populations remained at nearly undetectable levels during 1982. Larval surveys were conducted between June 8th and July 15th on 78 sites in Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, Lake of the Woods, Mahnomen, Roseau and Wadena Counties. The larval survey consisted of examining 30 shoots from each plot location. Only 6 larvae were found in these surveys.

In Region 1, a subjective rating of staminate flowering was made at each plot location. This was to relate larval counts with staminate cone production. It also gave a hint of favorable food sources for budworm buildup if staminate flowering is heavy. As indicated in Table 1, 43 out of 57 plots were rated as heavy flowering plots. This would indicate that conditions are favorable for a low-level, nearly undetectable budworm population to carry over and even to increase their numbers.

Table I. Jack Pine Budworm Early Larval Survey (Region I)

NO. OF PLOTS	NO. SHOOTS EXAMINED		NO. SHOOTS POSITIVE		STAM. FLOWERING
	VEG.	STAM.	VEG.	STAM.	
43	966	325	2	0	Heavy
13	294	96	0	0	Common
1	30	0	0	0	Light
57	1290	420	2	0	

The egg mass survey consisted of examining two branches from the mid-crown areas of 4 trees at each plot location. Eighteen inches of needle-bearing surface make up the sample unit on each branch. At each sampling point, it is the objective to select 4 trees of different crown classes. Obviously not all crown classes can be found at each sampling point.

In Region 1, egg masses were found in 4 locations: 3 Becker County sites, Sections 9, 14 and 15 of T. 139N, R. 36W; and 1 site in Roseau County, 26-161-37W. Because of the consistent find in Becker County a budworm population may be building, and an intensive early larval survey will be conducted in the area in 1983.

In Region 2, a 2000-acre area of defoliation occurred in Central St. Louis County near Eveleth. (See map.) Most of the defoliation was light with only 20% - 25% of the current year's foliage being eaten in the heaviest defoliated areas. No activity was detected in 1980 or 1981.

As determined by type mapping of jack pine on aerial photos, there are 2,886 acres of jack pine type in the area. Fifty-seven prism plots (10 BAF) were distributed over this pine type to document the present condition of the stands. Stand data which included basal area, volume/acre, and the amount of current year defoliation were collected on each plot. Jack pine age and height data were collected on 22 of the plots and were used to determine site indexes. Increment cores taken at breast height were collected on 19 of the plots. The number of annual rings in the last 1 inch of diameter growth were counted and used as an indicator of tree vigor. The data collected are summarized in Table 2.

Table 2 - Stand Data

	Average	Lowest Value	Highest Value
Basal Area (sq. ft.)	97	30	160
Volume (cds/acre)	30	8	55
Defoliation	Light	0	Heavy
Age	50	34	79
Site Index	68	47	80
Vigor (rings/last 1" DBH)	13	6	30

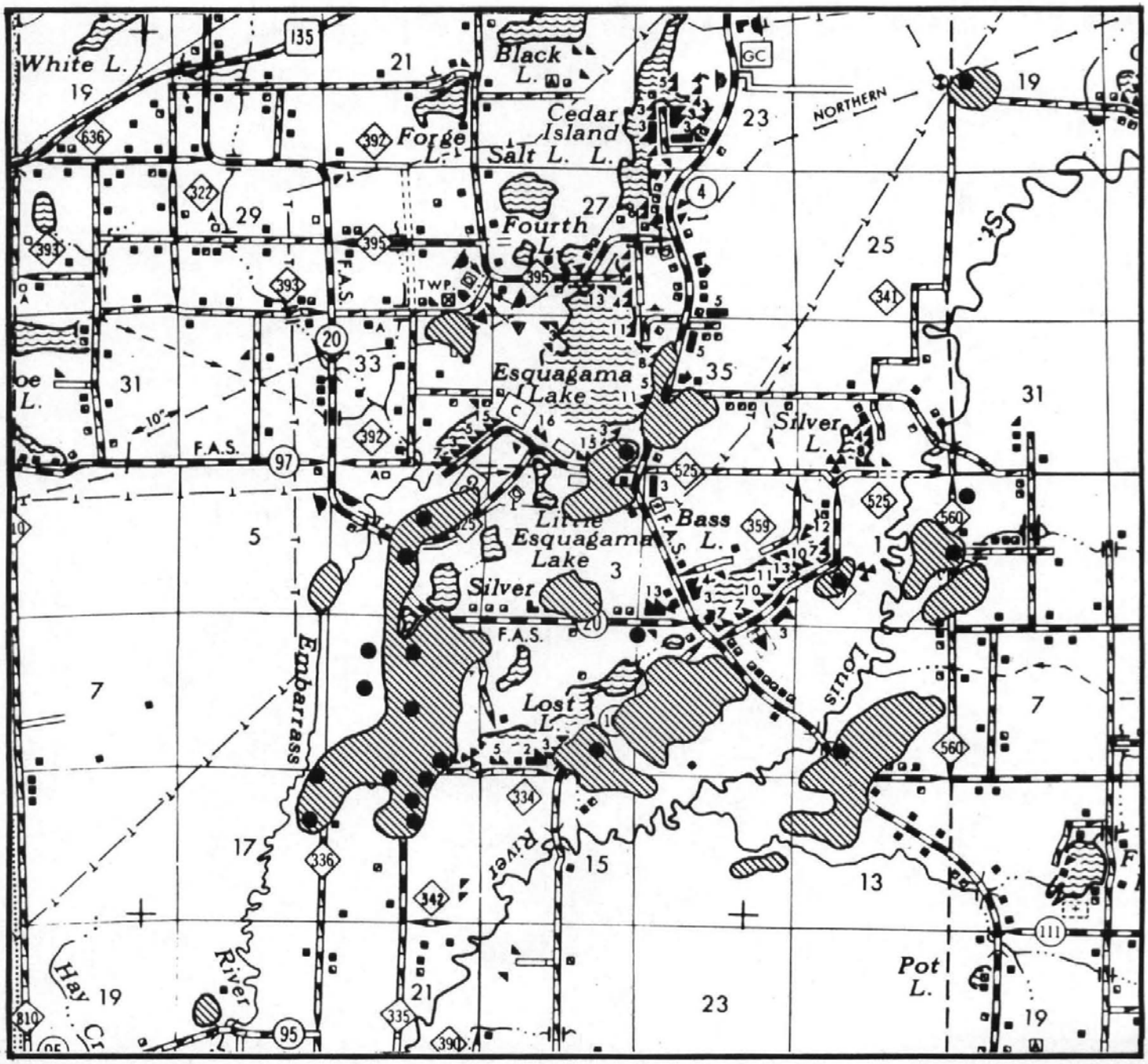
The jack pine in the outbreak area is presently in fairly good condition. However, most of the stands are at or beyond the recommended rotation age and about half of the stands are either overstocked or understocked. The stands are in no immediate danger of substantial mortality or top kill. They should be able to withstand several years of heavy defoliation if not put under additional stress such as by a drought.

Outlook for 1983

In Region 2, a survey of 22 egg mass plots was conducted in August 1982 to predict 1983 populations. Heavy defoliation was predicted on 2 plots, moderate defoliation was predicted on 11 plots and the remainder predicted light or no defoliation. Based on the egg mass survey and the present condition of the trees it is unlikely that spraying of an insecticide will be necessary in 1983. However, an early larval survey will be conducted during the spring of 1983 to make the final decisions.

In Regions 1 and 3, early larval and egg mass surveys will be conducted to monitor budworm activity.

Mapped 1982 defoliation and location of egg mass plots



area defoliated

● egg mass plots

BIRCH LEAF MINER - Fenusa pusilla (lepeletier)

Continued high populations were noted in Carlton, St. Louis, Aitkin and extending into Cook County. It is likely the sawfly is causing economically measurable levels of damage due to continued leaf damage, early leaf fall and lowered vitality. Bronze birch borers commonly noted on trees having thin and dead tops.

Phenological Notes

4-30-82 - Bud burst on birch. (Carlton Co.)

5-18-82 - Adults noted (abundant). 1st generation (Carlton Co.)

5-24-82 - Adults still active. (Carlton Co.)

7-09-82 - Mostly pupae. (Carlton Co.)

7-19-82 - 2nd generations adults noted. (Carlton Co.)

BIRCH DECLINE

The decline of paper birch continued statewide likely causing economic levels of damage. Many factors including drought, poor site conditions, insect defoliation by the birch leaf miner, Fenusa pusilla (Lepeletier), and others, and the bronze birch borer, Agrilus anxius Gary, accounted for much of the mortality.

THE FALL DEFOLIATOR COMPLEX

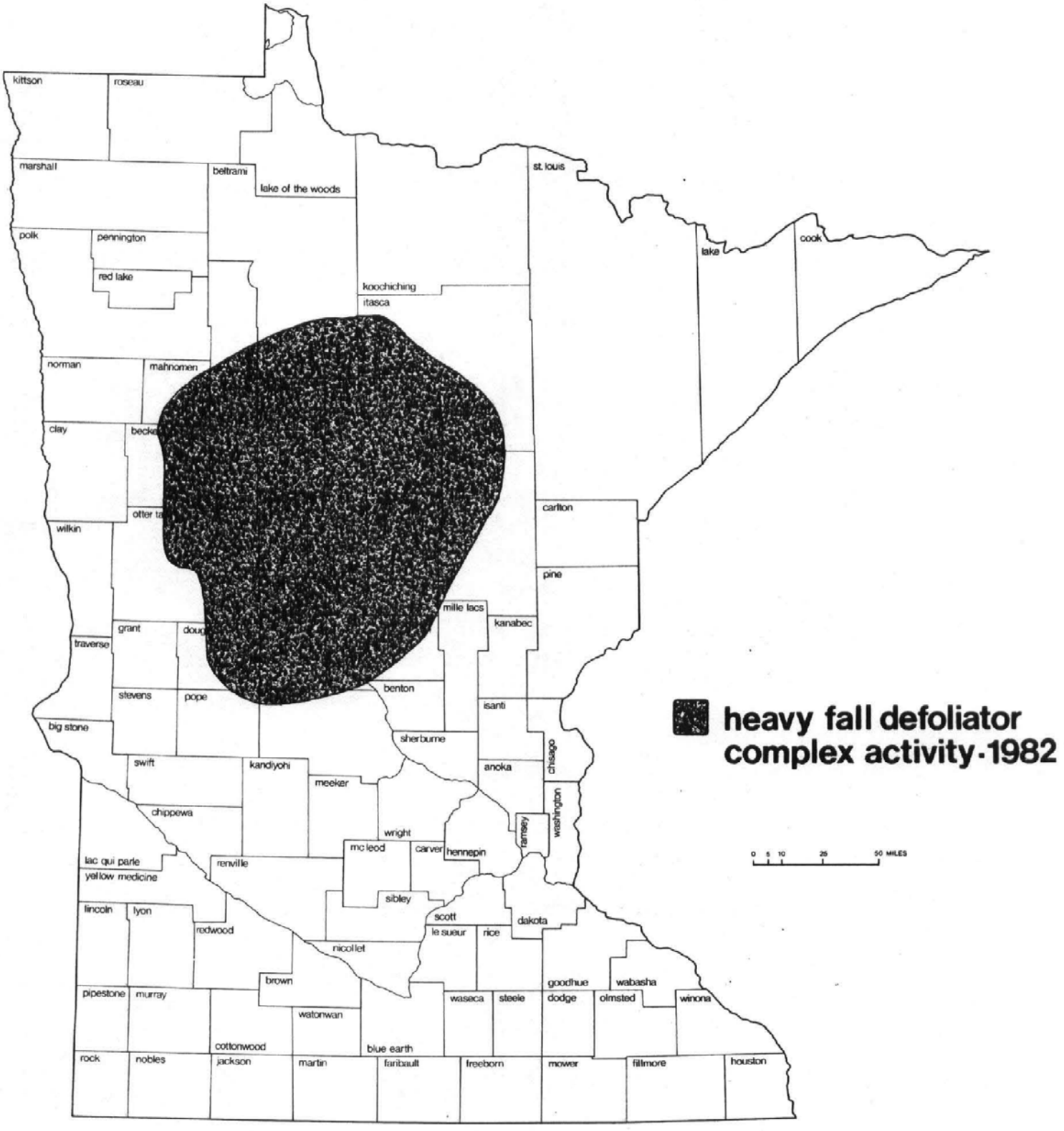
The fall defoliator complex in central Minnesota primarily consists of the Variable Oak Leaf Caterpillar, Heterocampa manteo (Doubleday); the Red-humped Oakworm, Symmerista leucitys and the birch skeletonizer, Bucculatrix canadensisella Chambers. Other species present in lesser numbers include the false tussock moth Halisidota tesselaris (Smith), Nadata spp. and Dicentria lignicolor.

Birch leaf skeletonizer feeding produced brown crowns in August throughout birch stands in central Minnesota. The oakworm complex totally defoliated elm, basswood, oaks and ash and fed on aspen, birch and maple when the preferred species were gone in portions of Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Mahnomen, Morrison, Ottertail, Todd and Wadena Counties. Since these trees are normally ready to drop their leaves, late season defoliation is not very harmful to the trees. Parasites, predators and disease will normally build up where these defoliators have been active for two or more years.

Outlook for 1983

Continued heavy defoliation is expected in portions of Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Mahnomen, Morrison, Ottertail and Wadena counties. A mild winter in 82-83 indicates populations will remain high in 1983. Egg parasites and diseases should begin to control the oakworm outbreak three to five years after it enters an area. Tree mortality will occur only if drought, secondary insects such as Agrilus spp. or armillaria root rot further weaken the trees.

Minnesota Department of Natural Resources
State Map



YELLOWHEADED SPRUCE SAWFLY - Pikonema alaskensis (Rohwer)

Defoliation of white spruce from this sawfly was minimal in Region 1 in 1982. The larvae were first observed on ornamental white spruce in the Bemidji Area during the week of June 14th. By June 18th, larvae were three-fourths of the length of the new spruce needles and were actively feeding. Control was recommended to begin during the week of June 21.

In Region 2 there was a general decline in population levels but somewhat of an increase in distribution. There was an increased occurrence in Cook County near Swampy Lake with occasional trees on the edge of a white spruce plantation being defoliated. No defoliation occurred within the plantation. Scattered trees in a plantation in the Jacobson District (STR 12, 52-22) were heavily defoliated. A small amount of tree mortality also occurred among trees defoliated over the past several years. In the McGrath District (Aitkin County) a few pockets of sawfly infestation in one plantation were sprayed to try to prevent the sawfly from becoming a problem throughout the plantation.

In Region 3 region-wide defoliation in 1982 was down over that reported in 1981. However, District requests for damage and larval identifications were received from all parts of the Region, especially in 5 to 15-year-old, open-grown white spruce plantations.

A white spruce seed orchard located in Section 16, T. 45N, R. 21W was attacked by this sawfly. Inspections were conducted on June 7 and June 28. Individual trees in the seed orchard were treated by nursery personnel in June with a contact insecticide to limit needle loss on the valuable grafted stock.

Outlook for 1984

White spruce plantations infested with yellowheaded spruce sawfly in 1982 will be surveyed in early June. In particular, the plantations in the Jacobson, Hovland and McGrath Districts, and the seed orchard in Region 3 will be inspected closely.

Phenological Notes

May 20 - White spruce buds were expanding and shedding bud scales (Carlton Co.)

May 25-31 - Adults observed (Carlton Co.)

May 15 - Second instar larvae observed (Cass Co.)

May 16 - One adult was still active; larvae were mostly in third instar with some still in the second (Aitkin Co.)

June 18 - Larvae 3/4 the length of new needles - actively feeding (Beltrami Co.)

July 1 - Mostly third instar larvae were present (Cook Co.)

July 15 - Mostly fifth instar larvae were present (Cook Co.)

July 19 - Some fifth instar larvae were still feeding but most had completed feeding (Carlton Co.)

INTRODUCED PINE SAWFLY - Diprion similis (Hartig)

In Region 2, minor defoliation of white pine from the feeding of this sawfly was observed in Carlton, St. Louis, and Itasca Counties. Generally, populations were very low.

In Region 3, there are 3 areas which historically harbor potentially damaging sawfly populations in mature white pine stands. These areas are the Sunrise area Townships of Chisago County (Townships 35 and 36, Ranges 20 and 21W), the Grandy Pines area of Isanti County (T. 37N, R. 23W, and T. 36N, R. 23W), and the stands along the Mississippi River and its tributaries in Morrison and Todd Counties.

Aerial surveys conducted in August of these 3 areas as well as other white pine areas of Region 3 detected only light defoliation in the Belle Prairie Morrison County Park (14-41N-32W).

Generally, populations were at low to moderate levels in Region 3 during 1982. Predators, parasites and diseases appeared to have reduced potentially damaging sawfly populations in Morrison County. Populations are expected to continue at low to moderate levels in scattered mature white pine stands throughout the Region.

Phenological Notes

July 21 - Fifth instar larvae were found in Carlton County.

July 22 - Fifth instar larvae and some cocoons were found also in Carlton County.

August 5 - Most sawfly larvae had pupated, but some first generation, fifth instar larvae remaining active in Carlton County.

August 8 - Second generation adults were present in Carlton County.

RED PINE SAWFLY - Neodiprion nanulus (Schedl.)

Small populations occurred in scattered locations around Grand Rapids in Itasca County. Generally only a few colonies occurred on any trees and caused very little defoliation.

Phenological Notes

June 16 - Fourth and 5th instar larvae present (Itasca County).

June 18 - Larvae beginning to pupate (Itasca County).

LARCH SAWFLY - Pristiphora erichsonii (Hartig)

Populations generally remained low with only scattered roadside defoliation in Aitkin, Cass Lake and St. Louis Counties. Some roadside larch were completely defoliated. Aerial surveys flown over larch stands in Region 2 showed no evidence of defoliation.

Phenological Notes

July 30 - Mostly 4th and 5th instar larvae with a few 3rd instar larvae still present (Lake County).

August 5 - Larval feeding completed (St. Louis County).

MOUNTAIN ASH SAWFLY - Pristiphora geniculata (Hartig)

High populations continued to cause heavy to complete defoliation of ornamental and natural mountain ash especially in Cook, Crow Wing, Carlton, Lake and St. Louis counties. A second generation of larvae was common.

Phenological Notes

April 25 - Buds breaking on mountain ash (Carlton County).

June 15 - First instar larvae present (Carlton County).

July 21 - First instar larvae of the second generation present (Carlton County).

GYPSY MOTH - Lymantria dispar (Linnaeus)

An established population of gypsy moths have been found in the Twin Cities area. Control operations are being planned for 2 areas where both egg masses and moths have been trapped. In Rochester, one moth was trapped behind a home on 7th Ave., NE. Retrapping efforts failed to yield another moth. Fifty to 75 other traps throughout the Rochester area also yielded no moths.

Elsewhere in the state, traps in State Parks, State Forest campgrounds and wayside rest areas were empty of moths.

Since a population of gypsy moths has successfully overwintered in Minnesota, more traps will be placed and an intensified survey will be conducted in 1983.

WHITE PINE WEEVIL - Pissodes strobi (Peck)

There was continued infestation of a plantation in the Orr District (T. 65N, R. 17W, S. 30). Terminal leader damage was especially damaging to the jack pine in the mixed jack pine/red pine plantation. Plots established in 1981 as "brood trees" showed negative results for infesting adjacent trees. Flagging, however, was common in the area.

A current infestation exists in jack pine plantation as SE Elbow Lake in Cook District. Manual removal of brood terminals was recommended.

PINE TUSSOCK MOTH - Dasychira pinicola (Dyar)

Aerial and ground surveys in the historic Pine Tussock Moth outbreak areas in Mission Township in Crow Wing County and Sturgeon Lake, Windemere, Kettle River

and Norman Townships in Pine County showed no detectable defoliation. An egg mass survey conducted on August 11th and 12th collected only one egg mass. Pheremone trapping (Table 1) of adult males was conducted in Pine and Crow Wing counties from July 20 to August 26.

In 1980, the Minnesota Department of Natural Resources, Division of Forestry, began field trials of compounds provided by G.G. Grant of the Canadian Forest Service to document the responses of the pine tussock moth, Dosychira pinicola (Dyar). Trials were conducted in areas of commercial jack pine where previous economic outbreaks and control operations had occurred. Preliminary trapping in July and August of 1980 confirmed the response of PIM males to (z)-6-heneicosen-11-one, the female sex pheremone of the Douglas-fir tussock moth Orgyia pseudotsugata (McDunnough). In 1981 and 82 various lure mixtures were randomly arranged in replicated field plots in the 1980 test areas. Results indicated that further refinement of the analogue and isomer mixture would be needed to define the PTM pheremone, but existing lures could be used to locate and monitor populations in susceptible stands. Larval, defoliation and egg mass surveys in 1981 and 82 documented low PTM populations in test areas. Efforts will continue to refine trap lures and correlate catch numbers to population and damage levels. Pheremone trapping of the PTM has been successful, and the development of a reliable early warning system will greatly reduce the amount of time needed for foliar detection surveys.

Table 1

A. Pine Tussock Moth Pheremone Trap Collections in Pine County

Canadian Lure Mix	Replicate 1	2	3	4	5	6	7	8	9	10	
A	0	2	2	0	0	5	8	5	0	2	24
B	5	2	0	1	0	20	6	0	5	6	45
C	10	1	3	0	0	2	6	7	1	3	33
D	27	0	4	0	0	7	0	3	10	5	56
E	1	4	0	1	1	4	1	3	1	4	20
F	5	2	4	1	0	14	4	0	0	9	39
G	13	0	0	1	6	5	1	0	0	6	32
H	6	0	0	0	1	10	5	7	0	3	32
Control	0	0	0	0	0	0	0	0	0	0	0

B. PTM Pheremone Trap Collections in Crow Wing County using Douglas Fir Tussock Moth lure

TRAP NUMBER	DATE				
	July 30	August 6	August 12	August 28	
1A	4	13	3	8	28
B	5	7	0	8	30
2A	0	4	1	2	7
B	3	10	5	4	22
3A	4	8	4	9	25
B	5	12	1	9	27
4A	3	12	13	12	40
B	8	18	17	12	55
5A	10	5	1	3	19
6A	4	4	6	6	20
B	11	3	1	3	18

Outlook for 1983

Pine tussock moth-caused defoliation of jack pine stands in Crow Wing and Pine counties was light in 1982. The third year of pheremone trapping efforts was used to test refined pine tussock lure mixtures and expand coverage into parts of Crow Wing County not previously surveyed. All survey results indicate low pine tussock populations in 1983.

DWARF MISTLETOE - *Arceuthobium pusillum* Peck

Dwarf mistletoe is the most destructive pest of black spruce in Minnesota. In a survey of 6 townships in Koochiching County, 37% of the black spruce acreage had evidences of mistletoe infection, as summarized in the following table.

ACRES AFFECTED BY DWARF MISTLETOE

Disease Severity	0	1-10%	11-25%	26-50%	51-80%	81-100%
Acres	24,698	10,001	3,368	1,145	234	67

Currently, the chief method of controlling this disease is with the use of a 5-foot cutting rule on the timber sale specifications. During the harvest, all live black spruce stems 5 feet and taller must be killed. Since dwarf mistletoe needs a living tree to grow and reproduce on, killing the non-merchantable residuals over 5 feet should help to control the number of infections and spread of the disease during the next rotation.

Burning of harvested areas is still the best control of dwarf mistletoe, and the 5-foot cutting rule was not instituted to replace burning. Since conditions for successful burning are limited and the sites are often inaccessible, burning cannot always be used. The 5-foot cutting rule, then, helps to control the disease when fire cannot be used.

DIPLODIA TIP BLIGHT - *Sphaeropsis ellisii* Sacc.

In Region 2, *Diplodia* tip blight was common in Itasca and St. Louis Counties in red pine stands. The most severe damage from *Diplodia* occurs when trees are under stress such as from drought. However, some damage and infection can also occur even if trees are not under severe stress. The most significant damage normally occurs to young hard pines growing under or next to mature red or jack pine which are commonly infected and serving as the source of inoculumn. Therefore, when a red pine plantation is being established, mature red pine and jack pine trees should be clear cut on the sites.

Aspen Stem Diseases

Hypoxylon mammatum (Wahl.) Mill

Phellinus tremulae (Bond.) Bond. et Boriss.

Both trembling aspen and bigtooth aspen are important commercial tree species in Minnesota. Two of the primary causes of losses to these tree species are white trunk rot caused by *Phellinus tremulae* and a stem canker caused by *Hypoxylon mammatum*.

1982 Phase II Inventory showed that 83% of the aspen acreage in 13 surveyed townships in Aitkin, Koochiching and Lake counties was found to be infected by either one or both of these diseases. A summary of disease occurrence is found in the following table:

	ACRES AFFECTED BY EITHER *HYPOXYLON* OR *PHELLINUS* OR BOTH					
Disease Severity	0%	1-10%	11-25%	26-50%	51-80%	81-100%
Acres Affected	2,747	2,946	3,667	3,917	2,065	763

SCAB AND BLACK CANKER OF WILLOW - *Fusicladium saliciperdum* (Allesch. & Tub.) and *Physalospora miyabeana* Fuku.

Two fungi, *Fusicladium saliciperdum* and *Physalospora miyabeana*, teamed up during the wet growing season to cause scab and black canker of willow in St. Louis, Itasca and Carlton Counties. *Fusicladium* attacks young leaves in the spring, kills them and the leaves shrivel and turn black. The fungus grows down from the leaves into the twigs where it causes cankers. *Physalospora* acts much the same but is active later in the summer attacking the second crop of leaves. Willows of any size may die within 3 years from the repeated killing of leaves and young shoots. Homeowners can ameliorate the disease by removing and destroying all dead leaves, twigs and branches. Early spring applications of Bordeaux mixture while the trees are still dormant will control the disease complex.

PINE NEEDLE RUST - Coleosporium spp.

Pine needle rust was simply spectacular in 1982! Adequate moisture during the summer for the alternate hosts, aster and goldenrod and for pine infection in the fall lead to abundant rust infection on pine. The 2-3 weeks of rainy weather received during May of 1982 promoted heavy pustule or spore production on the pine needles. It is at this stage that field reports were received.

Disease incidence was particularly heavy from Hubbard County southward throughout Region 3. One plantation in 5-142-35W of Hubbard County had 1/3rd of the trees showing infections. Many reports were received in the Alexandria area. Field checks were conducted on state and county plantations in Crow Wing County in response to calls. In the heavier infected areas in Region 3, trees were flagged to rate vigor and reinfection during the spring of 1983.

Outlook

Abundant moisture during the summer and fall of 1982 should have promoted pine infections. If May of 1983 is wet, this disease should once again be prevalent.

OAK WILT - Ceratocystis fagacearum (Bretz) Hunt

In Region 2 the Oak wilt fungus continued to kill trees in Aitkin County (Sec. 3-49-23) which is the only known pocket of infection in northeastern Minnesota. Two red oaks which began to show wilt symptoms in 1981 died in 1982. Two additional red oaks and two white oaks began to show symptoms of oak wilt infection during 1982.

In Region 3 this disease is a continuing problem in privately-owned stands in the Zimmerman District (Sherburne County). Additional active pockets have been confirmed in Wright, southern Isanti and Anoka Counties.

Aerial surveys conducted in this Region during July and August pinpointed active oakwilt pockets first mapped in 1981. District and PFM personnel then contacted owners interested in control activities and helped identify hazard trees to direct chemical treatment and removal. Additional contacts will be made in 1983 with followup evaluations of treated areas to determine control effectiveness or needed changes in treatment.

Outlook

Oak wilt will continue to spread in the affected counties where residential development and right-of-way maintenance causes wounding to oaks during the April to June hazard periods.

DUTCH ELM DISEASE - Ceratocystis ulmi

This disease is still very common in cities and woodlots. Foresters discriminate against elm whenever timber sales are made. In some parts of northwestern Minnesota, heavy disease incidence is still a relatively new event. Communities are beginning to struggle with the problem of who should be responsible for tree removal and disease control, and whether or not an

ordinance is appropriate. The city of Kelliher was an example. Both the local DNR Forester and the Regional I & D specialist gave technical assistance to community leaders struggling with Dutch elm disease control and ordinances.

SHOOT DIEBACK IN WALNUT

Increased occurrence of shoot dieback was observed in both state and private walnut plantations surveyed in July, 1982. Five trees were killed by the disease on a state plantation in Fillmore County Sec. 14-T.103-R.9. This disease was first reported in 1980. Fifty dead or heavily infected trees were identified on a private plantation in Wabasha County Sec. 18-T.110-R.12. These trees were marked for removal at the landowner's request. The crowns of these trees were completely destroyed, while the stems were used for fuelwood. Later in the season, infected lower branches were removed from twelve additional trees. This plantation was ten years old in 1982. It had been through one thinning, leaving 300 stems per acre. The average height was 25' and the average diameter was 5" at breast height. It appeared that all shoot dieback had occurred during the 1981 and 1982 growing season.

J. E. Kuntz at the University of Wisconsin has isolated a Phomopsis species from small, dark, sunken branch cankers on one-year-old wood and a Phyllosticta species associated with rapid wilt and dieback of current year shoots. Cooperative efforts with the University of Wisconsin will be continued in 1983 in order to clarify what additional pathogens may be involved.

Plantation Surveys

In late June and early July four plantations totalling 84 acres were intensively surveyed for pest damage. Heavy brush competition restricted close inspection of the seedlings and the survey was discontinued after these plantations.

Location	Desired Species	Pest and % Affected		Comments
36-132-29	Red Pine	Pine Bark Aphid	4	Heavy Brush
		Armillaria	2	Competition
		Frost	1	
		Defoliators	2	
	White Spruce	Frost	1	
		Drought	1	
36-137-28	Red Pine	0		Heavy Aspen Overstory
	Jack Pine	Deer Browse	80	
21-137-28	Red Pine	Planting mortality	28	Heavy Brush Competition
16-135-27	Red Pine	Planting mortality	60	Heavy Brush Competition in
		Deer Browse	2	50% of area

PHYSIOLOGICAL NEEDLE DROOP

A condition of red pine characterized by needle bending inside their sheaths with a noticeably constricted area at the bend was evident in the Beltrami Island State Forest in Region 1 and in the Virginia District in Region 2. No pathogenic fungi were isolated from samples collected in the Virginia District, and no midge damage or other insect activity were associated with the drooping needles in either Region.

This condition has been labeled "physiological needle droop." Drooping can occur within a few hours on a hot and dry day. Needles wilt and permanently droop because there is insufficient water in the root zone. Needle droop most commonly occurs when adequate or abundant moisture is received during the early and mid growing season. These moisture conditions promote an abundant, succulent needle growth which is then prone to collapse under moisture restrictions often received in late August to mid September. Drooping has also been associated with red pine planted on jack pine sites.

In the Virginia District, the red pine plantation was characterized by trees less than 4 feet tall growing on a former jack pine site. The area of severe droop occurred in a low area with heavy competition. There were varying degrees of injury; terminals showed extensive drooping and drying of needles while branches still had live, straight needles.

In the Beltrami Island State Forest there were at least three areas of needle droop. The most serious needle droop occurred in a red pine planting which had occurred in 1982. Nearly all the trees showed some evidence of needle droop. In the other two areas the trees were older but all in the 2 to 4 foot height range. Like the red pine in the Virginia District, the degree of needle droop varied from tree to tree, and the red pine were growing on a site formerly occupied by jack pine.

HIGH TEMPERATURE INJURY

On July 4 and 5, 1982 the afternoon temperature in Rochester and surrounding areas reached 100°F. The result was varying levels of leaf scorch on all ages of hard maple and young green ash. Several ash examined in Rochester and Chatfield were completely defoliated within a week. In all cases trees refoliated completely within a month.

SOIL DEPOSITION

In a walnut plantation in Region 5, several pole size trees died during the spring of 1982. In July, further examination revealed 12 to 14 inches of new silt deposited around the trees since time of planting ten years ago. The smothering of the root system from the change in grade is thought to have been the cause of the walnut mortality.

FROST DAMAGE

Walnut

1982 was the first year in four years of record keeping that no noticeable major frost injury occurred to walnut trees in southeastern Minnesota.

White Spruce and Balsam Fir

Early morning frost on June 1 and 2 caused shoot damage on white spruce and balsam fir, and damaged leaves of oak. Damage occurred throughout northern Minnesota, but it usually occurred in pockets or scattered spots throughout the area and throughout plantations.

RED PINE NEEDLE LOSS AND SHOOT MORTALITY

In the Nimrod District in Wadena County and in the Moose Lake District in Pine County, extensive needle loss from the terminal shoots of open-grown 15 to 20 year old red pine was observed during November of 1982. At that time needles were red and resin soaked at their bases before falling. Only the upper crowns were affected, and terminal bud mortality was observed. When the bark of the terminal shoots was removed, localized resin pockets were found, but no distinctive cankers or insect feeding marks could be found. However, some past feeding by aphids was detected.

The specific causative agent or agents has not been identified. Both red pine plantations are privately owned, but access has been granted for further study. Recent row thinnings in both plantations will aid access for detailed inspections in 1983.

NURSERY PEST PROBLEMS

These problems were reported from the General Andrews (26-45-20) and Badoura (16-139-32) State Forest nurseries in 1982 includes:

HOST	82 DATE	SYMPTOMS	AGENT	CONTROL
Walnut freezer stock	April	Flocculence on roots	Storage	None
Jack Pine	April-September	Stem swellings	Pine - Oak gall rust	Culled
White Pine	April	Stem Cankers and pitching	Blister Rust	Culled
Red Pine	June-July	Dead tops Rootlets missing	White grubs	None
Red Pine	June-July	Flocculence	Aphid	None
Red Pine	Aug.-Sept.	Dead tips	Unknown	Under investigation
White Pine Greenhouse stock	March-April	Flocculence on stems	Pine bark aphid (adelgid)	Branch and stem drench with Malathion and Acephate

Rust problems continue to be a major concern on jack pine stock in the Willow River nursery and white pine stock at Badoura. Protective chemical sprays will be initiated on 1-0 jack pine at Willow River in 1983. Cultural work (mechanical and chemical) to eliminate alternate hosts in the windrows and surrounding types will continue at both nurseries.

Stunting of Nursery Stock

Stunting of red pine and white spruce nursery stock has been a problem in Lake State nurseries. Stunted seedlings are ½ of the size of normal seedlings. Neither the causal agent(s) nor the effects of planting stunted stock are currently known. Nutrient analyses of stunted seedlings show that in some cases, phosphorous deficiencies could be the cause.

Unusual, swollen short root tips were detected on 2-0 and 3-0 red pine seedlings in beds containing stunted seedlings at General Andrews State Nursery. Fifty fall-lifted, 2-0 and 3-0 red pine seedlings were examined. Neither the presence nor the abundance of swollen short root tips was correlated to seedling height. The nature of the swollen tips was not conclusively established, but appeared to be mycorrhizal. No evidence of pathological or nutritional problems was found.

In May 1982, 175 3-0 red pine seedlings (85 were stunted) were planted (T58 R28 S16) by a Hodag planting crew. The objective was to see if there were different growth and survival rates between the normal and stunted trees. In May of 1983, 55% of the normal-sized trees were dead and 51% of the stunted trees were dead. Throughout the entire plantation high levels of mortality occurred and it was interplanted in the fall of 1982.

Outlook for 1983

The outplanted seedlings will be monitored for height growth and survival. More outplantings will be established.

MINOR AND INCIDENTAL PROBLEMS

INSECTS

PEST	HOST/s	COUNTY	REMARKS
Elm Leaf Beetle *Pyrrhalta luteola*	Elm	Beltrami	Brown leaves, several locations.
Red Pine Midge *Thecodiplosis piniresinosae*	Red Pine	Hubbard	One plantation, noticed by landowner.
Introduced Pine Sawfly *Diprion similis*	White Pine	Douglas	Four private plantations controlled with insecticides.
Eastern Tent Caterpillar *Malacosoma americonum*	Cottonwood	Grant, Pope	Some heavy populations found.
Slug Oak Sawfly *Caliroa quercus coccinae*	Red Oak	Grant	Sapling size trees defoliated in Lake Carlos State Park.
Unidentified boring insect/ash shoots	Ash	Douglas, Pope	Kills terminals in seedling and sapling trees-widespread.
Balsam Fir Sawfly *Neodiprion abietis*	Balsam Fir	St. Louis, Lake Carlton, Aitkin	Very low populations, depressed from 1981.
Elm Leaf Miner *Fenusa ulmi*	Slippery Elm	Aitkin	Occasional light defoliation to understory elm.
Jack Pine Sawflies *Neodiprion virginiaus*	Jack Pine	Carlton, Aitkin, St. Louis, Crow Wing, Morrison	Occasional defoliation to roadside trees.
Red-Headed Pine Sawfly *Neodiprion lecontei*	Jack Pine	Carlton, Aitkin	Occasional defoliation to roadside trees.
Eastern Pine Shoot Borer *Eucosma gloriola*	Jack Pine	Carlton, St. Louis	Population decline from 1981. Flagging noted.
Fall Webworm *Hyphantria cunea*	Alder, Juneberry	Carlton, St. Louis	Occasional.

PEST	HOST/s	COUNTY	REMARKS
Pitch Nodule Maker *Petrova albicapitana*	Jack Pine	Northeast MN	Common.
Spiny Elm Caterpillar *Nymphalis antiopa*	Willow, Aspen	Northeast MN	Occasional defoliation noted.
Spring Cankerworm *Paleacrita vernata*	Box Elder	Itasca, Aitkin	Occasional defoliation.
Balsam Twig Aphid *Mindarus abietinus*	Balsam Fir	Northeast MN	Populations greatly reduced from 1982.
Elm Lace Bug *Corythucha ulmi*	Elm	Aitkin	Populations greatly reduced from 1981.
Oak Lace Bug *Corythucha arcuata*	Bur Oak	Sherburne	Leaf yellowing in August-September.
Pine Tortoise Scale *Toumeyella numismatica*	Jack or Scots Pine	Carlton, Aitkin, St. Louis, Pine, Isanti, Sherburne	Occasionally noted on roadside trees. Natural control occurring.
Poplar Vagabond Aphid *Mordwilkoja vagabunda*	Aspen	Carlton, St. Louis	Populations reduced from 1981 levels.
Bronze Birch Borer *Agrilus anxius*	Birch	Carlton, St. Louis, Lake	Adults common.
North Pine Weevil *Pissodes approximatus*	Red Pine	Lake	Minor problem-one incident in windbreak trees.
Poplar-Willow Borer *Cryptorhynchus lapathis*	Balsam Poplar	Aitkin, St. Louis	Occasional in regeneration clones.
Saratoga Spittlebug *Aphrophora saratogensis*			More noted in Northeast Minnesota.
White-Spotted Sawyer *Monochamus scultellatus*	Green uncured slabs	Carlton	One incident.

PEST	HOST/s	COUNTY	REMARKS
Honeysuckle Witches Broom Aphid *Hydaphis tataricae*	Honeysuckle	State Wide where Honeysuckle is grown.	
Basswood Thrips *Sencothrips tiliae*	Basswood	Southeast MN	Damages leaves similar to frost or foliage disease, spring.
Walnut Caterpillar *Datana integerrima*	Black Walnut	Southeast MN	Widespread, locally heavy in plantations-some individual trees.
Oak Twig Pruner *Elaphidionoides villosus*	Bur Oak	Brown	
Juniper Aphid *Cinara sp.*	Juniper	Southern MN	Extensive foliage damage and some mortality.
	DISEASES		
Cytospora Canker *Cytospora kunzei*	Blue Spruce	Beltrami, Crow Wing	Widespread on old ornamentals found killing trees in two areas.
Aspen Bronzing	Aspen	Beltrami, Hubbard	No change from previous years-no mortality observed.
Septoria Leaf Spot	Balm of Gilead	Beltrami, Roseau, L-O-W, Central MN.	Incidence reduced over 1981.
Oak Wilt *Ceratocystis fagacerum*	Oaks	Southeastern MN	Scattered throughout Southeast MN-many homeowner calls.
Maple Dieback	Maple	St. Louis	FTC defoliation and late frost on second foliage flush.
Armillaria Root Rot *Armillariella mellea*	Red Pine	St. Louis, Crow Wing	Occasional occurrences.
Pine Needle Rust	Red Pine	Aitkin	Common throughout the state.

PEST	HOST/s	COUNTY	REMARKS
Cone Rust *Venturia tremulae*	White Spruce	St. Louis	Common on pistillate cones.
Leaf Blight *Chrysomyxa sp.*	Sprout Aspen	Cook, Lake, St. Louis	Common decr. incidence.
Dutch Elm Disease *Ceratocystis ulmi*	Elm	Northeast MN	Common.
Oak Anthracnose *Gleosporium quercinum*	Oak	St. Louis	One incident.
Cedar Blight *Keithia thujina*	Cedar	Carlton	One incident.
Heart Rot Unidentified	Tamarack	Koochiching, Aitkin, Lake	Twenty-five percent infected on Phase II inventory on 13,800 acres.
Heart Rot Unidentified	Cedar	Koochiching, Aitkin, Lake	Twelve percent infected on Phase II inventory on 16,000 acres.
Fusarium Canker *Fusaria sp.*	Black Walnut	Fillmore	New cankers found in 1982.
Walnut Anthracnose *Gnomonia leptostyla*	Black Walnut	Southeast MN	Common throughout the region, most affected upland sites defoliated by September 1.
Leaf Spot *Cristulariella pyramidalis*	Black Walnut	Fillmore	First time reported in MN. Minor in Fillmore County. 14-103-09.
Honeysuckle Leaf Blight	Honeysuckle	Southeast MN	

SPECIAL PROJECTS

Spruce Budworm Loss Assessment

In 1982, the DNR cooperated with the USFS State and Private Forestry on a spruce budworm loss assessment survey. The objective was to estimate the volume of spruce and balsam lost due to budworm attack from 1977 to 1982. Acreages of mortality were determined from aerial sketch maps made during the summer months. Volume estimations were based on ground survey data collected from randomly selected stands that had been aerially sketch-mapped.

The following map depicts generalized areas of spruce-fir mortality from 1977 to 1982. Categories used were:

SEVERE = 50-100% of the host trees in a stand were dead,

PARTIAL = 20-49% of the host trees were dead, and

FEW = 1-19% of the host trees were dead.

The acreages in the mortality categories were:

SEVERE = 42,300

PARTIAL = 65,400

FEW = 78,100

185,800 Acres Total

Volumes, basal areas and percentages of dead host trees were computed from data collected in 34 stands. Five prism plots were taken in each stand for a total of 170 plots (See Table 1).

TABLE 1 Summary of the Ground Survey: Average Spruce Budworm Caused Mortality in Balsam Fir and White Spruce.

Mortality Category	Volume (C/A) Dead and Risk Tree	Volume (C/A) Total Live, dead and Risk Trees	Basal Area of Spruce & Fir Trees (sq. ft./acre)	Percent Dead Dead and Trees (%)
Severe	6.4	10.8	59	58
Partial	1.6[b]	7.9	43	22[b]
Few	1.6[b]	6.3	32	28[b]

a = Risk trees = Trees that have dead tops, declining crowns and will die within a year.

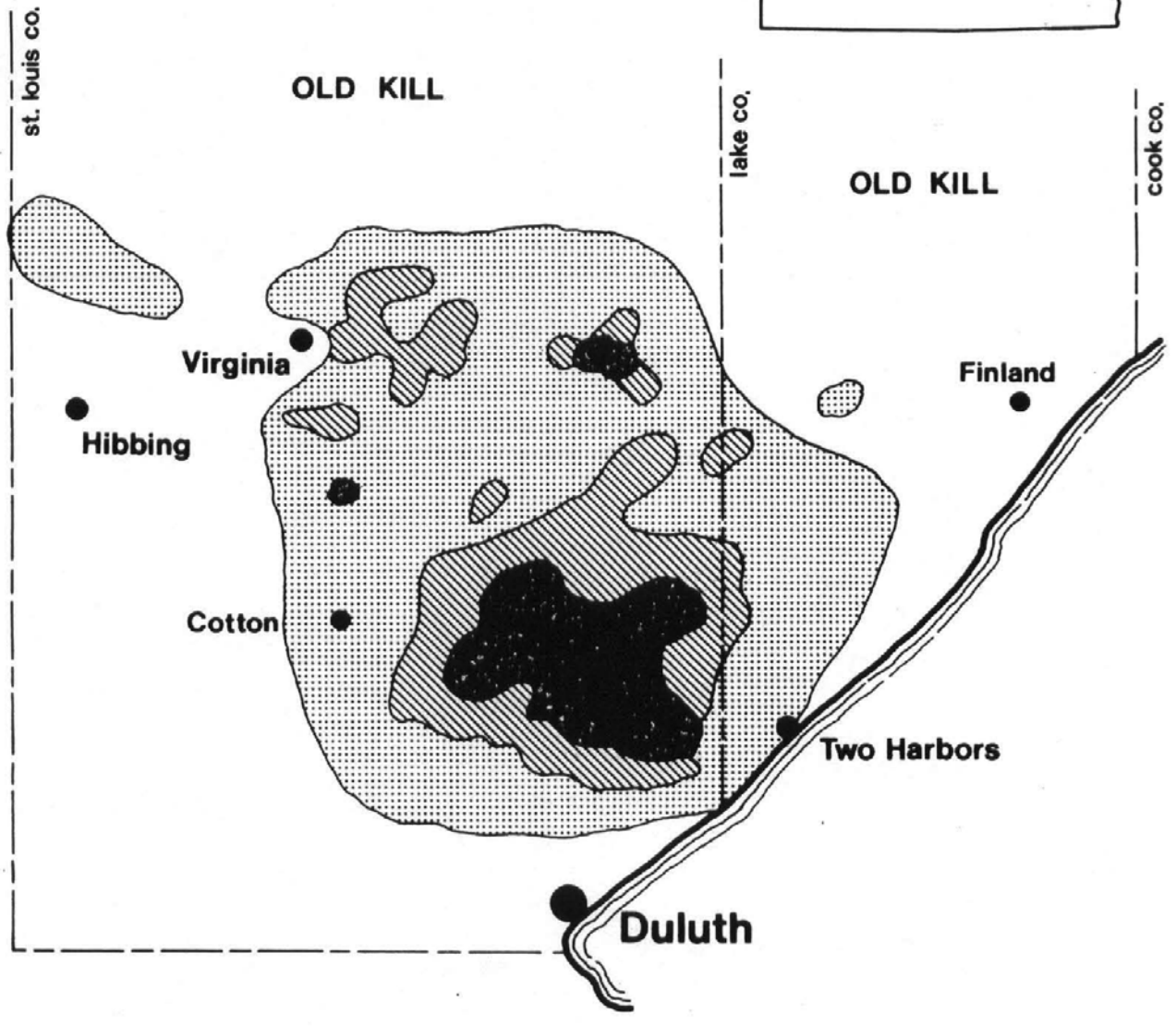
b = Not significantly different as determined by the Student's T-test (.05).

For the 5-year period, 501.7M cords were lost in the surveyed area. Only 8M cords of white spruce were lost while 493.7M cords of balsam fir were lost. Black spruce losses were not detected. In April 1983, the base pulpwood

stumpage price for a cord of balsam fir was $4.00 and $14.00 for a cord of white spruce, as determined by the MN/DNR. Therefore, the total dollar loss was $2,086,800.00. For the 84 townships surveyed, the 493.7M cords of balsam fir represents 20% of the available volume of growing stock and sawtimber (based on data from Timber Resource of Lake Co. MN and Timber Resource of St. Louis Co. MN, 1977).

Stands with high basal areas of balsam fir trees showed heavier mortality than stands with low basal areas.

Mortality of Balsam Fir caused by the Spruce Budworm from 1977 · 1982



heavy 50 · 100% of host trees are dead

moderate 20 · 49% of host trees are dead

light 1 · 19% of host trees are dead

scale: 1 inch = 16 miles

Fate of Pine Tussock Moth Larvae Collected in the General Andrews State Forest

Late instar larvae were collected on July 14, 1982 and reared in plastic containers to obtain a preliminary indication of parasite and disease records. Twenty-four samples were submitted.

Diseased PTM cadavers were forwarded to the USDA forest insect and disease laboratory in Hamden, Connecticut. The structures indicated the presence of the bacterial families: Bacillaceae, Micrococcaceae and Streptococcaceae. The fungi detected were Aspergillus spp. and Penicillium spp. Due to shipping delays the specimen's were unsuitable for "cause of death" determinations.

Parasite records include:

Hymenophera

Braconidae
Meteorus bakeri Cook & Davis
determined by P.M. Marsh

Chalcididae
Brachymeria compsilurae (Crawford)
determined by E.E. Grissell
(a secondary parasite of Diptera through Lepidoptera)

Ichneumonidae
undetermined

Diptera

Tachinidae
Exorista sp. larvarum complex
Compsilura concinnata (Meigen)
determined by D. Wilder

Additional collections will be made of larvae and eggs in 1983.

Weed Control in Black Walnut Plantations

In the spring of 1982, weed control plots were placed in several established upland walnut plantations in the southeast. A summary of results from five of these plantations is given in Table 1.

Plantations 1, 2, 4 and 5 are located on deep, moderately to well-drained, upland silt loam soils. Plantation 3 is on a alluvial loamy sand. Each of these sites supports a variety of perennial and annual grasses and broadleaf weeds.

Initially herbicides were applied to trees in these plantations at the time of establishment and during the first two years of growth. On these new plots, complete weed control was maintained throughout the growing season.

In the first year of release (1982), average height growth of trees on the weed control plots in plantations 1 and 2 was twice that of previous years average annual height growth.

Plantation 3 had an average height growth of 2.55' in 1982, more than tripling the previous ten year average annual height growth of .78'. However, it is important to note the growth of the control trees. Eight inches of rainfall in May of 1982, (compared with a five year average of four inches of rainfall in May) and lateral pruning of all trees in March, are likely to have contributed to the unusual height growth response.

Growth of the control trees in plantation 4 also appeared to reflect the effect of the abnormally high rainfall in May. Average height growth of the control trees was 131% over the average annual height growth in previous years. The response of the treated and control plots would be expected to have been equal had the sample size been larger.

Field evaluation of these plantations will be continued with the following objectives: (1) to determine whether or not height growth responses will be maintained, (2) to determine what level of weed control is necessary to obtain an acceptable growth response at various ages, and (3) to evaluate diameter growth responses.

TABLE 1. Height growth responses in established upland walnut plantations to use of additional weed control.

County & Legal	Age	Plot	A. Previous Years' Ave. Annual Ht. Growth	B. 1982 Ave. Ht. Growth	C. 1982 Range	% Inc. Over (A)	% Inc. Over Control Plot
(1)Fillmore 4-103-8	13	Broadcast	.75'	1.50'	.41'-2.55'	113	128
		4' Band	.75'	1.00'	.41'-2.16'	33	42
		Control	.82'	.70'	.41'-1.40'	-17	
(2)Winona 7-105-9	12	Circular 7-10'	.79'	1.60'	.72'-2.83'	103	100
		Control	.79'	.80'	.37'-1.2'	1	
(3)Olmsted 2-107-13	11	Circular 7-10'	.78'	2.55'	.46'-4.41'	227	59
		Control	.85'	1.60'	.64'-2.83'	88	
(4)Goodhue 4-112-14	10	4' Band	.77'	1.26'	.58'-2.33'	63	-35
		Control	.74'	1.71'	.58'-2.62'	131	
(5)Winona 7-108-9	4	6' Cir.	1.01'	1.29'	.72'-2.00'	27	57
		4' Band	1.08'	.94'	.58'-1.20'	-14	6
		Control	1.23'	.83'	.39'-1.33'	-50	

A. Previous year's average annual height growth was calculated by dividing total height by plantation age. Plantation age did not include 1982 or the first year of growth in these calculations.

Mycorrhizal Fungi Endemic to Badoura State Nursery

Red pine and jack pine seed beds were surveyed for the presence and occurrence of endemic fungal species that are capable of forming mycorrhizal associations with conifer roots. It is not known if mycorrihizae actually formed between the observed fungi and the seedling root systems. The survey dates were September 9, 16, 30 and October 13, 1982. The data is summarized in the table below. Only Laccaria laccata, Thelephora terrestris and the Hebeloma sp. are documented in the literature as forming mycorrhizae.

Compiled Data on the Species of Fungus Present in Conifer Nursery Compartments at Badoura State Nursery, Fall 1982.

Species, Are, Number of Compartments		Laccaria laccata	Inocybe Spp.	Hebeloma Spp.	Thelephora terrestris	Boletus Spp.
1-0	RP					
	C-8					
	C-9					
	C-10					
2-0	RP					
	B-3	+	+	+		
	B-4	+	+			
	B-5	+	+	+		+
3-0	RP					
	A-1	+	+	+	+	
	A-12	+	+	+	+	
1-0	JP					
	A-7					
2-0	JP					
	B-5	+	+			
	B-10	+	+	+		+

Insect Control in a White Spruce Seed Orchard

For the past several years, fir coneworms, Dioryctria abietivorella (Grote) and the spruce budworm, Choristoneura fumiferana (Clemens), have damaged cones in the white spruce seed orchard at Cotton, Minnesota. In 1982, a study was initiated to determine the extent of damage caused primarily by the coneworms and to find possible control measures.

Forty-three white spruce trees were sprayed with acephate (½ lb. active ingredient/acre) on May 28, 1982. In the fall, cones were harvested from 16 treated trees and 16 treated trees and 16 untreated trees and they were examined for evidence of coneworm and budworm damage. See Table below.

Cone and Seed/Cone Counts of Acephate-Treated and Untreated White Spruce Trees

	Ave. # Cones Per Tree	Ave. # Damaged Cones Per Tree	% Damaged Cones	Ave. # Seeds Per Cone
Treated	18.0[a]	10.6	59	13.3[a]
Untreated	27.1	11.5	42	7.4

a = No significant difference in couplet as computed by the Student's T-Test at the 5% level.

While the acephate didn't reduce the number of cones damaged, it did seem to reduce the amount of damage suffered by individual cones and it also seemed to slow larval development. Larvae found in treated cones were ⅛" long whereas larvae in untreated cones were 1" long. Similarly, the extent of the observed feeding damage was much less in the treated cones. Treated cones produced more seeds/cone than did the untreated cones.

1983: Work will continue, trying several other systemic activity insecticides to find an effective control for the fir coneworm.

COOPERATIVE OAK WILT CONTROL WORK PROGRESS REPORT

Minnesota Department of Natural Resources and the
Department of Plant Pathology, University of Minnesota
July 26, 1982
Submitted by: Jennifer Juzwik

The initial work of a cooperative oak wilt control project between the Department of Natural Resources and the Department of Plant Pathology, University of Minnesota, was started in September 1982. Three areas located on the Carlos Avery Wildlife Management Area between Wyoming and Stacy, Minnesota, are involved. A preliminary report was prepared following the first treatment. The objective of this project as stated in that report is to test the effectiveness of two chemical silvicides, Tordon RTU and Dozer (Fenuron TCA) for their use in preventing root graft transmission of Ceratocystic fagacearum from trees in established oak wilt infection centers to adjacent healthy trees.

This report is a summary of the work accomplished during spring 1982. Some recommendations are also made for the followup of the treatment areas.

Spring 1982 Progress

The main 0.04 ha infection centers within each area had been previously divided into north and south halves; Tordon RTU (liquid) was applied to all northern pin oaks in one half during September 1981. Dozer (pellets) was applied to the other in June 1982. All trees within a 12.3 m radius of the last Ceratocystis fagacearum infected trees were also treated. The small, outlying infection centers in Areas 2 and 3 were not divided, but received either the Tordon or the Dozer treatment. Table 1 contains summary statistics for each infection center treated.

Dozer was applied on an individual tree basis at an approximate rate of 70 lbs/acre. The area within the average dripline of small, medium, and large diameter trees was used to calculate the amount of chemical spread under each tree. The Hopkins Chemical Company sales representative suggested that the pellets be crudely crushed since previous users had problems with the pellets breaking down too slowly. We followed this recommendation.

Several trees in the area were also treated with Tordon in June 1982. In most cases, this was a second treatment. Either the tree involved had been girdled in September 1981 but apparently had not received the Tordon treatment (oversight) or the application seemed to only be affecting a very small percentage of the crown. Some of the oaks receiving a first treatment were those which had been inadvertently missed in September 1981. Several trees in Area 3 which were to receive the Dozer treatment were also treated with Tordon because the supply of Dozer was limited. Information on these spring 1982 Tordon treatments is contained in Table 2.

No data on percent crown kill has been taken yet. First collection of data is planned for either September 1982 or May 1983. We did observe herbicide damage on vegetation surrounding the Tordon treated stems. Both herbaceous and woody plants were affected.

Permanent tags were placed on oaks in all areas so that close follow-up of the study will be possible. All oak wilt infected, Tordon treated, and Dozer treated trees were tagged on the south side at the base. Healthy northern pin oaks on the perimeter of each treatment area were also tagged at the base on the

side facing the treatment areas. These trees will be important in several years when the areas will be closely watched for the reappearance of oak wilt. The tag sets and numbering sequence used in each area are listed in Table 3.

Recommendations For Follow-up

A number of reports exist on the use of a variety of chemical silvicides for barrier strip establishment for control of oak wilt. A brief review of this literature found two main problems with the previously reported studies. We should try to avoid these if our study is to add to the knowledge of oak wilt control. In most cases, the treated areas had not been followed closely enough nor for a long enough period of time to adequately test the success of the treatments. In addition, those involved in some of the previously reported work failed to check for root kill. In those who did, only one third (at most) of the roots of single trees were killed by the silvicide. We know that C. fagacearum can survive in the root system of an oak wilt killed oak for 3-5 years. Thus, root-kill of chemically treated trees is an important consideration if the fungus is to be eliminated in an area.

In summary, the areas should be closely checked at least once each growing season. Late July or early August may be best. However, a careful evaluation of the silvicide effectiveness (success and failure) according to diameter of treated oaks should be made in spring 1983. If at all possible it would be advantageous to obtain some estimate of root kill in these areas at the same time. Any symptoms of active oak wilt within or adjacent to treatment plots should be noted. Checks for any possible subsequent oak wilt reoccurrence should be made once (preferably twice - late June and early August) during the next five or more years.

Some type of report on silvicide effectiveness, and the value of these chemicals in oak wilt control work should also be given to Dow and Hopkins Chemical Companies once the results are recorded.

TABLE 1 Summary of Northern Pin Oaks Treated With Two Chemical Silvicides in Three Areas in the Carlos Avery Wildlife Management Area

Site	Infection Center	Area Treated	Number of Cf[a] Infected Trees	Treatment	Part of Plot Treated	Date of Major Treatment	Trees Treated Number	Trees Treated DBH Range	Mean DBH
1	Main	0.2 ha	26	Tordon	North	9/81	43	10.4-48.2cm	24.3cm
1	Main	0.2	26	Dozer	South	6/82	49	7.9-53.0	20.9
2	Main	1.04	35	Tordon	South	9/81	68	6.4-39.5	17.5
2	Main	1.04	35	Dozer	North	6/82	99	7.0-68.0	18.1
2	South of Main	0.09	5	Tordon	Entire	9/81	56	7.9-52.8	17.1
3	Main	0.32	24	Tordon	North	9/81	67	6.8-58.4	21.0
3	Main	0.32	24	Dozer	South	6/82	43	7.3-23.0	12.7
3	West of Main	0.05	5	Dozer	Entire	6/82	25	8.2-62.0	20.5
3	North-west of Main	0.14	4	Tordon	Entire	9/81	77	9.4-40.4	16.5

[a] Cf = Ceratocystis fagacearum

TABLE 2 Northern Pin Oaks Receiving Tordon RTU Frill Girdle Treatment in June 1982

Site	Infection Center	Trees Tested Number	Trees Tested DBH Range	Mean DBH	Treatment Status
2	Main	6	10.2-57.7cm	29.8cm	First
2	Main	10	23.8-67.2	41.3	Second
3	Main	12	21.7-57.1	37.9	Second
3	Northwest of Main	11	11.1-18.3	14.8	First
3	Northwest of Main	5	21.4-40.4	32.5	Second

TABLE 3 Permanent Tag Designations and Numbering Sequences of Northern Pin Oaks in Three Chemical Silvicide Study Areas

Site	Infection Center	*C. fugacearum* Infected	Tordon Treated	Dozer Treated	Healthy Perimeter
1	Main	ow1-ow26	T1-T44	62-112	200-277
2	Main	ow5-ow37	T1-T83	1-36 and[a] 1-61	229-286
2	South of Main	ow1-ow4	T84-T139	----[b]	200-228
3	Main	ow5-ow28	T1-T66	78-120	200-276
3	Northwest of Main	ow1-ow4	T67-T143	----	200-276
3	West of Main	ow29-ow32	----	53-77	277-295

[a] Two sets of tags with overlapping number sequences used.

[b] Chemical not applied.