1981

FOREST INSECT AND DISEASE REPORT

Minnesota Department of
Natural Resources
Division of Forestry

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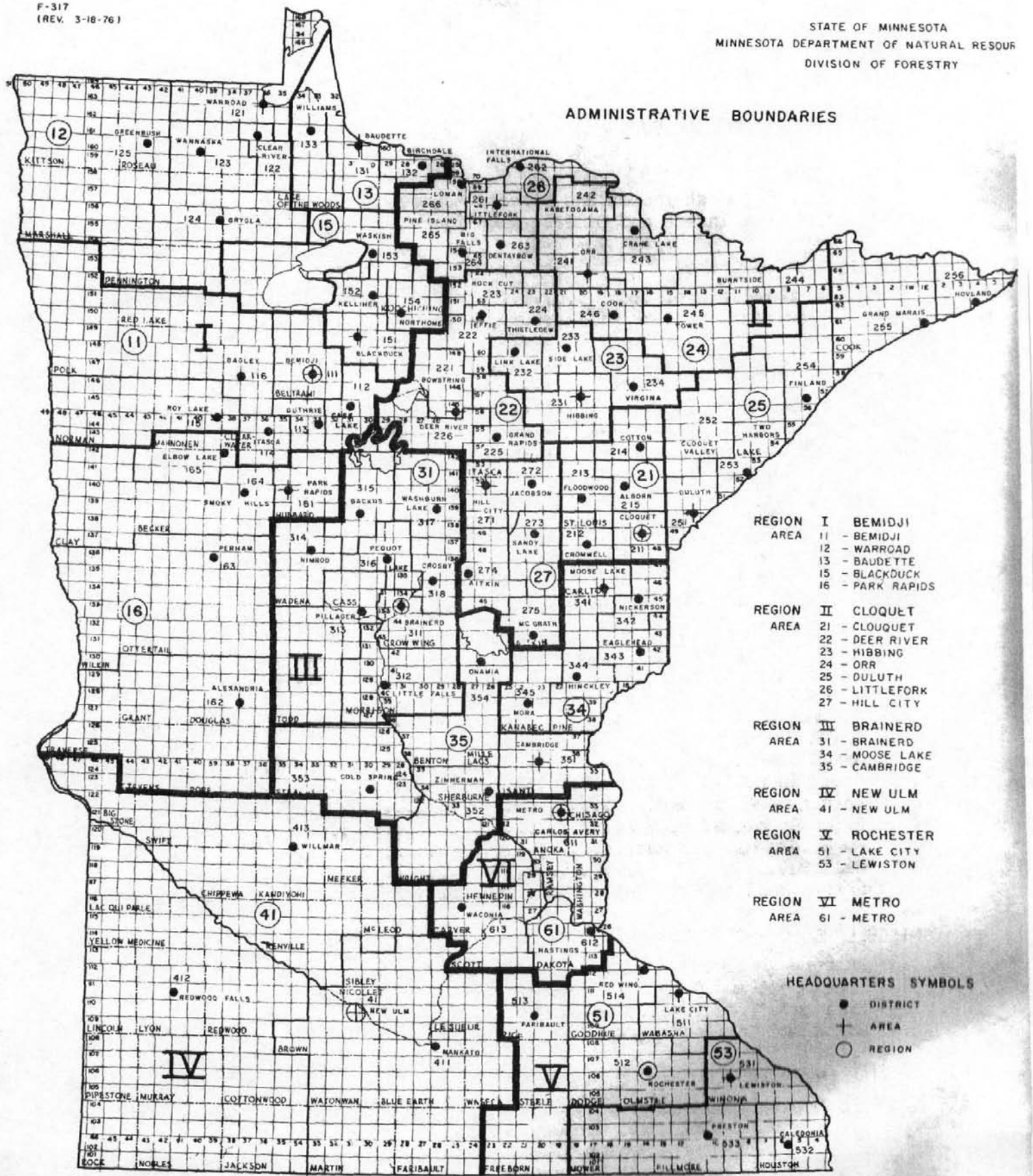
STATE OF MINNESOTA
MINNESOTA DEPARTMENT OF NATURAL RESOUR
DIVISION OF FORESTRY

ADMINISTRATIVE BOUNDARIES



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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1981 FOREST INSECT & DISEASE HIGHLIGHTS

The spring of 1981 was characterized by cold and wet weather. This weather pattern appeared to play an important role in limiting the impact of several defoliating insects. The pine tussock moth outbreak in Region III collapsed despite the fact that fall egg mass surveys had indicated a continuing infestation. The jack pine budworm population remained at low levels following the collapse of 1980. Forest tent caterpillar numbers continued to decline statewide. However, the Gypsy Moth Survey Program trapped over 100 moths within the Twin Cities area following the mild winter.

The Insect and Disease Unit cooperated with the University of Minnesota's Plant Pathology Department on two projects this year. One project was developed to evaluate methodology and conduct a survey of dwarf mistletoe incidence in Minnesota. The results of this study are contained in the "Special Projects" section of the report. The second project was a survey of sweetfern blister rust in Minnesota. This survey was centered in the major jack pine areas of the state.

A major change in program responsibilities occurred during 1981 when the responsibility for the Division's statewide herbicide program was shifted into the Insect and Disease Unit. The Unit now carriers responsibility for all pesticide use within the forestry programs. The change-over has made significant time demands on the Unit's manpower and will continue to do so in the future.

This year has also seen the incorporation of an intensified survey of insect and disease problems within the statewide forest inventory of Minnesota. A new reporting system within the Unit has also been developed to document program activities. After a second revision it appears to be solidified for 1982. The results of these new data gathering mechanisms should be extremely helpful.

The poor markets characteristic of 1981 began to affect the insect and disease program. A drop in demand for pine products left large volumes of pine material in the forests during the most hazardous period for bark

beetle buildup. In reaction to this hazard the Insect and Disease Unit developed harvesting guidelines for timber sales and thinnings in pine stands to reduce the potential for losses to bark beetles. A cooperative effort with the Forest Management and Utilization & Marketing Units produces guidelines that emphasized an integrated and improved management philosophy.

The 1981 Central International Forest Insect and Disease Conference was held in September in Bemidji, Minnesota.

INSECTS

Aspen Defoliators

Forest Tent Caterpillar - *Malacosoma disstria* Hubner

The present outbreak of the forest tent caterpillar, which began in 1977, declined considerably in most areas and collapsed in northwestern Minnesota. This is thought to have occurred because of the build-up of parasitic flies. In addition, an early but cold and wet spring may have contributed to mortality of newly hatched caterpillars. In some areas larvae probably starved to death. Overall, it was a combination of factors causing the decline.

Approximately a half a million acres were moderately to heavily defoliated in Lake, St. Louis, Carlton, and Pine Counties and another one-half million light and scattered in these counties plus Itasca County (see Map 1). There were local areas of defoliation in Becker County between Detroit Lakes and Park Rapids, and at Norway Lake in Kandihoyi County.

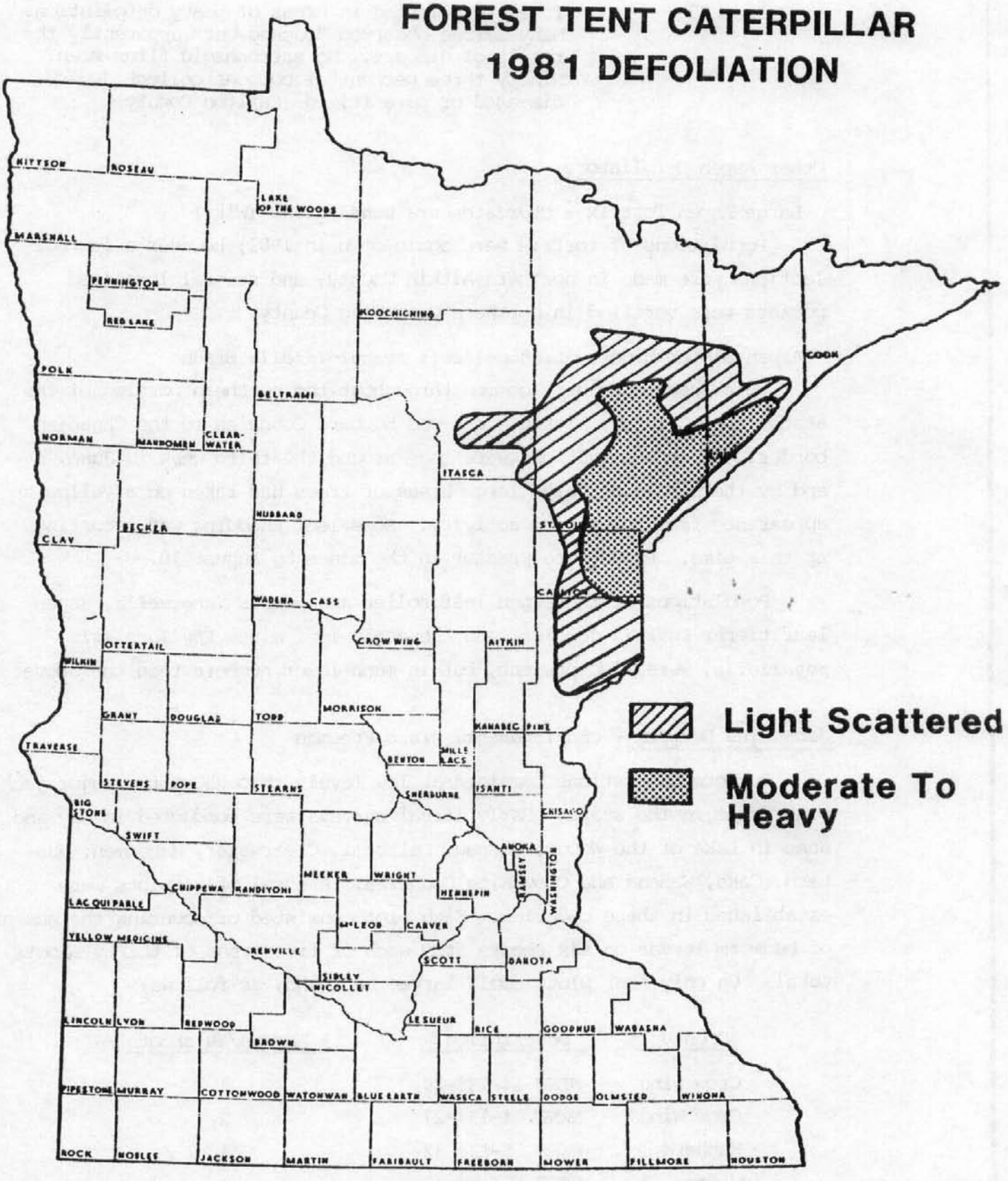
In some areas of Carlton County and south St. Louis County where heavy defoliation has occurred for four and five years, dead pockets of trees occurred. Plots were established in locations of heavy defoliation to assess mortality, incidence of disease, and increment loss. No data is available yet. The drought periods which occurred in the past five to six years have complicated the issue.

Outlook For 1982

Defoliation will continue in Lake, St. Louis, Carlton, Aitkin and Pine Counties, but populations can be expected to continue to decline due to continued buildup of parasitic flies (see Map 2).

Phenological Notes

May 1	- Egg masses beginning to hatch (Carlton County).
May 15	- Eggs still hatching (Carlton County).
June 9	- Sarcophagid flies very common (Carlton County).
June 12	- Mostly cocoon stage (Carlton County).


FOREST TENT CATERPILLAR
1981 DEFOLIATION
KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
PENNINGTON
RED LAKE
KOOCHICHING
COOK
POLK
BELTRAMI
NORMAN
MAHNOMEN
CLEAR-WATER
ITASCA
HUBBARD
BECKER
CLAY
WADENA
CASS
CROW WING
AITKIN
OTTERTAIL
WILKIN
GRANT
DOUGLAS
TODD
MORRISON
KANABEC
PINE
TRAVERSE
BENTON
MILLE LACS
STEVENS
POPE
STEARNS
SHERBURNE
ISANTI
CHISAGO
BIG STONE
SWIFT
ANOKA
MEEKER
WRIGHT
CHIPPEWA
KANDIYOHI
HENNEPIN
RAMSEY
WASHINGTON
LAC QUI PARLE
McLEOD
CARVER
YELLOW MEDICINE
RENVILLE
SCOTT
DAKOTA
SIBLEY
NICOLLET
LINCOLN
LYON
REDWOOD
LESUEUR
RICE
GOODHUE
WABASHA
BROWN
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
Light Scattered
Moderate To Heavy

June 29 - Trees refoliating in areas of heavy defoliation. Many larvae observed "sacked out" apparently the result of disease. No sarcophagid flies seen. Ninety-three percent of cocoons collected were diseased or parasitized (Carlton County).

Other Aspen Defoliators

Large Aspen Tortrix - *Choristoneura conflictana* (Wlk.)

Populations of tortrix were again down in 1981; however a few collections were made in northern Aitkin County, and several localized pockets were verified in northern Crow Wing County.

Aspen Blotch Miner - *Lithocolletis tremuloidiella* Braun

This insect was very common throughout the northern portion of the state, from Carlton, Aitkin, Cass and Hubbard Counties to the Canadian border. First observations were made around the third week in June, and by the middle of July, large areas of trees had taken on a yellowish appearance from the mining activity. Some leaf shedding was occurring at this time. Pupae were present in the mines by August 10.

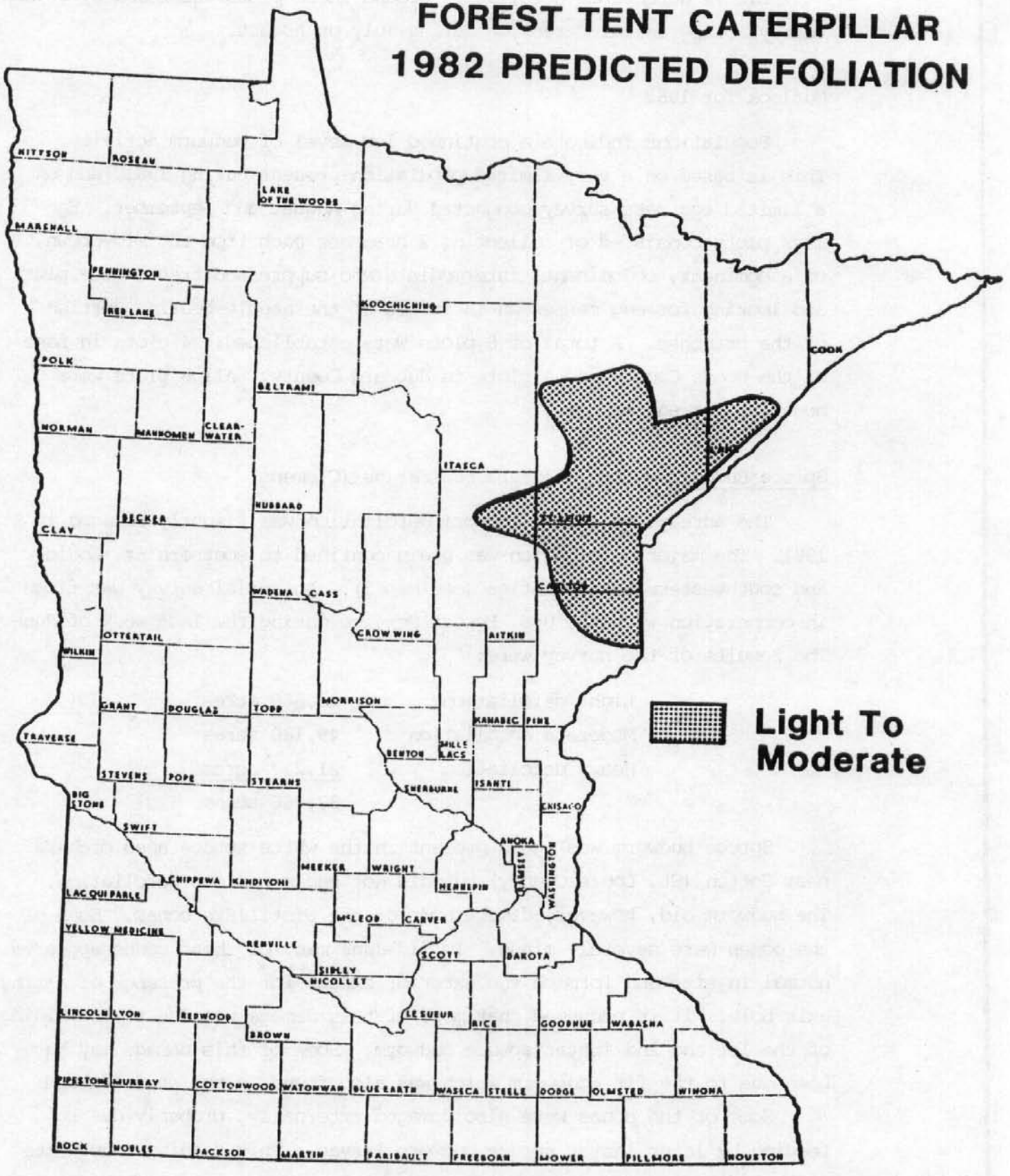
Populations of the aspen leaf roller *Anacampsis innocuella*, aspen leaf tierer *Enargia decolor*, and the aspen leaf miner *Phyllocnistis populiella*, were also present, but in much lower numbers than the above.

Jack Pine Budworm - *Choristoneura pinus* Freeman

Budworm populations remained at low levels throughout the major jack pine areas in the state. Early larval surveys were conducted in May and June in Lake of the Woods, Roseau, Beltrami, Clearwater, Mahnomen, Hubbard, Cass, Wadena and Crow Wing Counties. A total of 94 plots were established in these counties. Each plot consisted of counting the number of budworm larvae on six shoots from each of five trees or thirty shoots total. On only four plots could larvae be found, as follows:

County	Description	# Larvae/30 shoots
Crow Wing	NENW 14-136-29	1
Crow Wing	NWNW 4-134-27	2
Hubbard	NWSW 15-139-32	1
Wadena	NESE 16-138-33	1

FOREST TENT CATERPILLAR
1982 PREDICTED DEFOLIATION



Light To Moderate

Little detectable defoliation around these plots was found by ground surveys or by aerial detection during July or August.

Outlook for 1982

Populations indicate a continued low level of budworm activity. This is based on a very limited population present during 1981, and on a limited egg mass survey conducted during August and September. Egg mass plots consisted of collecting 2 branches each from the mid-crown of a dominant, codominant, intermediate and suppressed tree on the plot and looking for egg masses on 18 inches of the needle-bearing portion of the branches. A total of 8 plots were established: 4 plots in Lake of the Woods County and 4 plots in Hubbard County. All 8 plots were negative for egg masses.

Spruce Budworm - *Choristoneura fumiferana* (Clemens)

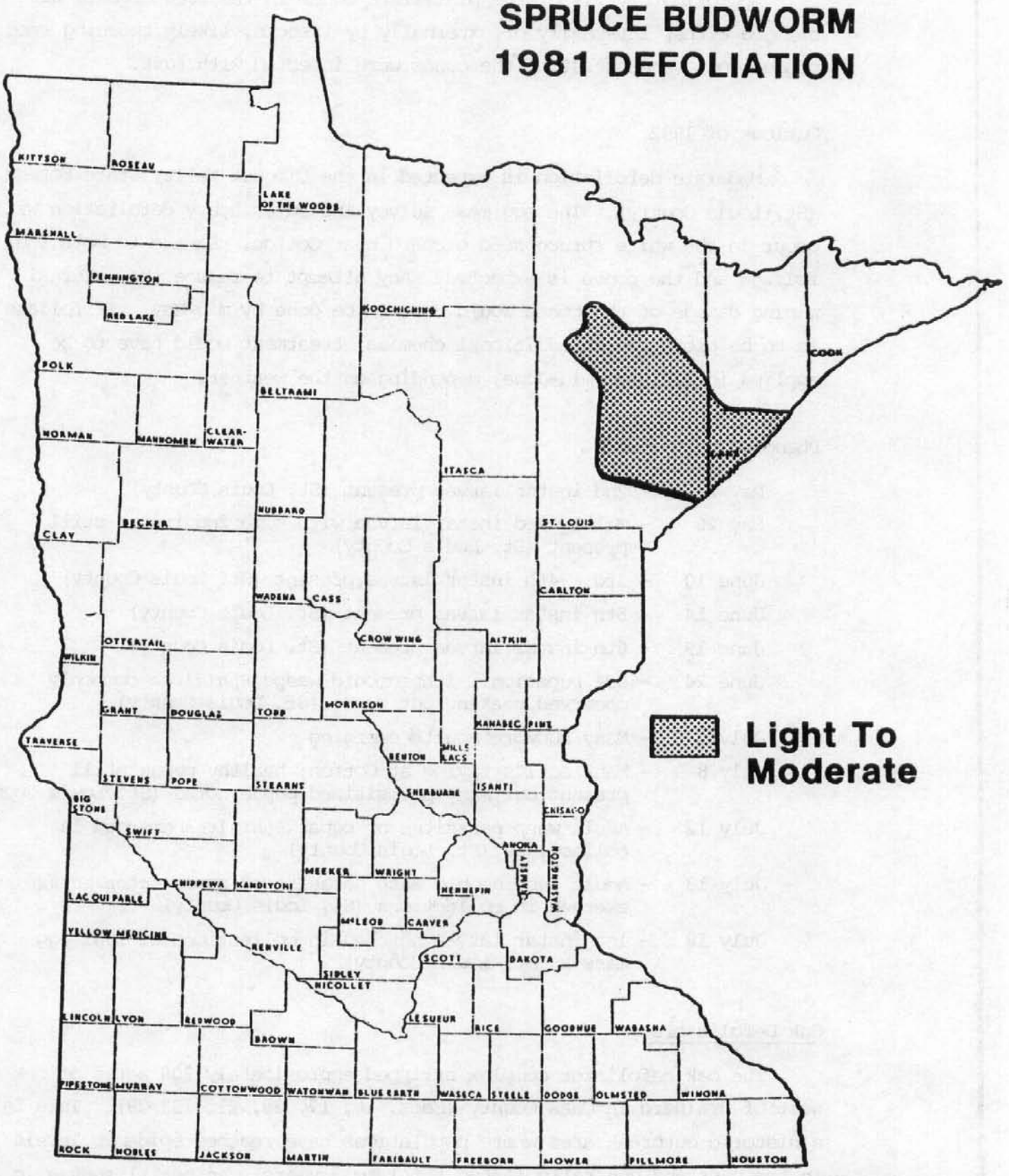
The acreage of spruce budworm defoliation was slightly reduced in 1981. The major defoliation was again confined to southern St. Louis and southwestern Lake counties (see Map 3). An aerial survey was flown in cooperation with the U.S. Forest Service during the last week of June. The results of the survey were:

Light defoliation	17,369 acres
Moderate defoliation	49,180 acres
Heavy defoliation	21,217 acres
	87,766 acres

Spruce budworm was again present in the white spruce seed orchard near Cotton (St. Louis County) but did not cause serious defoliation. The budworm did, however, damage some of the pistillate cones. Some of the cones were severely mined. In mid-June many of these cones appeared normal in size and form on the exterior except for the presence of a tiny exit hole. It is presumed that most of this damage was due to the mining of the 1st and 2nd instar spruce budworm. Some of this damage may have been due to the fir coneworm which was also found in the seed orchard.

Some of the cones were also damaged externally, probably due to feeding by later instar spruce budworm larvae. This feeding caused the cones to be misshapen and curled.

MAP 3


SPRUCE BUDWORM
1981 DEFOLIATION
KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
PENNINGTON
RED LAKE
KOOCHICHING
COOK
POLK
BELTRAMI
NORMAN
MAHNOMEN
CLEAR-WATER
ITASCA
HUBBARD
ST. LOUIS
CLAY
BECKER
WADENA
CASS
CARLTON
CROW WING
AITKIN
OTTERTAIL
WILKIN
MORRISON
GRANT
DOUGLAS
TODD
KANABEC
PINE
TRAVERSE
BENTON
MILLE LACS
STEVENS
POPE
STEARNS
SHERBURNE
ISANTI
CHISAGO
BIG STONE
SWIFT
ANOKA
RAMSEY
WASHINGTON
MEEKER
WRIGHT
CHIPPEWA
KANDIYOHI
HENNEPIN
LAC QUI PARLE
McLEOD
CARVER
YELLOW MEDICINE
RENVILLE
SCOTT
DAKOTA
SIBLEY
NICOLLET
LINCOLN
LYON
REDWOOD
LE SUEUR
RICE
GOODHUE
WABASHA
BROWN
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
Light To Moderate

Approximately 21% of the pistillate cones in the seed orchard were damaged either internally or externally by insects, likely reducing seed production. Another 4% of the cones were infected with rust.

Outlook of 1982

Moderate defoliation is expected in the Cloquet Valley State Forest (St. Louis County). The egg mass survey indicates heavy defoliation will occur in the white spruce seed orchard near Cotton. Damage to both the foliage and the cones is expected. Any attempt to reduce the internal mining damage of the cones would have to be done by mid-May. If foliage is to be protected an additional chemical treatment would have to be applied in early to mid-June, depending on the weather.

Phenological Notes

May 20 - 2nd instar larvae present (St. Louis County)

May 26 - Mainly 3rd instar larvae with some 2nd instar still present (St. Louis County)

June 10 - 3rd - 4th instar larvae present (St. Louis County)

June 14 - 5th instar larvae present (St. Louis County)

June 19 - 6th instar larvae present (St. Louis County)

June 24 - 83% pupation. Ichneumonid wasps *Ephialtes* commonly observed seeking out pupae (St. Louis County)

July 3 - Many budworm adults emerging

July 8 - Many adults flying at Cotton; healthy pupae still present but many parasitized pupae noted (St. Louis County)

July 12 - Adult wasp parasites of pupae (*Ephialtes*) emerged in collections (St. Louis County)

July 13 - Adult Ichneumonid wasp parasite of pupae *Ictoplectus* emerged in collections (St. Louis County)

July 18 - 1st instar larvae hatched in collections of 1981 egg masses (St. Louis County)

Oak Defoliators

The oak defoliator complex stripped approximately 300 acres of oak west of Brainerd in Cass County (Secs. 16, 17, 20, 21 133-29). This is a historic outbreak area where populations have reached epidemic levels in the past and generally lasted for 1 to 3 years. An aerial survey in

July detected heavy defoliation. Ground checks were made in August when the predominantly bur oak stands were totally stripped. During ground checks larvae of the red humped oakworm *Symmerista canicosta* Franc., variable oak leaf caterpillar *Heterocampa manteo* (Dbldy), orange striped oakworm *Amisota senatoria* (J.E. Smith), and other heterocamipids were collected. Defoliation is expected to be heavy again in 1982 but no tree mortality is expected until there are three consecutive years of heavy defoliation.

Introduced Pine Sawfly - *Diprion similis* (Hartig)

Populations remained at endemic levels in historic outbreak areas around the village of Sunrise (4-35-26) and in the Grandy Pines area north of Cambridge in Isanti County. Aerial and ground surveys in July and August indicated only light defoliation in these areas. Moderate defoliation continued in mature stands along the Mississippi River in the Little Falls district of Morrison County. The Morrison County park (14-41-32) was sprayed twice. A ground spray on 6-10-81 testing acephate did not achieve uniform coverage or control. The 24 acre site was sprayed with carbaryl from a helicopter in August and adequate foliage protection was achieved. Adjacent stands were not treated. Heavy defoliation and additional top kill were not observed, however, in stands known to be infested in 1981 (18-129-29), (9-130-29) and (10-42-32).

Outlook for 1982

Populations are expected to continue at moderate levels in scattered locations where mature white pine stands are adjacent to known outbreak areas along the river drainage.

Bark Beetles - *Ips*. and *Dendroctonus* spp.

Two genera of bark beetles, *Ips* and *Dendroctonus*, were encountered during 1981.

Dendroctonus spp.

Dendroctonus valens beetles were found in a red pine plantation in the Cloquet District, 18-48N-18W. The plantation was being row thinned during

the spring of 1981, and the beetles were found to be invading the freshly cut stumps.

In the Pillager District, 8-134N-30W, Cass County, the eastern larch beetle, *Dendroctonus simplex*, was found invading a tamarack stand which had been defoliated by the larch sawfly, *Pristiphora erichsonii*. The bark beetle had caused greater than 50% tree mortality. Natural openings in the stand due to the mortality were being invaded by lowland brush which will hinder natural regeneration. The stand is being salvaged, and presently 805 cords have been sold. A buffer strip of harvested tamarack is being planned on the northern edge of the stand, and an additional 150 cords of tamarack are scheduled for removal. The intent of the buffer strip is to isolate the beetle infested stand from surrounding, non-infested tamarack.

Ips spp.

Losses of standing trees due to these beetles were minimal in Region III, possibly due to abundant rainfall starting in late spring. Beetle activity, however, was high in the unsalvaged budworm affected jack pine stands in the Nimrod District in Wadena County.

In the same red pine plantation where *Dendroctonus valens* was found (Cloquet District, Region III), *Ips* beetles were found in both standing and cut trees. Beetle buildup may have been due to heavy porcupine damage occurring in 1980 and 1981. Approximately 30% of the trees throughout the plantation were damaged or killed by the porcupines. In some pockets up to an acre in size, nearly 80% of the trees were damaged by the porcupines. The highest populations of bark beetles were found in the stems of trees which were cut down during the thinning operation but not removed. Beetles, however, were also found in some of the standing trees recently damaged or killed by porcupines.

In red pine stands in the Littlefork District 21-65N-25W, and in the Orr District, 21-66N-22W, 6-20 inch DBH trees were being killed by *Ips* beetle attacks. The attacked trees were residual groups of trees left after the surrounding stands were clearcut. The trees were damaged by wind, and the bark beetles built up in the wind thrown trees and damaged tops. It was recommended that the remaining trees be cut or at least all trees with active bark beetle populations be cut and removed.

Bark beetles were also found to be killing trees in a private red pine plantation in Aitkin County. The beetles were found in trees in association with the root collar weevil and the Zimmerman pine moth.

In Region I, during spring aerial fire detection flights, a number of private plantations in southern Beltrami County and northern Hubbard County were found to have pockets of dead trees. On ground inspections showed that mortality resulted from *Ips* beetle invasions during late in the growing season in 1980. The trees remained green until March of 1981. All beetle infested plantations showed evidence of cutting in 1980. All but one had been thinned during the growing season and the slash left on the ground. In the one plantation where thinning had not taken place, survey lines had been cut through the plantation, and the beetle infested pockets were limited to the area immediately adjacent to the survey lines.

County plantations in Clearwater County also showed signs of heavy bark beetle activity. Activity was related to past thinning activities, drought-killed jack pine, and jack pine defoliated in previous years by the jack pine budworm.

Because of a mild winter which aided adult beetle survival, the early and dry spring, and predictions of dry growing season, there was considerable concern over the possibility of heavy bark beetle infestations occurring during 1981. Three approaches were used to try to prevent a large scale infestation:

1. Where larger slash was left after a thinning operation and the slash was green and attractive to bark beetles, this slash was pulled out of the plantation and burned during the early summer of 1981. This was done in the red pine plantation in the Cloquet District, and no beetles were found in healthy trees in the plantation throughout the summer.
2. Thinning operations were suspended in pine stands from March 1 to August 1 and all thinning operations were encouraged to begin as soon as possible after August 1 and to be finished as early in the winter as possible. The PFM foresters in Region I, in particular, encouraged the land-owners they worked with to follow this schedule.
3. Trap trees were used in Clearwater County on county land to try to reduce the population of the first generation beetles. Live, green

pine were cut down along the edges of bark beetle pockets during the week of April 13. The trees were not bucked up and the limbs were not lopped off. The objective was to cut down approximately ½ as many trap trees as dead trees in the pocket. The trees were kept in the shade and close to the pocket.

By May 7, the trees were being attacked and there were approximately 10 dust piles/square foot. By May 18, 30 dust piles/square foot were present on the trap trees, but no standing trees were found attacked. By June 5, the trap trees were removed and burned. Only one tree around one pocket was found to be invaded by bark beetles in July. No other bark beetle activity was noticed in the trap tree areas.

Another potentially damaging bark beetle situation developed during 1981. Traditionally strong pine markets became virtually non-existent by breakup time. By the first of June, many piles of winter cut jack pine were being stored on decks located in the timber sale areas, and many sale areas were surrounded by mature stands of jack pine or sapling to pole-size red pine plantations. A bolt market developed during this time, but the pulp market was nearly shut down.

For example, in Wadena County, 3,000 cords of jack pine were decked in jack pine stands for the entire 1981 growing season. No additional on-site losses could be found by the end of the growing season because of the abundant rain experienced in this area. Also large stands had been clearcut because of a previous budworm infestation, and those future planting sites helped to isolate some stands from the decked wood. This isolation may have increased beetle dispersal thereby decreasing concentrated attacks. Monitoring of these stands will take place to see if the *Ips* buildup in the log decks caused any problems.

A similar situation occurred in the Beltrami Island State Forest in Roseau and Lake of the Woods Counties. There were approximately 2,250 cords located in 42 different locations. In mid-June, all locations were inspected and a hazard rating was made. The hazard rating system was as follows:

Conditions	High Hazard	Low Hazard
Surrounding Timber Types	Pine	Hardwoods or mixed pine/ hardwoods

(continued)

Conditions	High Hazard	Low Hazard
Bark Beetle Activity	Common (easily found)	Light (had to make a real effort to find activity)

Both high hazard conditions would have to be present to rate the location a high hazard. Bark beetle activity was determined by looking for dust piles or by slicing through the bark and finding adults and larvae. Since many of the piles of sticks were 6 to 10 feet tall and 20 to 60 feet in length, only the top 2 or 3 layers of sticks were inspected.

The results showed that 100% of the sticks inspected had some bark beetle activity in them. 80% of the sticks were rated common, and the other 20% rated light. Based on the common rating and the presence of pine stands surrounding the piles, 18 locations containing approximately 1,000 cords were rated as high hazard.

Contacts were made with the pine using forest industry to see if they would accelerate their buying of the pine. Poor market conditions, however, prevented the industry from significantly increasing their buying.

Inspection of many of the sites in mid-August did not show any attacks in the surrounding stands. It did appear, though, that second generation beetle attacks were made deeper into the piles. The piles were large enough that the interior sticks did not dry out, and those then were more attractive to the beetles than the standing trees adjacent to the wood piles. The abundant rainfall received during the growing season also contributed to the standing trees being less attractive to the beetles than the wood piles.

Because bark beetle problems often are man-caused and during harvesting activities opportunities arise when conditions can be manipulated to minimize bark beetle activity, both timber sale and thinning guidelines were developed. These guidelines dealt with logging methods, slash manipulation, and timing of activities.

Outlook for 1982

Bark beetle activity will continue in stands under stress due to improper management; adverse weather; and insect, disease, animal or fire damage.

Phenological Notes

April 15	- Adults beginning to start galleries in Clearwater County
May 6	- Adults beginning to start galleries in northern St. Louis County
May 7	- Trap trees are attacked at 10 dust piles/square foot in Clearwater County
May 15	- Red pine just beginning to candle out in Carlton County
May 18	- 30 dust piles/square foot on the trap trees, egg laying is occurring but larvae are also present (Clearwater County)
June 5	- Trap trees are removed in Clearwater County
June 15	- First generation larvae beginning to pupate in Lake of the Woods and Roseau Counties
June 17	- First generation larvae beginning to pupate in Carlson County
June 18	- Callow adults found in Lake of the Woods and Roseau Counties
July 1	- Callow adults found in Carlton County
July 6	- First generation attacks of standing trees show fading foliage and emergence holes in Clearwater County
July 13	- Second generation nuptial chambers are being constructed in Lake of the Woods County
August 13/14	- Second generation pupation occurring in Lake of the Woods County
September 18	- Second generation mostly in the callow adult stage; some emergence has taken place, and third generation galleries are being constructed in Koochiching County.

Larch Sawfly - *Pristiphoro erichsonii* (Hartig)

In Region I, larch sawfly populations were not a problem in natural stands. No field reports were received and no defoliation was observed from the roadside or from the air. The two (2) acre upland planting of tamarack north of the Badoura nursery in Hubbard County sustained heavy defoliation. This was the fourth year of defoliation and tree mortality is occurring.

In Region II, sawfly populations were generally low but scattered defoliation occurred in Aitkin, Carlton, southeastern Itasca and Lake counties.

Light to moderate defoliation occurred in an area north of Canyon in St. Louis County. Oviposition was observed in Carlton County on June 14 and first and second instar larvae were collected in Aitkin County on July 1.

In Region III, defoliation was observed in Pine, Cass and Crow Wing Counties.

Populations appear to be increasing in Regions II and III. More extensive aerial surveys will be conducted in 1982.

Yellowheaded Spruce Sawfly - *Pikonema alaskensis* (Rohwer)

In Region I, the sawfly was not a problem in forest plantations. During a general plantation survey conducted in the Region, one of 4 plantations having a white spruce component showed signs of sawfly activity. However, only 1% of the trees were being defoliated. In a planting in Clearwater County, (STR 25, 145-36) in which past years sawfly feeding was evident, 40% of the trees were fed upon in 1981 but only 10% of the shoots on each tree were damaged.

In Region II, the sawfly damaged open growing plantings along roadsides and ornamental white and Colorado blue spruce in Aitkin, Carlton, St. Louis and Itasca Counties. It was present but at lower levels in Lake County. Moderate to heavy defoliation occurred in the following two white spruce plantations in Aitkin County: (STR 27, 50-22) in Sandy Lake District and, (STR 12, 52-22) in Jacobson District. Both of these plantations were sprayed in 1978 because of high sawfly populations. A county plantation in northwestern Aitkin County was sprayed in 1981 to prevent tree mortality. It was also necessary to spray a 20 acre State plantation in the Deer River District (STR 16, 143-28). One half of the plantation was sprayed with Sevimol-4 (1 qt. in 5 gal. water/acre) and the other half was sprayed with Seven XLR (1 qt. in 5 gal. water/acre) using a backpack mist blower. Both chemicals gave excellent results.

In Region III, sawfly populations continued as high levels in scattered open grown white spruce plantings. The 5 acre white spruce seed orchard west of General Andrews State Nursery (STR 16, 45-21) was sprayed in late June with malathion using a back pack sprayer. Other control operations tested the effect of orthene delivered from back pack mist blowers to individual trees in open field plantings in the Eaglehead district on 6-29-81 and Kathio State Park on 6-22-81.

A first record of yellowheaded spruce sawfly south of the Twin Cities was made this summer in Prior Lake (STR 31, 144-22). It was felt that the sawflies were imported into the area several years ago on white spruce transplanted from northern Minnesota.

Outlook for 1982

It is likely sawfly populations will be at high levels in some plantations again in 1982. Some of these plantations, especially young, open growing plantations, which have suffered defoliation the last several years, may require spraying to avoid tree mortality. Plantations should be checked in early June so control operations can be planned. Spraying should be done when the majority of the larvae are in the 3rd instar, mid to late June depending on the weather.

The two plantations in Aitkin County which suffered moderate to heavy defoliation in 1981 (STR 27, 50-22) and (STR 12, 52-22) should be checked early in 1982. Control is likely to be necessary.

Phenological Notes

June 8	- Adults still ovipositing (Carlton County) defoliation occurring (Region III)
June 10	- 1st instar larvae present; scarification of needles noticeable (Carlton County)
June 12	- Some adults still active (Aitkin County)
June 13	- 1st and 2nd instar larvae present (Carlton County)
June 15	- Homeowners being advised to spray for control (Region II) (Aitkin County)
June 19	- Ichneumonid wasps attacking larvae
June 22	- Bare branch tips evident (Region I)
June 29	- 4th and 5th instar larvae present (Aitkin County)
July 6	- Many larvae completed feeding. 5th instar larvae still feeding in Jacobson and Sandy Lake Districts. Many larvae parasitized. Possibly *Ephialtes* (Aitkin County)
July 12	- Most feeding completed but a few larvae still present (Aitkin County)

Gypsy Moth - *Lymantria dispar* (Linneaus)

Evidence of an established breeding population in Minnesota became stronger during 1981. Pheromone trap catches of adult male moths increased significantly in the Twin Cities Metropolitan area. One hundred and eight moths were caught at 64 locations during July and August of 1981. This compares to 27 moths at 17 locations the previous year. The size of the area in which moths were trapped expanded to include the more rural Scott, Anoka and Washington counties. In addition, the first catches outside Region VI were made this past season within the City of Rochester. This is of particular interest because Region V has the greatest potential for significant damage to its oak stands by outbreaks of gypsy moth.

Pheromone traps were placed in state parks and forest campgrounds located in the southern two-thirds of the state. No moths were trapped in these locations. A grid system of traps across selected metropolitan areas yielded the 108 moths. Despite the intensive trapping by APHIS and Minnesota's Departments of Agriculture and Natural Resources, location of a bona fide larval stage infestation has not been possible to date. This is not surprising since the population is still at a very low level.

Pheromone trapping will be carried out again during July and August of 1982. In those areas where significant catches were made in the past, trapping will be intensified. In addition, field surveys will be made to locate feeding larval populations or egg masses in those areas that have, in the past, produced high numbers of adult moths.

Pine Tussock Moth - *Dasychira pinicola* (Dyar)

Pine tussock moth populations were lower in numbers in 1981 in both areas that have had previous outbreaks: Mission Township (136-27) of Crow Wing County and the General Andrews State Forest (GASF) in Sturgeon Lake (45-20), Windemere (45-19), Kettle River (44-20), and Norman (44-19) Townships of Pine County. Larval surveys (Table 1) conducted in the GASF on 6/4/81 indicated reduced populations compared to the 1980 outbreak levels. Drop tarp samples (Table II), collected on 6/11/81 confirmed this observation. Aerial survey in early July detected only light defoliation in the GASF. August flights detected no defoliation in Mission Township. The fall egg mass survey (Table III) predicts continued low levels in 1982.

Larval and pupal collections were done in the GASF during 1981 to obtain parasites and disease organisms for identification by the Beltsville laboratory and the forest insect and disease laboratory in Connecticut. Verifications for the parasites have not yet returned from Beltsville laboratory.

The warm moist weather conditions that occurred throughout the 1981 larval feeding period produced an abundance of larvae that were apparently diseased by bacterial, fungal and viral agents. Additional samples will be taken and resubmitted in 1982 for positive identification.

Field tests of compounds provided by the Canadian Forest Service continued in 1981 to refine the synthetic lure used in pheromone trapping. For the first time traps were placed in Mission Township of Crow Wing County. Male moths were collected in low numbers. Field tests will continue in 1982 to refine this needed survey tool. Final results will be published by the Sault Saint Marie Research Centre.

TABLE I
PTM LARVAL SURVEYS

LOCATION	COLLECTION DATE	# LARVAE ON 5 BRANCHES FROM EACH SAMPLE TREE SAMPLE TREE # 1	2	3	4	5	TOTAL
Nursery	6/4/81	0	0	2	1	1	4
Nursery	6/4/81	1	0	0	0	-	1
Nursery	6/4/81	0	0	0	-	-	0
Nursery	6/4/81	0	0	0	0	0	0
SESE 11-44-20	6/4/81	0	0	0	0	0	0
NESE 1-44-20	6/4/81	8	5	10	18	5	46
Median South Interstate 35	6/4/81	0	0	0	0	0	0
NWSW 19-45-19	6/4/81	0	1	2	4	1	8
Center NE¼ 25-45-20	6/4/81	0	0	0	0	0	0
SESW 30-45-19	6/4/81	0	0	0	0	0	0
NWNE 31-45-19	6/4/81	0	0	0	0	0	0
B Median North Interstate 35	6/4/81	8	2	2	3	6	21
A Median Center Interstate 35	6/4/81	3	2	2	0	0	7

TABLE II
DROP TARP COLLECTIONS OF PTM LARVAE
6-11-81

LOCATION	NUMBER OF LARVAE 6 YARDS^2 OF DROP TARP UNDER AN OPEN GROWN 10-20' JACK PINE.* TREE # 1	2	3
1-44-20	4	6	3
6-44-19	10	10	6
N33-45-19	3	2	0
S33-45-19	0	0	0
29-45-19	3	7	4
19-45-19	2	0	1
30-45-19	5	9	12
31-45-19	0	2	2
17-45-20	4	3	1
18-45-20	12	7	18

*Historically tarp collections of 50 to 75 larvae per tree were considered to represent epidemic levels that would result in severe defoliation. During outbreak years, counts of 300 per tree were obtained.

TABLE III
PTM FALL EGG MASS SURVEY
8/12/81

PLOT #	LOCATION	EGG MASSES/DOUBLE ARM SWEEP/TREE # OF TREE 1	2	3
1	NE¼ 25-45-20	1	1	0
2	SWSE 25-45-20	0	0	0
3	SENE 30-45-20	0	1	0
4	NWNE 31-45-19	0	0	0
5	NWNE 26-45-20	0	0	1
6	SWNW 6-44-19	0	0	0
7	SENE 7-44-19	0	0	0
8	NENE 12-44-20	0	0	0
9	SESE 13-45-20	0	0	0
10	NWNE 24-45-20	0	0	0
11	NESW 24-45-20	0	0	0
12	NWSW 19-45-19	0	0	0
13	SESW 20-45-19	0	0	0
14	NE 29-45-19	0	1	0
15	NESE 29-45-20	0	0	0
16	SWNE 32-45-19	0	0	0
17	NENE 26-45-20	0	0	0
18	NENE 35-45-20	0	0	1
19	NENW 35-45-20	0	0	0

DISEASES

Diplodia Tip Blight - *Diplodia pinea* (Desm.) Kickx

In Regions III and VI, Diplodia tip blight was observed on Austrian pine in the Littlefalls District (STR 11 & 14, 42-32) Morrison County and in Carlos Avery District (STR 26, 31-21) and (STR 30, 28-20) in Washington County. In the first two cases Austrian pine was planted in small strips between larger blocks of red pine. The last case was a 5 acre Austrian pine plantation. Diplodia had caused extensive branch mortality and reduced vigor in the Austrian pine. Sanitation and salvage cuts to remove the Austrian pine component were recommended.

In Region II, Diplodia tip blight was found to be causing problems in many areas of Itasca County. In a private uneven aged red pine stand in Itasca County the disease was killing trees up to 10 to 20 inches DBH. Sanitation was recommended. Overstory red pine and jack pine were thought to be the source of Diplodia infections killing young 5-15' tall red pine plantations in Itasca County (STR 29, 60-24) and St. Louis County (STR 22, 55-14). Because fruiting on the cone scales of nearly mature red and/or jack pine was the major source of inoculumn it was recommended that those trees should be removed to reduce subsequent infection of the younger pines.

Outlook for 1982

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.

Scleroderris Canker and Dieback - *Gremmeniella abietina* (Gremmen)

The European strain of Scleroderris canker has not been found west of the State of New York. The North American strain was not found in any new locations in Minnesota in 1981. During the summer of 1981, 24 red pine, jack pine and white spruce plantations were inspected in Region I to monitor

insect and disease activities. No evidence of Scleroderris canker was found in any of these plantations.

The Federal government plans to drop its quarantine on Scleroderris canker primarily because it is expensive to maintain a quarantine and is not likely to completely prevent the spread of the disease. Several states including Minnesota have been considering imposing individual State quarantines to slow the spread. The scientists involved in research of the disease still consider it a serious threat to Minnesota especially to the red pine resource.

Pine Wilt Disease - *Bursaphelenchus xylophilus* (Steiner and Buhrer)

The pine wood nematode was confirmed in declining Scots pine *Pinus sylvestris* in Crow Wing County in 1981. Adjacent red *P. resinosa* and jack *P. banksiana* pines were not affected. To date this native wilt disease has only been noted in scots and Austrian pine *P. nigra* in Washington County windbreaks and scots pine Christmans trees in Sherburne County. The disease appears to be a gradual decline of introduced species stressed by environmental factors or other insect and disease agents. No statewide survey is presently conducted for this pest. The Division is supporting survey and research work being conducted by the Department of Plant Pathology of the University of Minnesota.

Outlook for 1982

New county records will be verified by sampling declining conifers. The disease does not appear to be a threat to managed stands.

Oak Mortality

In Region III, two lined chestnut borer *Agrilus bilineatus* and Armillaria root rot caused twenty acres of oak mortality in a mixed northern hardwood stand in Cass County (30-142-30). Directed cuts will be used to remove the infested material. These two agents will continue to be problems in the sand plain oak.

In Region II, two red oak trees on private land near Big Sandy Lake in Aitkin County (STR 3, 49-23) were found to be wilting due to oak wilt. The dying trees were found in the only known oak wilt on this site. However, oak wilt has not been active in this pocket for the past three years.

Oak Wilt continues to be a problem in the southern one third of the Region III and all of Region VI. A study being conducted in the Carlos Avery Wildlife Area is detailed below. An aerial survey conducted in July mapped pockets of oak mortality in Stearns, Benton, Sherburne, Isanti and Wright Counties. Ground checks in 1982 will determine the causative agents. Homeowners in the Big Lake area of Sherburne County were interested in oak wilt identification and mechanical and chemical control alternatives.

In Region V, on August 3 an aerial survey was conducted using color infrared film type 2443 at a scale of 1:15840 across Region V. Approximately 2600 acres were photographed on scattered tracts of state owned land within the Memorial Hardwood Forest. Active pockets of oak mortality were detected in:

County	Location	Estimated Acres
Wabasha	SENE 7-110-10	3
	SWNW 7-110-10	7
	SENW 34-110-10	3
Winona	NWSE 14-107-7	3
Houston	SESE 26-102-4	1
	SESE 23-102-4	1

Further ground checking will be done in 1982 for determination of casual agents, past history, estimates of volume affected.

Cooperative Oak Wilt Study

In Region VI, a cooperative study is underway between the Minnesota Department of Natural Resources and the Department of Plant Pathology, University of Minnesota. The objective is to test the effectiveness of two chemical silvicides, Tordon RTU and Dozer, for their use in preventing root graft transmission of *Ceratocystis fagacearum* from trees in established oak wilt infection centers to adjacent healthy oaks.

Three areas with active oak wilt infection centers are to be treated. The areas are located on the Carlos Avery Wildlife Management Area bordered by County roads 22, 19 and 75, and by Interstate-35. All have an infection center approximately one-tenth acre in diameter. Area 1 has no additional infection centers while areas 2 and 3 have two, small, side centers which resulted from overland transmission in 1980. Northern pin oak is the primary tree species on these sites. Bur oak, maple and aspen are also found.

The one-tenth acre infection centers within each area were divided into north and south halves for treatment purposes. The small, outlying infection centers in areas 2 and 3 were also treated, but not divided into halves for separate treatments. All apparent *Ceratocystis fagacearum* infected trees were tagged with red plastic strips on the south side at 1.3 meters height. Tordon treated trees were marked with white strips and trees for Dozer treatment with orange, all at 1.3 meters. The treated trees included all living northern pin oaks located within the infection center and those on the edges that were within 50 feet of the outermost, known infected tree.

On September 10-11, 1981, all trees were tagged. Those receiving Tordon treatment were frilled at the base with either an axe or a chainsaw. The chemical was applied undiluted (according to the label) to the cuts in the outer sapwood with a spray bottle. Because Dozer is most effective when applied before or during the active growing season, fall treatment seemed unwise. During spring 1982, the chemical will be applied in the pelleted or solution form to the drip-line area of all the orange tagged trees.

The areas will be closely checked several times in summer 1982. Tree diameters and silvicide effectiveness information (success and failure) on the treated trees will be carefully recorded. Any signs of active oak wilt within or adjacent to treatment plots will be noted. Checks for any possible subsequent oak wilt reoccurrence will be made two times per growing season during the next five years.

Dutch Elm Disease - *Ceratocystis ulmi* (Buism)

Dutch elm disease remained the number one disease problem of urban trees and a significant problem in the state's woodlands. All northern regions reported a continued spread and dramatic increase in disease incidence of woodland elms. The Southern and Metro regions had continued high levels of disease in all woodlots where elms remained. In cities, where the disease affects valuable shade trees, the disease rate increased significantly statewide despite continued control efforts.

A second successive mild winter during 1980-1981 contributed to the increased losses. Samples taken during the spring of 1981 by the Extension Service showed a three-fold increase in overwinter survival of adult native elm bark beetles. Survival of the other insect vector, the smaller European elm bark beetle, was assumed to similarly have improved.

The goal of elm tree removal projects in 1981 was the elimination of safety hazard trees and trees jeopardizing local disease control efforts. Tree removals were primarily done in state parks and along state trails. Costs varied widely with tree size, location and amount of disposal required on a given site. Removal totals by region are as follows:

State Park	# Trees Removed	Cost/Tree
Region 1 - Itasca, Lake Carlos and Old Mill State Parks	427	$ 24.64
Region 3 - Father Hennepin, Crow Wing, Interstate and Lindberg State Parks	120	$ 22.50
Region 4 & 5 - Whitewater, Sakatah Lake, O.L. Kipp and Fort Ridgely State Parks	245	$ 17.63
Region 6 - Afton, Snelling and William O'Brien State Parks - Minnesota Valley and Luce Line Trails	1,116	$ 15.76

Aspen Bronzing

Five areas of suspected leaf bronzing of aspen in Beltrami and Hubbard Counties were first detected during August of 1980. During that same year, trees showing the bronzing symptoms were marked with flagging in two of the locations in order to follow the bronzing symptoms from year to year.

In 1981, the flagged trees leafed out with apparently healthy, green leaves. These trees remained "normal" and "healthy" without any bronzing symptoms until at least July 29. On August 1, all trees flagged showed "textbook" symptoms of leaf bronzing including bronzed leaves, yellow petioles and color change occurring on branches low in the crown and on leaves toward the inner part of the crown. The other sites found in 1980 were also checked, and those too showed the bronzing symptoms after August 1st.

In addition to the 5 sites found previously, 2 additional sites were found, one each in Hubbard and Beltrami Counties.

On one site which had been marked in 1980, all trees on the site were marked, measured and had the bronzing visually rated. On selected trees,

individual branches were marked in order to observe the progress of the symptoms. Thirty-eight trees were found characterized as follows:

Height range: 8 feet to 50+ feet
DBH range: 1.0 inch to 13.3 inches
Percent of crown affected: 10% to 99%

The bronzing symptoms seemed to have shown up on all sizes of trees, and the extent of crown affected was very variable. Often only one portion or one branch of the crown showed the symptoms. After 2 years of observation, no tree or branch mortality were observed. Also, in this particular site where the trees are marked, both bigtooth and quaking aspen are present, but more bigtooth than quaking aspen showed the symptoms.

Septoria Leaf Spot - *Septoria musiva* Pk.

This leaf spot disease was very common on balsam poplar from Todd and Mille Lacs Counties northwestward to Kittson County and northeastward to Cook County. It was difficult to find balsam poplar that were not affected.

The leaves started showing small, angular brown spots in mid-June. As the summer progressed, these spots coalesced to form large, brown areas on the leaves. By the first of August, the leaf spots had taken on an ashen-gray appearance, and by August 10th leaves were being shed. Infections were heaviest on the bottom branches, and by August 28th, many trees were bare except for small tufts of leaves on the terminals.

Infected leaf samples were sent to U.S. Forest Service State and Private Forestry pathologists, and positive identification of *Septoria musiva* was made.

It is thought that the cool, moist summer that Minnesota experienced during 1981 was responsible for the widespread occurrence of this disease. Since the fungus overwinters on the fallen leaves, there is a great potential that balsam poplar will once again become infected with this leaf spot disease. However, it will take cool, moist conditions for this disease to become serious in 1982.

Anthracnose Diseases

The incidence of the various hardwood anthracnoses was very high during the summer of 1981. Anthracnoses are leaf diseases normally associated with

the warm wet weather of late spring. Above normal amounts of precipitation continued through the entire growing season this past year causing an increased number of disease reports.

The most prevalent leaf disease was oak anthracnose, *Gnomonia quercina*. It was found in varying amounts on white oaks across the state, being most noticeable on the lower crown of border or solitary trees. Infections were severe enough in one area of Region I that the bur oak took on a fall-like appearance in early August.

In addition to oak anthracnose, a leaf spot on bur oak probably caused by *Actinopelte dryina* was evident in late July, particularly in the prairie fringe area in the Northwestern part of the state. This fungus caused a small discrete, roundish, red-brown spot which coalesced when the spots became numerous.

Anthracnose of green ash, silver maple and sugar maple were present during June. Ash anthracnose, *Gloeosporium aridun*, was reported in Regions I and VI. Anthracnose on silver maple was common in Region II in Carlton, Aitkin and St. Louis counties. Sugar maples in Moose Lake were identified as having anthracnose, *Gloeosporium apocryptum*. Another leaf disease, tar spot on sugar maple, *Rhytisma acerium*, was also observed in Region I.

Birch Problems

Birch dieback continued to be a widespread problem in Regions I, II and III. Dieback is due to a combination of drought stress, exposure, bronze birch borer, and defoliation from both the birch leaf miner and the birch skeletonizer.

- Drought and Exposure: Open-grown ornamental trees and native birch grown on dry ridge tops continued to decline in 1981. Decline often is started by rootlet death brought on by drought occurring in previous years and by increased soil temperatures when stands have been opened up during construction activities. This stress has predisposed the birch to attacks by the bronze birch borer.

- Bronze Birch Borer - *Agrilus anxius*: This boring insect continued to cause dieback, but its major impact is to resort and homeowners. Particularly hard hit areas included the central lakes area of Brainerd and Crow

Wing Counties as well as northern Hubbard and southern Beltrami Counties.

Birch leaf miner - *Fenusa pusilla*: High populations of this miner occurred in Carlton, St. Louis, Lake and northern Aitkin Counties. The incidence in forest trees in central St. Louis and northern Lake Counties was much higher than in 1980. Scattered populations were also observed in Cook, Koochiching and Itasca Counties.

Phenological Notes

May 14-19 - Adults ovipositing (Carlton Co.)

June 3 - First generation larvae mining apparent (Carlton Co.)

Birch Skeletonizer - *Bucculatrix canadensisella*: Defoliation by this insect was reported throughout Region III, limited to northern Hubbard and Cass Counties in Region I, non-existent in Cook County in Region II where defoliation was noticeable in 1980, and occurring in pockets of heavy defoliation across southeastern Minnesota. Early leaf yellowing and drop were observed in Backus, Pequot Lakes, Brainerd and Washburn Lake Districts. Extensive defoliation occurred in Pine county along the Kettle River.

Sweetfern Blister Rust - *Cronartium comptoniae* Arth.

In cooperation with Jim Mital, University of Minnesota, a sweetfern blister rust survey was conducted in Region I. Twenty-one plots were established from Hubbard to Lake of the Woods Counties. A plot was a circular 1/10th acre plot on which all live jack pine were measured and inspected for the presence of sweetfern rust infection. On 12 of the plots, the number of dead trees were also tallied. On all plots, a site index was measured. A summary of the results is as follows:

LOCATION	SI	BA	AGE	# TREES	% INFECTED	# DEAD TREES	SWEETFERN
34-145-34	62	114	54	56	11%	18	PRESENT
34-145-34	58	82	31	64	29%	24	PRESENT
34-145-34	46	45	52	63	14%	7	PRESENT
9-143-34	53	69	62	29	0	-	ABSENT
2-139-33	63	70	47	34	0	-	ABSENT
27-144-34	58	90	58	31	0	-	ABSENT
17-147-36	57	96	55	29	3%	-	ABSENT

(results of summary continued)

LOCATION	SI	BA	AGE	# TREES	% INFECTED	# DEAD TREES	SWEETFERN
29-148-38	62	65	51	19	0	-	ABSENT
23-140-32	62	112	42	42	14%	-	PRESENT
23-140-32	64	83	41	32	22%	-	PRESENT
30-139-32	51	82	39	65	3%	-	ABSENT
21-146-35	58	59	61	25	20%	-	ABSENT
34-160-34	51	64	46	24	0	5	ABSENT
22-159-35	43	96	75	36	0	12	ABSENT
35-159-33	56	116	59	52	0	28	ABSENT
25-160-38	49	92	43	56	0	15	ABSENT
16-160-38	50	104	49	73	3%	39	PRESENT
32-160-37	47	90	56	85	0	28	ABSENT
29-161-36	70	98	59	25	0	12	PRESENT
29-161-36	45	27	39	24	21%	2	PRESENT
29-161-36	55	93	67	22	18%	10	ABSENT

Average results from this data are as follows:

TREE AVERAGES

	Non-Infected	Infected
Average DBH (inches)	6.3	6.24
Average Height (feet)	46.4	44.7

PLOT AVERAGES

	Non-Infected	Infected
Average SI	53	56
Average BA (sq. ft.)	84	83
Average AGE (years)	55	49

Using the t-test, there was no significant difference at the 5% level of confidence between non-infected and infected tree diameters or tree heights.

On every plot where sweetfern was found, infected trees were also found. On 4 plots where sweetfern was not present or close by, sweetfern rust infected trees were found. The absence of sweetfern is not always a reliable indicator of the absence of infected trees.

Generally, sweetfern rust was not a probelm in the jack pine stands surveyed in Region I. The greatest infection on a plot was 22% of the trees, while the average for infected plots was 13.5%. If average infection was based on all trees inspected, then average infection was about 8%. This amount of infection is still high since areas of sweetfern were sought out in which to do the survey. Also, there did not seem to be any reduction in diameter or height due to infection.

In Region II, based on Mital's work, sweetfern blister rust appears to be causing problems. Mital also found in several areas of Lake and Cook Counties that sweetgale appeared to be just as important an alternate host as sweetfern. Generally, in Minnesota, sweetgale has been considered as a minor alternate host to the rust fungus.

The number of dead trees on the plots was surprising. Jack pine mortality ranged from 7.7% to 35.0%, averaging 24% on the 12 plots where mortality was measured. The other plots may or may not have had mortality. The cause of mortality was not determined on a tree by tree basis, however, no mortality due to sweetfern was observed.

Pine - Pine Gall Rust - *Endocronartium harknessii*

Spherical galls on jack pine are very common throughout all of the jack pine range in Minnesota. Because of the presence of the oak, the alternate host to the pine - oak rust, it has been assumed that most galls are caused by this rust fungi.

In Roseau and Lake of the Woods Counties, red oak species are very rare but jack pine galls are common. It has been suspected that the jack pine, galls in these counties might be caused by the pine - pine rust fungus rather than the pine - oak rust fungus.

In May, when the galls were sporulating, collections were made in Lake of the Woods County. Both galls and spores were sent to the U.S. Forest Service, State and Private Forestry pathologists who germinated the spores and made positive identification of the pine - pine rust fungus, *Endocronartium harknessii*. This is the first positive identification of the pine - pine rust fungus being present in northwestern Minnesota.

Gall Rust - *Cronartium quercuum* (Berk.)

About 5% of the jack pine seedlings shipped from General Andrews State Nursery had rust galls on the main stem at the soil line. It is likely that an additional number of seedlings sent out were infected but had not yet developed galls. Seedlings with galls on the main stem will likely die, the gall will choke the tree at the point of infection. Foresters were advised not to plant trees with galls in the main stem.

Spruce Needle Rust - *Chrysomyxa ledicola* Lager

Heavy infections of ornamental blue spruce were reported in Lake of the Woods and Koochiching Counties in Region I. Infections of white, black and blue spruce were reported as very common throughout Region II. By August 10th, many large spruce had taken on a dusty appearance from the aerial spore masses on the needles. The cool, moist conditions experienced during the growing season probably led to the outbreak of this disease.

MISCELLANEOUS PROBLEMS

Nursery Problems

In 1981 nursery pest management activities centered on field inspections of outplanted Norway pine stock with tip dieback, the support of basic research and attempted reduction of pine-oak gall rust incidence in selected jack pine beds using protectant chemical sprays at the General Andrews Nursery.

An investigation was begun in early June of 1981 at the request of the Crow Wing County Land Commissioner to determine the probable cause of unacceptable levels (30% and greater) of mortality in 3-0 red pine planting stock that was lifted from the Badoura State Nursery during April.

Plantation checks were made on industrial, private and public lands in Crow Wing, Cass and Wadena Counties. Survey information and samples were also submitted by the USDA BIA at Red Lake, the timber and wood products division of Boise Cascade at International Falls and private Christmas tree growers in Benton County. State plantations were checked in the Brainerd and Moose Lake areas.

Field samples from two Crow Wing County (Wolf Lake) plantations were sent to the University for nutrient analysis. Samples for Crow Wing, Potlatch, Boise, Widmark and Kraemer plantations were screened for insect and disease damage. Weather records were collected from the Brainerd district office and Badoura Nursery for the time period between April 1 and June 1. Lifting, shipping, receiving and planting dates were collected for affected stock.

Results

1. Stock that was green on receipt, properly handled and planted with adequate moisture still died or remained dormant.

2. Both partially killed seedlings, those with brown tops and green bottoms, and green seedlings with no growth; were found to have dead terminal buds with various degrees of drying occurring from the top down.

3. Total root mortality did not occur prior to planting as new root initiation was observed as late as July 28 in association with adventitious bud formation and new needle growth.

4. The widespread mortality and reduced growth could not be tied to the presence of Diplodia, root rots or root and shoot insects.

5. There is no evidence that nutrient deficiency or excess is responsible for the death of seedlings or their failure to grow.

In summary, two probable causes of the bud and shoot dieback in the Badoura stock existed. They were:

1. Bud dessication due to periods of tip exposure during the winter of 1980-81.

2. Freezing temperatures (5^{o} F on April 14, 1981) during the period of time when the affected seedlings were lifted.

In 1981 up to ten percent of the 2-0 jack pine lifted in the General Andrews Nursery were culled in the beds after lifting due to stem swellings caused by the pine-oak gall rust. Moist summer conditions and heavy uredial infections on red oaks in the windrows and nursery beds indicated infections could be as high or higher in 1982. A pilot test was begun in July to determine the effectiveness of chemical sprays in reducing the number of infections in selected jack pine stock. When telial columns were observed on the underside of red oak leaves, a protectant spray (Ferbam) was deposited on selected jack pine beds at 10 to 14 day internals into August. Cull estimates will be obtained during the 1982 lifting season to compare treated and untreated seedling beds.

In addition, 5% of the trees sent out had stem galls. An additional percent of trees were likely infected but had not yet formed galls. Foresters finding seedlings with galls in Region II were instructed not to plant the infected seedlings since they would die.

Additional pest problems reported at the General Andrews (26-45-20) and Badoura (16-139-32) State Forest nurseries are as follows:

GENERAL ANDREWS NURSERY

HOST	DATE	SYMPTOMS	AGENT	RESULTING CONTROL
Shippable Red Pine	Winter 80-81	Tip browning	Winter Burn	Snow making
Red Pine transplants	4-22	Breakage	Ice damage	Cull damaged stock
White Spruce	4-22	Tip browning	Winter Burn	Culled
2-0 Jack Pine	4-22	Stem swellings	Pine-oak gall rust	Culled
Scots-Pine	4-22	Stem swellings	Pine-oak gall rust	None
Walnut	(Freezer stock opened in early April)	Flocculence on roots	Storage molds *Tricoderma* *Penicillium*	None
Red Oak	6-25	Leaf Browning and curling	Pine-oak gall rust	Pine Spraying initiated
Shippable Red Pine	10-10	Uneven growth, nodules on root system	Under investigation sample stock lifted 12-81	

BADOURA NURSERY

HOST	DATE	SYMPTOMS	AGENT	RESULTING CONTROL
White Spruce	4-3	Tip browning	Winter Dieback	Severely damaged culled
2-0 Norway	4-3	Tip browning	Winter Dieback	Severely damaged culled
White Cedar	4-3	Browzed	Whitetail	
Hardwoods	4-3	Browzed	Whitetail	Severely damaged culled
White Pine	5-20	Stem Canker	Blister Rust	Culled
Larch	5-20	Tip Dieback	Winter Dieback	Poor formed planting stock

The state forest nurseries provided stock or field support for the following research projects.

INVESTIGATOR	PROJECT
University of Minnesota	
Elvin L. Stewart	Enhanced survival of nursery stock in harsh environments after innoculation with the native mycorrhizal fungus *Suillus luteus*
Ed Sucoff	Pine nutrient analysis and growth initiation
Mike Wingfield	Pathogenicity of pine wood nematode
James Mitol	Sweetfern blister rust
Pathology Teaching Lab	Specimens for class review of rust diseases
North Dakota State	Rust disease of pines survey
Northeastern Area, State and Private Forestry	Nursery Mycorrhizal survey and nursery herbicide use testing.

Non-Insect and Disease Problems

In a red pine plantation in Cloquet District (STR 18, 48-18) planted in 1960 heavy porcupine damage occurred in 1980 and 1981. Approximately 30% of the trees throughout the plantaiton were damaged or killed by the porcupines. In some pockets up to one acre in size, 80% of the trees were damaged.

In Region IV. a severe summer storm caused defoliation, limb breakage, and blow downs affecting 300 to 400 acres of hardwoods along the Minnesota River near Mankato on June 23. The hail and accompanying rains destroyed 80% of the cash crops in Blue Earth County.

Christmas Trees

Christmas tree growers in Region III reported the following pest problems and control attempts in 1981.

HOST	SYMPTOMS	AGENT	CONTROL
SPRUCE			
Established	Needle drop	Rhizosphaera needle-cast *R. kalkhoffii* (Bud.)	Foliar Spray using Chlorothalonil
	Branch swellings	Gall aphids *Adelges spp.*	Prune and destroy green galls
	Needle loss	Yellow-headed spruce sawfly *Pikonema alaskensis* Rohwer	Foliar Spray using Malathion when larvae present
Planting Stock	Tip browning and deadshoots	Winter burn and dieback	Cull badly affected stock
RED PINE			
Established	Tip blight and needle drop	Diplodia tip blight *D. pinea* (Desm.) kickx	No shearing during wet weather Sanitation pruning or cuts with destruction of infected material
	Needle browning on one side of tree	Winter burn and sand abrasion	Placement of wind break using hay bales
1-2 years after planting	Orange Pustules on needles	Pine needle rust *Coleosporium asterum* (Diet) Syd.	Moving or chemical weed control to eliminate asters
Planting Stock	Dead tips	Winter Dieback	Cull badly affected stock
WHITE PINE			
Established	White flocculence on main stem	Pine bark aphid *Pineus strobi* (Hartig)	Branch and stem drench with Carbaryl

HOST	SYMPTOMS	AGENT	CONTROL
(White Pine-Established continued)			
	Pitch masses on main stem and breakage	Zimmerman Pine Moth *Dioryctria zimmermani* (Grote)	Removal and destruction of badly infested trees. Stem drench in late May to kill larvae and/or drench in late July aimed at adults and eggs.
	Needle Loss	Introduced Pine Sawfly *Diprion similis* (Hartig)	Foliar spray with Malathion or Carbaryl when Larvae present
	Branch Flagging	White Pine Blister	Pruning out of infected branches and chemical control of alternate hosts gooseberries and currant *(Ribes spp)*
SCOTS			
Established	Needle Browning needle loss	Winter burn, Needlecasts; *Lophodermium*, *Nemacyclus*	Variety selection; Foliar sprays with Chlorothalonil
	Black foliage and twigs	Sooty mold in conjunction with Pine *Aphrophora parallella* (Say) or pine tortise scale *Toumeyella numismaticum* (Pettit I Mc D) feeding.	Stem drenches using malathion or Carbaryl
	Pitch of frass nodules on branches	Ugly nest maker *Tetra-lopha* sp. Pitch nodule maker *Petrova albicapitana*	Pruning and destruction of nodules and nests
	Root collar resin tree mortality	Root collar weevil *Hylobius radicis* Buchanan	Sanitation removals; Pruning off of lower whorls

HOST	SYMPTOMS	AGENT	CONTROL
(Scots-Established continued)			
	Extensive twig mortality	Pales weevil *H. pales* (Herbst.)	Stump treatment using Dursban or Carbaryl in oil. Seedling dip or foliage protectant spray with Dursban or Carbaryl. Stump culture using tip-ups.
	Needle reddening and whole tree mortality	Pine wood nematode *Bursaphelenchus lignicolus* Mamiya	Sanitiation cuts with destruction of infested material
Planting stock	Swellings on main stem	Pine-oak gall rust *C. quercuum* Albers	Cull visibly affected stock

The red-pine needle midge, *Thecodiplosis piniresinosae*, was identified as the causal agent of needles drooping on red pine in a Christman tree plantation in Hubbard County of Region I. The trees were inspected in September at which time the drooping was very evident. The drooped needles also showed a flattened, resinous base. Although individual trees were not heavily attacked, drooping of needles was very easy to find in the plantation.

Minor and Incidental Problems

DISEASES

PEST	HOST/S	LOCATION (COUNTY)	COMMENTS
Gall Rust	Jack Pine	Lake of the Woods	Fruiting on May 28.
Pine Needle Rust *Colesporium asterum* (Diet.)	Jack Pine	Lake of the Woods Hubbard, Crow Wing, Stearns	Light and scattered.
Spruce Needle Rust *Chrysomyxa ledicola* Lagerh.	White, Black, Blue Spruce	NE Minnesota	Very common.
Spruce Cone Rust *Chrysomyxa* sp.	White Spruce	St. Louis	4% pistillate cones in seed orchard.
Cytospora Canker *Cytospora kunzei* Sacc.	White and Blue Spruce	NE and S. Minnesota	Primarily found on ornamentals. Killed 10-12 inch trees in Cloquet.
Rhizosphaera Needle Cast *Rhizosphaeria kalf-hoffi* Bud.	White and Blue Spruce	Carlton, Itasca	Ornamentals.
Maple Anthracnose *Gloeosporium apocryp-tum*	Maple	Carlton, Aitkin, St. Louis	
Shepards Crook *Venturia populina* (Vuill.) Fabric.	Aspen	NE Minnesota	Very common in sprouts, does not appear to be serious.
Fusarium canker *Fusaria* sp.	Black Walnut	Fillmore	Section 14, 103-9 infection pocket, remains active without noticable mortality.
Walnut Anthracnose *Gnomonia leptostyla*	Black Walnut	SE Minnesota	Common throughout Region, most affec-ted upland sites defoliated by September 1.
Walnut Dieback *Phyllosticta* sp. *Xanthomonas* sp. *Phomopsis* sp.	Black Walnut	Fillmore	Section 14, 103-9 remains active with no mortality in 1981.

PEST	HOST/S	LOCATION (COUNTY)	COMMENTS
Ash Anthracnose	Green Ash	S. and SE Minnesota	Common spring-early summer. Homeowner calls.
Maple decline	Sugar maple	SE urban areas	Continues as a problem.
	INSECTS		
Mealybugs *Pseudococcus* sp.	Silver maple	S. Beltrami, N. Hubbard, Clearwater, St. Louis	Heavy on ornamentals.
Cottony Maple Scale *Pulvinaria innumerabilis* (Rathvon)	Silver maple		Heavy on ornamentals.
Poplar Vagabond Aphid *Mordwilkaja vagabunda* (Walsh)	Cottonwood,	Ottertail, Carlton, St. Louis	Light, scattered, Ottertail. Common, greatly increased in Carlton and St. Louis
Pitch Midges *Cecidomyia* sp.	Jack Pine	Lake of the Woods, Becker, Roseau, Hubbard, Beltrami, Clearwater, St. Louis, Pine	Common throughout Jack pine types.
Pine Tortoise Scale *Toumeyella numismatica* (P. and McD.)	Jack Pine	Lake of the Woods, Pine, Hubbard	Light and very scattered, some twig dieback in Pine City.
Pine Spittlebug *Aphrophora parallela* (Say)	Jack Pine	Hubbard, Becker, Beltrami, NE Minnesota	Moderate, light in NE.
Pine Chafer *Pachystethus obliva*	Jack Pine	Hubbard	Very light.
White Pine Weevil *Pissodes strobi* (Peck)	Jack Pine	Lake of the Woods	Locally heavy in 4-8 yr. old trees.
Walkingstick *Diapheromera femorata* (Say)	Oak	Becker	Light
Boxelder Leaf Roller *Archips negundanus*	Boxelder	Ottertail	Light

PEST	HOST/S	LOCATION (COUNTY)	COMMENTS
Willow Sawfly *Nematus salicisodoratus*	Willow	Beltrami	Very light in Dale Peterson's backyard.
Wood Borer *Neoclytus muricatulus muricatulus* Kirby		Beltrami	Emerging from recently built home.
Balsam Fir Sawfly *Neodiprion abietis* (Hams)	Balsam Fir	St. Louis, Aitkin, Lake, Carlton, Itasca, Cook	Increased in 1981, not economic.
Elm Leaf Miner *Fenusa ulmi* Sundervall	Slippery Elm	S. Aitkin and SE Minnesota	Low levels.
Introduced Pine Sawfly *Diprion similis* (Hartig)	White Pine	Carlton	Very low populations.
Jack Pine Sawfly *N. virginianus* Swaine	Jack Pine	St. Louis, Crow Wing, Morrison	Moderate populations in roadside trees near Canyon, MN. Heavy defoliation roadside and plantation in Crow Wing and Morrison.
Mountain Ash Sawfly *Pristiphora geniculata* Hartig	Mountain Ash	Carlton, St. Louis, Lake, Cook, Crow Wing	Completely defoliated forest trees in Lake & Cook. Problem on ornamentals in Carlton & St. Louis.
Red-Headed Pine Sawfly *Neodiprion lecontei* (Fitch)	Jack Pine	Carlton and N. Aitkin	Roadsides only, no plantations.
Eastern Pineshoot Borer *Eucosma gloriola* Heinrich	Jack Pine	N. St. Louis	Associated with white pine weevil in causing shoot mortality and tree deformity.
Fir Coneworm *Dioryctria abietivorella* (Grote')	White Spruce	St. Louis	Damaging pistillate cones in seed orchard. Adults emerged July 22.
Pitch Nodule Maker *Petrova albicapitana* (Busck)	Jack Pine	St. Louis	Minor twig damage.

PEST	HOST/S	LOCATION (COUNTY)	COMMENTS
Spiny Elm Caterpillar *Nymphalis antiapa* (L.)	Willow Aspen	NE Minnesota	populations greatly increased in 1981.
Zimmerman Pine Moth *Dioryctria zimmermani* (Grote')	White Spruce, Red Pine	Aitkin	Some damage in plantations.
Balsam Twig Aphid *Mindarus abietinus* Koch	Balsam Fir	Carlton, St. Louis, Aitkin, Lake	Fairly common, twig curling.
Elm Lace Bug *Corythuca ulmi* O & D	Slippery Elm	S. Aitkin	Common chlorosis and light browning by late July.
Balsam Fir Sawyer *Monochamus notatus* (Drury)	Balsam Fir	Aitkin	Associated with previous mortality.
Poplar-Willow Borer *Cryptorhynchus lapathi* (L.)	Balsam Poplar	Aitkin	Causing localized damage.
White-Spotted Sawyer *Monochamus scutellatus* (Say)	Conifers	Carlton, St. Louis, Crow Wing, Cass	Frass piles and Adult emergence in log homes.
Rose Chafer Beetle *Macrodactylus subspinosus* (F.)	Jack Pine	Crow Wing, Morrison	Heavy defoliation in old fields.
Larch Sawfly *Pristiphora erichsonii* (Hartig)	Eastern Larch	Crow Wing	First instars feeding June 22-roadside trees.
Poplar Borer *Saperda calcarata* Say	Poplar	Crow Wing	Yard tree breakage.
White Grubs *Phyllophaga* sp.	Pine Seedlings	Cass	Roof feeding
Boxelder Bug *Leptocoris trivittatus* (Say)	Boxelder	Crow Wing	Leaf feeding and nuisance.
Oak Lace Bug *Corythucha arcuata* (Say)	Burr Oak	Benton, Sherburne, Stearns	Leaf yellowing.

PEST	HOST/S	LOCATION (COUNTY)	COMMENTS
Cankerworms *Alsophila pometaria* and *Paleacrita vernata*	Mixed hardwoods and Siberian Elm	Renville, Brown, Nicollet, Rice	Heavy defoliation in shelterbelts and small timber stands, eastward movement from 1980 outbreaks.
Walnut caterpillar *Datana integerrima* G & R	Black Walnut	SE Minnesota	Widespread locally, heavy defoliation on individuals.
Oak Twig Pruner *Elaphidionoides villosus* (F.)	Burr Oak	Kandihoyi	Homeowner calls.

SPECIAL PROJECTS

Dwarf Mistletoe Study

Eastern Dwarf Mistletoe of black spruce has long been thought of as one of DNR's more important forest problems (primarily because of the value of the black spruce resource).

However, there has never been a reasonably good technique of analyzing the amount of loss developed, hence we have no basis for making cost/benefit evaluations in management decisions.

With this in mind, a cooperative University of Minnesota DNR pilot evaluation procedure was worked up and carried out. Three Koochiching state forest townships were selected with three different levels of black spruce acreage. The presence of mistletoe was analyzed through aerial photo interpretation and cross-checked using Phase II forest inventory data.

One of these townships was then selected and the black spruce stands checked either from the air or from the ground after being dropped off by helicopter. The results of the study indicated that dwarf mistletoe mortality is very difficult ot analyze from aerial photographs. However, accuracy (see table) would undoubtedly increase as experience is gained.

Thirty-two stands were ground checked for a total of 715 acres (22% of 3,204). Stands ranged from SI. 24-25, 3-220 SQ. FY. BA. and DBH 5-7". Of the 32 stands ground checked nine (29%) were infected with mistletoe for a total of 89 acres (not including Sec. 1) out of production. Basal area loss is 3,893 square feet (5% of 78,159). It should be noted that 85 of the 89 acres out of production is from one stand totally decimated by dwarf mistletoe.

Photo Interpretation Summary

# of stands infected with mistletoe (from ground check)	9
# of stands correctly identified as having mistletoe	5
# of stands with mistletoe but not identified (error of omission)	2
# of stands without mistletoe but interpretated as having mistletoe (error of commission)	6

The helicopter however, proved to be a very good method for field checking: (1) Stand access was not a problem, (2) large acreages can be covered quickly, (3) maneuverability allows for thorough inspection, and (4) brooms in the tops of trees which could be missed in ground checks can easily be seen from the air, however some brooms in the lower portions could be missed. In contrast, a fixed wing aircraft proved impossible to use, too fast for adequate observation, or to keep oriented.

With further development, this method could probably be utilized to give a better picture of the extent of the mistletoe problem, however, it will require a long term commitment to gather the necessary expertise, and to do the field work necessary.

Frost and *Acrobasis* sp. Injury to Black Walnut Terminal Buds

In the spring of 1981 a project was initiated to monitor both frost and insect injury to terminal buds of black walnut to determine the relative importance of each type of injury.

The *Acrobasis* species reported in the literature that are of importance are *A. juglandis* (LeBaron) the pecan leaf casebearer, and *A. domotella* (Grote), the walnut tip moth. In the field they can be identified by the location of the overwintering hibernacula where the first or second instar larvae overwinter and by the feeding habits.

The feeding habits of both species are similar initially in that both feed at the base of expanding buds for the first few weeks. Later the tip moth will bore into a partially grown shoot where eventually the tunneled out shoot can die back to the previous years growth. In early to mid-June the larva drop to the ground to pupate. As leaflets begin to enlarge the casebearer moves from shoot bases to the underside of expanding leaves. Here they build a silk and frass tube attached to the undersurface of the leaflet. Other leaflets are fastened around the case for protection and as a food source. In mid-June the larva closes the end of the case and pupates inside.

Two 8 to 10 year old plantations were chosen to monitor terminal bud growth one in Winona County (2-108-9) and the other in Olmsted County (32-107-13). In each plantation in early April several trees were selected and the terminal shoot on each tree was flagged. Two different colors of flagging tape were used to separate one half of the selected trees in each

plantation, one half to be treated with insecticide and the other to be used as controls. At the time of flagging counts were made of the number of overwintering hibernacula that contain the first or second instar larvae and were found within one inch of the terminal bud. In the Winona County plnatation 57% of the original 70 trees flagged had terminal shoots infested with one or more hibernaculae. In the Olmsted County plantation 88% of the original 44 trees flagged had terminal shoots infested. The actual number of hibernacula per terminal shoot on this site ranged from 1-14 with the average being 3.

On April 16 and 17 in the Winona and Olmsted County plantations respectively one-half of the flagged terminal shoots were treated with Acephate (Orthene) at a rate of 1½ tablespoons per gallon of water. Only the single terminal bud on each of the flagged trees was treated by thoroughly wetting the bud. One half of the flagged trees in each plantation remained untreated as controls. Insect feeding activity was then monitored in both plantations at bi-weekly intervals through mid-June when most feeding activity ends as the mature larvae pupate and complete their life cycle.

The results are summarized in table (IV). Although there were a high number of *Acrobasis* larvae feeding on the terminal buds on the control trees at both sites only one tree on the Olmsted County site had its bud killed by mid-June by insect feeding. While 32% or ten (10) of the remaining thirty-two (32) trees flagged on both the treated and control had their buds killed by the May 9 and 10 frost. Twenty one (21) of the remaining flagged trees produced healthy terminal buds originating from the single overwintering terminal bud.

Based on these and previous observations it appears that the major cause of stem deformities in walnut plantations are late spring frosts. However, in years in which late spring frosts are absent minor terminal bud loss may result from the feeding of *Acrobasis* insects. Although the single application of Orthene appeared to be very effective in reducing the number of *Acrobasis* insects it is not recommended as a control since the impact is minor.

These two plantations are on soils acceptable for growing walnut but produces annually less than 12" of height growth. The lack of sufficient height growth coupled with spring frosts affecting 30-40% or more of the

plantation each year tends to compound the stem deformities producing poorly formed trees with few straight continuous stems.

In contrast bottomland sites with optimum soil conditions and where weed control has not been a factor and where average height growth is two to three feet or more each year the effects of late frosts are quite different. When the terminal buds are killed on these sites the lateral shoots that result maintain the average annual height growth. At this rapid growth rate one of the laterals will become the new terminal and evidence of the frost induced deformity dissappears within three years.

TABLE IV
FROST AND *ACROBASIS* sp. INJURY TO BLACK WALNUT

Date	# Trees With Evidence Of *Acrobasis* sp. Feeding On Terminal Bud.				# Trees With Frost Injury To Terminal Bud.	
	Winona County (2-108-9)		Olmsted County (32-107-13)		Olmsted County (32-107-13)	
	Treated	Control	Treated	Control	Treated	Control
4/16	5	0				
4/17			0	0		
4/21	0 (a)	5	0	0		
4/28	2	15				
5/5	1	16	1	12		
5/12	(e)		1	10	5 (c)	3
5/26			1	7 (b)	6	7
6/11			1	7	6	6
6/16			0 (d)	1	5	5

(a) The decrease reflects the effects of the insecticide treatment on buds all ready attacked.

(b) The decrease reflects the movement of primarily casebearers from the bases of the buds to newly formed leaves.

(c) Two killing frosts occurred on the dates of May 9 and 10, subsequent frost injury is recorded.

(d) Total number of trees on which the terminal bud was killed for each type of injury.

(e) Flagging had been removed from sample trees, the site was dropped.

Plantation Survey Region I

Twenty-one plantations located in Roseau, Lake of the Woods, Beltrami, Cass, Clearwater, Mahnomen, Becker and Hubbard Counties were surveyed for insect and disease problems. Eighteen plantations were red or jack pine, two were white pine and one plantation was white spruce. One other white spruce area was also surveyed, but it was part of a surveyed red pine plantation.

The survey consisted of looking at 19 trees in a row and the 10-tree plot was spaced so that approximately 1% of the plantation was surveyed. Each tree was inspected for problems, and the percent of each tree affected was recorded. At the beginning of each ten-tree plot, 1/100th acre circular plot was established to check stocking. In red pine plantations, the first tree of each 10-tree plots was inspected for Saratoga spittlebug feeding scars. This was done by taking a 10cm branch sample from a portion of a mid-crown branch that was 2 years old, and scraping away the bark to reveal any feeding scars present.

A summary of the problems or damage found in the plantations is presented in Table V. A summary of mortality is found in Table VI.

TABLE V
SUMMARY OF PLANTATION PROBLEMS

PROBLEM/DAMAGE	NUMBER OF PLANTATIONS	AVERAGE % OF TREES AFFECTED	RANGE
INSECTS			
Saratoga spittlebug *(Aphrophora saratogensis)*	6	23	2-30%
White pine weevil *(Pissodes strobi)*	4	5	1-10%
Pine needle aphid *(Pineus coloradensis)*	5	20	1-46%
Needle miner	2	9	4-14%
Yellowheaded spruce sawfly *(Pikonema alaskensis)*	1	1	---
DISEASES			
Diplodia tip blight *(Diplodia pinea)*	8	8	2-14%
Armellaria root rot *(Armellariella mellea)*	6	2	1-4%
Pine needle rust *(Coleosporium asterum)*	2	17	1-34%
Sirococcus shoot blight *(Sirococcus strobilinus)*	2	1	1-2%
Lophodermium needlecast *(Lophodermium pinestri)*	3	4	1-7%
White pine blister rust *(Cronortium ribicola)*	2	6	4-8%
MISCELLANEOUS			
Deer	12	14	1-88%
Porcupine	2	2	1-3%
Other (weather, mechanical, etc.)	4	14	1-23%

TABLE VI
PLANTATION MORTALITY

Plantations With Mortality	13	(62%)
Plantations Without Mortality	8	(38%)
% Mortality - All Causes	4.5%	
Range of Mortality	0-20%	

White Pine Blister Rust Evaluation Survey

This study is an evaluation of site characteristics including S.I., overstory, topography, slope. aspect, *Ribes* presence associated with different levels of white pine blister rust. This is being carried out in the hope that factors contributing to unacceptable levels of blister rust risk can be identified before a stand is committed to white pine management. Then it would be possible, with adequate planning and management, to reestablish white pine as one of our more important timber species without undue risk of blister rust.

Approximately 120 white pine sites with a wide range of characteristics have now been evaluated. The survey is based on a site evaluation and an analysis of blister rust on 50 trees per site. Presence and levels of infection, type of canker (fatal, lethal, non-lethal, or dead) and rate of mortality are looked at.

This data is presently being computerized. Analysis will indicate whether this evaluation system has a merit, or if further analysis is needed.