MINNESOTA FOREST HEALTH REPORT

1992

Minnesota Department of Natural Resources
Division of Forestry
Forest Health Unit

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BY

The Forest Health Unit

Minnesota Department of Natural Resources

Division of Forestry

July, 1993

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There are approximately 16.7 million acres of forest land in Minnesota, and 14.8 million acres are classified as being "timberland." (Miles and Chen, 1992) Over one-half of the forest land is publicly owned. "Minnesota forest ecosystems harbor 48 native tree, 176 bird, 60 mammal and 28 reptile species. Forests also add to the diversity of the state's landscape and provide opportunities for recreation and support for the state's economy." (Anonymous, 1992) The commercial forest lands (timberlands) support a forest industry valued at 3.5 billion dollars and is the third largest industry in Minnesota. Minnesota's forests enhance the environment of Minnesota which adds to the quality of life for all Minnesotans. It is important then to protect and enhance the health of the forest resources of Minnesota.

The Minnesota Department of Natural Resources (MN-DNR) has been charged by the legislature with the management of Minnesota's natural resources on state, county, and private forest lands. The Forest Health Unit is found within the Forest Management Section of the MN-DNR Division of Forestry and is charged with managing Minnesota's forest and tree resources to reduce the impacts of insects, diseases, and other pests so that the overall health of the forested resource in Minnesota is improved. Forest Health Unit personnel include:

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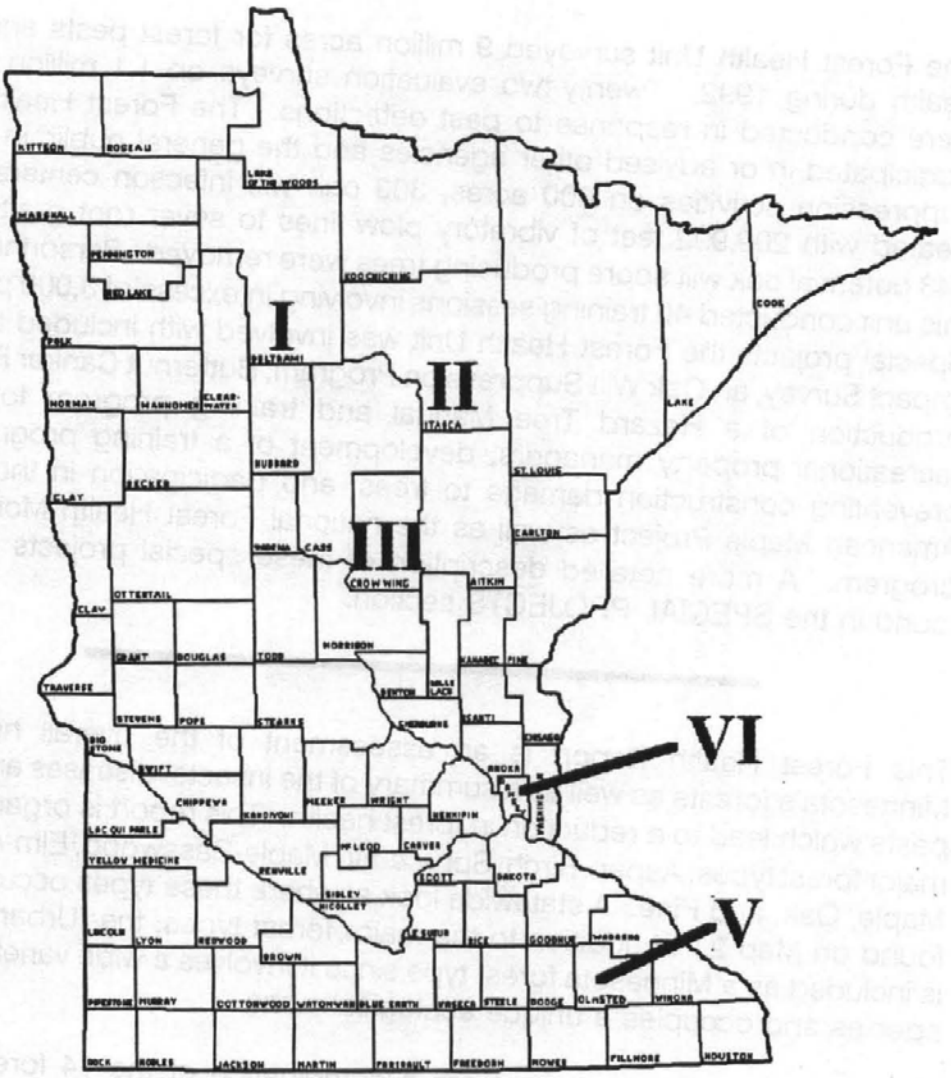
Map 1: Minnesota Counties and Office Locations



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The Forest Health Unit surveyed 9 million acres for forest pests and tree health during 1992. Twenty-two evaluation surveys on 1.1 million acres were conducted in response to pest detections. The Forest Health Unit participated in or advised other agencies and the general public in direct suppression activities on 600 acres, 303 oak wilt infection centers were treated with 209,992 feet of vibratory plow lines to sever root grafts, and 943 potential oak wilt spore producing trees were removed. Personnel from this unit conducted 40 training sessions involving in excess of 3,000 people. Special projects the Forest Health Unit was involved with included a Birch Impact Survey, an Oak Wilt Suppression Program, Butternut Canker Project, production of a Hazard Tree Manual and training program for DNR recreational property managers, development of a training program for preventing construction damage to trees, and participation in the North American Maple Project as well as the national Forest Health Monitoring program. A more detailed description of these special projects can be found in the SPECIAL PROJECTS section.

This Forest Health Report is an assessment of the overall health of Minnesota's forests as well as a summary of the insects, diseases and other pests which lead to a reduction in forest health. This report is organized by major forest types: Aspen-Birch, Spruce-Fir, Maple-Basswood, Elm-Ash-Soft Maple, Oak, and Pine. A statewide look at where these types occur can be found on Map 2. In addition to the major forest types, the "Urban Forest" is included as a Minnesota forest type since it involves a wide variety of tree species and occupies a unique ecological niche.

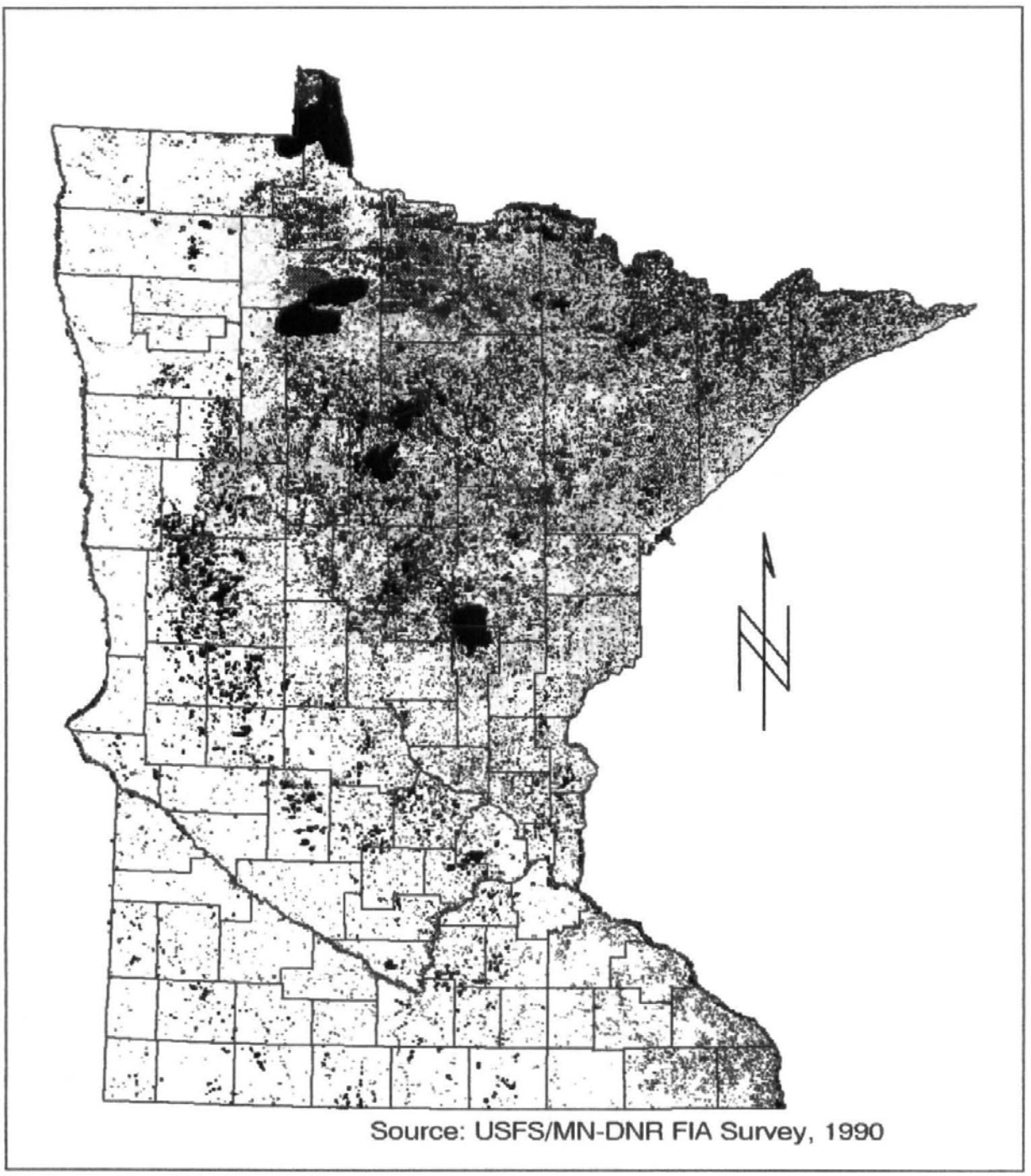
The forest types in this report are a combination of the 14 forest types identified in the 1990 Forest Inventory. Forest Type definitions, acreage, volumes, and tree numbers used in this report are based on the publication, *Minnesota Forest Statistics, 1990*, by Miles and Chen.

Names of insects are from either the 1985 USDA publication, *Insects of Eastern Forests* or from the 1982 Canadian publication by Rose and Lindquist, *Insects of Eastern Hardwood Trees*. Fungal names are from the 1989 American Phytopathological Society publication by Farr, et al, *Fungi on Plant and Plant Products in the United States*.

A complete citation can be found in the Literature section at the end of this report.

Map 2: Minnesota Forest Types

The Forest Covertypes of Minnesota



Scale: 0 25 50 mi

PINE
SPRUCE-FIR
OAK
ELM-ASH-COTTONWOOD
MAPLE-BASSWOOD
ASPEN-BIRCH
UNPRODUCTIVE LAND
WATER

Minnesota Department of Natural Resources
Division of Forestry
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Name: _____

Address: _____

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Circle the map(s) you are ordering:

Map 4 Map 6 Map 8 Map 9

OVERVIEW

The key word to describe the overall health of Minnesota's forests is ***"recovery."*** Beginning in the fall of 1987, Minnesota forests have suffered tremendous stresses and losses from severe drought conditions, major defoliation by the forest tent caterpillar, and the buildup of populations of bark beetles in conifers and *Agrilus* borers in hardwoods. Since 1987, 1992 has been the best year for tree recovery from the effects of adverse weather conditions and damaging insect populations.

Evidences of recovery include:

1992 has been the best year in terms of moisture received during the growing season since 1987. Map 3 shows precipitation from April 1 through September 28 and indicates that precipitation was fairly normal when averaged out over the entire growing season.

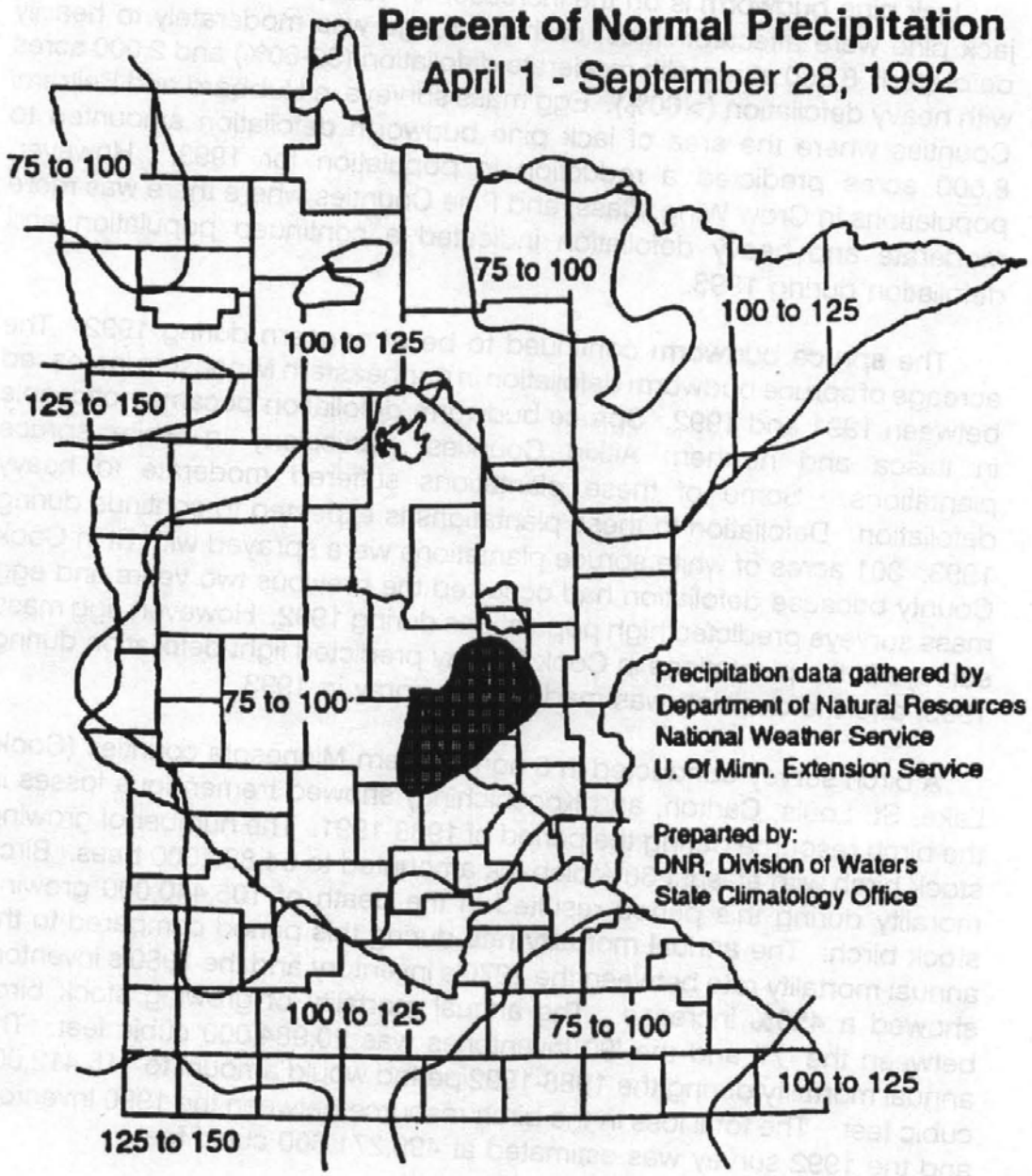
The 1992 growing season was unusually cool. This produced some late spring frosts which affected some of the bur oaks, balsam fir and white spruce in northern and central Minnesota, and willows in low lying areas in southern Minnesota. The cool weather also helped produce early fall coloration, particularly on the maples. But the stress on the trees from hot summer temperatures did not occur and removed one more stress that has effected tree health during the drought years of 1988-1991.

Forest tent caterpillar (FTC) has been the major defoliator in the state since 1987. During the years of 1989 and 1990, over 4,000,000 acres were heavily defoliated (>90%) each year. During 1992 there was no heavy defoliation and total area affected amounted to approximately 50,000 acres. Only about 2,500 of the 50,000 acres were moderately defoliated (30-60%).

New **oak mortality** resulting from a combination of drought stress, FTC defoliation, attacks by the twolined chestnut borer, and *Armillaria* root rot was greatly reduced during 1992.

The **yellowheaded spruce sawfly** (YHSSF) caused worry during 1992. Predictions of heavy populations were made based on an increase in YHSSF activity observed during 1991. Populations of YHSSF simply did not materialize as predicted, and concerns about this insect were reduced for 1993. However, 15 acres of white spruce in Mahnomen County and 8 acres of white spruce in St. Louis County were sprayed with Sevin for the control of YHSSF.

Map 3: Percent of Normal Precipitation: April 1 - September 28



Despite recovery, there are some areas of concern:

Jack pine budworm is on the increase. In 1992, about 17,000 acres of jack pine were affected. Most of this acreage was moderately to heavily defoliated: 8,600 acres with moderate defoliation (30-60%) and 2,000 acres with heavy defoliation (>60%). Egg mass surveys in Hubbard and Beltrami Counties where the area of jack pine budworm defoliation amounted to 8,500 acres predicted a reduction in population for 1993. However, populations in Crow Wing, Cass, and Pine Counties where there was more moderate and heavy defoliation indicated a continued population and defoliation during 1993.

The **spruce budworm** continued to be of concern during 1992. The acreage of spruce budworm defoliation in northeastern Minnesota increased between 1991 and 1992. Spruce budworm defoliation became noticeable in Itasca and northern Aitkin Counties, particularly in white spruce plantations. Some of these plantations suffered moderate to heavy defoliation. Defoliation to these plantations is expected to continue during 1993. 301 acres of white spruce plantations were sprayed with Bt in Cook County because defoliation had occurred the previous two years and egg mass surveys predicted high populations during 1992. However, egg mass surveys in the plantations in Cook County predicted light defoliation during 1993, and the decision was made not to spray in 1993.

A birch survey conducted in 5 northeastern Minnesota counties (Cook, Lake, St. Louis, Carlton, and Koochiching) showed tremendous losses in the birch resource during the period of 1988-1991. The number of growing stock birch with at least 30% dieback amounted to 54,829,000 trees. Birch morality during this period resulted in the death of 105,440,000 growing stock birch. The **annual mortality rate** during this period compared to the annual mortality rate between the 1970's inventory and the 1980's inventory **showed a 450% increase**. The annual mortality of growing stock birch between the '77 and the '90 Inventories was 20,984,000 cubic feet. The annual mortality during the 1988-1992 period would amount to 115,412,000 cubic feet. The total loss in the birch resource between the 1990 Inventory and the 1992 survey was estimated at 496,271,600 cubic feet.

Gypsy moth trap catches increased during 1992. A total of 84 moths were trapped during 1992 compared with 51 trapped during 1991. Trap catches occurred in areas of northern Minnesota where gypsy moth has never been trapped in the past. These new locations include Koochiching

County (International Falls), Roseau County (Roseau), and Red Lake County (Red Lake Falls). Another concern is a second year trap catch in a KOA campground in Carlton County. This campground was mass trapped in response to the trap catch in 1991, and 1 moth was trapped in nearly the same location as in 1991. An egg mass search in early October was negative for egg masses.

Four gypsy moths trapped in and around the harbors of Duluth and Superior were of concern due to the recent introduction of **Asian gypsy moths** into shipping ports in northwestern United States and southwestern Canada. Fortunately, tests showed that the 4 moths trapped in the Duluth-Superior harbors were North American gypsy moths and not the Asian gypsy moth.

ASPEN-BIRCH FORESTS

6,377,700 acres or 43.2% of the commercial forest land

- Includes the following cover types:

Aspen: 5,114,200 acres

"Forests in which quaking aspen or bigtooth aspen, singly or in combination comprise a plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)"

Paper Birch: 835,800 acres

"Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)"

Balsam Poplar: 427,700 acres

"Forests in which balsam poplar comprises a plurality of the stocking. (Common associates include aspen, elm, and ash.)"

FOREST HEALTH OVERVIEW

The aspen and balsam poplar cover types are generally in better health than they have been during the period of 1988-1991. This is primarily due to the reduction in forest tent caterpillar populations. The paper birch cover type sustained tremendous losses during the 1988-1991. With normal to above normal precipitation and normal to below normal temperatures, the overall health of the birch cover type should improve.

Pests reported in this type include:

- ✓ Forest Tent Caterpillar
- ✓ Aspen Leaf Rolling and Tieing Insects
- ✓ Ghost Moth
- ✓ An Aspen Sawfly

FOREST TENT CATERPILLAR

Malacosoma disstria Hubner

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

Forest	County	Light(<30%)	Moderate(30-60%)	Heavy(>60%)
Asp-Brch	Beltrami	1,500	0	0
Asp-Brch	Cass	500	0	0
Asp-Brch	Clearwater	1,500	0	0
Asp-Brch	Hubbard	10,000	0	0
Asp-Brch	**TOTAL[1]**	**13,500**	**0**	**0**
Oak[2]	Douglas	6,000	500	0
Oak	Kandiyohi	0	150	0
Oak	Otter Tail	28,000	2,000	0
Oak	**TOTAL**	**34,000**	**2,500**	**0**
TOTAL		**47,500**	**2,650**	**0**

GRAND TOTAL ACRES DEFOLIATED: 50,150

[1] Light defoliation also occurred in Itasca and St. Louis Counties, but because it was so scattered it was not mapped and acreage determination was not made.

[2] Basswood is the species favored most by the forest tent caterpillar in the oak forests.

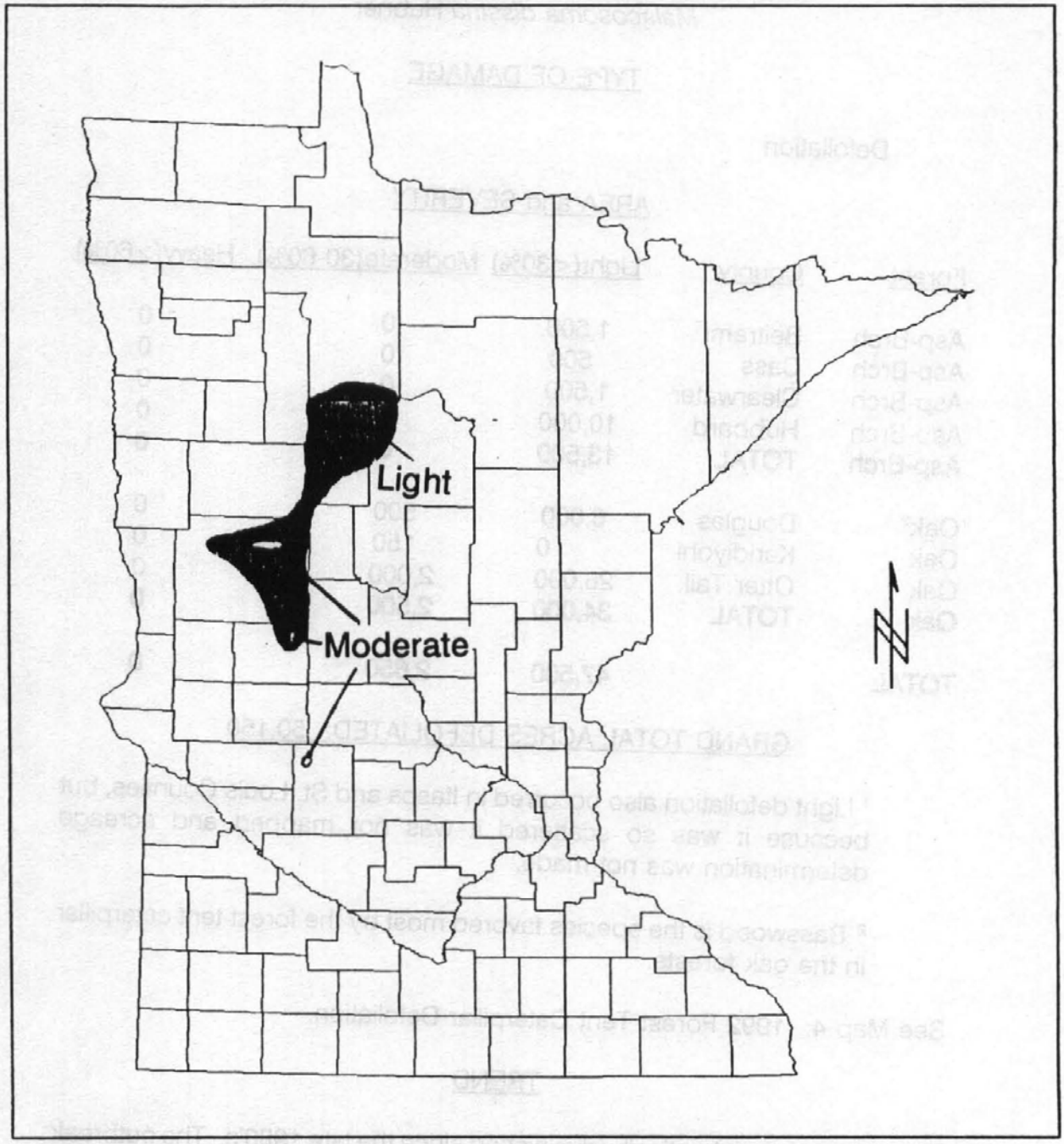
See Map 4: 1992 Forest Tent Caterpillar Defoliation.

TREND

Populations have drastically diminished since the late 1980's. The outbreak began in 1987 and during 1989 and 1990 4,000,000 acres were heavily defoliated each year. In 1991 1,645,000 acres were defoliated but most of the defoliation (1.2 mm acres) was in the light category.

Map 4: 1992 Forest Tent Caterpillar Defoliation

Forest Tent Caterpillar in 1992



Scale: 0 25 50 mi

Source: Forest Health Unit field survey.
FHIS-MGC Map Protocol, FTC-92.EPP

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Moderate Defoliation (30-60%)

Light Defoliation (<30%)

NOTES

Forest tent caterpillar activity in the aspen-birch forests of Minnesota was scattered and diffused. It was found causing light defoliation in Hubbard, Clearwater, Beltrami, and Cass Counties in the same areas where a variety of leaf rolling and leaf tieing insects were active. Heaviest feeding activity occurred in the Paul Bunyan State Forest in Hubbard County.

There were a few scattered pockets of defoliation in Itasca and St. Louis Counties where there were reports of caterpillars migrating across lawns and roads. In one location in eastern Itasca County, *Sarcophaga aldrichii* Parker was reported as still being abundant and bothersome.

Forest tent caterpillar activity in the oak forests was scattered but spotty. In northern Kandiyohi County, defoliation was seen in only two small areas totalling about 150 acres. In Cass, Crow Wing, Wright, and eastern Stevens County, only a few caterpillars could be found, and there was no observable defoliation. There were a few other areas in which landowners reported the presence of FTC and where ground checks found pupal cases. The largest area of defoliation occurred in Otter Tail County, but most of it was light (less than 30%).

Forest tent caterpillar in the oak forests is primarily a nuisance to lakeshore owners. Spraying with Bt has occurred around a number of lakes from Otter Tail County southward through Kandiyohi County. In 1992 spraying again occurred in Otter Tail, Douglas, and Stearns Counties. Combined acreage of spraying in these three counties amounted to less than 1,000 acres. During the period of 1988 through 1991, direct control actions around lakes in the oak forests exceeded 2,000 acres.

PHENOLOGY

May 1	Eggs hatching - Otter Tail Co.
May 6	Eggs hatching: 493 Degree Days[1] above a base of 32° F - Bemidji/Beltrami Co.
May 20	Eastern tent caterpillar larvae 6-10 mm in length and aspen leaf rollers 10 mm in length - Itasca Co.
May 25	FTC larvae 30 mm in length - Central Itasca Co.
May 30	FTC larvae 30-35 mm in length - eastern Itasca Co.
June 2	Only 2, 6th and 7th instar larvae found north of Gull Lake - Cass Co.
June 10	FTC in last instar - northern St. Louis Co.
June 14	Caterpillars ranging up to 35 mm in length - Itasca and Cass Co.
June 20	Frost - Itasca Co.
June 21	Frost - Itasca Co.
June 22	30% pupated on basswood - Long Prairie, Todd Co. Mostly FTC cocoons with a few late instar larvae still present - Itasca Co.

[1]493 Degree Days for FTC egg hatching was the same number of Degree Days as recorded in 1991.

ASPEN
LEAFROLLERS and LEAFTIERS

SPECIES

Fruittree leafroller	*Archips argyrospilus* (Walker)
Obliquebanded leafroller	*Choristoneura rosaceana* (Harris)
Green aspen leaftier	*Pandemis canadana* Kearfott
Darkheaded aspen leafroller	*Anacampsis innocuella* Zeller
Aspen leafroller	*Pseudexentera oregonana* Walsingham
Large aspen tortrix	*Choristoneura conflictana* Walker

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

County	Light(<30%)	Moderate(30-60%)	Heavy(>60%)
Becker	65,000	0	0
Beltrami	67,000	8,000	0
Cass	20,000	5,000	0
Clearwater	25,000	0	0
Hubbard	190,000	10,000	0
TOTAL	**367,000**	**23,000**	**0**

GRAND TOTAL ACRES DEFOLIATED: 390,000

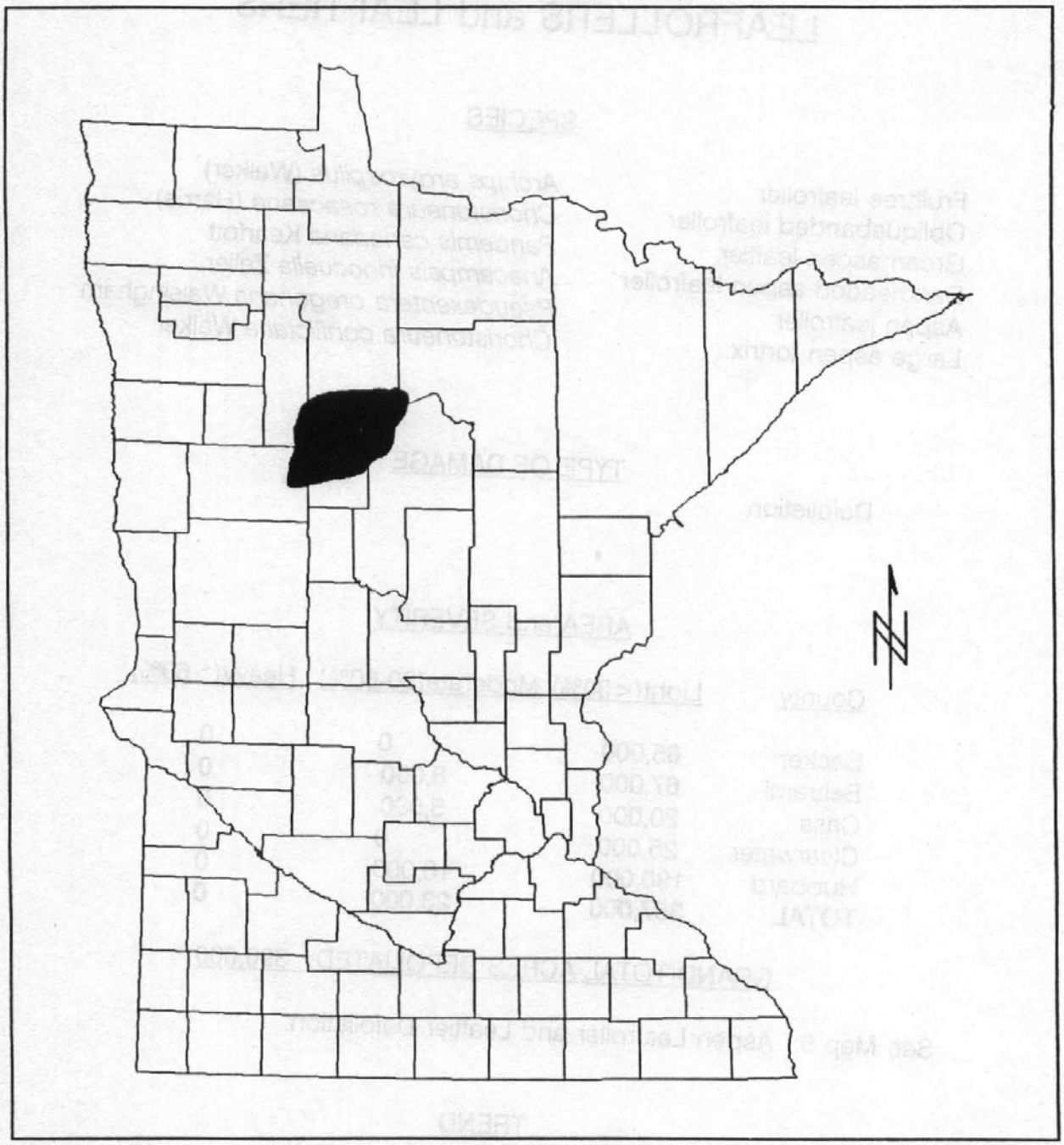
See Map 5: Aspen Leafroller and Leaftier Defoliation.

TREND

This is the second year of noticeable defoliation by a variety of leaf rolling and tieing insects. Since there have been no surveys conducted, it is unknown what their occurrence will be in 1993.

Map 5: Aspen Leafroller and Leaftier Defoliation

Aspen Leafroller in 1992



Scale: 0 25 50 mi

Source: Forest Health Unit field survey.
FHIS-MGC Map Protocol, ALR-92.EPP

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Division of Forestry
Forest Health Unit
Forest Health Information System

Aspen Leafroller Infestation

NOTES

Aspen leaf rollers and tiers can be found feeding on aspen leaves every year. Often their damage is located in the upper half of the aspen crowns. The affected trees have thin crowns because of the rolled leaves. The appearance of the trees are similar to aspen that have been defoliated by the forest tent caterpillar and then have produced a second crop of leaves that are smaller and more sparse.

In 1991 a variety of species were found causing light to moderate defoliation in St. Louis, Itasca, Cass, and Crow Wing Counties. In 1992 the area of noticeable defoliation shifted westward and was centered in Hubbard County. The occurrence of these leaf rollers and leaf tiers was in the same areas and on the same trees as forest tent caterpillar. In some areas, the leaf rollers and tiers caused more defoliation than the FTC.

GHOST MOTH

Sthenopis sp.

NOTES

Approximately 30 acres out of 100 acres of regenerating aspen were killed by ghost moth larvae tunnelling in the root systems. *Armillaria* spp. was also abundant in the damaged root systems. The aspen stands were approximately 4 years old. The trees died in patches up to 3-4 acres in size.

Ghost moth larvae are quite large, ranging in length up to 50 mm. When they are found attacking aspen, considerable root decay is also found associated with the tunnels. This was the first time that ghost moth has been encountered, and it is unclear why it is causing significant damage in the area of Lake County where it was found.

AN ASPEN SAWFLY

Nematus salicisodoratus Dyar

NOTES

Larvae of this sawfly defoliated about 2 acres of aspen on the south side of Blackhoof Lake and near Lake Edward in Crow Wing County. Second generation larvae were active in August. Defoliation by this species seldom damages its host trees unless the population persists for several seasons. This was the first report of this sawfly species in Crow Wing County.

SPRUCE-FIR

- 3,535,800 acres or 23.9% of the commercial forest land
- Includes the following cover types:

Black Spruce: 1,322,100 acres

"Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)"

Balsam Fir: 734,300 acres

"Forests in which balsam fir and white spruce comprise a plurality of stocking with balsam fir the most common. (Common associates include aspen, maple, birch northern white-cedar, and tamarack.)"

Tamarack: 705,100 acres

"Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)"

Northern White-Cedar: 680,500 acres

"Forests in which swamp conifers comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)"

White Spruce: 93,800 acres

"Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include aspen, maple, birch, northern white-cedar, and tamarack.)"

FOREST HEALTH OVERVIEW

The forests included in the spruce-fir type are generally in a recovery condition. During the drought years in the late 1980's there were heavy losses to the balsam fir resource, particularly when growing as an understory component in aspen stands. There were also losses to northern white-cedar due to fluctuating water levels, and losses in the tamarack type due to successful attacks of the eastern larch beetle, *Dendroctonus simplex* LeConte, on drought stressed tamarack.

Recovery of the spruce-fir types is due to the return to more normal precipitation patterns and amounts and a declining spruce budworm population. However, spruce budworm is still present in northeastern Minnesota, and in 1992 it was found south and west of its historic occurrence area. An on-going concern is the occurrence of dwarf mistletoe, *Arceuthobium pusillum* (Peck) on black spruce. Dwarf mistletoe is the major mortality agent on black spruce and accounts for an estimated 3,000,000 cubic feet of loss each year. As the movement toward new forestry practices such as leaving vertical structure increases, the incidences of dwarf mistletoe occurring in regenerating stands will increase which will dramatically affect the future health of black spruce forest type.

Pests reported in more detail include:

- ✓ Spruce Budworm
- ✓ Yellowheaded Spruce Sawfly

SPRUCE BUDWORM

Choristoneura fumiferana (Clemens)

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

County	Light(<30%)	Moderate(30-60%)	Heavy(>60%)
Cook	38,974	0	42,044
Lake	0	16,639	0
St. Louis	0	28,266	0
TOTAL[1]	**38,974**	**44,905**	**42,044**

GRAND TOTAL ACRES DEFOLIATED: 125,923

[1] Spruce budworm activity was also noted in Aitkin, Itasca, and Beltrami Counties.

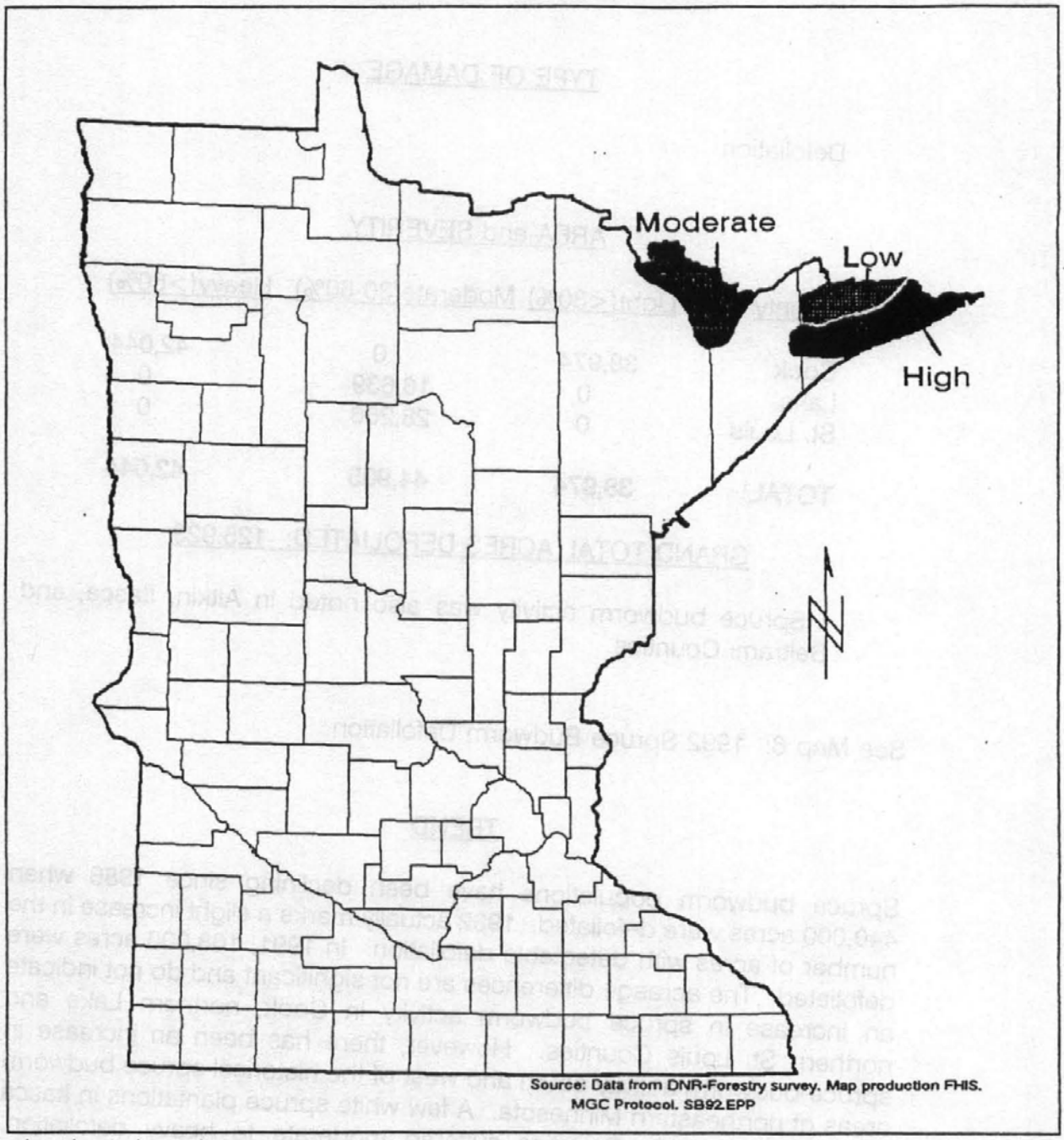
See Map 6: 1992 Spruce Budworm Defoliation.

TREND

Spruce budworm populations have been declining since 1986 when 440,000 acres were defoliated. 1992 actually marks a slight increase in the number of acres with detectable defoliation. In 1991, 108,000 acres were defoliated. The acreage differences are not significant and do not indicate an increase in spruce budworm activity in Cook, northern Lake and northern St. Louis Counties. However, there has been an increase in spruce budworm activity south and west of the historical spruce budworm areas of northeastern Minnesota. A few white spruce plantations in Itasca and northern Aitkin Counties suffered moderate to heavy defoliation. Defoliation in these plantations is likely to continue in 1993.

Map 6: 1992 Spruce Budworm Defoliation

Spruce Budworm: 1992



Scale: 0 25 50 mi

SPRUCE BUDWORM DEFOLEATION
HEAVY DEFOLEATION
MODERATE DEFOLEATION
LIGHT DEFOLEATION
NO DEFOLEATION

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Division of Forestry
Forest Health Unit
Forest Health Information System (FHIS)

NOTES

Egg mass and defoliation surveys conducted during the fall of 1991 indicated a possible need for control of spruce budworm in six white spruce plantations in Cook County. Total acres involved in the 6 plantations amounted to 301 acres. The plantations and acreage were:

Plantation 445-25: 94 acres

T. 64N R. 4E S. 35 & T. 63N R. 4E S. 2

Plantations 337-25 & 25A: 87 acres

T. 64N R. 4E S. 28 & 34

Plantation 426-25: 72 acres

T. 64N R. 4E S. 34

Plantation 355-25: 31 acres

T. 63N R. 1E S. 14 & 15

Plantation 356-25: 17 acres

T. 63N R. 1E S. 11

At a planning meeting in December, the decision was made to treat all 6 plantations with one application of a BT formulation if budworm populations were high enough to cause moderate to heavy defoliation. Early larval checks in the spring showed that populations were still high, and it was decided to go ahead with treatment.

Spraying was conducted on June 21, 1992 using 2 qts per acre of Dipel 6AF (24 BIUs) in 2 qts of water per acre. Plyac sticker and 8002 nozzles were used. There was no wind, the weather was cool, and the larvae were in the 4th to 5th instars. Rain fell 24 hours after treatment, and the weather remained cool. Larvae were inactive immediately prior to, during and immediately after spraying.

Approximately one week after treatment, two of the plantations were checked for larval mortality. Many larvae appeared to be in various stages of injury, and some dead larvae were observed. In later checks, many black and small pupae were found. Pheromone trapping later in the summer caught very high numbers of moths, and it was assumed that these were funneled in from the surrounding fir types.

There was continued concern that spraying was not as effective as hoped for. The application was done at a later instar than recommended, the weather was cool and wet and larvae were not real active, and there were high pheromone trap catches. An egg mass survey was conducted in early October to see if there was a potentially damaging population predicted for 1993. Defoliation predictions based on this life stage survey indicated light to moderate defoliation in 1993. With the amount of foliage present on the white spruce in the plantations, it was recommended not to spray in 1993. The egg mass survey results are summarized following the PHENOLOGY section.

Pheromone trapping was also carried out at 5 locations in NE Minnesota. At each location, 3 pheromone baited traps were used. Trapping results are summarized following the PHENOLOGY section.

There were some unusual observations of spruce budworm during 1992. Populations were found feeding in several white spruce plantations in both Aitkin and Itasca Counties, and moderate to heavy defoliation occurred in these plantations. And, in Beltrami County, in S. 21, T. 147N, R. 31 W., larvae and pupae were collected from a mixed balsam fir-aspen stand. Feeding was noted earlier by the local manager working in the stand. These may be isolated incidences without a reoccurrence during 1993, but they may also herald a movement of spruce budworm populations to other parts of the state where balsam fir and white spruce are found. Where spruce budworm is present in the white spruce plantations in Itasca and Aitkin County, additional defoliation is expected in 1993.

PHENOLOGY

June 10	Larvae 12-19 mm in length - west central St. Louis Co.
June 15	50% pupated - Koochiching Co.
June 22	95% pupated; 50% green, 50% dark - N. St. Louis Co.
July 14	Moths in flight - Itasca Co.
July 22	Moths flying - W. Lake Co.
July 23	Moths flying; 25% of pupae green; few larvae still present - Cook Co.

EGG MASS SURVEY

Plantation #445-25: 35-64N-4E & 2-63N-4E

Predicted 1993 Defoliation: LIGHT TO MODERATE

Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Light	2	1	0	Moderate
Light	1	0	0	Light
Light	0	0	0	None
Light	1	0	0	Light
Moderate	0	2	0	Moderate
Light	0	0	1	Light

Plantation #337-25A: 34-64N-4E

Predicted 1993 Defoliation: NONE TO LIGHT
Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Light	0	0	0	None
Light	0	0	1	Light
Light	0	0	0	None

Plantation #337-25: 28-64N-4E

Predicted 1993 Defoliation: MODERATE
Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Light	0	1	0	Light
Light	0	0	0	Light
Light	0	1	0	Light
Light	4	2	3	Heavy

Plantation #426-25: 34-64N-4E

Predicted 1993 Defoliation: MODERATE
Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Heavy	2	3	0	Heavy
Moderate	1	1	0	Moderate
Moderate	1	0	0	Light
Moderate	1	4	2	Heavy
Moderate	0	0	0	None

Plantation #356-25: 11-63N-1E

Predicted 1993 Defoliation: LIGHT TO MODERATE
Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Light	0	0	0	None
Light	0	0	0	None
Heavy	0	2	1	Moderate
Heavy	0	0	1	Light

Plantation #355-25: 14/15-63N-1E

Predicted 1993 Defoliation: NONE TO LIGHT
Recommended Action: NO SPRAY

	Number of Egg Masses			
Defoliation	Tree 1	Tree 2	Tree 3	Predicted Defoliation
Light	0	0	0	None
Moderate	0	0	0	None
Heavy	0	1	0	Light

PHEROMONE SURVEY

SITE NAME	DESCRIPTION	TOTAL NO. MOTHS
Logger Lake	SWNW S14-T63-R1E	2,105
Swamp River, OtterLake Road	SESE S28-T64-R4E	2,685
Jackson Lake Road	SESW S35-T64-R4E	5,010
Knife River	S36-T52-R12W	185
Big Noise	S19-T55-R10W	112

YELLOWHEADED SPRUCE SAWFLY

Pikonema alaskensis (Rohwer)

NOTES

Predictions made in 1991 indicated that 1992 would be a peak year for this defoliator. Generally, those predictions did not materialize. However, throughout central Minnesota, sawfly defoliation was more widespread than in 1991.

However, yellowheaded spruce sawfly is a chronic pest, defoliating young white spruce. Repeated defoliations have caused tree mortality, and there are a number of Christmas tree growers who annually treat their plantations to control the yellowheaded spruce sawfly. Because this defoliator is present every year and it is a chronic pest, an information bulletin was produced. This can be found in the 1992 PUBLICATIONS section.

Two state plantations in Mahnomen County and a 5 year old state plantation in St. Louis County were treated to prevent additional defoliation from this sawfly. Yellowheaded spruce sawfly had been found in these plantations for at least 2 years prior. The decision to spray these plantations was made because defoliation was becoming heavy and populations were building.

The plantations in Mahnomen County were located in S12 & 13-T143N-R 40W, and the plantation in St. Louis County was located in S24-T55N-R22W. Treatment occurred in mid June, and Sevin was used. A crew walked the plantations with backpack sprayers, and treated spruce with actively feeding larvae.

PHENOLOGY

June 2	Larvae 7mm in length on roadside white spruce that showed heavy 1991 defoliation; S35-T45N-R28W - Crow Wing Co.
June 9	Lilacs in full bloom; dandelions in fluff - Duluth, St. Louis Co.
June 10	Larvae 3-10 mm in length, eastern Itasca Co.
June 22	Larvae 25 mm in length, Tower, St. Louis Co.
June 27	Larvae still feeding - Crow Wing Co.
June 30	Mature larvae of 5 ft. white spruce causing about 30% defoliation; S21-T137N-R28W - Crow Wing Co.
July 20	Larvae on 2 yard spruce; south side of Gull Lake - Cass Co.

MAPLE-BASSWOOD

- 1,402,900 acres or 9.5% of the commercial forest land
- Maple-Basswood Cover Type:

> *"Forests in which sugar maple, basswood, yellow birch, upland American elm, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include white pine, elm, and basswood.)"*

FOREST HEALTH OVERVIEW

The overall health of the maple-basswood forests is rapidly improving. Three important damaging factors were lacking in 1992. The drought of the late 1980's had ceased in these forests for at least two years, and defoliation from both the introduced basswood thrips, *Thrips calcaratus* (Uzel), and the forest tent caterpillar, *Malacosoma disstria* Hubner, was at very low levels during 1992. The introduced basswood thrips has not been a major defoliator in maple-basswood forests in Minnesota since 1988. The forest tent caterpillar populations have waned since 1990.

During mid-summer there was concern in the maple-basswood forests because both sugar and red maples began to display fall coloration. The trees appeared to be in good health and it has been theorized that the unusually cool summer temperatures and the water-saturated soils led to the early fall coloration. Even though May and the beginning of June was dry, there was an overabundance of rainfall starting in mid-June which led to unusually heavily saturated soils.

The cooler, wetter summer conditions created succulent leaf conditions. This allowed the buildup of aphids on the leaves. There were large public concerns about the "dripping maples," but no serious tree health conditions are anticipated from the high aphid populations.

There was a complex of leaf feeders in Itasca County. The feeders were not heavy enough to cause noticeable defoliation, but many people

complained about the "rain" when walking in maple stands. The "rain" was the falling frass from the leaf feeding larvae. Species identified included the linden looper, *Erannis tiliaria* (Harris), and the maple leaf roller, *Cenopis acerivorana* MacKay, but there were at least 4 other species of larvae feeding on the leaves that were not identified.

In the Bemidji area, red maples had unusually heavy seed crops which turned the crowns brown as the seeds matured. Later in the summer as the seeds dropped, the crowns appeared thin and defoliated, and the crowns never filled in. There is some concern what the long term effect will be from this heavy seed crop, and there is some concern as to why it happened when weather conditions were generally cool and wet.

In 1992, Minnesota joined the North American Maple Project, and 8 permanent monitoring plots were established in the state. For more details about this project, see the SPECIAL PROJECTS section.

ELM-ASH-SOFT MAPLE

- 1,291,500 acres or 8.7% of the commercial forest land
- Elm-Ash-Soft Maple Type:

> *"Forests in which lowland elm, ash, red maple, silver maple, and cottonwood singly to in combination, comprise a plurality of the stocking. (Common associates include birches, spruce, and balsam fir.)"*

FOREST HEALTH OVERVIEW

The elm-ash-soft maple forests were generally in good health in Minnesota during 1992. There were no major defoliators in these forests. The cottonwood leaf beetle, *Chrysomela scripta* F., caused noticeable defoliation to shrub willows in the Kelliher area in Beltrami County. Feeding by this insect caused a blackened, scorched appearance to many willow clumps during June. The bagworm, *Thyridopteryx ephemeraeformis* (Haworth), also caused some noticeable defoliation on willow trees in the Bemidji area. Both of these defoliating insects were not severe or widespread enough to be of concern.

Willow blight, *Pollaccia saliciperda* (Allesch. & Tub.) Arx and *Glomerella cingulata* (Ston.), was again evident on ornamental willows in St. Louis, Lake, and Itasca Counties. This blight was common in the mid 1980's but was not found during the drought years of the late 1980's.

Weather conditions were generally favorable for these forests, except for late spring frosts. On May 6, a temperature of 33°F was recorded at Lewiston. Walnut and willow in low lying areas showed the effects of cold temperature injury in SE Minnesota after the May 6 date. A more generalized frost occurred on May 24th across the entire state, and frost occurred in central and northern Minnesota on May 27th and May 28th. Elm-ash-soft maple forests and associated species often are more vulnerable to these late spring frost because the forests tend to be found in low areas where cold air accumulates. Despite the blackening and shedding of the early foliage from these frosts, trees did refoliate and did not appear to suffer any long term harm.

OAK FORESTS

- 1,184,300 acres or 8% of the commercial forest land
- Oak Cover Type:

> *"Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include jack pine, elm, and maple.)"*

FOREST HEALTH OVERVIEW

The overall health of the oak forests is improving. Tremendous losses occurred in these forests during the late 1980's. Losses were from a combination of drought stress, defoliation by the forest tent caterpillar, attacks by the twolined chestnut borer and *Armillaria* root rot. Very little new oak mortality occurred during 1992. Oak wilt continues to be a major problem in the oak type and has become a significant urban problem. A more detailed report on oak wilt can be found under Urban Forests.

The 1992 growing season was abnormally cool and experienced a number of late spring frosts. Frosts in late May defoliated newly flushing bur oaks in the north central and northwestern parts of the state. The small leaves blackened and dropped, but a new crop of leaves were produced and the trees appeared to be in good health the remainder of the 1992 growing season. Additional information regarding frost damage can be found under Elm-Ash-Soft Maple Forests.

Oak had full complement of leaves and held the leaves for the entire 1992 growing season. Forest tent caterpillar activity was greatly reduced. Defoliation in these forests amounted to only 39,300 acres, and only 2,650 acres were moderately (30-60%) defoliated. Additional details summarizing forest tent caterpillar activities in the state can be found under Aspen-Birch Forests, and the FTC defoliation area can be found on Map 6.

Pests reported in more detail include:

- ✓ Oak Anthracnose
- ✓ Oak Lacebug
- ✓ *Fusarium* Canker on Black Walnut

OAK ANTHRACNOSE

Apiognomonia errabunda (Roberge) Hohn.

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

Acreage was not determined since this disease covered a large, multi-county area, it occurred only on the white oaks, and was scattered and spotty.

Counties with significant oak anthracnose included:

Wabasha, Winona, Houston, Fillmore, Olmstead

Severity: 20 to 80% defoliation

TREND

Outbreaks are related to wet and cool weather conditions during leaf flush. Conditions were ideal for this disease during 1992. The 1992 outbreak does not indicate an increasing trend in this disease; rather, it reflects weather conditions.

NOTES

In June across the southeast there was a widespread outbreak of oak anthracnose on eastern white oak, *Quercus alba* L. Reports came in from Austin to Winona County. Oak anthracnose occurs from the eastern provinces of Canada to the Gulf of Mexico. Occurring to some extent in most years in Minnesota, outbreaks can occur whenever environmental conditions are conducive for disease development.

The causal fungus, *Apiognomonia errabunda* (Roberge) Hohn., is the teleomorph stage of *Discula umbrinella* (Berk. & Broome) Sutton. This fungus causes leaf blotch and defoliation to a wide range of hardwood trees in the following genera: *Celtis, Fagus, Liquidambar, Platanus, Quercus,* and *Tilia.* The fungus has been found infecting all oak species in Minnesota, but 1992 occurrence was primarily on white oak.

Disease symptoms vary greatly with host species, weather conditions, and the stage of plant development at the time of infection. Symptoms tend to follow one of three patterns:

- A rapid developing blight of the leaves and shoots, characterized by browning and shriveling of young leaves during the period of leaf expansion. This symptom pattern occurs very infrequently, and could be easily confused with frost.

- Large irregular dead areas on distorted leaves that otherwise remain green. This symptom pattern usually is evident in late summer on bur oak, but this was the pattern common on the white oaks during the 1992 outbreak.

- Small necrotic spots on leaves that have reached mature size. This symptom pattern last occurred on black oaks during June of 1991. The usual foliar symptoms on black oak are brown spots up to 2 cm in diameter.

When outbreaks of anthracnose are promoted by wet weather and moderately cool temperatures, infections become prominent on the lower branches then spread upward. Enlarging lesions on the oak leaves tend to follow the veins or midrib and to be bounded by the veins. Often, all of the leaf tissue on one side of a midrib or major vein is killed, and leaf distortion results. After drying, lesions are papery in texture and turn tan to nearly white before weathering to a grayish white. At the edge of the lesions there is an abrupt transition from brown to normal green tissue. With all types of anthracnose on oaks the acervuli of the pathogen become visible even to the unaided eye. They appear as raised brown flecks on the lower surfaces of the foliar lesions.

Anthracnose outbreaks usually subside before midsummer. The exception is bur oak which can develop the disease in August. Defoliation from anthracnose does not impact long term health of the oaks. Direct control

measures usually are not warranted. However, homeowners with reoccurring anthracnose problems are encouraged to rake up the leaves in the fall and burn or compost them to reduce the inoculum under the trees during the following growing season. Leaves on the ground become a major source of new infections.

OAK LACE BUG

Corythucha arcuata (Say)

NOTES

Lacebugs caused bronzing and browning of leaves to both oaks and understory shrubs in central and east central counties of Minnesota during August. In Morrison County, populations occur every year and cause minor branch dieback. Generally the oaks in Morrison County that support populations of oak lacebug are in good condition. They produced well-formed buds in August indicating good tree vigor.

PHENOLOGY

August 18 Leaf bronzing noted in Morrison, Chisago, Pine, Crow wing, and Cass Co.

Fusarium Canker of Black Walnut

Fusarium spp.

TYPE OF DAMAGE

Branch death, crown dieback, tree mortality

AREA and SEVERITY

25 acres of 20 - 80% crown dieback and tree mortality

Counties: Filmore and Houston

TREND

Unknown

NOTES

Tree mortality in two widely separated pole size walnut plantations was observed in 1992. These two areas were a state plantation in Fillmore County, S. 2, T. 103N, R. 10W, and a private plantation in Houston County, S. 3, T. 102N, R. 4W. The mortality appears to be related to winter damage occurring in the same areas during the winter of 1990-91. A sample of the dying trees revealed large recent black streaks that seem to precede the large cankers that develop on some trees. Isolations from the streaking did not produce any *Fusarium* spp., but the pathogen was isolated from existing cankers on the same trees. It is possible that the *Fusarium* spp. is responsible for the mortality, having its beginning following the severe multiple wounds caused by the winter injury.

PINE FORESTS

- 812,300 acres or 5.5% of the commercial forest land
- Includes the following cover types:

Jack Pine: 447,500 acres

"Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple."

Red Pine: 301,600 acres

"Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)"

White Pine: 63,200 acres

"Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, jack pine, aspen, birch, and maple.)"

FOREST HEALTH OVERVIEW

The health of the pine forests in Minnesota is improving. These forests sustained heavy losses from drought stress and bark beetle activity during the late 1980's during the peak of the drought years. Since then, more normal precipitation patterns has reduced the stresses resulting in a reduction in bark beetle activity.

Both the jack pine budworm and the pine tussock moth populations, the major pine defoliators in Minnesota, are not at peak levels. However, there is evidence that the jack pine budworm population is building in the central part of the state. During 1992, the jack pine budworm did cause defoliation, and it is predicted to cause significant defoliation again in Cass, Crow Wing and Pine Counties. Despite this, population numbers are not expected to

cause significant damage to the jack pine resource as experienced during the outbreaks of the 1970's and the 1980's.

The health of the white pine forests is an ongoing debate and concern in Minnesota. Because white pine is relatively scarce compared to its historical occurrence in Minnesota and because it is a favored tree by diverse interests, i.e., timber industry, game managers, non-game managers, and recreationists, there has been an intensive focus on the occurrence, the health, and the management of this resource. A symposium on white pine in the Lake States was held in Duluth during September and was attended by over 600 people. A paper was presented reflecting the viewpoint of the MN-DNR, Division of Forestry, Forest Health Unit, and that paper can be found in the Publications section.

Pests discussed in more detail in this section include:

- ✓ Jack Pine Budworm
- ✓ Pine Tussock Moth
- ✓ Bark Beetles
- ✓ Red Pine Sawfly
- ✓ Jack Pine Sawfly
- ✓ Introduced Pine Sawfly
- ✓ Pine Needle Rust

JACK PINE BUDWORM

Choristoneura pinus Freeman

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

County	Light(<30%)	Moderate(30-60%)	Heavy(>60%)
Beltrami	2,500	1,000	0
Cass	0	1,500	0
Crow Wing	0	3,000	1,000
Hubbard	3,900	1,100	0
Pine	0	1,500	1,000
Wadena	0	500	0
TOTAL	**6,400**	**8,600**	**2,000**

GRAND TOTAL DEFOLIATED ACRES: 17,000

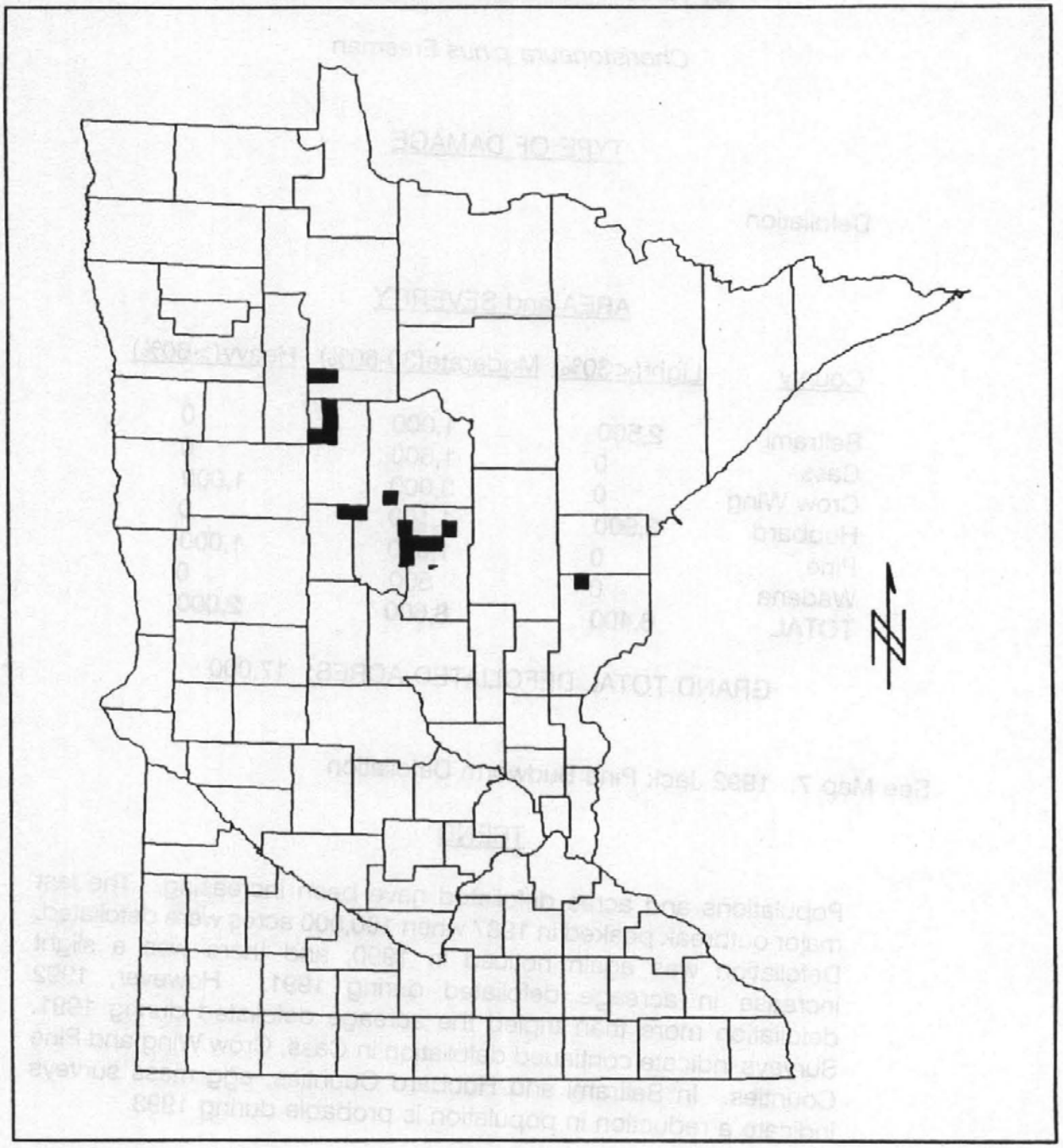
See Map 7: 1992 Jack Pine Budworm Defoliation

TREND

Populations and acres defoliated have been increasing. The last major outbreak peaked in 1987 when 100,000 acres were defoliated. Defoliation was again noticed in 1990, and there was a slight increase in acreage defoliated during 1991. However, 1992 defoliation more than tripled the acreage defoliated during 1991. Surveys indicate continued defoliation in Cass, Crow Wing and Pine Counties. In Beltrami and Hubbard Counties, egg mass surveys indicate a reduction in population is probable during 1993.

Map 7: 1992 Jack Pine Budworm Defoliation

Jack Pine Budworm in 1992



Scale: 0 25 50 mi

Source: Forest Health Unit field survey.
FHIS-MGC Map Protocol, JPB-92.EPP

Minnesota Department of Natural Resources
Division of Forestry
Forest Health Unit
Forest Health Information System

NOTES

Jack pine budworm feeding was heavy enough in Beltrami, Cass, Crow Wing, Hubbard and Pine Counties to turn jack pine areas reddish brown by mid-summer. Stands showing the most color occurred in the following townships:

Beltrami County

Eckles (147N-34W)
Lammers (147N-35W)

Hubbard County

Lake George (143N-34W)
Lake Alice (143N-35W)
Schoolcraft (144N-34W)
Rockwood (145N-34W)

Only Lake George Township in Hubbard County and Eckles Township in Beltrami County experienced any defoliation in 1991. The acreage of defoliation increased from a few hundred acres in 1991 to a few thousand acres in 1992.

Early larval surveys completed in June indicated that defoliation would be more severe and cover a larger area than in 1991. Larval counts in 1992 ranged from 0 to 16 per 30 shoots with an average of 5 shoots with feeding larvae per plot. There were 23 plots in Hubbard County and 8 plots had 0 or 1 larvae. Larval samples in Eckles and Lammers Townships in Beltrami County showed similar spotty results. These survey results were not similar to survey results during jack pine budworm outbreak during both the 1970's and the 1980's. It is possible the erratic, spotty survey results indicate a population reacting to the hot,dry weather conditions rather than an indication of a population building into a major outbreak.

Egg mass surveys in both Hubbard and Beltrami Counties indicate a population decrease from 1992. Again, this would not be consistent with a steadily building population. Perhaps, since weather patterns are more "normal," the small blip in the population cycle seen so soon after the dramatic crash of a major outbreak is subsiding.

In Cass, Crow Wing, and Pine Counties there was an increase in the severity and the extent of defoliation during 1992. Near Willow River in Pine County, some pines have more than 90% of their last year's needles and

new shoots partly defoliated. In Cass, Crow Wing, and Wadena Counties, very few of the new shoots were dead.

Egg mass surveys were conducted in stands that had been moderately to heavily defoliated during 1992. There were 3 locations in Crow Wing County where egg mass finds indicate a potential for moderate to heavy defoliation: **NENE S23-T136N-R27W**, **NESW S14-T137N-R29W**, and **SWNE S4-T45N-R30W**.

A major jack pine area in the northwestern part of the state in Roseau and Lake of the Woods Counties experienced no defoliation during 1992. No larvae were found during the larval survey, and egg mass surveys found no egg masses.

In St. Louis, Itasca, and Koochiching Counties few larvae were found during the early larval survey, and no noticeable defoliation was observed during 1992 in these three counties. No noticeable defoliation due to the budworm is expected in this area during 1993.

PHENOLOGY

June 4	2nd instar larvae in staminate cones - Pine Co.
June 9	4th instar larvae - Crow wing Co.
June 12	Larvae 10-13 mm in length; new needles 6-10 mm long; male conelets dry but larvae still present - central St. Louis Co.
June 24	Sixth and 7th instar larvae - Crow Wing Co. Pupation starting - Pine Co.
June 30	Pupation about 90% completed - Pine Co.
July 1	Pupation 90+% - Cass, Crow Wing, and Pine Co.
July 8	Budworm moths in pine tussock moth pheromone traps - Cass, Crow Wing, and Pine Co.
August 11	Additional budworm moths in pine tussock moth pheromone traps - Cass, Crow Wing, and Pine Co. Traps cleaned July 28-30

SURVEYS

LARVAL SURVEY

This survey involved counting the number of shoots that had budworm larvae feeding on them. 30 shoots on branches cut from the mid crown area from 5 trees were inspected at each location. Heavy defoliation is predicted when 20 or more shoots have larvae on them.

BECKER

Description	Count
SWSW S35-T139-R35	5/30
NENW S35-T139-R35	7/30
SWNW S02-T139-R36	1/30
NENW S04-T139-R36	0/30
SWSW S14-T139-R36	1/30
SENE S15-T139-R36	0/30
NENE S22-T139-R36	0/30
NWSW S22-T139-R36	0/30
SESE S34-T140-R36	1/30
SESW S27-T141-R36	0/30
NWNE S35-T141-R36	0/30
NWNW S36-T141-R36	0/30

BELTRAMI

SESE S04-T147-R34	12/30
NWNW S09-T147-R34	15/30
NENE S10-T147-R34	5/30
NENE S11-T147-R34	10/30
NWNW S11-T147-R34	8/30
NESE S26-T147-R34	9/30
SENE S35-T147-R34	0/30
NENE S01-T147-R35	2/30
SENW S02-T147-R35	1/30
SWNE S03-T147-R35	4/30
SESE S11-T147-R35	1/30

CASS

Description	Count
S10-T136-R29	12/30
S02-T138-R32	1/30
S15-T138-R32	1/30
S36-T138-R33	1/30

CLEARWATER

Description	Count
SWSW S08-T145-R38	8/30
SWNW S08-T145-R38	0/30
SWSW S19-T145-R38	0/30
SWNW S30-T145-R38	0/30
NWSE S09-T146-R35	0/30
SESW S22-T146-R35	0/30
NWSW S23-T146-R35	0/30
SWNE S34-T146-R35	0/30
NWNW S19-T148-R35	0/30
SESE S19-T148-R35	0/30
NWSE S29-T148-R35	0/30
NENE S32-T148-R35	0/30

CROW WING

S09-T136-R27	1/30
S23-T136-R27	15/30
S10-T136-R29	12/30
S23-T137-R27	2/30

HUBBARD

Description	Count
SESE S06-T139-R32	1/30
NWSW S09-T139-R32	5/30
NENW S10-T139-R32	0/32
SWSW S10-T139-R32	0/30
SWSW S11 T139-R32	1/30
SWSW S29-T139-R32	0/30
NENW S30-T139-R32	1/30
NENE S36-T139-R32	0/30
NESE S13-T139-R33	1/30
NWSE S26-T139-R33	1/30
NWSW S35-T139-R33	0/30
NWNW S23-T140-R32	0/30
SWSW S23-T140-R32	0/30
SWSW S26-T140-R32	1/30
NWSW S30-T140-R32	3/30
SESE S30-T140-R32	4/30
NWNW S34-T140-R32	1/30
SWSE S26-T140-R33	8/30
SENW S27-T140-R33	1/30
SESW S35-T140-R33	1/30
SENE S04-T143-R34	1/30
SWSW S06-T143-R34	1/30
NENW S08-T143-R34	4/30
SWSE S08-T143-R34	10/30
SESE S09-T143-R34	0/30
NENW S16-T143-R34	1/30
SESE S02-T143-R35	1/30
SENW S14-T143-R35	0/30
SENE S03-T144-R34	7/30
NESE S10-T144-R34	16/30
SWSE S22-T144-R34	3/30
SWSE S27-T144-R34	13/30
NENW S28-T144-R34	7/30
NWNE S29-T144-R34	4/30
NWNE S32-T144-R34	13/30
SESW S34-T144-R34	5/30
NWNW S01-T145-R34	0/30
SESE S22-T145-R34	1/30

HUBBARD

Description	Count
NWSW S24-T145-R34	8/30
NWSE S27-T145-R34	9/30
NWSW S35-T145-R34	10/30
SWSE S02-T145-R35	1/30
SWNE S03-T145-R35	0/30

ITASCA

S01-T147-R25	0/30
S12-T147-R25	2/30

KOOCHICHING

S07-T65-R24	1/30
S02-T65-R24	0/30
S01-T65-R24	0/30
S32-T66-R26	0/30
S24-T66-R27	0/30
S25-T153-R25	0/30

LAKE OF THE WOODS

SWNE S02-T158-R34	0/30
NESW S29-T159-R33	0/30
NWSW S30-T159-R33	0/30
SESW S35-T159-R33	0/30
SWNW S07-T159-R34	0/30
NWNE S13-T159-R34	0/30
NENE S16-T159-R34	0/30
SWSW S01-T159-R35	0/30
SWNW S04-T159-R35	0/30
NENE S07-T159-R35	0/30
NWNW S06-T159-R36	0/30
SENW S13-T159-R36	0/30
SWNW S06-T160-R36	0/30

PINE

Description	Count
S18-T45-R19	17/30
S24-T45-R20	0/30
S25-T45-R20	0/30
S25-T45-R20	8/30
S25-T45-R20	17/30
SESW S36-T45-R20	2/30

ROSEAU

SWSE S08-T159-R37	0/30
SENW S06-T160-R37	0/30
SESE S19-T160-R37	0/30
SESE S31-T160-R37	0/30
SWSW S14-T160-R38	0/30
SWNW S35-T160-R38	0/30
SWNW S26-T161-R36	0/30
SWSE S29-T161-R36	0/30
NENE S30-T161-R36	0/30
NWSE S30-T161-R36	0/30
NWSE S26-T161-R37	0/30

ST. LOUIS

Description	Count
SWSE S09-T9-R16	0/30
S33-T54-R14	0/30
S05-T55-R12	0/30
S01-T56-R13	0/30
S04-T57-R16	4/30
NWNE S09-T57-R16	0/30
S12-T57-R16	2/30
S07-T59-R17	0/30
S28-T60-R18	0/30
S31-T64-R12	0/30
T65-R14	0/30
T66-R20	0/30

WADENA

S08-T138-R33	1/30
S15-T138-R33	1/30

EGG MASS SURVEY

This survey was based on sampling 4 trees of different crown classes per sampling location. The sample unit was 18 inches of needle-bearing surface on a branch from the mid crown of each tree. The count represents the total number of egg masses found on the 4 trees. An average of 1 egg mass (4 total for the plot) predicts a potential for noticeable defoliation the following growing season.

BELTRAMI

Description	Count
SESE S04-T147-R34	0
SESW S08-T147-R34	0
SESW S08-T147-R34	1
NWNW S09-T147-R34	1
SESW S09-T147-R34	0
SESE S10-T147-R34	0
NENE S11-T147-R34	0
NENW S11-T147-R34	0
SWNW S15-T147-R34	0
NWNE S21-T147-R34	0
NESE S26-T147-R34	0
SENE S35-T147-R34	0
NENE S01-T147-R35	0
SENW S02-T147-R35	0
SWNE S03-T147-R35	0
SESE S11-T147-R35	0
CASS	
SWNW S20-T135-R29	0
NWNW S20-T139-R30	2
CROW WING	
SWNE S04-T045-R30	4
NESW S12-T134-R27	2
NENE S23-T136-R27	5
SWNW S09-T135-R28	0
NESW S14-T137-R29	3
HUBBARD	
NWSE S26-T139-R35	0
NENW S35-T139-R35	0
SWSW S35-T139-R35	0

HUBBARD

Description	Count
NENE S03-T143-R34	0
NWNE S05-T143-R34	0
SWSE S08-T143-R34	1
NENE S09-T143-R34	1
SESW S09-T143-R34	0
NWSW S10-T143-R34	0
NENE S16-T143-R34	0
SENE S03-T144-R34	1
NESE S10-T144-R34	1
NESE S15-T144-R34	0
SWSE S22-T144-R34	0
NENW S32-T144-R34	1
SESW S34-T144-R34	0
NENW S04-T145-R34	0
SESE S22-T145-R34	0
NESE S23-T145-R34	0
NWSW S27-T145-R34	0
SWSE S27-T145-R34	1
SWNW S29-T145-R34	0
SESE S34-T145-R34	0
ROSEAU	
NWNE S06-T160-R37	0
NWNE S27-T160-R38	0
NENE S19-T161-R36	0
NWSW S32-T161-R36	0
NESW S30-T161-R37	0
PINE	
S36-T45-R20	1

PINE TUSSOCK MOTH

Dasychira pinicola (Dyar)

TYPE OF DAMAGE

Defoliation

AREA and SEVERITY

No defoliation by the pine tussock moth was observed during 1992.

TREND

Pine tussock moth populations remain at low levels in Minnesota. This defoliator has caused severe defoliation and tree death in the past when populations were high. During 1961, 1,000 acres of jack pine were killed in Pine and Crow Wing Counties. In 1980 an aerial spray program using chemical insecticides was undertaken to reduce a dangerously high population and prevent tree mortality. Since the success of that operation, tussock moth populations have remained at low enough levels to preclude the use of direct control measures. Since the 1980 spray operation, the population has been monitored annually with pheromone traps. 1992 trapping results can be found following the phenology.

PHENOLOGY

June 4	No caterpillars observed - Pine Co.
June 25	4th and 5th instar caterpillars present - Pine Co.

RESULTS OF PHEROMONE TRAPPING

County	Description	Moths Trapped[1]
Cass	SWSE S15-T138-R32	15
Cass	SESW S25-T138-R32	34
Crow Wing	NWSW S09-T136-R27	41
Crow Wing	NWSW S09-T136-R27	30
Crow Wing	NESW S10-T136-R27	30
Crow Wing	NWSW S11-T136-R27	36
Crow Wing	NWNW S14-T136-R27	50
Crow Wing	NENE S23-T136-R27	33
Pine	SENE S06-T045-R19	29
Pine	SWNW S05-T045-R19	51
Pine	SWSW S17-T045-R19	7
Pine	SESW S30-T045-R19	53
Pine	NESE S30-T045-R19	27
Pine	SESE S13-T045-R20	15
Pine	SESE S25-T045-R20	23
Pine	NESE S25-T045-R20	21
Pine	NESE S26-T045-R20	41
Pine	SWSW S36-T045-R20	44
Wadena	NESE S03-T138-R33	67
Wadena	NENE S03-T138-R33	53
Wadena	SWNE S10-T138-R33	42
Wadena	SENE S15-T138-R33	19

[1] A count of 120 or more male moths in a trap would indicate a probable need for chemical control the following year.

BARK BEETLES

Ips spp.

NOTES

In the Twin Cities area, a small stand of red pine between 5 and 10 acres was fire damaged during May of 1992. Over the next few weeks both dead and scorched trees around the perimeter of the fire killed area became infested with bark beetles. Bark beetle attacks began immediately after the fire, and new galleries were still being formed the last week in June. Exposing early galleries in late June found pupae. Adult emergence began around July 10.

During the 1992 growing season, 3 separate red pine plantations in southeastern Minnesota were thinned for posts. One plantation was located on private land in Wabasha County, S23-T110-R10, and the other two plantations were located on state land in Winona County, S10-T108-R9. The logger utilized the posts to a three inch top, cut the posts to length, and peeled them on site. The posts were bundled by size, hauled to a treatment plant in Eau Claire, Wisconsin, and then hauled directly to a retail lumber yard in Eau Claire.

Bark beetle populations began to build up in the slash, but they did not completely utilized the slash during either the first or second generation. Problem populations were not expected unless an extended dry period occurred. Should a problem have developed, plans were made to take corrective actions, through immediate slash disposal and the use of trap trees and pheromone traps. However, by mid season enough rainfall had occurred to remove any concerns.

In central St. Louis County, overwintering bark beetle adults were actively constructing egg laying galleries and laying eggs as late as the latter half of June. At this time larvae from eggs laid earlier in the season were 3 mm in length.

These observations were trivial compared to the severe bark beetle outbreak during the drought period of 1988-1989. Despite this, any bark beetle occurrence warrants watching particularly so soon after the drought of the late 1980's. The forests are recovering from stresses due to drought, but are not fully recovered. There are still forests vulnerable to attacks by

bark beetles. Fortunately the unusually cool summer of 1992 and then the abundance of moisture received after an initial spring mini-drought helped to keep down populations of bark beetles.

SAWFLIES

NOTES

Red pine sawfly, *Neodiprion nanulus nanulus* Schedl - In Morrison County on the west-southwest side of Lake Shamineau (S7-T132N-R31W), roadside and lake side jack pines had high numbers of larvae that were 15-20 mm in length and had caused 70-95% defoliation by June 9th. Larvae were 20mm in length in Grand Rapids, Itasca County, on June 10th. In Cass County in S29-T134N-R29W, a pocket of red pine was infested with larvae that were 8-15 mm in length on June 22nd. On this same date, a few roadside jack pines in Cass County in S26-T138N-R32W had clusters of larvae that were 20 mm in length and feeding on new needles. A few cocoons of this sawfly were found at the Morrison County site.

Jack pine sawfly, *Neodiprion pratti banksianae* Rohwer - In Grand Rapids, Itasca County, on June 10th larvae were 20mm in length on June 15 and close to 25mm in length in Koochiching County. Larvae were 12 mm in length at Brimson in St. Louis County. On some branches, larvae chewed chunks of bark off the twigs in addition to consuming the needles. The population appears to have declined from the 1991 levels when 7,000 acres were moderately to heavily defoliated in southeastern Koochiching County. However, some defoliation did occur, and on some trees it was the third year of defoliation. No long term damage is predicted to occur from this defoliator.

Introduced pine sawfly, *Diprion similis* (Hartig) - Populations in Aitkin, Cass, Crow Wing, Morrison, and Pine Counties were at lower levels in 1992 than compared to population levels during 1991. However, in the city of Baxter in Crow Wing County, several jack pines were heavily defoliated in September. As of August 13th, this defoliator had 90% completed its second generation. One third generation adult was observed on this date as were a few predatory wasps and stink bugs.

A pine sawfly, *Neodiprion maurus* Rohwer - In Pine County in S18-T45N-R19W, a pocket of many clusters of these larvae had heavily defoliated about 30% of the jack pines by June 25th. On July 30th these larvae were 12-21 mm in length, and by August 12 they had completed their feeding and formed cocoons on the ground. The population decreased in 1992 compared to 1991.

PHENOLOGY

Neodiprion nanulus nanulus

June 9	Larvae 13 mm in length - Cass Co.
June 12	Larvae 5 - 23 mm in length - Morrison Co.
June 22	Larvae 8 - 15 mm in length - Cass Co.

Diprion similis

June 2	Adults mating on 1991 heavily defoliated white pines - Cass Co.
June 8	Nearly mature larvae, 22 mm in length - Kanabec Co.
June 25	Larvae 8-20 mm in length; 70% defoliation - Aitkin Co.
July 31	2nd generation larvae present - Morrison Co.
August 11	80% of larvae 22 mm in length; few cocoons - Cass Co.
August 13	Only a few 2nd generation larvae present, about 22 mm in length; 1 3rd generation male observed - Crow Wing Co.

Neodiprion maurus

June 4	No larvae observed - Pine Co.
June 25	Larvae 5 mm in length - Pine Co.
July 9	Larvae 5 - 17 mm in length - Pine Co.
July 20	Larvae 20 mm in length; nearly mature; stink bugs eating larvae - Pine Co.
August 12	All larvae on ground in cocoons - Pine Co.

PINE NEEDLE RUST

Coleosporium asterum (Dietel) Syd. & P. Syd.

NOTES

There was a high incidence of this disease occurring on both plantation and ornamental red pines in the Metropolitan Area of the Twin Cities. Infections were limited to the lower 4 feet of the crowns in most cases, but some trees had 80%+ of the foliage affected.

The occurrence of this disease is related to weather conditions during the previous growing season. Abundant moisture during the late growing season with infected alternate hosts leads to a heavy infection during the following growing season. The occurrence of this disease usually indicates a favorable growing season for the pines.

URBAN FORESTS

□ Forests, both naturally established and planted, of a wide range of native and exotic species which grow within and are influenced by the urban environment. An urban forest "stand" can be a single shade or ornamental tree in a yard, or a multiple-acre greenbelt in a park.

FOREST HEALTH OVERVIEW

Similar to the rural forests of Minnesota, the urban forests also are recovering from the adverse weather conditions and damaging pest populations of the late 1980's and early 1990's. Two severe ice storms late in 1991 caused tremendous tree loss throughout southern Minnesota. Oak wilt continues to be a major problem in the oak urban forests particularly north of the Twin Cities. An aggressive oak wilt control program has made a positive impact on the effects of this disease. Gypsy moth continues to be monitored statewide, and in 1992 there were several new locations where gypsy moths were trapped for the first time.

GYPSY MOTH

Lymantria dispar (Linneaus)

NOTES

There were 8,445 gypsy moth pheromone traps placed in Minnesota during 1992. Summary of the trap catches compared to 1991 follows:

COUNTY	1992 MOTHS	1991 MOTHS
Anoka	4	1
Carlton	1	1
Carver	2	2
Dakota	12	14
Hennepin	31	25
Koochiching	**1**	**0**
Olmstead	**1**	**0**
Ramsey	13	1
Red Lake	**1**	**0**
Roseau	**1**	**0**
Scott	**1**	**0**
Stearns	**1**	**0**
St. Louis (MN) **Douglas (WI)**	**2** **4**	**0**
Wabasha	1	1
Washington	9	2
TOTALS	**85**	49

The Minnesota Department of Agriculture is the lead agency in Minnesota for gypsy moth monitoring. Personnel from the Department of Agriculture placed 7,590 pheromone traps during 1992.

The Minnesota DNR cooperates with the Department of Agriculture and operates a statewide trapping grid that focuses on placing traps into recreation areas on an annual basis. See Map 8. These areas are considered to be a high risk due to the potential of visits from recreational vehicles from infested areas outside of Minnesota. In addition to public and private campgrounds, the DNR trap grid includes public accesses, city and county parks, highway rest stops, and selected resorts. Additionally, DNR began to operate delimiting grids in 1991 in areas where moths were caught in DNR traps. DNR trap locations are furnished to the MDA for inclusion in an annual statewide trap report prepared for APHIS.

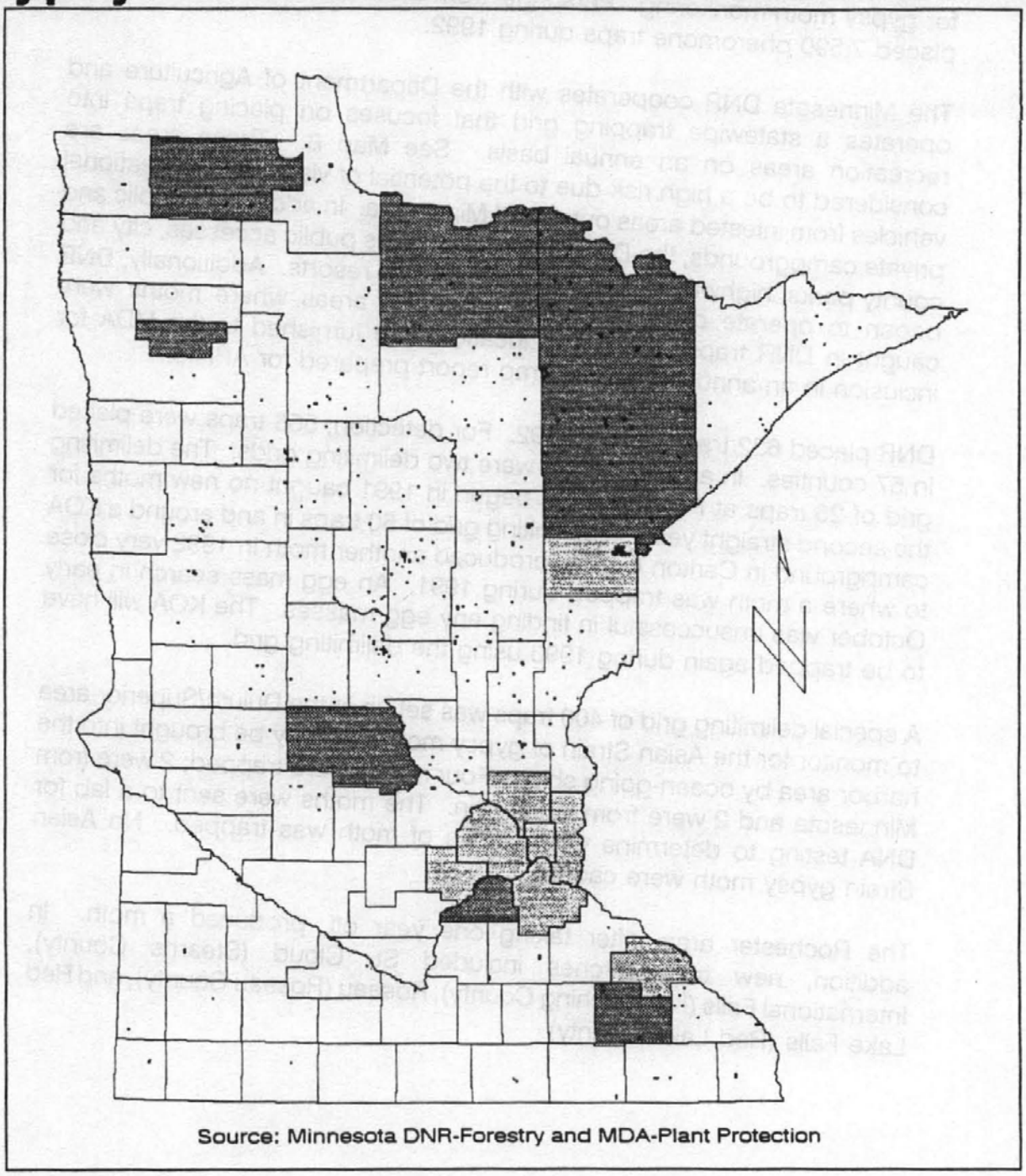
DNR placed 632 traps during 1992. For detection, 556 traps were placed in 57 counties. In addition, there were two delimiting grids. The delimiting grid of 26 traps at Pequot Lakes begun in 1991 caught no new moths for the second straight year. A delimiting grid of 50 traps in and around a KOA campground in Carlton County produced another moth in 1992 very close to where a moth was trapped during 1991. An egg mass search in early October was unsuccessful in finding any egg masses. The KOA will have to be trapped again during 1993 using the delimiting grid.

A special delimiting grid of 400 traps was set up in the Duluth/Superior area to monitor for the Asian Strain of gypsy moth that may be brought into the harbor area by ocean-going ships. Four moths were trapped; 2 were from Minnesota and 2 were from Wisconsin. The moths were sent to a lab for DNA testing to determine which strain of moth was trapped. No Asian Strain gypsy moth were caught.

The Rochester area, after taking one year off, produced a moth. In addition, new trap catches included St. Cloud (Stearns County), International Falls (Koochiching County), Roseau (Roseau County), and Red Lake Falls (Red Lake County).

Map 8: Gypsy Moth Status in Minnesota in 1992

Gypsy Moth Status in Minnesota in 1992



Source: Minnesota DNR-Forestry and MDA-Plant Protection

Scale: 0 25 50 mi

- Trapped by DNR-Forestry with moth(s)
- Trapped by DNR-Forestry with no moths captured
- New county with 1992 moth catch
- County with both 1991 and 1992 catch

Minnesota Department of Natural Resources
Division of Forestry
Forest Health Unit

OAK WILT

Ceratocystis fagacerum (T.W. Bretz) J. Hunt

TYPE OF DAMAGE

Vascular Wilt

AREA and SEVERITY

Acreage has not been assessed since 1988 when a complete inventory was made of oak wilt north of the Twin Cities. Oak wilt occurs over most of the southeastern portion of the state in an area covering at least 27 counties.

Counties with significant oak wilt include Anoka, Chisago, Dakota, Isanti, Olmsted, Ramsey, Sherburne, Wabasha, Winona, and Washington. Known infection centers range in size from single trees to almost 100 acres. The average size of an infection center varies by county with Anoka County having the largest average size, 2.08 acres. Anoka County also has the greatest number of infection centers, estimated at 1,700, and the largest number of acres of oak killed due to oak wilt, 2,800 acres.

TREND

The number of known oak wilt infection centers decreased about 15% in 1992 due to the first year of operation of a 4 year suppression program. This program treated 303 sites by early December when the ground froze. Another 100+ centers were scheduled for treatment before bud break in the spring of 1993.

NOTES

Oak wilt continues to spread over most of the infected parts of the state, but public education programs focused on prevention by avoiding pruning during May and June have begun to show some effect. Most new infection centers now appear near new homes. Wounding of the oak trees during the construction phase is the main source of new oak wilt infections.

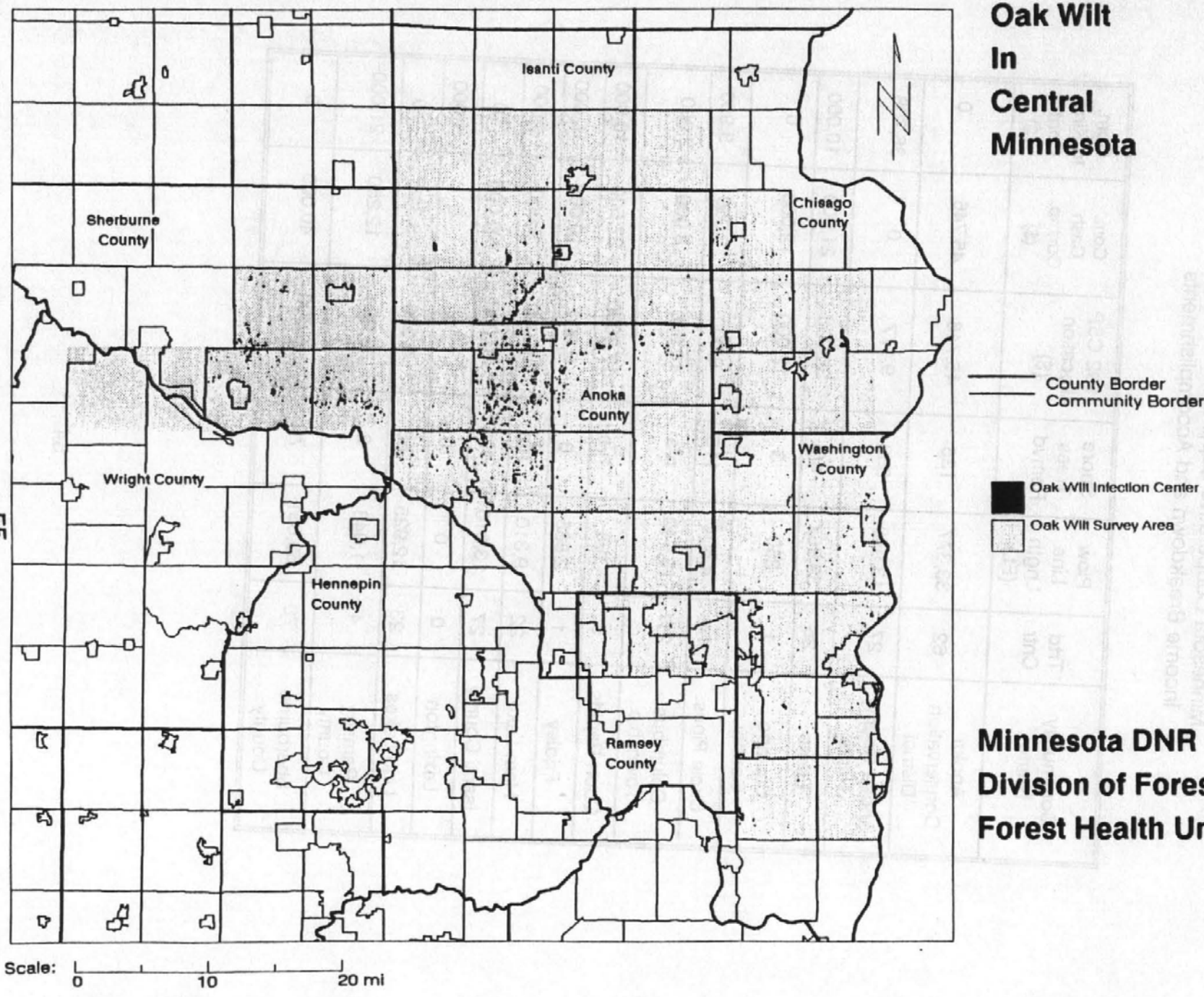
The big news in oak wilt suppression efforts in 1992 was the beginning of a cost share program with the U.S. Forest Service's Cooperative Suppression Program. USFS provided $250,000. Direct dollar grants were made to communities for work on private and public lands. In total, homeowners in 4 counties benefitted from a $555,500 program which operated through 14 local community partners. Of this amount, $250,000 was federal cost share and $213,800 was private and community cash. Another $97,700 was provided by local "in kind" match efforts.

As of December 7, 1992, when work ended due to frozen ground, 303 infection centers had received treatment with a vibratory plow to sever the root grafts. 209,992 feet (39.77 miles) of plow lines had been installed, and 943 potential spore producing trees identified and removed. Another 100+ infection centers are under contract to receive plowing early in 1993 as soon as the frost is out of the ground.

A summary of control accomplishments and dollars associated with the control efforts are summarized in the following table.

Minnesota Cooperative Suppression Program
Income Breakdown and Accomplishments

Community Name	Trtd Cntr	Plow Line Lngth (Ft.)	Spore Trees Remvd	1992 CSP Allocation ($)	Com. Cash Contrib. ($)	Com. In Kind Contr ($)
Anoka Conservation District	62	33,377	136	45,746	45,746	0
Anoka County Parks	27	13,950	353	9,177	0	36,708
Blaine	26	39,967	n/a	30,000	21,000	10,000
Chisago County	1	250	3	12,000	12,000	0
Circle Pines	14	4,504	115	9,000	3,050	5,950
Columbus Township	21	13,940	n/a	10,000	8,000	2,000
Coon Rapids	5	n/a	n/a	17,5000	27,500	10,000
Fridley	1	2,835	8	6,000	10,000	10,000
Ham Lake	22	9,310	n/a	10,000	9,000	1,000
Isanti County	27	13,310	187	20,000	20,000	0
Lexington	0	0	0	1,000	0	1,000
Lino Lakes	23	12,925	68	5,326	5,326	0
Ramsey County	4	1,943	3	33,250	12,250	21,000
Sherburne County	70	63,681	70	40,000	40,000	0


Oak Wilt
In
Central
Minnesota
Isanti County
Sherburne
County
Chisago
County
Anoka
County
Washington
County
Wright County
Hennepin
County
Ramsey
County
County Border
Community Border
Oak Wilt Infection Center
Oak Wilt Survey Area
Minnesota DNR
Division of Forestry
Forest Health Unit
Scale:
0
10
20 mi

ICE DAMAGE

During the fall of 1991, two severe ice storms occurred across large areas of southern Minnesota. The first occurred on October 31. Named the Halloween storm, it brought unusually heavy amounts of snow to the region. A second ice storm occurred on November 27.

The destruction to hardwood trees was severe and widespread. Twelve southern counties were declared federal disaster areas and included Blue Earth, Dodge, Freeborn, Goodhue, Mower, Olmstead, Rice, Steele, Waseca, Fillmore, Martin, and Fairbault Counties. Many of the rural areas were without power for weeks. The power failures were the result of the severe and widespread tree breakage from ice buildup.

Ground surveys revealed widely varying amounts of damage and varied with the species of tree. Table 1 is a summary of the observations of breakage susceptibility.

Table 1: Tolerance to Ice Breakage

HIGHLY SUSCEPTIBLE	MODERATELY SUSCEPTIBLE	MODERATELY TOLERANT
WILLOW	SILVER MAPLE	SPRUCE
SIBERIAN ELM	ASH	OAKS
POPLAR	BASSWOOD	SUGAR MAPLE
ASPEN	BIRCH	HONEY LOCUST
COTTONWOOD	WHITE PINE	HACKBERRY
	ELMS	WALNUT
		APPLE

The Federal Emergency Management Agency (FEMA) cost shared 75% of the cleanup costs. Costs were incurred for both labor and equipment as well as for tree replacement. The state added 15% for the municipalities.

Thirty-three cities in the affected counties received nearly $1,000,000. See Table 2. This money was for cleaning up the damage, removal of debris, and replacement of heavily damaged trees. For each tree replaced the city received 90% of the replacement cost per tree, which was $125.00.

Table 2: Disaster Relief Dollars for Storm Clean Up.

Governments and Cooperatives	Number	Dollars
Counties	10	$ 224,636
Cities	33	$ 957,161
Municipal Electric	6	$ 720,820
Rural Electric Cooperatives	9	$ 7,418,516
Other	7	$ 173,355
Totals	65	$ 9,494,488

Since only the most severely damaged trees were replaced, the long term impact may exceed the short term costs. It is unknown what the long term affects of tree wounds leading to hazardous trees may produce in the future.

ASH YELLOWS

NOTES

Ash yellows is caused by a mycoplasm-like organism which leads to a gradual decline and death of white, black and green ashes. This disease was first suspected to be causing ash decline in 1988 in a 5 acre black ash stand near Rochester in Olmstead County. In 1989, ash yellows was confirmed in this stand, and it was estimated that this disease had been killing trees in this stand for at least 3 years. The stand was subsequently harvested, and the regeneration was killed.

In 1991, there was widespread decline in green ash in urban areas. Decline was again observed during 1992. Although there was a new case of ash yellows confirmed in Ramsey County in 1991, green ash decline may also be related to winter injury and *Verticillium* wilt.

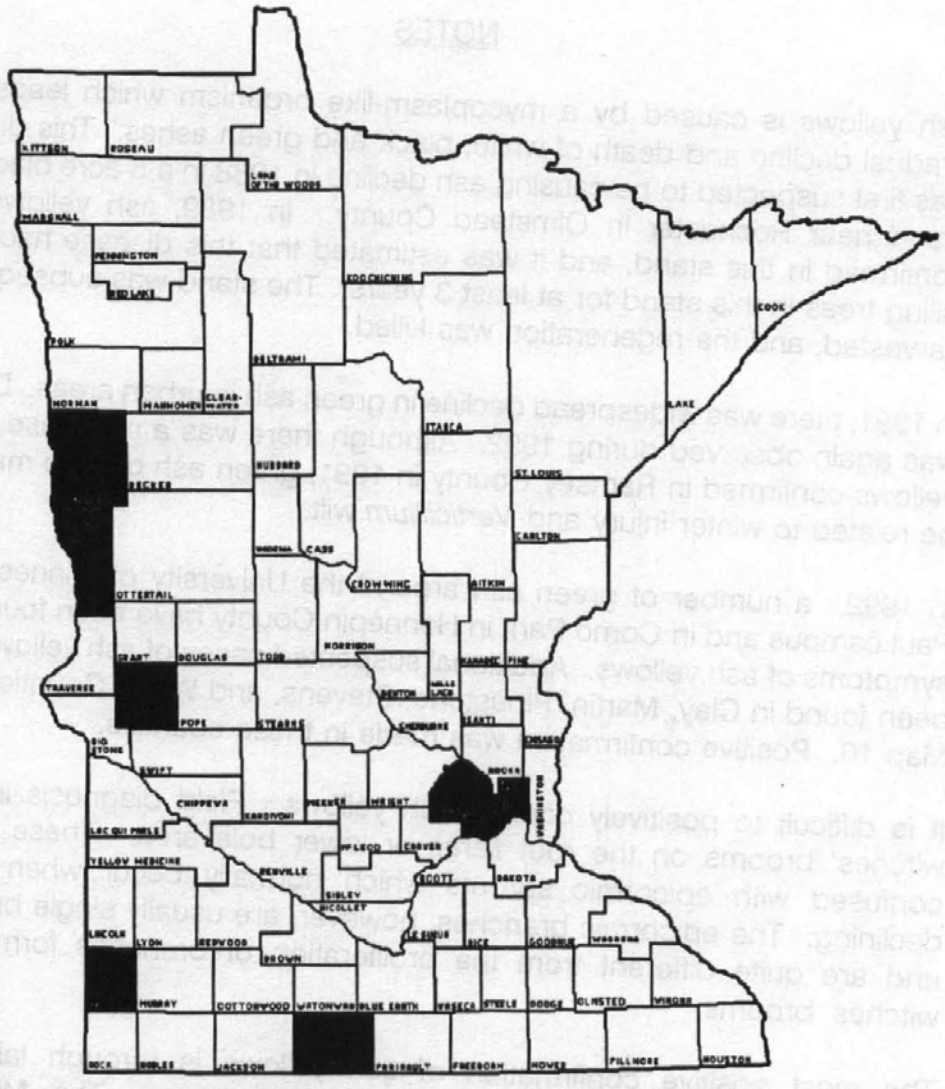
In 1992, a number of green ash around the University of Minnesota St. Paul campus and in Como Park in Hennepin County have been found with symptoms of ash yellows. Additional suspected cases of ash yellows have been found in Clay, Martin, Pipestone, Stevens, and Wilkin Counties. See Map 10. Positive confirmation was made in these counties.

It is difficult to positively confirm ash yellows. Field diagnosis includes witches' brooms on the root flares or lower bole area. These can be confused with epicormic sprouts which normally occur when ash is declining. The epicormic branches, however, are usually single branches and are quite different from the proliferation of branches forming the witches' brooms.

The most positive confirmation of ash yellows is through laboratory procedures which test for the actual mycoplasm. The Minnesota Department of Agriculture lab is now equipped to do the testing and confirmed the samples from the 6 new counties shown on Map 10.

Map 10: The Status of Ash Yellows in Minnesota in 1992

Ash Yellows Status: 1992



Counties with laboratory confirmed Ash Yellows in 1992. Ramsey County was also confirmed in 1991.

Source: MDA, Plant Protection Division

MAPLE LEAF SCORCH

NOTES

In 1991, during late June and early July following moderate temperatures and abundant rainfall, there was a period of intense heat. Several large sugar maples in urban areas were completely leaf scorched and died. Reports of leaf scorch came from Rochester, Zumbrota, Winona, and Spring Valley. These communities were all located in Olmstead County.

This type of leaf scorch is common on young sapling transplants when the roots systems have been damaged or reduced during the transplanting process. With proper care, the transplanted trees usually recover. However, the extent and severity of leaf scorch on large mature trees with the resultant death was not expected.

Because of this anomaly, maple trees in these communities were watched with interest during 1992. No leaf scorch was seen during 1992, and no further maple injury occurred.

NOTES ON INCIDENTAL INSECT OCCURRENCES

Blackheaded Ash Sawfly - *Tomostethus multicinctus* (Rohwer)

A green ash shade tree near Brainerd was infested with larvae of the blackheaded ash sawfly. The larvae have black heads and whitish bodies with black thoracic legs. It is documented as an occasional pest of shade trees and is uncommon.

Elm Leaf Beetle - *Pyrrhalta luteola* (Muller)

Elm leaf beetle was quite common in the Twin Cities area. As of early July, the first generation was nearly completed. Populations of this insect have remained high ever since the 1987-1989 drought. During 1988, this insect had 3 generations. Normally it has only two generations in Minnesota.

Rose Chafer Beetle - *Macrodatylus subspinosus* (F.)

Rose chafer beetles were stripping the leaves of mountain ash, maples, ash, lilacs and other shrubs in the Bemidji area. Control was undertaken by several homeowners.

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SPECIAL PROJECTS

- MINNESOTA FOREST HEALTH MONITORING
- BIRCH SURVEY
- NORTH AMERICAN MAPLE PROJECT
- BUTTERNUT CANKER PROJECT
- OAK WILT COST SHARE PROGRAM
- HAZARD TREE TRAINING
- BUILDING WITH TREES

MINNESOTA FOREST HEALTH MONITORING 1992

Although Minnesota was not a Forest Health Monitoring state in 1992, a number of projects were undertaken to provide baseline information and develop techniques to more effectively implement and carry out Forest Health Monitoring in Minnesota. This report is a summary of the progress that was made on these projects during 1992. Projects included:

☞ Establish Baseline Information on Forest Health Monitoring Plots

Minnesota received the locations of 393 plots associated with hexagons which wholly or partly fell within Minnesota. Using the UTM coordinates, plots were located on 7.5 minute USGS topographic maps. The Public Land Survey descriptions were determined from the maps, and plots were then located on aerial photography. From the photography, plots were classified as to whether or not they were forested. From this classification, the following summarizes the plots in Minnesota:

- ✓ 153 forested plots
- ✓ 146 agriculture plots
- ✓ 24 water plots
- ✓ 7 "non-forested" plots
- ✓ 6 urban plots
- ✓ 57 plots fell outside of Minnesota

NAAP photography is being ordered. Plot centers will be pin-pricked on the NAAP photography, and land use classifications for each FHM plot will again be assessed to determine whether or not the original assessment was accurate. Hexagons will be drawn on the photos, and the forest cover of the hexagons will be typed. FIA plots which fall within the hexagons will be marked on the photos. During the summer of 1993, the FHM plots and the FIA plots within the hexagons will be aerially photographed. Photography will be analyzed for crown conditions to establish a baseline of forest conditions, and the photos will be archived to preserve a historical record of forest conditions.

☞ Evaluate Photographic Techniques To Use in Monitoring FHM Plots

A test area of mixed hardwoods and conifers was photographed both in summer and in fall during leaf color change using a variety of cameras, films, and scales. Cameras included 35 mm, 645, and a video camera. Film included color infrared, true color negative, and true color reversal (transparency). Photo scales included 1:2,000, 1:4,000, 1:6,000, and 1:8,000. The photography will be evaluated during the winter of 1992-93. Evaluation will include both typing of the forested areas and an evaluation of crown conditions for selected stands. A report will be prepared which will include the evaluations as well as examples of the photography, and a recommendation of the most useful techniques for monitoring FHM plots. The scale, camera, and film recommended from this project will be used during the summer of 1993 to photograph both the forested FHM plots and the FIA plots that fall within the hexagons.

☞ Implement Forest Health Information System Pilot Project

The Forest Health Information System (FHIS) is designed to build a user-friendly interface to the EPPL7 GIS currently being used in Minnesota. The FHIS will permit Forest Health Professionals to manipulate and report forest health information in both report and map forms. MN DNR-Forestry personnel are designing the interface, specifying the operational characteristics, and setting the database. Personnel from the Land Management Information Center (LMIC) in St. Paul are responsible for the programming activities. To date the following have been accomplished:

✓ **Project Analysis.** Primary cooperators have been consulted in order to identify the nature of the products that the system will produce. The system will read and write several file types that will facilitate data exchange between state agencies and the USFS.

✓ **Interface Design.** A listing of desired features has been prepared and submitted to LMIC. Programming the interface should begin in the first quarter of 1993.

✓ **Set Data Standards.** A statewide data standard has now been established that is (1) geocorrected and (2) scaled to permit state and regional analyses using a grid cell size of 40 acres. The new standard is called "MLMIS GeoCorrected" or "MGC." A routine for converting old data sets to MGC has been written permitting FHIS to access the existing data. New data sets will be digitized directly according to MGC protocols.

✓ **Datafiles to Map Conversion.** A new routine called "PLS2MAP" has been developed that will convert Public Land Survey (PLS) information directly into a EPPL7 file. This will make it possible to digitize already existing information that is referenced to Public Land Information descriptions. Data will be fully referenced relative to other information layers in the system and can be analyzed using the GIS capabilities of the FHIS. A manual procedure has been developed for reading RBase datafiles into EPPL7 files, and the procedure can be modified for other database software.

☛ <u>An Assessment of the Health of Minnesota's Birch Resource</u>

Because of the highly visible losses to Minnesota birch resource in terms of dead and dying birch trees, an assessment was undertaken to try to quantify the losses and evaluate the causes of the losses. The assessment is being done in two phases: (1) an evaluation of inventory records to determine statewide trends in the birch resource, i.e. changes in acres, volume, and age class structure; and (2) a sample of the birch resource to determine numbers and volumes of birch that have died or are dying since the most recent forest inventory.

A detailed report on this project can be found under Birch Survey in the Special Projects section.

☞ Administration and Training

A Forest Health Monitoring Program Coordinator position was added to the MN DNR-Forestry Forest Health Unit. One of the professional staff of the Unit was named to this position. An additional 75% of a full time position was assigned to assist on FHM projects.

One Forest Health Staff and two Resource Assessment Staff personnel attended FHM training in New Hampshire in June.

A demonstration FHM plot was set up in southern Minnesota during the fall. Personnel went through the procedures for establishing a plot and actually did some of the measurements.

The Forest Health Monitoring Program Coordinator participated with the National Damage and Mortality Assessment Indicator Group in revising and standardizing the damage codes for FHM plot assessment.

BIRCH SURVEY

During and immediately following the drought years of the late 1980's, the species of tree that appeared to suffer the most dieback and mortality was paper birch. There was a need to evaluate the status of paper birch in Minnesota because of the high mortality that was occurring.

A study of paper birch was undertaken during 1992. The study consisted of two parts:

- ✓ a study to evaluate the present health of the birch resource and the change in the health of the resource over a short period (2-4 years);

- ✓ and a study to evaluate the change in the birch resource over a longer period (20-40 years).

The long-term study consists of evaluating past inventory records to determine changes in acreage, size classes, and mortality. This study began in 1993, and results will not be reported in this summary. The short-term study consisted of a field survey conducted during 1992, and the following report will summarize the preliminary data collected during the field survey.

Methodology

The majority of the birch resource is located in the 5-county area of northeastern Minnesota known as the "Aspen-Birch Unit." Because of the limited time and labor force available to do this study, the survey was confined to this 5-county area. Permanent FIA inventory plots were visited so that the 1992 results could be compared to the results when the plots were measured in the late 1980's. An actual tree by tree change could then be determined. Accurate estimates of losses by county, by inventory unit and statewide could be made because survey results would be tied to the FIA data base.

Birch trees were rated alive or dead. Dead trees were categorized "fine branches present" or "fine branches absent" to determine a relative length of time mortality had occurred. Live trees were assigned one of the following dieback classes: 0, 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 99%, and 100%. Up to 3 damages or causes of dieback could

also be recorded. FIA measured crown classes and plot parameters such as stocking, age, physiological class, slope, aspect, and use history were used to evaluate the effects of these parameters on birch dieback.

RESULTS

Sixty-one permanent FIA inventory plots were visited between July 16 and September 11, 1992. 1,074 birch trees were rated. This represented 2.9% of all the birch trees in the FIA data base and 5.6% of the birch in the Aspen-Birch Inventory Unit. A summary of live and dead trees is as follows:

Live trees on the 1990 Inventory	744	(77%)
Dead trees in 1992 that were alive on the 1990 Inventory	**191**	**(20%)**
Trees cut that were alive on the 1990 Inventory	36	(3%)
Live trees on the 1977 Inventory	329	(74%)
Dead trees on the 1990 Inventory	**94**	**(21%)**
Trees cut that were alive on the 1977 Inventory	19	(5%)

The difference in live trees between the 1977 Inventory (329) and the 1990 Inventory (744) is 415 trees. These trees were ingrowth, ongrowth, included on the fixed radius growth plot (not established in 1977), or on an inventory plot that was not present during the 1977 Inventory.

Annual volume of mortality and annual tree mortality (number of trees) were compared between two periods of time. Time1 was the period between when the FIA plots were measured for the 1977 Inventory and when they were measured for the 1990 Inventory. The average length of Time1 was 11.8 years, and the range was 7.2 years to 14.9 years between plot remeasurements.

Time2 was the period between when the plots were measured for the 1990 inventory and the 1992 survey. The average length for Time2 was 4.3 years, and the range was 3.0 years to 6.3 years between plot measurement and the birch survey.

Each FIA plot has expansion factors for what the plot represents in area, volume and tree numbers. The list of the expanded annual mortality volume and annual tree mortality for each plot can be found in the following table.

EXPANDED VOLUME AND TREE NUMBERS ON ALL PLOTS

PLOT	ANNUAL MORTALITY CU. FT. VOLUME Time1	ANNUAL MORTALITY CU. FT. VOLUME Time2	ANNUAL MORTALITY NO. OF TREES Time1	ANNUAL MORTALITY NO. OF TREES Time2
6008	0	0	0	0
8870	1644.8	0	1666	7892
8628	5036.9	0	2007	0
8478	11353.3	0	791	0
8151	8203.2	56406.0	4220	89239
8480	10447.3	24476.5	20704	20225
10194	2004.3	25681.5	693	3794
10138	0	70436.2	11651	77750
9942	0	36874.6	0	12913
9914	0	0	0	6748
9567	0	22776.2	0	6328
8256	7999.7	126881.7	11456	59880
9010	3389.5	68670.0	15202	34539
9446	0	16437.3	6037	20048
8847	6227.9	46052.7	382	7005
3809	0	69242.0	0	10261
4111	18015.1	0	16696	0
242	0	45737.5	0	14323
15	0	50769.9	0	7877
90450	0	75627.5	0	9460
6049	9752.0	32947.2	1920	2624
6201	15109.5	0	1819	0

PLOT	ANNUAL MORTALITY CU. FT. VOLUME Time1	ANNUAL MORTALITY CU. FT. VOLUME Time2	ANNUAL MORTALITY NO. OF TREES Time1	ANNUAL MORTALITY NO. OF TREES Time2
74334	0	9581.0	0	1846
6217	2030.2	7634.9	282	518
90446	0	18938.3	5842	11606
1037	0	13653.9	0	6431
1029	4220.6	19253.5	21454	17660
90106	16500.7	34441.8	1172	2310
8510	14198.9	35539.5	13357	5421
75147	---	25703.5	---	6838
90613	---	0	---	9283
75267	---	87196.6	---	164993
9376	0	0	0	14995
75246	---	0	---	0
10296	0	0	0	0
75165	---	72413.0	---	13686
10213	11668.6	45692.8	17567	14765
10123	0	0	20360	11376
10042	6985.0	61743.8	288	10978
75185	---	82643.9	---	20883
8157	6468.9	0	672	0
11923	---	0	---	8247
10420	---	0	---	7712
8431	0	8855.5	0	3016
8314	---	16187.3	---	3304

PLOT	ANNUAL MORTALITY CU. FT. VOLUME Time1	ANNUAL MORTALITY CU. FT. VOLUME Time2	ANNUAL MORTALITY NO. OF TREES Time1	ANNUAL MORTALITY NO. OF TREES Time2
11922	---	0	---	0
8491	0	0	0	0
463	---	73510.3	---	17214
90665	---	70053.5	---	10813
74186	---	0	---	0
74226	---	0	---	0
90401	0	0	47894	53372
74273	---	0	---	1949
1072	0	0	21042	13329
72185	---	0	---	0
72184	---	0	---	0
72117	---	0	---	0
90137	24930.3	0	4807	0
72199	---	107781.9	---	16281
72192	---	79662.8	---	3478
72142	---	31194.2	---	10621
TOTAL	186,186.7	1,670,698.8	249,981	853,831
AVG.	4,654.6675	27,388.5049	6,249.5250	13,997.2295

Plots with a --- for Time1 were plots that were not measured during the 1977 Inventory. Sixty-one 1990 Inventory plots were evaluated during the 1992 survey, but only 40 of these plots had been measured for the 1977 Inventory.

A t-test was used to test for significant differences between sample means. The test was performed using both an unpaired test using 40 plots for Time1 and 61 plots for Time2, and a paired t-test using the 40 plots that were common to both Time1 and Time2. Calculated t-values using Time1 minus Time2 were:

	UNPAIRED	PAIRED
Cubic Foot Volume:	-4.1849	-4.33516
Number of Trees:	-1.7686	-2.59063

The annual cubic foot volume mortality difference between Time1 and Time2 was significantly different between Time1 and Time2 at the 95% level for both the paired and the unpaired t-test. Annual tree loss was not significantly different between Time1 and Time2 at the 95% level for the unpaired test but was significantly different for the paired t-test.

No clear pattern of mortality related to site indices was apparent. The relationship between site and mortality can be found in the following table.

SITE INDEX	Time2 NO. OF TREES	Time2 % DEAD	Time1 NO. OF TREES	Time1 % DEAD
30 - 39	32	38	7	14
40 - 49	165	13	80	16
50 - 59	385	22	185	29
60 - 69	138	31	60	15

Mortality was found across all age classes. The relationship between stand age and mortality can be found in the following table.

STAND AGE	Time2 NO. OF TREES	Time2 % DEAD	Time1 NO. OF TREES	Time1 % DEAD
1 - 9	11	27	8	25
10 - 19	9	11	---	---
20 - 29	18	17	15	27
30 - 39	50	26	18	50
40 - 49	56	21	22	18
50 - 59	222	23	119	26
60 - 69	269	20	147	17
70 - 79	130	21	48	33
80 - 89	96	12	22	9
90 - 99	23	35	---	---

The DBH class with the highest mortality percentages for both the 1977 and 1990 Inventories was the 1-5 inch diameter class. The percent mortality in this class equaled the sum of the 5-9 inch class and the 9-15 inch class in the 1990 Inventory. The percent mortality in the 1-5 inch class for the 1977 Inventory was greater than the sum of all other diameter classes. See the following table.

DBH	Time2 NO. OF TREES	Time2 % DEAD	Time1 NO. OF TREES	Time1 % DEAD
1 - 5	154	33	106	54
5 - 9	534	19	204	12
9 - 15	255	14	123	9
15+	18	11	9	22

The relationship of mortality to crown classes is listed in the following table. Generally, as the trees became more suppressed, the percentage of trees dying increased. The dominant and codominant crown classes from the 1977 Inventory do not seem to follow the pattern.

CROWN CLASS	Time2 NO. OF TREES	Time2 % DEAD	Time1 NO. OF TREES	Time1 % DEAD
DOMINANT	130	17	54	28
CODOMINANT	617	18	261	12
INTERMEDIATE	138	27	70	31
OVERTOPPED	50	48	38	66

54% of the live trees showed 5% or less dieback, and 87% of the trees showed less than 30% dieback.

% DIEBACK	NO. TREES	% OF TREES	ACCUM %
0	186	25	25
5	220	29	54
10	203	27	81
20	48	6	87
30	26	3	90
40	25	3	93
50	13	2	95
60	9	1	96
70	6	1	97
80	2	-	--
90	2	-	--
99	1	1	98
100	6	1	99

Discussion

There was a significant difference in the annual rate of mortality between Time1 (the period from the 1977 Inventory to the 1990 Inventory) and Time2 (the period from the 1990 Inventory to the 1992 survey.) The total annual volume loss on the 40 plots that were paired was 186,186.7 cubic feet for Time1 and 1,024,351.8 cubic feet for Time2. This represents a 450% increase in the annual mortality rate between Time1 and Time2.

Using the assumption that birch mortality that was found on these 61 plots was representative of statewide birch mortality, the birch mortality impact statewide can then be estimated. From Minnesota Forest Statistics, 1990 (Miles and Chen, 1992), the annual mortality rate from the 1977 Inventory to the 1990 Inventory for all growing stock birch was 20,984,000 cubic feet. A 450% increase in the annual mortality rate from the 1990 Inventory to the 1992 survey, would equal 115,412,000 cubic feet.

To estimate the total mortality, the 115,412,000 cubic feet annual mortality would be multiplied by the average length of the survey period which was 4.3 years. The total mortality to growing stock birch during this period would be estimated at 496,271,600 cubic feet. Total mortality during the period between the 1977 Inventory and the 1990 Inventory would be 20,984,000 multiplied by 11.8 years. That total would be 247,611,200 cubic feet.

The estimated total mortality during the 4.3 year period from the 1990 Inventory to the 1992 survey was 248,660,400 cubic feet more than the total loss during the period between the 1977 and 1990 Inventories despite the fact this period was 11.8 years or greater than 2.5 times the length of the period between the 1990 Inventory and the 1992 survey.

The annual mortality loss in tree numbers increased by 123% during Time2. This was not a statistically significant difference at the confidence levels the data was analyzed.

However, if the assumption again was made that the sample from the 61 plots represented what was occurring statewide, mortality estimates expressed in tree numbers can be made using the percentage of trees from the sample that had died between the 1990 Inventory and the 1992 survey. That percentage was 20%.

From Miles and Chen (1992), the 1990 Inventory estimated that there were 527,199,000 live growing stock birch. If 20% of them had died after the Inventory was completed, then it can be estimated that 105,440,000 growing stock birch were lost during the period between when the 1990 Inventory plots were measured and when they were again field checked in 1992.

Mortality appeared not to be age-dependent. The youngest age classes had as high mortality as some of the older age classes. The accuracy of age determination is always suspect. Stand age is an average age of trees that are bored off the FIA plot. Within the stand, individual tree age may vary quite dramatically. No attempt was made to age all of the birch trees. Boring into trees on the plot is not allowed, and obviously we could not age trees that had died between the 1977 and 1990 Inventories since they had "disappeared."

It was surprising to see the higher percentages of small diameter trees showing mortality. When doing the ground survey, mortality to the larger trees seemed to be more significant, but the numbers show otherwise. The trend shown by diameter classes somewhat follows the trend shown by crown classes. There was a higher mortality rate in the suppressed and overtopped classes. These classes would include a higher percentage of small diameter trees.

The assumption could be made that more severe competition in the suppressed and overtopped crown classes resulted in poorer crown development and therefore poorer root development. During drought conditions trees with little crown and root development should be affected more severely than trees with large crowns and root systems. Therefore, mortality rates should be higher in these crown classes and diameter classes.

There was not a clear picture on the influence of site as measured by the tradition forestry site indices procedures (age over height.) One would expect as the site got better (a higher site indices), the less mortality. This relationship could not be seen from this study.

Despite the tremendous losses to the birch resource, the survey results provided optimism that the trend in birch decline and mortality was significantly improving. It would seem that the mortality had occurred in the past and was not continuing. Generally, birch mortality is a progressive

condition. Birch usually will die over multiple growing seasons. Assuming this to be true, if mortality levels would be sustained in the future, we would expect to see more trees in the higher dieback classes.

In Minnesota we have used 50% crown dieback on hardwoods as a rule of thumb to use in determining whether or not the trees should be salvaged. Trees with 50% or more of their crowns alive will probably survive if the major stress factor is mitigated. Crown rebuilding takes place and the tree survives until the next major stress event.

Over 90% of the live trees had less than 50% dieback, and 87% had 20% or less. These trees should recover with the return of more "normal" growing season precipitation.

Literature

Miles, Patrick D., and Chung M. Chen. 1992. Minnesota Forest Statistics, 1990. Resour. Bull. NC-141. St. Paul, MN: U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 130 p.

NORTH AMERICAN MAPLE PROJECT

In 1987, the North American Maple Project was initiated to address the concern that acid rain and air pollution were contributing to a decline of sugar maple. In 1988, 168 plots were established in 7 northeastern states and 4 eastern Canadian provinces. The plots are monitored annually for changes in crown density, dieback, and mortality.

No significant sugar maple decline has been found on the 168 plots located in northeastern United States and eastern Canada. There is no significant difference in the health of tapped trees vs. untapped trees. In fact, the condition of the stands in the study had improved since 1988 when the plots were first established.

In order to increase the area of sugar maple that is being monitored, Minnesota was added to the project in 1992. Eight plots were established; 4 plots are in stands managed for maple syrup production and 4 are in unmanaged stands. Plots are located in Becker, Itasca, Todd, and Olmstead Counties, as follows:

Sugar Bush		Unmanaged	
1	Zumbro Falls S12-T109-R14	2	Theilman S36-T11-R11
4	Becker S17-T141-R40	3	Maplelag S20-T141-R40
6	Little Itasca S28-T57-R26	5	Pokegama S35-T155-R30
7	Zuckerwald S15-T129-R33	8	Long Prairie S27-T129-R34

There were 12 dieback rating classes, 0%, 5%, 10%, 20%...90%, and 100%. Each live, dominant or codominant sugar maple tree was assigned a dieback rating class. The average dieback ratings of the undisturbed plots was 3.4% while the average dieback rating of the sugarbushes was 3.7%. These were not significantly different. The overall avenge plot rating for dieback was 3.5%

Another important measurement was foliage transparency. This is opposite of foliage density and is an estimate of the amount of skylight visible through the foliated portions of the crown. The same 12 rating classes were used that were used for crown dieback. The average transparency rating for the undisturbed plots was 8.6% while the average transparency rating for the sugarbushes was 8.4%. These were not significantly different. The overall average plot rating for foliage transparency was 8.5%.

Generalizations from field studies of tapped and untapped maples in the four areas in Minnesota were:

✓ Foliage density was high indicating minimal insect or disease damage and minimal stress from adverse environmental conditions.

✓ More sugar maple borer activity as indicated by the presence of borer cankers occurred in the Grand Rapids area (Itasca County) than in the other 3 locations.

✓ More *Eutypella* canker occurred in the Rochester area (Olmstead County) than in the other 3 locations.

BUTTERNUT CANKER PROJECT

The search for healthy butternut trees continues to have success as well as the work progressing toward the development of resistant trees. Again in 1992, scion wood was collected from several canker-free trees located in southeastern Minnesota. Work continues to progress on this project at the North Central Forest Experiment Station in St. Paul. A large number of grafts from a number of nearby states are being collected at North Central. General Andrews State Nursery in Minnesota has done a large number of these grafts using these scions. There are plans to begin some initial screening of these grafts by greenhouse inoculations.

In 1991, eighty-two grafts from eight field collected clones were successful. These grafts were planted during the spring of 1992 at Rosemont, Minnesota. Some limited inoculations of this material may take place during 1993 in order to begin screening for natural resistance.

In March and April of 1992, approximately 362 grafts were made from 19 clones. Thirty percent, or about 180 grafts, were successful and will be held in the greenhouse to be planted at Rosemont during the spring of 1993. There is an additional planting site on the University of Minnesota campus.

This program has been very successful to date. Both the U.S. Forest Service and the state cooperators have done a great job in getting the word out in search of uninfected butternut trees. In 1992, new butternut stands were reported from both Red Wing, Minnesota and Pepin, Wisconsin. With all the interest at times from the media, the word is out and private landowners have been directly contacting North Central. Additional trees are still needed from other states within the butternut natural range.

Research also continued in the lab with the tissue culture program. The phenology involved in the collections of the immature cotyledons was running three weeks behind last year. This year in Wisconsin the Forest Health Specialists are revisiting butternut stands used in a 1976 survey to determine changes in disease incidence. During their revisits they will be evaluating if any natural regeneration is occurring.

Oak Wilt Cost Share Practices

INTRODUCTION

Active oak wilt control revolves around two activities: (1) suppression of the disease at active infection centers and (2) elimination of spores *likely* to generate new infection centers outside of existing infection centers. The oak wilt cost share program includes two practices that are intended to deal with oak wilt by (1) lowering the incidence of the disease by mechanically severing root grafts and (2) preventing the disease from forming new infection centers by eliminating spore producing trees (SPT).

In general, the cost share program is designed to assist property owners through their local community, with priority being given to communities with approved oak wilt suppression plans. However, landowners may be directly assisted by DNR-Forestry if they own more than 3 acres, if the area to be protected is greater than three acres regardless of ownership, or if they live in an area with a low incidence of the disease.

P1 Suppression of Infection Centers

A. THE PURPOSE of this practice is to enhance the environment by protecting oak trees adjacent to an existing infection pocket and thereby conserving aesthetic and property values, habitat, tax base, and product values.

B. APPLY this practice to (1) designated communities (county, city, or townships) that have active oak wilt disease and have prepared a control plan, (2) private ownerships over 3 acres under the supervision of the local DNR forester, (3) in areas with a low incidence of the disease and under the supervision of the local DNR Forester, or (4) where the area protected is greater than 3 acres regardless of ownership.

C. POLICIES for this practice are as follows:

a) In organized communities, a community oak wilt plan must be in place unless the acreage treated or protected is large (> 3 acres) or the community has only a few oak wilt infection centers.

b) In communities, the proposed practice must be consistent with the community's plan.

c) Cost sharing is authorized for treating infection centers. This would include the following work:

1) locating of infection center perimeter
2) locating of root graft barriers
3) installation of root graft barriers
4) post-treatment monitoring of treatment efficacy

d) Cost sharing is not authorized for:

1) areas where no further spread is expected such as where natural barriers occur
2) survey work to locate infection centers
3) contacts with landowners to inform and educate about oak wilt or suppression

e) Any chemical use is not approved for cost sharing.

D. SPECIFICATIONS for this practice are as follows:

1) Root graft barriers must be 54" or greater in depth.
2) Barriers must be installed in accordance with approved MDA Guidelines.
3) Treatment must be essentially continuous around the perimeter of the pocket. Gaps are permissible where oak root grafts are not likely to exist.
4) Treatment will be undertaken in a manner that will prevent wounding and possible reinfection of residual trees. This will normally confine plowing to the period of 1 July through ground freeze in the fall.
5) All guidelines pertaining to the preservation of Threatened and Endangered Species or Historical/Cultural Resources will be strictly followed.

E. MAXIMUM COST-SHARE is as follows:

For private ownerships less than 500 acres, 50% cost share;
for private ownerships over 500 acres, 33.3% cost share;
for non-federal public lands, 25% cost share;

To a maximum of:

Center Size	Per Foot of Line Rate	Maximum per center
< 1 acre	$1.10	$500.00
1 - 2 acres	$0.90	$700.00
> 2 acres	$0.75	$1000.00

P2 Treatment of Spore Producing Trees

A. THE PURPOSE of this practice is to enhance the environment by protecting oak trees adjacent to an existing infection pocket and thereby conserving aesthetic and property values, habitat, tax base, and product values.

B. APPLY this practice to (1) designated communities (county, city, or townships) that have active oak wilt disease and that have prepared a control plan, (2) private ownerships over 3 acres under the supervision of the local DNR forester, (3) in areas with a low incidence of the disease and under the supervision of the local DNR Forester, or (4) where the area protected is greater than 3 acres regardless of ownership.

C. POLICIES for this practice are as follows:

a) In organized communities, a community oak wilt plan must be in place unless the acreage treated or protected is large (> 3 acres) or the community has only a few oak wilt infection centers.

b) In areas with wood disposal policies or firewood ordinances, the proposed practice must be consistent with the community's policies and ordinances.

c) Cost sharing is authorized for:

1) locating and marking of Spore Producing Trees (SPT)
2) felling of SPT
3) treatment of SPT to include:
   - loading and hauling to an approved Diseased Tree Disposal Site (including tipping fees)
   - on site treatment to prevent sporulation (eg. chipping, burning, debarking, etc.)
4) monitoring of treatment efficacy

d) Cost sharing is not authorized for:

1) treatment of trees dead more than one year
2) survey work to locate infection centers
3) contacts with landowners to inform and educate about oak wilt or suppression

e) Any chemical use is not approved for cost sharing.

D. SPECIFICATIONS for this practice are as follows:

1) Trees must be cut low to the ground (< 2" stump) or covered with soil.
2) Treatment must be undertaken in accordance with approved MDA Guidelines.
3) Treatment must be essentially continuous within the infection pocket.
4) Treatment will be undertaken in a manner that will prevent wounding and possible reinfection of residual trees. This will normally confine treatment to the period of 1 July through 1 April of the following year.
5) All guidelines pertaining to the preservation of Threatened and Endangered Species or Historical/Cultural Resources will be strictly followed.
6) This practice can only be engaged where practice P1 is already instituted.

7) Practice must be completed by April 1 of the year following death of the trees. This must include the spore prevention treatment of the SPT.

8) This practice can not be applied within 1/4 mile of an eagle nest.

E. MAXIMUM COST-SHARE is as follows:

50% cost share to a maximum of $1000.00.

HAZARD TREES
DETECTION, ASSESSMENT AND CORRECTION IN RECREATION AREAS

In 1987, the Forest Health Unit began work on developing a hazard tree rating system for use in State Park and State Forest campgrounds and day-use areas. During the four intervening years the system was refined. A department committee was set up to incorporate the rating system into a department-wide program that involved a hazard tree management policy, a hazard tree manual, and a training plan to uniformly implement the policy.

In March, 1992 statewide training for both the Divisions of Forestry and Parks and for Field Services personnel was conducted. Four one-day training sessions were held at Lake Bemidji State Park, McCarthy Beach State Park, Gull Lake Campground (Army Corps of Engineers), and Whitewater State Park.

All four of these training sessions were attended by 40 to 50 people. District Foresters and Technicians with State Forest Campgrounds located in their Districts, State Park Personnel, and Field Services personnel responsible for state building maintenance attended the sessions. The training included both classroom and field sessions.

The topics covered included the following:

- ✓ What is a hazard tree?
- ✓ Common defects of trees
- ✓ Inspection methodology
- ✓ Hazard tree reduction measures
- ✓ Hazard tree prevention
- ✓ Tree evaluation session in the field

On September 24th, an additional training session was held for the State Shade Tree Advisory Committee. Training took place at the Hok-Si-La Campground in Lake City, Minnesota. Approximately 30 to 40 people attended.

The Hazard Tree Manual was published in February, 1993.

BUILDING WITH TREES

On November 6, 1992 a seminar was given to the Rochester Area Builders Association titled, "Building With Trees." The short course covered tree valuation, basics on tree root systems, the causes of construction damage, and some methods on how to prevent construction damage to trees.

The following is a summary of the material presented during the short course.

TREES HAVE VALUE!

It is very important that builders, contractors, and developers understand the potentially high values that single or groups of specimen trees can reach in the landscape. There are many methods used for evaluating trees and shrubs in landscapes. The University of Minnesota Extension publication "Landscape Tree Valuation" lists four methods:

(1) Replacement cost

(2) Compounded replacement cost

(3) Decrease in fair market value of the real estate

(4) Council of Tree and Landscape Appraisers formula

The valuations suggested are adapted to Minnesota conditions and work well. The work is based on additional publications available from the International Society of Arboriculture (ISA).

TREES HAVE ROOTS!

Roots are opportunistic. They grow where they can compete, and where the requirements for life: moisture, nutrients, and above all oxygen are readily available.

90% of a tree's roots are concentrated in the upper 18 inches of soil. Primary direction of growth is horizontal.

25% of these roots are concentrated in the top few inches of soil; these are the non-woody absorbing roots. They absorb most of the water, minerals, and oxygen.

It is not uncommon for the root system of a tree to occupy an area more than 2 times larger than the tree height.

Tree root systems do not mirror image tree canopies.

All parts of a tree are interdependent. Leaves can not photosynthesize essential sugars without vital supplies of nutrients from the roots.

By relative mass: 5% = leaves; 5% = absorbing roots; 15% = twigs and branches; 15% = transport roots; and 60% = trunk or main stem.

CAUSES OF CONSTRUCTION DAMAGE

(1) Grade Changes

Raising the grade can result in suffocation of tree roots. Tree roots die at oxygen levels below 8%. Small wells often placed around filled trees do not correct grade change problems.

Lowering the grade, no matter how minimal, can lead to extensive root injury. Lowering the grade during construction most often results in severing of most of the root system where the grade was lowered.

(2) Soil Compaction

As undisturbed soils become compacted, air and water exchanges decrease. Both physical disruption and loss of oxygen are the result. Root growth is severely limited in compacted soils. Most growing roots will turn away from compacted soil.

(3) Cutting roots

Severing of up to 40 to 50% of the root system exceeds the minimum barrier placement guideline for root zone disturbance.

4) Tree Wounds

Large wounds to tree trunks can destroy 50% of the vessels moving water and nutrients. Proportional amounts of dieback can result. Wounds lead to decay and defective trees.

PREVENTING CONSTRUCTION DAMAGE

Single family home on wooded lot.

Locate any trees of importance and map their driplines along with the location of the proposed structures and resulting disturbance. Know your trees or find someone who does. Consider the health of those existing trees. Establish barriers to protect the roots.

MINIMAL BARRIER PLACEMENT: "Dripline" or 1 foot of radius per inch of trunk diameter at breast height.

Remove any trees in which greater than 40 to 50% of the root zone will be disturbed.

Consider traffic patterns and storage areas for building materials. Place physical barriers around the "save" trees or groups of trees.

Use a qualified landscaper to finish the site. For "save" trees where grade changes are unavoidable, install retaining walls protecting as much of the original grade as possible.

New Developments

(1) Tree and stand delineation

General accounting of the vegetation, groups of trees, individual trees, open areas, wildlife corridors, and other features

(2) Tree survey

Map that locates all tree root zones of the important trees, using minimum barrier placement

(3) Tree conservation plan

Develop a grading plan with location of roads, drives, utilities, and the impact on the existing vegetation.

Communicate and Supervise all operations.

Work with qualified landscapers for the installation of retaining walls and other corrections.

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1992 PUBLICATIONS

- Yellowheaded Spruce Sawfly

- The Problem With White Pine

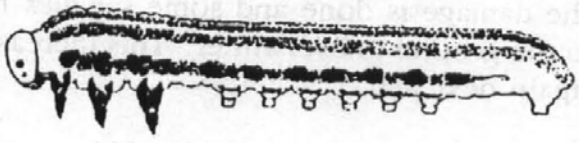
YELLOW-HEADED SPRUCE SAWFLY

Yellow-headed spruce sawfly (YHSS) is a native pest of white, blue, black and Norway spruce. Defoliation by the sawfly larvae degrades the appearance of spruce trees, but repeated defoliation over a few years may kill the trees. Damage is most severe on trees less than 10 feet in height. YHSS prefer open growing trees.

Biology

Adult sawflies, which look like small wasps, emerge in the spring when new shoots are expanding on spruce. This is about the time lilacs are in full bloom. The female adult, flies to a nearby spruce, saws a slit in the base of a new needle and deposits a single egg before moving on to the next needle.

The larvae hatch in 7 to 14 days and are present from late-May to late June. The young larvae feed on the edge of new needles. Older larvae will consume the entire needle often leaving only a short brown stub.



Sawfly larva 3X normal size*

Full grown larvae are 3\4 inch long, have a yellow to reddish-brown head and an olive green body with gray green longitudinal strips. When larvae complete their development and feeding, they drop to the ground, form a dark brown papery cocoon in the soil and overwinter.

Damage

YHSS larvae damage spruce by eating the needles and defoliating the tree. They feed on the new current year needles first but when these are consumed the larvae will move back on the branch and eat the older needles also. Complete defoliation may be fatal in a single season. Typically, spruces are not killed in a single year but rather are killed by repeated partial defoliation over a number of years.

Adults sawflies prefer sunny egg laying sites. As a result, open grown trees such as ornamentals, yard, roadside and open plantation trees are most severely damaged.

*(From USFS publication "A GUIDE TO INSECT INJURY OF CONIFERS IN THE LAKE STATES by Louis F. Wilson)

Damage is most severe on small trees, 1-10 feet in height. Larger trees are sometimes also defoliated however they are usually not killed. Sawflies commonly attack the same trees or groups of trees year after year.

Cultural Control

Because open grown plantations suffer the most severe defoliation and mortality, do not completely release plantations from competition until the trees are past their most susceptible size (about 10 feet). Spruce are fairly shade tolerant and do quite well in partial shade.

Chemical Control

Chemical control of YHSS larvae is often necessary for ornamental yard trees and occasionally for plantation trees. A wide variety of effective chemicals are labelled for use on sawflies. Products containing carbaryl, malathion, acephate, or methoxychlor.

Mark your calendars to check trees for larvae the first 2 weeks of June. Do not wait for defoliation to become evident before checking for sawflies. By the time you see defoliation, much of the damage is done and some sawflies have probably completed feeding and dropped to the ground to overwinter. This increases the likelihood that the trees will be attacked again next year.

Timing of a spray operation is important. Trees should be sprayed in the spring as soon as larvae can be found on the new shoots. Checking trees that were defoliated last year will make finding larvae easier. Trees should normally be sprayed about 10 days after bud caps are shed or about 2 weeks after lilacs are in full bloom. For most of northern Minnesota, the best time for spraying is usually between June 1st and June 20th.

Always read and follow the directions on the pesticide label. It is dangerous and illegal to use a pesticide in a manner inconsistent with the label.

Minnesota
DEPARTMENT OF NATURAL RESOURCES

Department of Natural Resources
Division of Forestry

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THE PROBLEM WITH WHITE PINE

Alan C. Jones[1]

ABSTRACT. White pine is a valuable tree well adapted to Minnesota conditions. However, white pine does have a number of problems that must be considered when trying to establish and culture this species. Problems are both inherent in the species and caused by conditions that are independent of the species. These problems include diseases and insects, animals, air pollutants, establishment problems, tree improvement efforts, shrinking budgets, the impatience of people, and the polarization of the stakeholders. These problems are not insurmountable, but they do add to the cost of managing white pine. Without consideration of these problems, investing in white pine will be an investment with little return.

INTRODUCTION

White pine is unquestionably a valuable tree. Ever since white people set foot on North America, white pine was recognized for its value and "was the species on which the United States was built" (Howard 1986). The Royal Navy reserved white pine for ship masts, and it was a crime if colonists cut down a white pine larger than 24 inches in diameter. "Prior to 1889, eastern white pine supplied at least half of the nation's softwood requirements" (Howard 1986). And, white pine's value goes beyond wood products. It is important to a variety of wildlife species, it is prized for its aesthetic qualities, and for some white pine is a balm to sooth one's troubled soul.

White pine grows best when "July temperatures average between 18° and 23° C...White pine grows on nearly all the soils within its range but generally competes best on well drained sandy soils of low to medium site quality" (Wendel and Smith 1990). Temperatures and soils sound like Minnesota. Yes, "white pine" and "Minnesota" go together like "lutefisk" and "Norwegians."

Take a valuable tree and combine it with environmental conditions ideal for its survival and growth, and you have a winning combination. White pine and Minnesota. That's what we are going to hear about during this Symposium where the virtues and values of white pine will be repeated over and over again.

But white pine has a number of significant problems. The problems are either inherent in the species or created because of external situations. It is critical to consider these problems. When Fats Waller, the legendary jazz pianist, was asked what jazz was, he replied, "If you don't know, don't mess with it" (Collier 1978.) The same advice should be said about white pine. If you don't know the problems with white pine, don't mess with white pine. To successfully establish and culture white pine, the problems must be recognized and managed. If not, we will be making investments without any returns. What are some of the problems white pine faces?

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Presented at The White Pine Symposium: History, Ecology, Policy and Management, Duluth, MN, September 16-18, 1992.

DISEASES AND INSECTS

Wendel and Smith (1990) report that "there are a total of 277 insects and 110 disease organisms known to attack white pine." Garrett (1986) makes the claim that "there are more diseases and insects associated with eastern white pine than with any other species of tree in North America." However, Wendel and Smith (1990) say that "only 16 insects and 7 diseases cause sufficient injury or mortality to be of concern."

Whether white pine has 1 disease and 1 insect that can cause significant damage or white pine has more damaging diseases and insects than any other tree species, diseases and insects have a significant impact on white pine. At the worst, these diseases and insects cause mortality; at the best, these diseases and insects alter management practices and add to the cost of establishing and culturing white pine. I will briefly mention two significant diseases and two significant insect problems.

WHITE PINE BLISTER RUST

This disease has dominated white pine conversations and actions since it was first recognized as a potentially catastrophic disease. White pine blister rust was first introduced into Minnesota in about 1916 (Sauerman 1992). By 1930 the disease was still not present throughout the state; its westward spread was barely into the Chippewa National Forest (Jones 1988). Efforts to control blister rust constituted the largest tree disease control program ever under taken. Control centered on eradication of the alternate hosts, *Ribes* spp. Eradication efforts began in 1909 and ended during the 1950's. During this time in excess of $100 million was spent, but despite the cost and the efforts, 650 million board feet were lost to this disease in 1952 (Anderson 1973).

The importance of white pine blister rust continues to be an ongoing debate. Forest pathologists emphasize its importance; forest managers deemphasize its importance. Sauerman 1992 and Mielke 1989 found lower than expected levels of blister rust infections in plantations they surveyed. However, they admitted that the heavy deer browse may have masked the incidence of blister rust or simply may have reduced the target areas for the fungal spores to start infections.

We really have no definitive long term impact information for white pine blister rust since the disease is a relatively newcomer in the state, and we have few examples of older plantations where blister rust has been active for many years. Sauerman (1992) found in northern Minnesota that younger trees tended to have a greater frequency of infection. Eighty-three percent "of the branch cankers (81% of the stem cankers) observed were in trees less than 12 years old since establishment." These findings are not surprising since plantation ages in Sauerman's survey ranged between 6 and 29 years. And, blister rust may have culled out significant numbers of trees as the plantations age.

We must be cautious drawing definitive conclusions of blister rust impacts based on surveys of young plantations. Most surveys are only glimpses; they are not long term views of what occurs in the stands over the life of the stands. We have few long term studies that track the development of blister rust in a stand over a long period of time. Because of the nature of the surveys, we really don't know if blister rust is simply a thinning mechanism or if blister rust will lead to total stand elimination over the life of the stand. We therefore need to keep in focus that we have very sketchy information related to what happens to these plantations as they age. Our inferences from survey results are limited to stands of similar ages, and inferences are based on a snapshot picture of disease development over a short period of time.

However, we have management practices that will help reduce blister rust to acceptable levels (Anderson 1973, Jones 1988, Robbins 1984, Sauerman 1992, Van Arsdale 1979). These practices include: microsite evaluations to avoid planting in high risk areas, underplanting, avoiding planting in small openings, pathological pruning, and *Ribes* eradication. Sauerman's (1992) survey illustrated the effectiveness of underplanting and pathological pruning. Ninety-two percent of the underplanted stands "had no incidence of rust...No underplanted stands had trees with stem cankers." Seventy-two percent of the pruned stands "had no incidence of blister rust...(and)...83% had no stem cankers."

All of these control practices require extra expense in dollars and human labor, and all of these practices if they are to be successful require a long term commitment to maintain them. It can be argued that with the low incidence rate of blister rust that Sauerman found in his survey (5% of the trees infected), that the expense of these blister rust control practices cannot be justified. However, blister rust is not the only problem on white pine. There are other diseases and insects; there are animal problems, air pollution problems, competition problems. All of these problems are capable of preventing white pine seedlings from developing into sawlog and super canopy size trees. It would be foolish not to invest in blister rust control practices so that white pine is given as much help as possible to survive and grow. These practices provide a hope that there will be a return on the investment. That's good economics. Without these practices, the risks are much greater that there will be nothing to show for the investment. That's bad economics!

WHITE PINE WEEVIL

This is the major insect pest of white pine. Houseweart and Knight (1986) say that white pine weevil "has been one of the most intensively studied forest insect pests, ranking comparably with the gypsy moth, the spruce budworm, or the southern pine beetle. Yet, the white pine weevil continues to be *the* major impediment to the culture and management of eastern white pine." However, Sauerman (1992) in his survey of 126 white pine plantations in Minnesota found that only 23% of the stands and only 9% of the trees showed weevil damage.

Whether white pine weevil is the major problem as it has been characterized in the Northeastern United States or it is a relatively minor occurrence as found in Sauerman's survey, the white pine weevil has the capacity to alter management practices. Weeviled white pine certainly will survive, but to produce a wood product and to keep white pine even with or above woody competition, weeviling needs to be controlled.

The standard weevil management practice is to grow white pine under an overstory since shade reduces weevil attacks (Houseweart and Knight 1986). Katovich and Morse (1992) point out that "growing white pine in shade requires a tradeoff." Understory white pines generally grow slower and in dense shade white pines will not survive (Wendel and Smith 1990). As white pines grow taller and their leaders become intertwined with the overstory, leader damage and death often results. Controlling weevil damage by maintaining an overstory increases costs of implementing the management practice. Weevil management also necessitates a periodic monitoring and release to prevent damaged leaders which is what the practice was intended to prevent in the first place.

OTHER DISEASES AND INSECTS

Red ring rot caused by *Phellinus pini* (Thore:Fr.) A. Ames and the potential of defoliation by gypsy moth, *Lymantria dispar* (L.), should also be mentioned. Red ring rot is the most significant decay

organism on white pine (Shigo 1989, and Wendel and Smith 1990) because it is a canker rot organism. Trees cannot wall off canker rot organisms, and decay is more extensive (Shigo 1989). This fungus invades dead and broken branches (Wendel and Smith 1990), and there is some evidence to suggest that dead leaders from white pine weevil attacks serve as infection courts for this decay organism (Ostrander and Foster 1957). It is interesting to note that even during Colonial times white pine reserved for ship masts had significant decay problems. "One record indicated that 102 of 106 large trees cut for that purpose had so much decay that they had to be discarded" (Garrett 1986).

Mosher (1915) reports white pine as favorite food for late instar larvae of gypsy moth. Later studies both in Canada and in Northeastern United States rate gypsy moth as avoiding white pine (Mauggette, et al., 1983) or as being intermediate in preference where "white pines were frequently nibbled on but were rarely defoliated heavily" (Campbell 1979). Campbell did observe that pure stands of white pine were "immune" to gypsy moth, and Brown, Cruickshank, Gould, and Husband (1988) found that overstory white pines were rarely fed upon by gypsy moth. But both observed that when white pine was an understory tree, larvae moved to the pines when the more favorable food in the overstory was depleted. Understory white pine heavily defoliated by gypsy moth sustained heavy mortality. The recommended control practice for the major disease and insect on white pine is to establish and culture white pine as an understory tree. This practice may lead to significant gypsy moth caused white pine mortality when gypsy moth arrives in Minnesota in the very near future.

ANIMALS

A number of animals feed on white pine. Porcupines will girdle the tops of trees, and hares will girdle seedlings and saplings. However, the animal that has the greatest impact on white pine is the white tailed deer. From Sauerman's survey (1992), he concluded that "deer are the most important serious damaging agent to white pine in Minnesota." Mielke (1989) concluded the same after his survey of white pine plantations on the Chippewa and Superior National Forests. He states in his report, "The general condition of most plantations is poor to fair. Repeated deer browse injury is probably the greatest limiting factor in plantation establishment. Some type of deer control measures must be implemented if plantations are to succeed."

The good news from Sauerman's survey (1992) was that deer damage decreased about 11 years after white pines were planted or the trees reached at least 9 feet in height. He also found that underplanted white pines "were not generally more susceptible to deer browse." However, he mentions that "control is difficult due to the mobility of the deer, recent high density populations, and associated costs." He then recommends implementation of "some economically effective means of deer control."

Deer population trends have been increasing. MN DNR Wildlife officials in a recent news release stated that Minnesota deer populations are record high, and the herd is estimated to number about 1.2 million (Anonymous, 1992). A June 19, 1992 article in the Bemidji newspaper, The Pioneer, titled "Deer Herd at Record Levels" quotes Steve Caron, Area DNR Wildlife Supervisor who says, "Currently we have 22 to 23 deer per square mile in the Bemidji area and this is the largest population we have ever had...Even if we have a severe winter in 1992-93 and we have a high harvest next fall, we shouldn't lower the population to less than 18 or 19 per square mile" (Miller, 1992). With the popularity of deer hunting, the activism of deer hunting groups, and the high demand for harvesting of aspen, deer populations will not be reduced in the foreseeable future.

White pine stands developed in the absence of both heavy deer browse pressure and white pine blister rust. This is a significant change since white people first set foot in Minnesota. Things simply aren't the way they use to be. If we get caught up into thinking that since white pine was significant in Minnesota at one time it can be significant again, we are only fooling ourselves. Deer numbers and blister rust have greatly reduced the chances of returning the Minnesota landscape to what it was even 100 years ago.

Deer browsing will have to be managed to successfully establish white pine. Repellents, protective coverings, and fencing are the techniques used to manage deer damage (Sauerman 1992). These techniques require annual or semi-annual maintenance to be effective. What agency, industry, or group has the funding, personnel, and commitment to annually for at least the first 11 years do this required maintenance?

AIR POLLUTANTS

Garratt (1986) states that white pine is "probably more susceptible to air pollutants than any other tree species in North America." And Hodges (1986) concludes that "eastern white pine is generally considered one of the most sensitive conifers" to air pollution. Damage ranges from "post-emergence chronic tipburn" to "chlorotic dwarf disease." Trees as old as 40 years old show symptoms of the latter damage (Garratt, 1986.)

In addition to the direct effect of air pollutants causing needle burning and tree dwarfing, air pollutants can indirectly cause problems. Garrett (1986) reviewed the literature related to these indirect effects. Some effects were: There was a higher susceptibility to *Phellinus pini* infections of trees with foliage injury due to air pollutants. White pine damaged from air pollutants could not compete with other woody vegetation, and there was speculation that widespread air pollution damage to existing white pine stands may lead to cover type conversions. Finally, there was a report gypsy moth had a preference for needles "spiced" with ozone.

ESTABLISHMENT PROBLEMS

Times and forest conditions have changed since white people first stepped foot in Minnesota. One change is the decreased role fire plays in shaping the natural landscape. Fire probably played a significant role in the development and maintenance of white pine stands in Minnesota prior to the arrival of white people. In Ontario, "most of the white pine stands...are of fire origin...(and)...improved fire control...could result in the elimination of...white pine..." (Wray 1986).

Significant regeneration of white pine will not happen on its own. And, because fire is no longer a dominant shaper of the landscape, practices that duplicate the disturbances of fire will have to be used to regenerate white pine. This will take an investment to scarify sites to expose mineral soil and then manage competition so that newly established white pines do not die from suppression.

The second change is the change in cover types in Minnesota. When white people first started settling in Minnesota, 58% of the cover type acreage or 18.2 million acres was conifers, and 13.3 million acres were hardwoods. Pine acreage made up only 5.8 million acres of the 18.2 million acres of conifers. Aspen-scrub oak type made up 2.9 million acres of the hardwood types or only about 9% of the forested land in Minnesota (Cunningham et al. 1935).

The 1977 forest looked much different. Only 30% of the forested acreage or 4.2 million acres was in conifers. Pine accounted for 1.3 million acres, and black spruce and balsam fir dominated with a combine acreage of about 2.1 million acres. There were almost 10 million acres of hardwoods, and the aspen type alone accounted for 5.4 million acres or 38% of all forested acreage in Minnesota (Jakes 1980).

White pine is rated as being "intermediate in shade tolerance, and vegetative competition is a major problem...Against the stronger competition of species such as the aspens, oaks, and maples, however, white pine usually fails to gain a place in the upper canopy and eventually dies (Wendel and Smith 1990). Because of the changes in cover types, the decrease in fire occurrences and intensities, and white pine's inability to compete with sprout origin woody vegetation, establishing white pine will be no easy task. We do have methods of controlling competition, but those methods can be hard on the land (mechanical site prep) or objectionable (chemicals) to a lot of groups that now favor the establishment of white pine. Whatever the choice of techniques will be, an investment will be required. Are we willing to make the investment and then continue to make additional investments to see that white pine survives and thrives beyond the seedling stage?

TREE IMPROVEMENT EFFORTS

Producing genetically resistant trees is perhaps the ultimate control of white pine blister rust. Many managers hope that a resistant i.e. immune tree will be produced, and a viable and significant white pine planting program can be started in Minnesota. We need to keep in focus that the track record for solving forest tree diseases through genetic manipulations has not been sterling. We have yet to embark on an American chestnut or an American elm planting program. Given the long time trees exist, the long time for trees to produce flowers, and the many other genetically controlled attributes that made the tree desirable in the first place, producing even a genetically resistant tree to a particular disease is a slow and difficult task at best.

A genetic improvement program for white pine in the Lake States was started during the early 1960's (Meier 1988). Since then "genetically resistant" planting stock has been made available to the National Forests and limited numbers made available to the States. This has created problems. Enthusiastic managers have either ignored the geneticists warnings of the limits of this stock, or geneticist simply have not told the whole story. It is stock that shows some resistance, but not immunity. Meier in discussions at the White Pine Workshop that was sponsored by the Chippewa National Forest in 1988 commented that the stock was only 20-30% resistant. When asked whether he would still recommend following all of the classic white pine blister rust management recommendations i.e. microsite evaluations, underplanting, pathological pruning, and *Ribes* eradication, with this genetically resistant stock, Meier at this same work shop replied affirmatively.

Managers have failed to consider that resistance does not necessarily mean the trees will not become infected. Resistance may mean that the trees will live longer with the infection before succumbing. The resistant stock has not been tested long enough to see if it is any more susceptible to air pollution damage, to see if it produces a straight tree, to see if it differs in its attractiveness to the white pine weevil, to see if deer have any different responses to this new stock. We need to use resistant stock cautiously. We still need to use the white pine blister rust and weevil management techniques with the resistant planting stock, and we still need to protect the stock from deer browsing.

SHRINKING BUDGETS WITH GREATER DEMANDS

With all the problems presented above, there are solutions. We know how to manage white pine to reduce blister rust, weevil damage, and animal damage. We know how to establish white pine. We know better how to communicate between researcher and manager. But all of this know-how implemented on the ground costs money and requires expenditures of people power. And, yet for public agencies there is a decline in budgets and personnel while at the same time an increase in demands society puts on public agencies. We no longer practice forestry the way we use to when we regenerated harvested stands by intensive mechanical site preparation, the planting of one species in row after row, the use of herbicides to maintain the dominance of the monoculture we established, and the replanting of the area with the same species if stocking levels fell below some standard. These changes have come about by societal demands, but they have also been driven by reductions in budgets where these kinds of investments can no longer be made on as many acres as had been done even 5 years ago.

To successfully establish and culture white pine, an investment will be needed. We will have to do more underplanting which will increase the cost of planting. We will have to do more periodic thinnings which will increase the investment we put into a stand. We will have take some kind of deer control measure and maintain that measure until the trees get above the deer. We may have to fence, spray repellents, or put individual tree guards around each tree. These all will increase our investment in the stand. The investments in white pine management do not stop after establishment. Investments will have to continue to maintain both the protection practices and the stands themselves. Public agencies simply may not have sufficient budgets to make both the initial investments and to continue to make the maintenance investments.

I-WANT-IT-NOW GENERATION

We are an impatient people. We like to see instant results. When working with trees, instant results may be 100 years. Few are willing to wait 20 years. And yet to see the results of all of our investments and efforts to establish and culture white pine, we will have to wait 80 to 100 years. How are we going to sell practices that take that long to produce a return?

Karen Bennett (1986) an Extension Forester with the State of New Hampshire says, "It is...difficult to convince (private landowners) to convert a site growing poor quality hardwoods to pine, to prune, to do pre-commercial thinnings; in short, to make an out-of pocket investment for a return they will never realize." Politicians who control budgets will also be difficult to convince. It seems that politicians have trouble seeing beyond the end of the fiscal term or end of their own term? And, in all fairness, how can we get a commitment from politicians to invest in white pine when there are so many other societal needs competing for limited funding?

POLARITY AMONG STAKEHOLDERS

The tremendous popularity of white pine has galvanized a strange association of bed fellows. White pine has brought together foresters, forest industry, wildlife managers, wildlife special interest groups, non-game managers, recreationists, and "environmentalists." Seemingly this group has come together in harmony with the goal of establishing more white pine in Minnesota. But this group has many hidden agendas. White pine for timber production. White pine for wildlife game species. White pine for eagles and bears. White pine for old growth. White pine for super canopy trees. White pine to walk and sled through.

Already white pine has caused polarization. The Kawishiwi pine sale produced head on confrontation among public agency foresters, the forest industry, recreationists, environmentalists, non-game wildlife personnel, and tree spikers. And, professional resource managers who took strong stands related to the Kawihiwi pines became the object of animosity and personal scrutiny by opposing viewpoints.

This polarity exists with many tree species and forestry practices. But no where does it exist with greater diversity of stakeholders and with greater passion than with white pine. This polarization will only increase the costs of managing our resources. If we are to work toward the goal of increasing white pine in Minnesota, there is a critical need for all of us to work together. We can't afford to draw lines between the "ecofreaks" and the "ecothugs." Establishing and culturing of white pine will require a commitment and a long term investment. Without some vision of the commitment and investment paying off monetarily, ecologically, aesthetically, or spiritually, there will be very few who will take the commitment seriously and invest to bring white pine back to Minnesota.

CONCLUSION

White pine does have problems. Some are inherent with the species and others are a reflection of the times we live in. The problems can be managed, and we can increase white pine in Minnesota. However, white pine will never occupy the predominance it had when Minnesota was first settled by white people. And, we will never see white pine established and cultured as red and jack pines have been managed. We will never see acres and acres of pure white pine in plantations. At best we will see white pine mixed with other species, and perhaps in this mixture white pine will be able to satisfy all the diverse needs.

To manage white pine, then, is to manage the problems associated with white pine. If we choose to ignore the problems with white pine or we choose to be ignorant of the problems, then we have no right to mess with white pine.

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