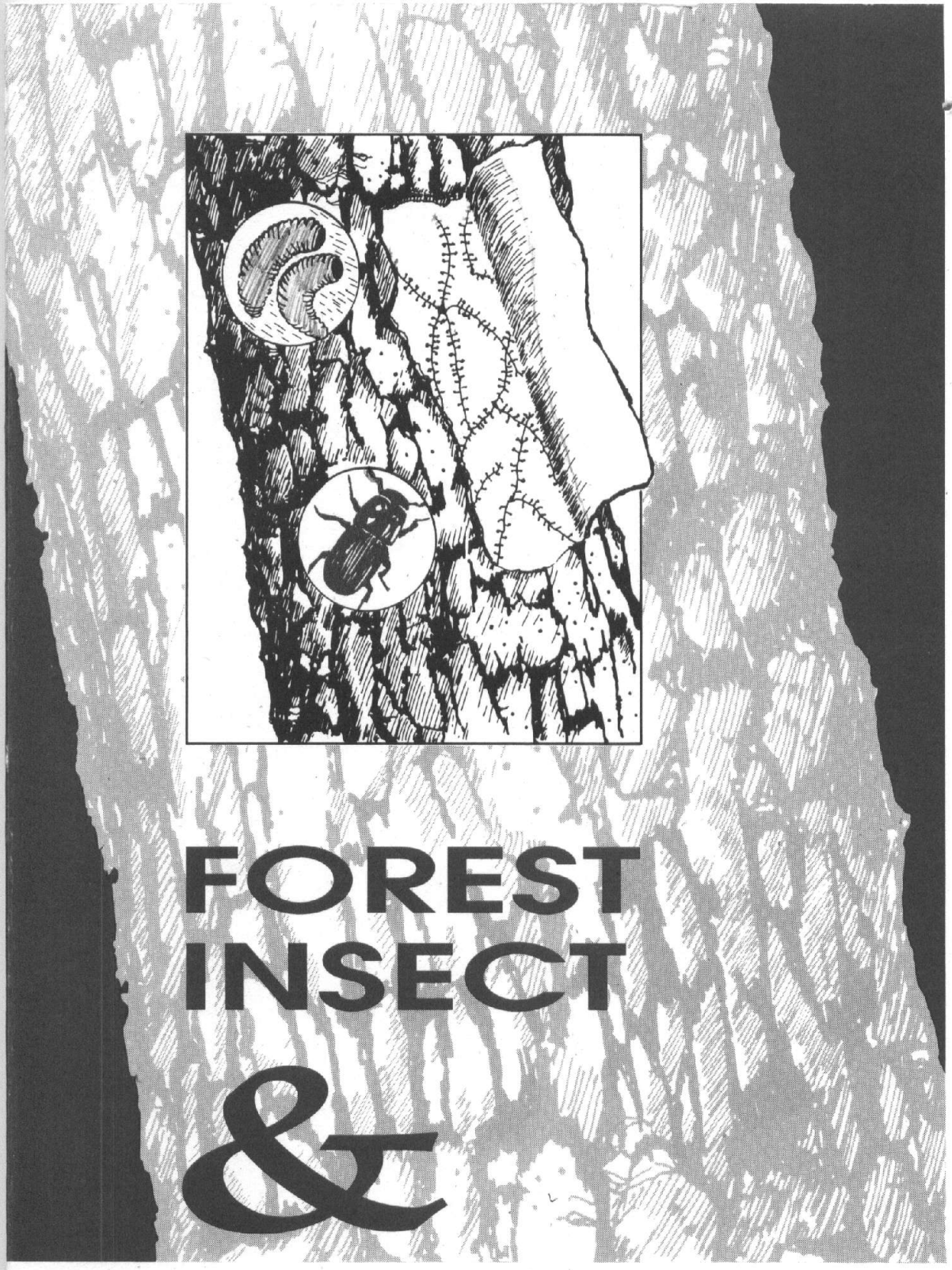

FOREST INSECT & DISEASE REPORT 1990

Minnesota Department of Natural Resources
Division of Forestry

FOREST PEST REPORT
1990

BY

The Forest Insect and Disease Unit

Minnesota Department of Natural Resources

Division of Forestry

May, 1991

MINNESOTA FOREST INSECT AND DISEASE MANAGEMENT PROGRAM

There are approximately 16.5 million acres of forest land within the State of Minnesota. Over one-half of the commercial forest land within the state is publicly owned. These forests support a 2 billion dollar forest industry, which is the third largest industry within the state. The Minnesota Department of Natural Resources (MN-DNR) has been charged by the legislature with management efforts and/or support on Minnesota's state, county, and private forest lands.

Minnesota's Forest Insect and Disease Management Unit is contained within the Forest Management Section of the MN-DNR Forestry Division. Field activities within this division have been regionalized into six regional administrative units. The insect and disease unit consists of a Forest Insect and Disease Supervisor, one statewide Pesticide Use Coordinator, five regional Forest Insect and Disease Specialists, and two seasonal Plant Health Specialists. The five Specialists and the two Seasonal Specialists have regional responsibilities.

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Tom Eiber
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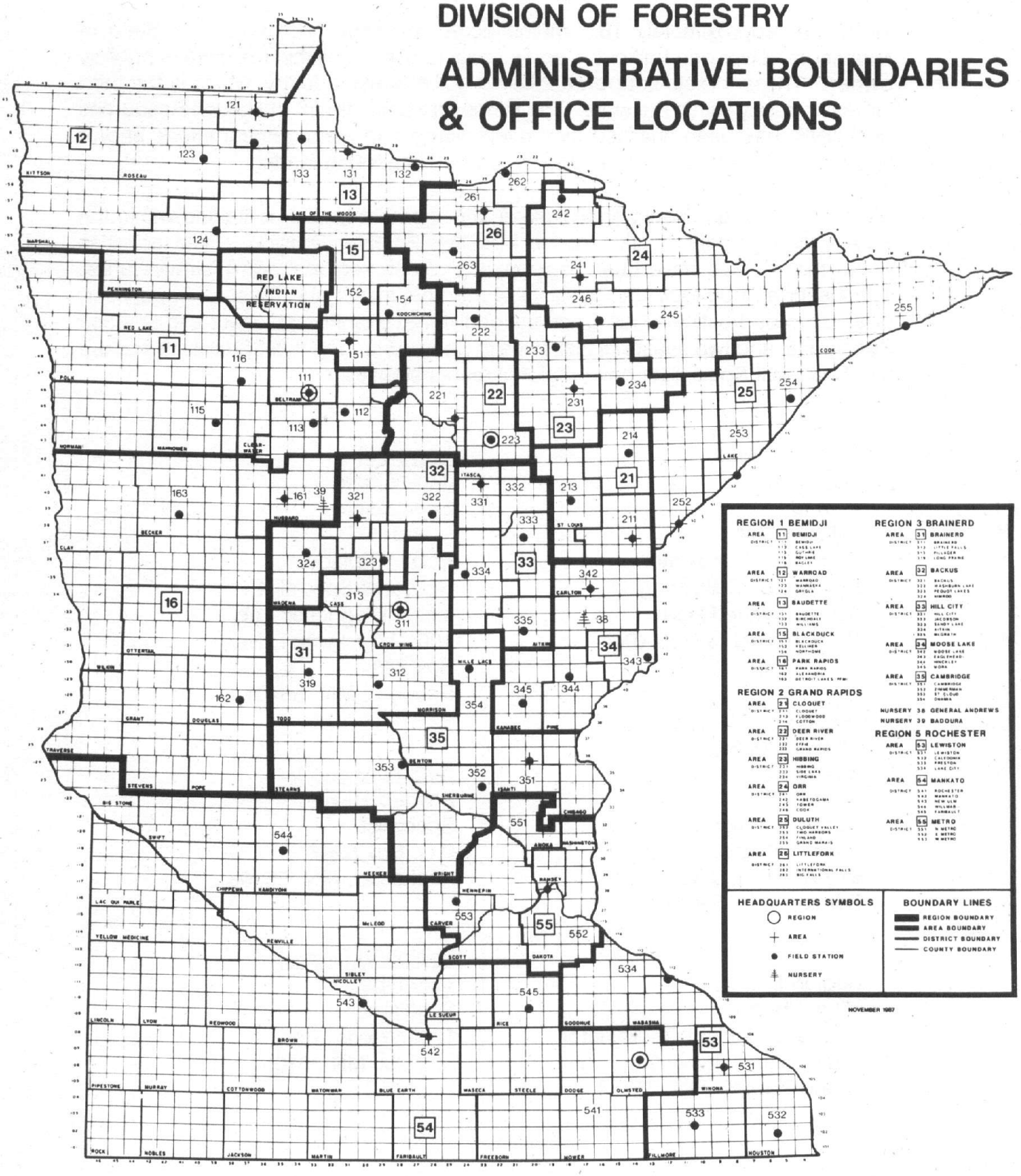
St. Paul, MN 55106

DIVISION OF FORESTRY

ADMINISTRATIVE BOUNDARIES & OFFICE LOCATIONS



NOVEMBER 1987

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ABIOTIC

INCIDENTAL PESTS

SPECIAL PROJECTS

HIGHLIGHTS

The most serious impacts to the forest resources of Minnesota continued to be drought stress and forest tent caterpillar defoliation. The drought started after the growing season of 1987 and was most severe during 1988. In 1989 the southern counties began to rebuild their soil moisture, and during 1990 adequate rainfall was received throughout central and southern Minnesota. In 1990, north central Minnesota experienced more drought conditions than it had during the previous two years, but the most severe drought conditions occurred in northwestern Minnesota.

The most severe drought-impacted forest resource was oak, particularly the red oak group. With drought stress came secondary organisms such as the two-lined chestnut borer and Armillaria root rot. Oak dieback and mortality was first noticed during 1989 throughout central and southern Minnesota, but in 1990 significant new oak dieback and mortality was noticed in Cass, Carleton, southern St. Louis, and southern Itasca Counties.

Adding to the drought stress was defoliation by the forest tent caterpillar. In 1990, 4.3 million acres were defoliated which was a 100,000 acre increase from 1989 defoliation. However, defoliation was more spotty and less intense, and there was less severe defoliation throughout the central and southern parts of Minnesota where the major oak resource is located. There were approximately 5,000 acres of private lands aerially sprayed with Bt to control the forest tent caterpillar. Groups of lakeshore owners who had lived through earlier defoliations organized themselves and hired aerial contractors to spray large areas around their lakes. The majority of the spraying occurred in Cass, Crow Wing, Ottertail, and Kandiyohi Counties. Sibley State Park in Kandiyohi County was sprayed for the second year.

Bark beetle populations were at low levels during 1990. Jack pine budworm seemed to be building in the Bemidji area. Larvae, egg masses, and light defoliation were found northwest of Bemidji. Spruce budworm populations continued to decline, and only 140,000+ acres were defoliated during 1990. Defoliation is expected to shift from Cook County to northern St. Louis County.

There were 122 gypsy moths caught in 97 traps during 1990. 112 of the moths were trapped in the Twin Cities area. One male moth was trapped in the Pequot Lakes area in Crow Wing County which was an unexpected and unusual catch.

Diplodia tip blight was noted killing trees and tops of trees in the Park Rapids area. This tip blight will often progress beyond the shoots when the infected trees are under stress.

Despite all the talk of drought, Anthracnose caused serious defoliation to ash and bur oak in southern Minnesota.

PEST CONDITIONS REPORT: INSECTS

JACK PINE BUDWORM
Choristoneura pinus Freeman

ACREAGE: 300

SEVERITY: Very light defoliation involving only current year needles.

TREND: The last widespread outbreak was from 1984 to 1987. The peak year was 1986 when over 100,000 acres of jack pine were defoliated. Populations started to decline in 1987 when 80,000 acres were infested, but 50% of the infested acres sustained only light defoliation. In 1988 only 300 acres showed some budworm defoliation, and in 1989 no signs of budworm were evident. During 1990, some larvae were found, and damaged shoots could be detected in Beltrami, Hubbard, and Crow Wing Counties.

REGIONAL NOTES

Region 1

Larval surveys conducted in Beltrami and Hubbard Counties showed an increase in budworm activity. Larval surveys are based on the inspection of 30 shoots at one location. In Hubbard County in the Park Rapids Area, larvae were found in Badoura (139-32) and White Oak (140-32) Townships, and in the Bemidji Area larvae were found in Lake Alice (143-35), Lake George (143-34), and Rockwood (145-34) Townships. In both White Oak and Rockwood Townships, there was significant chewing on the shoots. Larval counts were as high as 6 larvae on the 30 shoots sampled.

In Beltrami County in the Bemidji Area, larval counts were even higher. In Eckles (147-34) and Lammers (147-35) Townships larvae were found on 7 out of the 11 sample plots. Lammers had counts ranging up to 13 out 30 shoots with larvae, and on two plots in Lammers, all 30 shoots had obvious feeding signs. Foliage color change typical of budworm feeding was noticed at these two locations from the edge of the road.

REGION 1 JPBW LARVAL SURVEY

LOCATION	LARVAE/SHOOTS
BECKER	
SWSE 14-139-36	0/0
NWSW 14-139-36	0/0
NENW 22-139-36	0/0
SWNW 22-139-36	0/0
SESW 26-139-35	0/0
SWSW 35-139-35	0/0
HUBBARD	
NWSW 9-139-32	0/0
SWSW 10-139-32	0/1
SWSW 11-139-32	0/0
NENW 11-139-32	0/0
SWNW 12-139-32	4/2
NWNW 14-139-32	0/0
SWSW 28-139-32	0/0
NENE 36-139-32	1/1
NENE 14-139-33	0/0
SENW 15-139-33	0/0
SWNE 26-139-33	0/0
NWSW 35-139-33	0/0
SESE 35-139-33	0/0
NWSW 22-140-32	0/0
SWSW 23-140-32	1/2
SWSW 26-140-32	0/0
SESE 30-140-32	0/0
SESE 34-140-32	0/0
SESE 26-140-33	0/0
SWNE 27-140-33	0/0
SESW 35-140-32	0/0
NWNE 4-143-34	0/0
NWNE 5-143-34	1/1
SWSW 5-143-34	4/3

LOCATION	LARVAE/SHOOTS
HUBBARD	
NESE 8-143-34	2/1
NENE 9-143-34	8/30
SESW 9-143-34	3/3
NENE 16-143-34	4/4
NENE 32-144-34	0/0
NENW 4-145-34	0/0
SESE 22-145-34	2/6
NWSW 24-145-34	3/2
SWSE 27-145-34	2/7
SESE 33-145-34	6/1
BELTRAMI	
SWSE 21-146-35	0/0
SESW 22-146-35	0/0
SWSW 23-146-35	0/0
SWNE 34-146-35	1/1
SENW 33-146-35	0/0
SESE 4-147-34	6/4
SESW 5-147-34	5/2
NENE 10-147-34	1/6
NENE 11-147-34	3/2
SWSW 19-147-34	0/3
SWNW 25-147-34	0/0
NENE 1-147-35	4/3
SENW 2-147-35	13/24
SWNE 3-147-35	0/0
SESE 11-147-35	2/6
NENE 13-147-35	0/4
NWNW 19-148-35	0/3
SESE 19-148-35	0/0
SESW 28-148-35	1/6
NWSE 29-148-35	0/3

REGION 1 JPBW LARVAL SURVEY (Continued)

LOCATION	LARVAE/SHOOTS
LAKE OF THE WOODS	
SWSE 18-159-33	0/0
SWNW 20-159-33	0/0
NWNE 29-159-33	0/0
NENE 33-159-33	0/0
SWNW 7-159-34	0/0
NESW 11-159-34	0/0
NWNE 13-159-34	0/0
NENW 16-159-34	0/0
SENW 4-159-35	0/0
NENE 7-159-36	0/0
SWSW 19-160-36	0/0

LOCATION	LARVAE/SHOOTS
ROSEAU	
SESW 8-159-37	0/0
SESE 31-160-37	0/0
NWNW 28-160-38	0/0
SENE 36-160-38	0/0
NWSW 6-161-37	0/0
NWSE 26-161-37	0/0
NESE 30-161-37	0/0

REGION 1 EGG MASS SURVEY

LOCATION	EGG MASSES
HUBBARD	
SESE 4-143-34	0
NWNE 8-143-34	0
SESW 9-143-34	0
SENW 16-143-34	0
NENE 16-143-34	0
NWNE 17-143-34	0
SWSE 20-144-34	0
SWSE 22-144-34	0
SWSE 33-144-34	0
SESW 34-144-34	1
SESE 2-145-34	0
SESE 22-145-34	0
NWSW 24-145-34	0
NWSE 27-145-34	0
SESE 32-145-34	0
SWSW 36-145-34	0

LOCATION	EGG MASSES
BELTRAMI	
SWSW 9-147-34	0
NWNW 10-147-34	0
SESE 15-147-34	0
SWSW 16-147-34	0
NENE 21-147-34	0
SESE 26-147-34	0
SENE 26-147-34	0
NENE 1-147-35	0
NENE 2-147-35	0
SENE 3-147-35	3
SESE 11-147-35	0

Region 2

There was no detectable jack pine budworm activity during 1990.

Region 3

Very light defoliation was detected in Section 36, T.45, R.20W in Pine County. A larval survey was conducted at 13 sites in Crow Wing, Pine and Wadena Counties. At 7 locations, no larvae were found; all other locations had less than 20 larvae. Jack pine budworm moths were caught in pine tussock moth traps.

Jack pine budworm larval survey, 1990.

County	Legal description	Number budworms	Date	Remarks
Crow Wing	NWNW 14-136-29	0	6-8	
	9,10,11-136-27	0	6-14	
	SWNE 16-44-31	0	6-14	
Pine	NWSE 36-45-20	7	6-22	
	SWSE "	15	"	
	SESW "	15	"	
	SWSE "	19	"	
	Same plots		7-2	A recheck revealed 50-60% had pupated. Very little browning was visible.
Wadena	SWNW 15-138-33	0	6-25	
	SESE 3-138-33	1	"	6th instar
	SWSW 9-138-33	2	"	" "
	NWNW 17-137-34	0	"	
	NENE 30-136-33	0	"	
	SESE 18-138-34	0	"	

BARK BEETLES
Ips spp.

TREND: Weather conditions allowed the development of very high populations of bark beetles during 1987 and 1988 creating pockets of mortality in many red pine plantations. Rains and cooler temperatures in 1989 resulted in a large reduction in population levels in 1989. This trend continued through 1990, although drought conditions shifted to the northwestern part of the state and may have set the stage for an increase in bark beetle activity in this area in 1991.

REGIONAL NOTES

Region 1

There was no significant bark beetle activity in this Region during 1990. It was difficult to pick up bark beetles in pheromone traps in the study area on the southeastern edge of the Region. Drought conditions did intensify in the northwestern part of the Region during 1990. The dry conditions, particularly in the Warroad and Baudette Areas, may have allowed populations to increase. If dry conditions continue, particular care will have to be taken when harvesting in pine areas.

Region 2

Sufficient rainfall and normal summer temperatures helped reduce bark beetle populations to normal background levels in 1990. No additional mortality of red pine in plantations was reported. However, there were reports of large trees in backyards dying due to bark beetles.

The two-year pheromone trapping project initiated in 1989 continued in a 30-acre, 28-year old red pine plantation in Section 21, T.58N, R.24W in Itasca County. Bark beetles were caught in the traps, but the catch was much less than in 1989.

Region 3

The spring of 1990 brought significant rains to the southern parts of the region where the bark beetle problem had been most serious from 1987 through 1989. In these areas, the incidence of beetle activity returned to levels that would be considered typical for a normal bark beetle population. Incidence in stands was

under 5% with average stand mortality less than 1%. For all practical purposes, the major outbreaks ended in 1990 in the southern part of the region with only a few scattered plantations showing measurable mortality.

The northwestern parts of the region did not receive adequate rainfall. Bark beetle continued to decrease in the northwest, but not as dramatically as in the southern parts of the region. Damage was similar to that found in the south in contrast to the past few years when damage in the south and southwestern parts of the region far exceeded other areas.

The pine bark beetle had only two complete generations in 1990. There was no evidence of a third generation observed at any locations.

Region 5

No significant bark beetle activity occurred in the southeast since August of 1988. Pine mortality from bark beetles was confined to the 1988 season.

As part of the pheromone trap study, 75 pheromone baited funnel traps were again placed into a 15 acre red pine plantation in Fillmore county. Few beetles were trapped, and no additional mortality occurred.

Region 6

The spring rains were heavy over most of the Metropolitan Region in 1990 and effectively brought the end of the drought. Communities in Anoka County that had serious beetle problems for the past few years saw those problems all but disappear in one season. Populations and damage were down dramatically over the entire region and might have gone unnoticed were it not for a few isolated pockets of minor mortality.

The City of Lino Lakes continued to trap beetles in one housing development situated in a 40 acre red pine plantation where mortality was 10-15% in 1988. A few trees were lost in 1990 in the Sherwood Green development, but the problem appears to have abated much to the pleasure of city officials and residents. The average mortality in Anoka County was less than 1% in 1990. The City of Burnsville in Dakota County and O'Brien State Park in Washington County had similar experiences.

  

PINE TUSSOCK MOTH
Dasychira pinicola (Dyar)

TREND: In 1980, heavy mortality occurred in 2 townships in Region 3. Since that time populations have been monitored and have been insignificant. Again, during 1990, population surveys indicated that the pine tussock moth populations remain at a low level.

REGIONAL NOTES

Region 3

Seventeen pheromone traps were monitored during July and August. This year's catches were similar to catches from 1989 indicating low population levels.

PHENOLOGY

July 2: Beginning to catch moths
July 3: Larvae 50% pupated

PINE TUSSOCK MOTH PHEROMONE TRAP CATCH SUMMARY

CO	LOCATION	DATE TRAP PLACED	TRAP NO.	DATE TRAP CHECKED	MALE P.T. MOTHS
Wadena	SESE 3-138-33	6-25	16	7-6	16
				7-16	8
				7-26	2
				8-10	15
Wadena	SWNW 15-138-33	6-25	14	7-6	14
				7-16	2
				7-26	2
				8-10	4
Wadena	SWNW 10-138-33	6-25	15	7-6	6
				7-16	3
				7-26	4
				8-10	19
Wadena	NENE 3-138-33	6-25	17	7-6	6
				7-16	7
				7-26	1
				8-10	1
Crow Wing	SWNW 9-136-27	6-25	10	7-5	5
				7-16	7
				7-26	10
				8-10	14

CO	LOCATION	DATE TRAP PLACED	TRAP NO.	DATE TRAP CHECKED	MALE P.T. MOTHS
Crow Wing	SWSW 11-136-27	6-25	13	7-5	3
				7-16	13
				7-26	3
				8-10	9
Crow Wing	NWSE 9-136-27	6-25	11	7-5	6
				7-16	3
				7-26	2
				8-10	4
Crow Wing	SENE 10-136-27	6-25	12	7-5	5
				7-16	10
				7-26	15
				8-10	8
Pine	SWSE 25-45-20	6-22	3	7-2	2
				7-12	2
				7-25	15
				8-6	10
				8-13	24
Pine	NESW 30-45-19	6-22	4	7-2	2
				7-12	3
				7-25	6
				8-6	8
				8-13	30

CO	LOCATION	DATE TRAP PLACED	TRAP NO.	DATE TRAP CHECKED	MALE P.T. MOTHS
Pine	NENE 13-45-20	6-22	8	7-2	1
				7-12	0
				7-25	1
				8-6	7
				9-13	14
Pine	SWSE 18-45-19	6-22	9	7-2	0
				7-12	1
				7-25	5
				8-6	9
				8-13	13
Pine	SWNE 6-45-19	6-22	2	7-2	I
				7-12	2
				7-25	20
				8-6	8
				8-13	15
Pine	SESE 30-45-19	6-22	5	7-2	I
				7-12	5
				7-25	5
				8-6	9
				8-13	17
Pine	NENW 26-45-20	6-22	6	7-2	2
				7-12	2
				7-25	0
				8-6	6
				8-13	2

CO	LOCATION	DATE TRAP PLACED	TRAP NO.	DATE TRAP CHECKED	MALE P.T. MOTHS
Pine	NENE 26-45-20	6-22	7	7-2	2
				7-12	0
				7-25	1
				8-6	5
				8-13	4
Pine	SWNW 6-45-19	6-22	1	7-2	4
				7-12	0
				7-25	2
				8-6	5
				8-13	14



RED HEADED PINE SAWFLY
Neodiprion lecontei (Fitch)

ACREAGE: Not determined

SEVERITY: Defoliation to jack pine ranged up to 50%

TREND: Unknown

REGIONAL NOTES

Region 3

There was heavy defoliation of jack pine in Aitkin County. Roadside trees were stripped of foliage north of Staples in Cass County, and feeding was observed in Crow Wing County. Larvae were active on red pine in Wadena, northern Crow Wing, Cass, and Pine Counties.

PHENOLOGY

July 3: Larvae active on red pine and on 35 year old jack pine: Aitkin Co.
July 5: A few larvae still present; many pupated on jack pine in Aitkin Co.
August 9: Larvae feeding on jack pine in Crow Wing Co. Larvae range up to 22 mm in length; near cocooning length.

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EUROPEAN PINE SAWFLY
Neodiprion sertifer Geoffroy

ACREAGE: Not determined

SEVERITY: Locally moderate to severe defoliation

TREND: Unknown

REGIONAL NOTES

Region 5

By mid-June of 1990 there were numerous and widespread reports of sawfly damage in young forest and Christmas tree plantations across southeastern Minnesota. Both red and Scots pines were defoliated in varying levels. These were the highest levels of sawfly activity observed in this region.

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JACK PINE SAWFLY
Neodiprion pratti banksianae (Rohwer)

ACREAGE: Not determined

SEVERITY: Light to moderate

TREND: Defoliation was noted in only one stand in 1989 in Region 2 but became more widespread in 1990. In Region 3, this year's jack pine sawfly population was the largest population observed in 20 years.

REGIONAL NOTES

Region 2

Jack pine sawfly was very common in Region 2 in 1990 especially in Koochiching, Itasca, and St. Louis Counties. Defoliation was most common on sapling and pole-sized trees along roads and edges of stands. The level of defoliation was generally light to moderate.

Region 3

This is the largest population observed in the past 20 years. Sawflies and their feeding damage was widespread in the Region.

PHENOLOGY

July 3: Larvae feeding
July 5: Larvae feeding, near Willow River, Pine Co.

❀ ❀ ❀

SPRUCE BUDWORM
Choristoneura fumiferana (Clemens)

ACREAGE: 198,000

SEVERITY: 1-20% needle loss: Scattered in E Lake County
20-50% needle loss: NW Lake and NE St. Louis County
>20% needle loss: Cook County (see defoliation map)

TREND: Populations are continuing to decline from a peak of 440,000 acres defoliated in 1986. In 1988, there were 199,800 acres of defoliation. In 1989 the acreage dropped to 140,000 acres but increased slightly during 1990. Food source is running low in Cook County. Based on pheromone trap catches over the past 5-6 years, a population increase is expected in northern St. Louis County.

REGIONAL NOTES

Region 2

Defoliation was again concentrated in Cook County, NW Lake County and NE St. Louis County. Populations exist in other parts of St. Louis and Lake Counties, but have caused little defoliation. Heavy defoliation occurred in some young white spruce plantations in the Grand Marais District.

Pheromone trapping was again carried out in the Region. Three traps were used per plot. Results follow:

GRAND MARAIS DISTRICT

		Avg. # Moths/Trap
Jackson Lake Road	S12-T63N-R4E	192
Devilfish Lake	S32-T64N-R3E	197
Tom Lake	S16-T63N-R3E	113

TWO HARBORS DISTRICT

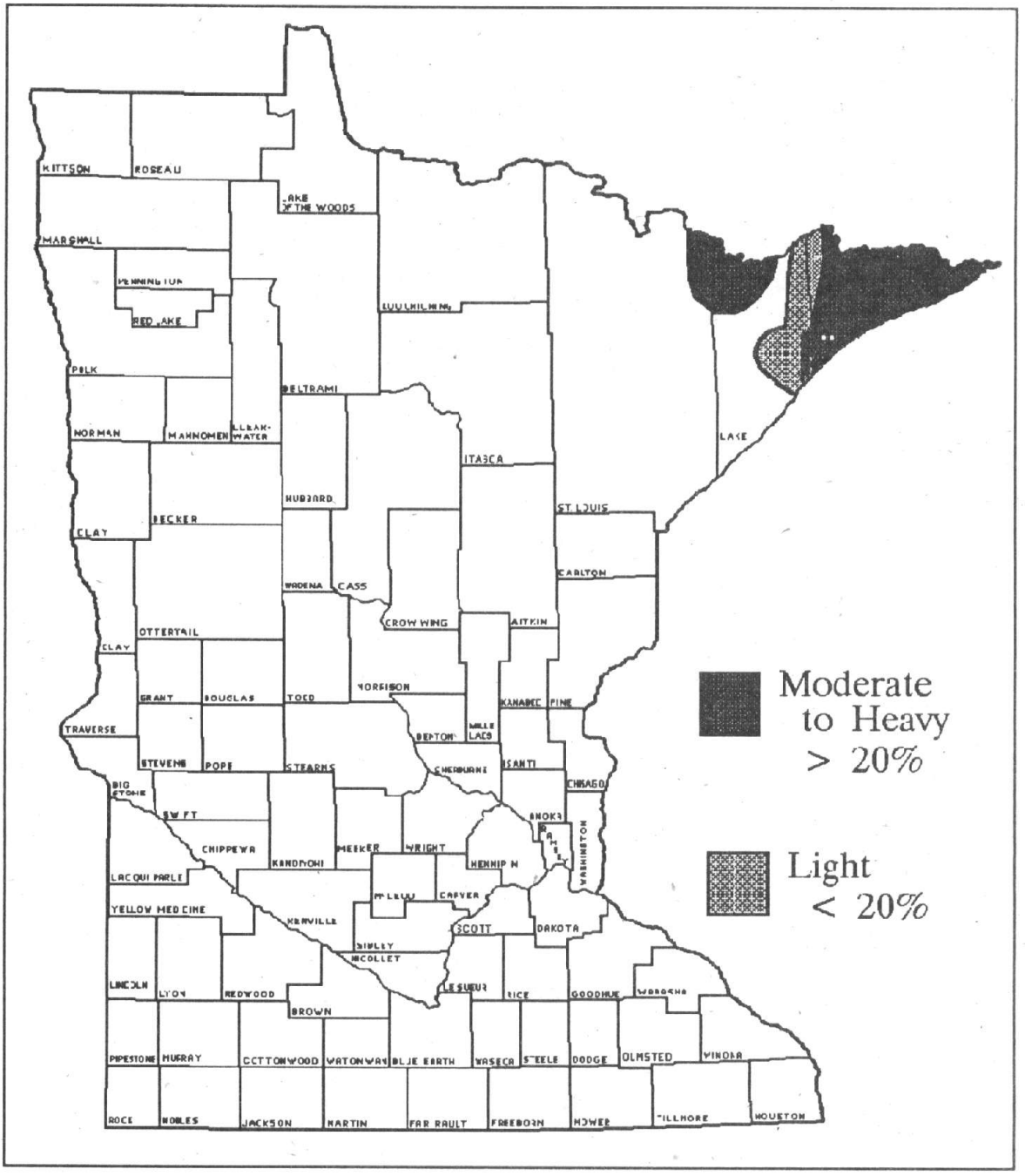
Knife River	S36-T52N-R12W	15
Big Noise	S19-T55N-R10W	16

Defoliation of the Two Harbors District sites was less than 5% needle loss. Defoliation of the Grand Marais District sites was heavy, >50% needle loss.

PHENOLOGY

May 5:	2nd instar larvae; Cotton, St. Louis Co.
June 30:	Mostly pupal stage; still a few larvae present and a few moths have emerged. Echo Trail, St. Louis Co.
July 2:	Late instar larvae present; Grand Marais, Cook Co.
July 7:	No pupae present yet; larvae still in last and next to last instars; Grand Marais, Cook Co.

MAP 1: 1990 SPRUCE BUDWORM DEFOLIATION



WHITE SPRUCE CONE INSECTS

ACREAGE: 10 acre seed orchard

SEVERITY: Very high level of incidence: 87.3% of the cones were attacked by insects.

TREND: In 1988, 12% of the cones were attacked by one or more insects. In 1989, 23% of the cones were attacked by one or more insects. 1990 saw a dramatic rise in insect activity.

REGIONAL NOTES

Region 2

Twenty cones from each of 20 trees representing 10 different clones were harvested on August 6 and then dissected to assess insect incidence.

PEST	INCIDENCE
All insects	87.3%[1]
Choristoneura fumiferana (Clemens)	8.5%
Coneworms	32.0%[2]
Cydia strobilella (L.)[3]	28.8%
Dasineura rachiphaga (Tripp)	19.8%
Hylemya anthracina (Czermy)	50.0%
Other insects	9.0%

[1] Percentages are not additive since some cones were attacked by more than one species of insect.

[2] Coneworms - Less than 0.1% of the cones were damaged by what appears to be *Dioryctria abietivorella* (Grate). The remainder of the coneworm damage was done by what may be a species of *Holcocera*.

[3] *Cydia strobilella* was formerly called *Laspeyresia youngana*.
For more detailed information, see "White Spruce Seed Orchard Pests" in the Special Projects section.

WHITE GRUBS
Phyllophaga spp.

ACREAGE: 13 acres

SEVERITY: Very high populations of white grubs were found on a site to be planted in 1991. There was 60% red pine mortality on a two-acre plantation planted in 1990.

TREND: Grubs are common on sites that have been in grass for a number of years. No widespread mortality has been attributed to grubs until this year, but grubs probably are often involved in the first year die off of planted seedlings in old fields. Often mortality is blamed on weather or seedling handling.

REGIONAL NOTES

Region 2

Sixty percent of 2-1 red pine planted on a two-acre private site in 1990 were killed by white grubs. The site had very heavy sod cover and was planted using planting bars. In October of 1990, two white grubs per cubic foot were found in the soil. Literature on white grubs indicates that one-half grub per cubic foot is likely to damage or kill 56% of the trees recently planted on the site.

On an adjoining 11-acre sod-covered field to be planted in 1991, 0.4 grubs were found per cubic foot of soil. This is a high enough population to damage or kill 52% of the trees the following year or two.

In winter, white grubs burrow deep into the ground to overwinter. These surveys were conducted in October and some of the grubs may have already burrowed deeper into the soil and been missed in this survey. There may actually be higher populations of grubs on these sites than were found in the survey.

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FOREST TENT CATERPILLAR
Malacosoma disstria Hubner

ACREAGE: 4,300,000

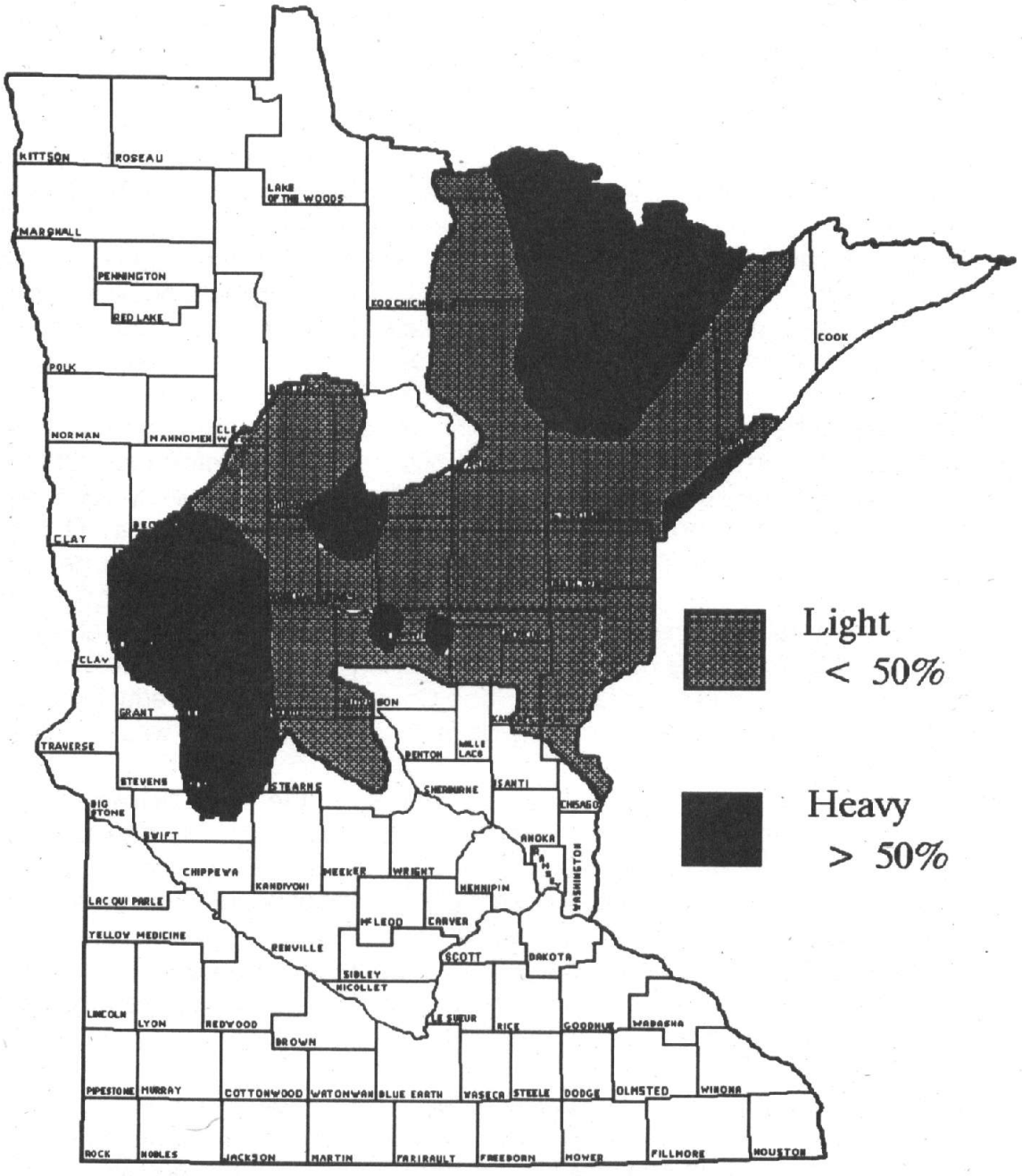
SEVERITY: Defoliation generally was less than 50%. Many areas were a mosaic of lightly defoliated and unaffected hardwoods. The area of heavy defoliation indicated on Map 2, was characterized by complete but scattered defoliation.

TREND: Populations around lakes in southern Minnesota have existed at varying intensities all during the decade of the 1980's. The more widespread infestation in central and northern Minnesota became evident in 1987. In 1988, 1,314,000 acres were defoliated, and in 1989, defoliated area amounted to 4,200,000 acres. During 1990, the effected area enlarged, but the intensity of defoliation was less than during the 1989 season. It is expected that the infestation in central and northern Minnesota will continue to decline in intensity and in area. It is unknown when populations around lakes in central and southern Minnesota will decline.

GUIDES: To meet the anticipated questions and needs for information by the general public during the projected 4-5 million acre FTC defoliation, a number of information sheets were produced. Each sheet could stand alone, or an entire packet of sheets could be given out. The packet provided information ranging from general FTC biology to organizing a spray project. An example of each informational sheet is found in the PUBLICATION section starting on page 59. The titles are:

- ✔ Forest Tent Caterpillar
- ✔ Forest Tent Caterpillar Homeowner Tip Sheet
- ✔ Questions Commonly Asked About Spraying Forest Tent Caterpillars
- ✔ Organizing to Spray Forest Tent Caterpillar
- ✔ Bt Microbial Insecticide"

MAP 2: 1990 FOREST TENT CATERPILLAR DEFOLIATION



REGIONAL NOTES

Region 1

FTC became evident in Region 1 during the month of May. Although activity began in late April with the first hatch occurring on April 24, caterpillars and defoliation did not become readily observable until the week of May 20th.

Earlier in the spring immediately following the first hatch in April, temperatures dipped below freezing at night, and daytime temperatures didn't climb out of the 30's and 40's for 4 consecutive days. Some larval mortality was observed in Bemidji, and the prolonged cold spell may have been responsible for FTC not being a significant factor north of Bemidji. South of Bemidji caterpillars survived the cold. When warm temperatures returned, most caterpillars became active, and unhatched egg masses erupted with tiny, black, crawly worms. Temperatures then again returned to below normal with frost occurring several times in May.

Estimates of defoliation due to the forest tent caterpillar are down from the high levels of 1989. In 1989 in Region 1, 531,500 acres were defoliated. Of this total, 460,000 acres were rated "heavily defoliated," or trees were nearly 100% stripped of their leaves. In 1990, total defoliation amounted to 73,500 acres. Of this total, 61,000 acres were heavily defoliated. Ottertail County led with the largest amount of defoliation. In 1989, Ottertail County defoliation amounted to 127,000 acres or 24% of the total acreage defoliated. In 1990, Ottertail County had about 45,000 acres heavily defoliated or 61% of the total Region defoliation. Defoliated acres remained the same in Douglas and Pope Counties, but the severity increased. In 1990, a higher proportion of defoliation in these two counties was rated heavy.

The area defoliated in 1990 was very similar to the area defoliated in 1989. Differences in acreage involved between these two years was due to the spotty nature of the defoliation in 1990. FTC did not cause widespread, continuous defoliation during 1990. Areas of complete defoliation were intermixed with areas of no or light defoliation. New areas of defoliation, however, did appear in southwestern Becker County in the Detroit Lakes area, in Cass County between Walker and Cass Lake, and in southern Beltrami County between the Hubbard County line and Bemidji.

Aerial spraying on private lands increased in the Region in 1990. In 1989, 200 acres were treated around Heilberger Lake in northwestern Ottertail County. In 1990 at least 2,000 acres were treated throughout northern and central Ottertail County. Heaviest activity occurred in Ottertail County and southward through the Alexandria vicinity. Bt was sprayed during the latter half of the week of May 20th. By mid week of the week following application, evidence of sick and dead caterpillars were fairly common in the sprayed areas.

Spring weather turned out colder than normal. The cooler temperatures seemed to delay leaf expansion. When the time to spray, based on caterpillar development arrived, leaves either did not exist or were so small that the concern was that more Bt would be on the ground than on the leaves. Spraying was delayed and timing was based on leaf size rather than caterpillar development. All who sprayed Bt estimate that the one application did reduce the population by at least 80%.

Private landowners in Ottertail have once again organized themselves to spray Bt during 1991. Estimates of spray area range up to 4,000 acres in this county. However, populations will be monitored in this area to determine if spraying is necessary. Elsewhere, egg mass surveys during the winter of 1991 seem to indicate a very low level population now exists north of Ottertail County. Expectations are for a significant decrease in defoliation in this Region.

Region 2

Heavy defoliation (>50% of leaves defoliated) occurred primarily in northern St. Louis County. This defoliation was somewhat scattered. Light to moderate defoliation occurred in much of the rest of Region 2. This defoliation was often very scattered. See Map 2.

Forest tent caterpillars were again the primary defoliators of aspen; however, aspen leaf rollers were also common. Overall, the defoliated area was greater than the acreage defoliated in 1989, but the defoliation was much more scattered and the amount of heavy defoliation was less than in 1989. Defoliation increased in Itasca and Koochiching Counties, but Region-wide the caterpillar population declined in 1990.

The caterpillars and aspen leaves began to develop early in the southern part of the Region. Larvae began hatching in late April near Duluth, Brookston and Grand Rapids due to warm sunny weather. However, the first two to three weeks of May were cold and snowy. This cold weather appears to have reduced the populations and also delayed their development.

Populations of the gray or friendly fly, *Sarcophaga aldrichi* were very high in most of the defoliated area. Calls about the fly were as numerous as calls about the caterpillars.

In 1989, very high populations of caterpillars occurred. Many homeowners tired of the caterpillars began signing petitions and contacting their local legislators and DNR about aerial spraying to control the caterpillars in 1990. To help people deal with the caterpillar, two public meetings were held in May 1990, by the DNR, Division of Forestry, and the St. Louis County Extension Service. No large scale spraying for FTC was done in Region 2.

An eggmass survey was conducted during the winter of 1989-1990 to predict 1990 defoliation levels. Actual defoliation was often much less than was predicted. This is believed to be primarily due to the death of young caterpillars after an early hatch followed by cold, snowy weather.

An interesting note: Research from the DNR Division of Fish and Wildlife Grand Rapids office reveals that an adult black bear eats as many as 25,000 forest tent caterpillars in a day.

FOREST TENT CATERPILLAR EGG MASS SURVEY RESULTS

LOCATION	AVG DBH	AVG NO. OF EM	PREDICT DEFOL	ACTUAL DEFOL
ST. LOUIS CO. S2-T50N-R18W	5.3	38	HEAVY	0
ST. LOUIS CO. S2-T50N-R18W	5.3	38	HEAVY	VERY LIGHT
ST. LOUIS CO. S36-T51N-R16W NEAR 4 CORNERS	3.2	23	HEAVY	MOD
ST. LOUIS CO. S36-T51N-R15W NEAR DULUTH INT'L AIRPORT	2.6	7	MOD TO HEAVY	VERY LIGHT
ST. LOUIS CO. S12-T51-R14W	3.6	10	HEAVY	VERY LIGHT
ST. LOUIS CO. S4-T51N-R12W	4.2	8	MOD	VERY LIGHT
ST. LOUIS CO. S29-T49N-R15W ELDE'S CORNER	2.3	13	HEAVY	O

LOCATION	AVG DBH	AVG NO. OF EM	PRED DEFOL	ACTUAL DEFOL
ITASCA CO. S14-T56N-R23W SNOWBALL LAKE	3.3	3	LIGHT TO MOD	MOD
ST. LOUIS CO. S22-T57N-R21W KELLY LAKE	2.2	20	HEAVY	VERY LIGHT
ST. LOUIS CO. T57-R17W LION SPRINGS	2.9	1	LIGHT	VERY LIGHT
ITASCA CO. S36-T56N-R25W JCT. 61 & 325	4.4	5	LIGHT	LIGHT
ITASCA CO. S27-T59N-R24W JCT. 339 & 7	5.1	22	HEAVY	HEAVY
ST. LOUIS CO. S6-T64N-R19W ORR AREA	2.3	47	HEAVY	HEAVY

Region 3

There were approximately 260,000 acres defoliated in this Region. Light defoliation occurred in all counties except Benton and Sherburne. Areas with defoliation were intermixed among areas with very light to no defoliation. Moderate to heavy defoliation occurred in the northwestern counties of Region 3. See Map 2.

Forty cocoons were collected near Garrison in Crow Wing County. They were all heavily parasitized. By July 3rd, heavily defoliated basswood along the southeast shore of Mille Lacs Lake were refoliated and looked healthy.

Approximately 2000 acres were sprayed in the Brainerd Lakes region with most of the acreage adjacent to Gull Lake. Spray areas included all properties along the north and west shores from the Round Lake Narrows to Wilson's Bay. The entire Pine Beach Peninsula was sprayed as well. Other spray areas included two blocks on the north side of Pelican Lake, the entire area around West Twin, the west end of the land between North Lang and Round Lakes, and the north side of Sylvan Lake. All areas were sprayed by a single operator, Scott's Helicopters of LeSuer,

Minnesota, at the request of the private landowners. Areas were sprayed with two applications of Bt (Dipel 8L) with a Plyac sticker about 7 days apart. Spraying was began the week of May 22nd and ended May 30th. Spraying cost landowners $42.00/acre for the two sprays.

Region 5

The area effected in this Region was between 2,000 and 3,000 acres. Heavy defoliation (>50% of leaves defoliated) occurred in both northern Kandiyohi and Meeker counties. In northern Kandiyohi county the defoliation was very widely scattered over many small separate areas. In Meeker county there were a few large areas of defoliation in the northeastern part of the county.

Forest tent caterpillar defoliation has been occurring in these areas at varying levels for over ten years. In 1989 and 1990 aerial applications of Bt occurred over both state and private lands. The peak of oak mortality, the combined effect of several years of defoliation, and the 1988 drought occurred in 1989.

Defoliation in 1990 decreased over 1989 levels but occurred in some new areas. Most of these areas are south of Norway and Green Lakes but north of Willmar. In these forests the forest tent caterpillar enjoys a wide variety of hardwood species including basswood, northern red and bur oaks, some aspen, birch, elm, and other species. This rich diversity of food sources, site conditions, and the geographical isolation of these insect populations may contribute to the persistence of the forest tent caterpillar in these forests.

Bt applications in state parks and on private lands in these counties began in 1989 in a successful attempt to remove the nuisance caused by armies of caterpillars in early June when people were trying to camp or enjoy lake homes. Coordinated efforts to use Bt began with public meetings and continued with personal contacts with county officials and lake homeowner associations. Each year DNR specialists field evaluated larval and foliage development in order to properly time the single Bt application.

In addition to nuisance control in Sibley State Park, there was concern over the potential mortality to the valuable northern red and bur oak resources from drought stress. In 1990, Bt was applied to 1500 acres of Sibley State Park in northern Kandiyohi county. This was the second year of Bt applications in Sibley state park. In Lyon county, Camden state park, was scheduled for a second year of Bt but was canceled due to the results of early larval surveys.

In these areas forest tent caterpillar larva began hatching from egg masses during the last week in April. The hatch reached new peaks over the next two weeks

every time afternoon temperatures rose to new highs. The favored host tree for egg laying and early larval feeding was basswood. The Bt application was timed to balance larval and target foliage development. In two years of Bt use the timing for a single application was in the third week in May and coincided with a 40% leaf development on bur oak. At this time there is an abundance of target foliage for the Bt on a variety of species, yet good canopy penetration is achieved. Larval development can range from 2nd to 4th instars at this time.

Dipel 8L at the rate of 8 BIU per acre with the addition of 2% Plyac sticker was used. Total spray volume was one gallon per acre.

Oak mortality in parts of northern Kandiyohi county has been severe. In Sibley State Park nearly 80% of the northern red oak was killed in 1989 by a combination of drought stress, FTC defoliation, and the twolined chestnut borer attack. A limited salvage harvest took place in the park the following winter. In 1990 there was an increase in the bur oak mortality.

After two years of Bt applications on state and private lands, no Bt applications are recommended in 1991.

PHENOLOGY

April 23:	Egg masses starting to hatch; Grand Rapids, Itasca Co.
April 24:	Egg masses starting to hatch; 333 degree days (Bemidji) above a base of 32°F; Pope, Ottertail, and Hubbard Cos.
April 25:	Major egg hatch; Brainerd, Crow Wing Co.
April 27:	Hatching continues; weather is cool and drizzling; Duluth, St. Louis Co.
April 29:	Three inches of snow overnight; larvae clustered on egg masses and alive; Grand Rapids, Itasca Co., and Bemidji, Beltrami Co.
April 30:	Snow flurries; daytime high near 32° F; Grand Rapids, Itasca Co.
May 1:	Snow in morning; temperature overnight of 20° F; leaves don't appear to be damaged; larvae appear alive, but not feeding; Grand Rapids, Itasca Co.
	About 50% hatched; Brookston, St. Louis Co.
May 4:	Egg masses alive with newly hatched larvae; highest and most active numbers of larvae this year; Bemidji, Beltrami Co.
	Bur oak leaves 1" in length; St. Paul
May 7:	Larvae are 1/8th inch in length; northern Ottertail Co.
	Red oak leaves 1¼" long; St. Paul

FTC PHENOLOGY (Continued)

May 10: Larvae are ¼ inch in length; first molt is complete; basswood leaves are the size of a quarter; bur oak leaves are 3/4ths inch long; no ash leaves; northern Ottertail Co.
Mid to second instar; basswood leaves 35% expanded; St. Cloud, Stearns Co.

May 15: 1st and 2nd instar larvae; Brookston, St. Louis Co.

May 17: Third instar; St. Cloud, Stearns Co.

May 18: Weather was cold and rainy all week. Aspen leaves are 1¼" long. Most birch and oak have not leafed out; Grand Rapids, Itasca Co.
First Bt spray; Avon, Stearns Co.

May 21: 2nd instar; defoliation visible in tree tops; about 30% of aspen clones have not leafed out; birch are not leafed; pin cherry in bloom; Balsam Township, Itasca Co.
2 instar; Kelly Lake, St. Louis Co.
Larvae ¼ - ½ inch in length; color and pattern of larvae are showing; some individual basswood branches stripped; basswood foliage half size; bur oak leaves 2 inches in length; Ottertail Co.

May 23: BT spray applied around Pelican Lake; NW Ottertail Co.
Late third instar; first Bt application on Gull Lake; Cass and Crow Wing Cos.

May 25: 1st and 2nd instar; dandelions are in bloom and aspen leaves are 1" long; Cotton, St. Louis Co.
Bigtooth aspen leaves ½" long; Virginia, St. Louis Co.
Birch and bigtooth aspen have not leafed out; Cook, St. Louis Co.
Most aspen have not leafed out; Gheen, St. Louis Co.

May 27: 3rd instar; Grand Rapids, Itasca Co.
Bt spray applied to all or parts of 6 lake shores in north central and northeastern Ottertail Co.

May 28: Larvae range up to 3/4th inch in length; still in clumps; Bemidji, Beltrami Co.

May 29: Larvae vary from 2nd to 4th instar; defoliation visible in tree tops; Grand Rapids, Itasca Co.
Fourth instar; second Gull Lake Bt spray; Cass and Crow Wing Cos.

May 31: 1st and 2nd instar; Duluth, St. Louis Co.
3rd to 4th instar; Calumet, St. Louis Co.
Dead larvae from the Bt spray of 5/27 are noticeable; Ottertail Co.

June 4: Hard freeze overnight; Grand Rapids, Itasca Co.

June 7: 3rd to 4th instar - Cloquet, Carlton Co.
Larvae range up to 2-2½ inches in length; Ottertail Co.

FTC PHENOLOGY (Continued)

June 14:	FTC starting to form cocoons; Grand Rapids, Itasca Co.
	Aerial application of Malathion to control late instar larval feeding at one resort; Ottertail Co.
	Cocooning is beginning; Ottertail Co.
June 17:	First adult moth observed; Ottertail Co.
June 20:	Cocoons are numerous on sides of buildings; Ottertail Co.
June 21:	50% pupated; Calumet, Itasca Co.
June 26:	80% pupated; Brookston, St. Louis Co.
	Mostly cocooned, but a few larvae are still present; Ottertail Co.
June 30:	80% pupated; aspen starting to refoliate; Echo Trail, St. Louis Co.
	75% pupated; Ely, St. Louis Co.
July 14:	Moths are still present; first new egg mass found; Ottertail Co.

TWO-LINED CHESTNUT BORER
Agrilus bilineatus (Weber)

ACREAGE: Not determined

SEVERITY: Dieback and mortality range up to 80% in stands dominated by red oak. Some property owners experienced 100% dieback and mortality to their shade and ornamental trees.

TREND: Populations began building in 1988. By the end of that growing season, oak losses in central Minnesota where drought conditions were the most severe averaged 10-20%. In 1989, mortality continued ranging up to 70% in some woodlots. During 1989, losses seemed to peak in southeastern and south central counties. During 1990, dieback and mortality shifted northward. Continued dieback and mortality will occur as drought conditions persist, but likely dieback and mortality peaked in 1990.

SURVEY: Two surveys were initiated in 1990 to determine oak losses due to drought and the two-lined chestnut borer. The first survey being done cooperatively with the North Central Forest Experiment Station will use data collected on FIA inventory plots. The second survey involves the interpretation of 35mm color aerial photographs taken in four counties in central and southern Minnesota. See "Oak Mortality Survey" in the Special Project section.

GUIDES: Guidelines for managing oak during these current outbreaks of two-lined chestnut borer and forest tent caterpillar, and during this time of drought were written to guide the management actions of both state and PFM foresters and to help reduce further losses. This guide is found in the PUBLICATIONS section starting on page 59 and is titled:

✔ OAK MORTALITY: GUIDELINES FOR MANAGEMENT

REGIONAL NOTES

Region 1

Oak mortality began to show up in 1989 in the southern part of the Region, particularly in Douglas and Ottertail Counties. In 1990, oak dieback and mortality continued in this area, but the number of new cases seemed to diminish. It was observed that oak dieback and mortality increased in woodlots harvested during the winter of 1989-90.

Elsewhere in the Region during 1990, oak dieback and mortality occurred in areas and stands for the first time. There was some oak mortality on droughty sites during 1989 in the Bemidji Area, but in 1990 oak mortality and dieback seemed to occur regardless of soil types. The hardest hit area was northern Cass County.

Oak dieback and mortality can be attributed to stresses brought about by drought and defoliation. However, the two-lined chestnut borer was also very much involved. Oaks that were cut revealed the characteristic two-lined chestnut borer galleries under the bark. In mid to late summer, larvae could also be found. Trees that were not cut were also diagnosed as being damaged and killed from the two-lined chestnut borer because crown symptoms showed up in mid and late summer, and the trees retained the brown leaves. These observations are consistent with a tree attacked by two-lined chestnut borer.

Region 2

High levels of oak mortality occurred due to two-lined chestnut borer and the drought. Forest tent caterpillar defoliation and Armillaria root rot no doubt increased mortality in some locations. Severe mortality and top dieback began to show up in late July and continued into the fall. Highest levels of mortality occurred in Carlton, southern St. Louis, and southern Itasca Counties.

Building sites and lots which received the additional stress of soil disturbance and root damage often suffered up to 100% mortality of oaks near the disturbance.

Mortality due to two-lined chestnut borer first became noticeable in 1989. The mortality in 1990 was much more widespread and severe than in 1989. Research on past outbreaks in Wisconsin and Michigan has shown a pattern with 2 years of elevated borer populations and elevated oak damage, followed by a sharp decline in borer populations and oak damage the third year. Whether this happens during this outbreak remains to be seen and likely will depend on precipitation patterns. If this pattern is followed, damage due to two-lined chestnut borer should decline in 1991.

Region 3

Four years of drought have stressed oaks throughout the central and north central part of the state. TLCB populations have built up to enormous levels in that time causing widespread mortality. It appears that 1989 was the peak year for oak mortality in the southern counties of Region 3 with 1990 being the peak for the northern counties.

New oak mortality was scarce in Crow Wing County, and there was a low level of new mortality noted south of the Big Rice River in Aitkin County.

Region 5

There was very light individual oak tree mortality across the southeast during 1990. The peak in oak mortality due to the 1988 drought occurred in 1989. Losses in the southeast hardwood forests were light and estimated at less than 1%.

In 1990, oak mortality in the southeast occurred mainly to bur oak. The individuals that died were primarily in urban areas or on very poor forest sites. In some of the urban areas the bur oaks killed by the two-lined chestnut borer were in stands that were leaf scorched in 1988 during the height of the drought. In addition the trees that died had their root systems disturbed close to the time of the drought by either construction or landscaping.

Region 6

The TLCB continued to kill significant numbers of oaks in Anoka County in 1990. Accurate surveys are not possible due to the close coincidence of oak wilt and TLCB. Damage by the borer has also been enhanced in areas with home construction where soil work (grade changes, excavations, etc.) and other forms of construction damage are common. Damage levels in the Metropolitan Region were down significantly over 1989 levels, a fact likely due to the good spring rains experienced in the region in April and May.

PHENOLOGY

August 2: Less than 5% of infested oaks showing symptoms in Region 3.
August 9: Many more oaks beginning to show wilting foliage.

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INTRODUCED BASSWOOD THRIPS
Thrips calcaratus (Uzel)

ACREAGE: Not determined

SEVERITY: Very light defoliation

TREND: Defoliation was light in 1989. In 1988, defoliation was very heavy at 90%.

REGIONAL NOTES

Region 2

Defoliation by the basswood thrips was very light in 1990 at locations being monitored in Carlton and St. Louis Counties. Defoliation of basswood by thrips has been observed in MN since at least 1982. The native basswood thrips *Seriocothrips tiliae* Hood was thought to be causing this damage. However, work in Wisconsin showed that the introduced basswood thrips was causing damage in that state. A survey conducted in Minnesota in 1990 showed that the introduced basswood thrips was the most abundant thrips presence on the sites surveyed. Wisconsin DNR organized the survey and did the laboratory work and identification.

Three sites in Region 2 were included in the survey, and the introduced basswood thrips were by far the most abundant thrips in the samples.

The locations surveyed in Region 2 are listed below:

Carlton County	Sec. 24-T48N-R16W
Carlton County	Sec. 16-T49N-R18W
St. Louis County	Sec. 02-T50N-R19W

Region 5

Light defoliation was reported in Winona and Houston counties.

Basswood forests have been defoliated by basswood thrips across Minnesota, Wisconsin, and Michigan for over ten years. In 1989 the defoliation in the southeast was very heavy to a resource still under drought stress.

In 1990 basswood thrips numbers appeared to have been greatly reduced. A survey conducted in cooperation with the Wisconsin DNR showed that the

introduced species and not the native basswood thrips was the most abundant thrips found at survey sites. Survey sites in the southeast were in state parks in Houston and Winona Counties.

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PEAR THRIPS
Taeniothrips inconsequens (Uzel)

Minnesota DNR-Division of Forestry cooperated with the University of Vermont on a survey for pear thrips. The objectives of the survey were:

1. To determine pear thrips regional distribution and abundance;
2. To determine regional distribution and abundance of other soil inhabiting thrips such as the basswood thrips;
3. To determine the regional distribution and abundance of soil-borne pathogens of pear thrips such as *Verticillum*;
4. To predict pear thrips abundance in 1991.

Survey procedures included selecting stands dominated by sugar maple. Five well-distributed sugar maples at least 8 inches DBH were selected in each surveyed stand. Soil samples were then collected at 6 feet and 12 feet from the base of each tree. The samples were taken with a tulip bulb planter. Each of the 10 samples were kept in separate plastic bags. The samples were then shipped to the University of Vermont for analysis. Sampling was done in the fall of the year between leaf drop and freeze up.

The results indicated very low populations of pear thrips in Minnesota. In all the samples, only 3 thrips of any species were captured. One basswood thrips was taken in Winona County while two unidentifiable thrips were taken from a stand in Pine County near Duxbury. Final data are not included at the request of the University of Wisconsin. In any event, it would appear that Minnesota suffers little threat from the pear thrips in sugar maple stands.

REGIONAL NOTES

Region 1

SURVEY SITES:
Itasca County, Section 1, T.149N, R.28W
Cass County, Section 6, T.143N, R.29W

Region 2

SURVEY SITES:
Carlton County, Section 27, T.49N, R.19W
ST. Louis County, Section 9, T.52N, R.12W

In a cooperative survey with the Wisconsin DNR (see introduced basswood thrips) no pear thrips were found on the three sites surveyed in Region 2.

Region 3

SURVEY SITES:
Pine County, Section 33, T.42N, R.17W
Pine County, Section 17, T.45N, R.16W

Region 5

SURVEY SITES:
Winona County, Section 29, T.107N, R.10W
Fillmore County, Section 13, T.102N, R.12W
Fillmore County, Section 35, T.104N, R.10W
Olmsted County, Section 16, T.105N, R.13W

GYPSY MOTH
Lymantria dispar (Linneaus)

ACREAGE: 41

SEVERITY: Multiple moth catches, but no defoliation

TREND: During the decade of the 1980's, isolated infestations have been located and treated with Bt for eradication. In 1990 an aerial spray project was carried out in Elk River and Minnetonka. No spray projects are planned for 1991.

NEW STATEWIDE INITIATIVE

Gypsy moth is becoming more serious in the Midwest and threatens to rapidly infest new areas. A new initiative was begun in 1990 relating to the recreational vehicle spread of gypsy moth. The region shares a common recreational clientele and serves as a major receptor for recreationists from urban centers in infested areas within and just outside the region. This project addresses the potential recreational vehicle spread of the gypsy moth. It includes a program of awareness and voluntary inspection.

Problem: Recreational vehicles travel freely, move often, and can easily carry gypsy moth in several life stages to uninfested areas. Summer camping is common in the region with recreational vehicles from uninfested areas being commonly found in infested areas during times of larval activity and oviposition.

Objectives:

1) Develop a regional strategy for dealing with recreational vehicle spread of the gypsy moth.

2) Hold multi-state workshops on an annual basis in conjunction with the State Cooperators Meeting or the North Central Forest Pest Workshop.

3) Develop, print, and distribute recreationally focused materials including a gypsy moth card, poster, and information sheet.

4) Prepare an educational environmental awareness poster for distribution to schools for use in science and biology classes.

5) Develop a list of potential future products that could be used to enhance the program.

STATEWIDE TRAPPING RESULTS

From detection trapping efforts, 122 moths were taken from 97 traps. Most of the moth catches occurred in the Twin Cities area. There was a total of 112 moths caught in this area. The number of moths caught nearly equaled the number of traps catching moths, and there is no one spot that seems to have a concentrated population. Because of this, no spraying is planned for 1991.

Outside the metro area, 3 moths were trapped in Rochester, and 1 moth was trapped from each of Wabasha, Sterns, and Crow Wing Counties.

1990 Gypsy Moth Trap Catch Summary

COUNTY	MOTHS	TRAPS
Anoka	10	10
Carver	1	1
Crow Wing	1	1
Dakota	24	20
Hennepin	36	26
Olmstead	3	3
Ramsey	20	13
Scott	5	4
Sherburne	1	1
Stearns	1	1
Wabasha	1	1
Washington	19	16

REGIONAL NOTES

Region 1

150 traps were distributed in State Parks, in high use area on State Forests, and on private lands. No gypsy moths were trapped.

Region 2

140 gypsy moth pheromone traps were set out by Division of Forestry and Division of Parks personnel in Region 2. No gypsy moths were trapped.

REGION 3

Pheromone traps were set out in State Parks and State Forest Campgrounds, on private lands, and in Camp Ripley. A single moth was caught in the Pequot Lakes area at a private campground in the NESW of Section 2, T.136N, R.25W. This catch will be followed up in 1991 by mass trapping at a rate of 16 traps per acre. Mass trapping will attempt to detect if a population is present and delimit its location.

Region 5

In 1990, 120 detection traps were again placed across the southeast in state parks and forest stations. No moths were reported from these traps.

Region 6

Gypsy moth activities in Region 6 are largely the responsibility of the Minnesota Department of Agriculture. The region is heavily trapped on an annual basis and normally returns a scattering of single and double moth catches. The Division of Forestry's role in detection and suppression is limited to providing assistance in egg mass hunts and eradication spray operations.

Two isolated infestations were sprayed in 1990 for eradication using 3 applications of Bt (Foray) at 20 BIU/acre per spray. Sprays operations were conducted on May 18, May 24, and May 30. First year, post-spray trapping yielded a single moth near each site. The sites will be monitored, not sprayed, in 1991. Both operations appear to have been successful.

PEST CONDITIONS REPORT: DISEASES

WHITE SPRUCE CONE DISEASES
Pucciniastrum americanum (Farl.)
Chrysomyxa pirolata (Wint)

REGIONAL NOTES

Region 2

ACREAGE: 10 acre seed orchard

SEVERITY: 14.4% of the cones were infected by rust fungi
13.9% of the cones were infected by American Spruce-Raspberry Rust - *Pucciniastrum americanum*
0.5% of the cones were infected by Inland spruce cone rust - *Chrysomyxa pirolata*

TREND: Rust incidence in 1989 was 16.8%

1000 cones were inspected for rust incidence in the seed orchard on July 1, 1990. Fifty cones were examined on 20 trees representing 13 different clones. Cones were rated as infected or not infected. The number of infection pustules per cone was also determined.

For more details, see White Spruce Seed Orchard Pests in the SPECIAL PROJECTS section starting on page 54.

DIPLODIA BLIGHT and CANKER
Sphaeropsis sapinea (Fr.:Fr.) Dyko & Sutton

ACREAGE: Not determined

SEVERITY: Top kill and tree mortality

TREND: This disease is endemic in the pine areas in Minnesota. In addition to infections of twigs, branches, and boles, this fungus lives and fruits on cones. When moisture conditions are good, infections take place and kill shoots. When trees are stressed, infections spread and the fungus forms cankers. Often the cankers will kill portions of the tree, or the entire tree will be killed. During 1990, drought conditions provided the stress, and Diplodia caused top kill and mortality.

REGIONAL NOTES

Region 1

In Park Rapids, Diplodia-killed red pine became evident during the winter of 1989-90. Red pine without an overstory were showing branch, top and tree mortality. *Sphaeropsis* fruiting bodies were present under the outer bark flaps. If the tree or branch had recently died, brown, resin soaked wood could be found at the edge of the dead areas. The affected red pine were all in the 12-18 foot range and growing on very dry sandy soil.

One particular landowner losing a large number of pine from a windbreak could not believe drought was a factor. There was an irrigation system set up to water the trees, and the trees got 30-60 minutes of water every day. This kind of watering in the deep sand of the site produced excellent grass, but was not deep and intense enough to give the trees adequate water.

Due to the increase in the occurrence of this disease on red pine, plantation surveys of 5-25 year old red pine plantations in the Park Rapids Area were undertaken. Survey procedures included using a sample plot of ten trees in a single row. Sample plots were uniformly distributed throughout the plantation so that an accurate view of the plantation was gained.

One plantation in the Detroit Lakes Field Station Area, Section 12, T.141N, R.37W, had significant levels of Diplodia. Of 130 trees included in the survey, 17 were dead from Diplodia. Cankers were present on both the main stem and lateral branches. Fourteen other pines also had Diplodia cankers but the trees were still

alive. Three of the fourteen trees had 25% or more crown dieback due to Diplodia cankers. Four other pine in the 130 tree sample were dead from Armillaria root rot. Both the incidences of Diplodia cankers and Armillaria root rot infections should increase as a result of drought stress on the trees.

Two other plantations inspected had no Diplodia, but Armillaria root rot was active. In a 7 year old plantation in Sections 33 and 34, T.141N, R.36W, 7 out of 300 trees inspected were dead from Armillaria root rot. Another 7 year old plantation in Sections 15 and 16, T.141N, R.36W, 7 out of 200 trees were dead due to Armillaria root rot. In this latter plantation, there were a lot of blank spots. Some rows had areas with 50 to 60 feet of no trees. This was especially common on south facing slopes and on the crests of hills.

Region 3

This disease was found causing mortality in 1989 and 1990 in two red pine plantations in the Nimrod District. The trees were 3' and 8' tall. There was also evidence of older infections. This evidence included tufting of needles and older sapling mortality. Abundant fruiting bodies were found on main stem cankers.

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ASH YELLOWS
Mycoplasma-like Organism

ACREAGE: Not Determined

SEVERITY: Not Determined

TREND: In 1988 ash yellows disease was found in a 10 acre black ash woodlot in Olmstead County. In 1989 the stand was harvested and the ash regeneration was destroyed.

REGIONAL NOTES

Region 5

In 1990 no new cases of ash yellows were reported by the DNR. The outlook for this disease remains uncertain.

Region 6

A single green ash tree in Roseville (Ramsey County) was determined to contain the ash yellows organism. The confirmation was made by Dr. Ben Lockhart of the University of Minnesota. The tree was a single stem green ash approximately 14" DBH. The tree had a large witches broom about 7 feet off the ground that was associated with a large pruning wound. The tree will be removed, the stem and branches chipped, and the stump ground out before the 1991 growing season. Several other trees in the area also had smaller, poorly-defined witches brooms. The area will be surveyed in 1991.

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ANTHRACNOSE LEAF DISEASES
Apiognomonia quercina
Apiognomonia errabunda
Glomerella cingulata

ACREAGE: Not Determined

SEVERITY: Light to complete defoliation

TREND: After the drought years of 1987-89, there was a return to moderately high levels of this disease in 1990. Disease occurrence did depend on the species and local climatic conditions.

REGIONAL NOTES

Region 5

With a steady amount of rainfall in 1990, outbreaks of Anthracnose increased in occurrence and intensity all across the Region. In early summer ash trees were heavily defoliated in south central counties. Each new rainfall brought higher levels of infection and additional defoliation. By mid summer most crabapple trees across the region were completely defoliated.

Later in the season a stand of bur oak near Red Wing was almost completely defoliated. In bur oak the disease progressed very characteristically from the lower crown and moved upward. Anthracnose-infected trees can be confused with oak wilt or two-lined chestnut borer mortality.

Region 6

Good spring rains in April, May, and June brought about a return of anthracnose to the Metropolitan Region in 1990. In all cases, the damage was light and caused little refoliation. Damage ended by mid-June.

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BUTTERNUT CANKER DISEASE
Sirococcus clavigignenti juglandacearum Kuntz

ACREAGE: Not Determined

SEVERITY: Butternut is being considered for the threatened species list.

TREND: A project was started in 1989 by the U.S. Forest Service and state cooperators to find resistance to the disease.

REGIONAL NOTES

Region 5

In 1990 scion wood was collected from 4 or 5 canker-free trees located in southeastern Minnesota. In the summer, work progressed on the development of tissue culture propagation techniques at the North Central Forest Experiment Station. In the fall a very good stand of butternut was located on private land in Olmstead County from which more cuttings will be collected. Additional trees have been reported and will be field checked. It has been a pleasant surprise to find individual trees that appear to be canker-free growing among dead and infected butternuts.

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OAK WILT DISEASE
Ceratocystis fagacerum (Bretz). Hunt

ACREAGE: This disease is estimated to infect 1000-1500 acres in southeastern Minnesota counties. A 1988 survey in central Minnesota counties found approximately 5,000 acres infected.

SEVERITY: Tree mortality

TREND: Oak wilt has likely been present in Minnesota since the turn of the century. Although the oak wilt fungus first was described and identified in Wisconsin in 1942, an earlier report indicates that it was present in the region as early as the 1880's. The disease is now found in at least 21 states and more than 600 counties. By 1988, oak wilt had been reported from 31 counties mainly in the southeast and east central portions of the state. See Map 3. This disease will continue to increase as urban sprawl adversely effects oak woodlots through construction damage.

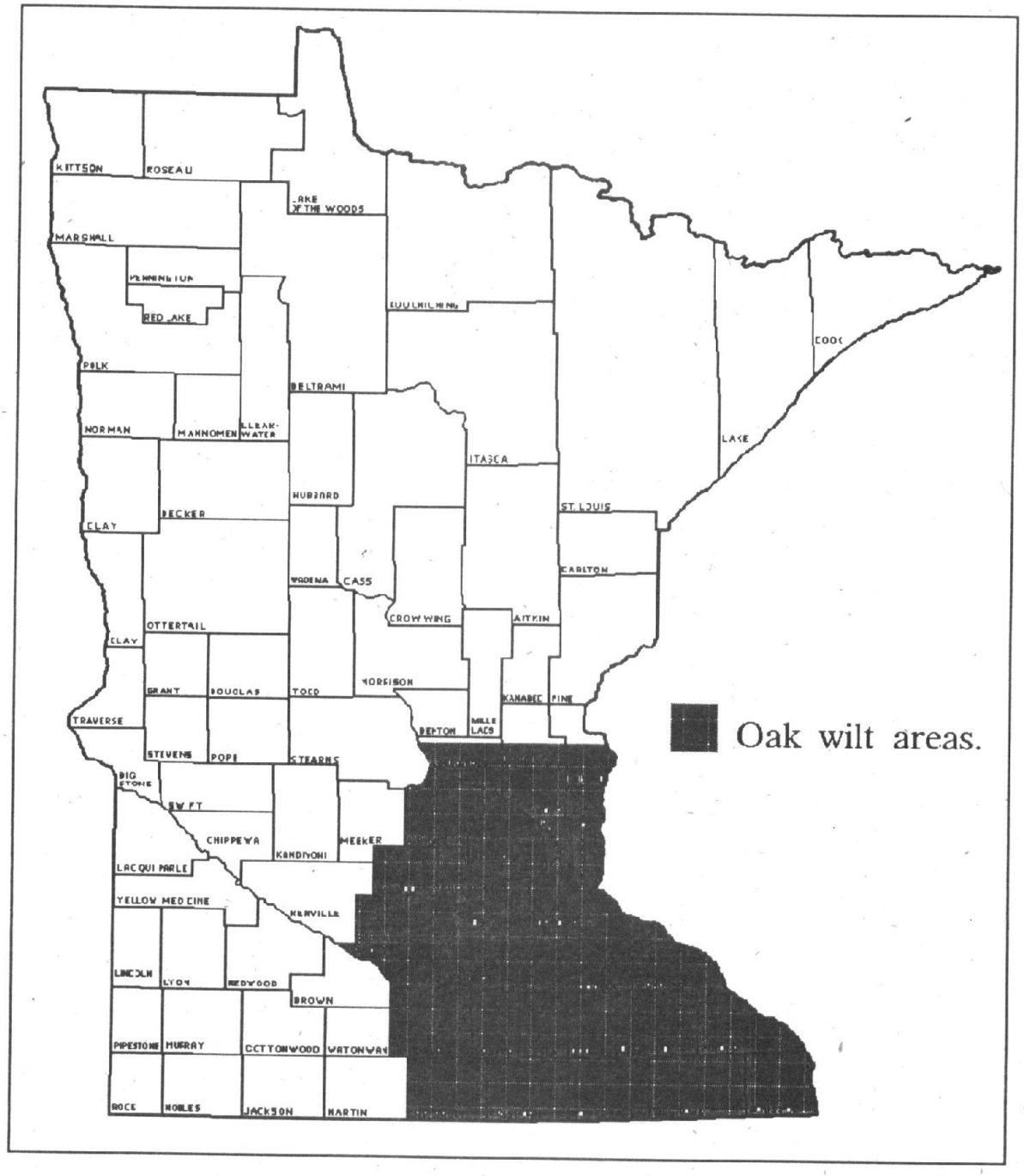
REGIONAL NOTES

Region 3

Four sites were treated in the Sand Dunes State Forest in 1990. Three of the areas were in forested areas while one was in the day use area at the Ann Lake Campground. Treatments included the instillation of vibratory plow line, and all standing oak trees inside the plow lines were removed during the winter. Results will not be known for several years. A fifth site was reported as potentially having the disease after the suppression operation was completed.

The oak wilt infection center in the Ann Lake Campground had been under treatment for several years through the use of sanitation and herbicide stump treatments. The control action was declared ineffective in 1990, and vibratory plow lines were installed.

Map 3: THE RANGE OF OAK WILT IN MINNESOTA



OAK WILT TREATMENT BLOCKS FOR 1990
THE SAND DUNES STATE FOREST

Site number	Site Name	Legal Description	Plow Line (Chains)
Site 1	Ann Lake Camp	S 21&22 of T34-R27	23
Site 2	Fuelwood Area	S 29 of T34-R27	13
Site 3	Private Land	S29 of T34-R27	29
Site 4	Orrock	S29 of T34-R27	7

Treatment Date: August 1990

Costs:			
	Contract vibratory plow	$3900.00	
	DNR Labor/materials	$ 508.00	
	Total costs		$4408.00

Region 5

In 1990 another vibratory plow control demonstration was placed on private land in Olmstead County.

Region 6

The Interagency Oak Wilt Suppression Program became active in 1990. It is a multi-year, state-wide oak wilt control program. It will treat infection centers in a predetermined order by mechanically severing root systems and removing spore producing trees. Initially, this project will focus in Anoka County where almost half of the state's oak wilt problem is located. The long range plan is to include all areas in the state that have oak wilt.

In addition to suppression of existing infection centers by the mechanical disruption of root grafts, the control program would also assist prevention activities by managing various aspects of (1) new development, (2) building construction, (3) external building modifications, and (4) oak wilt inspections. In addition to the funding assistance, technical advice would be available to communities from the Departments of Natural Resources and Agriculture.

The Suppression Program is working with Anoka County and will facilitate work by assisting the county in the purchase of a vibratory plow. Funding assistance to the county will be $75,000 in 1991 from state and federal sources. The plow will be available to communities that have an approved Oak Wilt Suppression Plan. It is expected that four communities plus the county and state will be able to use the plow in 1991.

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Cytospora canker
Leucocytospora kunzei (Sacc.) Z. Urban

ACREAGE: 10

SEVERITY: Minor impact in plantations, but major problem in yard trees

REGIONAL NOTES

Region 1

This disease was causing tree death and branch mortality to a windbreak in Ottertail County. Sanitation was recommended as the only control measure.

Region 3

A single European larch plantation established in 1982 and located in the NWNW of Section 16,T.52N, R.22W in Aitkin County had topkill of saplings. The damage was due to both Cytospora canker and porcupine chewing. The cankers girdled the stem at the node. Unknown borers had infested the branch nodes for some years, causing tissue deformation. These were ultimately infected by the canker fungus. Although this fungus is a proven pathogen of European larch, it appeared to be more of an opportunistic or secondary type of infection.

Region 6

Cytospora canker continues to be a problem in the Metropolitan Region. There has been no noticeable increase as a result of the drought.

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ABIOTIC DISEASES

DROUGHT
Dustdri agin

ACREAGE: Not Determined

SEVERITY: Hardwood species, particularly oak and birch, continued to dieback and succumb in all parts of the state. The drought worsened in the northwest and north central counties where the Palmer Drought Index listed these areas as being in mild to extreme drought conditions. The rest of the state received normal levels of precipitation.

TREND: The drought started after the growing season of 1987. In 1988 it was most severe in the southern and central counties of Minnesota. It continued in 1989 but expanded northward and lessened in the south. In 1989, the southern counties began rebuilding soil moisture. In 1990, adequate rains alleviated the impact of the drought in central, northeastern, and southern Minnesota. North-central Minnesota experienced more drought conditions than it had during the previous two years, but the most severe drought occurred in the northwest, particularly from Bemidji north and westward. It is unknown what 1991 holds for moisture. Generally, snow pack has been below normal during the winter of 1990-91. Snow also came late after the ground had frozen. With the frost in the ground, snow melt will run off rather than soak in and help replenish the water tables.

REGIONAL NOTES

Region 1

The drought intensified in the northern part of the Region but abated in the southern part of the Region. An example of the continuing drought in this Region is illustrated by the 5 year precipitation departures from normal in the Blackduck Area.

YEAR	DEPARTURE	CUMULATIVE DEPARTURE
1986	-4.25	- 4.25
1987	-2.61	- 6.86
1988	-1.83	- 8.69
1989	-0.30	- 8.99
1990	-7.09	-16.08

Oak and birch mortality increased throughout the Region, and it is expected to continue to increase until a year after the return of moisture during the growing season.

Region 2

The drought has not been as severe as it has been in other parts of the state, but it has been severe enough to cause considerable tree damage and mortality from 1987 through 1990.

The yearly precipitation totals in Region 2 for the years 1987 through 1990 have not departed much from normal. In 1988 and 1989, parts of Region 2 actually ended the year with above normal yearly precipitation totals. The biggest problem in Region 2 occurred due to the lack of timely rainfall during the growing season for the past 4 years. This stressed trees and allowed the build up of opportunistic pests such as bark beetles and the two-lined chestnut borer.

Drought conditions can occur and stress trees even during years that end with normal or near normal levels of precipitation. For example, from April to July 31, 1987, most of Region 2 was 0-4 inches below normal for that time of year. The rest of Region 2 was 4-6 inches below normal. In 1988, from April 1 to August 1 most of the Region only received 50% to 75% of the normal amount of precipitation, However by September 26 most of the Region had received 100 to 125% of the normal rainfall for the period April 1 to September 26th.

In 1989, part of Region 2 had received only 50% to 75% of the normal precipitation for April 1 to August 28th. Again in 1990 from April through September, much of Region 2 was 0-4 inches below normal and other parts of the Region were 4-8 inches below normal in precipitation for that period.

Shortages of precipitation occurred during the growing season when trees have the highest demand for water. This happened in parts of Region 2 for four years in a row, putting trees under moisture stress each year.

In addition to the lack of growing season moisture, above average growing season temperatures also occurred during 1987 and 1988. Unusually high temperatures started earlier than normal during both springs and extended through the summers. This extended the growing seasons and increased the water requirements of trees.

It may take 4-8 years for a tree to recover from a drought. It takes time for a tree to rebuild its root system, crown, and energy reserves. For rebuilding to occur, rainfall must be timely and reach normal levels during the growing seasons in the years following the drought.

Region 3

The drought ended in the southern parts of the region with good soaking rains in April and May. Adequate rains continued throughout the summer, but fall was once again a time of shortfall. 1990 moisture was essentially used during the growing season, but little if any soil recharge occurred. The northwestern part of the region remained relatively dry during 1990. Conditions there more closely resembled Region 1 conditions.

The return of moisture to the southern parts of the region helped to lower attack by the two-lined chestnut borer and the pine bark beetle, but did not completely eliminate the problem. The abundant moisture in the spring and early summer was not matched by the fall. As a result, trees are still weak and are likely to continue to fall prey to secondary pests. Given the low soil moisture as we enter 1991, a note of caution must be aired. Low moisture in 1991 will likely cause a return of serious tree mortality.

Region 5

There was light mortality in oak, birch, and other species, and active decline in species like sugar maple. The peak in oak mortality due to the 1988 drought occurred in 1989. Losses in the southeastern hardwood forests were light and estimated at less than 1%. Pine mortality from bark beetle was confined to the 1988 season.

The actual drought that took place in southeastern Minnesota was confined to the 1988 season. The resulting oak and pine mortality was lighter than in other regions in the state due to the higher water holding capacity of the finer textured soils and the absence of insect defoliation. The more important long term impact of the drought is now seen in the continuing mortality in oak and birch, and the decline of sugar maple. Decline is occurring as the trees try to strike a new balance with root systems damaged in 1988. Examples were seen in bur oak mortality and in maple decline. An example of maple decline is seen in the town of Chatfield where most of the maple boulevard trees are in advanced stages of decline. At this stage it is also impossible to separate out the influence of soil conditions, deicing salts, wounds, or other abiotic and biotic agents. It is best to wait for the declining trees to complete their dieback and then either prune out the dead wood or replace the trees. This example is multiplied in hundreds of towns, backyards, and woodlots with maple and other declining species across the regions.

Region 6

The drought began to lift in 1990 with abundant spring rains. Summer rains were adequate, but fall rains never arrived. As a result, trees began to recover from the drought in 1990. Since much of 1990 precipitation was used in that year, little soil recharge occurred as 1991 began. While tree vigor has begun to recover, a dry 1991 season could bring a return of serious mortality from drought-induced pests.

Anoka County was the most seriously affected county in the region during the drought. This is largely due to the sandy soil which has a poor water holding capacity. These soils have a poor ability to buffer the affects of a prolonged drought. As a result, tree mortality from two-lined chestnut borer in oak, bronze birch borer in birch, and the pine bark beetle in red pine have been devastating. This trend was dramatically reversed in 1990, a trend we hope will continue.

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WINTER INJURY
Koldern ell

ACREAGE: Not determined

SEVERITY: In southern Minnesota, the most severely damaged species was Arborvitae, where individual branches to entire shrubs or trees were killed. In northern Minnesota in Region 2, 60% of the white spruce in some plantations were affected.

TREND: Periodically, extremes of low temperatures and climatic conditions cause winter injury or mortality to newly planted stock and introduced species. 1990 produced conditions which led to winter injury.

REGIONAL NOTES

Region 2

Numerous reports were received of winter injury on young white spruce plantations. Trees from 1' to 4' tall were most commonly effected with some or all of the needles turning brown. In most cases, the buds were not damaged and developed normally. It is believed the damage likely occurred in December 1989 when very cold sub-zero windy weather occurred with little or no snow on the ground. Most reports came from Lake and St. Louis Counties. Winter injury was also observed on red pine in Itasca and Carlton Counties.

Region 5

In 1990 winter damage to Arborvitae, red and white pines, and balsam fir was reported. Along with the extremely low temperatures of December, the patterns of injury to individual plants was typical of those that result from winter drying.

Region 6

Winter damage was similar to the pattern reported for Region 5. Specifically, 31 plant genera were damaged during the winter of 1989/1990. Damage was as high as 75-100% of individual trees in walnut, oak, and redbud. Damage to individual

trees was as high as 50-75% in pine, fir, maple, and hackberry. Cedar was commonly damaged, but overall damage to individual plants was moderate. A survey of winter damage is available from Bert Swanson, U of M Arboretum, Chanhassen, MN.

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HAIL DAMAGE
Skyiss fallin

ACREAGE: Most severe damage occurred in a 3-square mile area in Sections 16, 17, 18, 19, 20, and 21 T.150N, R.27W, Itasca County.

SEVERITY: 85%+ stripping of leaves and severe scarring of stems, particularly to aspen under the age of 15 years

REGIONAL NOTES

Region 1

A hail and wind storm occurred on the night of August 25, 1990. Both wind and hail damage occurred over a multi-township area in Itasca County, but the most severe damage occurred in a 3-square mile area. The main timber type was aspen, and damage included stripping of the bark and multiple impact cankers on the stem. The hardest hit stands were those under 15 years of age.

There was concern that the severity of the damage to stands in the 4-8 year age class range may have a long term effect on the stand. The high number of impact cankers would lead to poor wood quality, and significant stem dieback would cause poor stem form. Because of these concerns, 35 acres of 4-8 year old sprouts were sheared during the winter of 1990-91. Resprouting should produce clean stems and potentially higher quality trees.

There were a number of stands in the 10-15 year age class that also were significantly damaged. Because the sprouts were larger and therefore more to

lose if sheared, it was decided to not shear these stands. They will be watched, and if significant dieback or mortality occur, plans will then be made to shear these stands.

Region 2

Balsam fir along a 3/4 mile stretch of road in Cook County was damaged from hail. Impact cankers were readily visible on the trees.

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HAZARD TREES
Treesiss breakin

In 1990, hazard tree evaluations were conducted in Forestville state park. The designated tree are being removed by park personnel.

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INCIDENTAL PESTS

PEST	HOST	COUNTY	NOTES
INSECTS			
Strawberry root weevil *Otiorhynchus ovatus*	Conifers	Crow Wing	Fewer than past 2 yrs; Adults, 6/27-8/7
Flatheaded borers	Red pine	Lake	In log cabin
White spotted sawyer *Monochamus scutellatus*	Red pine	Koochiching	Adults from wood piles stripping bark from plantation trees
Red pine sawfly *Neodiprion nanulus nanulus*	Red pine	Itasca	Light defoliation of yard trees
Pine spittlebug *Aphrophora parallela*	Scots pine White pine	Carlton Morrison	Heavy defoliation in plantation in Carlton Co.; nymphs on 6/11 and adults on 6/28 in Morrison Co.
Adelgids and aphids *Pineus strobi* *Cinara strobi*	White pine	Itasca	Christmas trees
Anobiid beetles	White pine	Itasca	In log cabin
White pine cone beetle *Conophthorus coniperda*	White pine	Beltrami	Causing heavy cone drop in Bemidji area
Yellowheaded spruce sawfly *Pikonema alaskensis*	White spruce	St. Louis Clearwater	Moderate defoliation to roadside trees, St. Louis Co.; killing trees in windbreak, Clearwater Co.
Ash plant bug *Trapidosteptes* spp.	Ash	Crow Wing Stearns	Causing yellow mottling and brown leaf edges, 7/23
Eastern ash bark beetle *Hylesinus aculeatus*	Green ash	Kittson	Killing 20% of green ash in campground, Lake Bronson State Park
Linden looper *Erannis tiliaria*	Basswood	Crow Wing	Minor defoliation, 7/14
Birch tubemaker *Acrobasis betulella*	Birch	Itasca	
Birch leaf miner *Fenusa pusilla*	Paper birch	Crow Wing Carlton	Early June and early August
Painted hickory borer *Megacyllene caryae*	Butternut	Kanabec	Formed galls

PEST	HOST	COUNTY	NOTES
Petiole gall aphid *Pemphigus populicaulis*	Cottonwood	Crow Wing	Observed, 7/20
Poplar vagabond aphid *Mordwilkoja vagabunda*	Cottonwood	Crow Wing	Observed during July
Wooly elm aphid *Erisoma americanum*	Elm	Crow Wing	Observed, 6/18
Brownheaded ash sawfly *Tomostethus multicinctus*	Hardwoods	Beltrami	Occurrence but no defoliation, Lake Bemidji State Park
Spiney-elm caterpillar *Nymphalis antiopa*	Hardwoods	Beltrami	Occurrence but no defoliation, City of Bemidji and Lake Bemidji S.P.
Walking sticks *Diapheromera femorata*	Hardwoods	Crow Wing	First week of September
Honeysuckle aphid *Hyadaphis tataricae*	Honeysuckle	Cass Crow Wing	Witches' brooms; spreading for the past 8 years; 7/18
Crimson erineum mite *Eriophyes elongatus*	Maples	Beltrami Becker Crow Wing	Common occurrence in Region 1; noted on June 24 and 27 in Region 3
Eriophid mites	Maple	St. Louis	Yard trees
Maple bladder gall mite *Vasates quadripedes*	Maples	Beltrami Becker Clearwater Crow Wing	Common occurrence in Region 1; noted on June 14 in Region 3
Aphids	Maples	Beltrami	Yard trees: curled leaves and sooty mold
Maple petiole borer *Caulocampus acericaulis*	Maple	Clearwater	Falling leaves noted on June 19
Red maple cambium borer *Phytobia setosa*	Maple	St. Louis	In twigs
Cynipid leaf gall maker *Andricus quercusflocci*	Oak	Region 1 Crow Wing	Very common on bur oak in Region 1
Oak Lecanium scale *Lecanium quercifex*	Bur oak	Lake of the Woods	Causing leaf drop and sooty mold to yard trees in Baudette
Oak sapling borer *Goes tesselatus*	Oak	Crow Wing	
Lace bugs *Corythuca* spp.	Oak Willow	Lake of Woods Crow Wing Pine, Morrison	Leaf yellowing and blackening; July

PEST	HOST	COUNTY	NOTES
Rose chafer beetle *Macrodactylus subspinosus*		Crow Wing	Widespread, but fewer noted than past 3 years; July
DISEASES			
Sirococcus tip blight *Sirococcus conigenus*	Red pine	Cook	
Spruce needle rust *Chrysomyxa* spp.	White spruce	Beltrami St. Louis	Found in St. Louis Co. seed orchard; pustules beginning to show on 6/20
Needlecast *Lophodermium* spp.	Red pine	Carlton Wadena	Seedlings
Willow blight *Fusciladium saliciperdum* *Physalospora miyabeana*	Willow	Crow Wing	
Leaf spot *Phyllosticta sorbi*	Mountain ash	Itasca	
Black knot *Apiosporina morbosa*	Plums Cherries	Crow Wing Cass Pine Morrison	
Fusarium root rot *Fusarium* spp.	Black walnut	General Andrews State Nursery	Grafting stock
ABIOTICS			
Construction damage	Balsam fir	Lake	
Fertilizer injury	White spruce	Beltrami	Chlorotic and etiolated new growth
Herbicide injury	Black spruce	Itasca	3-4 feet dieback on 10 feet saplings



PHENOLOGICAL SUMMARY

DATE	EVENT	LOCATION/COUNTY
April 12	1. Flower buds on some aspen breaking; 2. 106 Degree days (>32°)	1. Swan River/Itasca 2. Bemidji/Beltrami
April 15	Dandelions blooming against a south building wall	Bemidji/Beltrami
April 19	1. First frog chirping; first sight of killdeer 2. Red maple in flower; red pine buds elongating	1. /Beltrami 2. St. Paul
April 20	Aspen buds breaking; still ice on some lakes	Grand Rapids/Itasca
April 23	FTC starting to hatch	Grand Rapids/Itasca
April 24	1. FTC starting to hatch; 2. 333 degree days; 3. Willow leaves beginning to appear; maples are in bloom; aspen catkins are out but no leaves.	1. /Pope, Ottertail, Hubbard 2. /Beltrami 3. Grand Rapids/Itasca
April 25	1. Buds breaking on red-berried elderberry, black cherry, honeylocust, and lilacs 2. FTC major egg hatch	1. Grand Rapids/Itasca 2. Brainerd/Crow Wing
April 26	1. Red pine buds elongating; bud breaking on European larch, apple, and birch; some aspen clones leafing out 2. Early aspen clone foliating	1. /Itasca 2. Brainerd/Crown Wing
April 27	FTC hatching; weather cool and drizzling	Duluth/St. Louis
April 28	1. Mixed rain/snow; snow on cars coming from west 2. Jack pine buds elongating	1. Bagley/Clearwater 2. Brainerd/Crow Wing
April 29	1. 3-5 inches of heavy wet snow on ground; 2. FTC larvae huddled together on egg mass, but alive; 3. Aspen leaves show no cold weather damage	1./Beltrami, Itasca, Ottertail 2. Bemidji/Beltrami 3. Grand Rapids/Itasca
April 30	1. Snow flurries; daytime high, 32°F; 2. Snow again; cold and blustery; 418 Degree days	1. Grand Rapids/Itasca 2. Bemidji/Beltrami
May 1	Snow in morning; overnight temp, 20°F; leaves don't appear to be damaged; FTC appear alive, but no feeding	Grand Rapids/Itasca
May 2	Cherry foliage shows slight frost damage; FTC hatched in April, dead; new hatching beginning; 433 degree days	Bemidji/Beltrami
May 3	FTC accelerating its hatch	Bemidji/Beltrami
May 4	1. Maximum FTC hatching activity; egg masses are covered with new larvae; dandelions in full bloom; 474 degree days 2. Bur oak leaves 1" long	1. Bemidji/Beltrami 2. St. Paul
May 5	Spruce budworm larvae, 2nd instar	Cotton/St. Louis
May 7	1. FTC larvae 1/8th inch long; basswood breaking bud 2. Red oak leaves 1¼" long; most species foliating	1. /Ottertail 2. St. Paul

DATE	EVENT	LOCATION/COUNTY
May 10	1. FTC ¼ inch long; basswood leaves average the size of a quarter; bur oak leaves, ¾ inch long; no ash leaves; marsh marigolds blooming 2. First FTC molt nearly complete 3. 600 degree days 4. FTC mid second instar; basswood leaves 35% expanded	1. /Ottertail 2. /Ottertail, Beltrami 3. Bemidji/Beltrami 4. St. Cloud/Stearns
May 15	1. FTC: 1st and 2nd instars 2. Lilacs in bloom	1. Brookston/St. Louis 2. St. Paul
May 17	1. Trilliums starting to bloom; ferns elongating out of fiddlehead stage 2. FTC in third instar	1. /Cass 2. St. Cloud/Stearns
May 18	1. Weather cold and rainy all week; aspen leaves 1¼ " long; most birch and oak not leafed out 2. Gypsy moth spray #1 3. FTC spray 4. Red pine candles 3" long	1. Grand Rapids/Itasca 2. Minnetonka & Elk River 3. Avon/Stearns 4. St. Paul
May 21	1. FTC, 2nd instar; defoliation visible in tree tops; about 30% of aspen clones not leafed out; birch not leafed out; pin cherry in bloom; 2. FTC, 2nd instar; 3. FTC, ¼ to ½" long; getting color and patterns; individual branches of basswood stripped; basswood foliage ½ size; oak leaves 2" long; lilac blooming; first kingfisher; 4. First bellwort blooming 5. Elm leaf miner maturing	1. Balsam Twn./Itasca 2. Kelly Lake/St. Louis 3. Marion Lake/Ottertail 4. /Becker 5. St. Paul
May 23	1. Aerial Bt spray for FTC 2. 834 Degree Days 3. FTC: late third instar; first Bt application completed	1. Pelican Lake/Ottertail 2. Bemidji/Beltrami 3. Gull Lake/Cass & Crow Wing
May 24	Gypsy moth spray #2	Minnetonka & Elk River
May 25	1. FTC, 1st and 2nd instar; dandelions blooming; aspen leaves 1" long 2. Bigtooth aspen leaves ½" long; red pine buds ¼ to 1" long; 3. Birch and bigtooth aspen have not leafed out 4. Most aspen have not leafed out	1. Cotton/St. Louis 2. Virginia/St. Louis 3. Cook/St. Louis 4. Gheen/St. Louis
May 27	1. FTC, 3rd instar 2. Aerial Bt spray for FTC 3. 952 Degree Days 4. Elm seed ripening	1. Grand Rapids/Itasca 2. Marion Lake/Ottertail 3. Bemidji/Beltrami 4. St. Paul
May 28	1. FTC larvae range up to ¾" long; Color and spots clearly visible; larvae still in clumps; 2. Basswood and maple leaves fully developed; chokecherries in full bloom	1. Bemidji/Beltrami 2. Marion Lake/Ottertail
May 29	1. FTC larvae vary from 2nd to 4th Instar; defoliation visible 2. FTC in fourth instar; second Bt spray for FTC	1. Grand Rapids/Itasca 2. Gull Lake/Cass

DATE	EVENT	LOCATION/COUNTY
May 31	1. FTC, 1st and 2nd instar 2. FTC, 3rd and 4th instar 3. Red-berry elder in full bloom 4. Dead FTC larvae from May 23rd Bt spray	1. Duluth/St. Louis 2. Calumet/St. Louis 3. Nashwauk/Itasca 4. Pelican Lake/Ottertail
June 2	Cotton grass and Caragana blooming	Grand Rapids/Itasca
June 4	Hard freeze overnight; Trillium in bloom	Grand Rapids/Itasca
June 6	Dead and "sick" FTC from May 27 Bt spray; estimate of 80-90% kill	Marion Lake/Ottertail
June 7	1. Red pine pollen shed; Maianthemum in bloom 2. FTC, 3rd to 4th instar; Mertensia, yellow trout lily, and yellow rocket blooming 3. FTC larvae range up to 2½"	1. Grand Rapids/Itasca 2. Cloquet/Carlton 3. /Ottertail
June 10	Lillies of the Valley in bloom	Grand Rapids/Itasca
June 11	Pine spittlebug nymphs	/Crow Wing
June 14	1. FTC starting to form cocoons 2. FTC mostly cocooned; few larvae still present; malathion spray of FTC 3. Maple bladder gall mite; linden looper 4. 1514 Degree Days	1. Grand Rapids/Itasca 2. Little McDonald Lake/ Ottertail 3. /Crow Wing 4. Bemidji/Beltrami
June 17	FTC moths observed	/Ottertail
June 18	Wooly elm aphid	/Crow Wing
June 19	Maple petiole borer damage evident	/Clearwater
June 20	1. FTC cocoons starting to appear on sides of buildings 2. Pustules of spruce needle rust evident	1. /Becker 2. /St. Louis
June 21	1. FTC, 50% pupated 2. Yellowheaded spruce sawfly and spiney elm caterpillar larvae actively feeding; 3. 1739 Degree Days	1. Calumet/Itasca 2. /Beltrami 3. Bemidji/Beltrami
June 26	1. FTC 80% pupated 2. FTC mostly cocooned; few larvae still present	1. Brookston/St. Louis 2. /Ottertail
June 27	1. Yellowheaded spruce sawfly causing heavy defoliation to windbreak 2. Adult strawberry root weevil, first report	1. /Clearwater 2. /Crow Wing
June 28	Pine spittlebug adults	/Crow Wing
June 30	1. FTC, 80% pupated; aspen refoliating; most spruce budworm in pupal stage; still a few larvae present and a few moths emerged; black-eyed susan, anemone, vinca, rose, and tansy in bloom 2. Peonies and lupine in bloom	1. Echo Trail/St. Louis 2. Ely/St. Louis

DATE	EVENT	LOCATION/COUNTY
July 2	1. Spruce budworm, late instar larvae present 2. Pine tussock moth, beginning to catch moths	1. Grand Marais/Cook 2. Region 3
July 3	1. Pine tussock moth, 50% pupated; jack pine sawfly, larvae feeding 2. Redheaded pine sawfly larvae active on red pine	1. Region 3 2. /Aitkin
July 5	1. Jack pine sawfly, larvae feeding 2. Redheaded pine sawfly, few larvae present, most pupated on jack pine 3. Rose chafer beetle 4. Bark beetles, 2nd generation attacking slash 5. Spruce budworm, no pupae present; still in last and next to last instar	1. Willow River/Pine 2. /Aitkin 3. /Crow Wing 4. /Lake of the Woods 5. Grand Marais/Cook
July 9	Oak wilt damage becoming visual	St. Paul
July 14	1. FTC, moths and egg masses present; 2. 2612 Degree Days	1. Heilberger Lake/Ottertail 2. Bemidji/Beltrami
July 16	Eastern ash bark beetle, both adults and pupae present	Lake Bronson/Kittson
July 17	Oak lecanium scale with sooty mold on bur oak causing leaf drop	/Lake of the Woods
July 18	Honeysuckle aphid	/Cass, Crow Wing
July 20	Petiole gall aphid	/Crow Wing
July 23	Ash plant bug	/Crow Wing, Stearns
July 24	Crimson erineum mite, first report	/Crow Wing
August 2	Two-lined chestnut borer, <5% of infested oak showing symptoms	Region 3
August 9	1. TLCB, many more oaks starting to show symptoms 2. Redheaded pine sawfly, larvae are 25mm long feeding on jack pine; larvae near cocooning length	1. Region 3 2. /Crow Wing
Aug 13	Spruce needle rust, pustules evident on blue spruce	Grygla/Beltrami
Aug 31	White pine cone beetle; WP cones dropping	Bemidji/Beltrami
Oct 8	Blue spruce fall shed	St. Paul



SPECIAL PROJECTS

WHITE SPRUCE SEED ORCHARD CONE PEST STUDIES

Insect, disease and other damage to white spruce cones were monitored and evaluated at the white spruce seed orchard near Cotton, MN. A poor cone crop yielded only five bushels of cones in 1990. This follows two large cone crops of 153 bushels in 1988 and 122 bushels in 1989. Cones were not picked for seed extraction and the seed orchard was not clean picked for insect control in 1990.

A. Cone Rust Incidence

One thousand cones were inspected for rust incidence in the seed orchard on July 1, 1990. Fifty cones were examined on 20 trees representing 13 different clones. Cones were rated as infected or not infected. The number of infection pustules per cone was also determined.

Total Rust Incidence	14.4%
Pucciniastrum americanum (Farl.)	13.9%
Chrysomyxa pirolata (Wint)	0.5%

Cones infected by *P. americanum* had an average of 1.13 infections or pustules per cone.

Cones on ten trees of clone 7237 were also inspected for rust infection. No rust infected cones were found, however, this clone produced a low number of cones in 1990. From observations over ten years, this clone appears to be resistant to both rust infections. We recommend that this clone be saved when the orchard is rouged in the next few years.

B. Cone Insect Incidence

On August 6, 1990, four hundred cones were harvested, cut in half on a cone cutter and inspected to assess the incidence of insect attack. Twenty cones from 20 trees representing ten different clones were examined.

Insect Pests	Incidence[1]
Total Insect Incidence	87.3%
Choristoneura fumiferana (Clemens)	8.5
Coneworms	32.0[2]
Cydia youngana (Kearfote)	28.8
Dasineura rachiphaga (Tripp)	19.8
Hylemya anthracina (Czerny)	50.0
Other Insects	9.0

[1] Percentages are not additive since some cones were attacked by more than one species of insect.

[2] Coneworms - Less than 0.1% of the cones were damaged by what appears to be *Dioryctria abietivorella* (Grate). The remainder of the coneworm damage was done by what may be a species of *Holcocera*.

C. Overall cone rating

When cones were dissected and examined, the cones were also rated as "good" or "no good". To be rated as "good", more than 50% of the seed must appear sound. Overall 3.2% of the cones were rated as good.

Cones were rated as "no good" due to attack by insects, rust fungi, or lack of sound seed. It is believed, but not proven, that the presence of empty seed coats is often due to a lack of pollination. The incidence of empty seed coats increases as the size of the cone crop decreases. In 1990, few cones contained any sound looking seed.

D. Fungicide and Insecticide Trials

No pesticide trials were conducted in the seed orchard in 1990 because of the small size of the cone crop.

E. Datapod

A weather recording datapod was placed in the seed orchard at 1:15 PM on May 4, 1990. A computer printout of the weather data will be generated by USDA-Forest Service S & PF. It is hoped that we will eventually be able to relate rust incidence to weather during the infection period in the spring.

F. Phenological Studies - Cotton, St. Louis County

5/04 Maples in bloom, very few aspen buds breaking, about 10% of the forest tent caterpillar eggmasses have hatched. No activity in spruce buds.

5/23 Male conelets are shedding their pollen, female conelets are almost all upright with open bracts.

5/25 Vegetative buds starting to expand. All have bud caps attached yet. Some have expanded up to ¾", but some are still tight and not swelling. Female conelets are still upright and open. Male conelets are shedding pollen. Raspberry leaves are 2" long and still expanding. Dandelions are in bloom, maple leaves are 1" long and trembling aspen leaves are 1" long.

5/31 Female conelets are closed and starting to turn down. Vegetative shoots are 1"-2" long.

7/01 *Pyrola* is just starting to bloom. Raspberries are still in bloom, but almost done.

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BARK BEETLE PHEROMONE TRAP CONTROL STUDY

The field work for the pheromone study was completed in 1990. The final evaluation photos were flown March 15, but results will not be available until fall 1991.

The study proceeded according to plan. All 10 study plots were trapped with standard Ipsdienol lures. See previous Annual report for full study description.

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OAK MORTALITY SURVEY

An extended drought began in Minnesota in 1987. In some portions of the state, drought conditions persisted into 1990. The drought resulted in oak mortality beginning noticeably in mid-summer of 1988 and continuing through the present time. In some cases, oak mortality was a direct result of the drought. However, the two-lined chestnut borer, defoliation by the forest tent caterpillar, and Armillaria root rot in combination with drought stress were the major factors in oak mortality. Armillaria root rot will likely continue to cause mortality in most drought stressed stands.

A survey was conducted to estimate the oak resource losses statewide. The survey was a cooperative effort involving the DNR-Division of Forestry, the North Central Forest Experiment Station Forest Inventory and Analysis Work Unit, and the Forest Pest Management Unit of State and Private Forestry (USFS).

The objective of the survey was to assess the impact of drought on oak forests in Minnesota as measured by the number and volume of dead oak trees per acre, the number and volume of oak trees with crown dieback, and the acres of oak with dieback and mortality due to the drought and associated secondary organisms. Because the drought is continuing in portions of the state, this survey was considered to be a picture in time of losses rather than a cumulative total.

The survey consisted of two parts. The first part used dieback and mortality data collected on FIA inventory plots. U.S. Forest Service inventory crews were trained by DNR Pest Specialist to collect oak dieback and mortality data while measuring FIA plots. DNR Pest Specialists also revisited FIA plots that were typed as oak and had been measured prior to the start of the oak mortality survey. This was necessary since there were counties where the FIA inventory was completed, but were being impacted by oak dieback. To include these counties in this survey would help to gain a broader and more accurate picture of oak mortality.

The inventory crews were directed to add to their data collection the following:

1. If the oak tree was dead, did it die during the period of 1988 to the present? Yes or No.

2. Does the oak tree have ≥50% crown dieback which occurred during the period of 1988 to the present? Yes or No.

When DNR Pest Specialists revisited completed FIA plots, they evaluated all of the oaks on the plots and asked the same two questions. Both the inventory crews

and the Pest Specialists confined their survey to the period of leaf-on to fall coloration.

Because of the few numbers of oak plots visited by both FIA crews and DNR Pest Specialists, a second survey involving interpretation of 35mm color infrared aerial photographs was undertaken. Aerial photos were taken in early September in Cass, Crow Wing, Douglas, Stearns, and Kanabec Counties. Four flight lines were used in each county to sample the county. Interpretation will involve determining oak mortality and dieback in randomly selected stands along each flight line.

RESULTS

Data is being analyzed, and results are not yet available. However, preliminary summaries from FIA plots revisited by DNR Pest Specialists are as follows:

COUNTY	TOTAL # PLOTS	≥50% DIEBACK #PLOTS/TREES	MORTALITY #PLOTS/TREES
AITKIN	5	2/3	2/3
BECKER	4	1/1	0
BELTRAMI	2	0	1/1
CASS	5	2/3	2/3
CROW WING	1	0	0
GOODHUE	2	1/1	1/1
HUBBARD	4	3/6	2/4
ITASCA	3	0	2/4
WABASHA	3	0	0
WADENA	3	1/1	0
WINONA	3	0	0
TOTALS	**39**	**10/15**	**11/17**

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FIA: DAMAGE CODE STANDARDIZATION

In 1987 a project was started to standardize the death and damage codes, and the methodology for using the codes in the permanent plot inventory system called "Forest Inventory and Assessment" or FIA. Eleven mid-western states were involved in this project, and the ultimate result should allow this 11-state area to better assess insect and disease impacts on a region-wide basis.

A preliminary report was made in the 1988-89 Forest Insect and Disease Report. At the time of that report, the cooperating states had received the list of standard reporting categories that all states would report, and a methodology for all states' inventory crews to use when collecting death and damage information.

On December 27, 1990, the final package of materials was sent to all states and the U.S. Forest Service. This package included:

- ✔ Training Slide Set. This included 30+ lettered introductory slides representing all of the Standard Reporting Death and Damage Categories, and over 300 slides illustrating the key factors for field coding.
- ✔ A numerical listing and a description of each slide.
- ✔ A training outline for the states to use in developing their own training program for inventory crews.
- ✔ A tatum guide with the standardized codes and categories.
- ✔ A transcribed introduction to Minnesota's crew training sessions which gives an overview of the new standardized system.
- ✔ A master list showing all of the death and damage codes being used by all 11 states.

This project is now completed.

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PUBLICATIONS

Bt Microbial Insecticide

Bt is the common abbreviation for *Bacillus thuringiensis* subsp. *kurstaki*. It is a common, naturally occurring soil bacteria found in most regions of the world. A German scientist named Berliner first isolated Bt in 1915. Bt was produced and sold as an insecticide as early as 1960. It is registered and sold for use as an insecticide in over 50 countries for use against *Lepidoptera* caterpillars. Another bacteria, *Bacillus thuringiensis* subsp. *israelensis*, is registered for and widely used against mosquitoes.

Mode of Action

Bt is very selective. It is active against only one group of insects, the caterpillar stages of *Lepidoptera* which includes the moth and butterflies.

To work, Bt must be eaten by a caterpillar. Unlike many chemical insecticides Bt cannot be absorbed through the skin and kill a caterpillar. Bt is more effective when eaten by a small young caterpillar than when eaten by a large, older caterpillar. Bt can remain viable on foliage for 4 to 10 days. Timing of the application and good coverage of the foliage are essential.

The insecticidal agents of Bt consists of spores and crystals. When eaten the crystal dissolves and paralyzes the insect gut causing the caterpillar to stop feeding, and may cause death during the next few days. The insect gut lining begins to break apart and may permit spore germination and growth of the bacterial spores in the body cavity. This causes a general infection which leads to death.

Insecticide Use*

Bt is registered for use against hundreds of insects on a world-wide basis to protect crops, forests, and shrubs. In Minnesota, Bt can be used for caterpillar control on forest and shade trees to control about two dozen insects. Major insects affected include tent caterpillars, gypsy moth, jack pine and spruce budworm. In addition, bagworm, spanworm, red humped caterpillar, cankerworms, and saddled prominent can be controlled with Bt. It does not control sawflies, bees, grubs, maggots, or any adult insects.

Unlike chemical insecticides the active ingredients in a Bt formulation are measured in BIU's (Billion International Units) it is measured in this way because it is a living organism and its potency varies from strain to strain. Application rates vary for different Bt formulations and the target caterpillar, but are normally between 4 and 12 BIU's per acre. In some spray programs, a single application of 12 BIU has been as effective as 2 applications of 8 BIU's. Most formulations also list recommended application rates in ounces or pounds per acre.

Historically the most commonly used formulations have been oil formulated emulsifiable concentrates. Depending on the product being used and the pest involved these formulations may be mixed with oil or water. For some pests they may be applied undiluted as an ultra low volume application (ULV).

Water-based flowable formulations of Bt have recently gained wide acceptance in forest spray programs . These are mixed with water or applied undiluted with ULV equipment.

ULV applications are more efficient since the aircraft spends more time spraying the product and less time spraying water. Stickers such as Plyac or Bond are sometimes added to the Bt formulations to help them adhere to the foliage.

Registered Formulations*

Bt is produced by a small number of companies, but Bt is packaged and sold through a much larger number of firms. There are over 60 formulations of Bt registered for use in Minnesota. A brief summary follows. In addition to forest and shade tree registrations for Bt, it is registered for use on a wide variety of food and crop plants including (but not limited to) cotton, corn, soybeans, small grains, fruit (including strawberry, citrus, apples, etc.), lettuce, spinach, squash, onions, and many other crops. It also carries labels for aquatic crops such as rice and wild rice, most greenhouse crops (tomatoes, lettuce, spices, etc.) and stored birdseed, spices, grain, seed, and tobacco.

Trade names for Bt registered in Minnesota include Attack, Dipel, Foray, and Thuricide. Bt is produced by Abbott Laboratories (Chicago, IL), Duphar BV (Holland), Novo Industri (Denmark), Sandoz (Des Plaines, IL), and Ecogen (Langhorne, PA).

Pesticide users are cautioned to read the label on the container before each use. Misuse of a pesticide is a violation of state and federal law and may cause serious damage to the environment. Read and follow label directions carefully.

Safety

In general, Bt is very safe for use. The EPA has found no hazards to human health associated with the use of Bt. It has no known carcinogenic or mutagenic properties at field application rates or in laboratory studies. There are no known poisonings or chronic exposure problems. In concentrated form, it may cause sensitization in hypersensitive individuals following long inhalation exposure or accidental injection. EPA considers Bt sufficiently safe that it has exempted it from food residue tolerances, groundwater restrictions, Endangered Species labeling, Special Review requirements, spray area reentry interval, and protective clothing for applicators.

Bt has no known effect on nontarget organisms in aquatic and terrestrial habitats, including bees, fish, birds and wildlife. It is the pesticide of choice for use near lakes, rivers and dwellings.

Bt does kill the caterpillar stages of most butterfly and moth species. In some instances, killing nontarget caterpillars could be of concern, especially if they are a rare or beneficial species of butterflies.

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*Use of trade names should help the reader. Their use does not imply an endorsement of products by the State of Minnesota or the Department of Natural Resources.

Minnesota Department of Natural Resources
Division of Forestry

February 1990

recycled paper

OAK MORTALITY

GUIDELINES FOR MANAGEMENT

September 20, 1990

Oak mortality caused by a combination of drought stress, defoliation by forest tent caterpillar, girdling by the twolined chestnut borer, and root damage by *Armillaria* root rot is in epidemic proportions throughout Minnesota. Nothing could have been done in forested situations to prevent this mortality. Because of the large amounts of dead and dying oaks, the manager will be asked what should be done to stop the mortality, to prevent additional mortality and to salvage the dead and dying oaks. No research has been done to answer these management questions. However, based on observations in Minnesota and in consultation with scientists actively studying these problems, the following guidelines have been developed to manage oak during the current and post drought cycles.

RECOMMENDED MANAGEMENT PRACTICES

Most oak stands should be left alone during the winter of 1990/91 through the growing season of 1991. There are significant risks under current conditions with any type of activity in oak stands. Salvage cuts to prevent economic loss due to involvement of significant numbers of high quality, high value trees are the only recommended activities in the stands. If the drought and pest damage abate next year, there is still time to salvage and thin during the fall and winter of 1991/92. Consider the following options:

✔ DELAY HARVESTING

Even if mortality and dieback are great enough to make a merchantable sale but the main product is firewood, delay any salvaging until the fall and winter of 1991/92 or later if the drought continues.

✔ ACCEPT LOSS OR DEGRADE

If oak mortality and oak dieback (at least 50% dieback) are not enough to make a merchantable sale, delay any harvesting activities until the winter of 1991/92. Dead and decadent oak with veneer quality logs probably cannot be stored on the stump through the winter without the veneer being degraded. Once the bark becomes loose, veneer buyers will be reluctant to buy it as veneer. Staining should not be a problem but there are problems in kiln drying dead oak which may result in lowering the grade of the lumber. The trade off is to accept a lower quality product to avoid the risk of increasing oak mortality.

✔ SALVAGE DEAD AND DECLINING HIGH VALUE OAK

If the oak mortality and the oak with at least 50% dieback will make a merchantable sale, and the quality is high enough to produce veneer and grade lumber, consider a salvage harvest this winter. Only the dead and dying trees should be included on the sale. Do not cut live trees to "sweeten the pot," and do not use the salvage opportunity to thin or bring the rest of the stand under management.

Oaks should be marked during the leaf on period. It is important to differentiate between dead or dying oaks and oaks that are alive and showing little or no dieback.

Any management operation initiated should only take place during the period when the ground is frozen to minimize damage to the root systems.

If the salvageable material is not great enough to make a sale but the oak quality is high and delaying the sale would result in the loss of a high proportion of veneer and #1 quality logs, a light thinning to increase the volume to make a merchantable sale could be done. **This is the least preferred management alternative and the following must be considered:**

If the stand is opened up and the drought continues, chances are good that additional mortality will occur. Will the stand have enough volume to do a second salvage (or clearcut) if it is further damaged?

The term "light thinning" should rule your actions. Keep stand stocking close to the A or 100% stocking level. This will range from 115 sq. ft. of basal area for an average tree diameter of 10 inches to nearly 130 sq. ft. for average diameter of 15 inches. (See page 29, in Managers Handbook for Oaks in the North Central States.)

In mixed stands, thinning in areas of the stand without oak can be undertaken to increase the value of the thinning to economic levels. Do not remove non-oak species from areas of the stand where oak is present.

✔ OAKS IN YARDS

Remove oaks which are dead and have at least 50% dieback this winter. Twolined chestnut borer will overwinter in trees killed and damaged this year. Complete removal of infested trees and disposal of infested logs and branches should be done by May 1. Infested firewood should be covered with a heavy plastic tarp with the edges buried with soil if the wood is not used by May 1. Keep the pile covered until July 15.

Remove and dispose of declining oaks by July 15 if the trees do not leaf out, the leaves show signs of being sparse and small, or the leaves turn brown in June and early July.

Avoid oak firewood killed in 1990 unless it has been debarked or can be kept covered with a heavy plastic tarp from May 1 to July 1. Bringing more infested wood into an area will only compound the problem.

Control defoliators before 40% of the foliage is lost. Develop spray plans using Bt during the winter of 1990/91 if forest tent caterpillar defoliation is expected.

Water healthy and declining oaks on a regular basis during the growing season. Make sure the trees get at least 1&1/2 inches of water per week. Water so that the entire root system receives this amount of moisture, and water so that the 1&1/2 inches comes all at once. Remember, the absorbing roots are at the dripline and beyond.

RATIONALE

❶ Oak mortality is likely to continue at least as long as drought conditions prevail and up to 5 years after the end of drought conditions.

❷ Oaks with at least 50% crown dieback can be expected to die during 1991.

❸ Oaks with at least 20% crown dieback and infested by the twolined chestnut borer are at high risk to die during 1991 if they do not receive sufficient moisture or they experience 40% or more defoliation. If the trees survive, they will likely produce only low quality lumber and firewood. However, these trees will be beneficial for wildlife.

❹ Oak stands that have been defoliated in 1989 and/or 1990 will experience some level of dieback and mortality if defoliation in 1991 is heavy enough (>40%) to trigger refoliation.

❺ Any management activity opening up the stand may result in higher losses the following year if the drought continues. When the stand is opened up, ground temperatures will be higher and evapotranspiration rates will be increased. If the 1991 growing season is again droughty, the residual oaks that are still alive will be under greater stress and at higher risk of dieback and mortality. Additional mortality may not be preventable around existing pockets of oak mortality.

❻ *Armillaria* root rot will live on and build up on dead stumps and root systems. Oak mortality will increase the amount of *Armillaria* in the stand. Logging will also increase the amount of *Armillaria* in the stand by producing more stumps. Thinning in the healthy parts of the stand may provide an opportunity for *Armillaria* to colonize more root systems of residual trees under drought or defoliation stress.

❼ Oak stump sprouting should not be counted on to regenerate the oak component. There are too many uncertainties concerning root energy reserves, the presence of *Armillaria* root rot, and future soil moisture to rely on stump sprouting.

Forest Tent Caterpillar

The forest tent caterpillar (FTC), *Malacosoma disstria*, is a native defoliator of a wide variety of hardwood trees and shrubs. The FTC's range in North America extends from coast to coast and from the tree line in Canada to the southern states. It feeds primarily on aspen and birch trees in northern Minnesota and on basswood and oaks in central and southern Minnesota. The only hardwood not regularly fed on is red maple. FTC will eat tamarack foliage during outbreaks. It is often mistakenly called the armyworm.

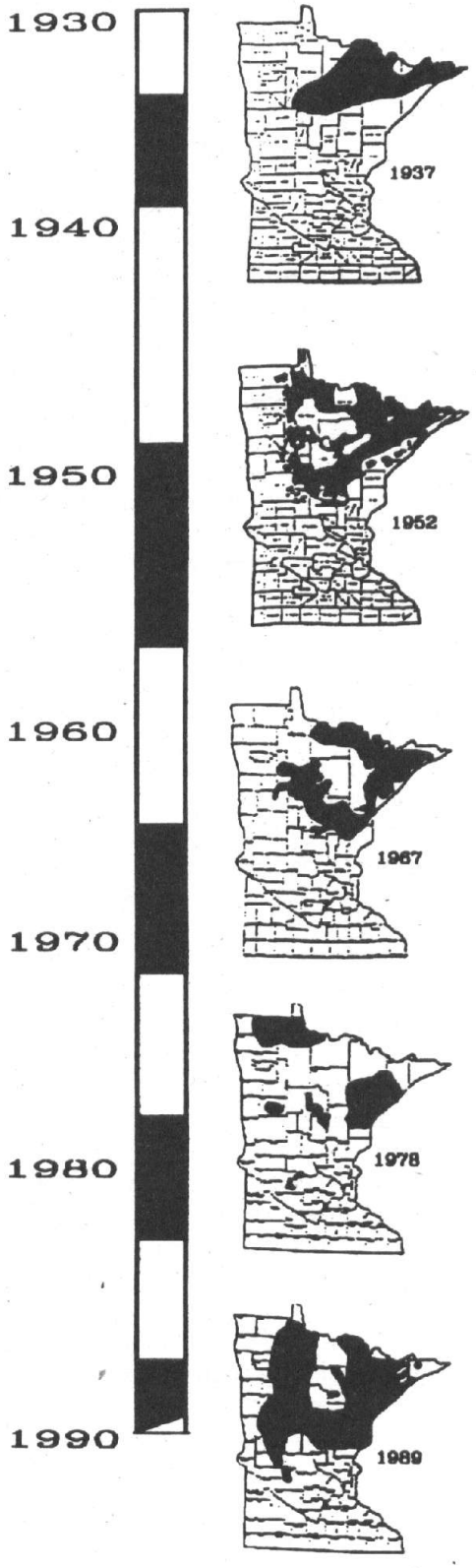
Widespread outbreaks of FTC occur at intervals of 10 to 20 years. Statewide the outbreaks last for 3 to 5 years. Local outbreaks normally last for 2-3 years. Widespread outbreaks existed in Minnesota in 1922, 1937, 1952, 1967, 1978, and 1989. Outbreaks commonly begin over large areas simultaneously. This is primarily the result of weather preceding the outbreak. Population buildups can be triggered by a cool winter followed by a warm spring. Cool springs and warm winters usually accompany population collapse [5].

Outbreaks can begin suddenly or develop slowly over a period of years. Outbreaks normally collapse quickly due to natural causes with defoliation reduced by as much as 80% in a single year. Defoliation occurs in early May in central Minnesota and early June in northern areas. Defoliation will normally be obvious by mid to late May.

Damage

Defoliation from FTC does little damage to tree health. FTC defoliation reduces the vigor of trees, but vigor recovers within a few years of the population collapse. Most trees develop a second set of leaves after attack, but these leaves are smaller and tend to cluster near the branch tips. Clustering is less common the year after attack, but the leaves are still smaller[1]. The second year after the collapse of an outbreak 80% of the trees have normal sized leaves.

FTC defoliation reduces stem growth. As defoliation intensity and duration increase, stem growth decreases. For example a single light defoliation does not reduce growth. However, one heavy defoliation of aspen may reduce stem growth by 50 to 60%. Two years of heavy defoliation reduces growth by 90%. Growth rate recovers quickly, returning to 80% of normal during the first year after the end of the outbreak[1].



Trees rarely die from FTC defoliation alone. A Minnesota study documented the death of 396 aspen trees out of 4877 surveyed two years after the outbreak ended. Identifiable problems other than FTC accounted for the death of all but 4 trees.

FTC defoliation weakens trees and makes them more susceptible to attack from a wide variety of other pests. Defoliation can kill trees in combination with other problems such as drought, late spring frost, or other defoliators. Secondary pests do more damage than the FTC. Weakened aspen die from subsequent attack by Saperda borer, Hypoxylon canker, or Armillaria root rot. Weakened oaks die from two lined chestnut borer attack or Armillaria root rot.

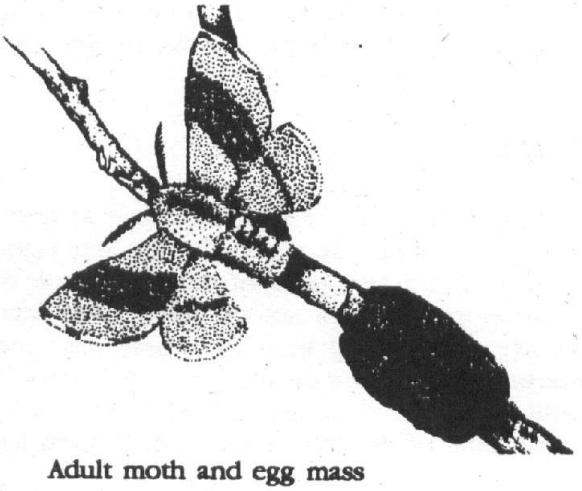
FTC Nuisance

During outbreaks, Forest Tent Caterpillars can number from 1 to 4 million per acre [2]. They create an extreme nuisance to people living or vacationing in forested areas. Young larvae spin threads and fall from the trees onto picnic tables, patios, and people causing serious annoyance. Mature larvae wander widely in search of food and often appear to migrate across roads and open areas. Resting larvae commonly form large clusters of thousands of caterpillars on buildings, tree stems, cars, campers, and other stationary objects. Caterpillars often emit a greenish-black fluid when disturbed which stains paint and cloth. During the height of defoliation, insect frass (excrement) becomes a serious nuisance as it rains down from insects feeding in the tree crown.

Mass flights of tent caterpillar adults are common during outbreaks[3]. These flights can move millions of moths hundreds of miles creating a nuisance where the flight ends. Mass flights can trigger new outbreaks suddenly where the insect had not been a problem before. These flights are often associated with the passage of a cold front.

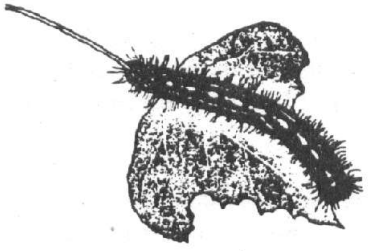
Life Cycle

The Forest Tent Caterpillar overwinters in an egg mass on twigs of host trees. The eggs are extremely hardy and easily survive Minnesota winters. It has been shown that less than 10% of the eggs are killed at -40°F and 50% survive -50°F[4]. Eggs hatch in the early spring about the time of bud break. The larvae have five growth stages each lasting 7 to 10 days. During the early stages, larvae remain in clusters on the leaves. They are blue-black with white spots down the back. Long brown hairs sparsely cover the body.



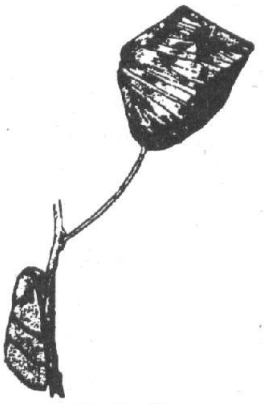
Adult moth and egg mass

Older larvae develop a deep blue velvet coloration with a sparse covering of long brown hairs. A line of white to cream colored spots runs down the back. These spots often look like footprints or a series of keyholes. As the larvae get larger, they consume increasing amounts of leaves and can wander widely in search of more food. They often drop from the leaves to the ground. Large larvae are solitary, but commonly rest in large clusters.



Mature larva

Mature larvae spin silk cocoons with white to yellow threads on vegetation buildings and other stationary objects to begin pupation. This occurs from late May to late June. The pupae form inside the cocoons. Adults emerge 7 to 10 days later. The adult moth is buff colored and has a broad brown band across the front wings. They are night fliers and come to lights in large numbers. As a result of this, it is common to find high populations of adults and larvae near populated areas.



Moth & cocoon

After mating, the female lays 30 to 50 eggs in clusters about 0.5" long around a twig. Each female lays 150 to 200 eggs. A tough casing covers the egg mass and protects the eggs from drying out.

Natural Control

The FTC is a native insect and has evolved in the forest ecosystem for thousands of years. Natural control mechanisms have also evolved which help to keep outbreaks from seriously damaging forested areas. The natural control mechanism that causes population collapse is starvation induced by the caterpillars' feeding itself. During the early stages of an outbreak, the trees have enough foliage to support the increasing number of caterpillars. After a year or two of complete defoliation, the large number of caterpillars need more foliage than is available. Starvation typically kills 75-95% of the caterpillars. Late spring frosts that defoliate the trees have much the same effect. However, frosts hard enough to cause defoliation to different tree species at the same time are not common. Defoliating frosts force the young caterpillars to wait 7-10 days for refoliation. Frost is the only factor that causes a collapse during the first few years of an outbreak.

Another significant natural control occurs near the end of the outbreak cycle. Native flies, *Sarcophaga aldrichi*, kills many FTC pupae in their cocoons. Although the fly often plays a significant role in the collapse of an outbreak, its population often increases to the point that it also becomes a nuisance. Bacterial and virus diseases become important late in the outbreak cycle. This is commonly due to the weakened state of the larvae as low level starvation begins and is enhanced by the constant contact of the larvae with each other. Cool, wet spring weather also plays a role by slowing down the development rate of the insects while making disease transmission easier.

Management

Since FTC has such a wide host range, silvicultural options are severely limited. Forestry practices such as thinning and pruning have no use in FTC management. Silvicultural actions are limited to planting non-host species such as red maple or conifers. In general, management options are limited to the acceptance of the nuisance or insecticide sprays.

Insecticide Treatments

Forest tent caterpillar rarely causes severe damage to trees and, as a result, the forest does not normally need the protection of pesticides. The Department of Natural Resources generally restricts insecticide spraying operations on state land to outbreaks which pose a serious danger to the survival of the forest. The forest tent caterpillar, is a native insect, and a part of a natural and

balanced ecosystem. Natural control systems cause the collapse of populations resulting in cyclical outbreaks. This is confirmed by its cyclical outbreaks which are successfully controlled by natural mechanisms. As a result, the DNR does not spray the tent caterpillar on public lands for nuisance control except in areas of concentrated recreational use.

Private landowners may desire and justify spraying to protect the leaves and preserve aesthetics. In making this decision the landowner should consider his goals, environmental concerns and his ability to pay. The DNR provides technical advice to landowners and landowner groups wanting to undertake control programs. Advice includes evaluation of alternatives, pesticide selection, spray timing, and contracting.

Insecticide treatments can be effective against the FTC. When applied while the caterpillars are small, insecticides can protect the foliage and the aesthetics of an area. It is difficult to achieve satisfactory control with insecticides on areas smaller than 10 acres or where less than 80% of the forested area will be treated. Several insecticides are registered for controlling the Forest Tent Caterpillar. This includes chemicals such as malathion, carbaryl and acephate along with the biological insecticide *Bacillus thuringiensis* var *Kurstaki* (Bt). The DNR recommends the use of Bt because of its environmental safety. Bt is a naturally occurring bacteria effective against caterpillars and is registered as an insecticide by several companies. It has no effect on most insects, birds, people, and other animals.

If you have any questions on or about the management of the forest tent caterpillar, contact your local DNR forester.

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Minnesota Department of Natural Resources
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February 1990

QUESTIONS COMMONLY ASKED ABOUT SPRAYING FOREST TENT CATERPILLARS

What are the reasons to control forest tent caterpillars?

1. To protect valuable ornamental foliage and perennial plants from defoliation. Examples would be fruit trees, small fruit crops and gardens. These plants or areas are often small in size and are suitable for treatment from the ground.

2. To reduce caterpillar populations in order to reduce the nuisance to people. This could include resorts and private campgrounds which might suffer economically during the June activity of the FTC. Also groups of homeowners or lakeshore associations may wish to preserve the aesthetics of their land. Due to the size of the trees and the acreage involved, spraying must be done by helicopter.

3. To prevent defoliation on high value oaks that have suffered drought stress, FTC defoliation and two-lined chestnut borer attack in the past two years. These already weakened trees may die from the additional stress of defoliation and continued drought.

What are some of the proven methods for controlling FTC?

1. Before they hatch (any time from July 1 of one year to early May of the next) hand pick the eggmasses off valuable perennial plants.

2. Hand pick caterpillars off plants and put them in a soapy water solution to kill them.

3. Build a 24" high polyethylene wall enclosing the area. Spray the plastic with vegetable oil to prevent the caterpillars from climbing on the wall. Repeat oil application as needed.

4. Use a product like Tanglefoot on the trunks of shrubs and trees. This prevents caterpillars from adjacent areas climbing up treated trees. However, caterpillars already in the tree are totally unaffected.

5. Spray an insecticide to kill young caterpillars. Products include chemical insecticides, insecticidal soaps and biological insecticides.

Will spraying this year reduce the FTC problem next year?

No, spraying will only affect this year's population of caterpillars. Since the moths are strong fliers, forested areas will be reinvaded during moth flight and eggs will be laid on treated trees for next year.

Can I spray to protect the trees in my backyard?

If you have fruit trees or small, ornamental trees, you can probably spray them from the ground with hand held equipment and be fairly effective. Do not spray fruit trees with chemical insecticides while they are flowering. This could seriously affect beehives in the area. If you have large shade trees, you physically will not be able to reach the foliage spraying from the ground and invasion of hungry caterpillars from adjacent, unsprayed trees will occur. Spraying trees of this size should be done from the air by a helicopter.

Which insecticides can be sprayed? Are some better than others?

Each product has restrictions as to what plants and sites it can be applied to legally. Chemical insecticides, containing malathion, acephate, carbaryl or diazinon, are sprayed directly onto the caterpillars and will kill them on contact. These insecticides can also kill bees and other helpful insects. Insecticidal soaps also work by direct contact to the insect.

Available biological insecticides currently contain Bt, which is a bacterial preparation that kills only caterpillars. Because of the limited toxicity, Bt products are the favored insecticide to use for nuisance control or for use near lakes and homes. Bt insecticides are slower to act since they must be ingested by the caterpillar before they are effective. If eaten by bees or adult moths and butterflies Bt has no effect.

Is Bt completely non-toxic? If it is why would anyone be against its use?

Insecticide products containing Bt are toxic only to butterfly and moth caterpillars. It is not toxic to other groups of insects, fish, mammals or humans. In fact, Bt must be taken internally by caterpillars where it causes a natural disease which kills them.

Some people are against any type of insecticide application regardless of the product used. Bt is toxic to all caterpillars and in some instances killing them would be of concern, especially if any rare species are involved. If your neighbor objects to spraying, take precautions to avoid the problem and liability of spraying their land by mistake.

ORGANIZING TO SPRAY FOREST TENT CATERPILLAR

Winter: Preplanning

1. Organize a neighborhood or town meeting to discuss the spray operation. Ask your local forester, county extension agent, etc... to attend and discuss Forest Tent Catepillar (FTC) biology and control, the use of pesticides and to address landowners' concerns.

2. Obtain permission to spray from each landowner involved. Ideally, permission should be granted in writing. Spraying a landowner's property who has not granted permission is a violation of state law. Many people have concerns about spraying pesticides regardless of the reason or type of pesticide involved. Be aware of your neighbors wishes or their reactions regarding plans to spray and actual spraying activities.

3. To be effective, the spray block should be at least 10 acres in size, and 80% of the forested area in the spray block needs to be treated. Large forested tracts contiguous to the area being protected may require treatment of a border strip along the edge to prevent reinfestation by FTC into the sprayed area. The width of the strip should be at least 100 yards.

4. Secure funding. Possible funding could include assessments of the landowners based on acres or feet of lakeshore to be treated. Similiar spraying in the past has cost between $10 - $40/acre depending on treatment size, location etc.

5. Determine acreage to be treated. Prepare maps or make a mosaic of aerial photos. Sources of photos for determining acreages and making maps include the ASCS office and the local DNR Forestry office. Some spray services have the capability of taking 35mm aerial photos which will provide a current picture of the treatment area.

6. Contact aerial applicators. Provide maps and acreage estimates. Obtain bids for supplying Bt (and sticker, if recommended) or the pesticide of choice and application costs on a per acre basis. Ask for bids for both one (or two) applications with the understanding that the second application is optional at your determination. One application is usually sufficient to protect tree foliage, particularly if the forest composition is made up of only a few different tree species. Two sprays may be necessary to reduce caterpillar nuisance and to protect foliage when forest composition is diverse. A list of aerial applicators can be obtained through the Mn Association of Aerial Applicators, 2916 South Shore Drive, Prior Lake, MN 55372. Phone (612) 447-1187.

7. Negotiate and develop a contract with the aerial applicator of your choice. Your local DNR Forester can furnish you with a sample contract.

8. Provide the name, address, and phone number for the contact person who will act as project supervisor and liaison between the applicator and the landowner group.

Spring: Prespray

1. Set up a network of caterpillar and foliage watchers throughout the spray area to monitor development. Members of the network should be well distributed to represent all parts of the treatment area. Observers should identify observation trees with numerous egg masses within 8-10 feet of the ground.

2. In April, begin to monitor the egg masses. Egg masses should be inspected every day after the 20th of April. Record date of hatching, and then watch the development of the caterpillars. Treatment timing will be based on caterpillar length and foliage development (see below.)

3. Foliage should also be observed by network members. Oaks will be slower in leaf development than other hardwoods. Be sure that leaf development is based on the slowest tree species present that constitutes a significant component of the forested area to be protected.

4. Set up a system for efficiently and quickly contacting landowners in the treatment area. Remind landowners that the area will be sprayed, and spraying will usually occur during the month of May.

Spring: Spraying

1. Determine the proper time for spraying. Caterpillar lengths and foliage development will vary but generally should be:

Caterpillars: 3/8ths to 1/2 inch in length
Foliage: at least 1/2 sized leaves

During very high populations, the young caterpillars may eat the foliage off as it appears. If this occurs, time the operation on the size of the caterpillars alone. Unfortunately, heavy leaf consumption may lower the success of the spray.

2. Notify the applicator that he has 6 days to spray.

3. Notify the landowners to alert them to the 6-day spray window. Be prepared to notify landowners when the applicator arrives so that all stay informed. This will allow concerned people to leave or stay indoors during the actual spraying.

4. The project supervisor should be on hand to assess weather conditions and to monitor application. The supervisor should have the authority to stop the spray operation if weather conditions change, the contract specifications are not being followed, or if the operator is acting in an unsafe manner.

5. If a second spray is needed, it should be scheduled to occur 7 days after the first.

Minnesota Department of Natural Resources
Division of Forestry

February 1990

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FOREST TENT CATERPILLAR
HOMEOWNER TIP SHEET

Dealing with forest tent caterpillars (FTC) can be very frustrating! During the first three weeks of June, they can be a downright nuisance. They don't cause a health risk to humans, but the presence of hundreds or thousands of caterpillars can be a real headache. Fortunately, the nuisance associated with FTC outbreaks can be reduced by individual homeowners. The effect of FTC defoliation on shade trees, ornamental plantings and gardens is also an important consideration for the homeowner.

Homeowners may want to adopt two basic strategies. First, identify the trees or buildings that you want to protect. Then work to protect the things you selected and ignore the rest (or at least try to). It takes a lot of time and energy to try to protect everything on your property. Second, be persistent. Some treatments may require daily monitoring or retreatment.

NUISANCE

How can I keep them off my house, patio, lawn furniture, etc.?

1. Caterpillars can be brushed off the house with a stiff broom or knocked down by a stream of water. If possible, do this daily. Avoid squashing caterpillars on the house. You can also treat lawn furniture, patios, decks, screens, etc. with either of these two methods. The longer caterpillars sit on painted surfaces, the more difficult it is to wash away any staining that may occur.
2. Spray a labelled insecticide on the concrete foundation of your house. Some products containing either chlorpyrifos (Dursban) or malathion are labelled for home structural application. Chlorpyrifos has a longer residual, but malathion has a good knockdown rate. Don't spray onto paint or stain as the insecticide may damage the finish. Repeat applications as indicated on the product label. Commercial applicators may be able to use more effective insecticides.
3. Dispose of dead caterpillars by burying them or mixing them into the compost pile.
4. Cocoons may be difficult to remove by water pressure. They can be brushed off the house with a stiff broom. Bag, burn, bury or compost the cocoons.

REDUCE DEFOLIATION

While aspen and hardwoods are the preferred hosts, FTC will feed on any broadleaved plant with the exception of red maples. In the forest situation, outbreaks usually collapse before tree damage occurs. FTC can consume 60% of a tree's foliage for 2 to 3 years and the tree will show no ill effect. In the suburban landscape, the situation is a little different. First of all, the trees are much more valuable and secondly, they are apt to be subjected to many other stressing agents (soil compaction, construction damage, other insect and disease pests, lawn herbicides, etc.).

Is Minnesota the only place with FTC problems?

Unfortunately not. FTC outbreaks occur simultaneously over wide areas. People in adjacent counties in Wisconsin and districts in Ontario are also putting up with the caterpillars, frass and defoliation of their hardwoods.

Why don't governmental agencies aerially spray FTC to control defoliation?

FTC is a native defoliator of hardwood trees, especially aspen and basswood. The first outbreak was recorded in Minnesota in the late 1870's and there have been five major outbreaks since 1933. Outbreaks usually last 3-5 years and cause no permanent damage to the trees. The survival of the forest is not threatened and therefore the forest does not need the protection afforded by pesticides. Trees generally refoliate by early July. Therefore it is also extremely difficult to obtain a level of control which will actually reduce populations in future years. Control programs can prolong local outbreaks. Controlling FTC on federal, state and county lands can't be justified biologically or economically.

If people want to control the nuisance caused by FTC on private lands, it is both their option and responsibility. For nuisance control, the DNR does not recommend spraying public lands except in areas of concentrated recreational use (i.e., State Parks).

Minnesota Department of Natural Resources
Division of Forestry

February 1990

How can I tell if my tree(s) are at risk?

1. Birches and oaks are often at risk because they are vulnerable to insect pests, FTC and cambium borers, which will act together to reduce tree vigor causing branch dieback and possibly killing the tree. FTC cause defoliation which reduces tree vigor and makes trees more susceptible to the borers. Cambium borers cause dieback in branches of the upper crown. If your birches or oaks have suffered 2 years of heavy defoliation or have branch dieback, then treatment to prevent FTC defoliation is warranted.
2. Newly planted woody ornamentals and tree saplings are very vulnerable to any type of stress and with the loss of leaves, some may be killed.
3. The production from fruit trees, raspberries, strawberries and other fruit and vegetable crops will be greatly reduced or lost if the plants suffer moderate defoliation.
4. Shade trees and ornamental shrubs are vulnerable if they have been recently damaged by construction, trenching, soil compaction, blacktopping, etc.

What can I do to protect my trees, shrubs and garden from heavy defoliation?

1. Before they hatch (any time from July of one year to early-May of the next) hand pick all the eggmasses off of valuable plants. Destroy or dispose of them.
2. Hand pick caterpillars off plants and dispose of them.
3. If you can determine that there are no eggmasses in a tree or if you have sprayed the tree, you may be able to prevent migrating caterpillars from climbing up the trunk by the use of barriers. Basically, you construct a barrier band around the trunk made of duct tape, tin foil or tar paper and coat it generously with grease (axle grease, vaseline). Never apply grease directly to the tree bark. The band should be in the shade or you run the risk of killing the bark and cambium under the band. Check the band daily to see if more grease is necessary. Remove the band in early July after the caterpillars have formed cocoons.
4. Although recommended by homeowners, this method has not been scientifically proven. To protect an area (garden), build a 24 inch tall enclosure of plastic sheeting and secure its lower edge to make sure that caterpillars can not crawl underneath it. Spray the sheeting with vegetable oil to prevent the caterpillars from climbing the wall. Repeat oil application daily, or more often as needed.
5. Spray an insecticide to kill caterpillars. Each product has restrictions as to which plants and sites it can legally be applied to. If applying to shade and ornamental trees, the label should say it is for use on shade and ornamental trees. Please read and follow label directions.
   a. Biological insecticides containing Bt (<u>Bacillus thuringiensis</u>) are the recommended products to use for FTC control in the backyard because of their safety and the low toxicity to non-target organisms. Bt products are only toxic to caterpillars; they do not kill bees, flies, mosquitos,etc. However, Bt products are slower to act since they must be eaten by caterpillars before they take effect. Apply Bt to the leaves of host plants not to the bark or other non-edible materials. It is most effective on young caterpillars.

b. Chemical insecticides and insecticidal soaps should be sprayed directly onto caterpillars or onto plants they infest. Insecticidal soaps are insecticides made from naturally-derived fatty acids. Commonly used chemical insecticides contain malathion, acephate (Orthene), carbaryl (Sevin) or methoxychlor. These products can also kill bees and other helpful insects, so exercise caution when using them in areas where beneficial insects might concentrate.

c. Commercially available systemic insecticides (Ace-caps) can be injected into tree stems to kill FTC. They must be implanted in the tree early, before caterpillars hatch. Such implants require wounding the tree and they should be avoided unless other control measures are unavailable. It is recommended that they be injected by commercial pesticide applicators.

6. This year's FTC moths will be attracted to lights during early July. Turning out your yard and exterior lights may reduce egg-laying on you trees and thus reduce next year's population.

Can I do anything to help defoliated trees and shrubs?

1. The most important thing you can do for your trees is to keep them well watered. Supply 1 inch per week if you do not receive that much in rainfall.
2. Do not fertilize trees or use a weed and feed product on your lawn during an outbreak. Heavy nitrogen fertilization encourages the tree to produce more leaves which may deplete energy reserves and put additional stress on the tree. Have your soil tested to determine if fertilization is necessary.
3. Stressed trees are easily attacked by other serious insect or disease pests (two-lined chestnut borer, bronze birch borer, Armillaria root rot). You may need to protect trees from these additional pests in order to maintain their vigor.

Are there any long-term solutions?

FTC have cyclic outbreaks with about 10 years between population peaks. One long-term solution to defoliation and nuisance is to maintain tree vigor. Maintain tree vigor between outbreaks by watering, fertilizing, properly pruning trees and by avoiding root and trunk damage. Another method is to plant trees that are not preferred food hosts. If most of the trees in an area are not hosts for FTC, then fewer caterpillars will be found there. Foliage of red maples and most conifer species is not eaten by FTC.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES - DIVISION OF FORESTRY

April, 1990

Brand names are not meant to be an endorsement of a particular commercial product.

Pine Bark Beetle Newsletter

Number 4 February 1990

Historical Background

As we prepare to enter the 1990 bark beetle season, it would be good to quickly review the past few years. As you remember, 1986 was a year with abundant moisture, in fact, too much in some places. 1987 gave us the beginnings of our current drought, which by August (1987) was serious enough to have triggered bark beetle problems in several counties (Pine and Sherburne). Problems were largely concentrated in small trees with small root systems, over dense plantations, and locations where fresh slash had helped beetle numbers increase. The winter of 1987-88 brought little snowfall and then spring of 1988 arrived.

May and June of 1988 were hot and dry. Very hot and very dry in most of Minnesota. The bark beetles began early and had completed their first life cycle by Memorial Day. That was the first of what was to be four generations in the central part of the state, three in the north. The beetle continued to develop unimpeded through June because red pine trees were unable to make the pitch needed for defense. July and August beetles became very aggressive and killed red pine at will. Losses from Anoka, Sherburne, Benton, and Stearns Counties averaged 12%, but some areas had 20-25% mortality. One 40 acre stand near Royalton (20 miles north of St. Cloud) was completely killed in 6 weeks.

Normally, the beetles begin their annual dormant period about Labor Day, but about 30-40% of the beetles in central Minnesota went on for a fourth generation. Cold fall temperatures in 1988 killed much of that fourth generation, but the attacked trees died anyway, turning brown from November through February.

The 1989 beetle season started with severely weakened trees and poor soil moisture. Moisture was deficient all year and the beetles could have done great damage had it not been for the weather. The spring of 1989 was quite cool in many areas, in fact, hardwood trees in some areas (western Hennipen County) had their buds and early leaves damaged by a severe freeze in May. The bark beetles, which had completed their first generation before Memorial Day in 1988, had development slowed by the cold spring and did not emerge until the first or second week of June in 1989. It is also likely that some of the larvae of that first generation were killed by the cold temperatures.

In This Issue:

The summer of 1989 did not go well for the beetles. While rainfall continued deficient, the temperatures remained reasonable. Trees had some moisture to produce pitch and evaporation from the needles stayed within reasonable limits. The result was that the beetles had only two generations in 1989, neither of

which went unchallenged by the weather and the trees.

Beetle Wars: 1990

Where does that leave us for 1990? Whereas the trees were showing some nice signs of recovery in the late summer of 1989, the fall rains never arrived in many areas. Fall rains are very important to trees in that they recharge the soil before the ground freezes in the fall. Unfortunately, much of water from the snowmelt runs off during the spring melt. Spring and early summer rains often come too late to help the tree in April and May.

There is no question that there are a lot of bark beetles in most Minnesota pine stands. The main question now becomes how much moisture will we get in March, April, and May and will the spring bring above normal temperatures. Your guess on the weather is as good as mine, maybe better, but if the spring turns out to be warm (or hot) and dry, you can expect the bark beetle problem to quickly return to 1988 levels. Cool and wet would be ideal for our pine trees.

We can summarize the past few years as follows.

1986 - Healthy trees, lots of water, flooding in some areas, beetle populations low, but increasing in areas with slash or flooded red pine.

1987 - Healthy trees, good soil moisture early, degrading to poor soil moisture in upper soil by August, beetle populations low to moderate, but increasing.

1988 - Moderately healthy trees early, tree health rapidly degrading as drought sets in, beetle populations explode in highly stressed trees.

1989 - Highly stressed trees, general lack of soil moisture at any depth, cool spring, beetle populations remained high, but only had 2 generations dramatically reducing damage.

1990 - Trees highly stressed, some dying during winter from general lack of soil moisture. General weather trend: above average temperatures and below normal moisture.

Prediction? Well Yogi Berra always said, "It ain't over 'til it's over." Well, if the drought has ended, I've missed it. Something better happen soon or our pines are in serious trouble!!!!

Common Questions (And Answers!)

Over the past year, I have had many questions from concerned landowners that have the bark beetles or who are worried that they might get them. I have collected some of the more common ones for answering here.

Question. I have heard that the beetles overwinter in the litter. Would raking up this material be effective?

Answer. No. It might provided that all the litter and organic material on the site were collected, but it would have to be complete and include adjacent areas like neighbors yards. Beetles in grass, sod, and around bushes would likely be missed, keeping the action from being very effective. Litter could be stored in large plastic bags until mid-June and then redistributed over the site or composed under plastic. Either of these two treatments should kill most of the beetles.

Question. Can I thin my stand to control the problem?

Answer. At the moment, no, because during outbreaks, we suggest that stands under attack NOT be thinned until after the outbreak has collapsed. One of the best management actions to PREVENT beetle attack is to keep stands thinned. This prevents beetles from building up damaging populations.

Question. When can I thin my stands?

Answer. There is no totally safe time to thin stands DURING an outbreak and it should be avoided until after the drought. If you must thin during an outbreak, we suggest you follow the guidelines on page 8.

Under normal conditions, we recommend that stands be thinned in the fall and early winter. In the north (see map), stands should be thinned between September 1 and March 1. In the south, they should be thinned between September 1 and February 1. This permits the resins and karimones to evaporate over the winter and render the slash relatively unattractive to the beetles. Unfortunately, the moisture content of this material remains acceptable to the beetles, so slash created even in this period can be attacked during outbreaks since the beetles are already in the area.

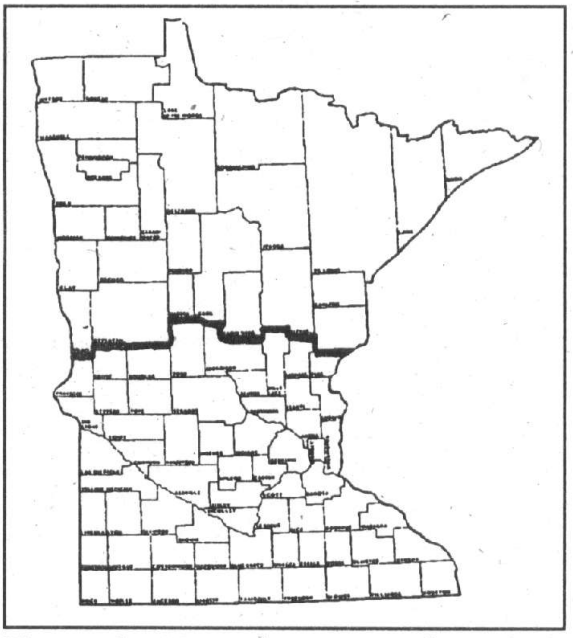


Figure 1 Hazard zones for slash production.

Question. I need to thin my stand. Can I cut a few trees as a sacrifice to the beetles and then destroy them after they draw the attack?

Answer. Yes, this technique is called Trap Tree Control and can be quite effective. Great CAUTION must go with the application of this action since failure to dispose of the trap trees correctly or promptly can actually increase the problem. In general, trap trees should be felled about April 15 and destroyed about May 21. Trees should be destroyed by burning, burying, or debarking. Trap trees should not be used for firewood UNLESS THE BARK IS REMOVED AND DESTROYED or the logs treated to destroy the beetle's habitat. See page 6 for more help.

Question. Can I prune my trees this summer?

Answer. No. Pruning should be avoided DURING A BEETLE OUTBREAK since the resins produced at the pruning wound may attract any bark beetles in the area. This attraction of beetles to wounded trees should present little problem during low populations, but can trigger a fatal attack during outbreaks.

Pruning improves the value of the tree and the visibility in the stand, but does not help manage bark beetles. Even when the beetles are not epidemic, pruning should follow the same timetable as thinning. Pruning can be done at anytime other time of the year provided that the green branches >2" are destroyed within 3 weeks of being cut.

Question. I have some trees that were killed last year. Should I cut these down?

Answer. Since beetles only breed ONCE in a tree and overwinter on the ground, removing dead trees does not contribute to beetle management. Dead trees should be removed to improve aesthetics, lower fire hazard, and increase safety. Remember that a live tree will bend in the wind, but a dead, dry tree is likely to break. It is safe to cut up dead material for firewood, since the beetles will not utilize this material a second time. Be careful bringing this material into the home in the fall since many other insects will likely crawl under the loose bark for winter protection. These insects will become active once inside a warm house and can quickly become a nuisance.

Question. Can I prevent beetle attack by watering my trees?

Answer. The drought has been a major factor in the current buildup of beetles. Watering the trees was very effective during 1988 and will continue to be effective in areas where precipitation has remained low. Trees defend themselves against attack with pitch which is 90% water. The other 10% is also very important since it contains the toxic chemicals that kill both the beetles and the blue-stain fungus.

The tree must be in good health to make these materials so watering is only part of the story. Most of the red pine in central and southern Minnesota are highly stressed and will have a poor pitch flow even if they have plenty of water. As a result, the outbreak is likely to continue until the trees recover their vigor, not just their water supply. This may take several years.

Perhaps the biggest danger we face at this time is a continuation of the drought. Under this rather unpleasant scenario, large areas of red pine, currently under severe stress, could be killed by beetle infestation.

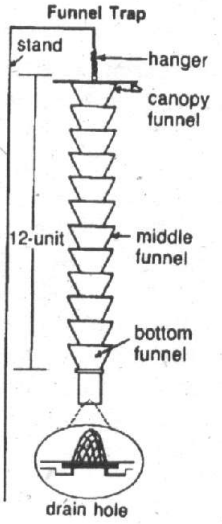
Question. Can I fertilize my tree back to health?

Answer. NO! Fertilizer is just one of the elements that a tree needs to be healthy. The current beetle epidemic was NOT triggered by a shortage of chemical elements in the soil, but by a severe shortage of water. Fertilizing may actually make the problem worse since fertilizers are salts. In this situation, adding even a small amount of fertilizer to the soil will DECREASE the amount of available soil moisture. Even if watered, rapid growth of the tree, triggered by fertilization might use energy reserves that might be better used for defense. In general, fertilize to MAINTAIN health, not to recover it.

Question. I have heard about pheromones and their use in traps. What is a pheromone and how could it be useful in beetle management?

Answer. A pheromone is a chemical given off by the male bark beetle that attracts females and other males. It is produced when the male bores into the bark of a pine and consumes some of the resin in the bark. This is modified into an alcohol-like material that evaporates from the tree. Pheromones have been known from bark beetles for about 20 years, but recently we have found ways of producing these materials artificially. When used with a trap which can capture and kill the beetles, they have been used to survey beetle populations.

The Lindgren Funnel trap was developed by Dr. Staffan Lindgren at Simon Fraser University in Vancouver, British Columbia. Originally developed for the control of the sapwood-boring ambrosia beetles which attack logs on the west coast, the trap is now sold for the survey or control of about a dozen beetle species. The trap carries a US Patent (#4,471,563) and is only available from a single supplier. It is used in conjunction with a pheromone lure and holder designed specifically for the trap. The lure, *Ipsdienol,* is specific to the pine bark beetle.



Lindgren Funnel Trap

Recently, field experiments have lead us to believe that placing pheromone baited traps in the forest in large numbers may catch and kill enough beetles to provide some protection to the stand. These traps were used in South Dakota and Minnesota in 1988 with promising results. Trapping densities were high in these areas (4 to 9 per acre) and the establishment costs expensive ($200+/acre), but beetle mortality was reduced significantly. The results of the trapping program in 1988 were very encouraging and large scale field trials using pheromone traps were begun in 1989. Unfortunately, the final results will not be available until 1991.

Question. How do the traps work?

The trap uses no pesticides to kill the beetles. Insects are attracted to the trap by the lure and the physical appearance of the trap. They fly to the trap, attempt to land, fall into the funnels, and are collected in a jar at the bottom. Beetles die from dehydration, starvation, or being consumed by predators. The cup at the bottom is designed to keep the beetles from escaping once they have been captured.

Question. Can a private landowner purchase pheromone traps?

Answer. Yes. Pheromone trapping is a very new technology which shows tremendous promise. At the present time, the traps are a commercial

product still in an experimental stage. Although we are undertaking full scale, operational field trials, the traps are not available through the over-the-counter retail markets. We have discussed this matter fully with the company and are able to tell you that they will sell traps and lures to the general public in Minnesota.

Traps will be shipped by Phero Tech directly to the landowner. (For those who purchased traps in 1989, please note that this procedure is different.) Traps will cost about $45 each, but I suggest you call Phero Tech for a firm quote before sending them an order. This price should include the trap, two lures, and a special holder for the lure as well as transportation and service fees. We currently suggest 4-6 traps per acre to be placed in the field by April 15. This requires that the traps be ordered by March 7 to ensure delivery before April 15.

Question. The traps are quite expensive. Are they economical and who guarantees that they will work to control the outbreak?

Answer. Yes the traps are expensive. Trapping densities of 5 per acre require an initial investment of $200 per acre. Since the relative economics of their use depends on the landowners objectives and his perception of the value of his trees, there is no easy answer. The DNR currently uses about 1500 traps on state lands and on selected private lands in conjunction with our evaluation. We believe that this technology may play a significant role in the management of pine plantations.

Unfortunately, there are no guarantees that the use of traps will control the outbreak, either from Phero Tech or the DNR. Scientific research has shown that the traps catch beetles, but the research on the control application of traps does not yet exist. In simple terms, there is some element of risk on the part of the landowner.

Keep in mind that the traps can be used in future years. We estimate the useful life of a trap at 10 years. Given that life span and the cost of the new lure each year, we estimate the overall cost of trapping at about $10 to $15 per acre per year. Most of the costs are "up front".

Question. I have 10 acres of red pine being attacked, but I can only afford a few traps. Would two or three traps do any good?

Answer. Probably not. The primary principle behind the traps is that they capture and kill enough beetles to lower the population to a level you and your trees can tolerate. A few traps will not collect enough beetles to accomplish this goal. If you can't afford to trap at full density, you are probably better off not trapping at all.

Question. I understand and accept the risks. How can I order traps?

You will need to place your order directly with the company. You will have to pay in advance. Since the traps are exported from Canada, you will have to furnish your Social Security Number as a Federal ID number. This is required by U.S. Customs. Your order should be sent directly to Steve Burke, Sales Manager, Phero Tech Inc. 7472 Progress Way, RR #5, Delta, British Columbia, V4G 1E9, Canada. Their phone number is 604-940-9944. (Remember postage to Canada is 30 cents.) Your order must be in their hands by March 10 or they will not guarantee delivery. Orders can be sent by FAX to 604-940-9433 and followed up with a check before shipping.

Question. Who can I contact in DNR to discuss using traps?

Answer. Your local forester or your Region Insect and Disease Specialist. The names, addresses, and phone numbers of these specialists are included at the end of this newsletter.

Question. What do I need to set up my traps once they arrive?

Answer. Almost any post or rod that can have a wire attached so that the trap can hang freely. Keep in mind that the traps are almost 5 feet tall and should be kept at least 5' from a pine tree. We can send you more information on request after we discuss your problem with you.

Question. Pheromone traps are too expensive. What other options are available?

Answer. Thinning, watering, harvesting, trap trees, and no action. Your local forester has technical information and would be happy to discuss these other options in detail with you in detail, but the basics of some of these techniques follow.

PHEROMONE LURES

People who purchased funnel traps last year will need to purchase new lures for the 1990 season. They can be purchased directly from Phero Tech for about $4.00 each. Phero Tech will ship your lures with the DNR order to save extra shipping. They will then be mailed to you at the address you use with Phero Tech in time for spring placement. We suggest that you purchase at least two lures for each trap, one to be hung in April and the second to be hung in early June. Some cooperators hung a third lure on their traps in July of 1989 and continued to catch beetles through he first week in August. This is optional on each owners initiative.

TRAP TREES

The trap tree technique is used to reduce or prevent attacks of living trees which are growing near an active bark beetle infestation. This option utilizes recently cut, living trees in order to draw the attack of bark beetles to this breeding material rather than to the remaining stand. Trap trees are collected and destroyed once the beetles have started their brood and before they emerge, thus reducing the potential beetle population. Low value stems (crooked, forked, etc.) are excellent choices for trap trees since their removal also improves the quality of the stand.

The success of the trap tree technique relies on 3 principles:

1. Overwintering adults which emerge in the spring prefer to attack nearby slash and logs on the ground.
2. Bark beetles will aggregate their attack on a few cut logs or highly stressed trees in preference to healthy trees.
3. Timing is critical. While bark beetle larvae are still developing inside these logs, trap trees are destroyed or debarked. This limits reproduction and directly reduces population numbers. IMPORTANT: If trap trees are not removed or destroyed before the new beetles emerge, the landowner has accentuated the problem by increasing the beetle population in his stand.

The operation of the trap tree technique is labor intensive. It is cost efficient where the landowner has access to cheap labor and where the cash needed for other techniques is not available. Trap trees may not be a viable option in urban situations where the logs might pose a safety hazard or where timely log and slash removal and disposal is difficult. Unless the bark is removed, using trap logs for firewood is not a disposal method since the larvae can complete their life cycle in the wood pile.

Procedures for implementing a trap tree program:

1. About April 1st, cut live pines and lay them in the pocket or on the edge of the pocket. Cut 4-5 trees per acre of bark beetle infestation with a minimum of 3 trees per pocket. It is preferable to leave the trees entire so that some drying takes place. This will make the downed trees more "stressed", thus more attractive to bark beetles. Keep the logs in the shade. Bark beetles will avoid sunny areas as temperatures in the sunny areas may become too high. Flag or otherwise mark the log locations because they become difficult to relocate once the foliage and vegetation reach their peak.
2. In mid- to late- May, begin inspecting the inner bark of trap trees for the presence of advanced stages of beetle development (large bark beetle larvae and pupae). If either are found, the log should be treated as in #3 below. The presence of exit holes in

conjunction with galleries necessitates immediate action. Destroy this material at once. If neither are found, continue to monitor the logs at 3-4 day intervals.

3. Trap logs should be removed or treated to destroy habitat in late May, but this will vary with location and weather. To destroy bark beetle habitat, all the bark must be removed or the slash and logs should be chipped, burned, buried, submerged or piled and wrapped airtight with a plastic tarp. For any of the treatments, branches <2" in diameter can be left untreated. If the logs are buried, a pit should be dug and the whole bole and branches >2" in diameter should be buried under at least 6" of soil. If the tarp method is used, plan on leaving it on 4-6 weeks, covering the pile completely, weighing the edges down with soil and avoiding poking holes in the tarp. DO NOT CUT AND PILE TRAP LOGS FOR USE AS FIREWOOD unless the bark is removed and destroyed.

4. Evaluate each pocket to determine if the trap logs were effective in preventing attack on nearby trees. Check all the edge trees for signs of active infestation. If there are no new signs of infestation, the trap logs worked in one cycle. In this case, only monitoring should be continued for the remainder of the growing season. If nearby trees were still attacked, two things should be done. First, remove or destroy the newly infested, living trees. Second, continue the trap log procedure as outlined above, but contact your local forester or regional specialist before starting a second trap tree cycle.

Remember to DESTROY the trap log habitat by any of the following methods.

Debark the log and destroy the bark (particularly if adult beetles have begun to form).

Burn the log (Cook the bark, do not consume the log to ash).

Chip the log (This is very hard on the beetles).

Cut the logs into short lengths, stack, spray with water, and then wrap tightly in plastic (This encourages fungi that will kill the beetles, but leave them wrapped for 4-6 weeks).

Bury the logs under 6" or more of soil.

Submerge the logs under water.

Be creative and show some originality in the destruction of the beetle's habitat, but DO NOT CUT AND STACK the infested logs behind your house for firewood unless the beetles have been destroyed.

ADVANCED TRAP TREE OPTION

If you have surplus trees that need thinning, consider providing trap logs throughout the summer. Under this scenario, you would cut a few trees each week from mid-April through the first of August. Leave the trees on the ground for three weeks and then destroy them. The next week cut a few more. Make sure you mark the logs (perhaps color code them with spray paint) so that you can identify the logs by cutting date.

With this system, you will have a constant supply of ideal trap material for the beetles throughout the summer. At any moment in time you will have newly cut material, old material (soon to be destroyed), and middle aged material available for the beetles. For example, trees might be cut and destroyed on the following schedule.

Set	*Color*	*Cut*	*Remove*
One	**Red**	June 5	June 26
Two	**Blue**	June 12	July 3
Three	**Yellow**	June 19	July 10
Four	**Green**	June 26	July 17
Five	**Orange**	July 3	July 24
Six	**Red**	July 10	July 31
Seven	**Blue**	July 17	August 7
Eight	**Yellow**	July 24	August 14
Nine	**Green**	July 31	August 21

This seems like a lot of trees, but remember that you would only cut a few trees each time. For example, if you cut one tree per acre each week and had a five acre woodlot you would cut a total of 45 trees over the entire summer, but would only cut or process 5 trees at any one time. In addition, it is likely that this might put an end to the beetle population on your property.

Can't sacrifice that many trees? Cut and process every other set of logs. Perhaps every third set, but be sure that the beetles always have some trap logs available.

THINNING DURING AN OUTBREAK

Sometimes, a stand of pine must be thinned during the growing season while the bark beetle is in outbreak status. It is an understatement to say that this should be avoided, but it may be unavoidable. While the operation does pose a serious risk to the residual stand, following a few simple guidelines can help minimize the problem.

1- Try and complete your operation by May 1. Have all slash >1" chipped, buried, burned, or otherwise destroyed by May 15. Remove all merchantable logs from the area (and any pine areas) by May 1.

2- If operations continue on into May, June, and July, remove all merchantable material from the stand within 3 weeks of cutting. Treat all slash >1" in size by burning, chipping, etc. within 3 weeks of cutting.

3- Require the operator work in a single row at a time. Logs should be felled in the row and skidding operations should be limited to "down the row". Felling, skidding, or driving across the row should be prohibited. This should decrease the chances of trees being wounded.

4- Avoid removing trees from residual rows unless this can be done without wounding the remaining trees.

5- Trees wounded during the thinning should be removed at the time they are wounded as the running pitch on the wound will attract beetles to the stand.

This may seem like a lot to do, but the alternate to these practices either creates a great risk to the stand or leaves it unthinned. As always, contact your local forester for more information.

Those landowners considering the use of advanced trap trees are advised to consult their local forester (private consultant, city, county, or DNR forester) for advice.

PESTICIDE OPTION

A limited pesticide option is available for the prevention of damage to standing, live trees. The use of pesticides for pine bark beetle control is very difficult because the main bole of the ENTIRE tree must be sprayed from the ground to where the tree is less than 2" in diameter. On most trees, this will require the use of high pressure, professional spray equipment. This will probably mean that most landowners will have to hire a professional applicator.

MORE HELP

For more information on the pine bark beetle contact your local forester or your DNR-Forestry Insect and Disease specialist listed below.

Region 1. (Northwest Minnesota) - Al Jones, DNR - Forestry, 2115 Birchmont Beach Road NE, Bemidji, MN, 56601 Phone (218) 755-2894.

Region 2. (Northeast Minnesota) - Mike Albers and Jana Albers, DNR - Forestry, 1201 East Highway 2, Grand Rapids, MN, 55744 Phone (218) 327-4418.

Region 3. (Central Minnesota) - Tom Eiber, DNR - Forestry, 1601 Minnesota Drive, Brainerd, MN, 56401
Phone (218) 828-2616.

Region 5. (Metro and Southern Minnesota) - Ed Hayes, DNR - Forestry, Box 6247, Rochester, MN, 55903. Phone (507) 285-7428.

Pine Bark Beetle Newsletter
Minnesota DNR - Forestry
1601 Minnesota Drive
Brainerd, MN 56401

OTHER PUBLICATIONS AVAILABLE

1) Oak Wilt In Minnesota. March 1990. D.W. French and T.G. Eiber. DNR-Forestry. 28 pp.

This publication summarizes the current status of oak wilt in Minnesota, outlines the basic biology and history of the disease, and presents the results of the Oak Wilt Inventory that was completed in 1989. Results are presented for 44 townships that cover the northern Metropolitan Region and the southern parts of Region 3.

2) How To Identify And Manage Pine Bark Beetles. August 1989. Forest Insect and Disease Unit. DNR-Forestry. 4 pp.

This publication is a revision of the 1988 publication of the same title. Full of high quality color plates, the text is oriented to resource managers and homeowners. Topics include identification, life cycle, prevention and control, and an activities calendar.

These publications can be obtained from your Region Specialist.

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