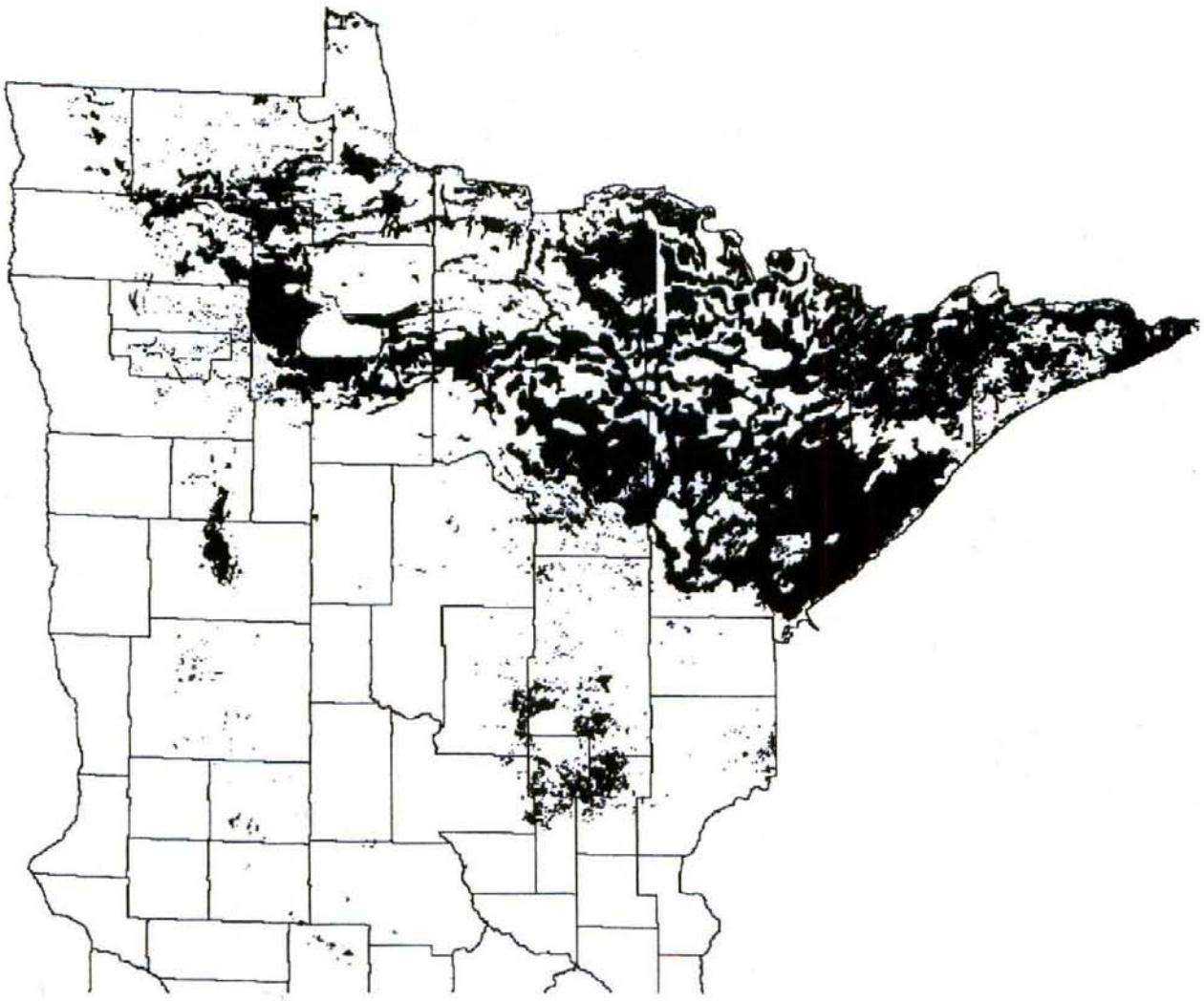
Minnesota Forest Health Annual Report *2001*



Department of Natural Resources
Division of Forestry - Forest Health Unit

Preface

The Forest Health Report is an assessment of the overall health of Minnesota's forest trees and summarizes the insects, diseases and other pests which damage trees, primarily in the forest, but also in the urban environment.

Our main purpose in publishing this Report is to record and interpret forest pest diagnosis, damage and trends. Secondarily, it is to inform readers about special project results and accomplishments in the Forest Health Program.

Because of the difficulty in aerially detecting visible symptoms, detection and monitoring of most forest diseases is accomplished via ground surveys. Diseases are reported only in general terms because of the sporadic and short duration of most foliar diseases and the relatively static nature of root, stem and branch diseases and the difficulty of assessing change. Since this report reflects the change in pest status from year to year, disease information is frequently omitted unless a significant change has occurred. It should not be construed that forest diseases are absent or unimportant within the state. In fact, diseases cause more direct mortality and likely cause more growth loss than do insects.

The **Forest Health Unit's** goal is
to promote healthy forest ecosystems for societal needs and benefits.

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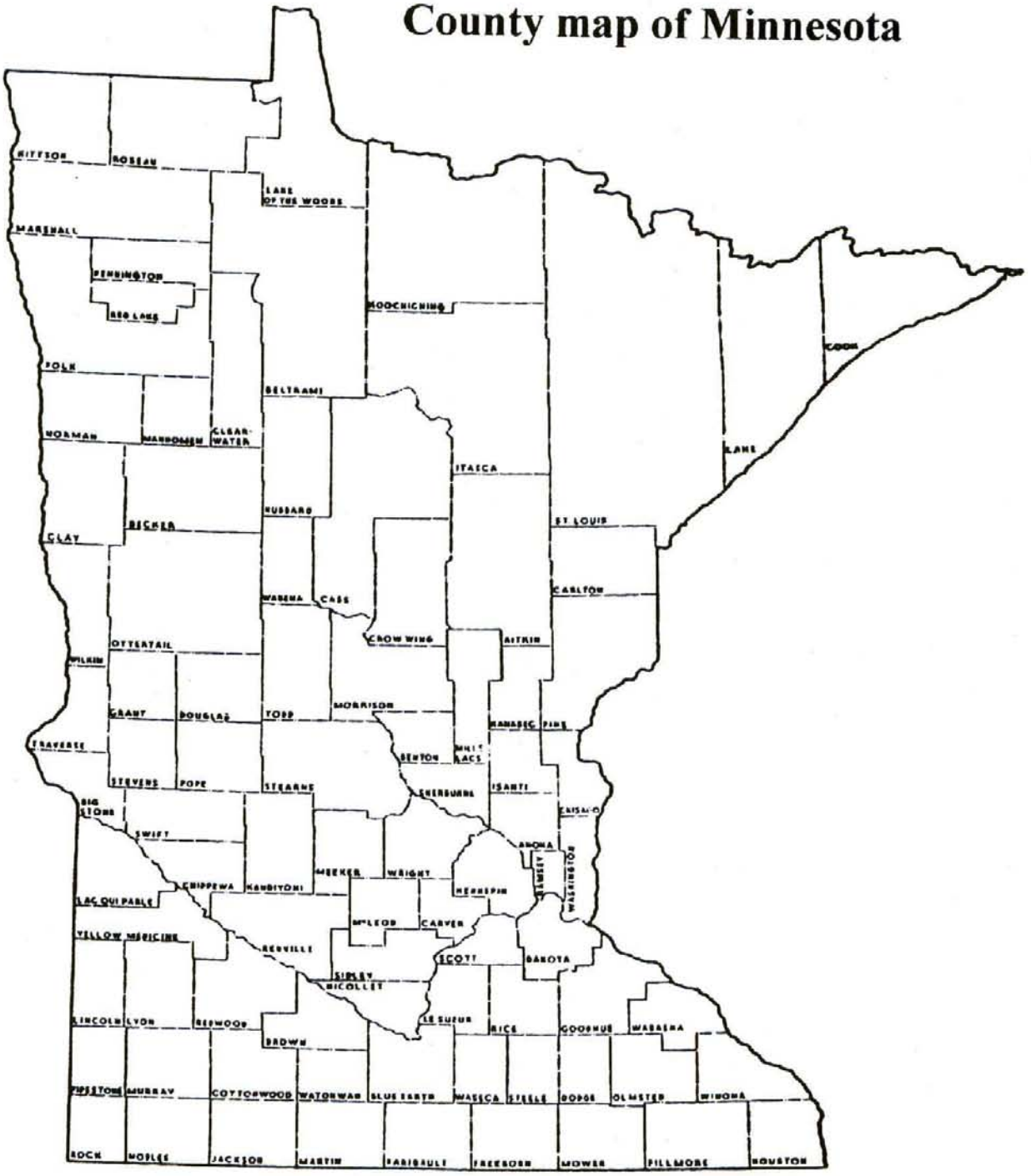
County map of Minnesota



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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
FOREST ECOSYSTEM HEALTH PROGRAM
COOPERATIVE LANDS - FOREST HEALTH MANAGEMENT
FFY 2001 GRANT ACCOMPLISHMENTS
Forest Health Management
Forest Health Monitoring (Off-Plot, only)

❑ FOREST HEALTH MONITORING - OFF-PLOT ACTIVITIES

Detection Surveys

A general aerial detection survey of the major forested areas of MN will be conducted from early June through mid-July. During the aerial survey, each forested Forest Health Monitoring plot will be checked. Follow-up ground verification of selected aerial survey polygons and checking of unknown polygons detected from the aerial survey will also be carried out. Survey maps will be provided to the field staff during the growing season to provide the managers with current forest damage information, and insect and disease incidence information. Survey data will be digitized and stored as data layers for use with the EPIC GIS program. Survey results will be made available to USFS State and Private Forestry. Additional aerial and ground surveys may be undertaken in response to new pest outbreaks.

Item	Target	Accomplishment
General pest detection	12.0 million acres	13.0 million acres
FHM plots checked aerially	300 plots	300 plots
Forest pest status and trends to USFS	December 15	Done
Forest Health Highlights to USFS	January 15	Done

2001 Detection Survey Results	
Pest	Acres
INSECTS	**7,790,800**
Forest tent caterpillar	7,750,900
Spruce budworm	19,400
Larch casebearer	18,800
Pine spittlebug, root collar weevil, bark beetles	2,300

DISEASES	**18,800**
Oak decline	16,700
DED, Hypoxylon canker, Diplodia, bacterial leaf spot	2,100
WEATHER (wind, winter injury, drought)	**39,500**
FLOODING/HIGH WATER	**18,100**
FIRE	**1,200**
AIR POLLUTION	**140**
TOTAL	**7,868,540**

Gypsy Moth Monitoring

Detection monitoring for gypsy moth will include Division personnel placing traps in state forest recreation areas and state parks as well as in areas of public concentrations in rural forested counties outside of the MN Department of Agriculture's (MN DOA) trapping grid. These efforts are coordinated with the MN DOA as the lead agency for detection activities. Delimiting trapping efforts will also be undertaken as requested by the MN DOA on an "as need" basis.

Item	Target	Accomplishment
Placement of gypsy moth traps	200 traps	0[1] traps

[1] Minnesota Department of Agriculture is responsible for gypsy moth trapping. Minnesota was adequately monitored by the MN DOA and there was no need for MN DNR Forestry establish and maintain any of their own trapping grids.

Pest and Host Evaluations

Populations of historically important forest insects and diseases will be monitored by ground-based, life stage surveys. Evaluations of new pest outbreaks will also be conducted to determine severity and trend. Potential host impacts will be evaluated, and control measures prescribed when appropriate.

Item	Target	Accomplishment
Forested acres evaluated	750,000 acres	5,940,00 acres
Life stage surveys conducted for	jack pine budworm spruce budworm forest tent caterpillar pine tussock moth larch beetle fall defoliator complex	See results in following table

2001 Pest/Host Evaluations		
Pest	Survey	Trend
Jack pine budworm	larval & egg	populations nearly non-existent
Spruce budworm	larval & egg	populations at 40 year low levels
Forest tent caterpillar	egg mass (2001 & 2002); pupal	significant defoliation in 2001; some areas predicted less defoliated in 2002; 73% of cocoons paratized
Pine tussock moth	pheromone traps	population declining
Larch beetle	pheromone traps mortality survey	testing a variety of baits; verified beetles present; significant pockets of mortality; not detectable from the air
JP mortality (Wadena Co)	plantation age 0-10 yrs	not conclusive, continuing
Bark beetles	life stage and timing	initiated trap tree trials; recommended salvage
JP seed orchard	gall rust; root collar weevil (RCW)	RCW not present; Gall rust significant
Fall defoliator complex	larval	populations declining
Deer repellant study	seedling damage	product trials

2001 Pest/Host Evaluations		
Pest	Survey	Trend
Basswood thrips	phenology of basswood and thrips	Cooperative study with U of WI
Tatters	defoliation survey	2,000 acres affected
Oak wilt	sites inspected for ow	422
Wildland urban interface	oak & pine acres assessed	2,957

❑ PREVENTION AND SUPPRESSION

Sub-Section Forest Resources Management Planning

Efforts were started during FFY2000 to develop forest resource management plans based on the sub-section level of the DNR's ecological classification system (ECS). Two immediate outcomes of the planning process include (1) identifying a desired future forest composition 50-100 years or more into the future, and (2) identifying forest stands to be treated over a 7-year period. Stand treatments over the planning period would include activities such as harvesting, thinning, regeneration, prescribed burning, and reinventory. The planning process calls for an assessment of forest insects and diseases in each sub-section. Assessments will include (1) identifying the forest insects and diseases known to cause tree mortality or grade reductions in the sub-section, and (2) developing trend information including population estimates and outbreak maps.

Item	Target	Accomplishment
I & D assessments prepared	2	1

Community Forest Health Grants

State money has been allocated "to undertake projects that improve the health of forest ecosystems including insect and disease suppression programs (and) community-based education programs." More than half of this funding is specifically targeted for oak wilt suppression, and a large portion of the remainder will also be spent on oak wilt suppression. Specific components of this grant program include: (1) Develop educational programs relating to the prevention, treatment, and management of tree health problems in the community using integrated pest management (IPM) techniques. (2) Suppress destructive tree insects and diseases in a community's tree and forested ecosystem. Regional Forest Health Specialists develop and lead regional steering committees which review projects submitted by communities, and allocate funds appropriately. Currently, the funding for this program ends on June 30, 2001. The continuance of this grant program will be contingent on new funding allocated by the 2001 legislature.

Item	Target	Accomplishment
Community Forest Health grants	30	75

Oak Wilt Suppression

Surveys have identified 15,359 acres of active oak wilt in Minnesota. Most of the infections are found in the Twin cities, in counties immediately north of the Twin Cities, and in scattered locations in southeastern Minnesota. Since 1991, 6,976 oak wilt infected acres have been treated by plowing root graph barriers around infection centers and removing spore producing trees. FEHP staff provide technical oak wilt control assistance to communities, private individuals, and resource managers.

Item	Target	Accomplishment
OW infection centers treated	120	492
OW sites w/ PSP removed	no target	328

❑ SPECIAL PROJECTS

Developing Guidelines for White Spruce Plantations Threatened by Spruce Budworm

This is a cooperative Focus Fund Project with the University of Minnesota, Department of Forest Resources. The objectives of the project are: (1) Develop management guidelines for established white spruce plantations including a density management diagram and information specific to spruce budworm concerns. (2) Determine if stand thinning conducted during an ongoing budworm outbreak can be beneficial in reducing growth loss, top-kill, or mortality. (3) Determine the impact of long-term spruce budworm feeding on the productivity and health of established white spruce plantations. (4) Investigate the hypothesis that monoculture plantations of white spruce are not ecologically sound and may be encouraging defoliations and damage by spruce budworm. This project will be completed during FFY2001.

Item	Target	Accomplishment
Conduct workshop presenting results of the study	1	1
Final report	Review and approve	Being produced

Herbicide Efficacy Trials for Oak Wilt Control in SE Minnesota

In 1998 and in 2000 herbicides were applied to red oaks in and adjacent to active oak wilt pockets. The objective of this study is to determine if herbicides are effective in reducing the spread of oak wilt.

Item	Target	Accomplishment
Treated plots monitored	11	11 - no final report presently

❑ TECHNOLOGY TRANSFER

Training and Presentations

A major emphasis for the MN FEHP personnel is technology transfer through formal training events centered on forest ecosystem health to talks and presentations at other kinds of events.

Item	Target	Accomplishment
Presentations or training events	15	37
Number of people reached	800	1,400

Media Outreach

To help inform and educate resource managers as well as the general public, both written materials, and the radio and TV medium will be produced and used. Examples of written materials include the Forest Health Newsletter, brochures addressing pest problems in depth, and news releases which address current pest conditions. TV and radio appearance will also be used as necessary to address significant pest outbreaks.

Item	Target	Accomplishment
Forest Health Newsletters	4	4
DNR news releases	5	10
brochures/ publications	3	5
Newspaper/ TV /radio opportunities	3	40

Requests for Assistance

An important function of the program is to respond to foresters and general public who have questions or need assistance with pest identification, tree damage, or pest management issues and problems. Responses can occur via phone, letter, e-mail, walk-ins, and field visits.

Item	Target	Accomplishment
Forest health assists	750	1,200

❑ COMMITTEES, COORDINATION, and MEETINGS

Forest Ecosystem Health personnel are called on to participate in work groups, task forces, and standing committees. Their roles include providing pest management and tree health information, and providing a broader ecological perspective.

Center for Continuing Ed: "Global warming conference", planning committee

MnReleaf : statewide steering, regional steering committees
Costal Zone Management Grant Project preparation committee for Parks
State Land Forest Development Coordinating Committee
Subsection Planning Committees
DNR Region 3 Leadership Committee
Gypsy Moth Advisory Committee (GMPAC)
GMPAC task force on GM silviculture
Gypsy moth : scientific advisory committee
Natl GM Review conf.
Lake State Task Force on Oak Wilt
Oak Wilt Multi-Agency Coordination Committee
Oak Working Group
MN Risk Mapping Working Group
Lake State Risk Mapping Working Group
Community Forest Health Grant Steering Committee
MN Shade Tree Advisory Council (MNSTAC)
MNSTAC FH subcommittee
NE MN Shade Tree Advisory Council
Regional Releaf Steering Committee
Wildland Urban Interface Project Steering Committee
DNR Metro Region CFM Team
DNR Metro U&CF Team
DNR Metro PA Team
Metro CFM team
Metro U&CF team
Natl FHM conf.
Midwest Exotic Forest Pests conf.

Insects

Aspen Leafblotch Miner

Phyllonorycter tremuloidiella (Braun)

Aspen leaf blotch miner was widespread on quaking aspen in the northern half of our State during late summer. These aspens were also defoliated by forest tent caterpillar (FTC) earlier in the season. The aspen refoliated after defoliation by FTC only to be attacked by the blotch miners. Destruction of leaf tissue by two insects likely causes considerable reduction of energy reserves and may cause some dieback in the aspen. *Phyllonorycter ontario*

Bark Beetles

Ips pini (Say) and other *Ips* species

Host: All pines
Damage: Discoloration and mortality
Area: 1308 acres
Severity: See table
Trend: Widespread mortality of red pines in Sherburne and Wright Counties due to long term drought and the build up of bark beetles. Isolated pockets of bark beetles found in Chisago County.

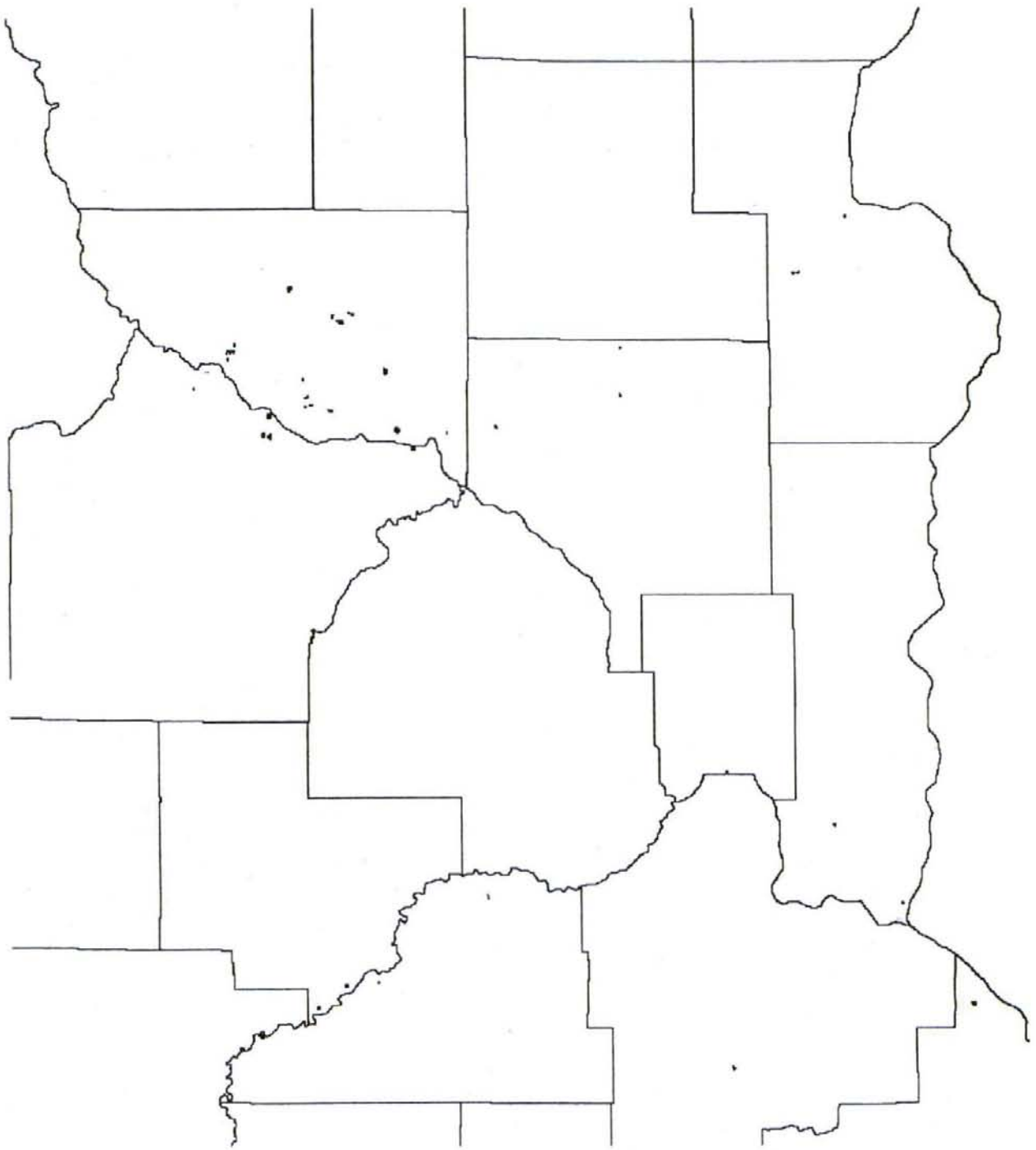
Bark beetles - 2001		
County	**Trace to light mortality**	**Moderate to heavy mortality**
Chisago	27	93
Sherburne	572	234
Wright	143	239
Totals	**742**	**566**

People living anywhere on the Anoka Sand Plain (Wright, Anoka, Sherburne, Chisago and Isanti Counties) witnessed the red pines change color over winter and, in some cases, become worse this spring and summer. Normally, winter injury symptoms disappear as the new, green shoots and needles grow. Some of the red pines have followed the typical winter-injury scenario and are fine, others are struggling, and a number of pines died. But not from winter injury.

2001 was the beginning of the fourth year of drought on portions of the Anoka Sand Plain, as measured by subsoil moisture. In some Sherburne County locations, soil moisture and water table levels have met or are lower than those during the drought in 1988. Some lake levels have dropped six feet below their normal levels. As a result, tree root systems were left high and dry and this puts all trees under stress. For the last two years, red pines have been indicating their level of drought stress in the form of winter injury. You can see it in pine plantations, windbreaks, roadside plantings and backyard trees. Even the small understory pines in pine plantations died from a lack of soil moisture.

With the deepening drought stress, red pines became vulnerable to insects and diseases which took advantage of their weakened state, causing the foliage and branches to die. In early June, a few pines with discolored foliage

Bark beetles - 2001



were felled in three red pine plantations in the Sand Dunes State Forest. Pine bark beetles (primarily *Ips pini)*; Diplodia shoot blight (*Sphaeropsis sapinea)*; and red turpentine beetles (Dendroctonus valens), were attacking and killing the trees. Apparently, a recent hail storm had induced the Diplodia epidemic in the shoot tips and, in some cases, Diplodia was causing branch mortality.

An aerial survey the week of June 23rd found nearly fifty red pine plantations with discolored, dead and dying tree crowns in Sherburne and Isanti Counties. Most of the affected trees are located in plantation interiors, indicating a serious drought stress and likely bark beetle buildup. Pines in backyards, along roadsides and in windbreaks were also affected.

Three stands in the Sand Dunes S.F. were targeted for bark beetle management with trap trees. In mid-June, the bark beetles were active in the upper boles, 50 to 60 feet above the ground. Trap trees are usually felled in April and are most attractive to beetles that are emerging from their overwintering sites in the soil. This was late June and the bark beetles were already in the upper crowns. So, instead of dropping the trap trees to the ground, trap trees were girdled and left standing. Girdling was accomplished by hand with a chain saw blade at approximately four feet above the ground. The girdled trees were arrayed in rows because the infestation was general throughout the stand and because logging and cleanup would be easier. A logger was contracted prior to any girdling work, but this delayed the girdling by two weeks. In one stand, the girdling technique was compared to three other treatments; girdled and felled, girdled and baited with bark beetle pheromone and not girdled (totaling fifty trees). Trees and bark beetle populations were monitored in early, mid and late July.

On July 25th and 26th , the experimental trees were felled so that treatments could be compared and so that the logger could come in and remove all the girdled trees before the bark beetles emerged and moved to nearby trees. On each of the 50 experimental trees, crown discoloration was estimated, bark was removed to measure the extent and condition of the bark beetle infestation, the presence of Diplodia blight, *Dendroctonus*, *Armillaria* or other agent was noted and the stump was inspected for evidence of active sap flow.

The findings:

1. Unfortunately, most 'girdled only' trees were not colonized by bark beetles. Why not? We suspect that girdling trees on the 23rd of June was already too late for the generation emerging in June and that the girdled trees were not any more "stressed" than surrounding trees. So the bark beetle infestation remained a general infestation rather than being trapped out. The only girdled trees that were colonized by bark beetles were the ones with greater than 70% foliage discoloration and even then, they may have been infested earlier in June.
2. 'Felled and girdled' trees attracted lots of bark beetles and still had active infestations in them in late July. So, even during the growing season, trap trees should always be felled, not left standing. On the ground they dry out quicker, become attractive and colonized much more quickly than standing girdled trees.
3. The most surprising result is that 'pheromone baited and girdled' trees were not colonized by any bark beetles. This group of trees had little or no crown discoloration and all had abundant sap flow. Perhaps beetles were attracted to the trees but were unable to successfully colonize the trees because of the profusion of sap flow.
4. Twenty standing trees received no treatment and were chosen to be the experimental controls. These trees were not attractive to bark beetles unless they had more that 70% crown discoloration, then they were completely colonized by the end of July.
5. For all treatments, bark beetles were collected from the base, middle and top of the stem for identification and cataloging by Dr. Seybold, Entomology Dept, University of Minnesota. For more information on the bark beetle study by Dr. Seybold, see Special Projects Section.

From this data, rules were developed to aid the forester in choosing which trees to remove from the stand in addition to all the girdled trees.

A. If crown discoloration was 0 - 40%, bark beetles did not colonize these trees. Do not cut.
B. If crown discoloration was 80 - 100%, bark beetle colonization was 100%. Cut these trees.
C. If crown discoloration was 41 - 79%, bark beetle colonization was variable.
   If two or more entire branches or the top of the tree was dead, then bark beetle colonization was 100%. Cut these trees. All others with less branch mortality should not be cut because bark beetle colonization was not predictable based on external symptoms.

D. Trees with pre-existing problems at their bases had 50 to 100% bark beetle colonization. Cut these trees. Problems included *Dendroctonus* infestation at base (pitch tubes), canker in lower bole, more than 40% of tree's circumference dead, or freshly wounded by machinery.

The most predictive symptom of bark beetle colonization is lack of sap flow on the cut stump. If the stump was dry, there was always 100% bark beetle colonization. If the stump was at least 50 - 60% wet, there was no bark beetle infestation anywhere on the bole.

Using the above rules, a salvage sale was set up during the first week in August and removed 270 cords in the three stands. The logger finished by the end of the first week in August. The stands will be continually monitored for bark beetles for the remainder of the summer. As other bark beetle pockets continue to develop, trap trees will be felled and the new pockets will be cleaned up by late September.

Four news releases were developed for this outbreak and disseminated to local newspapers. They were:

Shouldn't these pines look green by now? (Drought impact area)
Using "trap tree" technique to manage bark beetles in pine.
Managing pine bark beetles on suburban lots
Clean up storm damage now to avoid bark beetle damage later. (for Baxter windstorm)

These can be found in the Publications Section.

Elm Leaf Beetle

Xanthogaleruca luteola

From a distance, you might suspect Dutch elm disease caused the discoloration and drooping of elm leaves. Up close, you can easily see the skeletonized, curled, drying and falling leaves. The elm leaf beetle, as larvae and adults, were responsible for this damage which was observed in central and north central counties in July and August.

Fall Defoliator Complex

include the following:

Dryocampa rubicunda	Greenstriped mapleworm, Rosy maple moth
Anisota senatoria	Orangestriped oakworm
Anisota virginiensis	Pinkstriped oakworm
Symmerista canicosta	Redhumped oakworm
Heterocampa manteo	Variable oakleaf caterpillars

Hosts	Oaks, maples and other hardwoods
Damage	Defoliation
Area	Less than 600 acres in Region 3, small pockets in Region 1.
Severity	Light to moderate defoliation
Trend	Region 1: Increasing.
	Region 3 : Severely declining populations

Late season defoliation of red and bur oaks, along with understory hardwood species, was reported in scattered oak stands in central Hubbard County. Defoliation wasn't noticeable from a distance or from roadside observation but was readily observed when walking of offroad trails in some wooded areas. The defoliation was caused by , variable oakleaf caterpillars and by redhumped oakworms. Trees of all sizes were attacked by these insects.

We have not seen much of this particular group of caterpillars in Region 1 since the 1982-83 seasons when they caused widespread defoliation of oaks in Beltrami and Hubbard Counties. Unlike the defoliations in '82-83, the

feeding in 2001 wasn't observed until early September. Damage to tree vigor is close to nil, since the trees would have been losing their leaves in a couple of weeks anyway. Except for being a nuisance to campers, hikers, and homeowners there is little harm done and infestations seldom last more than two years.

In Region 3, very low numbers of orangestriped oakworms, redhumped oakworms, pinkstriped oakworms, and greenstriped mapleworms were seen.

Forest Tent Caterpillar

Malacosoma disstria (Hubner)

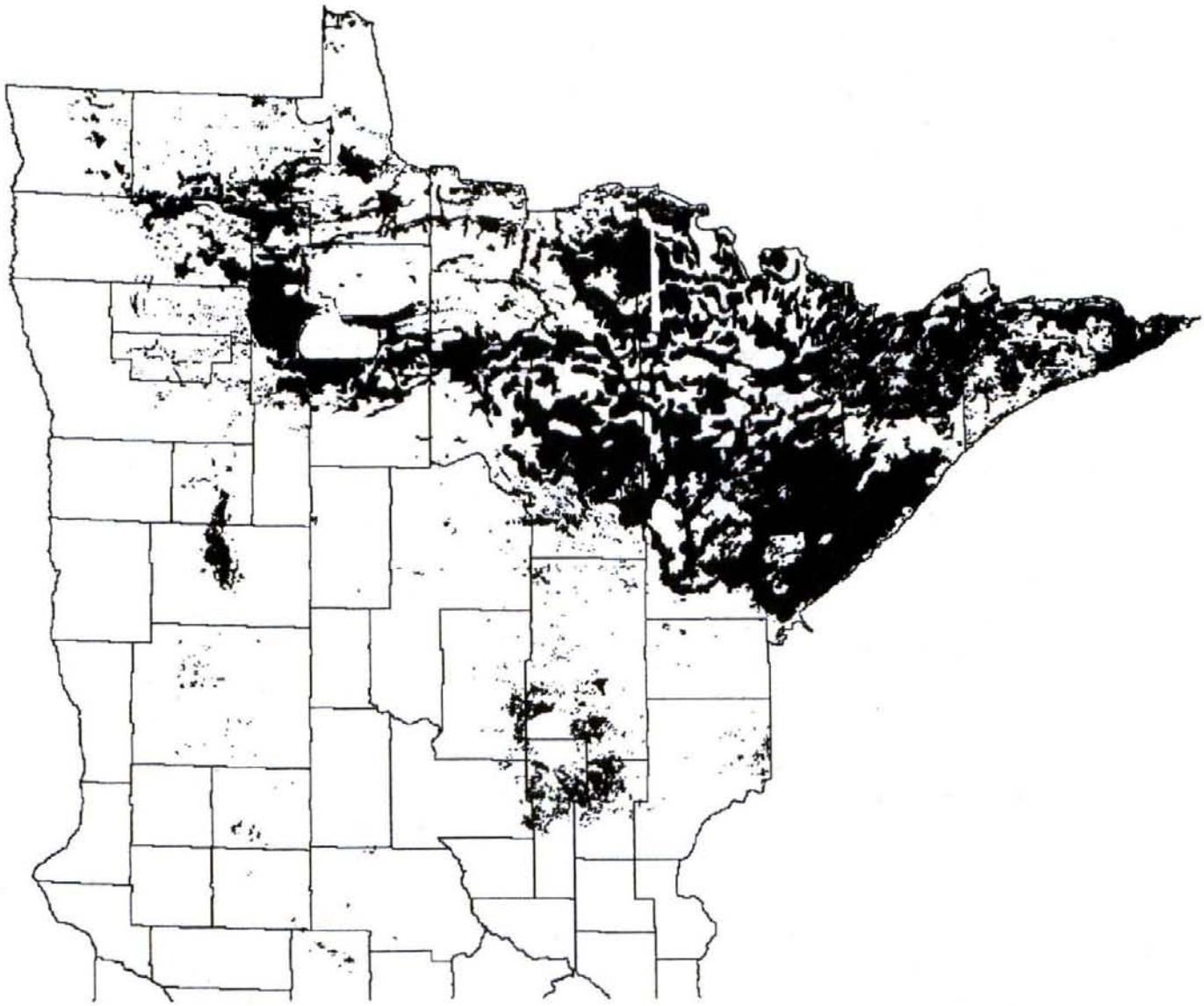
Host: Basswood, aspen, oak and other hardwoods
Damage: Defoliation
Area: 7.75 million acres
Severity: See table below
Trend: Increased in 2001, expected to decline in 2002.

Forest tent caterpillar defoliation 2001 - Aerial survey results

County	Acres
Aitkin	103987
Becker	860006
Beltrami	654,797
Carlton	3165
Cass	16291
Clearwater	150923
Cook	569293
Crow Wing	28913
Douglas	5186
Hubbard	1702
Itasca	865564
Kanabec	70744
Kandiyohi	6439
Kittson	35881
Koochiching	803210
Lake	1022746
Lake of the Woods	220685
Mahnomen	25001
Marshall	180936
Meeker	89
Mille Lacs	80072
Morrison	9078
Ottertail	8989
Pennington	19782
Pine	15095
Polk	13891
Pope	1630
Red Lake	16894
Roseau	155618
St. Louis	2650940
Stearns	16872
Todd	350
Wright	76
Totals	**7,758,000**

The forest tent caterpillar (FTC), *Malacosoma disstria,* is a native defoliator of hardwoods, especially, aspen and

Forest tent caterpillar - 2001



birch trees in northern counties and basswood and oaks in central and southern counties. Slightly more than 2 million acres were defoliated statewide in 2000 and in 2001, 7.75 million acres were defoliated. See map. This is the most acres ever documented in Minnesota. Defoliation was widespread and heavy throughout Regions 1 and 2 . Defoliation was scattered in Region 3 except near Mille Lacs Lake, where it was concentrated. Complete defoliation of host trees and shrubs occurred over large areas. The end of June was hot and wet which led to rapid refoliation of defoliated trees and shrubs in most locations. However, in quite a few stands of aspen in Itasca County, refoliation was sparse.

The table below gives a projected schedule of FTC life stages for 2001 that we developed in late winter.

Projected schedule* for FTC life stages and host tree foliage	
Host tree buds break	Apr 18 - May 10
FTC hatch	Apr 18 - May 15
FTC major feeding period	June 5 - June 25
FTC pupate	End of June
Host trees refoliate	Early to mid-July
FTC moths fly and lay eggs	July 1 - July 15

* = The timing of biological events varies from year to year because timing depends on weather and location. For example, events will occur near the earlier date: when the spring is early; when May and June are hotter than average; or, when the location is south of Mille Lacs Lake.

Here are the actual phenologies that occurred in Region 3. See field notes at the end of this section for phenologies for Region 2.

FTC Phenology and Associated Flora			
Averages for 1999-2001 (3 years that were warmer than average) For Aitkin, Crow Wing, Mille Lacs and Todd Counties:			
Stage	**Ave. date**	**Herbaceous plants that are blooming**	**Tree and shrub phenology**
Pre-hatch	Late April	Blood root Anemone (starting)	Aspen leaf buds break Red and silver maple flowering Arrowwood blooming
Hatch to 1st instars	April 30	Hepatica Dwarf trout lilies Blood root Anemone Wild strawberry Marsh marigold	Aspen leaves < 1 inch Basswood buds < 3/4 inch Ash, oak , boxelder flowers Apple, plum and pear flowers Red maple flowers (No Amelanchier flowers)

2nd instars	May 7	Marsh marigolds Large bellwort Bloodroot Anemone Trillium (starting) Dandelions	Aspen leaves about 1 inch Basswood buds < 1 inch Oak leaves showing Amelanchier blooming Crabapples blooming Lilacs blooming Pears flowering Pin cherries blooming
3rd instars	May 18	Trillium (fading) Bastard toadflax Hoary puccoon Pussy toes Creeping phlox	Aspen seed is flying Basswood lvs 50% full size Bur oak flowers Juneberry in bloom Crabapples blooming Choke cherries flowering Lilacs blooming
4th instars	May 24	Meadow parsnip Downy phlox Thalictrum (starting) Cottongrass Dandelion gone to seed	Choke cherries blooming S. maple seeds falling Ohio buckeye flowers Ash leaves showing
5th instars	June 7	Solomon's seal Waterleaf Wild ginger Wild lily of the valley Blue iris Downy phlox Oxeye daisy	Basswood done blooming Lilac seed pods Black locust flowering Red osier dogwood flowering Juneberries turning pink Blackberries blooming
Cocoon/ pupae	June 12	Rosey twisted stalk Wild geranium Hydrophyllum Water hemlock Lupine Blue iris Goat's beard Orange + yellow hawkweeds Queen Anne's lace N. bedstraw	Black locust flowering
Moths	July 1	Fireweed Milkweed Soapwort Evening primrose Bull thistle Butterfly weed Bladder campion	None noted.

So for timing a spray operation with Bt products, we would suggest timing of the first spray as follows:

Caterpillars in 2nd or 3rd instars.

The phenology of nearby herbs, trees and shrubs are as follows:

Basswood leaves are expanding to leaves < 50% full-sized.
Aspen leaves are still expanding to leaves < full-sized.
Oak leaves are beginning to show.
When Trillium, large bellwort, Amelanchier , pine cherries or choke cherries are blooming.
When crabapples, lilacs or pears are blooming.

To control defoliation, it is less effective to spray Bt after the caterpillars are larger, into the late 4th and 5th instars.

In late June, cocoons of the forest tent caterpillar were collected at twelve locations in central and northeastern Minnesota to determine levels of parasitism and disease. Cocoons from each location were sealed in a paper grocery bag and examined in late July after moths had emerged and died. We found that parasitism and disease of pupae varied from 43% to 96%. *Sarcophogid* flies were the major parasite. See table. From egg to moth, all life stages of the forest tent caterpillar are subject to mortality from many different causes. Extremely cold temperatures sometimes kills eggs during the winter. Freezing temperatures just prior to, during and following hatching kill many young caterpillars. Starvation following complete leaf defoliation also takes a great toll. Predatory beetles, ants, true bugs, spiders, birds, small mammals and bears also consume many caterpillars. Viral, fungal and bacterial parasites also help control this pest.

This year many dead caterpillars were observed at most collections sites. These dead caterpillars may serve as reservoirs of diseases for next year's populations. *Sarcophogid flies* were the major parasite found in the collection. When forest caterpillars have formed their cocoons in tents of one or more leaves tied together with silk, the adult flies deposit living maggots on the cocoons. These maggots bore or chew through the silken cocoons and through the body walls of caterpillars or prepupae, consuming soft tissues and causing death.

Overall, life stage mortality must be very high before it causes a reduction in the next year's population. For example, if each female lays an average of 150 eggs and 98.7% of the progeny dies, the number of emerging adults will be equal to the parent population. In order to reduce the population by one half, 99.3% must die. This study only determined mortality of the pupal stage and therefore does not gives us an accurate prediction of next year's population. After two or three years of defoliation, the level of mortality is increasing and will eventually result in a population collapse. An egg mass survey would be required to more accurately predict population levels in 2002 and will be done over the winter. We can confidentially conclude that FTC is expected to remain at high population levels in much of Minnesota for 2002 based on this study and past experiences .

Egg mass surveys were conducted in the fall of 2001 to predict levels and locations of defoliation in 2002. See Survey Results section at end of report) Defoliation in Region 2 is expected to decline in 2002 below 2001 levels. It appears that 2001 might have been the peak year of defoliation. Heavy defoliation is however still expected along the north shore of Lake Superior from Duluth to Finland, in and around Cloquet, Hibbing, Grand Rapids as well as near International Falls. Other areas of heavy defoliation will also likely occur that were not included in the egg mass survey.

Much effort was put into public relations before and during the growing season. A series of information sheets to help private landowners and homeowners understand and deal with the forest tent caterpillar were developed during the last outbreak. These were updated and posted on the DNR web site. They were also distributed at public meetings, through State Parks and Forestry offices throughout the Region, and also through the mail. A Region-wide news release was done. This received Statewide as well as Regional coverage. Before and during the course of the summer, 7 radio interviews, 4 TV interviews and 8 newspaper interviews were also done concerning forest tent caterpillar. A segment for the Environmental Journal was also taped and aired throughout Minnesota. Three public meetings were held at the start of the growing season. One was held in Lakewood Township and included Bob Olen, and Mike Reichenbach- MN Ext Service. This workshop was attended by 85 people and 3 TV camera crews. Another public meeting was held in Grand Rapids for20 people. This was taped by ICTV and aired locally. A third meeting was held for the Itasca County Resort Association in Marcell. This was attended by 40 people.

In Region 3, there was an extensive release of FTC information and materials before and during the months of defoliation. DNR Stations, Extension Service offices newspaper publishers and radio and TV stations were supplied with general information about FTC and received updates until early July. In addition to this, eight stations requested "live" interviews. For the Aitkin Co. Fair, a large format poster depicting FTC life stages and current maps was created by Mark Platta and Bryan Hargrave.

In order to create a few permanent displays, egg masses, larval instars, pupae and moths were collected periodically at Father Hennepin State Park and other locations.

FTC collections - 2001		
April 30	Egg masses only	Fr. Hennepin State Park, Isle, Mille Lacs County
May 3	1st and some 2nd instars	same
May 7	2nd instars	Lakeshore, Cass Co.
May 18	3rd instars	Fr. Hennepin State Park
May 24	4th instars	same
May 30	4th instars	same
June 15	5th instars	same
June 21	5th and some 6th instars, no cocoons	same
June 28	cocoons	same

Field notes:

4/27 Pokegama Lake west of causeway covered with ice. Grand Rapids, Itasca Co

4/28 Pokegama Lake free of ice. Grand Rapids, Itasca Co

4/30 FTC hatching on cherry in front of DNR building. Grand Rapids, Itasca Co

5/1 FTC hatching near Hibbing, Northome and Big Fork.

5/15 FTC larvae are ½ - 5/8 inches long. Grand Rapids, Itasca Co

5/17 FTC larvae close to 3/4 inches long and streaming out of trees on silk threads by the thousands. Birch leaves are fully expanded and big tooth aspen have been leafing out for about 1 week. Grand Rapids, Itasca Co

5/18 FTC larvae approximately ½ inch long. Virginia, St Louis Co

6/12 Complete defoliation of trees by FTC between Duluth and Two Harbors. Roads are covered with caterpillars and smell bad. Lots of flies. St Louis Co

6/14 FTC spinning cocoons. Raspberries starting to bloom. Grand Rapids, Itasca Co

6/20 FTC starting to spin cocoons on top of Hawk Ridge. Some flies present but not many. Lilacs in full bloom near lake shore in Duluth, St Louis Co.

6/28 First FTC moths emerging. It has been humid and hot for the past week, 90+. June was very wet helping refoliation. Trees are refoliating fast; some started 1 week ago and you can see the difference daily. Grand Rapids, Itasca Co

7/8 Lots of FTC moths along Lake Avenue in Duluth. Parts of Lake Avenue smell bad because of all the dead moths. Lots of moths are active laying eggs in the basswood trees along the street. Duluth, St Louis Co

7/14 Lots of FTC moths flying in Duluth on top of the hill by Best Buy. They are laying eggs on the side of the building, on the sidewalk and even on blades of grass. Duluth, St Louis Co

7/18 Still some FTC moths active. Grand Rapids, Itasca Co

7/20 Some FTC moths still flying at Lakewood Baptist Church north of Duluth. St Louis Co

Field observations of the forest tent caterpillars in central Minnesota revealed the following information:

1. Hatching occurred primarily on April 29th and 30th .
2. Ideal weather for feeding took place until the fourth week of May when it turned very cold, windy and rainy. FTC do not feed if the temperature is below 59 degrees and they mass together to tough it out. Development was slowed, but not enough to put a dent in the population or amount of defoliation.
3. Caterpillars were between 1 and 2 inches long by May 28th . Mass migrations were already occurring.
4. Defoliation is noticeably less than last year around Mille Lacs Lake and in southern Todd County as detected by aerial mapping and ground surveys.
5. Defoliation is noticeably more than last year in the Brainerd Lakes area and near Hinckley.
6. Many caterpillars died and are stuck on leaves and twigs. Similarly, many live caterpillars appear to be parasitized or diseased (limp bodies, not feeding).
7. Tent-making and cocooning started June 21st, although a few cocoons were found earlier in two locations. Done forming cocoons by the last week in June.
8. Earliest moth observation was June 28th in Brainerd, Crow Wing Co.
9. More parasitic flies were observed this year than last, but not enough to indicate that there will be fewer tent caterpillars defoliating our trees next year.
10. Main moth flight was before and on the fourth of July.
11. Trees were refoliated by July 19th .

Disease and parasitism study of forest tent caterpillar in Minnesota - 2001											
Location of Cocoon Collection	Collection Date	Cocoons Collected	Diseased or Parasitized	Emerged Moths		Fly Maggots or Puparia	Adult Wasps	Dead or Diseased Caterpillar/Pupae	Cocoon Abundance	Refoliation Comments	Other Comments
				Number	Percent						
Lakewood (N. Duluth) NWNW S23 T51 R12	6/26/01	91	71%	26	29	30	0	36	sparse	starting	many dead and few live caterpillars
Ely SWNE S34 T63 R12	6/26/01	114	83%	19	17	69	0	4	abundant	starting	many dead and few live caterpillars
Orr SESE S30 T65 R19	6/26/01	108	71%	31	29	21	0	1	sparse		many dead and few live caterpillars
International Falls SENE S35 T71 R24	6/26/01	106	96%	4	4	66	0	10	sparse		many dead and few live caterpillars
Virginia SWNE S12 T58 R18	6/27/01	147	67%	48	33	52	5	9	abundant		many dead and few live caterpillars
Hibbing SESE S23 T57 R21	6/27/01	93	78%	20	22	18	7	32	rare	occurred many days previously	many dead and few live caterpillars
Nashwauk NWNW S19 T57 R22	6/27/01	130	43%	74	57	41	0	25	abundant		many dead and few live caterpillars
Grand Rapids SESE S32 T55 R25	6/27/01	124	77%	28	23	37	4	20	abundant		many dead and few live caterpillars
Rum River S.F. NWNW S20 T40 R26	6/28/01	139	71%	40	29	42	2	4	abundant	occurred many days previously	many dead and few live caterpillars
Father Hennepin S.P. SENW S3 T42 R25	6/28/01	110	71%	34	29	19 and many tiny maggots	2	4	rare	occurred many days previously	many dead and few live caterpillars
Birch Lake S.P. NWNE S36 T127 R33	6/28/01	94	82%	7	8	62	3	23	sparse	occurred many days previously	many dead and few live caterpillars
Bay Lake NE S3 T45 R28	6/28/01	140	71%	41	29	37 and many tiny maggots	0	6	abundant	occurred many days previously	many dead and few live caterpillars

Gypsy Moth Program Summary, 2001

taken in part from the MDA Gypsy Moth Report
by Kimberly Thielen Cremers

Cooperative Program:

The cooperative strategic plan was completed, signed and distributed this year. The plan formalizes the Department's role in the gypsy moth program and outlines a process for outside input that will help address any concerns our clients might raise. It also outlines the transfer of leadership to take place once areas of the state become generally infested. While that will be some time from now, formalizing the agreement is an important step in gaining future support and funding for the job that needs to be done to protect our natural resources.

While finalizing the strategic plan is an accomplishment to be proud of, the real work has just begun. The advisory committee started work this fall to outline annual work plans and long term operational plans in a number of areas. The effort to develop the strategic plan has helped create a cooperative spirit, which has already improved the level of involvement for DNR representatives. That input can only improve the work done within the cooperative program and the public support behind it.

Task forces are working on silvicultural recommendations and work plans for treatment and survey efforts. All are to be completed this year. The scientific subcommittee has been activated and will be meeting soon to outline research issues. An education subcommittee will be activated this winter to address outreach efforts and education needs in the face of national concerns for public safety. The Executive Council made up of the Division Directors (or their equivalent) for each participating agency will be meeting in February to outline the key policy and legislative issues for the up-coming year.

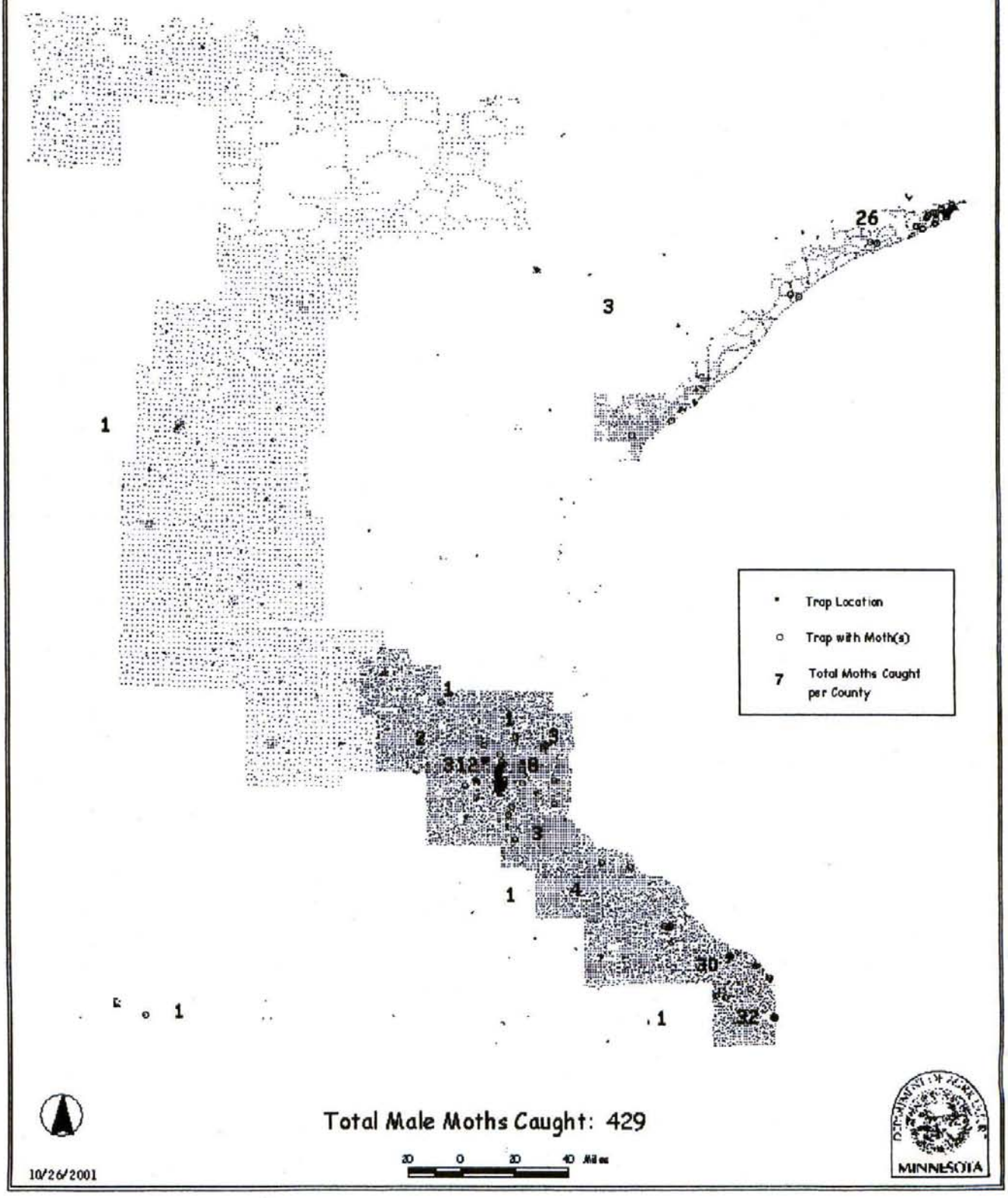
While the news so far has been good, we have one disappointing note to add, that Steve Seybold, UMN Forest Entomologist will be leaving us. He took a position in CA and will be leaving in April. Steve has been of immense help in ensuring the scientific basis for cooperative decisions and as an ambassador to both state agencies. We will sorely miss both his friendship and his contributions to the cooperative program.

Survey Program:

Under the leadership of MDA, approximately 15,000 pheromone traps were set across the state during 2001. Traps were set at a density of one trap per square mile in the five southeastern most counties of the state, the Twin Cities metropolitan area extending north to the city of St. Cloud, and along the North Shore of northeastern Minnesota, including the city of Duluth. In 2001 the northwest and central part of the state received one trap per four square miles, while towns, cities, and incorporated communities within this area were trapped at 1 trap per square mile.

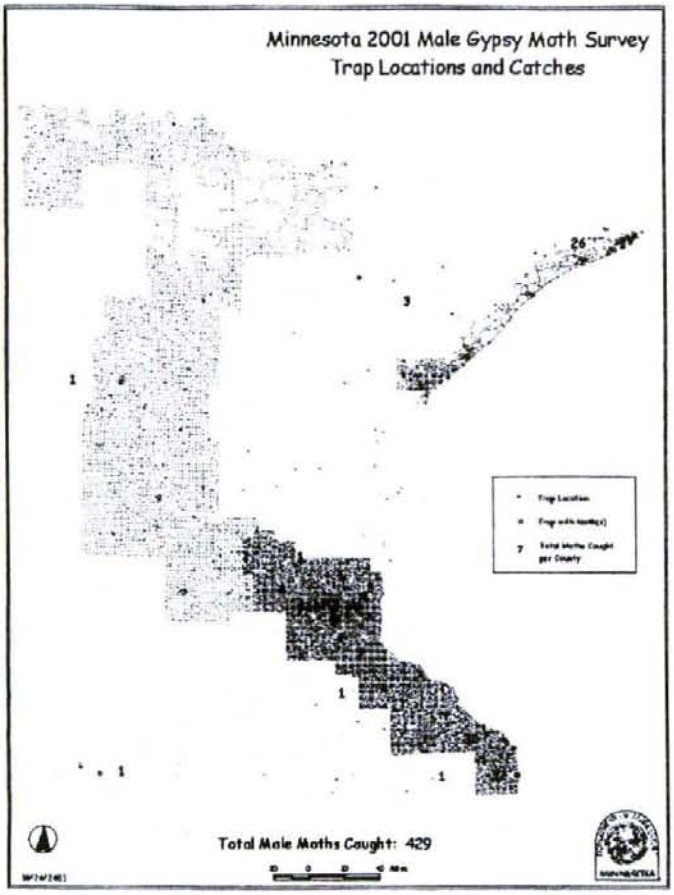
For the first time, saw mills and pulp mills were added to the detection survey. The United States Department of Agriculture-APHIS, PPQ (USDA) oversaw this trapping due to the regulatory nature of these sites. Using information provided DNR, they focused primarily on mills producing more than 500 MBF. Outreach activities were coupled with an effort to enlist mills that import wood products across

Minnesota 2001 Male Gypsy Moth Survey
Trap Locations and Catches



Total Male Moths Caught: 429

10/26/2001

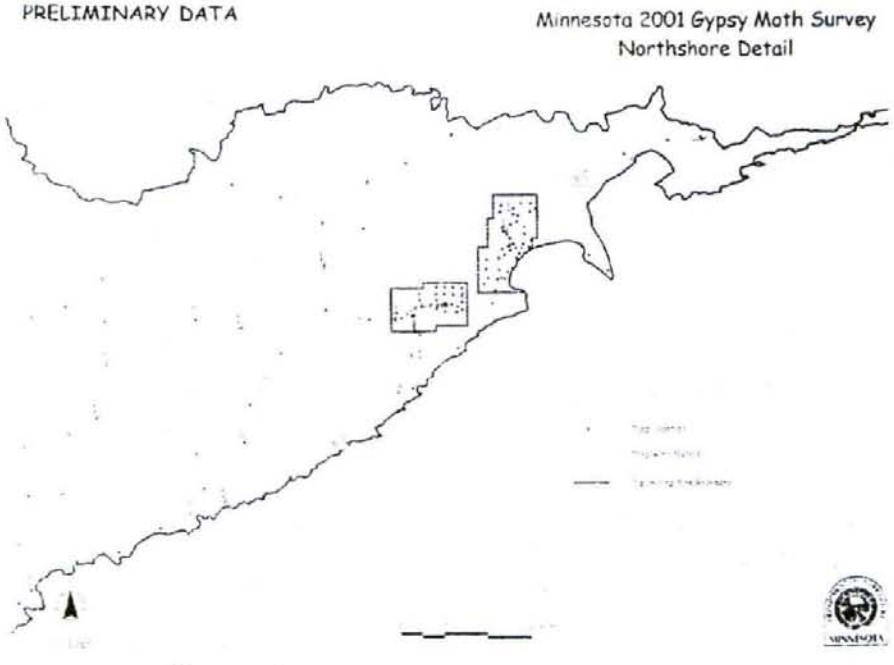


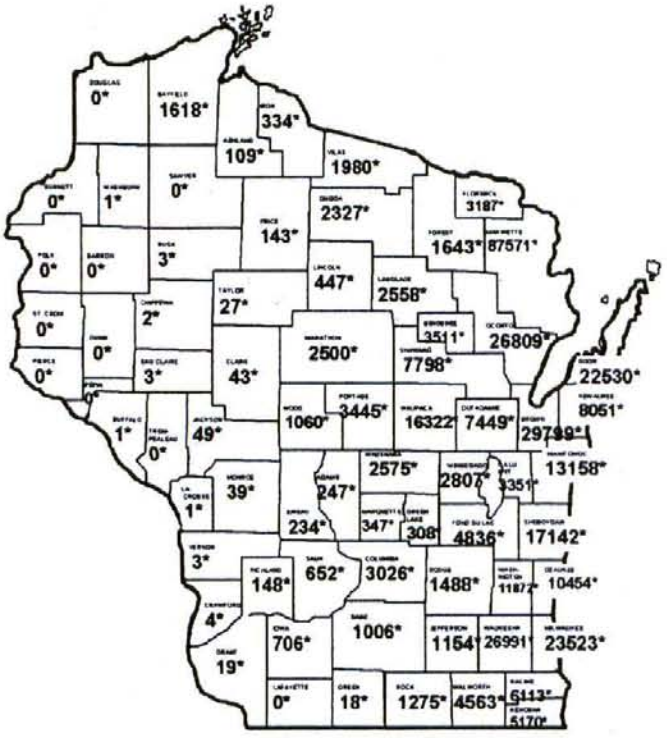
state lines in a voluntary compliance agreement. See the discussion below for more details on the effort.

If you take the number of positive moth catches at face value, it appears that after two years of steady decline, Minnesota took a turn for the worst (see map 1). In 1998, Minnesota had a total of 953 moths. In the following two years, numbers dropped to 296 moths and 182 moths respectively. In 2001, the moth totals rose to 429 positive catches. However, over 85% of the moths were found on only 7 sites (332 of the 429 moths). Each of these sites received delimit trapping due to a history of past catches. Standard detection traps had a total of only 62 moths, the lowest number in some time!!

The north shore situation improved for a second straight year. In 1999, an unprecedented 96 moths were caught over a three county region. In 2000 that number dropped to 32 and in 2001 the number dropped slightly lower with 29 moths found. The city of Two Harbors in Lake County, which in 1999 had 32 moths, came up empty after two years of heavy delimiting. The northern tip of Cook County faired the worst, for the second year in a row (see map 2). Catches remained high at 26 moths, slightly up from 2000's 22 moth finds. The relatively high number of moths scattered over a wide area with no obvious focal point, may be due to the ever-increasing populations of gypsy moth across the waters of Lake Superior. While conclusions at this time would be premature, the north shore now appears as much at risk of introductions as SE MN. This year, the entire upper peninsula of MI was quarantined and the Bayfield/Apostle Islands area of WI produced very high numbers of moth catches (see WI map).

In the Twin Cities metro region, four delimiting sites in Hennepin County created some concern. These four sites alone produced 285 of the 429 (66%) total moths found in the state (see map 4). In early September, an egg mass survey was conducted at a SW Minneapolis delimiting site that yielded a record breaking 170 moths in a trapping grid of 36 traps per square mile. The site had little prior history of catches prior to 2000, but in 2000, a general detection trap yielded 10 moths. No eggmasses were found that year. This year, over 50 staff members from multiple city,



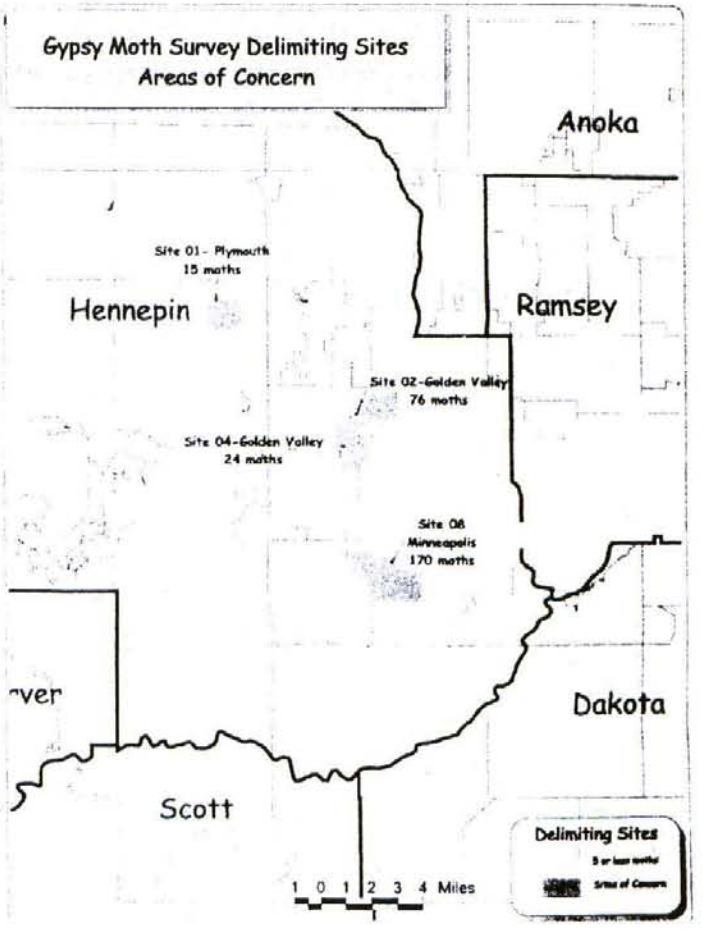


county, state and federal agencies were on hand for an extensive search of the area and hundreds if not thousands of egg masses were found in a one-block area. The site was placed under a state quarantine that will be lifted after treatment this coming spring. A treatment area of 425 acres is being proposed. The public meeting is scheduled for December 18, 2001 from 7-9 p.m. at the Armatage Park Neighborhood Recreation Center located at 2500 West 57th Street.

A second egg mass survey was conducted at two delimit sites in Golden Valley which yielded a total of 100 moths combined, 76 at one site and 28 at the other. Both sites were delimited at 16 traps per square mile in 2001. After only one short hour of searching, 30-40 egg masses were found within a heavily wooded parcel of land adjacent to a commercial site within the 76 male moth delimit site. The second site which is composed of a residential neighborhood resulted in no egg masses found. Due to the proximity of the sites and the high number of male moths captured across the two sites, treatment is being considered for the entire block of approximately 2,000 acres. The suggested treatment block strattles Hwy 394 at approximately Theodore Wirth Parkway. The public meeting for this area has not yet been scheduled, but is planned for January.

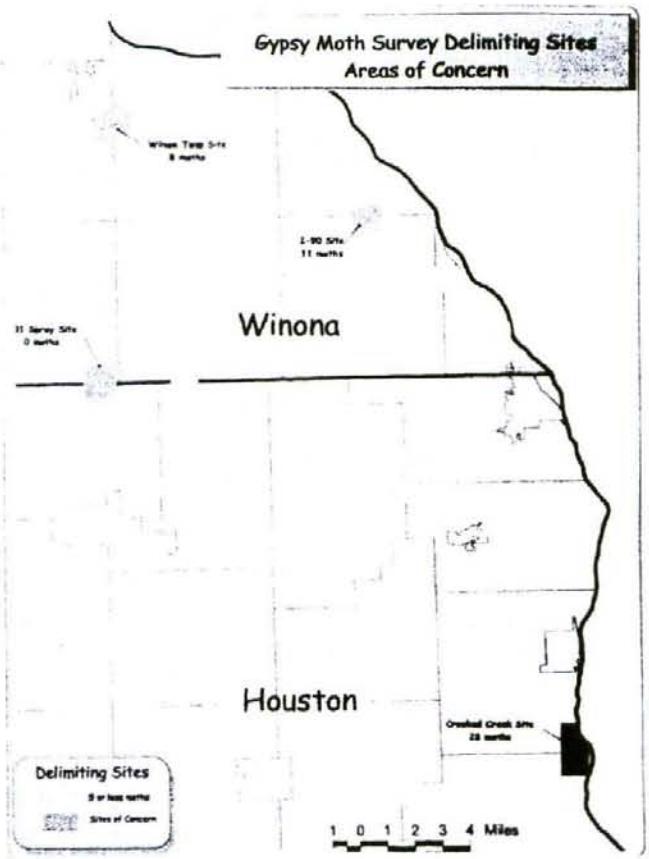
A third egg mass survey was conducted in Plymouth, just south of Bass Lake. This site has a history of male moth capture dating back to 1997; however the site is approximately one block in size and the number of male moths remains low. In 2001, 15 male moths were found in 9 traps. No egg masses have been found. This site will receive heavy delimit traps in the 2002 trapping season.

Similar results occurred in the SE part of the state when compared to the Twin Cities metro area, with three delimiting sites making up 73% of the total moths found in the area. Two of the three sites received egg mass surveys and no egg masses were found (see map 5). One of the three sites, Crooked Creek in Houston county, is being proposed for a pheromone flake treatment due to the history of male moth capture, topography, cover type and difficulty of trapping the site as well as searching for egg masses. The site overlaps state land where timber sales are under way. SE DNR Forestry staff are working with the logger to inspect material coming off the site



and APHIS will be working with the WI buyer to help monitor life stages that may have been moved offsite.

Nursery and Mill sites had a total of six positive moths. All were single catches in 5 different sites. One nursery had two traps with a single moth each. No treatment programs are scheduled.



Eradication Program:

In the spring of 2001, a single 28 acre site on the Winona/Houston county border received three treatments of Dipel DF using a helicopter. Dipel DF was used in order for the farm to maintain its organic certification. Subsequent trapping this year yielded no moths. The site will again be trapped at high density in 2002.

The Minnesota Department of Agriculture along with the USDA-APHIS,PPQ also monitored gypsy moth treatments of a Minnesota wholesale nursery in the spring of 2001. The site had been under compliance since 5 moths were caught in the summer of 2000. The Compliance Agreement was lifted after completion of two applications of Dimilin in May 2001. Follow-up delimit trapping in summer 2001 caught no moths. The MDA/USDA continue to recommend that all nurseries receiving stock from regulated areas should administer appropriately timed, annual treatments to their premises regardless of the previous season's survey results.

Compliance Agreements:

The MDA and USDA–APHIS,PPQ entered into compliance agreements with two major mills, one in Grand Rapids and the second in Cloquet, in the fall of 2001. The purpose of the agreements is to allow the importation and processing of pulpwood from gypsy moth regulated areas of the Upper Pennisula of Michigan.

The major components of the agreements are designed to: track all regulated articles and shippers moving material across state lines; process all regulated articles and destroy any associated waste product on site; disallow movement or storage of any regulated materials during the gypsy moth larval stage; regulate the handling and storage of regulated materials within designated areas on site; require vegetation free zones around designated areas; provide unrestricted mill access for regulatory officials; hold mill operators responsible for any eradication costs that may be incurred.

The MDA/USDA will (at no cost to the company): conduct annual detection surveys; inspect shipments when necessary; monitor compliance; provide training to appropriate mill staff; and provide all updated information necessary to the companies. The required training of mill staff was completed by MDA/USDA personnel in September 2001.

Plans for 2002:

Final treatment decisions based on catches in 2001, will be made after the public meetings this winter. Planned treatments will begin when 80% of the larvae reach the second instar stage of development, usually in early May. Standard NEPA guidelines will be followed and those documents can be made available upon request, later this spring.

Due to budget restrictions, DNR will not participate in the regular detection survey. As in the last two years, DNR Parks will provide MDA trappers with passes to state owed recreation areas. State lands will be trapped by MDA as part of their normal detection grid. Because funding constraints dictate that the MDA grid rotate around the state from county to county on a 3-4 year basis, not all state lands will be trapped in 2002. However, in most cases that trapping frequency is sufficient to detect emergent populations before they have had a chance to spread.

In 2001, state owned recreation sites along the major freeways, outside the normal MDA trapping grid, were trapped through special funding provided by the USDA. That funding, and thus a similar trapping effort, has not yet been confirmed. If possible, those high risk sites outside the normal trapping grid will again be trapped in 2002.

Sites with multiple moth catches, single moth catches over multiple years or single moth catches in close proximity to other moth catches are delimited with an intensive trapping grid. The seven areas of particular concern will be heavily trapped to monitor treatment success and/or population status. DNR staff will be made available to help with special trapping needs in specific areas as needed.

The situation in the Grand Portage area has raised a concern about the effect of cold temperatures on moth flight. If cold temperatures in August and September retard moth flight, our detection methods may be ineffective and the scattered pattern of moth catches may be more indicative of a resident population than of new introductions. To test that theory, a study is being designed that would utilize the release and capture of marked male moths in specific sites. While funding has not yet been secured, DNR Forestry and the USFS will likely take the lead in the project, the scope of which has yet to be determined.

MDA has seen a number of staff changes this last year. Their new staff deserves a round of applause for their cooperative spirit and the already evident expertise they bring to the program. If you have the chance, welcome Anne Selness, Unit Supervisor for the Shade Tree and Invasive Species Unit, Kimberly Thielen-Cremers, Gypsy Moth Program Coordinator, Val Cervenka, Gypsy Moth Trapping Coordinator, Peter Dzuik, Exotic Species Coordinator and Erich Borchardt, the unit's GIS Specialist.

Imported Willow Leaf Beetle

Plagiodera versicolora

Cottonwood Leaf Beetle

Chrysomela interrupta

By August 15th many willow trees and willow brush in northeastern Minnesota were heavily skeletonized by leaf beetles. This damage was caused by the larvae and adults of two species of beetles, *Chrysomela interrupta*, cottonwood leaf beetle and *Plagiodera versicolora*, imported willow leaf beeltle. Both beetles have two generations each year and the cottonwood leaf beetle also feeds on poplars. Black or greenish blue adults and black larvae identify the imported species, while light yellow and black stripes or bars on adults, and whitish larvae with black spots distinguish the cottonwood beetle. Defoliation was especially noticeable in Itasca and St Louis Counties.

Introduced Basswood Thrips

Thrips calcaratus Uzel

A basswood site south of Grand Rapids (Sec 5-T54N-R25W) was included in a study by Shala Werner -University of Wisconsin, Dept. of Entomology, on the phenology of introduced basswood thrips and leaf emergence of basswood. The site was visited and samples taken every 6 days from mid-April until budbreak and then once every 4 days until May 25th. Very few thrips were trapped in the thrips emergence trap at this site although thrips could be found on the overstory trees and a light amount of thrips damage was apparent.

Introduced Pine Sawfly

Diprion similis (Hartig)

During September, second generation larval numbers of the introduced pine sawfly had increased on jack and white pines, but no reports were received from the general public that this pest had caused heavy defoliation.

Jack Pine Budworm

Choristoneura pinus pinus Freeman

In Region 1, there was neglible defoliation in Hubbard, Becker and Beltrami Counties. In Region 3, egg mass case surveys conducted on August 14, 31 and September 5 indicated that this insect pest of jack pines is at zero or very low levels in Region 3. No egg mass cases were found during this survey. Survey locations:

Pine Co.	Crow Wing Co.	Wadena Co.
St. Croix State Park	NESW 9-136-27	SWSW 10-138-33
NWSE 17-40-18	NESE 11-134-28	NWNW 5-135-33
NENW 16-40-18	SWNE 16-44-31	
SESE 10-40-17		

Eastern Larch Beetle

Dendroctonus simplex LeConte

Host:	Tamarack
Damage:	Mortality
Area:	Undetermined acres
Trend:	Large increase from past years

Mortality of tamarack by eastern larch beetle was common across the Region 2 in 2001. Levels of mortality varied from scattered small pockets several dying trees to large areas where 30-50% of the trees were dead or dying. Infested trees became obvious by late winter of 2000-2001 because woodpeckers searching for overwintering larch beetle larvae, pupae and adults had stripped bark off of boles and large branches revealing white sapwood or purple inner bark. Populations of eastern larch beetle appear to have started to build in many of the stands in 2000 or earlier. The level of mortality observed this year is much higher than normal. Larch beetle has always been common in tamarack stands in Minnesota but usually is limited to scattered, small pockets of trees stressed by beaver flooding, road construction, drought, defoliation, fire, etc. However it appears that in this recent outbreak eastern larch beetle can sometimes act as a primary agent of mortality.

A consistent stress factor that may have contributed to the current mortality has not been identified in Region 2. Trees from 40 to 160 years and older have been killed by the beetle. Mortality occurred on upland as well as lowland sites, and in pure stands as well as in mixed stands. In some stands, recent logging may have allowed the beetle to build up its population in slash and then attack the remaining portion of the stand. Larch casebearer has been common during the past two years across the Region. The level of defoliation by the casebearer, however, has been generally quite light.

Reports of tamarack trees with no bark were received this winter from locations in Pine and Aitkin Counties. Woodpeckers were stripping the bark off the main bole right down to the snow line! Bark was sometimes also removed from the larger branches. The woodpeckers were looking for larch beetle adults which overwinter under the bark of the tamarack (larch) trees. The beetles kill the trees and the woodpeckers are feasting on the beetles. Damage levels varied from scattered individual trees killed to 30-50% of the stands killed. In one case, a stand contained a large pocket of damage where 80-90% of the trees were dead. Most of the damaged trees observed this winter appear to have been attacked by the beetles last spring and summer. In some stands, trees killed over the past few years were obvious as well. Some of the damage seen this winter appears to be the result of beetle populations building up on logging slash. The beetles then attacked and killed live trees left for natural seeding or pockets of trees in surrounding stands. In other situations, there was no readily apparent cause for the buildup and attack. Old age is likely a contributing factor in most stands.

Research on the eastern larch beetle in Newfoundland, by D.W. Langor and colleagues, found that the larch beetle overwintered as adult beetles in infested trees. Larvae and pupae under the bark did not survive through the winter. In Minnesota, larvae, pupae and adults were able to survive the winter of 2000-2001. Surviving larvae and pupae were found 6 feet and more above the ground. These life stages obviously survived above the snow line. The winter of 2000-2001 was long and cold with lots of snow, but the temperature in Grand Rapids did not decline below -30 F, and the past 3 or 4 winters have been unusually mild. This mild weather may have allowed not only the adults, but also the larvae and pupae to overwinter, allowing much larger populations of larch beetle to build up. These larger populations of beetles may allow larch beetles to attack relatively healthy trees and kill them.

Pheromone trapping for eastern larch beetles was done in cooperation with Dr. Steve Seybold, U of MN. Four traps were placed in each of 3 locations in St Louis, Carlton and Itasca Counties. Traps were placed in Sec 18-T49N-R19W, SWSW Sec 7-T56N-R25W and NWNW Sec 2-T55N-R18W. Traps were baited with the following materials:

1. Control
2. Alpha-pinene + seudenol
3. Alpha-pinene + seudenol + frontalin
4. Alpha-pinene + frontalin.

Funnel traps (16 units) were suspended from rebar approximately 3 chains apart. Traps were re-randomized weekly by moving the entire trap and baits between rebar sites. Beetles were collected from the traps weekly. Traps were placed in stands on May 4th and 5th and removed from stands on October 10th.

Alpha-pinene + seudenol proved to be attractive to *D. simplex*. The ratio of males:females in the traps was 4:1. Some traps attracted 6,000 beetles in one week. Larch beetles were caught during the first week the traps were in place suggesting that the larch beetles started flying prior to that time. At the time the traps were placed there was

still frost in the ground on the St Louis site which was a very wet tamarack site. Beetles were collected in traps through at least September 9th. The frontalin appears to be very attractive to clerid beetles which are bark beetle predators. Also a species of woodborer, *Phymatodes dimidiatus* (Cerambycidae) was also attracted to the seudenol. Dr Seybold's lab is examining the trap catches. A scientific paper will be written analyzing the results.

Foliage on some tamarack trees newly attacked in 2001 began to fade to yellow and then to tan as early as July 19th. The foliage on many of these trees began to fade from the bottom of the tree upward. This resulted in currently infested trees having green foliage on the top of the tree and no foliage or yellow foliage on the bottom. This made aerial survey for current year infestation difficult and ultimately, not very useful.

Another symptom of current year attack is heavy resin flow . This appears to be heaviest from the upper bole and resin flows and drips onto the lower bole and ground.

Birders in northern Minnesota have suggested that black-backed woodpeckers, three-toed woodpeckers and hairy woodpeckers are most likely the birds that strip the bark off of the tamarack trees to feed on the larch beetles.

A few black spruce trees, close to baited traps on the Arbo site (Itasca Co.), appear to have been attacked by larch beetle. Beetles from one of these trees are being reared by Dr. Steve Seybold and will be sent off for positive identification.

The following observations were made in Itasca County, Arbo Township in SWSW Sec 7-T56N-R25W unless otherwise noted.

5/4,5 Pheromone traps placed in Carlton, St Louis and Itasca counties. Larch beetle adults trapped during following week.

6/7 Overwintering larvae, pupae and a few adults still found under bark of trees infested last year. Grand Rapids, Itasca Co.

6/14 Most overwintering larvae have pupated. Pupae and a few callow adults found under bark of trees infested last year. Adults are still excavating galleries under bark of trees newly attacked this year. No new larvae were found.

6/28 Found a few pupae and new adults under bark of trees killed last year. Found larvae on live trees attacked this year.

7/19 Lots of larvae, pupae and callow adults in green tamaracks attacked this year. Foliage on a few trees newly attacked this year starting to turn yellow.

7/26 Some larvae and pupae but mostly callow and brown adults in trees attacked this year.

9/6 Lots of larvae and callow adults (50:50) under bark. Few beetles caught this week.

9/20 No beetles in any traps on Grand Rapids site. Lots of pupae under bark.

9/27 No larch beetles in traps. Caught one checkered beetle. Found a few larvae and lots of pupae under bark. Also finding some callow and brown adults under bark.

10/10 Pheromone traps removed from sites in St Louis, Carlton and Itasca counties.

Larch Casebearer

Coleophora laricella (Hubner)

Host:	Larch
Damage:	Defoliation and discoloration
Area:	18,800 acres. Casebearer damage from the ground or air is difficult to see unless it is quite heavy. So the acreage reported is likely significantly lower than the actual acreage involved.
Severity:	Variable
Trend:	Widespread defoliation, not easily discerned by aerial survey techniques.

During the last two years, the larch casebearer, an exotic needle miner, has caused extensive yellowing of larch needles in northern Minnesota. Casebearer damage was common across northern Minnesota in 2000 and appears to have increased in 2001 in the northwestern counties and decreased in the northeastern counties. Larch casebearer occurs almost every where tamarack occurs in northwestern Minnesota and where FTC hasn't already feasted on them. Going north from Bemidji, defoliation tends to disappear about 15 miles south of Baudette. This is where FTC is also the heaviest. Going south from Bemidji, casebearer defoliation extends as far south as Park Rapids, southern Hubbard and northern Cass Cos. Feeding damage was visible by the first week of June in northeastern and north central Minnesota. Moths were observed on June 27th near McGregor in Aitkin County.

Fortunately, there are two introduced parasites that help control the larch casebearer and other bio-controls including over twenty-five native parasites and predation on eggs or larvae by beetles, true bugs, lacewings, mites, and daddy long-legs. Two imported wasp parasites, *Agathis pumila* and *Chyrsocharis laricinellae*, were first introduced in the 1930's in Canada and Michigan.

In a collection of larch from the Aitkin Area, we found 90% of the parasites were *Agathis*. In a June collection of larch from Beltrami County, the parasites were mostly *Chrysocharis*.. During past surveys these two imported parasites were sometimes prominent, while in other surveys the native species were more prevalent.

This may be the peak year for damage to larch in northeastern and north central Minnesota by the casebearer because bio-controls tend to build rapidly. Since widespread mining of larch needles was first observed in northwestern counties this year, it will probably occur there again in 2002.

Multicolored Asian Lady Beetles

Harmonia axyridis (Pallas)

Calls and complaints about the multicolored Asian Lady Beetle were very few compared with last year. They were present throughout the Region and in some locations were very numerous. Last year was the first year they became evident through northeastern Minnesota generating a flood of calls.

Pale Green Weevil

Polydrusus impressifrons (Gyllenhal)
Polydrusus sericeus (Schaller)

The first observation of the pale green weevils this year was on June 8th near Grand Rapids.
A collection of the weevils from 2000 was sent to Dr. at the Canadian National Collection in Ottawa and to Dr. Bill Mattson, USFS in Rhinelander, Wisconsin. They identified the weevils as *Polydrusus sericeus* rather than *P. impressifrons*. Further investigations to determine if both are present in Minnesota are warranted as well as to determine the host and impact of the immatures.

Pine Root Collar Weevil

Hylobius radicis Buchanan

On Thursday, September 27, 2001, the Browerville jack pine seed orchard was surveyed for root collar weevils. On sampled trees, soil adjacent to the root collar was slowly excavated and inspected for the presence of weevil larvae, adults and tunnels. The results are as follows:

	# trees sampled	#infested trees
South unit	6	0
North unit	17	0

There was evidence on all surveyed trees of past infestation and nothing even remotely recent. Great news!

That lead us to wonder what was causing the continued mortality and leaning at the orchard. Further investigation revealed that the affected trees have girdling roots. That is, below the soil, roots are encircling the root collar and choking it off and causing internal decay. This is very common in planted trees especially containerized/potted trees.

Pine Tussock Moth

Dasychira pinicola (Dyar)

The pine tussock moth population in Minnesota is at such low numbers that it is insignificant as a defoliator of jack pine. Since 1981, the numbers of tussock moth caterpillars in Pine and Crow Wing Counties have diminished or remained low, but since 1996 this pest had increased at several trap sites in northeastern Wadena and southeastern Hubbard counties. During this year's trapping at 9 sites (in these 2 counties) fewer than 30 male moths were caught each two weeks in all traps. The numbers of trapped moths were lower than numbers trapped in 2000 except at one site in Wadena County where 122 moths were trapped in 2001 and 104 trapped in 2000. No caterpillars were found in drop cloth sampling of 27 jack pines at 9 sites in May of 2001. See Survey Results section.

Defoliation by the tussock moth caterpillars was not noticeable in 2001. Since less than 30 male moths were trapped at each two-week interval, trapping in 2002 is not warranted. Drop cloth sampling for caterpillars will be completed in May of 2002 at or near the 9 trap sites, and elsewhere in the 2 counties, but very low caterpillars wilt probably be found.

Pine Webworm

Pococera robustella

The pine webworms are caterpillars which live on pines in nests of brown excreta (frass particles) and needles tied together with silk. Most of these webworms have little effect on the vigor of their hosts. Webs of the pine webworm had increased to a noticeable level by mid September in one jack pine plantation just north of Brainerd. On ornamental pines hand removal easily controls this pest.

Spruce Beetle

Dendroctonus rufipennis (Kirby)

Host:	White spruce
Damage:	Mortality
Area:	Current distribution appears confined along the North Shore of Lake Superior
Trend:	Unknown

Spruce beetle continues to attack and kill trees in Region 2. It is only being found along the North Shore of Lake Superior, mostly within 5 or 6 miles of the lakeshore. Spruce beetles have not generally been found away from Lake Superior except in one tree 25 miles up the Gunflint Trail (collected by Albers and Seybold in October 2000). These were found last year.

Tom Ludwig, Park Manager at Judge Magney State Park, applied for and received a Coastal Zone Management Grant to survey for spruce beetle along the shore concentrating in the State Parks. As a part of this grant he baited funnel traps with a commercially available lure used in western US and Canada for spruce beetle. This lure did not attract any spruce beetles. Similarly the commercial bait was unattractive to spruce beetle in traps placed along the Gunflint Trail in a University of Minnesota study.

Additional white spruce trees have been attacked in Cascade River State Park and in Judge Magney State Park as well as on private home sites along the shore of Lake Superior. Often the trees being attacked appear healthy and vigorous with full crowns.

A white spruce tree that blew down in Cascade River State Park in April was examined on June 12th. In addition to spruce beetle, the tree was also infested with *Ips perturbatus,* the northern spruce engraver, and with *Polygraphus rufipennis,* the 4-eyed spruce beetle. Spruce beetle adults were actively flying and landing on the tree as we examined it, but were not entering a pheromone trap nearby. Spruce beetle eggs were found in an egg gallery but no new larvae were found on this date.

A white spruce that had blown down in mid-April in Judge Magney was also examined on June 12th. There were many spruce beetle attacks up to about 30 feet on the bole. Brood galleries were being excavated but no new larvae were apparent.

More standing live white spruce trees were found with pitch tubes near the soil line. Beetles were collected and sent to Dr. Bright in Ottawa for identification. He identified then as *Dendroctonus punctatus* LeConte, Boreal spruce beetle.

A spruce beetle alert was developed by DNR to help identify spruce beetles and their damage. This was included in a Forest Insect and Disease Newsletter and distributed at a number of meetings and training sessions. People were asked to notify their nearest DNR Forest Health Specialist if they found trees they suspected were infested with spruce beetles to help develop a range map for Minnesota. The current range based on historic and recent collection records includes Ely, Itasca State Park, and the North Shore area.

A training session on spruce beetles was held for Master Gardeners in Cook County at Cascade River State Park on August 13, 2001.

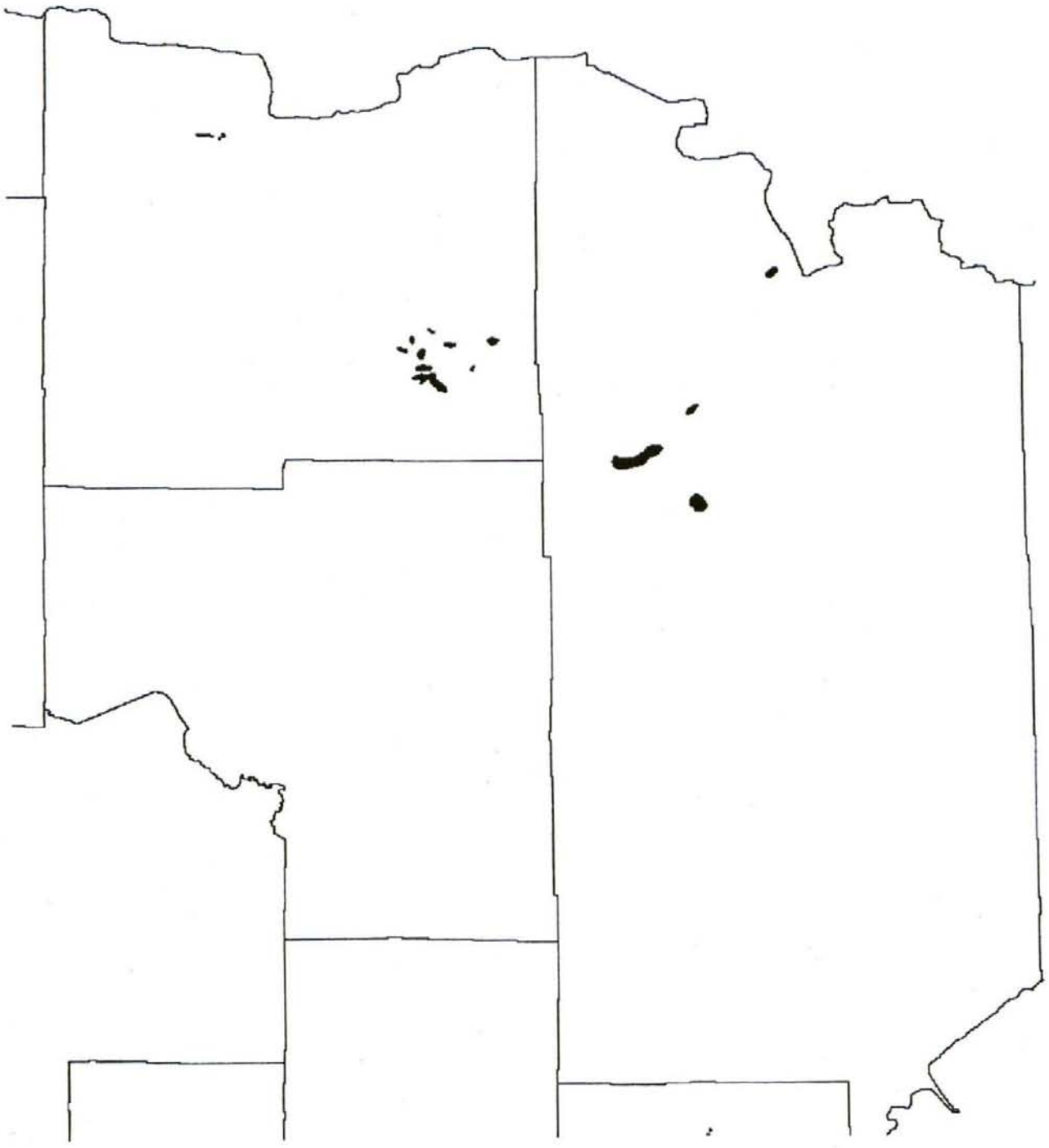
Spruce Budworm

Choristoneura fumiferana (Clemens)

Host:	Balsam fir, white spruce
Damage:	Defoliation, topkill and mortality
Area:	19,385 acres
Severity:	Trace to heavy (See table)
Trend:	Stable to slight decline

Spruce budworm populations continue to decline in 2001, compared to 2000. Budworm defoliated 27,783 acres in 2000 and only 17,224 acres in 2001. See map and table.

Spruce budworm - 2001



Spruce budworm defoliation 2001						
County	**Trace (0-25%)**	**Light 26%-50%**	**Moderate 51-75%**	**Heavy >75%**	**Moderate-Heavy* > 50%**	**Total**
Aitkin			46			46
Benton		64		64		128
Carlton				195		195
Carlton				195		195
Cass	35					
Chisago			37	37		74
Isanti		116		116		232
Koochiching		188	5765	998	387	7338
Mille Lacs		46		46		92
Pine			42	42		84
Sherburne		486	74	560		1120
St Louis					9691	9691
Stearns			86	86		172
Totals	**35**	**900**	**6050**	**2339**	**10078**	**19367**

* The USFS surveyors, that cover part of Region 2, combine the moderate and heavy categories into one called moderate to heavy(greater than 50%) and do not report moderate and heavy separately.

In Region 2, a larval survey was completed on 11 plots in June, and defoliation and egg mass surveys were completed on 24 plots in August and September. Larval , defoliation, and egg mass survey data by plot can be found in the Survey Results section of this report. A comparison of defoliation levels in 1999, 2000 and 2001 are summarized below. The level of defoliation declined in 2001 relative to 2000 and 1999. The egg mass survey predicts an increase in the amount of moderate defoliation expected in 2002.

	Level of Defoliation			
	0	Light	Moderate	Heavy
Plots defoliated in:				
1999	4%	65%	17%	13%
2000	26%	52%	17%	4%
2001	54%	33%	8%	4%
Predicted defoliation in: 2002	58%	13%	25%	4%

Egg mass surveys in Region 3 during August and September indicated that numbers of this forest pest are at very low levels in Region 3, except on white spruce plantations in Aitkin and Sherburne Counties. See Survey Results section.

Bob Tiplady and Mark Platta worked with Darren Blackford, a Univ. of Minnesota graduate student, to collect branch samples for egg mass counts in late April in order to study population dynamics. This is in fulfillment of a focus fund project "Developing Guidelines for white spruce plantations threatened by spruce budworm".

Striped Alder Sawfly on Birch

Hemichroa crocea

Larvae of the striped alder sawfly were reported feeding on paper birch near Grand Rapids and Tower in mid-August. This is another introduced species. The larva is yellowish green with a shiny black head and a dark-brown or black subdorsal stripe on each side of the body running the length of the body. The larvae feed in groups and can consume the entire leaf except for the larger veins. Their primary host is alder but they will also become epidemic, feeding on birch and willow. There are two generations per year.

Two-lined Chestnut Borer

Agrilis bilineatus (Weber)

The two-lined chestnut borer killed red and white oaks in Itasca County this summer. There was approximately 15% mortality of oaks on a 20 acre site in Section 1- T54N-R25W. The owner began building a new home on the site about 5 years ago causing some construction damage. Also the owner had cut oak logs and left them piled in a log deck for a couple years to allow them to dry. Evidence of past borer activity could be found in the log deck. Three pockets of mortality also occurred within the city of Grand Rapids. One site was a new church construction site, which likely caused the stress contributing to the borer attack. The two other sites did not have any obvious stress event except that at one of the sites the owner did have firewood piles and may have brought the chestnut borer in with the firewood. The oak from the church site was taken to the UMN where Dr. Seybold found oak bark beetles (*Pseudopityophthorus)* in addition to *Agrilus* spp. woodborers.

A number of other pockets of oak mortality were reported in the Region and likely two-lined chestnut borer was involved. July, 2001 was very hot and dry, stressing trees throughout Region 2. Forest tent caterpillar has been active in Region 2 for 1 to 3 years now, depending on the location, adding stress to trees as well. An increase in two-lined chestnut borer is likely next year due to the existing damage and stresses on trees.

At Fr. Hennepin State Park and elsewhere along the shore of Mille Lacs Lake, a TLCB outbreak has started. Some is related to oak slash, but most is related to FTC defoliation. We observed that TLCB occurs throughout the Park occurring in small groups of 1 to 3 oak trees in widely scattered locations. Some trees are already dead and leafless while others exhibited topkill.

Oaks that are more than 2/3rds green yet this fall may live. In 2002, if a drought occurs or enough FTC defoliation occurs to trigger a summer refoliation, then more oaks will be attacked and killed. Otherwise, expect oak vigor to return to normal and next year's mortality to be limited to already infested trees.

I think it would be a daunting task to find and remove all the currently infested trees. And, since this is a widespread outbreak in the oak resource surrounding the Lake, I suggest that TLCB populations wouldn't be significantly reduced by cutting and removing all the currently infested trees. Instead, I would work on a few, selected trees that could pose a falling tree-hazard to campers, hikers or vehicles and those in areas that are mowed. I would leave the rest to become snag trees and future coarse woody debris.

Recommendations:

Mark/ flag dead and dying oaks now, while the leaves are still on them. Chose trees with more than ½ of their crown dead or red.

Option A. For winter 2001-2002, remove trees that pose a threat to people. I wouldn't go more than 50 feet from a target to take down a tree. Only work during the winter on frozen ground because working during the winter minimizes impact to the remaining trees. Do not damage the remaining trees by falling trees, root breakage or soil compaction from heavy equipment because these trees will be targeted and killed by TLCB in 2002.

The wood from these trees needs to be treated with caution because the insects survive and can be carried to other locations to start more outbreaks. The wood should be debarked, sawn into lumber or used as firewood prior to April 1, 2002. (If you have a vendor cut firewood out, write it into the contract that he must NOT damage remaining trees and penalize him for any damage, and he must season the wood for 1 year under a tarp or use the firewood prior to April 1, 2002.)

Option B. Wait a year or more to see what happens. Even if the drought ends and FTC defoliation ends, I do expect some additional mortality in summer 2002, but to already infested trees. If trees continue to be stressed, we could have more trees dying. By waiting, we don't have to do any precautionary work with the firewood, if the trees have been dead for a year or more. Again, only do cutting and tree removal during the winter, and do not injure the remaining trees.

Replant oaks in Tubex shelters on sites where oaks were cut down.

Walkingsticks

Diapheromera femorata (Say)

Walkingsticks in northeastern Stearns County caused heavy defoliation of about 520 acres of oak, basswood and several other tree and shrub species by mid September (SW1/4 S36 T127 R3–l60 acres; SE 1/4 S35 T127 R33–160 acres; NW 1/4 S1 T126 R33–160 acres; and NENE S2 T126 R33–40 acres). On June 22 these insects averaged ½" long, and on August 7 many were 3 ½" long and were mating. Their eggs are dropped onto the ground and will remain dormant until the spring of 2003. This is the only known location in Minnesota where large numbers of this interesting insect persist.

Yellowheaded Spruce Sawfly

Pikonema alaskensis (Rohwer)

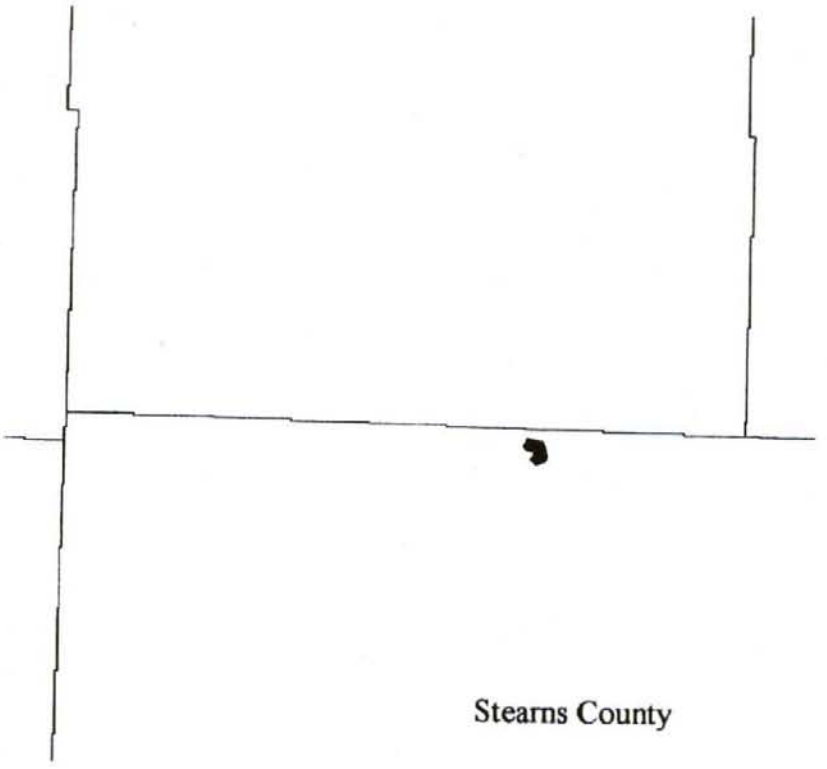
Yellowheaded spruce sawfly is always present in Region 2; mostly occurring on ornamental trees growing in the open. There have been a number of reports of sawfly defoliation in white spruce plantations in Region 2 as well as in Region 3. This may indicate a possible population buildup.

However, a number of these in Region 2 were found to be forest tent caterpillar feeding damage on white spruce rather than sawfly. Nevertheless, increased monitoring of open grown white spruce in the 1 to 6 foot height range is likely warranted.

Yellowheaded spruce sawfly defoliation was reported in a white spruce plantation in SESE Sec 21-T62N-R25W. Trees were 20-25 feet tall.

6/21 Spruce sawfly larvae from 1/4 to 3/4 inches long with most being 3/4 inches. Burnt Shanty Lake, Itasca County.

Walkingsticks - 2001



Stearns County

Diseases

Annosum root disease

Hererobasidion annosum (Fr.:Fr.) Bref.

Heterobasidion annosum causes a root disease of pines that has serious consequences for current and future productivity of affected conifer plantations. The disease has not been reported in Minnesota but has recently been found and identified in central Wisconsin. For the past three years, informal surveys of several thinned plantations with declining pockets have been conducted in Sherburne County. Three locations were sample, two in the Sand Dunes State Forest and one in a private plantation in Santiago Township. Collections of fruiting bodies and root specimens were sent to Dr. Glen Stanosz, Univ. of Wisconsin, for identification. So far, no *H. annosum* has been found.

Gall rust of Jack pine

Cronartium quercuum (Berk.) Miyabe ex Shirai

Three surveys were conducted to help determine the causes of jack pine mortality in plantations in northern Wadena County. A more complete report can be found in Special Projects Section.

A. Incidence of gall rust on seed orchard trees at Long Prairie (Browerville).
B. Incidence of jack pine gall rust on seedlings at Badoura Nursery.
C. Incidence of gall rust on planted seedlings in Wadena County.

A. On Thursday, September 27, 2001, all the trees at the Browerville jack pine seed orchard were inspected for the presence of jack pine gall rust by walking by each tree and visually inspecting its branches. The absence or presence of galls were split into four groups. The results are as follows:

	South Unit	North Unit
>10 galls/trees	13 trees	7 trees
4-10 galls	9	26
1-3	5	28
no galls	64	123

The tree tag number was recorded for each of the trees having more than 4 galls/tree. (* = 4-10 galls/tree)

South Unit

139-1120	396-1158*	232-1124*	259-1117	169-1065	406-1120
170-1065	444-1108	618-1084	233-1077	122-1116*	210-1109
404-1111*	484-1105*	160-1149	373-1034	160-1150*	111-1143
696-1161	109-2136*	170-1069			

North Unit

268-1121*	232-1103	122-1095	no tag*	268-1120	407-1074*
407-1077*	232-1115*	321-1043*	no tag R9*	170-1052	160-1132*
456-1132*	232-1108*	139-1107	no tag	no tag*	259-1104*
406-1118*	168-1055*	372-1032*	1040-2042*	404-1103*	150-1066
481-1041*	452-1061*	322-1058*	401-1036	484-1095*	373-1022*
469-1049*	no tag*	403-1055*			

Peine and Blenis, gall rust pathologists, recommend that trees in seed orchards with greater than 3 galls per tree should be removed. If that advice of is followed, 20% of the trees should be removed from this orchard. In the above listing, those trees are indicated with an asterisk. Peine believes that one to three galls per tree is tolerable; we have 12% in that category. 80% of the trees have no gall rust infections.

B. In 2001, selected jack pine 2-0 seedlings were inspected for gall rust at the Badoura Nursery. The incidence of gall rust was determined for each of three seedling sources in adjacent beds growing near oaks in the hedgerow: improved seed from the Crow Wing Seed Orchard, improved seed from the Long Prairie Seed Orchard and collected seed from Warroad Area. 50 seedlings in a row were systematically chosen and inspected. 750 seedlings from the Long Prairie Seed Orchard source were inspected. 600 each from the Crow Wing Seed Orchard and from Warroad Area sources were inspected. See Table. Seed orchard stock had five to six times less gall rust than unselected stock.

Incidence of jack pine gall rust on seedlings at Badoura Nursery			
Seed source	Number galled	Number sampled	Incidence of gall rust
Long Prairie Seed Orchard	10	750	13 per 1000 seedlings
Crow Wing Seed Orchard	7	600	11 per "
Warroad Area	40	600	66 per "

C. Incidence of gall rust on planted seedlings in Wadena County.

Seventeen jack pine plantations (ages 3-9 years) were surveyed during the late spring of 2001 by Area personnel, a student worker and by Seasonal Forest Health Specialists. See Survey Results Section. Ten 1/400th acre plots were taken per acre. In all, 2171 plots were taken. The survey was designed by Dr. Dan Gilmore, Univ. of Minnesota.

Looking at all trees (live and dead), gall rust accounted for 40% of the damaging agents.
Of the live trees 224 stems/ acre were infected by gall rust and accounted for 43% of the damage.
Of the dead trees, 71 stems/ acre were infected by gall rust and accounted for 43% of the damage.

Oak tatters

Cause unknown

Again, oak tatters did strike portions of southern Minnesota this year. As of this report, all the affected trees in several counties did recover new foliage. It is interesting to note that as far as we know all of the new foliage was free of symptoms.

The most striking aspect of this season's tatters was that it could be more appropriately named oak/hackberry tatters as the vast majority of the affected trees were hackberry. There was also a difference however between the southeastern and the southwestern parts of the state. In the southeast, primarily bur oak was affected. The defoliation was widely scattered and usually only small acreages were tattered. The defoliation was seen in Wabasha, Fillmore, Olmsted, Dodge and Mower Counties. In the southwest, hackberry defoliation was very high and seemed to affect every hackberry in at least the seven southwest counties of Brown, Watawan, Murray, Martin, Jackson, Cottonwood and Redwood.

This was the first time we have seen a large outbreak on hackberry. The oak tatters in southeastern Minnesota have been diminishing in extent for the last three years. In talks with Iowa officials, they have seen similar outbreaks in hackberry in past years.

Oak tatters is a relatively new condition that affects the first emerging oak leaves in the spring. It has been observed throughout several mid-western states for years. The first reports were from Iowa in the 1980's. More recently, it has been observed in Minnesota and Wisconsin. Oak tatters affects primarily the bur oaks. Ti has also been observed on a few other species. The newly emerged leaves of affected trees have a reduced leaf tissue between the veins which gives the leaves a lacy or tattered appearance, hence the name oak tatters. The injury appears at the time of leaf emergency, late May. Generally large portions of the landscape have been affected. However, within the affected area, a few unaffected trees can be found. Within a few weeks, a new flush of leaves will appear and be free of the symptoms.

The cause remains unknown. The pattern of symptoms suggests internal injury to developing tissues, before or at the time of leaf development and inside the over wintering buds. Oak tatters can be confused with early season outbreaks of oak anthracnose and the effects of late spring frosts.

Oak tip blight

Botryosphaeria quercuum

Last spring and summer, many of the oaks across central and southeastern MN showed signs of tip blight. Small twigs and branch segments 2 to 12 inches long wilted and browned as the weather warmed. This year, many of those same trees are showing extensive dieback. In some cases, the effected branches have died back to the main trunk.

The primary culprit is a fungal disease caused by *Botryosphaeria quercuum*. As noted in Sinclair, Lyon and Johnson, the symptoms are indistinguishable from oak twig pruners and cicada injury. However, close inspection shows distinct lesions and pycnidia, or the asexual fruiting structures of the fungus on the bark of affected twigs. The wood beneath the bark is discolored dark brown to black, with streaks that extend beyond the edges of the canker and/or infected twig. Development of pycnidia and wood discoloration begins as soon as the leaves wilt, often before they themselves have become brown.

B. quercuum frequently produces an annual canker. Affected trees wall off the infection and produce new shoots at the base of the damaged portion. Repeated infection can lead to clusters of shoots at the branch tip. In weakened trees, the fungus can become more aggressive and produce a perennial canker that can kill larger portions of the tree. That is what we are seeing among some trees this year. Branch segments 1-6' in length have died back and in some cases whole branches have been killed. Sucker sprouts are beginning to form at the base of some of these branches.

The fungus can infect wounds or damaged tissue. The timing of infection is not exactly known, but field observations indicate there is a relationship between the tip blight and weather related injury, such as that caused by hail and frost. Many, but not all of the trees sampled also bad signs of small bark beetles. While the beetles have not been specifically identified, their size and habit suggests they belong to the genus *Pseudopityophthorus,* the largest genus of balk beetles. Their rote is not known. The beetles may be coming in after the fimgus, attracted to the damaged tissue, or like the fimgus, they may be attacking tissue weakened by weather-related stress. The presence of the beetles in some twigs with no obvious lesions indicates they may have predated fimgal infection and thus acted as a facilitator by providing an entry point for the fimgus.

The most common member of the genus, the oak bark beetle *Pseudopityophthorus minutissimum*, is distributed from Quebec and Massachusetts south to Georgia and west to Colorado (Baker, Eastern Forest Insects). The beetles, which range in size from 1-2 mm long, produce at least two generations per year in the Lake States. Young adults emerge in spring and fly to tree tops to feed on buds, twig crotches, and the axils of leaves and immature

acorns. While they are suspected of carrying the oak wilt fimgus, their role in the spread of that disease has not yet been determined.

They lay their eggs m branches from .5 to 4" diameter. Although the beetles are not especially aggressive and prefer to breed m dead and dying branches, they can attack branches that appear otherwise healthy. Many of the twigs attacked last year were less than .5" m diameter indicating other species may have played a role as well.

Once started, there is little one can do to control fungal infections. Prune out affected portions, being sure to clean your tools between cuts. Since many of the oaks are slow to leaf out this spring (and to avoid spreading oak wilt), you should wait until July to prune your trees be sure you do not remove portions that are still alive. If possible, sucker sprouts should be pruned out. If the trees are suckering badly, you may need to weigh the threat of branch failure that these sprouts will pose in the future if allowed to develop into large branches, against the loss in the tree's aesthetic value if you prune the suckers out now. Sucker sprouts are never as strong as the original branches and are much more prone to breakage later on.

Chemical treatment of the beetles is not advisable because the timing is critical and nearly impossible to pinpoint. Therefore prevention is the best course of action for both the beetle and the fungus. Avoid wounding and maintain overall tree health through proper tree care. To help damaged trees recover, minimize additional stresses so they can devote starch reserves to branch replacement. Water during excessively dry spells and control other pest outbreaks (like FTC). To limit infestation and/or infection by other opportunistic pests, prune out wilted shoots and destroy them.

Oak wilt

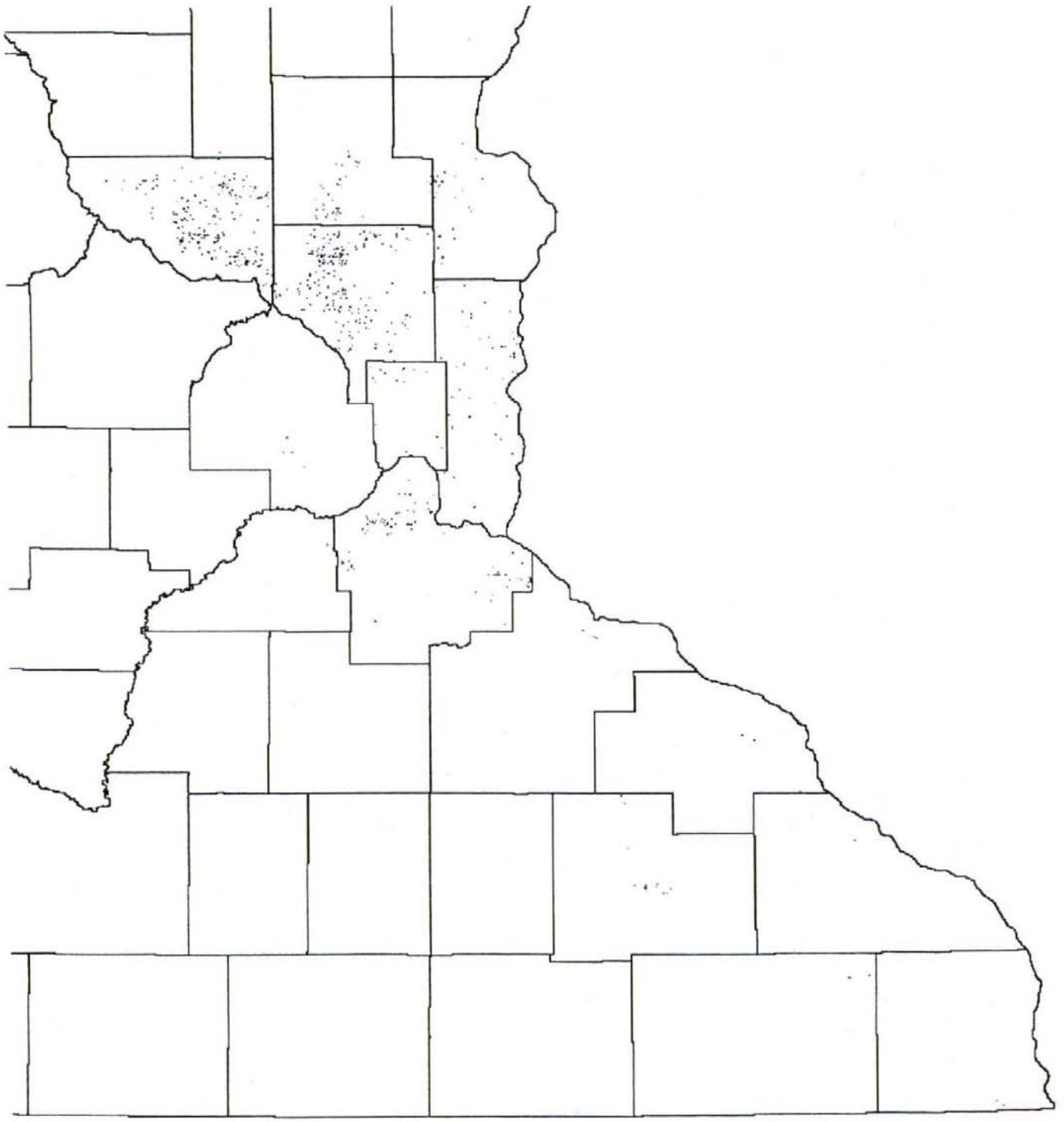
Ceratocystis fagacearum (TW Bretz) J. Hunt

Host	Oaks
Damage	Mortality
Area	3703 acres
Severity	Varies by county, see table below
Trend	Increasing in Region 3. Currently, we have treated and controlled 35 % of the existing oak wilt infection centers in Region 3.

Oak wilt in Region 3: Summary data for active and controlled sites
Data from 2000 and 2001
Analysis based on EPIC data & computations.

County	Total area of active and controlled sites (ac)	Total area of treated sites (ac) as of 12/2000	Percent of sites controlled as of 12/2000	Number of sites treated in 2001
Chisago	632	237	37	28
Isanti	578	321	36	25
Mille Lacs	25	9	36	035
Pine	1	1	100	0
Sherburne*	4390	1408	32	155

Oak wilt infection centers - 2001



Stearns	41	2	5	0
Wright	14	0	0	0
Regionwide	**5681**	**1978**	**35**	**208**

* = Excludes state land in the Sand Dunes State Forest.

A new version of the oak wilt map was prepared. See map. It documented all counties with one or more infection centers that were found by December 2000.

On State-owned lands in the Sand Dunes State Forest in Sherburne County , only two control projects were needed and were accomplished as follows:

Oak wilt control in Sand Dunes State Forest - 2001			
Location	**Perimeter**	**Control method(s)**	**Previous activities on site**
Near campsite 24 in Ann Lake Campground, 21-34-27	370 ft.	Vibratory plow	None
Just of 161st St. State Forest Land 35-34-27	400	Vibratory plow	None

There were sixteen forest health - oak wilt related projects for the Mn ReLeaf biennium, 2000-2001. Reports and financial statements were due June of 2001. Here is the breakdown of projects by local unit of government:

Region 3 - Mn ReLeaf - Forest Health Grants for biennium, 2000-2001.				
Local unit of government	**Type of grant and grant number**	**Forestry Area**	**Number of sites treated or TA hours in 2000**	**Grant amount requested***
Chisago County	Oak wilt suppression A07992	Cambridge	26 sites	$ 15,000
Chisago County	Oak wilt suppression A19042	Cambridge	10	5,000
Chisago & Isanti Counties	Technical assistance A04773	Cambridge	140 hours	5,000
Isanti County	Oak wilt suppression A07991	Cambridge	26	15,000
Isanti County	Oak wilt suppression A19039	Cambridge	20	5,000
Isanti County	Technical assistance A20762	Cambridge	144 hours	5,000
Mille Lacs East Central Woodland Owners Council	Oak wilt suppression A08350	St. Cloud	3	1,250

Sherburne County -1	Oak wilt suppression A03275	Cambridge	74	20,000
Sherburne County -2	Oak wilt suppression A07845	Cambridge	51	15,000
Sherburne County -3	Oak wilt suppression A 06918	Cambridge	18	6,000
Sherburne County -4	Oak wilt suppression Pending	Cambridge	25	2,500
Sherburne County	Technical assistance A13809	Cambridge	200 hours	2,100
Sherburne County	Educational A06918	Cambridge	Newsletter and education program	5,000
Stearns County	Oak wilt suppression A06924	St. Cloud	3	1,300
Stearns County	Technical assistance A16557	St. Cloud	200	5,000
Totals			**sites = 256 TA hours = 684**	**108,150**

* = Grant amount is less than 50% of total project monies.

Region 6 Mn ReLeaf Participation			
Participant LUG	**2001-02 Grants**	**2001 LMIC Map**	**2000 Active OW**
Afton	No	Yes	Yes
Andover	Yes	Yes	Yes
Anoka	No	Yes	No
Anoka County Conservation	No	No	Yes
Anoka County Parks	Yes	No	Yes
Apple Valley	Yes	Yes	Yes
Arden Hills	No	**No**	**Yes**
Bayport	No	**No**	**Yes**
Baytown Township	Yes	Yes	Yes
Birchwood	No	No	No
Blaine	Yes	Yes	Yes
Burnsville	No	Yes	Yes
Castle Rock Township	No	Yes	Yes
Circle Pines	No	**No**	**Yes**
Columbus Township	Yes	Yes	Yes
Coon Rapids	No	Yes	Yes
Cottage Grove	No	Yes	Yes
Dellwood	No	Yes	Yes
Douglas Township	No	Yes	Yes
Eagan	No	Yes	Yes
East Bethel - ck maps	Yes	No	Yes
Forest Lake Township	No	Yes	Yes
Grant	No	Yes	Yes

Ham Lake	Yes	Yes	Yes
Hugo	No	Yes	Yes
Inver Grove Heights	Yes	Yes	Yes
Lakeville	Yes	Yes	Yes
Lino Lakes	Yes	Yes	Yes
Linwood Township	Yes	Yes	Yes
Mahtomedi	Yes	Yes	Yes
Maplewood	No	**No**	**Yes**
Marine on St. Croix	Yes	Yes	Yes
May Township	Yes	Yes	Yes
Minnetonka	No	Yes	Yes
Mounds View	Yes	Yes	No
New Brighton	Yes	Yes	Yes
New Scandia Township	No	Yes	Yes
North Oaks	Yes	Yes	Yes
North St. Paul	Yes	Yes	Yes
Oak Grove	Yes	Yes	Yes
Oak Park Heights	No	Yes	Yes
Oakdale	Yes	Yes	Yes
Ramsey	Yes	Yes	Yes
Ramsey County Public Works	**Yes**	**No**	**Yes**
Ravenna Township	No	Yes	Yes
Rosemount	No	Yes	Yes
Roseville	No	Yes	Yes
Savage	Yes	Yes	Yes
Shakopee	Yes	Yes	No
Shoreview	No	Yes	Yes
St. Francis	Yes	Yes	Yes
St. Paul	No	Yes	Yes
Stillwater	No	**No**	**Yes**
Stillwater Township	Yes	Yes	Yes
Sunfish Lake	No	Yes	Yes
Vadnais Heights	Yes	Yes	Yes
West St. Paul	No	No	No
White Bear Township	Yes	Yes	Yes
Woodbury	Yes	Yes	Yes

Public education and program goal setting were important parts of this year's oak wilt activities.

1. **Community Forum: How will we manage oak wilt in the future?**
Lent Town Hall, Chisago County
Jan. 18, 2001
Sponsored by Chisago County Extension Service

With state-funding of the oak wilt cost-share program at a cross roads, Chisago County felt that they needed to chart the future direction for oak wilt control in their county at a community forum. To that end, they wanted to know (1) how successful the cost-share program was, and (2) what is the result if oak wilt is left unmanaged. Olin Phillips spoke about the political and financial aspects of the programs. Jana Albers spoke about the successes of the control practices and projected oak wilt futures with and without management. The audience was split into four groups to discuss ideas and proposals for Chisago County.

2. **Oak wilt 2001: Keep the momentum going.**
A legislative fact sheet that documented the successes of the cost-share programs and encouraged continuation of the programs supported by legislative funds. See Special Projects Section.

3. **Controlling oak wilt: 1988 - 2008**
On March 20 and 21, this slide talk was presented at the Shade Tree Short Course in St. Paul. The talk covered, what has been accomplished by the cost-share programs in the last decade and what could happen in the future if cost-share programs are discontinued. See Special Projects Section.

4. **Oak wilt : multi-agency and vendor meeting at Cambridge**
On September, a large group of people met in Cambridge to discuss oak wilt control in Chisago, Isanti and Sherburne Counties. It was set up and chaired by Rod Elmstrand, Chisago Co. Extension. Local OW vendors (consultant, plowing, Alamo, etc.), Steve Kunde, Steve Cooke, Gary Johnson, Jenny Juzwik, Tim Edgeton, Steve Nelson, Mark Wurdeman, John Nelson and Jana Albers attended.

By the end of the day, we concluded that we need to accomplish goals in three main categories:
A. Political support - in order to continue funding and implement local initiatives,
B. General education - in order to keep OW alive as an important forestry issue and prevent long distance spread of OW (this would include billboards, jingles, demo areas, fliers). Educating individual landowners is still a job for the LUG thru MN Releaf and helps take care of short distance spread.
C. An "ecosystem approach" to controlling OW. Instead of billing our efforts solely as OW control, step back and take a broader approach that promotes a "sustainable, native forest". After the plowing and STR, we come back in and plant suitable trees, based on the LTA, thus diversifying the forest and making it less prone to oak wilt in the future.

5. A **Mn ReLeaf Grant was submitted for oak wilt education** by Chisago County for Chisago, Pine Isanti and Mille Lacs Counties. The goal is to develop transferable and sustainable educational packages and tools that will serve all local units of government well into the future. The products will be made available through agency websites that are dedicated to the dissemination oak wilt disease management information.

Rhizosphaera needlecast of spruce

Rhizosphaera kalkhoffii Bubak

Rhizosphaera needlecast disease infected approximately 75% of a 5 acre blue spruce plantation east of Grand Rapids. These trees were being grown for Christmas trees and as ornamental nursery stock and were 3 to 6 feet tall. The plantation only had a couple of small pockets of infected trees last year. The owner sprayed the trees with chlorothalonil using a back pack mist blower in 2001 but only completed one application rather than the recommended two applications.

Spruce needlerust

Chrysomyxa spp.

A golden cast to Colorado Blue spruce trees in northern Minnesota was due to the orange-colored spores of the spruce needle rusts (*Chrysomyxa ledi* and *C. ledicola*). The spores are exposed as the fungal blisters on current year's needles burst. In some areas, the majority of the susceptible Colorado Blue spruce were infected. Heavy infections were observed in and around Cloquet, Cromwell and International Falls. Infection depends on having the correct weather conditions for infection at the same time the spores from the alternate hosts are present. Indeed this is why this rust is usually seen only in the northern areas of the Minnesota. The alternate hosts are Labrador tea and leather leaf, both native heaths and prominent members of sphagnum bog communities. Norway and Black Hills appear to be quite resistant, white spruce is somewhat resistant, but Colorado Blue and black spruce are very susceptible. Not only is the black spruce susceptible but it grows in the same habitat as the alternate hosts.

The fungi of spruce needle rusts require an alternate host to complete their life cycles. Spores released from infected spruces during late summer infect the native heaths and overwinter on them. The following spring the heaths return the favor and release spores that infect young current year spruce needles.

The shedding of the infected needles occurs after sporulation of the fungus on the needles in August to September. The majority of current year's needles may be lost. And although this makes the tree unsightly, it will survive. Repeated attacks over consecutive years, which usually does not happen, will slow the growth of the tree but rarely kills it.

Willow scab and black canker of willow

Venturia saliciperda Nuesch, and,
Glomerella miyabeana (Fukushi) v. Arx

Willow blight also called 'willow scab and black canker' was reported on trees in Carlton and Itasca Counties. The disease, willow blight, is actually caused by two fungi, *Venturia saliciperda* and *Glomerella miyabeana,* that occur together. These fungi were imported from Europe and first reported in eastern North America about 1927. The disease apparently first spread through northeastern Minnesota in the early 1980's when large numbers of willow trees in windbreaks and yards were infected and killed.

Symptoms and disease development are as follows. Infected leaves are killed rapidly and become blackish. Leaves remain attached to the tree for some time but eventually dry up and fall off. The fungi move into the petiole and twig causing shoot dieback. Black lesions and cankers develop on twigs, shoots and branches. Shoots and leaves and entire trees take on a scorched or burnt appearance. Damage early in the season is often more severe in the lower part of the crown.

Willow blight is most apparent in years with wet spring weather which favors spread of the disease. Control on shade and ornamental trees consists mainly of pruning out and destroying diseased twigs and branches during the dormant season to reduce inoculum and further spread of the disease. The fungi overwinter on dead infected twigs. High levels of infection two or three years in a row may kill trees of any size.

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Abiotic agents

Drought

USFS aerial surveyors mapped 36,509 acres of moderate to heavy dieback on sugar maple caused by drought. They identified 11,739 acres in Lake County and 24,769 acres in Cook County. This damage was not reported or confirmed by any ground truthing at this time. Much of Lake and Cook Counties have been defoliated by forest tent caterpillars during this outbreak. Also July of this year was very hot and dry. These events may have been involved in the aerially observed dieback.

Ice storm

An ice storm in April caused heavy damage to trees in the Cloquet Area. It damaged hardwood trees as well as conifers. Red pine plantations thinned 1 or 2 years before the storm suffered especially heavy damage. In some plantations over 50% of the trees were broken off.

On July 17 a number of these were examined for bark beetle activity. Plantations examined were in SE1/4 Sec 34-T48N-R17W, NW Sec 8-T47-R17W,NE Sec 5-T47-R17W and SESW Sec 16-T48-R18W. Bark beetle populations were beginning to build. Attack by overwintering bark beetles had been light. Adults of the first generation of 2001 had completed nuptial chambers and started excavating brood galleries. Some of these galleries were up to 3 inches long. No new larvae were evident at this time. Most of the plantations with significant damage were currently being salvaged or salvage had already been completed.

Winter injury

Host:	Conifers, particularly, red pines.
Damage:	Discoloration, dieback and mortality
Area:	1052 acres on the Anoka Sand Plain
Severity:	See table below
Trend:	With fall and winter precipitation, effects of drought should be decreasing, thus decreasing the amount of discoloration in 2002.

Each winter and spring some of trees and shrubs experience injuries due to cold temperature and/or dehydration. Winter drying occurs in late winter and early spring when warm, dry winds desiccate needles and twigs. At this time of year, roots are not active and water in the soil is frozen but the shoots and needles are transpiring. There isn't any water to transport up to the shoots so the needles become progressively dehydrated by the spring winds. Affected needles turn red from the tip down and often have a mottled appearance. Buds are usually not killed. Normally, snow cover prevents winter drying of young conifers by providing shelter from drying winds and by preventing deep frost formation in the soil. In some years it's common to see young conifers with a strong line of demarcation separating the brown, desiccated tops from the healthy, green branches that were covered by snow.

This year, winter injury was coupled with prolonged drought on the Anoka Sand Plains in Wright, Sherburne, Isanti and Chisago Counties. Discoloration of conifer foliage persisted into the summer and there was ssome mortality of conifers due to desciation, particularly, red pines. As the drought continued, bark beetles took advantage of the low vigor trees and local outbreaks ensued. See section on Bark Beetles.

Winter injury - 2001

Acres of Winter injury - 2001 - Aerial survey results				
County	**Trace 1-25%**	**Light 26-50%**	**Moderate 51-75%**	**Heavy 76-100%**
Aitkin		96	44	
Benton		59		
Crow Wing	101			
Isanti			155	
Mille Lacs		74		
Sherburne			214	
Stearns	7	110		
Todd		27		42
Wright	39		84	
Totals	**147**	**366**	**497**	**42**

Incidental Pests

Insects and Mites	Host	County	Comments
Ash flowergall mite	Ash	Crow Wing	
Aspen leafblotch miner	Aspen	Todd, Wadena	
Box elder bug	Box elder	Crow Wing	
Bronze birch borer	Paper birch	Stearns	Yard trees
Common bark lice (psocids)	Bark of various hardwood trees	Crow Wing	
Cottonwood leaf beetle	Willow	Wadena	
Crimson erineum mite	Maple leaves	Crow Wing	
Elm leaf beetle	American elm	Crow Wing	
Fall webworm	Hazelnut	Wadena	
Gall wasp (Neuroterus macrocarpae)	Burr oak	Morrison, Wadena	
Gall wasp (Disholcaspis)	Burr oak	Crow Wing	
Greenstriped mapleworm	Red maple	Crow Wing	Rare
Honeysuckle aphid	Honeysuckle	Sherburne	
Introduced pine sawfly	White pine	Crow wing	
Larch beetle	Larch	Aitkin	
Larch beetle	Larch	Crow Wing	SWNE S30T45R29
Larch beetle	Larch	Cass	NENE S27TI36R32
Larch beetle	Larch	Morrison	4 miles N of Randall
Larch casebearer	Larch	Aitkin, Crow Wing	
Maple bladdergall mite	Maple leaves	Crow Wing	
Nematus sawfly	Juneberry	Crow Wing	
Northern pine weevil	Red and Scotch pine	Morrison, Pine	
Oak applegall wasp	Oak	Aitkin	

Insects and Mites	Host	County	Comments
Oak webworm	Burr oak	Cass	
Orangestriped oakworm	Oaks	Morrison	Rare
Pale tussock moth	Oaks	Crow Wing	
Paper wasps	House eaves	Crow Wing	
Pine webworm	Jack pine	Crow Wing	
Pine tortoise scale	Jack pine	Morrison	
Pine bark beetle	Pines	Widespread on stressed R 3 pines	
Pinkstriped oakworm	Oaks	Crow Wing	Rare
Pitch mass borer	Pine	Todd	
Potter's wasp	Logs	Aitkin	
Powderpost beetles	Logs	Aitkin	
Red pine shoot borer	Red pine	Crow Wing	
Red turpentine beetle	Red pine	Widespread on stressed trees in R 3	
Redheaded pine sawfly	Jack pine	Crow Wing	
Redhumped oakworm	Oaks	Morrison	Rare
Rose chafer beetle	Hardwood trees, herbaceous plants	Crow Wing	Brainerd
Scarab beetle (Osmoderma eremicola)	Damp and decaying wood	Crow Wing	
Spider mites	Spruce	Crow Wing, Todd	
Spruce gall adelgid	Spruce	Crow Wing	Yard trees
Stag or pinching beetle (Pseudolucanus placidus)	Damp, decaying wood	Crow Wing	
Two-lined chestnut borer	Burr oak	Crow Wing, Sherburne	Yard trees stressed from septic effluent
Willow leaf beetle	Willows	Crow Wing, Isanti, Pine	
Yellow-headed spruce sawfly	Spruce	Widespread in R 3	
Jackpine Budworm	Jackpine	Hubbard, Becker,	Negligible def. In 2001

Insects and Mites	Host	County	Comments
		Beltrami	
Redheaded Pine Sawfly	Jackpine	Beltrami	Mod. Def. Localized
Spruce Bud Scale	White Spruce	Clearwater	Windbreak Trees
Imported Willow Leaf Beetles	Willow Species	Hubbard, Beltrami	Less activity in 2001
Yellowheaded Spruce Sawfly	White Spruce	Hubbard, Beltrami	More reported in 2001
Introduced Pine Sawfly	White, Scots	Hubbard, Beltrami	Down from 2000
Larch Casebearer	Tamarack	L.O.W., Beltrami	Large Infestation Forest Stands
Larch Beetle	Tamarack	Roseau, L.O.W., Beltrami	Forest Trees more Reported in 2001
Variable Oakleaf Caterpillar	Oaks and Other Hardwoods	Hubbard	Localized, Light to Mod. Def. Fall Def. Complex
Birch lace bugs *Corythucha pallipes*	White birch	St Louis	
Striped alder Sawfly *Hemichroa crocea*	White birch	St Louis	
Blister beetle	Lupine	St Louis, Itasca	
Cedar tree borers *Semanatus ligneus*	Bemidji	Beltrami	Rustic furniture builder
Forest tent caterpillar *Malacosoma disstria*	European Larch	Koochiching	Yard tree
Larch sawfly *Pristiphora erichsonii*	Tamarack	St Louis	Isolated stand west of Floodwood along Hwy 2
Pine tortoise scale *Tomeyella paricornis*	Jack pine	Carlton	Also heavy sooty mold
Spruce gall midge *Mayetiola piceae*	White spruce	Itasca	Road side tree 90% of current year shoots affected
Spruce needleminer Species unknown	Black spruce	Itasca	Along Hwy 2 from west of Floodwood to Grand

Insects and Mites	Host	County	Comments
			Rapids
Wooly aphid Eriosomatidae	Sumac	Itasca	Hollow apple type galls on leaves
Aspen Blotch Miner	Quaking Aspens	Central Counties	Widespread in Stands Less. Def. By FTC
Forest Tent Caterpillar	Aspens, Birch, Willows, Oaks, Other Hwds.	North & Central Counties of Region 1	Increased Activity in Central Counties
Redhumped Oakworm	Oaks and Other Hardwoods	Hubbard	Part of Fall Def. Complex
Spruce Budworm	White Spruce	Hubb., Cass, Beltrami, Becker, Clearwater	Decreased Act. In 2001. Two new sites in 2001

Diseases	Host	County	Comments
Anthracnose	Burr oak	Widespread in R 3	
Apple scab	Apple	Pine	
Armillaria	White pine	Crow Wing	Yard tree
Aspen shoot blight	Aspen	Cass	
Butternut canker	Butternut	Todd	
Dutch elm disease	American elm	Widespread but in few numbers in R3.	
Elm wetwood	Chinese elms	Wadena	Yard trees
Oak wilt	Oak	Sherburne	
Pine-oak gall rust	Red and white oaks	Wadena	Telia on underside of leaves
Rhizosphaera	Blue spruce	Cass, Wadena	Yard trees
Septoria canker	Hybrid poplar	Morrison	
Sirococcus shoot blight	Red and scotch pines	Sherburne, Morrison	Drought-stressed pines
Sphaeropsis shoot blight	Red and scotch	Sherburne, Morrison	Drought-stressed pines

	pines		
Spruce needle rust	Blue and black spruce	Aitkin, Carlton	
Tar spot	Maple	Crow Wing	
White pine blister rust	White pine	Crow Wing, Todd	
Diplodia Tip	Red Pine	Hubbard	40 + year old Plantation trees
Rhizosphaera Needlecast Blight	Blue Spruce	Northern Counties	Continuation of Previous infestations. Epidemic
Spruce Needle Rust	Blue Spruce	Northern Counties	Epidemic in plantation and yards
Armillaria	Balsam Fir	Hubbard, Beltrami	Yard trees, Compacted and water logged soils

Animal and Abiotic	**Host**	**Location**	**Comments**
Animal			
Deer browsing	Young white and jack pines	Widespread in R 3	
Goat browsing	Fruit trees	Morrison	
Pileated woodpecker holes	Paper birch	Mille Lacs	
Porcupine girdling	Red pine, oak, maple	Crow Wing, Morrison	
Rabbit girdling	Balsam, spruce	Crow Wing	
Sapsucker holes	Scotch pine	Crow Wing	
Squirrel damage	Pine cones	Crow Wing	
Sapsuckers	Birch, Mt. Ash, Silver Maple	Beltrami	Stressed Yard Trees
White Tail Deer	Red Pine, White Spruce	Clearwater	County Plantations.
Abiotic			

Animal and Abiotic	Host	Location	Comments
Construction damage and overfill mortality	Red and white pine, oak	Crow Wing	Yard trees
Drought mortality	Red pine	Cass	On top of steep lake shore
Fire damage	Balsam	Crow Wing	Yard trees
Flooding stress	Ash	Crow Wing	Brainerd water pipe leak near yard tree
Girdling roots	Spruce	Crow Wing	Yard tree
Hail damage	All trees	Scattered in R 3	
Herbicide damage	Basswood, spruce, white pine	Aitkin, Crow Wing, Morrison	Yard and park trees
High water mortality	Conifers	Crow Wing	Along shore of lake
Root suffocation	White pine	Crow Wing	l2 inches dirt overfill above root collar
Sewage mortality	Red and white pine	Crow Wing, Wadena	From septic tank effluent
Sunscald cracks	Hybrid poplars	Morrison	
Tornado winds	All trees	Crow Wing	S and SE of Brainered
Transplant mortality	Balsam	Southern Cass	Yard trees
Transplant mortality	Pine, spruce	Crow Wing, Pine, Todd	Burlap, rope, and wire not removed from root ball
Winter burn	Conifers	Widespread in R 3	
High Water Table	Balsam Fir, White Spruce, Red Pine	Beltrami, L.O.W., Roseau	
Tree Planting Mistakes	White Spruce, Red Pine	Beltrami, Hubbard, Itasca	Planting too deep, Wrap around roots, Tree spade mortality
Construction Damage	Red Pine	Beltrami	Excavating around Root critical zone

Phenology for 2001

Date	Event	County
4-9	A few aspen clones with swelling buds. Pussy willows are out. Snow in fields is spotty, but 6" deep in deciduous forests. Had a heavy rainfall on the 7th. First robin spotted.	Itasca
4-10	Nothing green in the swamps. Larch beetle grubs, pupae and adults under bark. Significant snow melt since yesterday and resultant flooding.	Aitkin
4-17	Oak wilt mats detected (but bark not cracked open) and nitidulid beetles are flying (as detected by trapping).	Metro locations
4-19	Silver maples blooming	Crow Wing
4-19	Mourning cloak butterfly. Everything else is still in winter mode.	Wadena
4-22	First dandelions bloom next to buildings. Few aspen catkins out. Sambucus leaves are 1" and flowers are < ½ inch. No FTC yet.	Itasca
4-23	Lots of rain and cool temperatures. Silver maple buds froze. Aspen catkins observed on the 22nd and elm flowers on the 21st.	Ramsey
4-25	Cold weather continues. Aspen catkins are full blown.	Itasca
4-27	Red maple, American elm, and birch in small leaf	Crow Wing
4-27	Simultaneous bud expansion of bur and red oaks.	Ramsey
4-28	Basswood buds elongated with green showing through the bracts. Blueberry buds expanding. Weather hot and sunny. Up to 70 degrees. (Ice out on Pokegama Lake)	Itasca
4-29	Apples, pears, plums blooming	Crow Wing
4-29	Basswood buds showing green growth	Crow Wing
4-30	Aspen leaf blades 1" wide, Jack pine shoots 1", ash leaves 1"	Cass
4-30	80% aspen in small leaf	Todd
4-30	Forest tent caterpillar hatching	Todd
4-30	Leatherleaf in bloom. Aspen leaves on few clones < ½", catkins still attached. Red maple in bloom. Pussy willow catkins yellow, some with tiny leaves showing. Red osier buds broken, some with tiny leaves.	Itasca
4-30	Ice still on NW corner of Mille Lacs Lake. Phenology similar to Itasca.	Aitkin
4-30	A few dwarf trout lilies in bloom. One anemone in bloom. Bloodroot in bloom. Red maples in bloom. At Fr. Hennepin State Park: 2-3% of the FTC are hatched.	Mille Lacs
5-1	No FTC hatching at Birch Lake Campground	Morrison
5-1	Larch needles 1/4 inch long	Crow Wing
5-3	Oaks in small leaf	Crow Wing
5-3	Larch beetle adults found under bark. Larch spur shoots and needles ½" long. They're easily visible as greening up. Silver maples blooming. At Wealthwood: bloodroot, spring beauty, Dutchman's breeches, dog tooth lily and red and sugar maples blooming.	Aitkin

5-3	At Fr. Hennepin SP: FTC still 1st and 2nd instars. Basswood buds ½" long. Largest trembling aspen is 1" long. Ironwood buds are 3/4" long. Amelanchier, no flowers yet. Spruce bud bracts just curling a bit. Marsh marigolds blooming.	Mille Lacs
5-5	Rainy, cool days and freezing at night. Bloodroot still blooming. Aspen leaves nearly 1" on many clones. Red maples in full bloom. Amelanchier blossoms showing white. Tiny white and purple violets showing in lawns.	Itasca
5-7	Basswood leaf blades to 1 ½" long and trembling aspen leaf blades to 2" long	Todd
5-7	NE part of county: Basswood and grey dogwood leaves 3/4 to 1" long. Paper birch catkins are out. Marsh marigolds blooming. Bloodroot still blooming.	Cass
5-7	Dandelions in full bloom. Red oak catkins 3/8", not pendant; leaves ½" long. Bigtooth aspen leaves are 3/4" long.	Crow Wing
5-7	At Lakeshore: FTC in 2nd instar. Basswood leaves in elongated bud to 1 ½ " long. Red maple and balsam poplar leaves are 1" long. Trembling aspen leaves are 1 ½" long. Amelanchier blossoms are halfway out of bud; leaves < 1" long; racemes are 2" long. Large bellwort is beginning to bloom. Bloodroot and anemone done. Thalictrum one foot tall. Trillium starting to bloom.	Cass
5-7	Forest tent caterpillar second instars (4 to 6 mm long)	Todd
5-8	Hybrid plums in full bloom	Crow Wing
5-9	Saw first dragonflies today. Morels found. Trembling aspen and balsam poplar leaves are between 1 and 2 inches long. Red maple leaves are 2". Some ashes on uplands are breaking bud. Basswood leaves < 3/4". Paper birch leaves < ½ ". Amelachier in bloom. Anemone, large bellwort and marsh marigolds in bloom. Most Hepatica are still purple.	Cass
5-9	Trilliums in bloom.	Itasca
5-10	T. aspen leaves nearly full-sized. Red and bur oak leaves 1-2". Ash leaves nearly 3". Paper birch leaves > 1". Bigtooth leaves ½ to 1 ½ inches. Red and jack pine candles are 1-2" long. Amelanchier blooming. Pin cherry in white bud stage; choke cherry in green bud stage. Trillium, marsh marigolds, short pussytoes and dandelions in bloom.	Crow Wing
5-10	T. aspen leaves 1-2". Paper birch leaves < 1". Red maple leaves < 3/4". Balsam poplar leaves > 2". Red maple blooming. Amelanchier starting to bloom.	Itasca
5-10	Ash buds still small. Red maples still flowering, green leaf buds visible. Red oak buds < ½ elongated, silver maple buds > 1 ". Basswood mostly in early bud elongation. Bigtooth buds up to 1". T. aspen leaves 1". Birch catkins still present, buds green and slightly elongate. Peak marsh marigold and spring beauty blooms. Trillium near peak. Blooming = Dutchman's breeches, large bellwort, anemone. Equisetum sporophylls shedding pollen.	Aitkin
5-10	At Fr. Hennepin SP: FTC in 2nd instar. Red oak leaves unfurling, 1" long. Basswood leaves unfurling, 1 ½" long. Red maple leaves 1 ½". Red oak leaves 1". Paper birch leaves 1 1/4". Ash leaves 3 1/2". Red pine candles are fat and 1-2 inches long. Amelanchier blooming. Anemone blooming.	Mille Lacs
5-11	Red turpentine beetles in pheromone traps	Crow Wing
5-13	Sambucus, wild ginger and Hepatica blooming.	Itasca
5-14	Wild plums blooming	Morrison
5-14	Basswood leaf blades to 2 ½" wide	Todd
5-14	FTC to 5/16" long (8 mm)	Todd

5-14	White spruce shoots 1 1/4" long and most bud caps off	Todd
5-14	No walking stick hatchlings on oaks	Stearns
5-14	Basswood leaves are silver dollar sized. No FTC observed.	Cass
5-14	Bigtooth leaves 1".	Itasca
5-14	Red and white oaks blooming	Stearns
5-15	Amelanchier still blooming. FTC are 5/8 inches long. Pin cherry, dandelions in farm fields, Trillium and marsh marigolds blooming.	Itasca
5-15	Aspen seeds flying. Pin cherry in bloom. Big tooth leaves are 1-2" long. Crabapples starting to bloom. Red pine candles are 2". Jack pine cone flowers are visible. Sambucus blooming.	Cass
5-15	Peak pine-oak gall rust sporulation.	Wadena
5-16	Lilacs blooming	Crow Wing
5-16	FTC ½" long	Todd
5-16	Jack pine rust galls 90% sporulating	Wadena
5-16	Chokecherry blooming	Crow Wing, Todd
5-18	FTC are 3/4 inch long. Crabapples and choke cherries in bloom.	Itasca
5-18	Trillium and white violets in bloom.	Aitkin
5-18	FTC are 3/4 inch long. Trillium fading. In bloom: crab apples, dandelions, tick seed, chokecherries, lilac just starting. Crowfoot seeds visible.	Mille Lacs
5-21	Jack pine pollen shedding	Cass
5-21	Chokecherry blooming	Crow wing, Todd
5-23	FTC 1 ½" long	Crow Wing
5-24	Spruce budworm mostly 3rd instars, some 2nds. 10 to 90% of bud caps off white spruce buds, shoots tender.	Aitkin
5-24	Silver maples dropping seeds (fruit)	Crow Wing, Wadena
5-24	Ohio buckeye in full bloom. Thalictrum starting to bloom.	Itasca
5-30	Red pine pollen shedding	Crow Wing
5-31	Siberian elm with many seeds (fruit)	Crow Wing
6-5	Red osier and pagoda dogwood blooming	Todd
6-5	Lilacs in seed (fruit)	Todd
6-8	FTC 1/8 to 1 3/4" long	Todd
6-8	Sarcophagid flies active	Todd

6-9	Bark beetles building up in drought-stressed and storm damaged red pine plantations.	Sherburne, Wright, Isanti, Chisago
6-12	Black locust in full bloom. Heavy anthracnose noted on oaks.	Crow Wing
6-12	FTC starting to cocoon up.	Itasca
6-14	Many, many, many FTC spinning cocoons. In bloom: Yellow hawkweed, Q. Anne's lace, black raspberry and lupine.	Itasca
6-15	FTC - 2nd day of cocooning. Noted lots of DED, oak anthracnose and willow blight. In bloom = goat's beard, orange and yellow hawkweed, water hemlock. At Big Sandy: FTC starting to pupate. Lupine and oxeye daisy in bloom. Peak of blue flag bloom. Lost of oak anthracnose.	Itasca, Aitkin
6-15	At Fr. Hennepin SP: No FTC cocoons yet. In bloom: wild geranium, Hydrophyllum and water hemlock is just starting.	Mille Lacs
6-18	FTC not cocooning yet. Very sparse population. Very few flies.	Crow Wing
6-20	In bloom: oxeye daisy, orange and yellow hawkweed and blue flag.	Carlton
6-22	At Fr. Hennepin SP: No FTC cocoons at all, only a few sick caterpillars. A good sign.	Mille Lacs
6-22	Walking sticks (green) averaged ½ " long	Stearns
6-28	FTC moths near lights.	Brainerd
7-6	Yellow-headed spruce sawfly larvae ½" to 3/4' long	Crow Wing
7-9	Walkingsticks mostly 1 ½ inches long.	Stearns
7-9	Orangestriped oakworm 1/4" to 1/2" long	Morrison
7-9	Greenstriped mapleworm ½" to 1" long	Crow Wing
7-9	Pinkstriped oakworm 1/4" long	Crow Wing
7-10	In bloom: Milkweed, bird's foot trefoil, red clover, oxeye daisy, bull thistle, fireweed, white tansy and four o'clocks.	Itasca, Crow Wing
7-11	Yellow headed spruce sawfly damage is widespread and severe this year. In bloom: black-eyed Susans, Turk's cap lilies, basswood in full bloom.	Aitkin
7-13	Walking sticks 1 to 2 3/4" long; most 1 ½" long	Stearns
7-16	Basswood in bloom. Also blooming: jewelweed is beginning, peak bloom for Canada thistle, bull thistle is beginning, yarrow, water hemlock, cow parsnip, zigzag aster, blue vervain and meadow sweet.	Aitkin, Kanabec
7-16	Orangestriped oakworms hatching	Todd
7-17	Red pine shoot borer pupating	Crow Wing
7-19	Trees starting to refoliate after FTC defoliation. A few pale green weevils found. In bloom: full bloom for showy ladyslippers, end of yellow ladyslippers, meadow rue, oxeye daisy, daisy fleabane, false Solomon's seal, goat's beard, white tansy, milkweed about a foot tall.	Aitkin
8-7	Walking sticks to 3 ½" long and mating	Crow Wing, Stearns
8-20	Found moth = pale tussock moth, Halysidata tessellaris.	Crow Wing

9-4	Redhumped oakworms 1" long	Morrison
9-4	Walking stick defoliation reaches 90 to 100% on codominant oak trees.	Stearns
9-10	Red maple leaves turning red and orange	Crow Wing
9-10	Ash leaves turning yellow	Crow Wing
9-10	Sumac leaves red	Crow Wing, Morrison
9-10	Birch leaves yellowing	Crow Wing
9-11	Black ash approaching peak color.	Itasca
9-13	Redhumped oakwoms to 1 ½" long	Stearns
11-17	Still very mild and unseasonal weather for the month. Today is sunny and hit 60 degrees.	Itasca

Special projects

Strategic plan for the Gypsy Moth
Controlling oak wilt: Accomplishments from 1988 to 2001
Oak wilt suppression: Using herbicides
Jack pine mortality in young plantation in Wadena County
Co-colonization of red pine in central Minnesota by *Ips.* spp.
Tree assessment along the proposed road construction project in Itasca State Park
R6 Wildland urban interface project
Metro urban and community forest health surveys
Deer repellant study
Urban Hazard Tree Manual
Hazard tree training

A STRATEGIC PLAN FOR THE COOPERATIVE MANAGEMENT OF GYPSY MOTH IN MINNESOTA

The gypsy moth, *Lymantria dispar,* is one of the nation's most serious tree pests. Millions of acres of trees have been defoliated by gypsy moth caterpillars in a single year. The moth currently infests nearly all of the eastern United States, from Maine south to North Carolina and west to Wisconsin. With the moth at Minnesota's doorstep, there is an immediate need to examine ways to delay gypsy moth establishment and mitigate adverse impacts resulting from gypsy moth defoliation or related management activities. These impacts may affect tree, water and wildlife resources; Minnesota communities; timber, tourism and nursery industries; and the quality of life for Minnesota residents. In recognition of the inevitable arrival of the gypsy moth, a coalition of state and federal agencies have joined together to develop a ***Strategic Plan for the Cooperative Management of Gypsy Moth in Minnesota.*** The plan presents a coordinated approach to the statewide management of the gypsy moth. The plan's mission is to:

MISSION STATEMENT

Delay, prevent or mitigate adverse impacts directly or indirectly associated with gypsy moth infestation on the state's natural resources, citizens and industries.

This cooperative strategic plan serves as a dynamic blueprint to:

- formalize the relationship between and among the participating agencies,
- monitor the status of the gypsy moth within Minnesota and neighboring states,
- assess the implications for Minnesota,
- recommend appropriate management strategies, and
- implement those strategies that will maximize resource sustainability.

EXECUTIVE SUMMARY

The gypsy moth, Lymantria dispar, is one of the nation's most serious tree pests. The pest is currently established in nearly all of the eastern United States, from Maine south to North Carolina and west to Wisconsin. Although establishment of the gypsy moth in Minnesota is inevitable, tactics that delay its establishment allow more time to implement activities that may help reduce the impact on the state's residents, industries and natural resources, as well as provide public officials and land managers more time to make and implement informed policy and management decisions. In response to expanding populations within Wisconsin and increasing detection trap catches in Minnesota, the Cooperative Minnesota Gypsy Moth Program was initiated. The following Strategic Plan represents a comprehensive guideline for the management of the gypsy moth within the state.

As endorsed by the Minnesota Departments of Agriculture (MDA) and Natural Resources (MNDNR) and the United States Department of Agriculture (USDA), the plan formalizes the relationship between the participating agencies and lays the foundation for cooperative program activities. The plan also provides a model for the management of other invasive pests. The model revolves around the structure of the program which places the MDA and MNDNR commissioners in an equal partnership over the program at the state level. The Gypsy Moth Program Advisory Committee (GMPAC) coordinates the program under the supervision of the State Executive Committee (GMSEC), which is in turn responsible to the commissioners. Management and policy recommendations are formulated cooperatively within GMPAC along procedural guidelines set forth in the GMPAC bylaws. While all participant organizations operate under their own individual mandates, participants are committed to the cooperative planning and implementation of GMPAC recommendations. Public input and outreach would be achieved through the Gypsy Moth Program Statewide Network (GMSAN), an interactive

network of interest groups and individuals. Issues which cannot be resolved within GMPAC or its subcommittees, will be outlined, researched and referred to GMSEC.

The gypsy moth program as outlined in the plan, involves three levels or phases of gypsy moth infestation: pre-infestation (no established populations are known to exist in the state), transition (increasing male moth catches indicating low-level populations are likely to exist in some portions of the state, while other portions remain uninfested) and general infestation (permanent populations of gypsy moths exist in all or portions of the state). MDA is recognized as the lead regulatory agency. MNDNR will be the lead agency in forest and gypsy moth population management activities under generally infested conditions. State or Federal Quarantine Declarations as well as significant changes in biological populations will be trigger points for decisions on leadership roles during transitional phases. Fiscal, political and regulatory considerations will also influence the decision.

Three federal cost-share programs parallel the three phases of gypsy moth infestation. These are eradication (pre-infestation), Slow-the-Spread or STS (transition) and suppression (general infestation). During each phase ofgypsy moth management, the respective lead agencies will oversee and direct these cost-share programs. Implementation is contingent on adequate levels of funding.

There are eight components of gypsy moth management described in the plan: regulation and quarantines, surveys, treatments as specified in the 1995 Federal Environmental Impact Statement (FEIS), silviculture, biological control, research, education and public relations, and funding. The goals for each component are as follows:

Regulation and Quarantine: to prevent the artificial spread of the gypsy moth to non-infested areas within Minnesota and other states by regulating the movement of high risk articles.

Surveys: To provide state officials and program managers with the biological, social and economic data needed to make informed decisions.

Treatments (FEIS): To lesson the impact of the gypsy moth on people and the environment, while minimizing the impact on non-target organisms; and to avoid potential environmental impacts from diverse and uncoordinated treatments conducted by landowners and local programs.

Silviculture: To utilize forest management practices, where applicable, to minimize the negative impacts associated with gypsy moth outbreaks.

Biological Control: To evaluate, select, introduce and monitor suitable biological control agents capable of delaying the establishment and/or reducing the impact of the gypsy moth, without adverse impact to non-target species.

Research: To identify research needed to support survey and management decisions and to facilitate research efforts that meet those needs.

Education and Public Relations: To develop and distribute accurate information to public officials, agencies, businesses and citizens on the potential impacts of the gypsy moth and gypsy moth control efforts, and to actively seek out and encourage public input into various aspects of the cooperative program.

Funding: To identify sources for and obtain the financial backing needed to accomplish program goals.

The next stage of the cooperative program is the development of action plans for each component of gypsy moth management. Action plan development and implementation will begin once the strategic plan has been approved and signed.

Controlling oak wilt: Accomplishments from 1991 to 2001

By Jana Albers, DNR Forestry

It's been ten years now, since we first began our cost-share programs for oak wilt suppression. So the time seems to be ripe for tallying our accomplishments. Minnesota's cost-share programs have proven that we can do something to control oak wilt and be able to measure our accomplishments at the local level and at the landscape level .

Have we made any progress?

Success can be measured in a number of ways:

1. Here's a concrete way to measure success; look at the basic numbers.

In the last ten years, 6976 acres have been treated. That amounts to 31% of the known acreage. Statewide, 15,359 acres still remain infected. See table.

Oak wilt is a serious problem in the sandy-outwash plains that make up the Anoka Sand Plain. Here there are expanses of oak monotype and they're interconnected by root grafts. Once oak wilt gets a toe-hold, it runs rampant through the monotype.

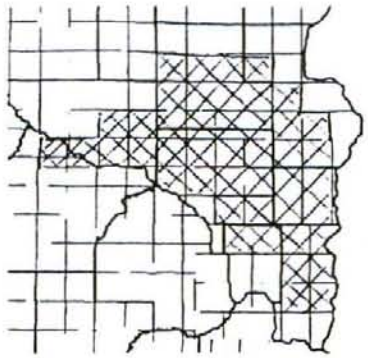
In the southeastern counties, the disease situation has hardly changed in ten years; the number of infection centers remain low and in some counties, acreages are decreasing. In most of the region, oak wilt does not pose a significant threat because of soils and covertype. On the dry outcrops, where pin oak becomes infected, an infection center may enlarge to about an acre before being extinguished, usually running out of oaks to infect. However, there are two problem areas, one near Wabasha and another near Rochester. In both situations, oak wilt is a problem on sandy, outwash plains, just as it is in Anoka Co.

Note: the most recent statewide data is from 1998, other data for subsequent calculations is from 2000.

Acres* of oak wilt		
County	**Controlled**	**Active**
Anoka	3182	5712
Chisago	230	386
Dakota	1128	2639
Fillmore	3	41
Goodhue	12	114
Hennepin	0	47
Houston	7	9
Isanti	330	589
Mille Lacs	0	7
Olmsted	51	254
Pine	0	1
Ramsey	509	242
Scott	0	7
Sherburne	1324	3129
Stearns	3	41
Wabasha	20	150
Washington	175	1915
Winona	2	70
Wright	0	16
Total for state	**6,976**	**15,359**

* = Data from 1998 and 2000.

For the remaining "successes", data from the original 44 township area was used because the 1988 survey data could be compared to the 1998 survey data. A "before" picture compared to an "after" picture.

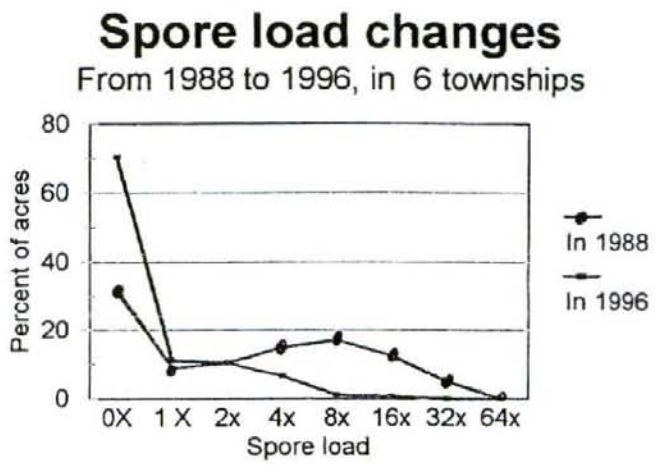


2. How many acres of oak forest (residential and woodlot) have we protected from the threat of oak wilt?

oak becoming infected is reduced. In areas where there are many infection centers that are clustered and close together (< 1500'), treatments reduce the amount of infective spores in the area. An estimation of the amount of spores in an area based on the proximity of other infection centers is called the "spore load". For example, a spore load of 4X means that four to seven infection centers are within 1500' of the area of interest. A spore load of 0X indicates that oak wilt has been eradicated within 1500' of the area. Each spore load class doubles the spore load of the previous class.

The graph shows an example of spore load reduction as of 1996 for several townships in Anoka and Ramsey Counties.

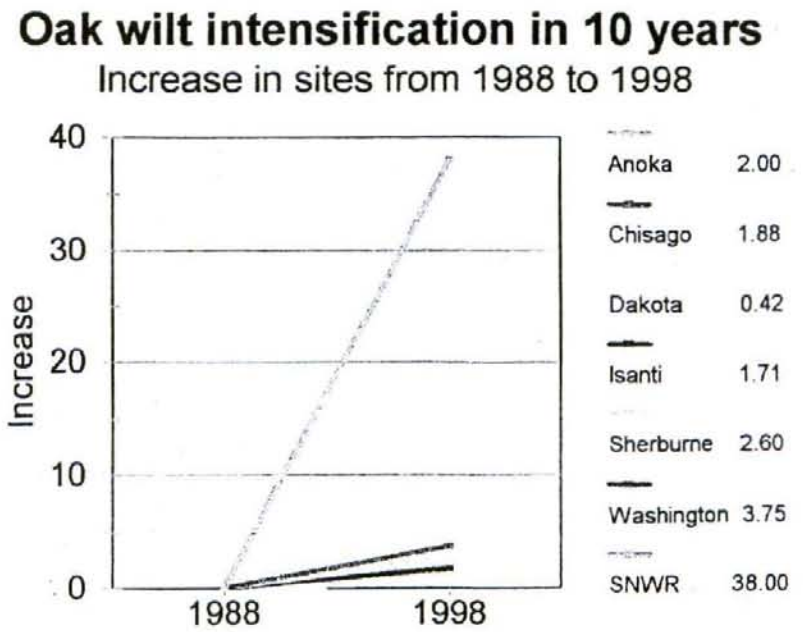
By 1998 in the 44 township area, the spore load was reduced on 54,800 acres which amounts to 10% of the residential and forested acres.



3. Progress can also be measured by the rate that the disease intensified in a given area over a period of time.

Oak wilt infection centers create new (satellite) infection centers within 1500' of the original center. The disease intensifies by creating the new infection centers. There was a pronounced difference in the amount of disease intensification between treated areas and untreated areas. During the ten year period from 1988 to 1998, the rates of disease intensification in the treated areas ranged only from 0.4-fold to 4-fold. See graph. The rate for the Sherburne National Wildlife Refuge can be thought of as the untreated (wild) rate of intensification since no disease control was practiced there. At the SNWR, the rate of intensification was a 38-fold increase in number of new infection centers.

Rate of intensification



Rates in all counties were 10-fold to 100-fold less than the rate for the SNWR.!! Comparing the untreated rate to the treated counties' rates, control efforts in all counties successfully slowed disease intensification.

Another way of looking at this is to use the Sherburne National Wildlife Refuge's rate of intensification to project the number of infection centers we would now have if the cost-share programs never existed. See table.

Projected acres of uncontrolled oak wilt intensification compared with actual acres *Formula: starting acres x SNWR rate of intensification = projected amount in 1998*		
County	Projected number of acres for 1998 without control	Actual number of acres in 1998 with control
Anoka	51,338 ac	5712
Chisago	9,766	386
Isanti	9,804	589
Sherburne	19,304	3129
Washington	20,938	1915

4. Treatment methods improve program effectiveness.

To control oak wilt, a deep vibratory plow line is made to cut root grafts so the fungus can't spread from infected to healthy trees via root grafts AND the oaks inside the trench should be cut down and properly disposed so the fungus can't produce fruiting bodies and be spread overland by insects. Unfortunately, this is often not the scenario that takes place. Homeowners want their high value oaks inside the plow line to live as long as possible and promise to take them down "as they die" from oak wilt. This is "Slow removal". You can see the problem already. In some instances, only half of the prescription is taken because the other half of the medicine is too bitter.

Cut-to-the-line saves program control costs, actual data.				
	Routinely use CTL	Number of sites controlled	Number of treatments	Number of treatments per site
Chisago	Yes	144	216	1.50
Isanti	Yes	200	272	1.36
Sherburne	No	617	1499	2.43

Some counties and communities are now strongly encouraging homeowners to take the full dose right away, cutting to the line (CTL) the same year that the plow line was installed. In heavily forested areas, the effectiveness is increased 25-fold, in heavily urbanized areas, it's still a 15-fold increase. The increase in efficacy depends on how much forested land exists close to the infection centers. See table. By strongly encouraging homeowners to cut-to-the-line, there's a greater area protected and a much better return on control dollars spent.

Projected acres protected by control actions, based on 1999 infection centers				
	Acres of active oak wilt	If plowed and CTL	If only plowed	How much better
Isanti	589	16,347	567	28 times
Chisago	386	12,621	486	26 "
Sherburne	3129	46,174	3298	14 "

5. Success can also be measured on the statewide level.

One of the statewide goals is to restrict or contain the disease to areas where it already exists. In reality that is expressed by slowing the disease spread into new areas. In the last decade, the northern "front" of the disease has

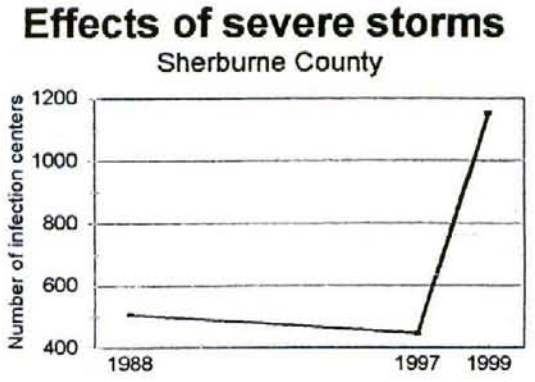
only moved north 5-7 miles. The disease front has remained fairly static in the south and southwest, but is spreading west at 12-14 miles per decade along the interstate as oak woodlots and forests are developed for residential use.

6. Success depends on public education.

For several years the jingle, "Don't prune in May or June", appeared on billboards and was heard on the radio in the spring. Local contacts with affected homeowners also tops the list for effective public education. These were extremely effective in educating the public - very little oak wilt was spread out of the Anoka Sand Plain area and this can be credited it to an informed public.

7. Summer storms wreck havoc on control programs.

Tornados and straight-line winds can set back oak wilt control efforts because they create open wounds during the time when insects can carry the disease to them. The number of oak wilt infections increases more rapidly than it normally would. This was the case in Sherburne County which was hit by severe storms in May, June and July of 1997 and 1998. Storm damage essentially tripled the number of infection centers as detected in July of 1999 by aerial photography. See graph.



What has it cost?

Over 120 counties and communities have participated in this program. During the last ten years, counties and communities developed excellent local programs with pass-through dollars from the DNR. $ 5.27 million was spent on the cost-share programs. See table. If you include all dollars spent, it cost $755 per acre to treat oak wilt infection centers.

Summary for oak wilt cost-share programs 1991 to 2000		
	State and federal sources	Community and private matches
Federal CSP	$ 2,071,000	$ 1,443,300
Minnesota ReLeaf	912,700	845,000
Subtotal	2,983,700	2,288,300
Total	**$ 5,272,000**	

Gazing into the future

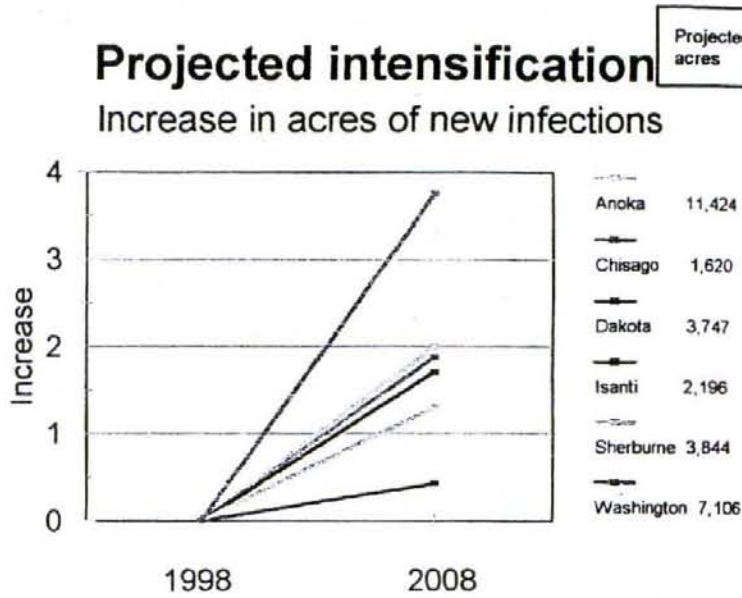
Now, let's gaze into our crystal ball to see what the next ten years could bring us.

1. Local disease intensification

Here are the projected new (additional) acres of oak wilt if the community cost share programs continue to hold oak wilt intensification to its historical rate. See graph.

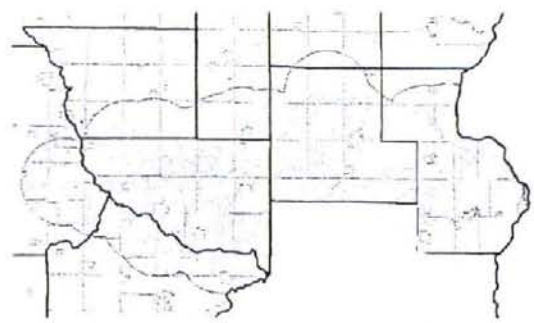
Even this modest increase in acres could easily outstrip current programs' abilities to handle the workload.

Note: New (additional) acres are listed next to county name in legend.



2. Regional spread into next tier of counties.

Oak wilt will spread regionally because it is easily carried to new, distant locations by transportation of fresh, infected logs. And there is lots of movement, especially firewood after storm damage. The average spread of oak wilt in the last decade was five to seven miles north. This image is a modeled picture of the territory oak wilt could move into in the next 10 years. Even then, there are more than 1/4 million forested acres in this region that are susceptible to oak wilt.



3. Statewide spread threatens all our oaks.

Again, oak wilt can be carried long distances by transportation of fresh, infected wood. In Aitkin County, for example, a cabin owner brought infected firewood from his home in the Twin Cities and started an oak wilt infection center that expanded for several years before it was extinguished.

High risk areas are

- where oaks grow on sand, and,
- where rapid development is occurring in oak woodlots, both on suburban and recreational lands.

Conclusion

The most important messages are that cost share programs control oak wilt and they slow its spread.

We need to realize that this disease is capable of rapid, local intensification and is capable of spreading to new, distant locations. It is a complex disease with complex management. It's a challenge that I'm sure we can meet, given past accomplishments. Here are some suggestions:

- Continue to support fundamental research to find new control methods, including the use of systemic fungicides on individual, high value oaks and silvicides in more remote areas where vibratory plowing is impractical.

- Encourage community and county governments to build self-sustaining programs to lessen their dependence on state cost share funds.

- Encourage private vendors, communities, counties and other cooperators to plan for an increased workload and demand on their time and expertise.

- Make better use of communication technologies to keep spreading the message to home owners, builders and developers.

- Seek new opportunities for incorporating the oak wilt message into existing educational efforts, such as during Tree Inspector, Woodland Advisor and Woodland BMPs Workshops.

- Seek to involve new partners in promotion and on-site detection, such as land surveyors, SWCD technicians, utility crews and private forest management consultants, anyone who has reason to observe oak forests that are slated for or in the process of being developed.

- Continue to monitor and document our progress and use this info to keep local, state and federal elected officials informed and engaged.

- Continued public investment at all levels is crucial to maintaining suppression efforts.

Oak Wilt Suppression: Using Herbicides

Observations following one year of applications of herbicides to suppress oak wilt disease. Results to date (fall-1999) are reported for 123 treated trees, on 5 sites, all cooperating private land ownerships. Herbicides were used where vibratory plowing was not an option.

Application method: Low - Volume Basal Treatment:
Mix: 3 Quarts of Riverside Diluent XLT
1 Qt. Garlon 4
3 Ounces Stalker
Was applied with a backpack sprayer, equipped with a cone nozzle. Spray was applied to the lower 18 inches of the stem. Spray was for coverage only, not to the point of runoff. For trees greater than 8 inches dbh, axe cut notches were placed around base of tree every 3 inches, just before treatment.

In the fall of 2000 the rate of stalker was increased to 4-5 ounces. All trees regardless of size were completely girdled with a chain saw at 18 inches above ground. The herbicide mix was then applied to the cut surface of the girdle only.

TREATMENT SITES:
A trained contractor completed all treatments. All treated trees were pre-marked on each site by the Forest Health Specialist. All secondary and primary trees are treated on these sites, creating a 50' to 60' barrier. This is the disadvantage of using a herbicide the option. All the secondary and primary trees were killed. The host is effectively destroyed for 50' to 60' feet depending on the site.
Treatments began in the fall 1998 and were completed by winter 1999; the dates are listed by site.

Site 1, Waldorff, Treated 1/25/99.
Results: All trees leafed out in the spring. Signs of herbicide activity continued throughout the summer. At the time of the final field check, 9/24/99 all trees appeared completely dead with no sprouts.

Comments: Appears to be very effective for killing oak. In follow-up field checks the next few years, this site will offer observations effectiveness of herbicide barrier.

There were 2 separate treatment sites, on this property.
#1 A barrier between an active infection center and area of red oaks to be protected.

Fifteen (15) trees all pin oak, recorded by dbh. All dead after one year, no sprouts.

9.1	10.2	10.2	11.3	8.2	13.7	6.9	6.7
6.4	6.5	5.9	8.7	10.1	6.9	9.0	

#2 active infection center on west side of property.

Ten (10) trees all pin oak, in dbh. All dead after one year, no sprouts.

13.9	4.3	2.5	1.9	4.5	9.2	8.5	9.5	10.1	12.5

Year 2000; all the above trees remained dead and did not sprout. A small red oak observed in the fall of 1999 with possible signs of flash back, did slightly die back without additional symptoms. A small bur oak next to a treated red oak remained free of any herbicide symptoms. No new wilt appeared outside the barrier of treated red oaks.

Year 2001; No new wilt was observed outside the barrier of treated red oaks.

Site 2, Elwood, Treated 11/30/98.
Results: Some trees did not leaf out in the spring. By early August all oaks were completely dead, no sprouts.

This was a new, from the edge, infection center. Spreading rapidly thorough high-density small diameter pin oaks. A site that would be difficult to isolate or get ahead of with a vibratory plow. There were approximately 35 trees 2 to 6"in dbh all pin oaks.

Comments: Again appears to be effective. Follow-up observations this site will offer the opportunity to see if the oak wilt spreads out of treatment area. On August 18th, two 5-inch pin oaks trees were removed from this site to observe their root systems. One treated and one live tree donated by the landowner. The root collar on the treated tree was discolored throughout the root collar zone and well below ground line. Armarillaria was evident throughout the root collar. The only parts of the tree that did not appear dead were 2 feet below ground, quarter inch diameter roots.

Year 2000; all the above trees remained dead and did not sprout. No new wilt appeared outside the area of treated red oaks.

Year 2001; No new wilt was observed outside the area of treated red oaks.

Site 3, Smith, Treated 11/30/98.
Results: As of field check on 9/24/99, the average dieback was 50%. This treatment site was a large, old but still active infection center where basically all the remaining red oak on the site were killed to prevent future reproduction of the fungus. The site is within a quarter mile of several vibratory plow sites installed in 1998.

Comments: This treatment was not as effective as some of the others and obviously not what we would like to see. The possible reasons include, under treatment (not enough herbicide applied), or a less intensive frill than what may be needed. The recommendations were changed. We changed to a continuous chain saw frill and increased the stalker to 4 ounces. The site was retreated.

Year 2000; by mid-season several of these trees were making limited progress as above. Ten trees were retreated with the year 2000 method above.

Year 2001; all treated retreated trees were dead. No new wilt was observed.

Fifteen (15) trees 12" to 18" dbh. One bur oak, the rest pin oak. Trees by dbh and % of crown dead on 9/24/99.

15, Bur-100%	14.8-40%	12.9-25%	12- 20%	13-40%	14.6-20%	11.1-90%	7.4-100%
13.6-50%	16.9-40%	18.7-70%	15.9-90%	14-100%	12.1-10%	15.9-75%	

Site 4, Ward, treated 9/15/98.
Results: By mid season the activity level was low. By August 1 it became evident that the site was under treated treatment (not enough herbicide applied), or a less intensive frill than what may be needed. The only symptom on the treated trees was generally smaller leaf size. The site was retreated in August 99. This was a large old active multiple (2) infection centers with multiple wilting trees. Follow-up observations next year will determine any symptom development and time of mortality.

Thirty five (35) trees all pin oak recorded in dbh.

11.6	14.2	12.5	13.8	9.6	11.9	14.2	10.4
9.1	11.9	13.5	11.8	10.0	15.9	13.0	11.7
12.0	11.3	9.0	10.7	10.1	9.7	12.2	15.4
13	15.9	14.8	3	5	4	5	6
2	3	4					

Year 2000; the re-treatment trees made a lot of progress, however a few trees remained partially alive. One tree on the edge of the site was missed in the re-treatment and based of field symptoms wilted. The remaining live trees and three new trees were retreated or added. The three new trees were treated about the first of August. By late August they appeared completely top dead, and borer activity had all ready reached the root collar. The effects of treatment appear quickly when treating in August.

Year 2001; all treated trees were dead, no new wilt was observed.

Site 5, Kepp, Treated 12/18/98.
Results and comments will be the same as See Smith above.

Twelve (12) trees average 19.6" dbh. Trees by dbh and % of crown dead on 9/24/99.

15.1-5%	18.9-50%	19.1-100%	19.2-40%	14.7-100%	17.3-100%	17.7-100%	30.2-100%
14.5-50%	25.6-80%	25-25%	17.9-25%				

Year 2000; by September 1 all of these large diameter trees appeared dead, after 2 seasons. It took two years to kill these large diameter oaks with the axe cut and bark treatment. No wilt was observed moving into nearby un-treated red oaks.

Year 2001; no new wilt was observed.

In September 2000, five new sites were added on state land in Wabasha County. The year 2000 method as stated above was used. Fifty five (55) trees that averaged 10 inches dbh were treated in 5 locations. All five centers were centered on 5 current season wilted trees. These were by field observations. However, in the spring of 2001 (see 2001 report), on four sites the spore pads had formed on the year 2000 wilted oak.
Wabasha County oak wilt plots established in September 2000.

Spring 2001, May : Results of sampling to determine root mortality in treated trees.

Five oak wilt centers were treated with the herbicide method in September 2000. In May 2001 the treated trees appeared mostly dead. By mid-season all treated trees appeared dead. In May and again in September samples were taken using Johann Bruhn's TTC method (tetrazolium stain) to determine whether the roots were still alive just below the root collar. Two trees were sampled per center. A Pulaski was used to scrape off the soil from a large primary root on each sampled

tree, then a wood chisel was used to expose and sample a piece of cambium from the root. The cambium was placed in the TTC stain solution and kept in the dark. Upon returning from the field observations were made for color change in the cambium of the samples (indicating living root tissue).

Tree #	Location	Size	May 2001 Appearance	May 2001 TTC result	September 2001 Notes	September 2001 TTC result
Site 1. Oak wilt pads confirmed on killed tree at center of pocket.						
Tree 1	Approx. 20' at 280° from OW killed tree	8" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts, cambium slightly discolored	Pink: cambium still alive
Tree 2	Approx. 15' at 205° from OW killed tree	11" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Callus on sample location of root sampled in May.	Pink: cambium still alive
Site 2. Oak wilt pads confirmed on killed tree at center of pocket.						
Tree 3	Approx. 50' at 20° from OW killed tree	19" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Cambium and ba	
Tree 4	Approx. 55' at 315° from OW killed tree	13" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Cambium slightl discolored.	
Site 3. Oak wilt pads confirmed on killed tree at center of pocket.						
Tree 5	Approx. 20' at 250° from OW killed tree	13" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Cambium slightly discolored on sampled root.	Pink: Cambium still alive.
Tree	Approx.	14.5"	85% of	Cambium	Crown now completely	Pink:

6	25' at 360° from OW killed tree	DBH	crown appeared dead	still alive	dead, no sprouts. Cambium appears "whiter" than other samples.	Cambium still alive.
Oak wilt killed tree	Plot center				Original OW tree on this pocket… crown completely dead. Sampled root had slightly discolored cambium, and a streak of discoloration in the wood.	Pink: Cambium still alive

Site 4. Discoloration in wood and sweet fermenting odor in wood of killed tree—no pads observed					
Tree 7	Approx. 20' at 20° from OW killed tree	5.8" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Hypoxylon on trur Armillaria mycelial fan under bark. Half o sampled wood slightly discolored, other ha with Armillaria.
Tree 8	Approx. 55' at 140° from OW killed tree	11.2" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Cambium slightly discolored.

Site 5. Oak wilt pads confirmed on killed tree at center of pocket.						
Tree 9	Approx. 20' at 10° from OW killed tree	9.5" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Cambium slightly discolored.	Pink: Cambium still alive
Tree 10	Approx. 25' at 270° from OW killed tree	6" DBH	100% of crown appeared dead	Cambium still alive	Tree dead, no sprouts. Dark discoloration and killed under bark on sampled root.	No color: Cambium is dead
Control		9.8" DBH	Healthy living crown	Cambium alive		
Control					Live tree (different tree than before). Crown	Pink: Cambium

					healthy. Cambium of sampled root white, healthy.	alive.

Jack pine plantation mortality in Wadena County: Survey results & analysis

Background

To begin with, jack pines are one of the few trees that can withstand the droughty, nutrient-poor sandy soils found in many areas of Minnesota, notably Wadena County. Sometimes, seedlings are planted and then must go ten days without rain. After surviving that, there are hungry deer and insects and diseases to contend with. This just doesn't sound like a recipe for success.

Backus Area Foresters are concerned about jack pine seedling survival, noting mortality levels in plantations in northern Wadena County that occasionally exceed their expectations. In most cases, however, the plantations are still considered well-stocked. In May and June of this year, twenty plantations less than eight years old were surveyed for establishment losses and incidence of gall rust. Collections were made to determine which gall rust species were infecting the seedlings and saplings. Most plantations have been annually bud capped to prevent deer browse.

Establishment losses are losses during the first one or two years that seedlings are in a plantation. Seedlings die if they are planted improperly, if the roots are trimmed off, if the roots dry out during planting, if the microsite is unfavorable, if rains aren't timely, if the soil is cold and the air is hot, and so on. For the last eight years, establishment mortality in these plantations has averaged 22%. Deer mortality is less than five percent due to a program of bud capping otherwise it would be much, much higher.

Gall rust is not a problem for tall saplings or pole sized trees but can cause mortality in seedlings. A gall on the mainstem of seedling can girdle it or can be a point of fracture, in both cases, killing the seedling. A rule of thumb for seedling mortality is that about 25% of the mainstem galls kill the infected seedlings. The other 75% of the galls do not kill the seedling because the galled tissues did not completely encircle the stem and, ultimately, the tree will be able to grow over the gall.

Earlier surveys

In 1984, a University of Minnesota/ DNR-Forestry survey found that 100% of the galls (n=30) found in Wadena County were caused by *Cronartium quercuum*, commonly called pine-oak gall rust. In May and June of 2000, all the sampled galls (n=100) were still pine-oak gall rust. The alternate host for this rust is oak and there are plenty of oaks on and near these sandy, plantation sites. And, in fact, gall rust is very widespread in the county since jack pine and jack pine/oak are the main covertypes there. The recent survey also found that the bulk of the infections occurred during the "wave years" of 1996 and 1998. Up to fifteen galls could form on the elongating mainstem during a wave year; the average being three galls. Woody galls developed but do not fruit (bear spores) for at least three years so the galls from 1998 and 1999 were not collected. Gall rust was also found on the lowest portion of the mainstem and in one year old plantations, indicating that a small proportion of the trees are infected with gall rust while still in the nursery.

Plantation surveys showed that 50% of the jack pine seedlings had galls on their mainstems. Gall rust losses were estimated to be 13%. This gall rust estimation is based on the average incidence in Wadena County of 50% mainstem galls and the observation that about 25% of infected trees die.

On average, establishment mortality accounts for 22%, deer browse less than 5% mortality and gall rust is estimated to cause 13% mortality. So, the total average mortality of seedlings is about 40%. Seedlings are planted at 800 trees/ acre, and, doing the math, about 480 trees/ acre survive. Foresters would like have 400 to 500 trees/acre to consider the plantation well-stocked.

Plantations become poorly stocked if establishment, deer browse or gall rust mortality exceeds the average. Gall rust incidence, as you might expect was quite variable, ranging from 33% to 84%. And this is where the problem

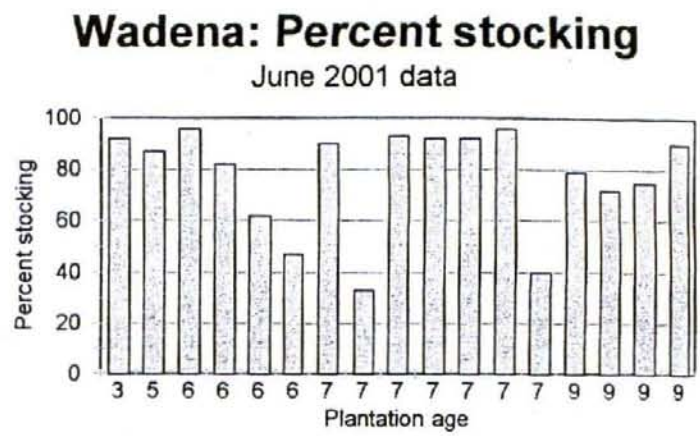
lies, especially if establishment or deer browse mortality are also high.

What can be done? Investigate mortality factors of jack pine plantations to statistically determine if gall rust alone or gall rust and other agents are the cause of plantation mortality and failure.

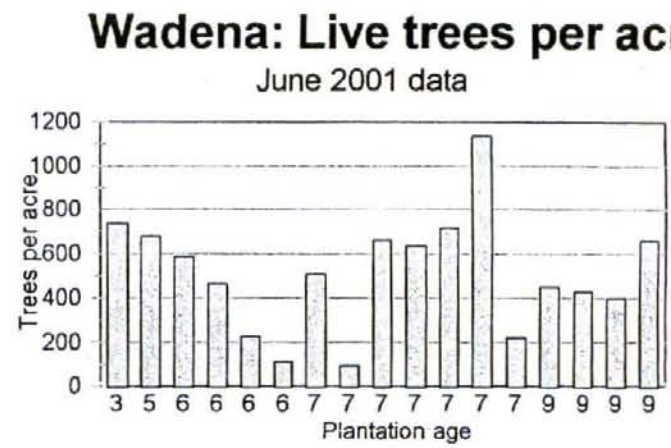
Survey in 2001

Seventeen plantations were surveyed in late spring 2001. 1589 temporary, 1/400th acre plots were tallied for seedling damage. There were 10 plots per acre. Data table is in Survey Results section.

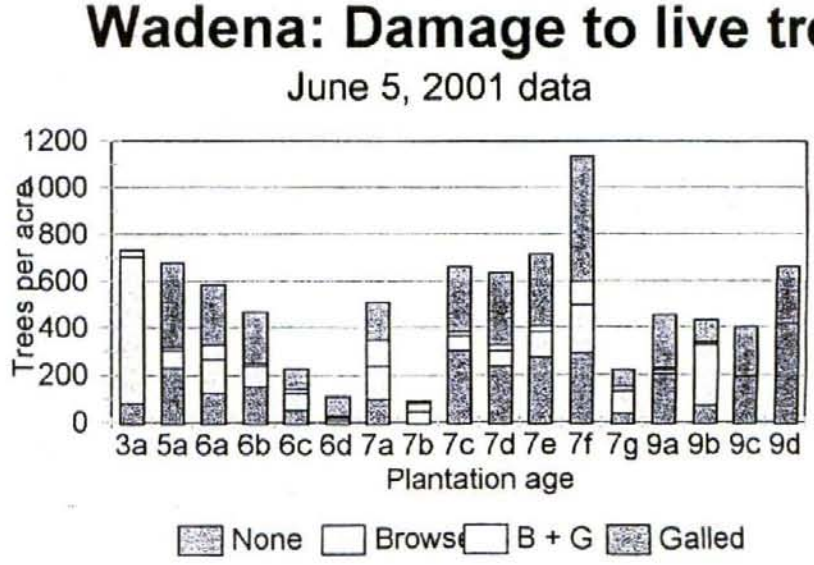
An average of 88% of the plots were stocked (range 33-96% stocked plots). See chart.



For Backus Area, the minimum desired stem density is 400 stems per acre. 24% (4 of 17) of the plantations did not meet the minimum desired stem density. See chart.

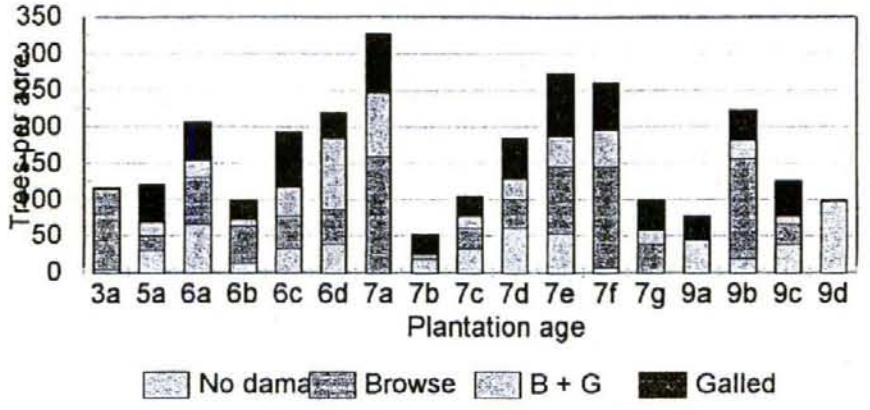


Many of the seedlings were damaged by deer, mice, gall rust and other agents. Damage incidence was extremely high; only one plantation had more than 400 undamaged live stems/acre. 53% of the plantations had less than 200 undamaged stems per acre. The overall average number of undamaged stems/acre was 169. See following charts and table.



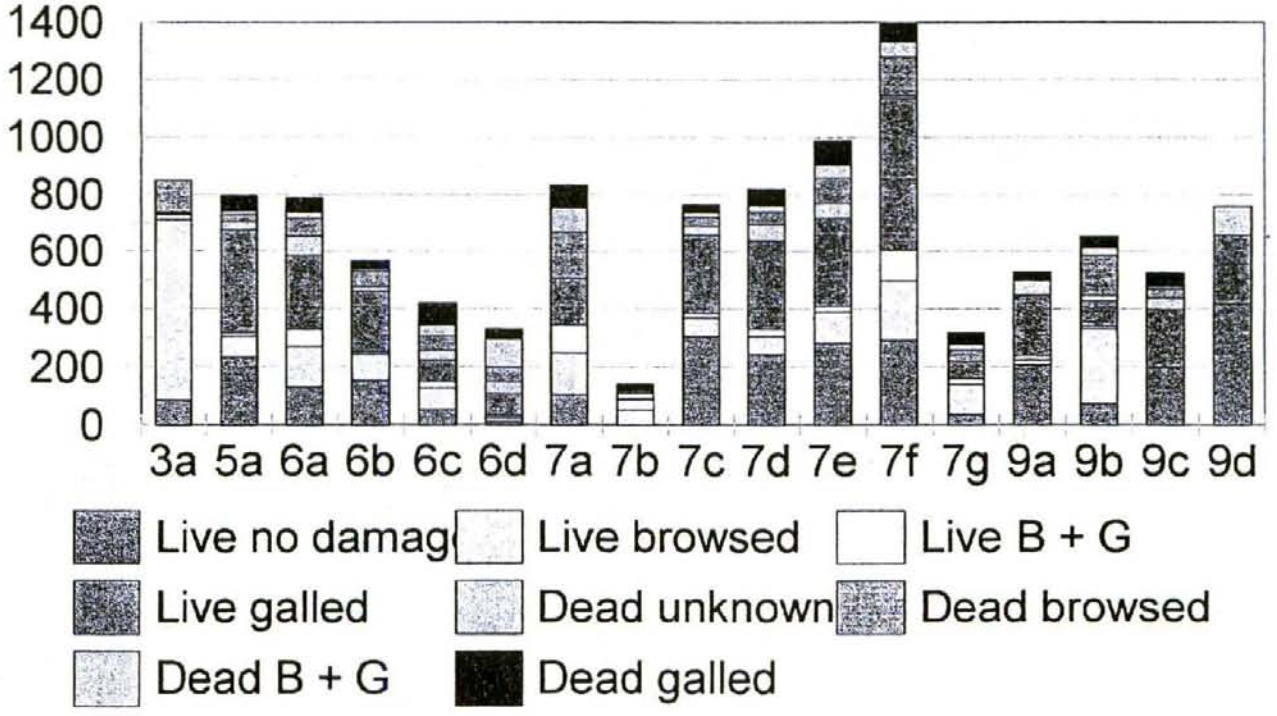
Wadena: Dead trees

June 5, 2001



Wadena: Damage to live and dead tree

June 5, 2001 data

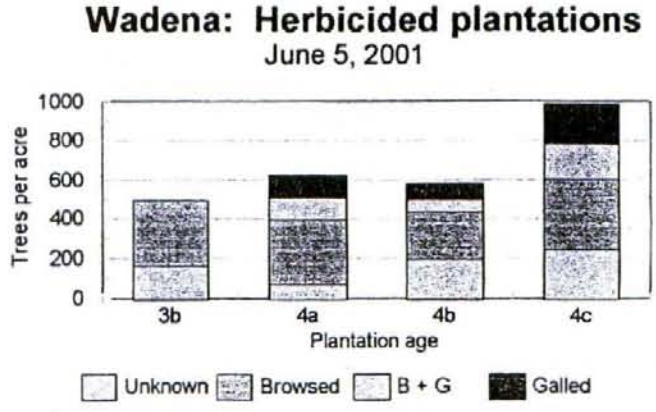


Incidence of browse and gall damage in 17 jack pine plantations in Wadena County, 2001		
	Number of stems/acre	**Percent of trees**
Live trees		
Browsed	119	18
Browse and galled	27	4
Galled	197	29
None	169	25
Total for live	512	76
Dead trees		
Browsed	59	9
Browse and galled	28	4
Galled	43	6
Unknown damage	34	5
Total for dead	164	24
Grand total	676	100

Of the live trees, browse accounted for 29% of the damage, and gall rust accounted for 43%.
Of the dead trees, browse accounted for 53% of the damage and gall rust accounted for 43%.

Looking at all trees (live and dead), browse accounted for 31% of the damage and gall rust accounted for 39% of the damage. Only 25% of the seedlings were undamaged.

Four additional plantations were surveyed although they had been treated with herbicides the year before. These plantations averaged 672 stems/acre. An average of 52% of the seedlings were browsed and 21% were galled.



BACKUS AREA JACK PINE SUMMARY 1990 THRU 2000

YEAR	NUMBER OF SEEDLINGS	SEED ZONE SOURCE	PRECIPITATION JULY	AUGUST
2000	0	96-JP_LPSO&96-JP-NSO	3.67	2.10
1999	35,000IM	95-JP-LPSO	5.0	5.87
1998	63,500IM	93/94-JP-LPSO	2.56	1.02
1997	18,500IM	93-JP-LPSO	5.14	1.01
1996	57,500REG	84-A16 & 83-A15	2.82	3.19
1995	69,500REG	84-A16	7.97	6.29
1994	0	81-3W	4.80	2.51
1993	40,500REG	81-4W	4.58	4.75
1992	96,500REG	81-4W	4.09	4.14
1991	80,000REG	81-4W	4.53	1.86
1990	45,000REG	80-4W	1.31	1.56

LPSO= Long Prairie Seed Orchard
NSO= Nickerson Seed Orchard
A-33= Hill City seed source
A-16= Park Rapids seed source
A-15= Blackduck seed source
3W= Brainerd/Backus seed source
4W= Park Rapids/Bemidji seed source

From 1997 to present, all state lands received IMPROVED Jack Pine

Co-Colonization of Red Pine in Central Minnesota by *Ips.* spp. (Coleoptera: Scolytidae)

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Introduction

In the North Central United States, three species of *Ips* (Coleoptera: Scolytidae) are known to infest pines. The most common of these is *Ips pini* (Say)(Schenk and Benjamin, 1969; Kennedy, 1969; Raffa, 1991). Additionally, *Ips perroti* (Swaine)(Ayres et. al. 2001) and *Ips grandicollis* (Eichhoff)(Lanier 1970, 1987) colonize pines in this region of North America. The latter species has been commonly collected from Scots pine, *Pinus sylvestris,* planted in shelter belts across the state of Iowa (Mark Shour personal communication). All of these species of *Ips* have been collected in Minnesota (Dodge, 1938). A recent infestation of *Ips* spp. in a red pine, *Pinus resinosa,* plantation in Central Minnesota gave us the opportunity to investigate the colonization behavior of *Ips* spp. in this region.

Methods

In late June 2001 a stand of red pine, *Pinus resinosa,* in the Sand Dunes State Forest (Sherburne Co., MN - SE SE Sec.17 - T 034 - R 27) was determined to be infested with *Ips* spp. and was treated using four possible bark beetle management options. Fifty trees were studied, only 18 trees were colonized by bark beetles. The treatments followed by their GPS coordinates and the number of sample trees included:

1) Girdling (N 45 25' 52.7" W 93 43' 0.40")(n=3);
2) Girdling followed by treatment with *Ips pini* aggregation pheromone (racemic ipsdienol and lanierone, Phero Tech Inc., Delta British Columbia) stapled to the bark at breast height (1.3 meters)(N 45 25' 53.4" W 93 43' 6.5")(n=1);
3) Girdling and felling trees (N45 25' 52.9" W 93 42' 57.6")(n=10); and
4) Untreated standing trees near the girdled trees (N 45 22' 52.6" W 93 42' 54.4") (n=4).

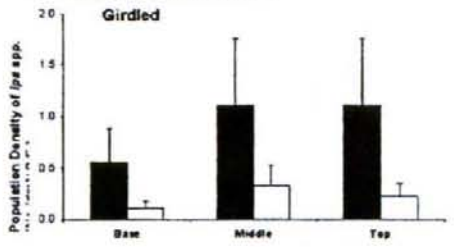
Trees were girdled at 1.3 meters above ground with a chain saw. Entire rows of trees were treated because the entire stand was infested. On July 25 through 27, 2001 the experimental trees that remained standing were felled for examination. Samples of bark and phloem (approximately 25 cm by 12 cm) for each treatment were collected from each of five trees. Samples were taken from the basal one-third, middle one-third, and upper one-third of the bole of each tree. There were a total of 19 samples with evidence of bark beetle colonization. All of these samples were examined, beetles recovered, and identified. Population densities were calculated for each sample and expressed as the number of beetles per dm^2. Specimens were pinned and deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota, and in the California Academy of Sciences, San Francisco, California.

Results

A total of 201 *Ips pini* and 96 *Ips grandicollis* were recovered from the samples, but no *Ips perroti* were found in the samples. Across all treatments, *Ips grandicollis* was more abundant in the base of the trees and *I. pini* was abundant throughout all three tree sections and perhaps slightly more abundant in the middle and top sections of the trees (Figure 1). The tendency for *I. grandicollis* to colonize the basal third of the trees was evident not only from the cumulative data set, but also from the data sets from the groups of felled and girdled trees, felled trees, and standing trees (Figures 3-5). Only in the group of girdled *P. resinosa* (Figure 2) did the density of *I. grandicollis* increase with height. In all treatment groups and in the cumulative data set, the density of *I. pini* was lowest in samples from the basal section and higher in the mid-range and top samples. We also found a beetle associate of *Ips* (Family Tenebrionidae, *Corticeus* spp.) to be fairly common in the samples and evidence of cerambycid wood-borer galleries in the samples.

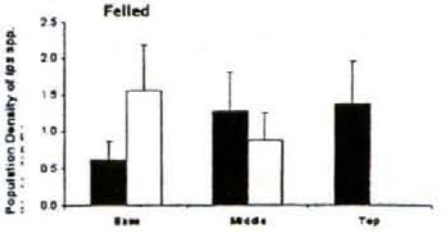
Acknowledgements: We thank Jana Albers, Mark Platta, and Bob Tiplady for their assistance with data collection.

1.



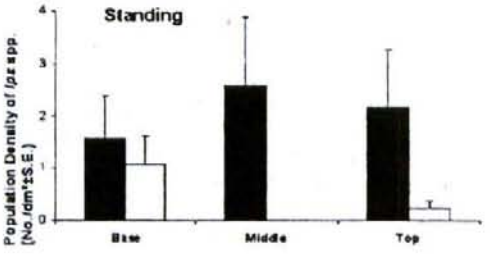
Density of *Ips pini* (dark bars) and *Ips grandicollis* (white bars) collected from bark samples taken at three heights of girdled red pine, *Pinus resinosa*, near Zimmerman, Minnesota (July 25-27, 2001)

2.



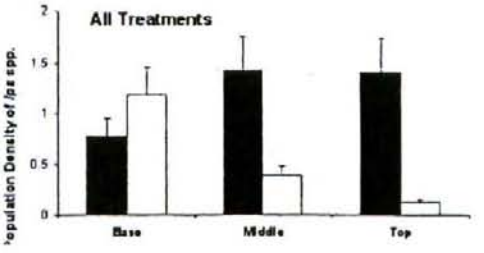
Density of *Ips pini* (dark bars) and *Ips grandicollis* (white bars) collected from bark samples taken at three heights of felled red pine, *Pinus resinosa*, near Zimmerman, Minnesota (July 25-27, 2001)

3.



Density of *Ips pini* (dark bars) and *Ips grandicollis* (white bars) collected from bark samples taken at three heights of standing red pine, *Pinus resinosa*, near Zimmerman, Minnesota (July 25-27, 2001)

4.



Density of *Ips pini* (dark bars) and *Ips grandicollis* (white bars) collected from bark samples taken at three heights of red pine, *Pinus resinosa*, near Zimmerman, Minnesota

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Tree assessment along the proposed road construction project in Itasca State Park

Alan Jones met with John Ludwig, Becky Marty, Mike Kovacovich (ISP) and John Filardo (Region Engineer) on July 31st and reviewed the road project with them.

First a description of the project: The new road corridor will be about 4 miles long and will follow the current road bed. It is generally going to be 30 feet wide except in a few spots where there is some cutting that is required, but those areas represent only a minor portion of the entire length. The center line follows closely the existing centerline and is marked with a nail and painted circle. The edges of the project are marked with orange painted lath; so, it is relatively easy to see where the road boundaries will be. John pointed out that the plan calls for the outer two feet on both sides will be gravel which will provide a little cushion for root systems. Basically the project involves widening the road, and where cut and fill are not necessary which is most of the project the need for major disturbance should be reduced.

The pines that fall within the orange stakes are probably a given that they will have to be removed. But there are pines right on the edges of the boundary. These are the trees that need attention. The areas where there will be cutting done, the plan calls for building retaining walls so that the cut slope does not have to be so long.

Between John and Becky, rough tree counts are as follows: there are approximately 40 large pines from the Park Office to the entrance. This is the road segment that goes though Preachers Grove, more of the old growth part of the park, and is probably of most concern. Becky figures there is another 80 to 90 smaller pines between the Park Office and the Headwaters. She will do a more accurate count and stratify the count by diameter class.

Alan was very impressed with the care taken to minimize pine removal as the project was being developed. Obviously park personnel and the county engineer spent lots of time designing the road upgrade to preserve the existing character of the road.

Because of the difficulty in meshing everyone's schedules, and the first chance we had to get folks together was during the week of August 20th . Both Mike and John said that it was too late to bid the project out and expect any work to be done this construction season; so, there is time.

A team was assembled to come back and spend more time evaluating the trees. The team was Jana Albers, Alan Jones, Mike Kovacovich, Becky Marty, Jack Rajala (as requested by the Commissioner), and Dr.Gary Johnson (Univ of MN). John Filardo, Regional Engineer was also asked to be present to help interpret the project, particularly the cut and fill areas. He agreed.

Meeting objectives for August 20th :

1. Provide an estimate of how many other large trees would likely be damaged or killed in the process of removing trees and stumps. (Allen Garber's suggestion)
2. Identify trees that could be maintained with reasonable expectations of survival and provide mitigation measures that would improve their survival.
3. Provide information on how to protect trees during all phases of the construction project.

On Monday, August 20th, Mike, Jack, Gary, John F., John L., Lance Crandall, Alan and Jana met at Itasca SP to follow through on Allen Garber's request to estimate the number of trees potentially impacted by road construction and to discuss mitigation measures for both threatened trees and planned tree removals. We met and discussed the project indoors, John Filardo and Mike Kovacovich told us about the road expansion project, the 100 foot road construction segments and the "big tree" inventory along the road. Gary Johnson discussed the concept of the "critical root radius" and mitigation measures that could be used on these soil types and for the tree species in the Park. As a group, we decided how to proceed: work linearly from one end to the other. We reviewed the tree tally the Park developed for trees that could be impacted by the new road.

Park's original tally for threatened trees along the entire road		
Tree size class, DBH	Red and white pines	Hardwoods, spruces
< 10"	68 trees	477 trees
10 - 20 "	44	76
20 - 30 "	32	3
> 30 "	10	0

After that, we drove the length of the road to see the scope of the project and decided to start on the south half of the road. We assessed 51 - 100 foot road sections by walking from Preacher's Grove to the Peacepipe parking lot. John Filardo provided engineering maps and road profiles and discussed grades, slopes, retaining walls, etc on each section as we worked on it. Jack Rajala talked about the feasability of individual tree removals, suggested methods and equipment to be used and offered a ball-park cost estimate for the entire project. Gary Johnson used a probe to assess root location on all the trees identified as having a potential impact from construction activities and offered an assessment for each of those trees.

At that point, we were about half done, but have assessed most of the large, threatened red and white pines along the road corridor. Findings to date:

1. Parks and Engineering have done a great job in limiting tree impact in their planning process! The most significant idea is to restrict construction activities and equipment compaction to the 30 foot road corridor. If that was not done, the tally of removed trees and threatened trees would have been tripled. We all agreed that we could save hundreds of trees on other projects in the state, if only the projects were as well thought out as this one.
2. Our general opinion is that the original Parks tally was essentially correct in its assessment of the trees marked for removal and for the threatened trees. In a few situations, a group member offered a new idea/ method (ie: using stump grinder on a removal instead of grubbing out a root system) that would save the threatened tree in question. We did find two road sections where a change in layout and depth of fill would save additional trees. However, we also identified a couple of situations where additional trees should be removed because of stability problems.
3. Gary found that viable root systems extend out and under the existing road due to the presence of its gravel underlayment. If at all possible, these roots should not be injured during construction. Our recommendation is to limit road surface excavation depth to 8 - 10 inches from the top surface of the existing asphalt. We realize that there will be a few exceptions where the road grade must go lower than the existing pavement.
4. We noted that most of the threatened trees that need to be removed have stem decay, root decay or stem decay and a crack in addition to the instability that would be caused by construction damage.
5. We observed that where a mature pine must be removed there is usually another mature pine nearby (within 30 feet) or the pine is part of a larger pine stand. The overall impact of tree removals should be minimal.

On September 7th, Mike Kovacovich, Becky Marty, John Filardo, Alan Jones and Jana Albers finished assessing the trees from Peace Pipe to the Headwaters using the same methods as described above.

Final Report

The original survey of trees along the corridor tallied trees that were in the path of construction and covered an area of land that can be considered the maximum area of impact. The original survey can essentially be viewed as a worse case scenario for tree removal along the corridor.

This survey tallied trees on a smaller area of land because we had the benefit of knowing the exact layout of the pavement, road slopes and retaining wall locations. We also had the ability to move the road slightly and alter road curves and slopes so that the large trees could be saved. Fortunately, we were able to retain a substantial number of trees compared to the first survey:

1. We were able to retain nearly 30% of the large pines.
   See the table below for data on retained pines.
2. There still are several "gateways" of large, old pine trees.
3. We were able to retain more than 90% of the large hardwood trees.

Parks and Engineering have the recommendations for each 100 foot segment of road and the locations of the affected trees.

Pines in the road construction corridor at ISP		
	Number of pines retained in the second survey	Percent of pines retained compared to original survey
Trees directly in the path of construction	19	8 %
Trees adjacent to construction, within the planned corridor	90	58 %

DNR, R6 Wildland Urban Interface Project
Forest Health Assessment

Overview

The DNR worked collaboratively with the adjoining cities of Hugo (Washington county) and Lino Lakes (Anoka county) to create land development and managements tools which incorporate natural resource conservation goals. The project includes three major components; detailed mapping of land cover and plant communities; forest health and damage risk assessment; and comprehensive planning. This paper deals with one aspect of resource and damage risk assessment, forest health.

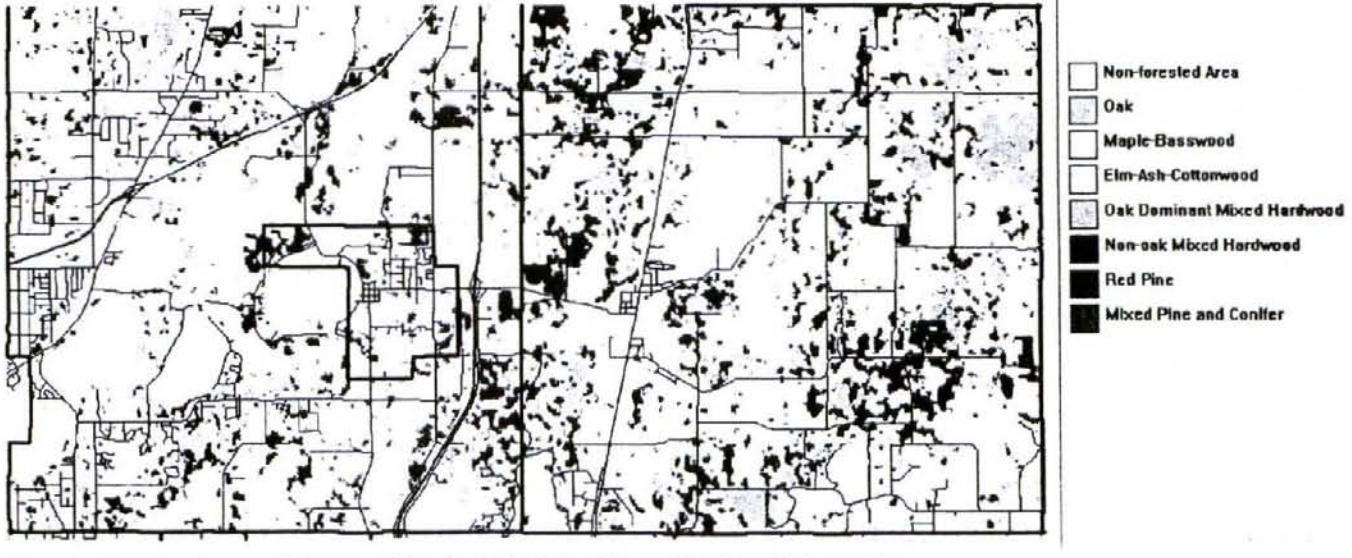
What forest health means has been hotly debated. In the broad sense, it means forest sustainability, which encompasses the interaction of all organisms resident within that resource and their ability to respond and adapt to a variety of ongoing disturbance factors in the context of physical conditions, such as water, light and soil characteristics, that drive those interactions. In the narrow sense, it means the presence, absence and frequency of adverse disturbance factors capable of driving changes in the make-up and distribution of dominant forest species. In the context of this project, the more narrow definition was used.

A new system of land cover assessment, called the Metro Land Cover Classification System (MLCCS), has been developed combining traditional land use surveys with land cover inventories. It provides a useful tool for assessing all land cover types at varying resolutions. Portions of both communities have been inventoried using MLCCS, but the inventories are not yet complete. That data were not used in this particular assessment. Available sources of land cover data include Landsat imagery taken and originally analyzed in 1991 by the Met Council and refined by the DNR and University of Minnesota (Level II); two early 1990 Landsat images compiled and analyzed by the USGS Gap Analysis Program in 1995 (GAP), and digital orthophoto quads (DOQ) based on photography taken in 2000.

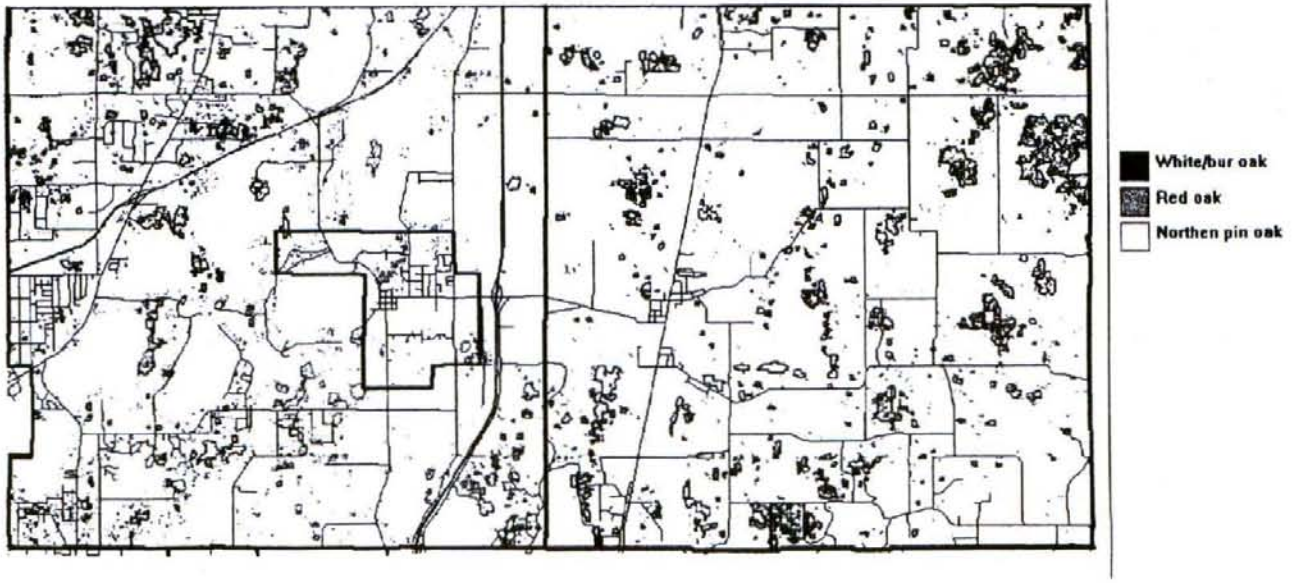
The Level II data, has been readily available for some time and has been used in a number of other projects. The ease of use and familiarity associated with the data set lends itself to further analysis. However, the data is based on broad forest classifications which lump related types together, oak cover types for instances **(see map 1, Forest Cover, Level II)**. In the GAP data, all vegetation types were described by the dominant species, which allows for a closer look at associated issues **(see map 2, Vegetation Cover, GAP)**. However, because the data was analyzed for all vegetation types on a statewide basis, the errors associated with forest cover in the metro region are somewhat higher than those in the Level II data **(see map 3, Comparison of Gap & Level II Oaks)**. DOQs do not have any forest type designations, but allow a comparison between forest cover data and aerial photos. DOQ's were used to inventory mature pine stands in the metro region in 2001. The resulting data is both accurate and current. However, it does not include all pine stands **(see map 4, Comparison of DOQ and GAP Pine)**. For the purpose of pest risk assessment, having a complete set of pine data is not necessary, because bark beetles are associated with drought stress and drought stress is associated with overcrowding not seen in young pine plantings. In this case, the DOQ data works well. For all other pest risk assessments, the Level II data was used, even though the data is somewhat outdated.

Map 1, Vegetation Cover, GAP (1995)

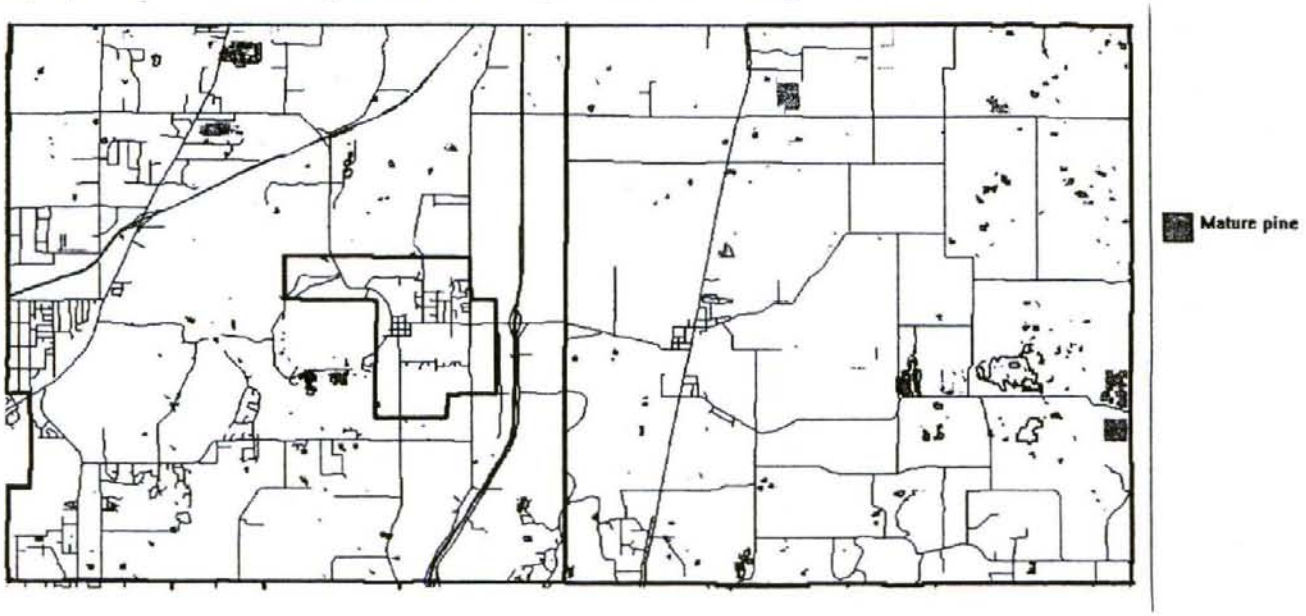
Map 2, Forest Cover, Level II (1991)



Map 3, Comparison of GAP and Level II Oaks (Level II data is in red)



Map 4, comparison of DOQ and GAP Pine (GAP data is in red)



Forest Resource

Relatively few forested acres remain in either community **(see table, Acreage by Forest Types, Level II)**. Oak forest types are the most common and contain the largest tracts of relatively undisturbed land. These offer the best opportunity for forest conservation for multiple use. However, because the remaining tracts of 'native forests' are so few and so small, the economic and social pressures for multiple use are very high. Protecting the remaining tracts will become increasingly important as the pressure to develop increases.

Table; Acreage by Forest Types, Level II:

Acres in Hugo	% of land base in Hugo	Acres in Lino Lakes	% of land base in Lino Lakes	Forest Type
1194.90	5.21	704.75	3.32	Oak
402.53	1.76	218.61	1.03	Oak Dominant Mixed Hardwoods
557.75	2.43	296.67	1.40	Maple-Basswood
211.27	.92	222.39	1.05	Elm-Ash-Cottonwood
3576.48	15.59	2056.89	9.7	Non-oak Mixed Hardwoods
255.75	1.12	136.325	.64	Red Pine
1.11	.01	4.448	.02	Mixed Conifer

Many of the remaining tracts are incorporated into sub-developments that limit alternative uses. Because natural processes have been interrupted on these sites, the trees are much more likely to suffer excessive stress as a result of the normal variation in weather patterns and storm events. Because of their association with residential property, tree values are directly related to home and land values, and the cost of associated maintenance and/or replacement goes up proportionally. The increase in value does offer some alternative methods of tree care that are not feasible in the more natural setting, but the need for care increases dramatically because of the residual trees' impact on real estate and human quality of life.

To ensure the health of both native and developed forest sites, it is important to understand the major disturbance factors that can influence the health of residual trees. While development is the single largest and most important disturbance factor, key damage agents, like insect and diseases, together with stressful weather events can lead to substantial tree loss.

Major Forest Damage Agents

Besides development, the major damage agents with the potential to induce tree mortality are oak wilt, gypsy moth, pine bark beetle, oak decline, Armillaria root rot, two-lined chestnut borer and drought. Oak decline is commonly associated with a combination of the later three. Pine bark beetle attack is commonly associated with drought and overcrowding. Drought stress is a function of soil hydrology, weather patterns and root health. Oak wilt is most common where sandy soils promote extensive root grafting and where various forms of disturbance create wounds which serve as feeding sites for the insect vectors that carry the oak wilt fungus. Spring storm events are commonly associated with an increase in the number of oak wilt infection pockets. So in addition to assessing where host species occur, soils and disturbance levels need to be taken into account. Other contributing factors such as stand density and rain fall were not taken into consideration because the data is not available at a scale small enough to analyze for an individual community.

Oak Wilt

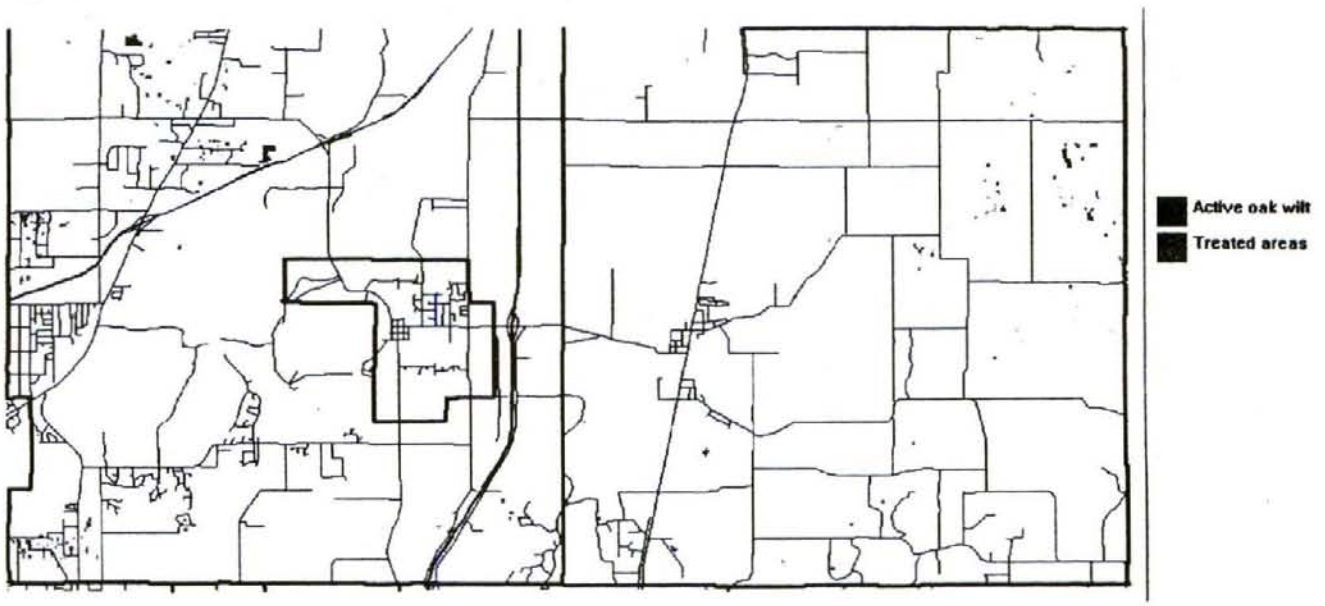
Oak wilt is caused by the fungus *Ceratocystis fagacearum*. It is the leading biotic mortality agent among MN oak Oaks in the red oak group, which include northern red, pin and black oaks, are the most susceptible. Oaks in the white oak group, which include white and bur oaks, tend to be more resistant. White and bur oaks can be infected with the fungus, but the disease acts more like a slow decline, killing trees over a prolonged period of time. Some white and bur oaks actually survive infection, although this is rare **(see map 5, Oak Wilt, All Sites, 2000)**.

The fungus can spread throughout a stand of oaks through roots grafts between adjacent trees. Root grafts can expand an infection pocket up to 100ft in one year. But the average rate of spread via root grafts is about 25ft per year. Sandy soils promote extensive root grafting, so oak wilt spreads more quickly causing more tree mortality among stands growing on sandy soils than those in clay.

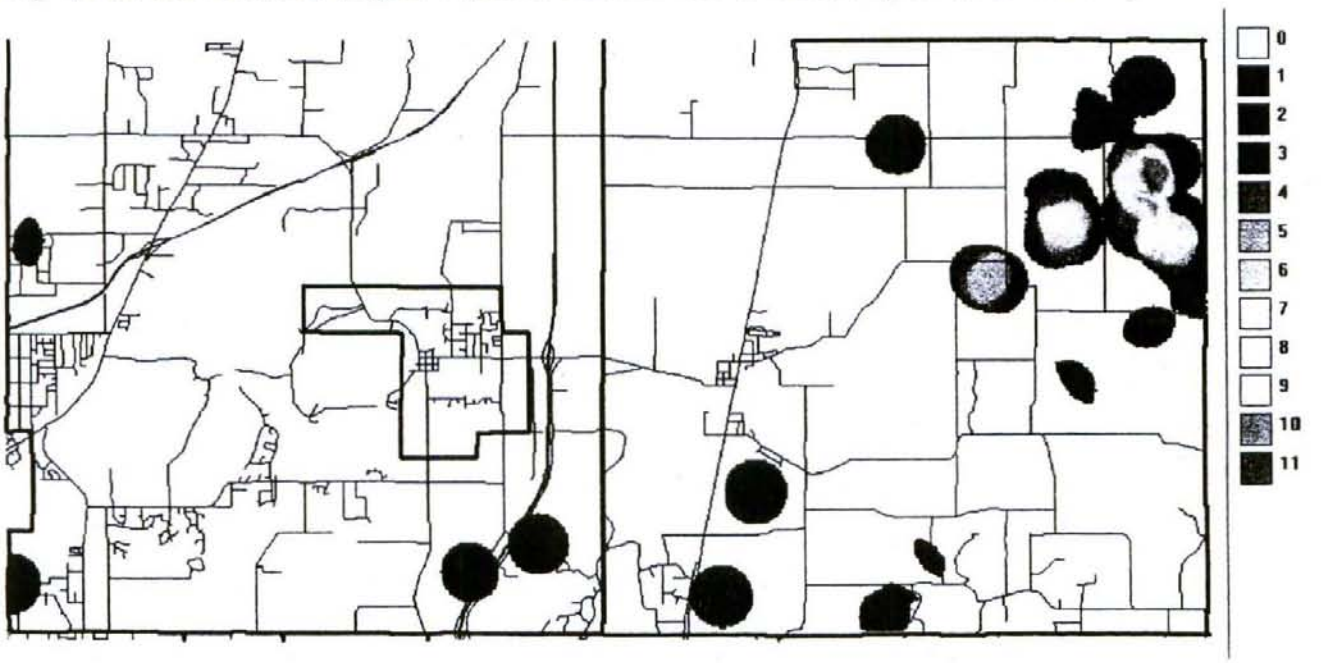
The fungus is spread over long distances by beetles that carry the sticky spores on their bodies as they move from tree to tree to feed on sap and fungi. Strong fliers, the beetles are attracted to fresh wounds and fly to new openings within minutes of their creation. While wind storms contribute the highest proportion of wounds, improper pruning and construction damage during peak infection periods are responsible for a large percent of the new infection pockets seen each year. The beetles can move the

oak wilt fungus over long distances, but the average spread via insect vectors is 1500ft per year. An oak tree growing within 1500ft of an infected tree is at risk of infection. The higher the number of infected trees in the vicinity, the higher the risk of infection **(see map 6, Oak Wilt Surface Density)**.

Map 5, Oak Wilt Infection Pockets, All Sites, 2000



Map 6, Oak Wilt Densities (legend represents the number of infection pockets on the site)

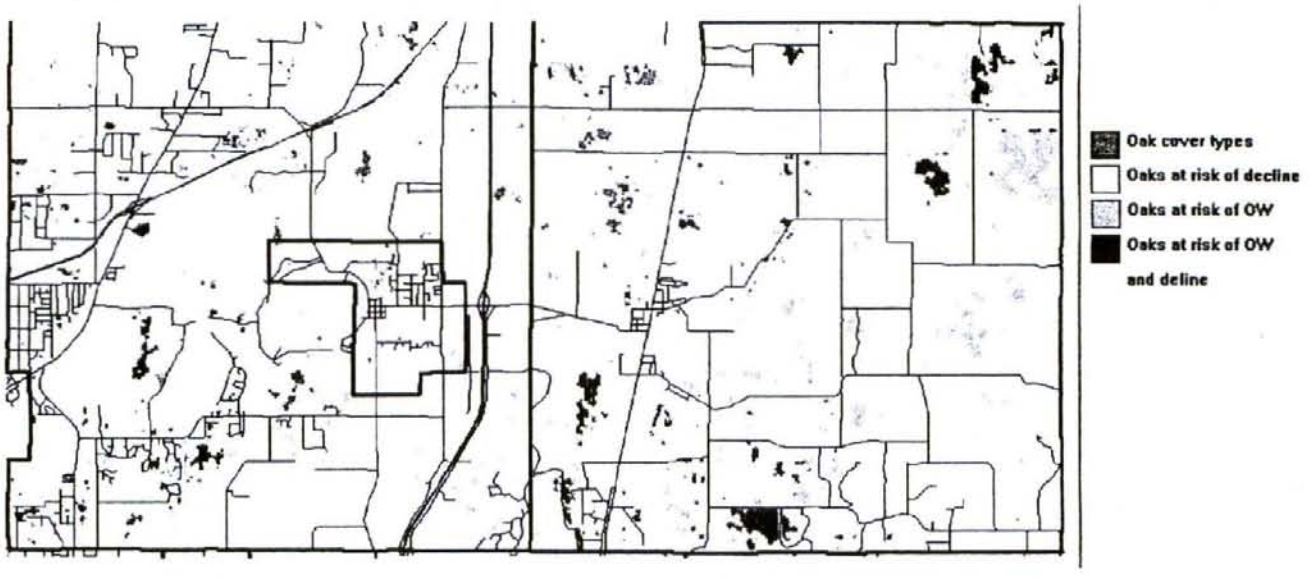


Oak Decline

Declines typically involve three main factors; a predisposing factor such as improper site selection and/or preparation prior to planting; an inciting factor like a drought period that stresses the trees and/or uses up starch reserves, and contributing factors, like an opportunistic pest. The combination of factors create a spiraling effect which eventually leads to tree mortality. In the case of the oak decline

we typically see in this area, drought stress is combined with Armillaria root rot and two-lined chestnut borer. As such trees growing on sandy soils are more prone to oak decline, because they are more prone to drought stress **(see map 7, Oaks at High Risk, combined oak wilt and decline data)**.

Map 7, Oaks at Risk, Combined Oak Wilt and Decline



Armillaria root rot is caused by a fungus that normally functions as an important decomposer, recycling nutrients from woody debris. It produces root-like structures called rhizomorphs in the soil that grow outward in search of woody material. The network of rhizomorphs continue to expand as long as there is woody material to support the colony. So they are on or adjacent to almost all tree roots within any particular stand, where the fungus can feed on tissue sloughed off as a normal part of root maintenance and growth. When trees become stressed, the rhizomorphs are able to overcome natural defenses and attack healthy root tissue where they cause root rot. After repeated bouts of stress, the fungus can kill enough of the root system to kill the tree.

Two-lined chestnut borers only attack weakened oak trees. They do not feed on other species and rarely attack vigorous oaks. But once oaks become stressed, the borers attack the upper branches moving downward as the tree declines. Their feeding interferes with the normal flow of water and nutrients throughout the tree, stressing it further. Frequently two-lined chestnut borer and Armillaria can be found in the same tree. There is no control for either problem beyond prevention through proper tree planting and care. Once trees have been attacked, they die within a few seasons, and sanitation is the only recourse.

Because prevention is so crucial, forestry staff as well as builders and developers need to understand the need for proper planting and maintenance, and tree protection during construction. Normal construction operations can lead to the death of most, if not all, of the trees left on a site after new building construction. Since this frequently occurs after the developer has gone to great lengths to protect certain trees, the additional tree loss can be very costly. And often new home owners are stuck with the cost of tree removals that could have been prevented.

Gypsy Moth

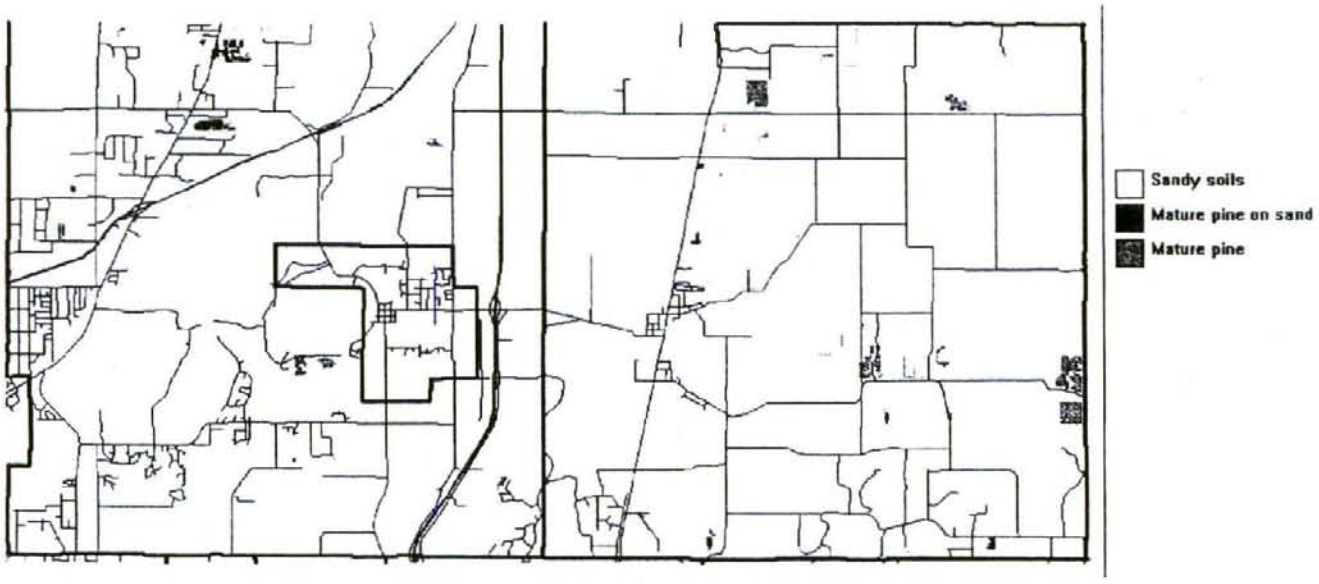
All oaks are susceptible to defoliation by gypsy moths. Repeated defoliation leads to oak decline and mortality. When combined with other stressors, gypsy moth can quickly kill large numbers of oak trees (see maps above for the distribution of susceptible oaks). Fortunately this exotic pest has not yet become permanently established in MN. But it is in WI and moving this direction. The rate and frequency of defoliation is a function of the percent of oak within a stand. The rate of mortality after defoliation is a function of tree vigor. Where possible, diversify oak stands to help reduce the amount of defoliation. Where changing the composition of forest stands is not possible, increase stand vigor by removing dead and dying trees and thinning the residual trees to limit future tree losses.

Pine Bark Beetle

Like two-lined chestnut borers, bark beetles usually attack weakened trees. However, when they find a tree to their liking, they put out an aggregation pheromone that attracts more beetles into the area. En masse they overwhelm tree defenses and kill them. Because there are three generations of bark beetles per year (unlike two-lined chestnut borer which only has one) populations can build up quickly. When a pocket of stressed trees becomes saturated with bark beetles, the beetles can spread into adjacent healthy pine and can kill them too. So the potential for loss is much greater than with other opportunistic pests.

Pine on sandy soils are prone to drought stress and therefore prone to bark beetles, although any pine stand can be affected under the right conditions, like the excessive competition found in an overly dense stand. Pines on stress prone sites, including those on new construction sites, should be monitored for signs of beetle attack **(see map 8, Pine at Risk of Bark Beetle attack)**. When an outbreak occurs, a quick response and proper sanitation can contain the outbreak and protect residual trees.

Map 8, Mature Pine at Risk of Bark Beetle Attack

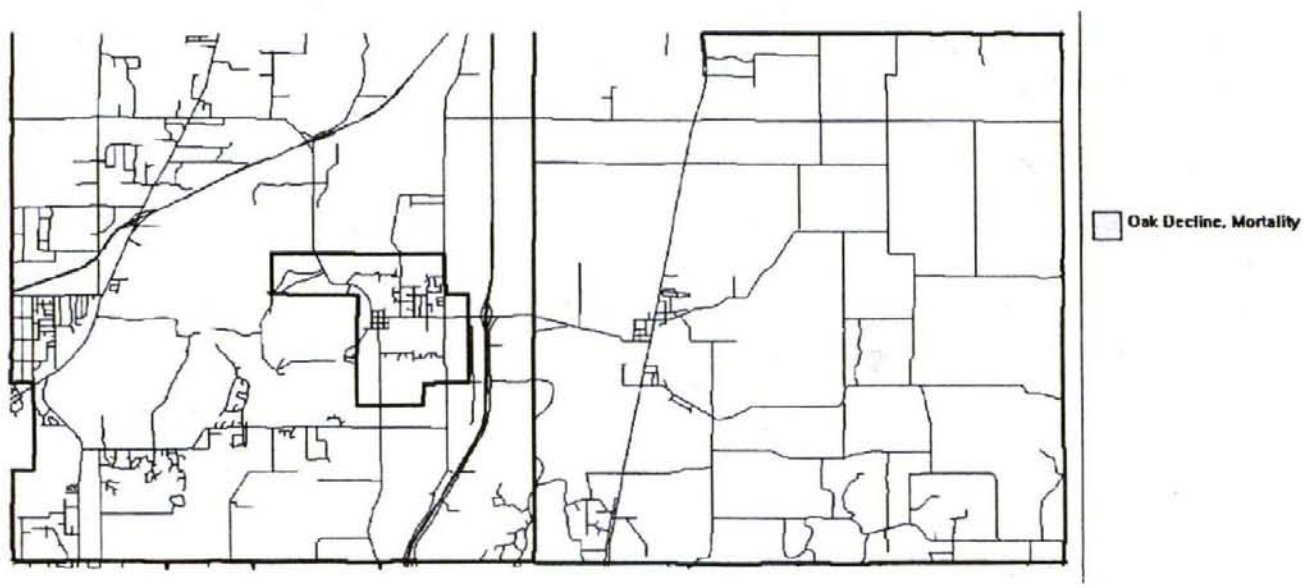


Damage Surveys

Three damage surveys were completed during 2000 using other methods of assessment. The area was flown and damage visible from the air was sketch-mapped. Two large infection pockets were identified in Hugo **(see map 9 Aerial Survey Results)**. Communities participating in the state run cost-shared suppression program submit maps of active oak wilt infection pockets and those treated that year. These are digitized and incorporated in the regional oak wilt data base. Lino Lakes updated their data in 2000. Data from Hugo date back prior to 1997. This information is the source of the oak wilt map seen above. Field crews assessing homes in the area for fire danger, made note of sites with obvious forest health problems. These were ground checked to verify the damage agents involved. Few serious health problems were noted in Hugo. In Lino Lakes there were two types of damage recorded by the fire crews; construction damage resulting in oak decline in new developments; and pine damage resulting from a combination of Diplodia tipblight, hail and bark beetles among older developments built into pre-existing pine plantations.

Diplodia tipblight is caused by a fungus that infects new shoots, and wounds. When the fungus infects new shoots, shoots, cones and needles are killed, hence the common name 'tipblight'. In branch wounds, the fungus causes a perennial canker, that can lead to branch loss and breakage. Hail and drought stress promote new infections of Diplodia. Losses due to bark beetles were due to a combination of stresses associated with competition in overly-dense stands unthinned since development, plus fungal infections and mechanical injuries that have accumulated over time.

Map 9, Aerial Sketch Map Results



Conclusions

Overall, residual forest resources in Hugo are healthy and growing vigorously. Those in Lino Lakes are under more pressure from development and show a variety of damage associated with human activity. However, without a tree inventory, accurately assessing the extent of damage compared to the percent healthy and vigorous is difficult. Roughly 1/3 of the trees show signs of stress, and a portion of these are likely to die. Many of those that survive will be at risk of tree failure posing a hazard to area

residents. How great the loss might be and how soon is impossible to tell based only on the existing data. Although Hugo's trees are in fairly good shape, tree health will likely decline as development pressures increase. When that happens, damage patterns will resemble those seen in Lino Lakes with similar consequences.

Recommendations

Recommendations to incorporate natural resources into planning efforts and city codes and ordinances have been addressed elsewhere in this report. To manage the risk of loss from hazard trees and insect and disease organisms, the following actions are recommended:

1 Inventory all trees in developed areas.
2 Take stand inventories of all 'native' stands using representative sample plots.
3 Identify and prioritize management activities based on the inventory data.
4 Develop an operational plan to implement those activities as staff and funding allow.
5 Develop a management plan to address long term forest management issues, incorporating a system of adaptive management that allows flexibility in meeting changing demands.

Metro Urban & Community Forest Health Surveys

April and December, 2000

In 2000, two surveys of the Metro Region urban and community forest contacts were conducted. The first, in April, explored their resource needs. The second, asked for specific information on insect and disease occurrences in their area.

Results

Of the 188 urban contacts, 49 responded to the April survey and 48 responded in December, a 26% response rate for both surveys. Respondents indicated their primary source of information was the DNR (33%), followed by the U of MN (15%). The majority (63%) of respondents felt their information needs were being met. With multiple answers possible, printed material was the most preferred format for shared information (43% of the responses), while email was the second most preferred (24%). Eight or 14% said they used all forms of information available.

Twenty-six (54%) of the communities responding in December, submitted insect and disease reports. Seventeen communities (65%) reported tree removals for Dutch elm disease control (see table 1). They removed a total of 1,682 elm trees, for an average of 99 trees per community. Fifteen communities (58%) removed a total of 530 oak wilt spore trees, an average of 37 trees per community. To control the spread of oak wilt via root grafts, communities reported plowing a total of 26,850 ft of plow line, for an average of 1,790 ft per community.

Table 1. Wilt diseases reports

Area	Elm				Oak			
	Treated Sites	Trees Removed	Feet Trenched	Untreated Sites	Treated Sites	Trees Removed	Feet Trenched	Untreated Sites
East	0	16	0	2	2	15	100	10
North	10	457	0	10	87	390	26200	49
West	8	1209	0	0	14	125	550	1
Total	18	1682	0	12	103	530	26850	60

For each community, one report was given for each damage type observed. See Table 2. Wilt diseases were the most common damage agents reported (36 of 145 reports or 25%). Spring defoliators, leaf/needle spots and storm/wind were the most common non-wilt damage agents (15, 13 and 12 reports, respectively). Among damage types occurring on a community-wide basis, spring defoliators, leaf/needle spots and root injury/girdling were the most common (7, 6 and 5 reports). Looking at biotic versus abiotic damage agents, 35 reports or 24% were due to abiotic causes.

Table 2. Damage types by severity

	High	Medium	Low	Blank	Totals
bark beetles	2		3	1	6
discoloration		1			1
distorted growth	1				1
leaf/needle galls	1	5	2	2	10
leaf/needle spots	1	3	7	2	13
root injury/girdling	1	2	2	5	10
rots or declines	3	1		1	5
spring defoliators	1	5	4	5	15
stem galls or rusts	1	1			2
storm damage	4	2	3	3	12

sucking insects	1	1	1	1	4
summer/fall defoliators	1	1	1		3
tipblights	1	1		3	5
weather injury	3	3	3	2	11
wilt				36	36
wood borers	1	2		2	5
wounds/cankers		1	4	1	6
Totals	22	29	30	64	145

Excluding reports missing their severity data and the wilt diseases, 22 reports or 27% were of high severity (see table 3). Storm damage, weather injury and rots/declines were the most severe (4, 3 and 3 reports of high severity). Twenty-nine reports (36%) were of moderate severity and 30 reports (37%) were of low severity. Fifty-eight or 40% of the reports lacked severity information.

Five of six communities reporting bark beetle and borer damage, described it as community-wide. Seven of eleven communities reporting root rots, declines and cankers again described the distribution as community-wide. Defoliators, galls, sucking insects and weather related damage typically occur over a larger scale and thus allow some opportunity to examine regional patterns. However, of the 70 reports of these damage types, only 24 occurred over a large scale. Fifteen of 145 reports (10%) omitted the distribution information.

Table 3. Damage type by distribution

	Blank	Community wide	Individual Trees	Pockets of Trees	Totals
bark beetles	1	2		3	6
discoloration			1		1
distorted growth				1	1
leaf/needle galls	1	2	6	1	10
leaf/needle spots	2	6	1	4	13
root injury/girdling	1	5	4		10
rots or declines	1	1	3		5
spring defoliators	2	7	3	3	15
stem galls or rusts			1	1	2
storm damage	1	4	2	5	12
sucking insects	1	2		1	4
summer/fall defoliators			2	1	3
tipblights	2	2		1	5
weather injury	1	4	4	2	11
wilt				36	36
wood borers	1	3		1	5
wounds/cankers	1	2	3		6
Totals	15	40	30	60	145

Discussion

A good number of communities returned their survey form which allowed us to update their records, something that was badly needed. However, most choose not to submit the other information requested. Many that submitted damage reports, left crucial data blank, such as host and damage severity. Based on the apparent confusion about how to interpret the classifications provided, the form used needed more explanation.

Distribution patterns were not as expected for the various types of damage, and biotic damage agents were more commonly reported than abiotic agents, even though abiotic agents typically cause more damage. This suggests a bias in what is being seen and what is deemed "worthy" of being reported. The data gaps and inconsistencies have masked large scale patterns in the damage observed. So while damage agents generally ignore community

boundaries, occurring in pockets as a function of site condition, damage occurrence appears to be random. So the survey did not adequately address the need to monitor and assess urban forest health across the region.

However, the survey did accomplish a couple of things. There were several communities who volunteered their services in tracking pest occurrences on an annual basis, if we can provide a realistic format for doing so (and a method of verifying or ranking data accuracy). Monitoring damage occurrence across the diverse and fragmented urban forest is difficult. It is nearly impossible where aerial detection is limited, so our current methods could stand to be enhanced. The willingness of these folks to assist in the effort is encouraging.

The surveys also provided some valuable information on resource needs. Apparently, the DNR is doing a good job of reaching people in the metro area. Most feel their needs are being met. That is good to know. So far, we have met that need through our monthly newsletter and cooperative trainings (primarily the Shade Tree Short Course). More than a third of those responding expressed interest in receiving electronic information as well as the newsletter and asked to be but on a list server. Doing so would allow a two-way exchange of information that could serve both DNR managers and our clients. It could open other opportunities as well to announce grant opportunities, enlist help to monitor pest outbreaks, gather and share data on important problems and report exotic species. Although we do not apparently have the staffing to manage such a system, it is something that ought to be explored in the future.

Finally, the surveys served to highlight those issues that have (or in some cases have not) gained the attention of community leaders. Many of the communities reported that they do not have a tree inspector, city forester or any other type of natural resource manager on board. This is understandable for the smaller communities, but many of the larger communities have a substantial natural resource that they are largely ignoring. This highlights the need for us to work with the Metropolitan Council to incorporate natural resource conservation into community comprehensive planning, and to explore other means of outreach and education which promote natural resource conservation.

Of those communities with professional staff, most have focused on the serious threat to their forest resources that the wilt diseases pose. However, many communities do not have an active DED or oak wilt program. Given the increase in both DED and OW seen over the last few years, the importance of wilt disease management needs to be better communicated. Improved methods of locating disease pockets, alerting city managers and supporting management efforts need to be explored. Finally, the number of reports of questionable accuracy highlights the need for general education, even among professionals. While DNR's outreach efforts are to be commended, we must do all we can to keep the current budget crisis from becoming an excuse to back off.

Top Notch Survey

Top Notch Tree Care conducted a similar survey of the perceptions held by community foresters on various forest health issues. While a discussion of their results does not constitute an endorsement, they are worth noting. The issues addressed included wilt disease impacts, and buckthorn management among several other urban forestry issues. Although the responses varied among communities, overall the number of trees removed by the survey participants jumped dramatically in 2000. The wounding effect of the 1997 and 1998 storms was the most common reason given for the increase, next to mild winters and staffing shortages that have hindered sanitation efforts. Other factors named by the respondents as contributing agents include an increase in the number of elms - largely volunteer elms in unmanaged areas, wounding associated with increased development, an increase in bark beetle populations, and a more aggressive strain of the fungus (the last two unconfirmed).

Almost all communities responding to the survey practice some form of buckthorn management (no numbers available). Most are small scale operations on public property. However, there are a number of communities that actively encourage neighborhood organizations to get involved in the effort. The management techniques and the chemicals used, as well as the success rates reported vary widely among communities. Public awareness of the issue is fairly high in the opinion of those responding. Both individuals and neighborhood groups are working to control the invasion. The biggest issue is the difficulty of follow through in what must be a long term project.

Deer repellents and bud capping

Deer browse on young trees can cause leader death or damage that results in undesirable bushy form rather than straight and single-trunk trees. Such browsed trees are usually unacceptable for timber or landscaping purposes. To protect trees from deer browse, a number of chemical taste or odor repellents have been marketed. Bud capping (stapling a white paper over the terminal leader and buds) has provided physical protection of young conifers. Bud caps are labor intensive.

To test selected chemical repellents and bud capping, three experiments were set up on state-owned plantations last fall and the results were read in April and May of this year. The chemical repellents included Ropel (bitter taste), Treeguard (bitter taste) and Plantskydd (blood odor). The locations of the three plantations, the experimental treatments, and the results are described below.

1. At the Crow Wing county plantation groups of 30 to 33 jack and white pine seedlings (10 to 24 inches tall) were treated as described and distinguished by colored tapes, and the following observations were recorded May 3.
2. At the Pine County plantation, 16 miles east of Sandstone, oak seedlings (1 to 4 feet tall) were treated as described and the following observations were recorded April 13th.
3. At the St. Louis County plantation, approximately 15 miles north of Orr, white pine seedlings (10 to 24 inches tall) were treated as described, and the following observations were recorded April 27th.

Percent of seedlings protected			
Treatment	**Crow Wing County**	**Pine County**	**St. Louis County**
	White and jack pines	Red oaks	White pines
Bud capping, white paper	0		97
Bud capping, newspaper	6		
Ropel	0	21	78
Ropel and BC	3		91
Plantskydd	31	44	97
Plantskydd and BC	6		100
Treeguard	0		93
Treeguard and BC	3		100
Ropel and Plantskydd		25	89
Treeguard and Plantskydd			97
None	0	No control tmt.	85

Variables at the Three Plantations:

1. Crow Wing County. Rainfall after experiment was set up: Oct. 14 & 15--.71inches; Oct. 25 to 27--.97 inches; Nov. 1,2 & 5--2.1 inches. Heavy mouse girdling. Deer per square mile (simulated from modeling): 18.
2. Pine County. Rainfall after experiment was set up: Nov.--.72 inches; Nov. total--4.48 inches. No mouse

girdling. Deer per square mile (simulated from modeling): 22.
3. St. Louis County. Rainfall after experiment was set up: Nov. l,2,3--.84 inches; Nov. 6,7--.74 inches. No mouse girdling. Deer per square mile (simulated from modeling): 12.

Conclusions:

Where number of deer per square mile is 18 or more, bud capping and/or the three tested repellents provided very little browse protection.

Where number of deer per square mile is 12 or less, bud capping and /or the three tested repellents may provide good browse protection.

Where rainfall after bud capping and /or application of the three tested repellents is less than l.6 inches before snowfall, good browse protection may occur. Heavier rainfall may cause removal of chemical repellents. Of the three tested repellents, Plantskydd provided the best protection.

Thanks to the local DNR foresters for help in setting up, treating or reading this study: Doug Hecker, Dave Sapocie, Molly McGlip, Bob Bachman and Keith Simar.

Urban Hazard Tree Manual

A multi-agency working group is drafting an urban tree risk management manual that will serve as a guide to assist communities establish programs to detect, assess and correct hazardous defects in urban trees. This manual will have application for tree species and environmental conditions common th the northeastern US. The manual will provide information to community decision makers on how to establish community programs and will provide public works staff and other urban forestry professionals with the nuts and bolts of how to conduct hazard risk assessments on individual trees.

The chapter, "Recognizing common defects and understanding why trees fail", was drafted by Jana Albers , sent to reviewers and submitted to the manual editor at State & Private Forestry -USFS.

Hazard tree training sessions

Two training sessions were conducted; one in Rochester and the other in New Ulm.

Technology transfer fliers

Utilization of diseased wood
Oak wilt 2001: Keeping the momentum going
Larch beetle
Spruce beetle
Shouldn't these pines look green by now?
Clean up storm damage now to avoid bark beetle damage later
Using the "trap tree" technique to manage bark beetles in pine
Managing pine bark beetles on suburban lots
Forest tent caterpillar: What's on the menu?
The friendly fly: A fly that parasitizes forest tent caterpillars
Media activities in R2

Utilization of diseased/ infested wood

As we move into July, trees struggling with various forms of disease become noticeable as their leaves wilt, yellow and/or drop. Afflictions range from the wilt diseases, slow declines (usually a combination of age, stress, and disturbance), mechanical injury such as construction damage or bark beetle infestations (often associated with weather-related stress). Removing and disposing of these trees can be an expensive proposition. Since taking the wood to the landfill wastes a valuable resource and is prohibited by most landfill operations, many homeowners struggle to find an effective solution to the problem.

If you have large quantities of wood, your first alternative is to contact your local DNR forester to obtain a list of the wood suppliers in your area. Besides taking the wood off your hands, some will remove the trees for you (this depends on the volume and quality of the wood). This is particularly true if you have whole stands that are being cut or thinned for new construction or major renovation. If that doesn't describe your situation, there are still alternatives. Here are some of them.

Insects and Disease Concerns

The primary concern is whether or not you are spreading potentially dangerous insects and diseases by using and/or moving wood products. The primary answer is YES YOU CAN, so you need to be careful. However, there are things you can do to prevent the accidental movement of key pests (see below, especially if you have a bark beetle infestation).

Burn the wood prior to April first. Spring is the season most insects and disease organisms initially infest trees. They emerge from their overwintering grounds and move to new locations. Often their travels involve moving into or out of freshly cut wood. If you burn the wood prior to their emergence, you eliminate the possibility of them getting out to infect new trees.

Remove the bark. Bark and turpentine beetles (including pine and elm bark beetles) need intact bark over moist wood in order to reproduce successfully. Moving fresh cut wood with the bark still attached risks moving any insects inside to the new site. There they can introduce wilt diseases or infest healthy trees leading to additional tree loss. You can prevent moving these insects by removing the bark. The wood will dry quicker and any bark beetles inside will die before they have a chance to infest new trees.

Removing the bark prevents the oak wilt fungus from fruiting. It too must have intact bark over moist wood in order to reproduce.

Removing the bark also prevents moving hitchhikers, like the gypsy moth that like to hide eggs and pupae in bark cracks, from one place to another.

Chip the wood. Once dry, none of the wilt disease fungi, and few other tree pests, insect or fungal, can survive long in chipped wood. While there is a very small chance that some of the canker causing fungi could survive long enough to release spores, the chance is slim indeed. If you are worried about canker diseases, you can spread the chips out to speed drying or cover the chips temporarily with black plastic to 'bake' them dry. Wood chips can be used in the landscape as mulch or sold for other wood products. Beware of fresh poplar or willow chips - they might sprout on you!!!

Cover the wood pile for 1 year. Fresh firewood can be stored for longer periods of time by covering the wood for the first year with plastic and sealing the edges so no insects can get into or out of the pile. The best way to 'seal' the pile is to bury the edges of the plastic in dirt and place wood or rocks over the edges to keep them in place. While decay fungi can survive under the plastic, insects and most disease organisms cannot survive for longer than a year. The oak wilt fungus only fruits during the first year after the tree's death. Elm bark beetles utilize the wood for only one year after the tree's death. Once the wood has aged, it can be uncovered and used as desired.

Special bark beetle concerns. If your trees died because of a bark beetle infestation, it is particularly important that you get the trees down and that the wood is handled properly. When the wood is cut and how it's handled can help clean up an infestation or promote its expansion. If possible, cut several live trees during the winter or early spring and leave them on the ground to serve as 'trap trees'. As bark beetles emerge from their overwintering sites, they will be attracted to the cut trees and will attack them in large numbers. Once the beetles are inside the cut logs (around mid-May), the logs must be removed. All cutting and tree removal should be done by June 1st to prevent the second generation of beetles from expanding the population. The wood must be debarked, chipped or buried to keep the second generation of bark beetles from attacking the remaining trees. The slash (smaller branches and twigs from the tree tops) should be burned, or cut into small pieces and scattered where it will dry quickly. For specific details on managing a beetle infestation, see the DNR publication "How to Identify and Manage Pine Bark Beetles" or contact your local area forester.

Oak wilt in 2001 : Keeping the momentum going

Oak wilt causes serious losses

Oak wilt is responsible for killing thousands of oak trees annually in residential settings, woodlots and forests. Oaks are undoubtably the most valuable and plentiful of our shade trees as well as providing diversity, habitat and lumber.

By May of 2000, surveys had identified 15,359 acres of active oak wilt in Minnesota. Most of the infection centers are concentrated in the Twin Cites, counties immediately north of the Twin Cities and in scattered locations in the southeastern counties. See map and table (over).

Oak wilt can be controlled - successfully!

Oak wilt is not another Dutch elm disease. Oak wilt is a disease that we can DO something about. And, oak wilt suppression programs have proven to be successful every year since 1991. The tally now stands at 6,976 acres controlled.

Oak wilt suppression - cost share programs have been extremely effective in controlling oak wilt in local communities. From 1991 to 1997, the federal Oak Wilt Suppression Cost-Share Program controlled nearly 60% of the identified oak wilt infection centers in areas of Anoka, Chisago, Dakota, Isanti, Ramsey, Sherburne and Washington Counties. In 1998, state funding replaced federal funding and the coverage was increased to include all areas and counties with oak wilt.

During the last ten years, excellent cost-share programs developed at the community level that distributed the cost share monies and provided oak wilt inspections, homeowner assistance, program regulation and community education. Programs operated at the local level, blending in with other community services. Over 140 communities/ counties have participated in this program. In at least four communities, Apple Valley, Burnsville, Edina and North Oaks, the incidence of oak wilt was lowered to a point where the community could control oak wilt without the aid of state cost share monies.

Keeping the momentum going

People and projects are poised to continue the oak wilt control program. Building on the foundations already laid by the state program, we need to renew our partnerships with local communities and counties by continuing to provide technical assistance and cost-share monies.

We need to be persistent in aggressively treating oak wilt infection centers. If we loose momentum, it will be a daunting task to control oak wilt in the future.

Oak wilt threatens our statewide oak resource because it is easily carried to new, distant locations by transportation of freshly infected firewood.

Without continued funding, it is certain that oak wilt will resurge over the already treated areas and intensify in nearby woodlots and forests.

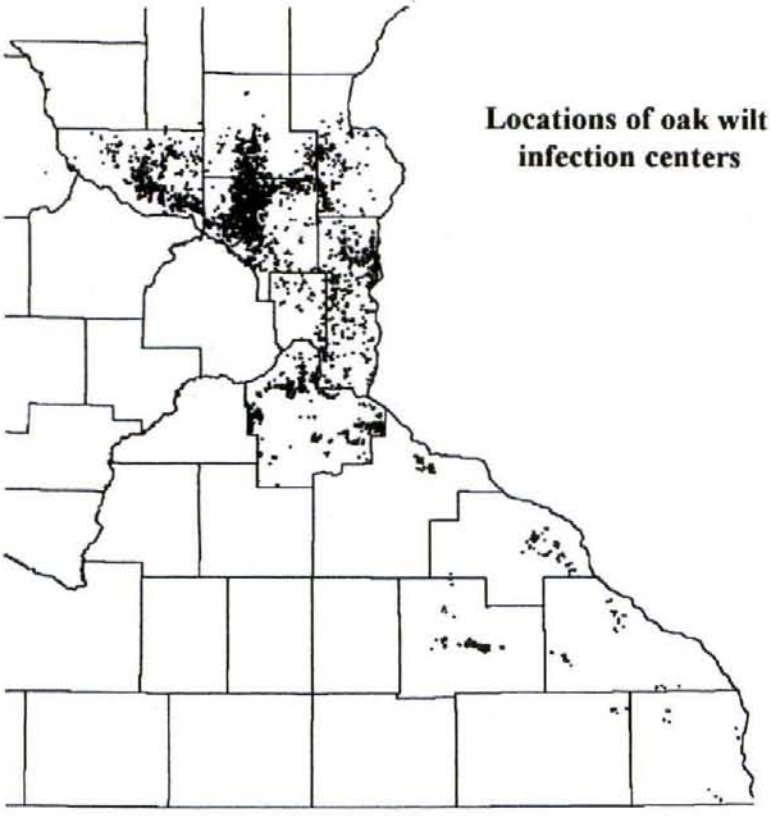
Deferring control actions to the future will ensure:

- the needless loss of thousands of acres of oaks in residential lots, woodlots and forests,
- millions of dollars will be spent taking down dead oaks on private and public lands,
- residential property values will decline,
- the beauty and shade of the oaks will be gone,
- the remaining oak habitat will be fragmented or lost, and,
- fire danger will increase due to the presence of dead and fallen oaks.

Our goals are to limit oak wilt to the currently infested counties and to decrease the number of infected acres, eventually, making oak wilt occurrence less than one infection center per square mile.

Recommendation

Continue to support xxxxxx by re-funding and expanding legislation passed in xxxx. We support funding forest health legislation at the level of $600,000 per biennium.



Locations of oak wilt infection centers

Acres of oak wilt		
County	**Controlled**	**Active**
Anoka	3182	5712
Chisago	230	386
Dakota	1128	2639
Fillmore	3	41
Goodhue	12	114
Hennepin	0	47
Houston	7	9
Isanti	330	589
Mille Lacs	0	7
Olmsted	51	254
Pine	0	1
Ramsey	509	242
Scott	0	7
Sherburne	1324	3129
Stearns	3	41
Wabasha	20	150
Washington	175	1915
Winona	2	70
Wright	0	16
Total for state	**6,976**	**15,359**

Typical oak wilt infection center

A typical infection center is about 1 acre in size. The center is occupied by dead oak trees and the perimeter is made up of dying oaks. Next year, the circle of dead trees enlarges by about 25 feet in all directions as the fungus spreads through connected roots . Old infection centers have new "satellite" infection centers which are the result of insects carrying the fungus to nearby oaks. Insects, active in April, May, June and early July, can spread the fungus up to 1/3 mile in a year. The satellite infection centers also grow at 25 feet per year and often merge with the original infection center.

Wounded oaks and oak wilt infection

Insects carry the oak wilt fungus to wounded trees in spring and early summer. Unfortunately, this the time when construction activities occur. Oak wilt gets carried to the wounded oaks and then spreads to nearly oaks in the next few years.

Heavy storms break branches and damage oak trees. These wounds are liable to become infected if within 1/3 mile of an existing infection center. The damaging storms of 1997 and 1998 doubled the acreage of oak wilt in Sherburne County.

How oak wilt is controlled

Existing infection centers can be controlled by severing roots between infected and healthy trees with a vibratory plow. New infection centers can be prevented by immediately removing the dead/ dying oaks which prevents the insects from carrying the fungus to healthy trees. New infection centers can be indirectly prevented through public education and focused educational efforts, such as, the Best Management Practices for Conserving Wooded Areas in Developing Communities.

Community cost-share programs

Upon successful application, the community offers participation in the community oak wilt suppression program to interested landowners. Infection centers are verified by the community forester. The community makes a 50/ 50 cost-share agreement with the landowners. Sites are plowed and dying trees are removed by local vendors. The community reimburses the landowner as per the agreement. The state program reimburses the community for dollars spent in actual control work and for community time and expenses in program management.

Larch beetle: Got bark?

During winters after larch beetles build up, reports of tamarack trees with no bark are common. Woodpeckers strip the bark off the main bole right down to the snow line. The woodpeckers are looking for larch beetle adults which overwinter under the bark of the tamarack (larch) trees. The beetles kill the trees and the woodpeckers are feasting on the beetles. Bark is sometimes also removed from the larger branches.

Damage levels varied from scattered individual trees killed by the beetles to 30-50% of entire stands killed. In some cases, stands contained large pocket of damage where 80-90% of the trees were dead. Most of the damaged trees observed this winter appear to have been attacked by the beetles last spring and summer, however in some stands trees killed over the past few years were obvious as well.

Small, 1/16 inch holes in the bark, lots of dark brown boring dust and copious resin flow are indications of attack. And of course, in winter, woodpeckers may strip bark off looking for breakfast, lunch and dinner. In Newfoundland it is reported that about 50% of trees attacked in the spring turn yellow earlier than normal, in August and early September.

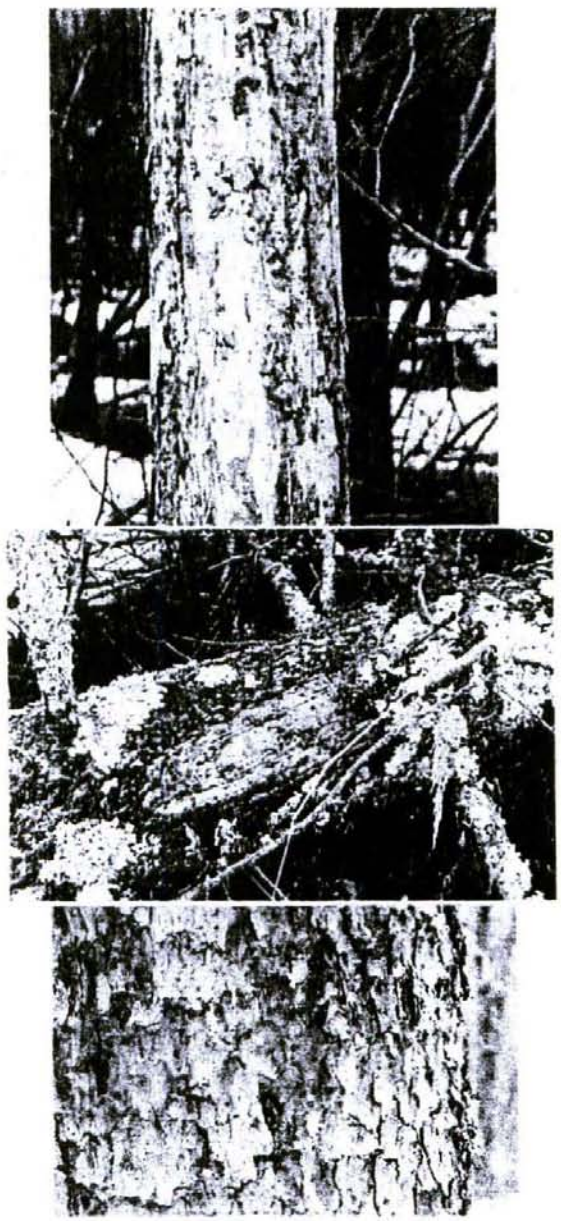
Larch beetle is a native insect. Native tamaracks and exotic larches are the only species attacked by the larch beetle. Larch beetle is usually considered a secondary pest attacking stressed and recently cut trees. Flooding, drought, defoliation and old age have been associated with larch beetle attack. However, larch beetle also appears to be able to develop widespread outbreaks and kill healthy trees as well.

Some of the damage seen this winter appears to be the result of populations the beetle building up on logging slash and piles of tops. The beetles then attacked and killed seed trees or pockets of trees in surrounding stands. In other situations, there was readily apparent cause for the buildup and attack. Old age is likely a contributing factor in some stands.

Larch beetle adults overwinter in attacked trees. Adults emerge in the spring, seek out and bore into suitable live trees or fresh logging slash. There they construct galleries and lay eggs. Larvae hatch from the eggs, feed on the phloem and eventually pupate and change into adults about 3/16 inches long.

These new adults stay in the tree and overwinter. There is one generation per year with three broods per year.

We are interested in knowing how widespread this damage is. If your trees have larch beetle damage please send the location to your local Regional Forest Health Specialist.



Photos by Darren Wysocki, DNR

Spruce Beetle in Minnesota

Spruce beetles have recently been found killing white spruce in northeastern MN along Lake Superior.

Major outbreaks of this bark beetle causing extensive spruce mortality have occurred in New England and eastern Canada and also from Alaska to Arizona.

Hosts include all native species of spruce but white spruce is probably the most important.

The spruce beetle tends to prefer larger diameter trees (12" and up) but have also been found on smaller trees.

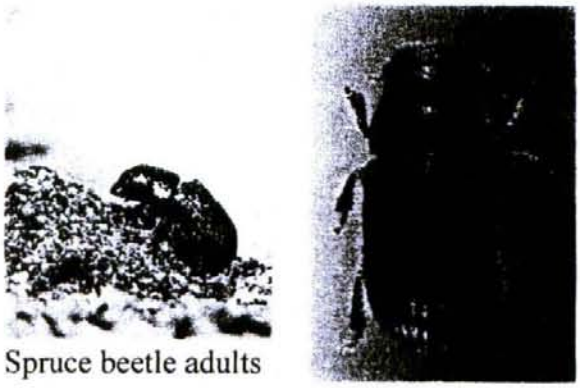
Signs of attack include red boring dust on the bark at the base of the tree, pitch tubes on bark of the main bole of the tree, exit holes, fading foliage, dead and dying trees.

When fresh, pitch tubes are easily seen. As they age, they become flattened on the bark and take on a color similar to the bark and can be very difficult to see.

Adult bark beetles are 4-6 mm long and are two toned (reddish brown wing covers and black head and thorax) or all black.

The beetles build up on trees stressed by soil compaction, spruce budworm or root rot and in blowdown or in piles of logging slash.

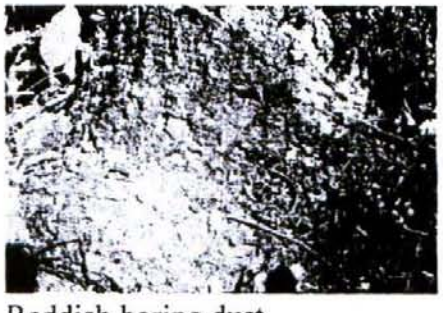
The distribution and importance of this bark beetle in Minnesota is not known. Please report infested trees and stands to your DNR Regional Forest Health Specialist.



Spruce beetle adults

New pitch tube

Old pitch tube



Reddish boring dust

Shouldn't these pines look green by now?

If you live anywhere on the Anoka Sand Plain, you've seen the red (Norway) pines change color over winter and, in some cases, get worse this spring and summer. Normally, winter injury symptoms disappear as the new, green shoots and needles grow. Some of the red pines have followed the typical scenario and are fine, but others are struggling. A number of pines have already died. On the dead and dying pines, you'll see orange/ brown needles on most of the branches and no new shoots or needles developing in the bud tips.

2001 is the beginning of the fourth year of drought as measured by subsoil moisture. Despite the rains we had in April, May and, now this week, soils are dry and water tables are very, very low. In some Sherburne County locations, soil moisture and water table levels have met or are lower than those during the drought in 1988. Some lake levels have dropped six feet below their normal levels.

Tree root systems were left high and dry and this puts all trees under stress. For the last two years, red pines have been indicating their level of drought stress in the form of winter injury. You can see it in pine plantations, windbreaks, roadside plantings and backyard trees. Even the small understory pines in pine plantations are dying off due to lack of soil moisture.

With the deepening drought stress, red pines became vulnerable to insects which took advantage of their weakened state. Earlier this spring, pine bark beetles attacked the upper crowns of many of these pines. An aerial survey this week found nearly fifty red pine plantations with discolored, dead and dying crowns in Sherburne and Isanti Counties. Most of the affected trees are located in plantation interiors, indicating a serious drought stress and likely bark beetle buildup. Pines in backyards, along roadsides and in windbreaks were also affected. In some cases, 100% of the pines were orange colored. Back on the ground, a few discolored trees were felled and all had bark beetles developing in them.

A few pine plantations did not show any discoloration. Trees growing in these plantations apparently have plenty of rooting space and an adequate supply of water because they have been recently thinned by harvesting.

How can I tell if my pines are infested with bark beetles?

You'll notice several large branches or the top half of the tree with discolored needles. These branches are dead and do not have new growth. Pine bark beetle activity begins in the upper crown and progressively moves down the stem. It's easiest if you can cut a symptomatic tree down in order to check it for bark beetle galleries and exit holes. Galleries occur in the thin layer of inner bark between the outer bark and the wood. In the active galleries, you can find eggs, grubs, immature or mature adults. Exit holes are created as the new generation of bark beetles chews its way out of the bark and, when hundreds occur in a group, look like holes from a shotgun blast. This is positive evidence that bark beetles are active and could threaten nearby pines (within 1/4 mile).

What can you do?

For dead and dying pines in backyards and along roadsides and in windbreaks:
1. Cut down the pines as soon as possible. To keep bark beetles from spreading to adjacent trees, you then must get rid of the tree tops and branches by chipping, burning, burying or otherwise destroying them. The logs should be debarked, chipped, burned or removed from the property. Do this within three weeks of cutting the trees. If you don't, you've made it worse for the remaining pines because you've just raised a huge crop of hungry bark beetles.
2. Water, water, water. Where possible, use a soaker hose to irrigate the root systems of the remaining pine trees for the rest of the summer. This is especially important if rainfall dips below average.
3. Watch your trees carefully. Are more trees changing color? Are bark beetles still a problem? Repeat step 1 and, later, step 3.

For dead and dying pines in plantations:

1. Doing nothing is always an option. If there are trees with discolored crowns in your plantation, there will likely be bark beetle-caused mortality in your plantation this year. And, if the drought is truly over, mortality that occurs this summer will be the only mortality that the bark beetles will cause.
2. Use a management method called the "trap tree technique" to limit mortality, thin the stand and make a little money. In a nutshell, some trees are girdled and harvested, all products and slash are removed or destroyed withing three weeks of being cut. Hint: have a contract with a logger in hand before you begin girdling the trees! That way you won't create a bigger bark beetle population and extensive tree mortality. More information is available at this website:
www.dnr.state.mn.us/forestry/publications/forestdi/june01/section2.html#bb. This information is also available from the Forestry offices listed below.
3. If your plantation is heavily damaged, you may want to thin or clearcut harvest the stand in this fall or winter. Make sure bark beetles are the cause of the damage first, then contact a forester for further advice.
4. A long-term goal is to improve tree vigor by thinning the plantation. There's a double benefit; your trees will be better able to withstand drought stress and you'll make some money. But wait for a year or two so the lingering effects of drought are over and only cut trees during the fall and winter to avoid bark beetle buildup and tree mortality.

Even if the drought turns around yet this summer, the water table recharge lags behind this. And, most importantly, tree vigor can't turn around overnight either. It will probably take two to three years for the trees to recover. In the mean time, pines will still be vulnerable to bark beetles, especially this summer. Take action where possible.

For a brochure on bark beetle identification and management, contact your local DNR Office, Extension Service or County Forester.

Clean up storm damage now to avoid bark beetle damage later

Pine trees that were damaged or broken off by the wind storm are perfect food and habitat for pine bark beetles this summer. If the damaged material is not quickly cleaned up, a generation of bark beetles will develop in them and then move into nearby undamaged pine trees.

Pine bark beetles are opportunistic insects. In an undamaged forest or planting, bark beetles attack and kill the damaged or drought-stressed trees. Storm-damaged pines are ideal targets for bark beetle attack, especially trees that are broken off. To avoid bark beetle damage to live pines, it is best to clean up the storm damaged material now, so bark beetle populations don't have the chance to build up and move into them.

Within the next three weeks, the downed trees and large branches should be burned, buried, chipped, or used for lumber or pulpwood. The tree bark can also be peeled off to make it unuseable by the bark beetles. Do not keep the pine wood for firewood unless the bark has been peeled off.

Bark beetles use pine trees for food, shelter and for raising their young. They live in the inner bark, a thin layer between the outer bark and wood. You can check for bark beetles by using a stout knife or hatchet to peel back the bark and look for tunnels and galleries along the surface of the wood. At the end of their life cycle, young adult bark beetles chew their way out of the tree, creating what looks like shot-holes in the bark. Trees attacked by bark beetles can have up to 150 bark beetle emergence holes per square foot of bark.

Bark beetles complete a generation in 30 to 40 days. They will re-infest the same tree or log as long as the inner bark is creamy and moist. Otherwise, they will fly away seeking another stressed or damaged tree or log. In northern Minnesota we usually have two generations per year, but in a year with a long growing season, we may have three generations. Large numbers of bark beetles can develop in a single year.

If large bark beetle populations overwinter and there is a drought next year, then bark beetles will start attacking the live, healthy pines and they may kill them.

Further information about bark beetle identification and prevention can be obtained from your local DNR office. The phone number 218-828-2565 or 828-2616.

Using the "trap tree" technique to manage bark beetles in pine

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 health 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 the 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 beetles larvae and pupae). If either are found, the log should be treated as in #4 below. The presence of exit holes in conjuction

with galleries necessities 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 trap 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).

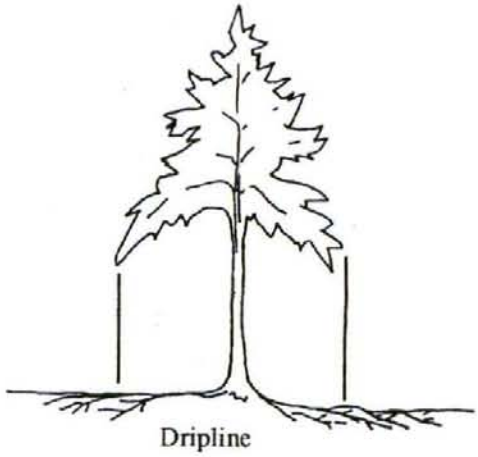
Bury the logs under 6" or more of soil.

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.

Managing pine bark beetles on suburban lots

The best, cheapest and most practical thing to do is to water the pine trees. Simply, water the trees. During the last severe drought, homeowners who only watered their pines fared as well as those who tried other means to keep their pines alive. Watering also prevents other opportunistic (and fatal) pests from gaining a toe-hold in drought-stressed trees.

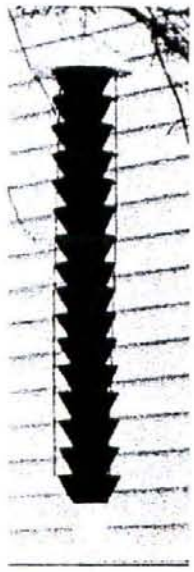

Dripline

Keep the trees well watered by providing at least one inch of water per week for the growing season. If nature doesn't supply it, use the garden hose. The top 8-12 inches of soil should be kept evenly moist around trees during periods of drought, at least as far as the branches spread (dripline). Avoid using a sprinkler, this just waters the grass and, although you think you're watering the tree, you're not. It's easiest to position the hose near or inside the tree's dripline and let it run for an hour or more, move it slightly and let it run. Continue doing this until you've watered most of the areas around your trees. Then repeat this next week if one inch of rain doesn't fall. If you have many trees to keep watered, a large diameter soaker hose might be more to your liking.

Mulching will keep soil moisture high. Use needles, bark, wood chips or other organic materials as mulching material in a layer that is only add two to four inches thick. Never place plastic under the mulch because this does not allow rain or irrigation water to get into the soil and root system.

Do not fertilize until the drought and bark beetle outbreak are over. A water-shortage triggered the bark beetle outbreak, it was not triggered by a shortage of chemical elements in the soil. In fact, the addition of fertilizers will decrease the amount of water available to the trees because fertilizers are salts.

If watering is not an option, another technique can be used to reduce populations of bark beetles which uses a trap baited with bark beetle pheromones. Pheromones are air-borne chemicals produced and excreted by insects that attract others of the same species. Pheromones could be thought of as insect perfumes. Bark beetles use pheromones to attract other male and female beetles to a tree so that the tree's defense system can be overcome by a massive number of beetle attacks.



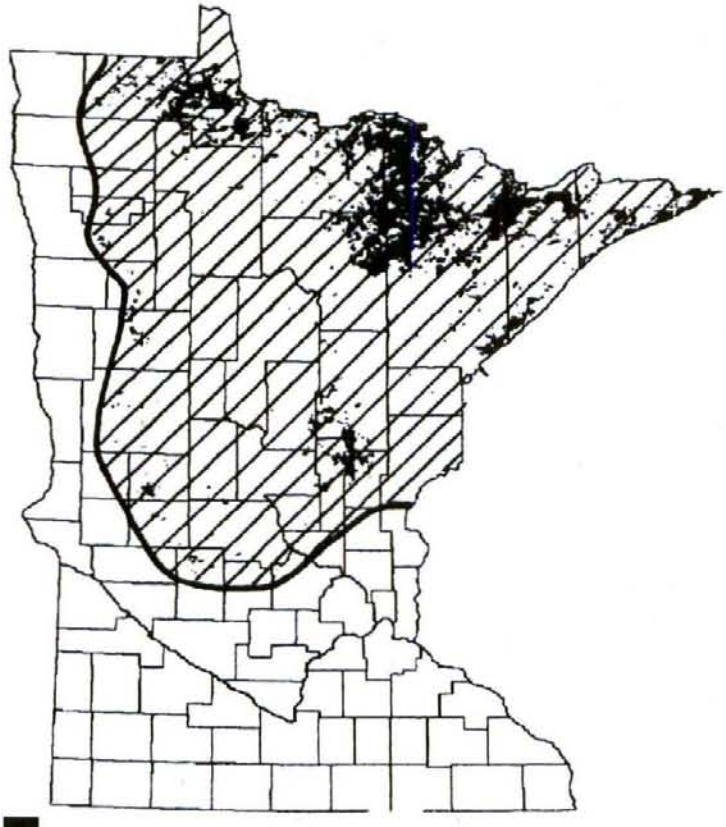
Usually reserved for research purposes, pheromone traps can be economically used on suburban lots, as they are too expensive to be used in woodlots and plantations. This technology reduces the local populations of bark beetles by attracting and catching the beetles in funnel traps. You can trap lots of bark beetles using pheromone traps but whether you trap enough beetles to affect the population and prevent them from attacking other pine trees has not been proven. The traps use no pesticides to kill the beetles; they die from dehydration, starvation or being consumed by predators. Pheromone traps will not prevent attack by other opportunistic pests.

Pheromones and funnel traps are available from one source, Phero Tech in British Columbia and they cost about $50.00 each. Shipping and handling are additional costs. Phero Tech Inc. can be reached by telephone at 604-940-9944 or by email at sales@pherotech.com. You'll need to provide a 5/8 inch diameter steel rebar to hold up the trap.

The best defense is to keep trees healthy by watering them during droughty weather.

Forest tent caterpillar in 2001: What's on the menu?

The forest tent caterpillar (FTC), *Malacosoma disstria,* is a native defoliator of hardwoods, especially, aspen and birch trees in northern counties and basswood and oaks in central and southern counties. Forest tent caterpillars are often mistakenly called "armyworms". Widespread outbreaks of FTC occur at intervals of ten to twenty years and are two to three years in duration. Outbreaks peaked in 1922, 1937, 1952, 1967, 1978, and 1990. Populations collapse due to starvation, predation and parasitism. Populations of the "friendly flies", native parasites, build up as the FTC populations peak.



Areas defoliated in 2000

Potential areas of defoliation in 2001

Projected schedule* for FTC life stages and host tree foliage	
Host tree buds break	Apr 18 - May 10
FTC hatch	Apr 18 - May 15
FTC major feeding period	June 5 - June 25
FTC pupate	End of June
Host trees refoliate	Early to mid-July
FTC moths fly and lay eggs	July 1 - July 15

* = The timing of biological events varies from year to year because timing depends on weather and location. For example, events will occur near the earlier date: when the spring is early; when May and June are hotter than average; or, when the location is south of Mille Lacs Lake.

In the forest, FTC defoliation usually does not affect tree health because FTC populations usually collapse before tree damage occurs. FTC can consume 60% of a tree's foliage for three years and the tree will show no ill effect. Even completely defoliated trees will usually develop a second set of leaves in mid-July without a loss in health.

More information on FTC and color photos can be found on these Websites:

- www.dnr.state.us/backyard/treecare/
- www.extension.umn.edu/distribution/horticulture/ DG7563.html
- www.na.fs.fed.us/spfo/pubs/fidls/ftc/tentcat.htm
- www.na.fs.fed.us/spfo

DNR Forestry
April 2001

Dealing with FTC can be very frustrating!

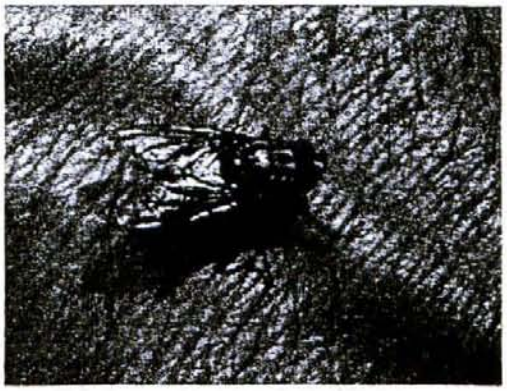
During their peak, FTC can create an extreme nuisance to people living or vacationing in forested areas. Young caterpillars spin threads and fall from trees onto picnic tables, patios and people. Large, mature caterpillars wander widely in search of food and often appear to migrate across roads and open areas. Resting caterpillars commonly form large clusters of thousands of caterpillars on buildings, tree stems, campers, and other stationary objects.

During the first three weeks of June, FTC 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. Homeowners may want to adopt two basic strategies. First, identify the small trees, gardens, lawn furniture, buildings, etc. that you want to safeguard. 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 safeguard everything on your property. Second, be persistent. Some treatments may require daily monitoring and action.

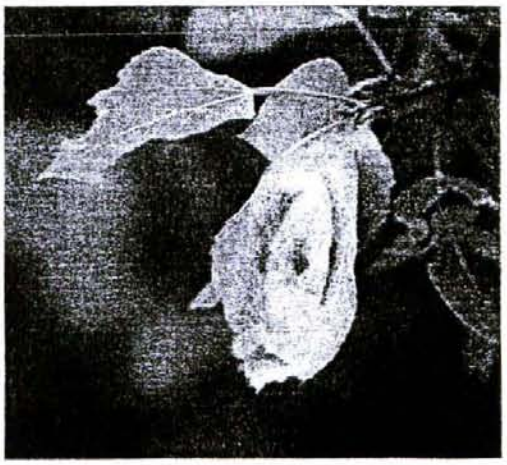
1. Before they hatch (any time from July to early-May) hand pick all the egg masses off of valuable plants. Destroy egg masses or dispose of them.
2. Some people think FTC are for the birds. Lure in birds with bird feeders, especially the pine and evening grosbeaks, and they'll do some of the work by eating the caterpillars.
3. In May and June, hand pick caterpillars off plants and dispose of them. Later, gather and destroy cocoons.
4. Caterpillars can be brushed off the house, lawn furniture, etc. with a stiff broom or knocked down by a stream of water. Bag, bury or compost the dead caterpillars.
5. Rig up a barrier around your garden, house or fruit trees (presuming you've already removed the egg masses from the twigs). Here are two popular methods:
    a. Use a wide band of masking tape, tree wrap tape or aluminum foil with a thick layer of Tanglefoot or petroleum jelly or a coating of vegetable oil spray. This stops the caterpillars from crawling up your tree until the band is full of them. (Then they just crawl over the backs of the caterpillars that are stuck.) This method needs at least daily attention and replacement of the goo. Remember to take the bands down by July 1st so the tree isn't injured by the tape or wrap.
    b. Stake up a 2 foot high plastic sheet and weigh down the edge with sand or dirt. Then either apply a 2 inch wide band of Tanglefoot, petroleum jelly or vegetable spray near the middle or let the top 6-8 inches flop down to create a moving and unstable flap the caterpillars can't cling to. You may want to weigh down the flaps so caterpillars don't get flipped into the garden when the wind blows.
6. Under some circumstances, you may want to spray an insecticide to protect gardens and trees at risk. 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. Trees at risk include: newly planted woody ornamentals and tree saplings; trees recently damaged by construction, trenching, soil compaction, blacktopping, etc.; birches or oaks that have suffered 2 years of heavy defoliation or have active branch dieback; and, drought stressed trees.
    Insecticides have restrictions as to which plants and sites where they can legally be applied. If applying to shade and ornamental trees, the label should say it is for use on shade and ornamental trees. Microbial insecticides containing Bt, (bacterial products made of *Bacillus thuringiensis*) are recommended 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 slightly 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 FTC when the caterpillars are small. Please read and follow label directions.
7. FTC moths are attracted to lights during the nights in early July. Turning out your yard and exterior lights may reduce egg-laying on your trees and thus reduce next year's defoliation.
8. The most important thing you can do for your defoliated trees is to keep them well watered. Supply 1 inch per week if you do not receive that much in rainfall from May 1 through September 1.
9. Do not fertilize defoliated trees or use a weed and feed product on your lawn during an outbreak year. Fertilization encourages the tree to produce more leaves which puts an additional stress on the tree.

The Friendly Fly: A Fly that Parasitizes Forest Tent Caterpillars

Friendly flies, Sarcophaga aldrichi, are a major factor in the collapse of forest tent caterpillar populations. During the last one to two years of an outbreak, these flies become very abundant because they use forest tent caterpillars as their food source.



Friendly flies are the most important insect parasites of forest tent caterpillars (FTC). In mid- to late-June, adult flies deposit live maggots on FTC cocoons. The maggots move into the cocoons, bore into the pupae and feed on them which kills the developing FTC. After completing their feeding, the maggots drop to the ground, form their own pupal stages and remain dormant until the next summer.



Friendly flies resemble house flies, but they are larger, slower and distinctly more bristly. Adult flies are gray in color and are 6 to l2 mm long, the sides of their faces are hairy, on each end of their two antennae is a single and branched bristle, their thoraxes have three black stripes, and their abdomens are checkered.

When friendly flies occur in large numbers, they too can be a nuisance because they drone persistently and often land on people and food. Adults are strong and active fliers and they swarm over everything (people, livestock, lights, light-colored garments and laundry hung out to dry). They don't bite but they can soil clothes, laundry and food with their regurgitations. Unlike other flies which can be shoo'd away, friendly flies must be brushed away.

Between forest tent caterpillar outbreaks, the friendly fly population collapses and they survive in low numbers by depositing their larvae on carrion, dung and various decaying materials.

Several species of other flies and wasps parasitize the eggs, larvae and pupae of the forest tent caterpillars. Predatory flies, beetles, ants, true bugs, spiders, birds, wood frogs, deer mice, skunks and toads also feed on forest tent caterpillars.

Media, Press releases, I&E activities March /23 - June/21/2001

By Region 2, Mike Albers

3/23 Interviewed by Sam Cook- Duluth Tribune about FTC
3/26 Interviewed for regional edition of NPR - FTC
4/25 Made press release through Jean Goad for ice storm damage in Duluth
-Do's and Don't of dealing with storm damaged trees
-Ice storm damage and bark beetles
4/25 FTC fact sheets sent to Area Offices and Parks in R2
5/2 Made press release through Jean Goad on Winterburn
5/2 Talk on Ftc to Itasca Resort Association
5/7 Interviewed by Marshall Helmberger , Timberjay - FTC
5/15 Interviewed by Sam Cook- Duluth Tribune- FTC
News release through Jean Goad - FTC (this release was picked up by the Arizona Republic newspaper among other newspapers)
Interview for some ST Paul radio station - FTC
5/16 Interviewed for KDHL radio in Duluth -FTC
Interviewed For Budgeteer, Superior WI- FTC
5/17 Interviewed by Hibbing newspaper-FTC
5/21 Interviewed by Mesaba Daily News - FTC
5/23 Interviewed for Red /Rock Radio, Duluth -FTC
5/22 Public workshop on FTC in Grand Rapids in cooperation with UM Extension
This presentation was taped and shown a number of times on ICTV
5/23 Public workshop on FTC in Lakewood township in cooperation with UM Extension –3 Duluth TV stations attended and taped segments for news programs.
6/5 Interviewed by Tom Mursman Star Tribune FTC
This interview appeared in the Star Tribune on 6/10
This article was picked up by the Pioneer Press on 6/11
6/7 Interviewed by Tom Robertson - MPR - FTC
6/8 Taped TV segment with Ron Cripa for KARE 11 in Twin Cities - FTC
6/11 Interviewed by Kim Kaiser for TV 6 in Duluth- FTC
6/12 Interviewed for Grand Marais newspaper - FTC
6/20 Taped segment for Environmental Journal on FTC to be aired on public TV throughout MN.
6/21 Interviewed by Tom Wilkowski, Duluth Tribune on winterburn, and anthracnose
7/9 Interviewed by Dave Strandberg-KDHL Radio- Duluth- FTC moths
7/9 Channel 10 Duluth- FTC moths
8/3 Spruce needle rust. Region-wide news release through Jean Goad
8/23 Interviewed by Scott Thistle -Spruce needle rust -Duluth News Tribune
9/21 Interviewed for Public Radio- Cook Co, Grand Marais- Spruce Beetle

Survey Results

Included:
Forest tent caterpillar
Spruce budworm
Pine tussock moth
Jack pine mortality in Wadena County
Forest Health Monitoring plots-aerial survey

Forest Tent Caterpillar Egg Mass Survey - Region 2

Predictions for Summer of 2001

Plots with no DBH listed were visual checks rather than actual counts of egg masses.

County and Legal	Average DBH	Average # of Egg masses	Predicted 2001 Defoliation	Remarks
Carlton S6T48R15		0	0	
Itasca NWSW S25T145R25	1.6	1.3	Light	Deer River
Itasca NWSW S23T56R27	1.8	0	Light	East of Deer river
Itasca NWSW S35T149R28	2.7	1	Light	north of Round Lake
Itasca NWNE S12T149R26	2.3	1.6	Light	east of Wirt
Itasca S27T61R26		Many	Heavy	Big Fork High School
Koochiching SENE S35T71R24	3.4	4.3	Moderate	NE of Int'l Falls
Koochiching SWNW S16T70R24	4.0	60	Heavy	SW of Int'l Falls
Koochiching NENW S10T68R25	3.25	19.5	Heavy	Littlefork
Itasca NWNW S21T59R24	3.0	5.5	Moderate	north of Buckman L
Lake SWSW S22T54R9		0.3	Light	Gooseberry Falls SP
Lake SWSE S2T29R57	1.9	2.3	Moderate	East of Finland
Lake SENE S36T52R10		Many	Severe	2Harbors 6thst&16ave
St Louis NWSW S26T50R15	1.8	0.3	L	N of Proctor

St Louis NWNW S23T50R15	2.1	0.3	Light	West suburb of Duluth
St Louis NWNW S10T50R15	1.0	1.6	Light	West suburb of Duluth
St Louis NWNW S23T51R15	1.5	0	0	West suburb of Duluth
St Louis SESE S2T51R15	1.9	2	Light	West suburb of Duluth
St Louis NWNW S11T51R14	1.5	.13	Light	West suburb of Duluth
St Louis NENW S29T58R17	1.5	17.6	Heavy	Virginia near cemetery east side of Hwy53
St Louis SWSE S29T58R20	1.3	14	Heavy	East of Hibbing on Hwy 169
St Louis SESE S23T57R21		Many	Heavy	Hibbing across from Walmart
St Louis NESE S19T62R18	2	5	moderate	0.6 m south of Cook on 53
St Louis NENW S10T61R16	2.2	7.3	Heavy	4m west of Tower on Hy 1
St Louis SESE S27T62R15	1.3	4.3	Heavy	Near Soudan SP
St Louis NESE S36T63R13	2.6	6.3	Heavy	3 m west of Ely on Hwy 1
St Louis SWNW S35T63R12	2.3	17	Heavy	0.4 m S of jct 1 and 169 S of Ely
St Louis NWNW S6T64R19	2.0	4	Moderate	Orr
St Louis SWSE S11T68R21	2.6	7	Heavy	Ash River Trail
St Louis SESE S36T52R13			Light	N of Duluth
St Louis SENW S6T51R13			Light	NW corner of Lakewood Twp
St Louis SWNW S19T51R13			Light	west edge of Lakewood Twp
St Louis NESE S9T51R13			Heavy	Lakewood Twp
St Louis NWSW S7T5R13			Heavy	Lakewood Twp
St Louis NENW S23T51R13			Light	Lakewood Twp
St Louis NENE S26T51R13			Moderate	Lakewood Twp

Forest tent caterpillar Egg Mass Survey - Region 2

Predictions for Summer 2002

County and Legal	Average DBH	Average # of Egg Masses	Predicted 2001 Defoliation	Remarks
Carlton SESE S14T49R17	1.8	32	Heavy	Downtown Cloquet
Carlton SESW S11T49R17	1.7	0.6	Light	Cloquet
Carlton SWNE S21T49R17	2	4	Moderate	Cloquet
Itasca NENW S23R145R25	3.0	25	Heavy	NW Deer river
Itasca NESE S19T145R25	3.3	42	Heavy	NW Deer River
Itasca SWSW S28T57R26	3.0	44	Heavy	NE Deer river
Itasca NESW S21T55R25	2.0	7.3	Heavy	Grand Rapids
Koochiching NENW S10T68R25	2.2	1.6	Light	East side of Littlefork
Koochiching NWSW S16T70R24	3.0	7.6	Heavy	West side of Int'l Falls
Lake SENW S29T57R7	2	5.6	Heavy	E of Finland
Lake NENE S36T53R4	1.6	35.6	Heavy	2Harbors 1 block N of water tower
St Louis SWNE S18T57R20	2.1	4	Moderate	W side of Hibbing
St Louis NWNE S32T58R20	2	5.6	Heavy	NE side of Hibbing
St Louis SWNW S6T58R17	2.2	2.6	Light	N of Virginia
St Louis SWSW S16T58R17	1.8	0	0	S of Virginia
St Louis SESW S5T61R18	2.2	1.3	Light	S of Cook
St Louis NESE S30T65R19	1.3	0.3	Light	N of Orr

St Louis SESW S11T68R21	2	0.6	Light	Ash River Trail &53
St Louis SWSW S27T62R14	1.5	0	o	E of Tower
St Louis NENW S33T63R12	1.6	0	0	W side of Ely
St Louis SWSW S4T50R13	1.9	38.3	Heavy	N of Lester River
St Louis NESE S21T51R13	1.6	4.3	Heavy	Duluth- Lakewood
St Louis NWSW S5T51R13	1.8	2.3	Moderate	Duluth- Lakewood
St Louis NENE S3T57R14	2	4.3	Moderate	Duluth- Rice Lake
St Louis SWSW S28T51R14	2	4.6	Heavy	Duluth -Rice Lake
St Louis SWSE S25T51R15	2.3	13	Heavy	Duluth N of Airport
St Louis SWSW S17T50R15	1.7	3.3	Moderate	Hermantown
St Louis SWSW S26T50R15	1.8	4.3	Moderate	Hermantown

Spruce budworm

Larval survey and defoliation estimates

Percent buds infested is derived from a 15 inch branch sample. The number of larvae found is divided by the number of buds on the sample and the resulting number is multiplied by 100. If the number is greater than 10 percent, heavy defoliation can be expected.

Actual defoliation is the average value for nine 15 inch branch samples per plot. Actual defoliation is a visual estimate of the percentage of needles consumed during the feeding period.

Percent buds eaten is the average value computed for nine 15 inch branch samples per plot. The number of consumed buds is divided by the number of remaining buds plus the number of buds eaten and the resulting number is multiplied by 100.

Egg mass survey

For each plot, three branches are clipped from the mid-crown of each of three co-dominant trees. The number of egg masses per 15 inch branch tip is tallied. The following scheme is used to predict next year's defoliation by spruce budworm.

Spruce budworm defoliation prediction		
Average number of egg masses per branch	**Expected defoliation next year**	**Expected percentages of new foliage consumed**
0 - 0.1	None to light	0 - 20 %
0.2 - 1.7	Moderate	21 - 50 %
1.8 or more	Heavy	51 - 100 %

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
Aitkin Co																	
NWSW 8-52-25Thinned Blandin	WS								0	0	0			0	0	0	Blandin, Thinned
NWSW 8-52-25 Unthinned Blandin	WS								0	0	0			0	0	0	Blandin Unthinned
NWNE 7-51-23	WS								L	1.8	H	> 50%	8.9	M	4.1	H	
Becker Co.																	
NWNE 21-141-36	WS	M-H	0.77														
SESE 21-141-36	WS				MH	1.11			M	0.66							
SESE 21-141-36	WS				--	--			MH	0.66							
Beltrami Co.																	
NWSW 12-147-30 Thinned Sam Welch's Cornor	WS								VL	0	0			0	0	0	Sam Welch's Cornor Thinned
NWSW 12-147-30 Unthinned Sam Welch's cornor	WS				L	0.1			L	0	0			0-VL	0	0	Sam Welch's Cornor, Unthinned
NESE 26-149-30	WS																
NENE 26-149-30	WS	H	0.88														

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
SESE 2-147-31	WS	H	0.55														
	"																
NESW 1-148-31	WS																
NW NW 12-147-30	WS				LM	0			VL	0							
SWSW 12-147-30	WS				VL	0			VL	0							
SESW 2-147-31	WS				MH	0.55			L	0.11							
Cass Co.																	
NENE 1-139-26	WS																
NWNE 1-139-26	WS				0	0											
NWNW 11-139-26	BF	14	0.11														
NENE17-140-27	BF																
SENW 21-145-30	WS	H	0.1		M	0.11			VL	0							
NWSE 9-145-30	WS	H	2.22														
SWSE13-136-31	WS	24	0						0	0	0	< 10%	0.1				
SWSE 13-136-31	"	21	0.11														
SWSE 22-138-31	BF																
NENW 1-139-25									0	0	0						
SWNE 30-139-25	WS	58	0.1														

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
NWNE 30-139-25	WS	52	0.1														
NWSE 8-145-30	WS																
SWSW 9-145-30	WS				LM	0			VL	0							
Chisago Co.																	
SESE 36-36-21	WS								0	0	0	0	0				
Cook Co.																	
NWNW 33-63-4E	WS, BF																
NESW 35-64-3E	BF																
NWSE 3-61-1E	BF																
SWNE 22-63-1E	BF																
NESW 10-64-1W	BF																
SENE 4-61-1E	BF, WS	1	0														
Crow Wing Co.																	
SENE 19-44-31	WS	3	0	0.44	0	0						< 10%	1.1				
SWNW 20-44-31	WS													0	0	0	
Hubbard Co.																	
SE 13-141-32	WS																
SWSE 13-141-32	WS	H	0.0														
SESE 1-142-33	WS	M	0.22														

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
SE 1-142-33	WS																
NWSE 23-145-33	WS																
NENE 24-139-34	WS	VL	0.11														
NWNE 21-141-36	WS																
SESE 1-142-30	WS				VL	0.55			VL	0							
SESE 13-141-32	WS				VL	0.11			VL	0							
Itasca Co.																	
NWNE 16-61-24 thinned Larson L	WS								L	0.44	L			VL	1.0	M	Larson L Thinned
NWNE 16-61-24 Unthinned Larson L	WS								L	0.11	L			VL	0.55	M	Larson L Unthinned
NENW 12-53-26 Thinned Smith Creek	WS				L	0			VL	0	0			L	1.4	M	Smith Creek Thinned
12-53-26 Unthinned Smith Creek	WS				L-M	0.1			L	0.1	L			L-M	0.55	M	Smith Creek Unthinned
SENE 24-149-27 Thinned Dora Lake	WS				L-M	0			L	0	0			0	0	0	Dora Lake Thinned
SENE 24-149-27 Unthinned Dora Lake	WS				H	0.8			L	0	0			0-VL	0	0	Dora Lake Unthinned
NESE 2-61-23	BF	88	0.66		L-M	0.2											

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
NENW 34-62-22	BF	29	0.22														
NWSE 26-62-23	BF	32	0.22														
NWSW 3-58-24	WS	<1	0														
SWNE 3-58-24	WS	<1	0	0.44	0	0		0	0	0	0	<10%	0	1	0	0	Blandin thinned
NWSW 35-58-24	WS													L	1.7	M	Blandin thinned 1998
NENW 23-59-24	BF	<1	0														
SWSE 36-62-24	WS																
NENE 17-53-25	WS																
NWSW 35-58-24	WS	40	0.44	23.78	H	0.1		26	M	0.8	M	>10%	10.3				
NWNE 7-60-25	WS																
NW 9-56-25	WS																
NWNE 4-60-26	WS																
SENW 12-53-26	WS	3	0.11														
SESW 11-53-26	WS	17	0	15.33	M	0.44		18.7									
SWSE 17-60-26	BF	1	0														
Koochiching County																	

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
SESE 28-65-26 Thinned, Big Falls, Johnson Landing	WS								L	0.11	L			0	0	0	Thinned, Big Falls, Johnson Landing
SESE 28-65-26 Unthinned, Big Falls, Johnson Landing	WS				H	1.0			M	0.33	M			0-VL	0.1	L	Unthinned, Big Falls,Johnson Landing
36-155-25 Thinned, Big Falls, Power line	WS								L	0	0			0	0	0	Thinned, Big Falls, Power Line
36-155-25 Unthinned, Big Falls, Power line	WS				L	0			L	0	0			0	0	0	Unthinned, Big Falls, Power Line
NWNW 4-65-22	BF	98	1.33	2.67	L-H	0		0.8	L	0	0	<10%	0	0	0	0	
NWNW 19-65-22	WS, BF	74	0.77														
NENE 24-65-23	BF																
10-67-22	WS	H	0.55														
SENE 23-67-22	BF																
NESW 31-70-26	WS	60	0.22		L	0											
SENW 4-71-22	BF WS	82	0.55		L	0											
SESE 35-71-24	WS																
SESE 8-69-23	BF	57	0.44		L	0											
SESE 16-69-23	BF																

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
NWNE 22-65-23	BF	83	0.88		L- M	0											
SWSW 25-69-23	WS	41	0.44														
NWSE 5-70-23	BF	95	0.77														
SWSE 36-62-24	BF WS	99	0.33														
SENE 27-70-25	WS	80	0.44		L	0											
NWNE 27-158-26	WS																
Lake Co.																	
SWNE 11-55-8	BF	<1	0														
SWSE 5-59-8	BF WS	0	0						0								
SENE 11-61-11	WS, BF																
SENW 31-62-11	WS, BF																
Mille Lacs																	
SWSE 1-35-27																	
Morrison Co.																	
NENE 1-41-29	WS	6	0	1.44	O-VL	0						< 10%	0.88	0	0	0	
SESE 1-42-30	WS								0	0	0						
NESW 11-42-32	WS																
Sherburne Co.																	

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
NWNW 33-34-27	WS	31	0.1	2.88	L	0						< 10%	0.22				
SWSW 21-35-27	WS											< 10%	0.88	0	0	0	Sherburne WL Refuge
NENE 29-35-27	WS	M-H		2.44	Trace	0			< 1 %	0	0						
St. Louis Co.																	
NESE 22-62-12	BF	12	0						0	0	0	<10%	0.11	VL	0	0	
NWNE 6-63-12	BF																
SESE 31-58-13	WS, BF	<1	0														
NWNE 4-62-13	BF																
NESE 6-63-17	BF WS	35	0.77	9.44	L	0		2.7	VL	0	0	<10%	0.4	O	0.11	L	
SWNW 2-64-17	BF																
NENE 8-51-18	WS																
SWSW 33-61-18	WS, BF	41	1.22	13.67	H	0.8		10	H	2.2	H	>10%	10.7	M	1.55	M	
NWNW 33-65-18	BF	86	1.22	5.33	M	0.44		8.7	M	0.55	M	>10%	8.3	M	2.2	H	
SWSW 26-61-20	WS	<1	0														
NWNE 25-63-20	BF	82	1.33		H	0.66		6	M	0.4	M	>10%	7.6	H	0.33	M	
NENE 12-68-20	WS, BF																
SWNW 33-60-21	WS	82	0.33														

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
SWSW 3-60-21	WS BF	87	2.0	10.22	L	0.2		1.7	VL	0	0	<10%	0	0	0	0	
NWSW 12-64-21	BF																
NESW 12-64-21	BF	95	1.55	2.89	L-M	0.01		1.2	L	0	0	<10%	0.3	0	0	0	
NWSW 15-67-21 Thinned 1998	WS thinned 1998	H	0.44		M	O											
NWSW 15-67-21 Planted 1978	WS	H	0		L	O											
16-67-21	WS	L	0.3		L	O											
NWNW 30-67-21	WS	L	0.44		L	0.3											
NWNW 30-67-21	WS	H	0.44		L	0.3											
SESW 12-68-21	WS	83	1.22		L	0											
SESE 13-64-21	BF	96	0.33														
5-68-19 Ash River Campground	WS			15.44	L	0		0.33	0	0	0	<10%	0				Sprayed with BT in 1999
10-67-22 Velpar Short trees	WS				L	0.6											

Spruce budworm survey - 2001

Location	Species	1998		1999			2000					2001					
		Egg mass survey			Egg mass survey		Larval survey		Egg mass survey			Larval survey		Eggmass survey			Notes
		Actual defoliation	Ave. # egg masses	Ave # of larvae on twig	Actual defoliation	Ave # egg masses	%of buds on twigs infested	Ave # of larvae on twig	Actual defol.	Ave # egg masses	Predicted defol. for 2001	% of buds on twigs infested	Ave # of larvae on twig	Actual Defol.	Ave # egg masses	Predicted defol. for 2002	
SENW 10-67-22	BF, WS							0	0	0							

Pine tussock moth

Pheromone trap results

A count of 30 or more moths in a trap over a 7-14 day period could indicate population build-up and possible need for chemical control during the next year.

COUNTY	LOCATION	DATE TRAP PLACED	TRAP NO. OR NAME	DATE TRAP CHECKED	MALE P.T. MOTHS IN TRAP	COMMENTS
Hubbard	SESE 9-139-32	5-29	1	6-14 6-28 7-11 7-24 8-7 8-21 9-5	18 22 22 28 22 4 0	
Hubbard	SESE10-139-32	5-29	2	6-14 6-28 7-11 7-24 8-7 8-21 9-5	20 25 18 23 28 22 0	
Hubbard	NWNW 33-139-32	5-29	3	6-14 6-28 7-11 7-24 8-7 8-21 9-5	3 21 18 16 18 4 1	
Hubbard	SWSW 29-139-32	5-29	4	6-14 6-28 7-11 7-24 8-7 8-21 9-5	14 23 11 20 22 6 0	Minor bird predation
Hubbard	NESE 26-139-32	5-29	5	6-14 6-28 7-11 7-24 8-7 8-21 9-5	0 23 22 16 21 24 3	Trap on ground

Hubbard	SESE 35-139-33	5-29	6	6-14 6-28 7-11 7-24 8-7 8-21 9-5	10 21 20 17 26 31 2	
Wadena	SWSW 10-138-33	5-29	7	6-14 6-28 7-11 7-24 8-7 8-21 9-5	8 22 19 21 20 10 5	
Wadena	SWSW 19-136-33	5-29	8	6-14 6-28 7-11 7-24 8-7 8-21 9-5	7 20 19 15 9 0 0	 Bird predation Bird predation
Wadena	NWNW 5-135-33	5-29	9	6-14 6-28 7-11 7-24 8-7 8-21 9-5	14 26 20 18 23 21 0	

Jack Pine Regeneration Plots in Wadena County (6/5/01)														
Dead trees														
S-T-R, Stand		# of plots	Dead Trees	Unknown	Deer Browse	Mouse	Deer & Mouse	Sum Deer &/or Mouse	Both Browse & Gall	Gall <9"	Gall >9"	Gall Sum	Total Gall	Total Browse
29-136-33,09	9d	20	5	5	0	0	0	0	0	0	0	0	0	0
36-136-34,16	7a	60	49	0	3	17	4	24	13	8	4	12	25	37
34-137-34,02	7f	144	94	3	9	22	19	50	18	4	19	23	41	68
6-138-33,10&13	6c	85	41	7	5	5	0	10	8	4	12	16	24	18
17-138-33,02	7g	20	5	0	2	0	0	2	1	0	2	2	3	3
17-138-33,16	7b	78	10	4	0	0	0	0	1	3	2	5	6	1
19-138-33,12	9b	79	44	4	4	11	12	27	5	3	5	8	13	32
01-138-34,27	6b	80	20	3	0	8	2	10	2	1	4	5	7	12
12-138-34,11	7d	102	47	16	4	3	3	10	7	0	14	14	21	17
12-138-34,26	3a	124	36	2	15	9	10	34	0	0	0	0	0	34
13-138-34,15	6a	110	57	19	9	4	5	18	6	2	12	14	20	24
13-138-34,16	5a	245	74	19	7	4	2	13	11	3	28	31	42	24
13&24-138-34,9&14	9a	152	29	17	0	0	0	0	0	1	11	12	12	0
14-138-34,06	6d	58	32	6	5	2	0	7	14	0	5	5	19	21
15&16-138-34,01	9c	92	29	9	6	0	1	7	2	0	11	11	13	9
16-138-34,04	7c	102	27	8	4	1	2	7	4	1	7	7	12	11
16-138-34,06	7e	38	26	5	9	0	0	9	4	0	8	8	12	13
TOTAL		**1589**	**625**	**127**	**82**	**86**	**60**	**228**	**96**	**30**	**144**	**173**	**270**	**324**
17 plantations														

Jack Pine Regeneration Plots in Wadena County (6/5/01)														
(Live Trees)														
S-T-R, Stand		# of plots	All Tallied Live Trees	Undamaged	Deer Browse	Mouse	Deer & Mouse	Sum Deer &/or Mouse	Both Browse & Gall	Gall <9"	Gall >9"	Gall Sum	Total Gall	Total Browse
29-136-33,09	9d	20	33	21	0	0	0	0	0	0	12	12	12	0
36-136-34,16	7a	60	76	16	8	7	6	21	15	0	24	24	39	36
34-137-34,02	7f	144	409	106	37	25	11	73	39	11	180	191	230	112
6-138-33,10&13	6c	85	48	12	12	1	2	15	5	0	16	16	21	20

17-138-33,02	7g	20	11	2	5	0	0	5	1	0	3	3	4	6
17-138-33,16	7b	78	18	0	10	0	1	11	6	0	1	1	7	17
19-138-33,12	9b	79	85	15	8	34	9	51	2	4	13	17	19	53
01-138-34,27	6b	80	93	30	11	6	2	18	2	1	41	42	44	20
12-138-34,11	7d	102	162	62	4	12	0	16	6	2	76	78	84	22
12-138-34,26	3a	124	228	27	164	5	25	194	6	0	1	1	7	200
13-138-34,15	6a	110	161	36	25	10	5	40	16	4	65	69	85	56
13-138-34,16	5a	245	415	143	28	13	3	44	11	14	203	217	228	55
13&24-138-34,9&14	9a	152	171	79	4	2	0	6	6	5	75	80	86	12
14-138-34,06	6d	58	16	2	2	0	0	2	1	1	10	11	12	3
15&16-138-34,01	9c	92	92	46	0	0	0	0	0	0	46	46	46	0
16-138-34,04	7c	102	168	78	13	1	2	16	4	5	65	70	74	20
16-138-34,06	7e	38	68	27	7	1	2	10	2	0	29	29	31	12
TOTAL		**1589**	**2254**	**702**	**338**	**117**	**68**	**522**	**122**	**47**	**860**	**907**	**1029**	**644**
17 plantations														

JP Regeneration Plots for Wadena Co. (6/5/01)														
(Sprayed Plantations; cause of mortality)														
S-T-R, Stand		**# of plots**	**Dead Trees**	**Unknown**	**Deer Browse**	**Mouse**	**Deer & Mouse**	**Deer &/or Mouse Browse Sum**	**Both Browse & Gall**	**Gall <9"**	**Gall >9"**	**Gall Sum**	**Total Gall**	**Total Browse**
7-138-33,01	4c	315	778	197	212	15	53	280	142	94	65	159	301	422
01-138-34,19	3b	91	113	38	68	1	5	74	0	1	0	1	1	74
25-138-34,11	4b	151	219	75	59	6	26	91	23	21	9	30	53	114
25-138-34,16	4a	25	39	5	6	9	5	20	7	3	4	7	14	27
TOTAL		**582**	**1149**	**315**	**345**	**31**	**89**	**465**	**172**	**119**	**78**	**197**	**369**	**637**
4 plantations														

FHM plot observations: 2001 aerial survey

By Bill Befort, Resource Assessment

In reporting damage at the plots, I include, wherever possible, four of the five elements encoded on the maps: severity, host, agent, and damage type. Pattern is always omitted, as not applicable to a point observation, and agent is omitted when it seems too much like guesswork. Where the report says "none," it means I looked at the plot and saw no significant damage in its vicinity. In a few instances I got preoccupied with mapping and blew past the plot without making an observation; these are shown as "not recorded" in the damage column.

FHM plots: Damage observed during aerial survey - 2001		
Plot number	**1:100K Quadrangle name**	**Damage observed**
4609353	Aitkin	None
4609361	Aitkin	None
4609363	Aitkin	None
4609365	Aitkin	Light hardwood FTC defoliation
4609367	Aitkin	None
4609368	Aitkin	None
4609371	Aitkin	None
4609372	Aitkin	None
4609374	Aitkin	None
4609376	Aitkin	None
4609377	Aitkin	None
4609382	Aitkin	None
4609383	Aitkin	Light hardwood FTC defoliation
4609384	Aitkin	None
4609388	Aitkin	None
4909521	Angle Inlet	None
4509318	Anoka	None
4509345	Anoka	Oak wilt center near plot
4809112	Basswood Lake	(USFS flight zone)
4809126	Basswood Lake	(USFS flight zone)
4809128	Basswood Lake	(USFS flight zone)
4609512	Battle Lake	None
4609531	Battle Lake	Trace hardwood defoliation
4809451	Baudette	None
4809452	Baudette	None
4809454	Baudette	Heavy aspen FTC defoliation
4809456	Baudette	Moderate aspen FTC defoliation
4809457	Baudette	Moderate aspen FTC defoliation
4809461	Baudette	None
4809463	Baudette	None
4809478	Baudette	Light aspen FTC defoliation
4709351	Bigfork	(USFS flight zone)
4709354	Bigfork	(USFS flight zone)

4709361	Bigfork	(USFS flight zone)
4709362	Bigfork	(USFS flight zone)
4709364	Bigfork	(USFS flight zone)
4709367	Bigfork	(USFS flight zone)
4709373	Bigfork	(USFS flight zone)
4709375	Bigfork	(USFS flight zone)
4709376	Bigfork	(USFS flight zone)
4709378	Bigfork	(USFS flight zone)
4709382	Bigfork	(USFS flight zone)
4709383	Bigfork	(USFS flight zone)
4709387	Bigfork	(USFS flight zone)
4709368	Blackduck	(USFS flight zone)
4709453	Blackduck	(USFS flight zone)
4709457	Blackduck	(USFS flight zone)
4709462	Blackduck	(USFS flight zone)
4709464	Blackduck	(USFS flight zone)
4709471	Blackduck	(USFS flight zone)
4709474	Blackduck	(USFS flight zone)
4709476	Blackduck	(USFS flight zone)
4709481	Blackduck	(USFS flight zone)
4709483	Blackduck	(USFS flight zone)
4709485	Blackduck	(USFS flight zone)
4609415	Brainerd	None
4609418	Brainerd	None
4609424	Brainerd	None
4609426	Brainerd	None
4609431	Brainerd	None
4609436	Brainerd	Development in plot area
4609437	Brainerd	None
4609444	Brainerd	None
4609445	Brainerd	None
4609447	Brainerd	None
4709411	Cass Lake	(USFS flight zone)
4709413	Cass Lake	(USFS flight zone)
4709414	Cass Lake	(USFS flight zone)
4709416	Cass Lake	(USFS flight zone)
4709422	Cass Lake	(USFS flight zone)
4709425	Cass Lake	(USFS flight zone)
4709427	Cass Lake	(USFS flight zone)
4709428	Cass Lake	(USFS flight zone)
4709432	Cass Lake	(USFS flight zone)
4709434	Cass Lake	(USFS flight zone)
4709435	Cass Lake	(USFS flight zone)
4709438	Cass Lake	(USFS flight zone)

4709441	Cass Lake	(USFS flight zone)
4709444	Cass Lake	(USFS flight zone)
4709447	Cass Lake	(USFS flight zone)
4809211	Crane Lake	(USFS flight zone)
4809217	Crane Lake	(USFS flight zone)
4809222	Crane Lake	(USFS flight zone)
4809225	Crane Lake	(USFS flight zone)
4809226	Crane Lake	(USFS flight zone)
4809228	Crane Lake	(USFS flight zone)
4809231	Crane Lake	(USFS flight zone)
4809237	Crane Lake	(USFS flight zone)
4809238	Crane Lake	(USFS flight zone)
4809246	Crane Lake	(USFS flight zone)
4809247	Crane Lake	(USFS flight zone)
4609555	Detroit Lakes	Definitely nonforest as mapped
4609558	Detroit Lakes	None
4609563	Detroit Lakes	None
4609573	Detroit Lakes	None
4609584	Detroit Lakes	None
4609585	Detroit Lakes	Trace hardwood flooding mortality
4609254	Duluth	Light aspen dieback
4609257	Duluth	Trace aspen defoliation
4609258	Duluth	None
4609263	Duluth	None
4609272	Duluth	Moderate hardwood FTC defoliation
4609273	Duluth	None
4609276	Duluth	Trace aspen defoliation
4609278	Duluth	None
4609282	Duluth	Heavy hardwood FTC defoliation
4609284	Duluth	Trace aspen FTC defoliation
4609285	Duluth	Moderate aspen FTC defoliation
4609286	Duluth	None
4609288	Duluth	None
4709151	Ely	(USFS flight zone)
4709153	Ely	(USFS flight zone)
4709155	Ely	(USFS flight zone)
4709156	Ely	(USFS flight zone)
4709157	Ely	(USFS flight zone)
4709162	Ely	(USFS flight zone)
4709163	Ely	(USFS flight zone)
4709165	Ely	(USFS flight zone)
4709166	Ely	(USFS flight zone)
4709168	Ely	(USFS flight zone)
4709171	Ely	(USFS flight zone)

4709172	Ely	(USFS flight zone)
4709174	Ely	(USFS flight zone)
4709177	Ely	(USFS flight zone)
4709181	Ely	(USFS flight zone)
4709183	Ely	(USFS flight zone)
4709186	Ely	(USFS flight zone)
4709187	Ely	(USFS flight zone)
4409325	Faribault	Trace hardwood mortality
4409327	Faribault	Trace hardwood dieback
4409331	Faribault	Light hardwood dieback
4409344	Faribault	None
4709551	Fosston	Trace hardwood flooding dieback
4709553	Fosston	Trace hardwood FTC defoliation
4709562	Fosston	None
4709565	Fosston	Moderate hardwood FTC defoliation
4709572	Fosston	Heavy hardwood FTC defoliation
4709057	Grand Marais	(USFS flight zone)
4709065	Grand Marais	(USFS flight zone)
4709067	Grand Marais	(USFS flight zone)
4709068	Grand Marais	(USFS flight zone)
4709071	Grand Marais	(USFS flight zone)
4709073	Grand Marais	(USFS flight zone)
4709074	Grand Marais	(USFS flight zone)
4709076	Grand Marais	(USFS flight zone)
4709083	Grand Marais	(USFS flight zone)
4709085	Grand Marais	(USFS flight zone)
4709086	Grand Marais	(USFS flight zone)
4708978	Grand Portage	(USFS flight zone)
4708986	Grand Portage	(USFS flight zone)
4708988	Grand Portage	(USFS flight zone)
4509286	Grantsburg	None
4809512	Grygla	Moderate tamarack discoloration
4809513	Grygla	Not recorded
4809521	Grygla	None
4809522	Grygla	Light tamarack discoloration
4809542	Grygla	Probably nonforest as mapped
4809545	Grygla	Heavy aspen FTC defoliation
4709211	Hibbing	Heavy aspen FTC defoliation
4709212	Hibbing	Not recorded
4709215	Hibbing	Not recorded
4709218	Hibbing	Moderate aspen FTC defoliation
4709221	Hibbing	Moderate aspen FTC defoliation
4709223	Hibbing	None
4709224	Hibbing	Not recorded

4709226	Hibbing	None
4709227	Hibbing	None
4709235	Hibbing	Heavy aspen FTC defoliation
4709236	Hibbing	None
4709238	Hibbing	Heavy tamarack discoloration
4709241	Hibbing	Light aspen FTC defoliation
4709242	Hibbing	Light aspen FTC defoliation
4709247	Hibbing	Light aspen FTC defoliation
4309173	La Crosse	None
4309186	La Crosse	None
4709511	Lake Itasca	None
4709512	Lake Itasca	Trace hardwood defoliation
4709514	Lake Itasca	None
4709517	Lake Itasca	Moderate hardwood FTC defoliation
4709521	Lake Itasca	None
4709523	Lake Itasca	Trace hardwood defoliation
4709532	Lake Itasca	None
4709534	Lake Itasca	None
4709536	Lake Itasca	Light hardwood FTC defoliation
4709541	Lake Itasca	Light jack pine mortality
4709542	Lake Itasca	None
4709544	Lake Itasca	None
4509568	Lake Minnewaska	None
4509432	Litchfield	Trace hardwood FTC defoliation
4809312	Littlefork	Moderate tamarack discoloration
4809314	Littlefork	None
4809316	Littlefork	Moderate aspen FTC defoliation
4809318	Littlefork	None
4809323	Littlefork	Moderate conifer discoloration
4809324	Littlefork	Moderate aspen FTC defoliation
4809326	Littlefork	None
4809328	Littlefork	Heavy aspen FTC defoliation
4809332	Littlefork	Light balsam fir mortality
4809333	Littlefork	Heavy aspen FTC defoliation
4809337	Littlefork	Trace aspen FTC defoliation
4809342	Littlefork	Light aspen FTC defoliation
4809344	Littlefork	Trace aspen FTC defoliation
4809345	Littlefork	Trace aspen FTC defoliation
4809348	Littlefork	None
4609312	Mille Lacs Lake	None
4609314	Mille Lacs Lake	None
4609317	Mille Lacs Lake	Plot possibly nonforest; sandpit
4609322	Mille Lacs Lake	None
4609323	Mille Lacs Lake	Trace hardwood FTC defoliation

4609331	Mille Lacs Lake	None
4609341	Mille Lacs Lake	None
4609342	Mille Lacs Lake	Moderate conifer discoloration
4609346	Mille Lacs Lake	Light hardwood FTC defoliation
4609347	Mille Lacs Lake	None
4509351	Mora	None
4509354	Mora	None
4509381	Mora	None
4509385	Mora	Light hardwood FTC defoliation
4909438	Oak Island	None
4609452	Pine River	Trace hardwood defoliation
4609458	Pine River	None
4609461	Pine River	Nonforest; developed
4609463	Pine River	Plot possibly nonforest; airstrip
4609466	Pine River	Plot at edge of cutover area
4609467	Pine River	None
4609473	Pine River	None
4609475	Pine River	None
4609478	Pine River	Plot in Christmas tree plantation
4609482	Pine River	None
4609486	Pine River	None
4709313	Pokegama Lake	None
4709315	Pokegama Lake	None
4709316	Pokegama Lake	None
4709321	Pokegama Lake	Light aspen FTC defoliation
4709324	Pokegama Lake	None
4709333	Pokegama Lake	Moderate hardwood FTC defoliation
4709334	Pokegama Lake	Moderate hardwood FTC defoliation
4709337	Pokegama Lake	Light hardwood FTC defoliation
4709343	Pokegama Lake	Moderate hardwood FTC defoliation
4709346	Pokegama Lake	Trace hardwood FTC defoliation
4709348	Pokegama Lake	Moderate hardwood FTC defoliation
4609188	Port Wing	Moderate hardwood FTC defoliation
4409138	Rochester	Not shown on this quad
4409214	Rochester	Oak wilt near plot center
4409226	Rochester	None
4409232	Rochester	Trace hardwood dieback
4409248	Rochester	None
4809551	Roseau	Not recorded
4809552	Roseau	Moderate aspen FTC defoliation
4809554	Roseau	Heavy aspen FTC defoliation
4809563	Roseau	Heavy aspen FTC defoliation
4809564	Roseau	Moderate aspen FTC defoliation
4809572	Roseau	None

4809578	Roseau	Trace hardwood flooding mortality
4809585	Roseau	None
4809587	Roseau	Moderate aspen FTC defoliation
4809015	Saganaga Lake	(USFS flight zone)
4809017	Saganaga Lake	(USFS flight zone)
4809018	Saganaga Lake	(USFS flight zone)
4809028	Saganaga Lake	(USFS flight zone)
4609214	Sandstone	None
4609215	Sandstone	Not recorded
4609216	Sandstone	None
4609218	Sandstone	None
4609224	Sandstone	Trace hardwood FTC defoliation
4609225	Sandstone	Trace FTC defoliation; near harvest
4609228	Sandstone	None
4609245	Sandstone	None
4609246	Sandstone	None
4509476	St. Cloud	None
4509482	St. Cloud	None
4409355	St. Paul	None
4409358	St. Paul	None
4409374	St. Paul	None
4509226	Stillwater	None
4509238	Stillwater	None
4809628	Thief River Falls	Not recorded
4809631	Thief River Falls	Light hardwood FTC defoliation
4809643	Thief River Falls	None
4709117	Two Harbors	Heavy hardwood FTC defoliation
4709123	Two Harbors	Not recorded
4709125	Two Harbors	Heavy hardwood FTC defoliation
4709126	Two Harbors	Not recorded
4709128	Two Harbors	None
4709134	Two Harbors	Not recorded
4709135	Two Harbors	Heavy aspen FTC defoliation
4709137	Two Harbors	None
4709138	Two Harbors	Not recorded
4709143	Two Harbors	Moderate hardwood FTC defoliation
4709144	Two Harbors	None
4709147	Two Harbors	Not recorded
4809412	Upper Red Lake	None
4809414	Upper Red Lake	None
4809418	Upper Red Lake	Moderate hardwood FTC defoliation
4809421	Upper Red Lake	None
4809422	Upper Red Lake	None
4809431	Upper Red Lake	None

4809433	Upper Red Lake	Heavy hardwood FTC defoliation
4809435	Upper Red Lake	None
4809442	Upper Red Lake	Light conifer discoloration
4809448	Upper Red Lake	None
4709178	Vermilion Lake	(USFS flight zone)
4709251	Vermilion Lake	(USFS flight zone)
4709253	Vermilion Lake	(USFS flight zone)
4709254	Vermilion Lake	(USFS flight zone)
4709257	Vermilion Lake	(USFS flight zone)
4709262	Vermilion Lake	(USFS flight zone)
4709266	Vermilion Lake	(USFS flight zone)
4709268	Vermilion Lake	(USFS flight zone)
4709272	Vermilion Lake	(USFS flight zone)
4709273	Vermilion Lake	(USFS flight zone)
4709275	Vermilion Lake	(USFS flight zone)
4709276	Vermilion Lake	(USFS flight zone)
4709278	Vermilion Lake	(USFS flight zone)
4709281	Vermilion Lake	(USFS flight zone)
4709282	Vermilion Lake	(USFS flight zone)
4709287	Vermilion Lake	(USFS flight zone)
4709381	Vermilion Lake	(USFS flight zone)
4509526	Willmar	None
4509542	Willmar	None
4409117	Winona	None