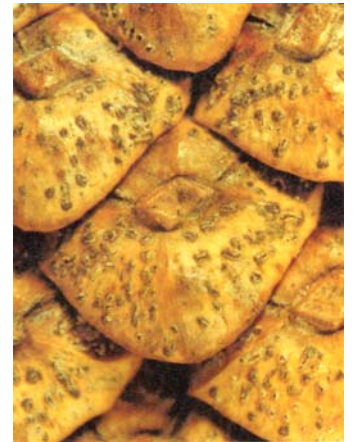
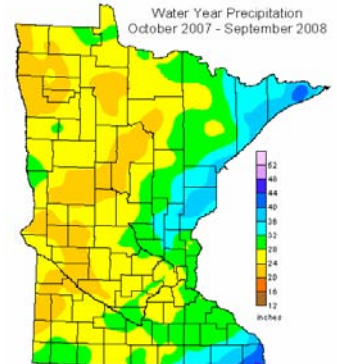


# Minnesota Forest Health Annual Report 2008

**DNR-Forestry  
Forest Health Unit**



# The Forest Resources of Minnesota

In Minnesota there are approximately 16.3 million acres of forested land, of which 14.9 million acres are classified as “timberland” or lands capable of producing timber. An additional 960,000 acres are not included in productive timberland due to their inclusion in the Boundary Waters Canoe Area Wilderness or other reserved land category. Forest land ownership is 46% private, 27% state, 14% county, 12% National Forest and 1% other federal ownership. (Source of data is the Minnesota 2001 Eastwide Database provided by the USFS-NCFES.)



Two major industries depend on Minnesota’s forested lands: forest industry and tourism. Forest industry is Minnesota’s second largest manufacturing industry, employing more than 55,000 people. The value of forest products manufactured in Minnesota exceeds \$7 billion and accounts for 16% of all manufacturing dollars generated in Minnesota. The tourism industry is Minnesota’s second largest employer employing over 140,000 people and accounting for a payroll in excess of \$3 billion. Gross receipts from tourism exceed \$6 billion. Over 70% of people who took at least one spring or summer trip in Minnesota rated “observing natural scenery” as the most important activity of their trip.

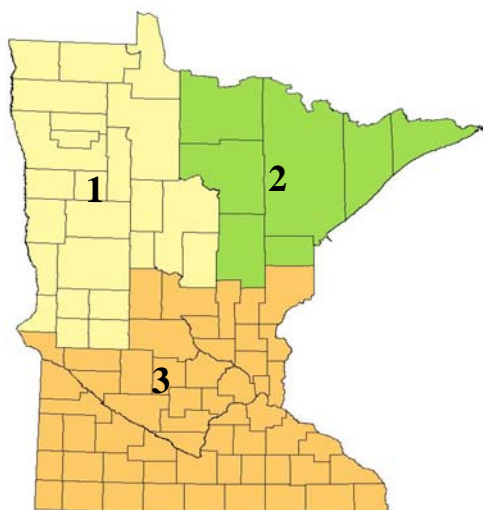
## Forest Health Staff - 2008

Olin Phillips  
Section Manager  
500 Lafayette Rd.  
St. Paul, MN 55155  
(651) 259-5282

Alan Jones  
Management Supervisor  
500 Lafayette Rd.  
St. Paul, MN 55155  
(651) 259-5271

Val Cervenka  
Forest Health Unit Coord.  
500 Lafayette Rd.  
St. Paul, MN 55155  
(651) 259-5296

Susan Burks  
Invasive Species Coord.  
500 Lafayette Rd.  
St. Paul, MN 55155  
651-259-5251



Jana Albers  
Reg 1 - Forest Health Specialist  
1201 E. Hwy. # 2  
Grand Rapids, MN 55744  
(218) 327-4234

Mike Albers  
Reg 2 - Forest Health Specialist  
1201 E. Hwy. # 2  
Grand Rapids, MN 55744  
(218) 327-4115

Ed Hayes  
Reg 3 - Forest Health Specialist  
2300 Silver Creek Rd. NE  
Rochester, MN 55901  
(507) 206-2834

Neville Wilson  
Seasonal Plant Health Specialist  
1200 Warner Rd.  
St. Paul, MN 55106



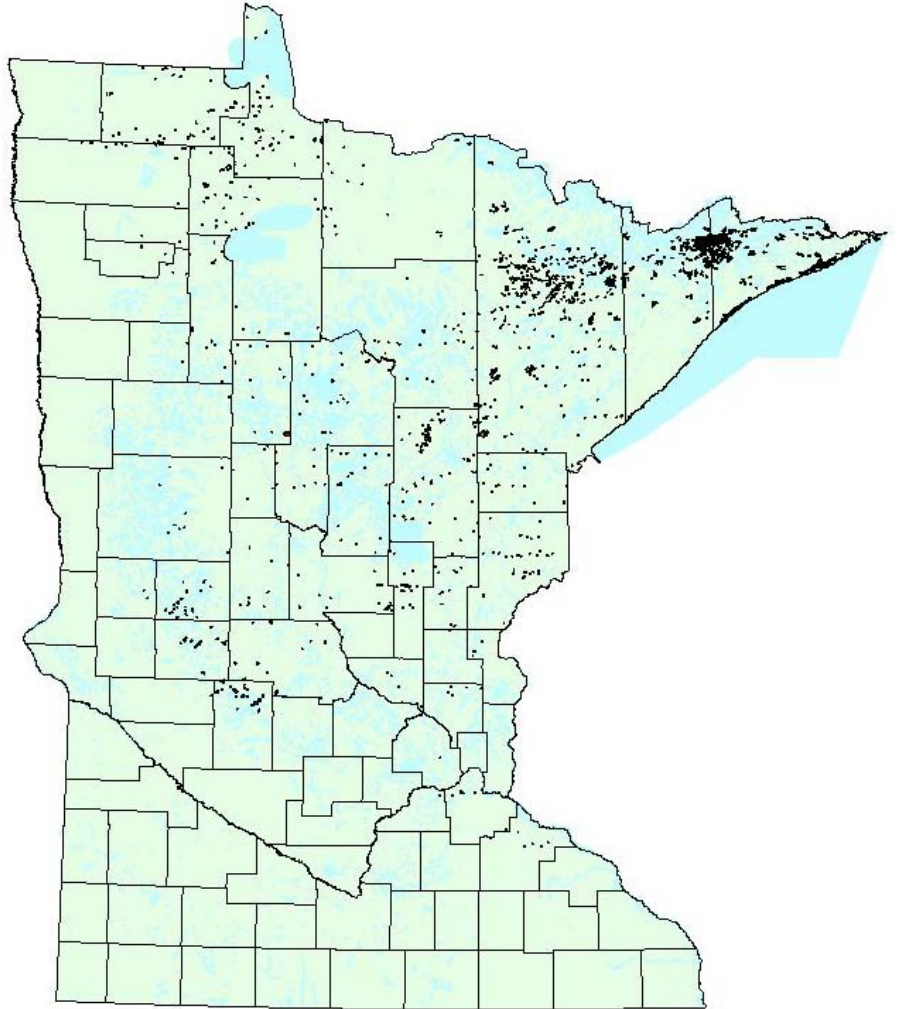
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## Aerial Survey Results - 2008

Since the early 1950's, aerial survey has been a valuable tool for monitoring the activities of forest insects and pathogens across the 16 million acres of forest land in Minnesota. For the past fourteen years, these surveys have been accomplished through the collaboration of DNR Forest Health and Resource Assessment Units and USFS, State and Private Forestry. The Forest Health staff plans the scope, timing and intensity of the surveys, trains Resource Assessment staff, provides ground-truthing, analysis and dissemination of survey data. Resource Assessment staff conducts the aerial sketch-mapping, digitizes the data and produces digital shape files. In addition to being used in Minnesota, the survey results are incorporated into the USFS's national database since our procedures and products comply with national standards.

This year, a new era in mapping was ushered in. Computers aided sketch-mappers in labeling polygons during the flights and streamlined post-flight digitization. Thanks to Mike Hoppus and Pat Churak, Resource Assessment's new sketch-mappers, and to Larry Hoyt, an experienced pro, who accomplished this year's aerial survey. Thanks also to Marc Roberts, USFS, for mapping the federal lands and post-flight map rectification, as usual, and for providing training in aerial detection and the use of the new computers this year.



Causal Agent	Number of sites	Acres
Unknown agent causing decline of aspen	391	157,275
Spruce budworm	285	41,263
Forest tent caterpillar	231	23,649
Unknown agent causing decline of hardwoods	326	23,378
Larch beetle	855	18,983
Larch casebearer	133	17,409
Ash decline	27	2,274
Jack pine budworm	28	2,326
Oak wilt	1800	1,895
Bark beetles	56	773
Birch decline	4	376
Two-lined chestnut borer	1	164
Combined weather & animal	51	1,734
Unknown agents	577	6,758
<b>Totals</b>	<b>4,917</b>	<b>304,089</b>

# Statewide precipitation summary

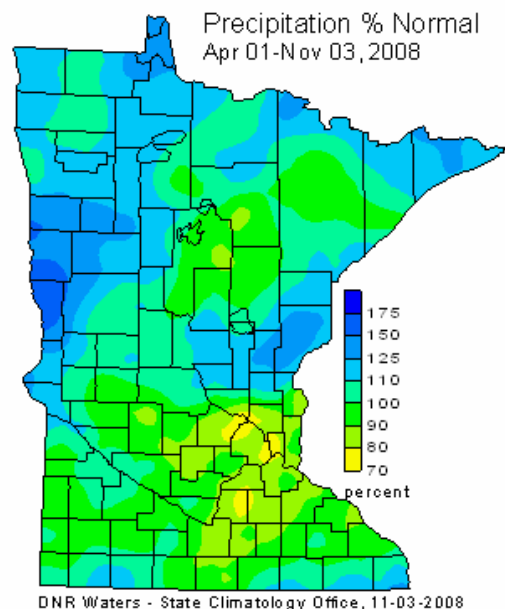
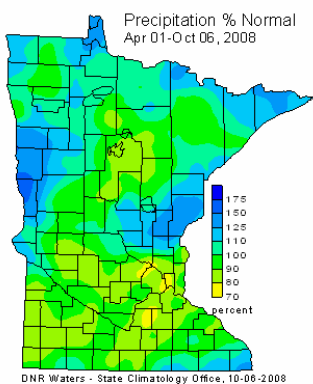
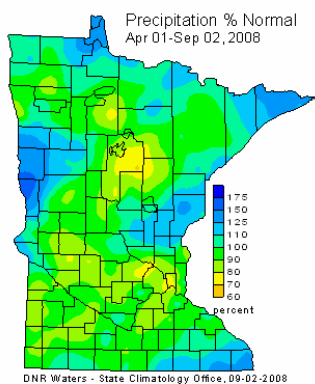
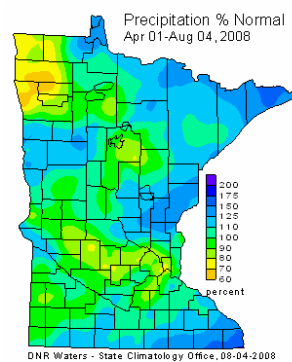
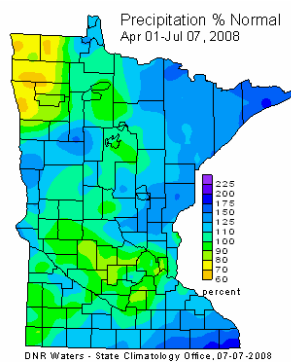
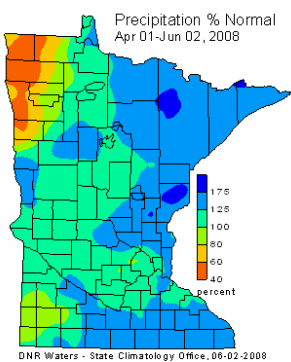
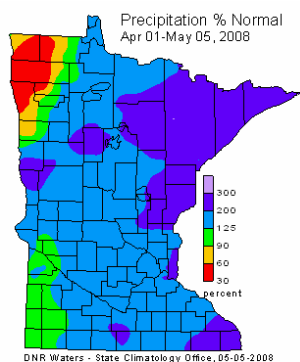
By the State Climatology Office - DNR Waters

Maps and analyses are excerpted from [HydroClim](#), a monthly electronic newsletter summarizing Minnesota's climate conditions and the resulting impact on water resources.

Substantial rains in late 2007 provided moisture relief to the drought-stricken counties, with the exception of a “moderate drought” ranking in Wadena, southern Cass, northern Todd and eastern Ottertail Counties. The spring of 2008 was cool and rainy over most of the state, except the Red River valley, which was drier than normal.

By mid-June a dry spell was settling into the central counties that intensified and lasted for more than sixteen weeks. For this time period, many areas received less than eight inches of rainfall. This dry spell came at a time of year when rainfall rates average roughly one inch per week. Thus, rainfall deficits over the sixteen-week dry spell topped five inches in many areas. Described another way, sixteen-week rainfall totals were less than 60 percent of normal for the period. In the southeastern counties, a dry spell was also developing. For the four and one-half month period beginning in mid-June and extending into early November, many southeastern Minnesota communities received less than ten inches of rainfall. This represents a negative departure from normal of five to eight inches in these areas.

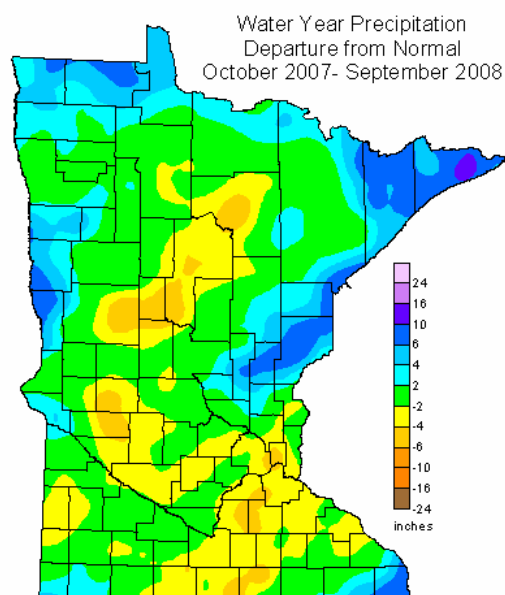
Warm season precipitation totals (April 1 through early November) were well below normal in some east central and southeastern Minnesota counties, as well as a small portion of north central Minnesota. Conversely, for some counties of northwestern and west central Minnesota, warm season rainfall totals were very large, surpassing the 98th percentile (one year in fifty) when compared to other April-through-October totals in the historical record.



The “water year” is a measure of the precipitation available for plants during the 2008 growing season because it includes the rainfall of late 2007, snowfall during the winter and all of the growing season rainfall from 2008. If this is compared to the historical records of rainfall, the departure from normal map is created. This is a good reflection of the amount of moisture that plants received during the growing season.

### What happened in May:

- With the exception of northwestern Minnesota, May 2008 precipitation totals were near historical averages in most Minnesota communities. In the northwest, rainfall totals fell short of average by approximately one inch. In most other Minnesota locations, a wet start to the month (including northern Minnesota snow on May 10) was counterbalanced by dry weather during the third and fourth weeks of the month.
- During the final week of May 2008, portions of the state were impacted by severe weather. Large hail, damaging winds, and tornadoes afflicted some Minnesota communities on May 25, May 30, and May 31.
- Maintaining a multi-month trend, monthly mean temperatures for May 2008 were below historical averages. May temperatures ranged from three to six degrees below normal across Minnesota. The cool temperatures in May delayed many of the normal signs of spring. Extreme temperature values for May ranged from a high of 89 degrees on the 25th at Waseca, to a low of 19 degrees at Embarrass (St. Louis County) on the 5th. Below-freezing temperatures were reported as late as May 27 and May 28 in northern Minnesota.
- Growing season precipitation totals to date (April 1 through early June) are well below average in northern sections of the Red River Valley. Elsewhere across the western one-half of Minnesota, growing season precipitation totals are close to historical averages. In the eastern one-half of Minnesota, growing season precipitation totals to-date are above average. In some sections of northeastern and southeastern Minnesota, growing season rainfall totals surpass the 95th percentile (one year in twenty) when compared to other April-plus-May totals in the historical record.
- The U. S. Drought Monitor, released on May 29, places a small area of northwestern Minnesota in the "Moderate Drought" category. In that region, inadequate spring rainfall led to very dry topsoil conditions. Other sections of northwestern Minnesota, and a portion of west central Minnesota are categorized as being "Abnormally Dry". The "Abnormally Dry" depiction in west central Minnesota is an acknowledgement of lingering moisture deficits from the 2007 growing season. All other Minnesota locales are deemed to be free of drought conditions. The U. S. Drought Monitor index is a blend of science and subjectivity where intensity categories are based on several indicators.
- The U.S. Geological Survey reports that stream discharge values are near to above the historical mid-range for the date across most of Minnesota. Along some stretches of the Minnesota River and its tributaries, stream flow exceeds the 90th percentile for this time of the year. While stream flows were somewhat high in many locations across Minnesota in April and May, flooding was not a major problem.
- The Lake Superior water level is up 13 inches from last year at this time and climbing closer to the long-term average.
- The Minnesota Agricultural Statistics Service reports that as of May 30, topsoil moisture was 1% "Very Short", 8% "Short", 81% "Adequate", and 10% "Surplus". Wet soils and cool temperatures delayed land preparation and the planting of crops in early May. However, favorable weather in late May allowed for significant planting progress.
- All of Minnesota's lakes were free of ice by mid-May. Throughout the spring, lake ice-out lagged behind historical averages by one to two weeks. In most locales, it was the latest lake ice-out since 1996.



### What happened in August:

- August 2008 precipitation totals fell short of average by two or more inches in most Minnesota counties. Isolated heavy rain events permitted a handful of communities to match or exceed historical averages for the month. Kittson, Clay, Becker, and Wilken counties reported August rainfall that exceeded the long-term average by more than two inches. Nonetheless, a general pattern of dryness prevailed across Minnesota in August, continuing a trend that began in mid-June.
- In spite of the persistent dryness across Minnesota in August, there were two substantial rain episodes during the month. Heavy rain fell on west central and northwestern Minnesota on August 11 and 12. Rainfall amounts ranged from two to four inches during this event. On August 27 and 28, another significant event dropped one to three inches of rain on portions of central Minnesota as well as much of the eastern one-third of the state. Although not included in the August statistics, a substantial rainstorm dropped two to four inches of rain on west central and northwestern Minnesota on September 1 and 2.
- Monthly mean temperatures for August 2008 were very near historical averages. Extreme temperature values for August ranged from a high of 93 degrees on the 3rd at Worthington (Nobles County), to a low of 27 degrees at Embarrass (St.



Louis County) on the 25th. As was the case throughout the summer, maximum temperatures above 90 degrees were not common.

- Much of Minnesota remains impacted by a mid-summer and late summer dry spell. For the eleven-week period during the last two weeks of June and into early September, many Minnesota communities received less than five inches of rainfall. This came at a time of year when rainfall rates average roughly one inch per week. Thus, rainfall deficits over the eleven-week dry spell topped five inches in many areas. Described another way, eleven-week rainfall totals were less than 50 percent of normal for the period. Temperatures over the eleven-week period were very close to historical averages. This held evaporative demand near seasonal norms and mitigated the situation somewhat.

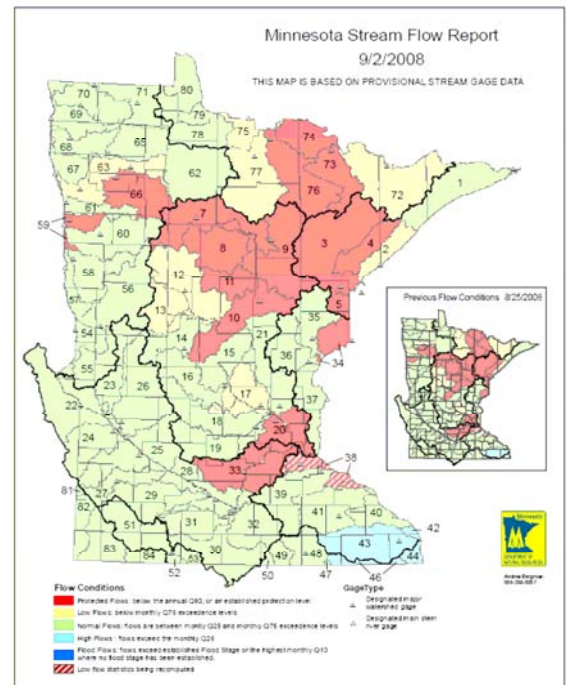
- Growing season precipitation totals to date (April 1 through early September) are significantly below normal in a small area of north central Minnesota, and a band that bisects central Minnesota from west to east. Conversely, in some portions of west central, northwestern, northeastern, and southeastern Minnesota, growing season rainfall totals are well above average, surpassing the 95th percentile (one year in twenty) when compared to other April-through-August totals in the historical record.

- The U. S. Drought Monitor, released on August 26, classified nearly all of Minnesota in the *D0 - Abnormally Dry* category or worse. Significant portions of the state were placed in the *D1 - Moderate Drought* classification. The U. S. Drought Monitor index is a blend of science and subjectivity where intensity categories are based on several indicators.

- The U.S. Geological Survey reports that stream discharge values are highly variable across the state. Many Minnesota streams have flows that are below the 25th percentile in the historical distribution for early September. In some northeastern Minnesota rivers, flows rank below the 10th percentile for early September. By contrast, the Red River and many of its tributaries report above-median flows in response to heavy rains that fell in August and early September.

- The Lake Superior water level is up 15 inches from last year at this time and is just below the long-term average for the season. Levels on inland lakes in drought-stricken areas of central and north central Minnesota are low. In some cases, water levels are similar to those observed during the droughts of 2006 and 2007.

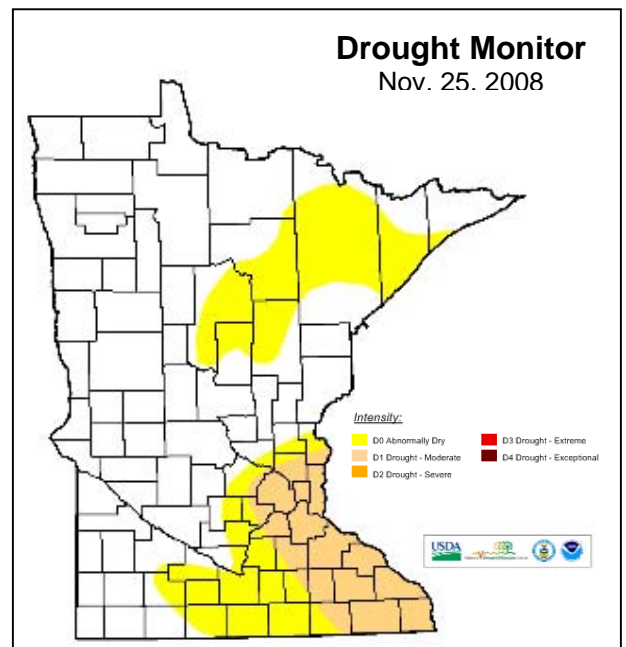
- The Minnesota Agricultural Statistics Service reports that as of August 29, topsoil moisture was 14% "Very Short", 36% "Short", 50% "Adequate", and 0% "Surplus". Some of the driest topsoil conditions were found in central and north central Minnesota. Fortunately, stored moisture lower in the soil profile supported crop conditions into early September. In the September 2 *Crop Progress and Condition Report*, 64 percent of Minnesota's corn crop and 65 percent of the soybean crop was rated in good or excellent condition.



## What happened in November:

In their final soil moisture summary of 2008, the Minnesota Agricultural Statistics Service reported that late-November topsoil moisture was 1% "Very Short", 6% "Short", 77% "Adequate", and 16% "Surplus". Surplus soil moisture conditions are found throughout the Red River basin. Subsoil moisture supplies were reported as 2% "Very Short", 16% "Short", 71% "Adequate", and 11% "Surplus". The focus of subsoil moisture deficits is on east central and southeast Minnesota. With the soils now frozen, substantial subsoil moisture recharge will not be possible until spring.

The U. S. Drought Monitor, released on November 26, classified many Minnesota counties in the *D0 - Abnormally Dry* category or worse. Portions of east central and southeastern Minnesota were placed in the *D1 - Moderate Drought* classification. For the five and one-half month period beginning in mid-June and extending into early December, many southeastern Minnesota communities received less than ten inches of precipitation. This represents a negative departure from normal of five to eight inches in these areas.



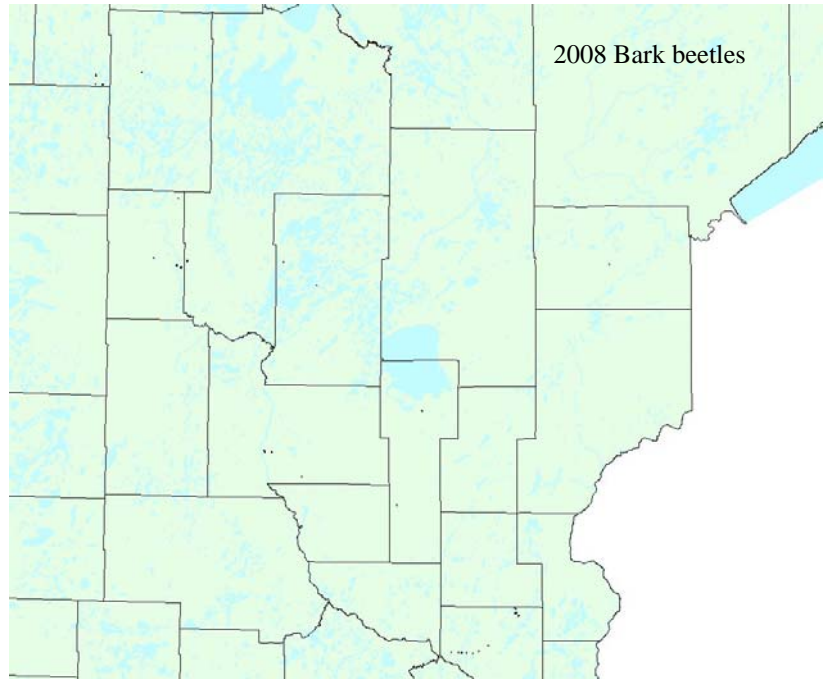
# Insects

## Bark beetles in pines

*Ips* and *Dendroctonus* spp.

The serious and prolonged drought from the summer of 2006 to the fall of 2007 created stress conditions favorable for bark beetle build-up and damage in 2007 and 2008. Aerial survey data bears this idea out. For the past eleven years, bark beetles have averaged 1,093 acres of mortality per year and this year, mortality occurred on 773 acres. Similarly, bark beetle have infested an average of 37 stands per year, this year, mortality was mapped in 56 stands.

At Side Lake (S24-T60N-R24), scattered pockets of 80 year old red pine trees, both dead and dying, were found in a stand that had been thinned twice and was being set up for another thinning. Trees have been dying over the past few years. Armillaria, wood borers, some *Ips pini* and quite a lot of *Dendroctonus valens* were found in the trees. The trees are growing on a very rocky site. Why trees continue to die could not be determined. The site is very rocky and the possibility of root injury during one of the past thinnings is a possibility but not a proven cause.



In Orr Area, bark beetles killed 6 - 8" dbh red pine along Town line Road north of Pelican Lake. In 2007, roadwork resulted in scattered piles of red pine trees being left along the road. Bark beetles killed red pine in 6 to 8 pockets up to ¼ acre in size near the piles in 2007. Bark beetles continued to attack live standing trees and were laying eggs on June 6, 2008. The pockets of dead trees killed in 2007 and a rim of trees being attacked in 2008 were harvested and disposed of in June and early July 2008. Subsequent surveys, in September, found only one additional tree killed by bark beetles in 2008 after the sanitation harvest.

## Eastern larch beetle

*Dendroctonus simplex*

Since 2000, an outbreak of larch beetle has occurred with significant levels of mortality on over 65,000 acres of tamarack. This year, tamarack mortality occurred on 18,983 acres (in 855 stands). Damage levels vary from scattered individual trees killed by the beetles up to 80% of trees in stands being killed. No consistent stress factor contributing to the current mortality has been found, however, the droughts in 2002 - 2003 and 2006 - 2007 have undoubtedly been involved.

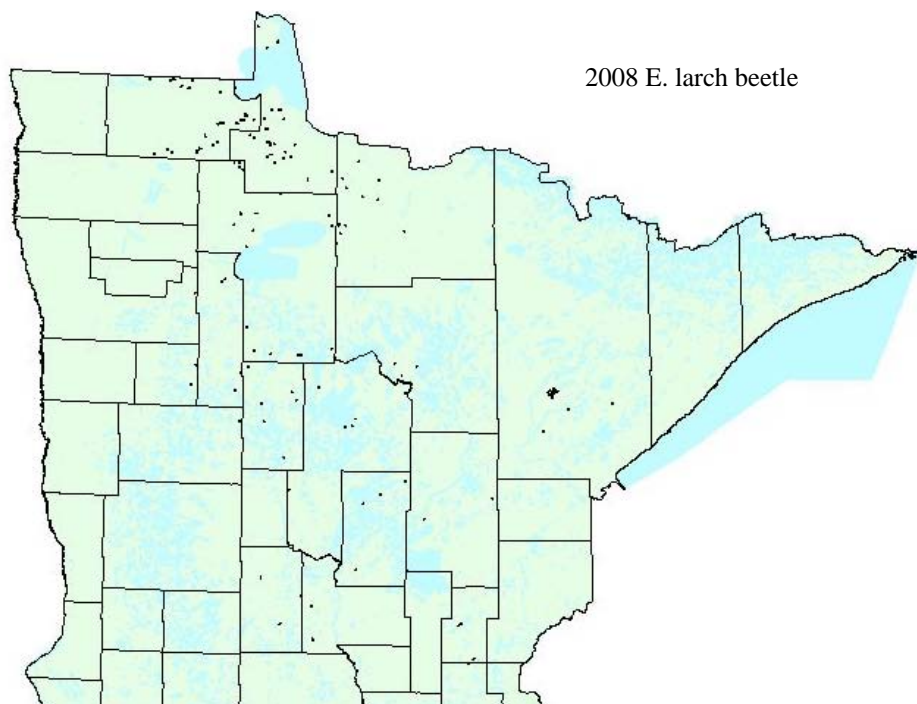
Many of the winters since 1998 have been very mild in terms of temperatures. Since eastern larch beetles overwinter under the bark on the trunk of the tamarack trees the mild winters may be allowing higher populations to survive the winter resulting in the outbreak. In examining trees in Minnesota, adults, larvae and pupae can all be found under the bark in the winter. An assumption was that the larvae would be the most likely stage to be affected by the mild winter temperatures. This was based on research by Langor and Raske, (1987), in Newfoundland, where they reported that only adults were able to overwinter because freezing temperatures caused complete mortality of immature stages. To examine this assumption in northern Minnesota, larvae have been excavated from tamarack trees in late winter, warmed and examined to determine if they were still alive. This was done in 2003, 2004, 2005, and 2007. Percent survival was not determined. The larvae were just watched over a couple day period to determine if most of them seemed to be alive or dead. In these years most larvae seemed to have survived the winter. The coldest temperatures in locations where larvae were collected in these years was -30 F although most locations did not reach temperatures lower than about -25 F.



M. Albers



In 2008, larvae were collected from a location near International Falls and also near Kabetogama on March 31<sup>st</sup>. These locations had reached -40 F at least one night during the winter. Forty nine percent of the larvae were alive. Adults were also collected at these sites and 70% of these survived the winter. Larvae and adults were collected high enough up the tree to be above the maximum snow level on the trees so they would not have been protected from the cold temperatures by snow cover. Larvae were also collected from one location in Arbo Township near Grand Rapids in Itasca County. 33% of the larvae were alive. No adults were collected from this site..



2008 E. larch beetle

It was harder than expected to decide whether larvae were live or dead. Only healthy creamy colored larvae were collected and they were examined under a dissecting scope. Larvae that wiggled and moved were counted as alive. Larvae that would not move were counted as dead. Some larvae would wiggle after warming in the lab for one day after being collected but many did not seem to move at all. Larvae were examined everyday for one week and everyday additional larvae were found to move. Some larvae could only be observed to move after prodding with a needle. The study was ended after 9 days.

Dr Rob Venette and his student, Abigail Walter, have studied cold hardiness of the eastern larch beetle under laboratory conditions. Their preliminary conclusions were presented in a poster titled “Connecting Overwintering Success of Eastern Larch Beetle to Health of Tamarack: Preliminary Results”. They found that larch beetle adults rather than the larvae are more likely to benefit from warmer winter temperatures. They also found that the adults did not suffer increased mortality due to cold exposure until they were chilled to temperatures around -40C (-40F) and that mortality was almost 100% at -50C (-58F). They concluded that the observed increase in tamarack mortality could be caused by higher populations of eastern larch beetle due to decreased winter mortality of adults.

## Forest tent caterpillar

*Malacosoma disstria*

FTC populations are building in central Minnesota. Compared to last year, the number of acres defoliated by FTC (23,649 ac) has doubled and the number of mapped locations (231 stands) has increased by 75%. These increases were mainly found in the west central counties. The number of additional observations of individual caterpillar from the northern and west central counties is also increasing. Taken together, these observations usually portend a north-wide outbreak in the near future.



2008 Forest tent caterpillar

## Galls on oak

*Unknown cause*

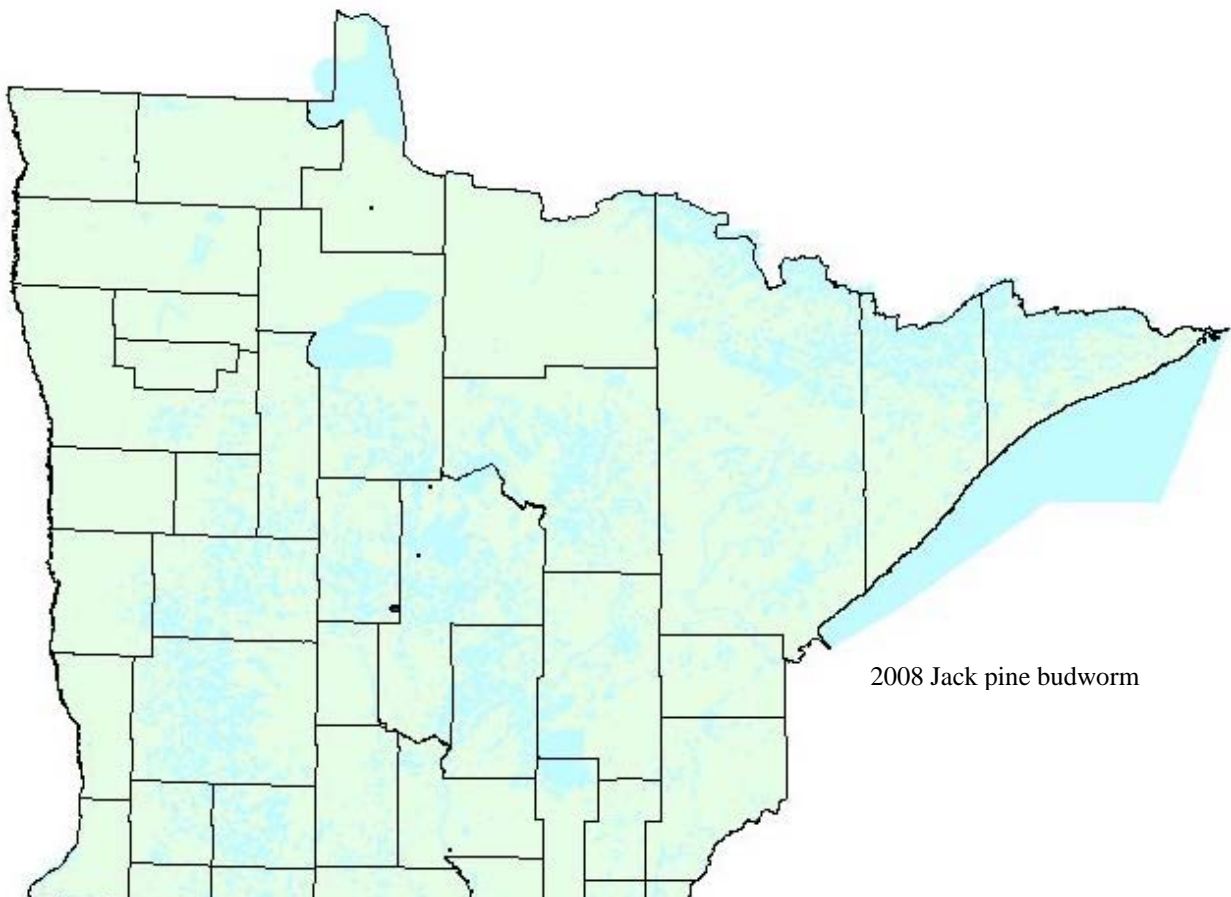
Woody galls on branches and burls on trunks of red oak have been reported as a problem and possibly causing mortality in Pine and Carlton County for several years. Foresters report the galled trees seem to be in pockets and that heavily galled trees die. A stand of red oak being harvested in Sec 31-T46-R16W in Carlton County was inspected. About 15% of the trees in the stand had galls and burls. Galls and burls were collected. The cause of the galls has not yet been determined.



## Jack pine budworm

*Choristoneura pinus*

In 2008, jack pine budworms defoliated 2,326 acres in 28 stands. Of those acres, only 124 acres were lightly defoliated and the remaining acres only had “trace” defoliation. Trace defoliation indicates that there was a slight amount of defoliation, usually from 1 to 5% of the foliage lost. Remnant populations causing trace to light defoliation occurred in Lake of the Woods, Roseau, Clearwater, Hubbard, Cass, Crow Wing, Morrison, Stearns and Chisago Counties. A single stand in Hubbard County accounted for 2,066 of the affected acres, so the remaining stands had only a few acres each.



2008 Jack pine budworm

In the Northwest Region, the budworm outbreak has collapsed based on data from the early larval surveys, aerial survey and egg mass survey conducted this year. A single budworm larva was found on 22 early larval survey plots. See tables below. No egg masses were found on 12 egg mass plots. See table below. This outbreak had its inception in 2002 and it peaked in 2006, when budworm defoliation, topkill and mortality affected 70,790 acres.

No defoliation due to jack pine budworm was observed during the aerial survey in the Northeast region in 2008. An early larval survey was conducted in St Louis and Itasca County in June. See results below. Defoliation was observed from the ground, however, in the Esquagama Lake area and Pike Township in St Louis County. In the Esquagama Lake area of St Louis County, jack pine budworm defoliation was limited to scattered shoots. There were a few spots with moderate to heavy defoliation but some current year needles still existed on most shoots such as in SE S4-T57-R16W. Moderate defoliation occurred on jack pine in SENW S31-T60N-R16W in Pike Township of St Louis Co.

### Jack pine budworm early larval survey: Spring of 2008

Roger Hannigan and Bob Tiplady

Note: All shoots show excellent growth.

Methods: From the ground, take 15 pollen cone clusters (S =staminate) on a shoot and 15 new vegetative shoots (V=vegetative). There will be a total of 30 shoots examined from 5 trees. Inspect the shoots and count the number of infested shoots. (No need to count the number of larvae.) If 20 of the 30 shoots are infested, then it is likely that moderate to heavy defoliation will occur.

<i>Location</i>	<i>Legal or GPS</i>	<i>Number of shoots infested</i>	<i>Abundance of pollen clusters at this location</i>	<i>Last year's (2007) defoliation at this location</i>	<i>Predicted defoliation for summer of 2008</i>
<b>Roseau</b>					
Warroad	48° 36.594 95° 10.763	S 0/18 V 0/12	Less common	None	None
Hayes L.	48° 08.591 95° 32.688	S 0/9 V 0/21	Less common	None	None
<b>Lake of the Woods</b>					
Zipple Bay	48° 50.406 94° 50.957	S 0/9 V 0/21	Few to rare	None	None
Blueberry Hill	NE 9-161-34	V 0/30	Few	None	None
West Faunce	48° 35.846 95° 20.546	S 0/6 V 0/24	Few	None	None
East Faunce	48° 33.829 94° 54.990	V 0/30	Rare	None	None
<b>Beltrami</b>					
Lammers Tnshp	NWNE 3-147-35	S 0/18 V 0/12	Common	None	None
Eckles Tnshp	NWNE 20-147-34	S 0/20 V 0/10	Common	None	None
Lake George	SWSW 10-143-34	S 1/20 (second instar) V 0/10	Less common	None	None
Northern Tnshp	NWNE 16-147-33	S 0/26 V 0/4	Common	None	None
Turtle Tnshp	NWNW 17-147-32	S 0/23 V 0/7	Common	Very Light	None
<b>Hubbard</b>					
Midge Lake	NENE 9-145-32	S 0/22 V 0/8	Common	None	None
Kabekona	SWSE 12-143-33	S 0/30 1 shoot had webbing.	Common to Abundant	Very Light	None
Mantrap Lake	SWSW 3-141-33	S 0/21 V 0/9	Common	Very Light	None
Nevis Tnshp	NWSW 25-140-33	S 0/22 V 0/8	Common	Very Light	None
Badoura	SWSW 11-139-32	S 0/12	Less common	Very Light	None



Tnshp		V 0/18			
Straight River	NWNW 33-139-35	S 0/30	Common	Very Light	None
<i>Becker</i>					
Two Inlets	NWSE 11-141-36	S 0/30	Less common	None	None
Shipman Lake	NESE 15-139-36	S 0/6 V 0/24	Few	Light to Very Light	None

Methods: From the ground, take 15 pollen cone clusters on a shoot and 15 new vegetative shoots (total of 30 shoots) from 5 trees. Inspect the shoots and count the number of infested shoots. (No need to count the number of larvae.) If 20 of the 30 shoots are infested, then it is likely that moderate to heavy defoliation will occur.

Location	Legal or GPS	Number of shoots infested	Abundance of pollen clusters at this location	Last year's defoliation at this location	Comments
<b>Crow Wing Co.</b>					
Crow Wing Tnshp	SESW 25-44-32	7,1,1,1,1	Common	L,L,L,M,H	Budworms 3-5 mm long. IF heavy defoliation occurred last year, few male cones were produced in 2008. Staminate cones were moist (pollen still developing).
Mission Tnshp	SESE 10-136-27	0,0,0,0,0	Abundant	0,0,0,0,L	Staminate cones dry and empty (pollen was already shed).
<b>Cass Co.</b>					
Boyer's ppty	NENE 12-133-30	0,0,0,0,0	Heavy	L,L,L,L,L	From JP along road adjacent to RP plantation that was defoliated for previous 3 years. Staminate cones dry and empty (pollen was already shed).

### Jack pine budworm early larvae survey in Region 2 - 2008

Mike Albers

Jack pine budworm early larvae survey in Region 2 - 2008	
<i>Esquagama Lake Area St Louis Co. - June 3 &amp; 19</i>	Number of larvae
SESW S4-T57N-R16W	0
NESW S4-T57N-R16W (jct 20 & 525)	2
SENW S4-T57N-R16W (jct 20 & 97 just south on 20)	6
SWNW S4-T157N-R16e	0
NESE S5-R57N-R16W	0
SENE S4-T57N-R16W	3
NE S16-T57N-R16W	7
SW S9-T57N-R16W (Jct 335 & 108)	0
<i>Wolf Lake Area Itasca Co. - June 17</i>	
NE S22-R59N-R23	0
SWSE S28-R59N-R23W	0
SW S33-T59N-R23W	2
NWNW S32-T59N-R23W (Jct Hartley L & Wolf L Rds)	0
NE S32-T59N-R23W	0

### Jack pine budworm egg mass survey: Fall of 2008

Roger Hannigan

Methods: Survey consisted of cutting two branches from each of four trees (each tree was representative of the 4 crown classes). Fifteen inches of two- and three-year old needles was examined. Number of egg masses on all 8 branches was

recorded. In addition, the remaining portion of the branch was also examined; no additional egg masses were found. Dates: Survey conducted intermittently from Sept. 18 through Oct. 1, 2008.

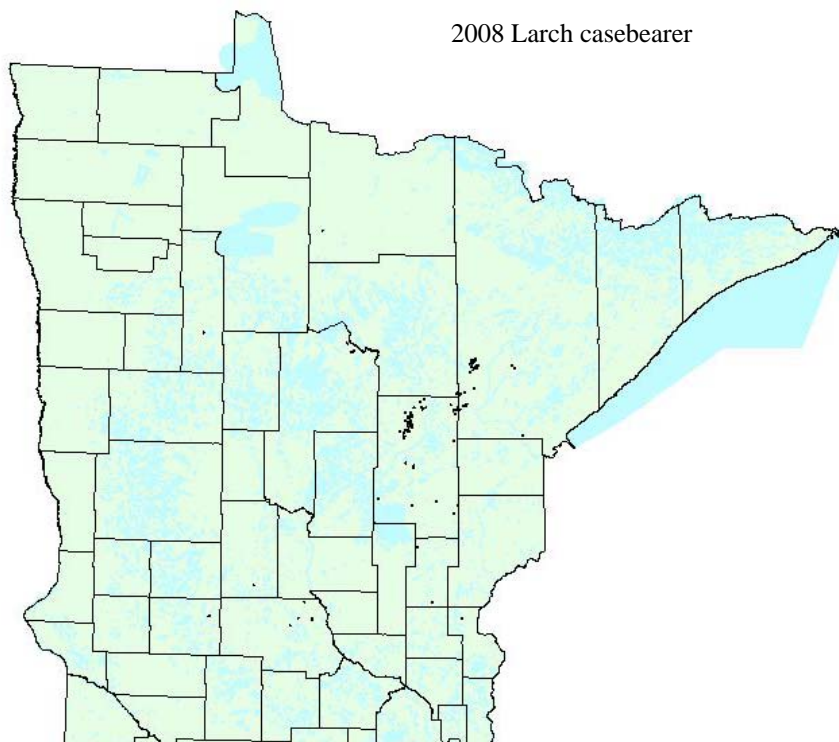
County and Location	Number of egg masses per 8 branches	Estimated defoliation during 2008	Predicted defoliation in 2009
<b>Beltrami</b>			
NENE3-147-35	0	None	0
NENE32-148-35	0	None	0
<b>Hubbard</b>			
SWSW 11-139-32	0	0 to very light	0
NWNW 33-139-35	0	None	0
<b>Wadena</b>			
NENE 3-138-32	0	None	0
SE 19-138-32	0	None	0
<b>Becker</b>			
SESE 15-139-36	0	None	0
SESE 32-141-36	0	None	0
<b>Roseau</b>			
SESE 28-160-38	0	None	0
SWNW 14-160-38	0	None	0
<b>Lake of the Woods</b>			
SENW 4-159-35	0	None	0
SWSE 28-159-33	0	None	0

## Larch casebearer

*Coleophora laricella*

Larch casebearer is an exotic insect that was first reported in North America in 1886. It occurs throughout the range of tamarack. It has been in Minnesota for a long time. This year, 17,409 acres of discoloration/ defoliation caused by larch casebearer were found during the aerial survey. Since 2000, these insects have defoliated 73,000 acres. See table.

Larch casebearer: Acres defoliated	
<i>Year</i>	<i>Acres</i>
2000	6363
2001	18800
2002	2544
2003	1660
2004	6700
2005	4600
2006	6013
2007	10900
2008	17409



## Poplar borer

*Saperda calcarata*

Based upon casual observations, it seems like poplar borer has been steadily increasing in northern Minnesota over the past few years. Poplar borers prefer sapling- to pole- sized trees. Open-grown trees and trees around the edges of stands are most vulnerable to attack. Many larger saplings may be attacked when populations are high and conditions are favorable. Usually, woodpeckers expand the boring holes that provide an opportunity for wood-decaying fungi to develop. Trees are not usually killed by the borer, but are subject to breaking off during windstorms.

Abundant damage from *Saperda* borer was observed in Woodenfrog State forest Campground. The campground manager noticed the damage while inspecting for hazard trees. Holes in the trunks, black sooty material below the holes and sawdust on herbaceous plants at the base of the trees were observed. Trees were mostly 4 to 6 inch dbh and damage occurred in pockets with multiple trees in campsites displaying the same defects. The worst damage was observed on campsites 24, 25, 28 and 40 but damage was seen throughout the campground.



## Red pine shoot moth

*Dioryctria resinosella*

Lots of new shoots of red pine turned tan along Hwy 52 south of Line Lake and along the road into Bear Lake State Forest Campground in northeastern Itasca Co. The current year shoots were hollowed out and pitch tubes were found at the base of some of the shoots.

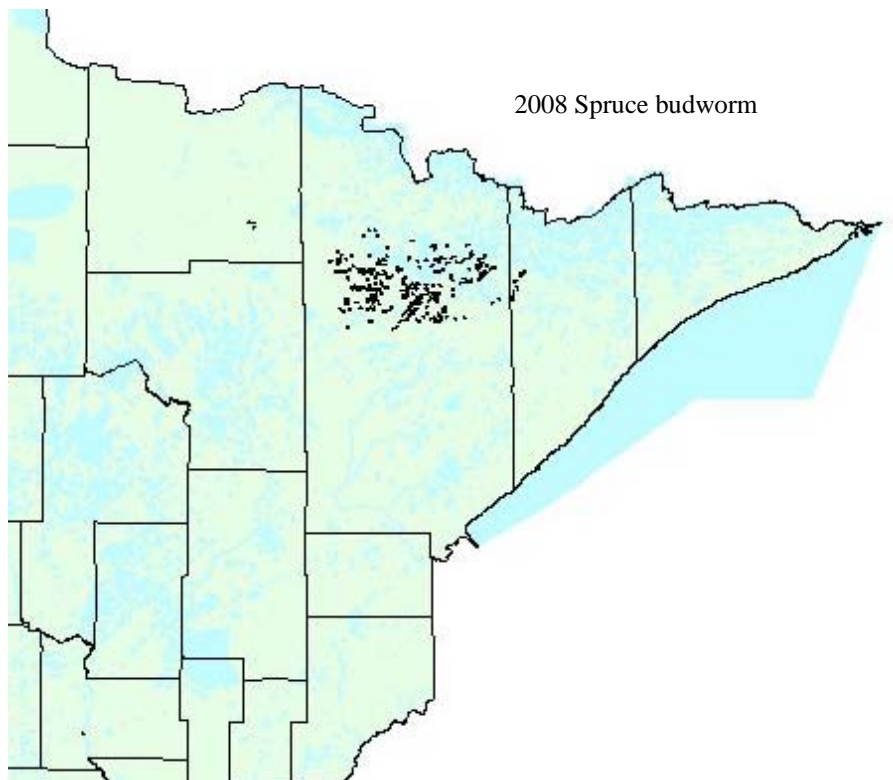


## Spruce budworm

*Choristoneura fumiferana*

Since 1954, when annual aerial sketch-mapping began in Minnesota, spruce budworm populations have caused defoliation of balsam firs and white spruces every single year. This year 41,263 acres of defoliation were observed in 285 stands, primarily in the northeastern counties. This is down from 101,400 acres in 2007 and 287,000 acres in 2006. Spruce budworm larvae were feeding in balsam fir buds on June 17<sup>th</sup> on the west side of Vermillion Lake along Cty Rd 23 in T 63N-R18W. Larvae were mostly 3/8 to 1/2" long (4<sup>th</sup> instar) with a few 5/8" long (5<sup>th</sup> instar).

In outbreak areas, budworm populations cause prolonged defoliation, sometimes as long as ten years. Widespread fir and spruce mortality results, but the host species are not locally eradicated. Instead, host trees are maintained at low densities as these mixed-wood stands mature. Then these trees serve as seed trees.





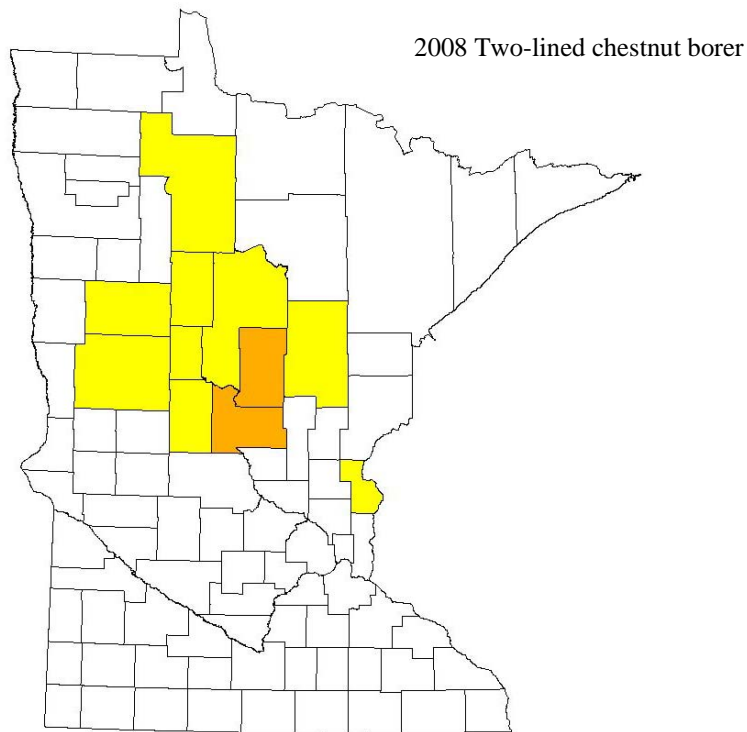
## Two-lined chestnut borer

*Agrilus bilineatus*

In locations where oak can be found growing on sandier soils and ridge-tops, crown dieback due to TLCB was readily apparent this year. Thousands upon thousands of trees were symptomatic of two-lined chestnut borer attack this year, continuing the upward population swing that began in 2006.

Since aerial survey is flown in early summer, damage and mortality due to two-lined chestnut borers (TLCB) is not usually sketch-mapped until the following year. The hardest hit counties in 2008 with widespread mortality were Morrison and Crow Wing (orange); several additional counties had pockets of mortality (yellow).

In Crow Wing County, the occurrence of three droughty growing seasons plus two years of defoliation caused by linden loopers and fall cankerworms allowed two-lined chestnut borer populations to build and kill thousands of oak trees. The cities of Brainerd and Baxter continued to suffer TLCB-caused oak mortality even though the insects and drought severity peaked last year. There are several 40+ acre pockets of TLCB attacked oaks that are comprised of 50% crown dieback and 50% mortality. The worst case observed this year was a privately owned, 40-acre tract of pure oak forest in Crow Wing County that was completely killed in the last two years. A nearby golf course lost 800 oak trees between January and December of 2008.



# Diseases

## Armillaria root disease

*Armillaria* spp.

In the fall of 2007, single and scattered small pockets of dying red pine were reported in red pine in stand 40 in Sec 4-T55-R12W near Brinson in St Louis Co. This plantation had been thinned 5 years earlier. Surveys in the fall of 2007 and in the summer of 2008 found that most single trees were infested by *Armillaria* and that they occurred mostly along skid trails. Ambrosia beetles were currently active in many of the trees. The pockets of dead trees were a result of wind and snow damage mostly along the north end of the plantation. Evidence of past bark beetle activity was found in these damaged and down trees but bark beetles (*Ips* sp.) did not appear to be currently active. However, ambrosia beetles as well as *Dendroctonus valens* were currently active in and around the pockets of damaged trees.

## Dwarf mistletoe

*Arceuthobium pusillum*

A 37-acre black spruce site was harvested and burned for mistletoe control. The prescribed burn was planned for 2007 but conditions were too dry so it was delayed until mid-August 2008. By the time of the burn, the needles had fallen off the slash. The site was harvested with a cut to length system and the slash mats would not ignite and burn. Even so, the forest managers felt the mistletoe control was good because the living black spruce seedlings were killed.

## Red pine pocket mortality

*Leptographium* spp.

In December 2007, *Leptographium* spp., fungi known to be active in pockets of dead and dying red pine, was confirmed in a red pine stand in the city of Andover, in Anoka County. A number of additional pockets are known to occur in the Sand Dunes State Forest in Sherburne County which were detected in 2005.

Red pine pocket mortality is known to be caused by a complex of insects and root disease fungi, including *Leptographium terrebrantis* and *L. procerum*. Red pine pocket mortality is a disease of plantation-grown red pine and the pockets are more common in stands that have been thinned.

Trees infected with *Leptographium* are stressed by a decrease in water conduction and a decrease in the production of defensive compounds. These stressed trees attract lower-stem feeding beetles, particularly the red turpentine beetle, *Dendroctonus valens*. Infected trees will have reduced height and diameter growth. As the disease progresses, successful invasion by additional pine bark beetles occur. Ultimately, the bark beetles (*Ips pini* and *I. grandicollis*) are responsible for tree mortality. The exit holes of the bark beetles are often evident on the dead trees within the pockets. Pockets typically start small with one to a few dead trees surrounded by trees that have reduced shoot growth and thin crowns. Root grafts provide a pathway for *Leptographium* to move from tree to tree. Once established in the communal root system of a red pine plantation, *Leptographium* spreads to healthy trees by these root pathways. Each year, a few trees on the pocket edge may die thus expanding the pocket.

Several insect vectors play a role including the root collar weevil, *Hylobius radicis*, pales weevils, *H. pales*, red turpentine beetles, pitch-eating weevils, *Pachylobius picivorus*, and *Hylastes porculus*. These insects can feed on freshly cut stumps, the lower stem, and roots of red pine transmitting the fungus. Pitch tubes, which are signs of attack by the red turpentine beetles, can be present on the lower bole of trees in the pocket margin. The wood in the vicinity of the pitch tubes and in the root collar area may be stained blue-black.

Red pine pocket mortality has not been observed in jack or white pine plantations. White pine regeneration within pockets also appears to be unaffected by this syndrome. The number of infection centers in a stand can vary widely.



*Photo courtesy of Wisconsin DNR-Forestry*

# Tubakia leaf disease of bur oaks

*Tubakia* spp.

Tubakia leaf disease is a late season leaf disease on native bur oaks. We have been seeing this disease across southern Minnesota since the 1990's. This year symptomatic trees were found from the southeast, west to Willmar and north to Sauk Centre. In most years this disease can be seen on individual bur oaks, usually after August 1<sup>st</sup>. Previously it was known to be caused by a fungus named *Actinopelte dryina* and the name was changed to *Tubakia dryina*. More recently Dr. Tom Harrington from Iowa State University at Ames has been studying the disease and has determined that the fungus is indeed in the *Tubakia* group of fungi but not *T. dryina*. This species remains un-described at this time. *Tubakia dryina* is a well known but minor leaf spot fungus in eastern USA, though it is not clear if it is the same as a European species known by the same name. In Europe and Asia, *T. dryina* is mostly an endophyte, meaning that leaves are infected but no disease symptoms are produced.

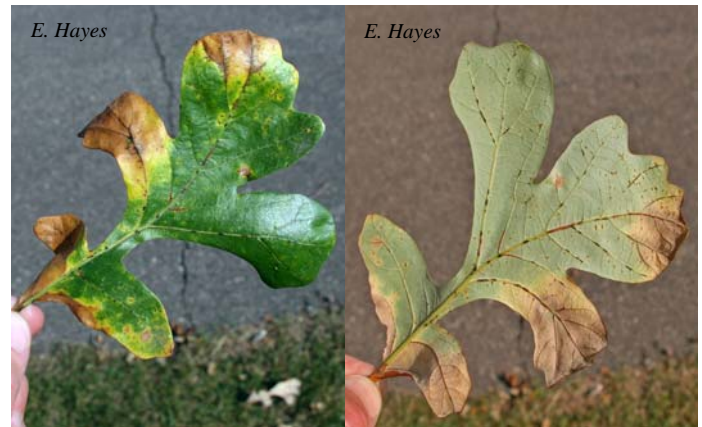
What's new and interesting in the Midwest is that our *Tubakia* species is endophytic in our bur oaks! Dr. Harrington has been able to isolate this unnamed species from inside branch tissues and from inside leaf tissues in June before any symptoms on the leaves appear. The fungus may over winter in branch tissue and move into new leaves each year. This may explain why we see the same oaks infected each year.

The fungus will also over winter on shed foliage. Observations over the last few years indicates that this leaf disease on our bur oaks has been increasing, suggesting that either the pathogen is new to this region, or the susceptibility of our oaks is increasing, or it takes a long time for the fungus to build up and become symptomatic. If the fungus is more closely related to fungi from other continents and if records suggest that it is new, then its recent arrival to the region would help explain the current amount of disease we are seeing.



**Symptoms:** Leaves of bur oaks may be affected as early as June, but leaf symptoms do not generally appear until peak summer temperatures are reached, in early August. During late July and August, bur oaks scattered throughout southern and southeastern Minnesota can exhibit the following symptoms:

- Leaves with multiple leaf spots that eventually turn brown. Brown or curled leaves are most commonly in the lower crown.
- The symptoms progress from the lower crown into the upper crown. Entire crowns of individual oaks can become brown with curled leaves and be mistaken for dead trees.



The appearance of symptomatic oaks can be very dramatic as the entire crown turns brown except a few leaves at the very top. Defoliation can reach 90% in a few days and affected trees look nearly dead. There appears to be genetic variability between individual bur oaks since affected trees will be found adjacent to other bur oaks that are free of symptoms. The leaf disease seems to affect the same individual bur oaks each year.

**Impact:** Hardwood trees can withstand late season defoliation events as the majority of the growing, wood formation and energy storage for the season has taken place. However, intense and repeated years of defoliation may have long-term impacts. Stored food reserves can be depleted and result in dieback in subsequent years. We are seeing some dieback in bur oaks that have been affected for several years. Oaks with dieback should also be checked for two-lined chestnut borer activity.

**Treatment:** There are no known controls at this time, however, arborists should look at trying systematic fungicides on oaks that are repeatedly symptomatic. Sanitation, raking and removal of infected leaves may or may not help.



# Invasive insects and pathogens

## Gypsy moth

*Lymantria dispar*

Itasca's "Bug Day" attracted an unwanted hitchhiker. "I've waited 28-years to see this and now I have. Scary, very scary." Those were the words of Mike Carroll, current NW Regional Director, former State Forester and former Region Forest Health Specialist. Carroll was referring to a gypsy moth caterpillar that was brought to him during Itasca State Park's Bug Day on July 10<sup>th</sup>. Passing by Carroll's display on forest pests, a park visitor stopped and asked, "do you want one of those, I have one", referring to the image of the gypsy moth larva on the Pest Alert fact sheet put out by the US Department of Agriculture.

The visitor relayed how they had just arrived from Madison, Wisconsin. This year the Madison area is seeing an outbreak in gypsy moths. Before leaving their Wisconsin home that morning, the family had collected and disposed a baggy full of gypsy moth larvae that had fallen from the overhanging trees into their vehicle through an open window. On the ride to Minnesota, the children found one more larva in the car.



Artificial movement dramatically increases the spread of these unwanted hitchhikers. The question posed by Carroll was "how many more gypsy moth caterpillars were transported to Minnesota by unsuspecting visitors?" A very scary thought, indeed.

## Minnesota Department of Agriculture Plant Protection Division, Gypsy Moth Unit

### 2008 State Summary Report

The gypsy moth detection program is a cooperative effort between state and federal agencies. Minnesota has been a state cooperator in the gypsy moth program since 1999. A strategic plan was created by representatives of the state Departments of Agriculture and Natural Resources, USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA APHIS-PPQ), and USDA Forest Service (USDA-FS). The plan describes the objectives and administrative structures necessary to manage the gypsy moth in Minnesota. It provides a mission statement, a framework for decision making, and outlines the strategies and mechanisms to implement the plan. On a biannual basis, these four agencies and the University of Minnesota come together to discuss issues related to gypsy moth management. It is this cooperative effort that has built a strong gypsy moth program in the state of Minnesota.

The Minnesota Department of Agriculture (MDA) is the lead agency undertaking the annual gypsy moth detection survey. Other cooperators setting detection traps include the Three Rivers Park District in the Twin Cities metro area and federal and tribal land managers statewide. Together, 20,188 delta traps were set across the state and a total of 12,255 male moths were caught.

Since 2004, Minnesota has been a formal member of the Gypsy Moth Slow the Spread (STS) Foundation. The STS Action Area is moved annually based on trap catch data and to cover the areas where moth populations are building. The Action Area has remained stable the last couple of years and even moved eastward in the southeast portion of the state in 2007. In 2008, portions of four counties (Houston, Winona, Lake and Cook) were included in the Action Area. This year set a record for moth numbers with high catches being identified over 100 miles west of the Action Area.

Extreme northeast Minnesota (commonly referred to as the North Shore) remains a challenge to survey because of the lack of maintained roads in the region. As moth numbers rose in the northeast, trapping routes were constructed to be hiked rather than driven. Although hiking field staff can only achieve about 40% of the traps set compared to driving staff, the extra attention to trapping on a pre-determined grid has enabled the program to gather more complete data on the existence of moth populations

across the landscape. Tourism is a large part of the local economy in Lake and Cook counties, and popular camping and outdoor recreation sites are still trapped heavily.

Sharp increases in moth numbers along the North Shore since 2005, along with noticeable variations in moth size and an unusually long adult flight season led MDA to request further research into the biology and behavior of northerly populations. A sentinel trap grid was established on areas of the existing grid along the North Shore to monitor male moth flight patterns. Sentinel traps were checked frequently by trappers who recorded the number of moths caught. In 2007, all male moths captured in detection traps in St. Louis, Lake, and Cook counties underwent wing length analysis. Preliminary results indicate the possibility that a portion of the males are immigrants from high-density populations. This study was continued for the 2008 moths caught in the same counties. To address the question of how temperatures over time affect lure release rates from traps, MDA participated in a regional lure release study to measure these differences. These research projects are both being coordinated through the USDA-FS Field Station in Morgantown, WV.

### ***Survey Program***

In 2008, MDA filled positions for 32 routes and 6 lead workers to oversee field operations. Routes were divided into two geographic regions, northern and southern, to account for the climatic range across the state. Southern trappers set traps between June 2 and July 3. The northern season is normally delayed about three weeks but was extended this year to account for an extended flight period. Trap set began in the north on June 9 and ended on July 17. Traps remained in the field for six weeks in the south and eight weeks in the north. Trap removal in the south began on August 11 and was completed by August 28. Trap removal in the north began on September 15 and was completed by October 10.

All trap data in Minnesota is collected and recorded using STS protocols. To gather comparable data, trapped areas beyond the STS Action Area do not follow the APHIS/PPQ-recommended trap density but rather use equivalent metric grids to achieve similar results. The entire state is not surveyed every year. Trapping is typically done on a rotating basis throughout the western part of the state, but to maximize the effectiveness of the program this year, only the eastern border, Twin Cities metropolitan area and a portion of the St. Cloud/Brainerd corridor were trapped.

### ***High-risk sites***

A determination of risk for the introduction and establishment of gypsy moth is based on human activity levels, preferred habitat for gypsy moth, and the advancing gypsy moth front from the east. Standard grid densities differ according to the risk of introduction: smaller grid sizes yield higher trap densities which result in higher resolution of actual moth populations. The STS Action Area was trapped on at least a two-kilometer grid. Nearly the entire North Shore was trapped at a higher density, between 0.5 and 1.0 kilometers, to increase accuracy and pinpoint recurring populations. Urban areas (Twin Cities metro, St. Cloud and Rochester) outside of the STS Action Area are considered high-risk for gypsy moth introduction by human movement and were subsequently trapped on a 1.5-kilometer grid.

Isolated traps with high numbers in 2007 were surveyed intensively in 2008 through site delimitation. This survey technique involves narrowing down a large area to find out if gypsy moth populations are persisting and if treatments should be administered. In 2008, field staff attended to 86 delimits across the state, with each site trapped at a grid density varying between 250 and 1000 meters. Seventy-eight other sites such as cities and areas along the North Shore that carried a higher risk than the standard grid contained 3,271 traps set between 250 and 1000 meters.

The standard trapping grid overlaid many high-risk sites such as state parks, mills, and nurseries. MDA supplemented the standard grid with random traps to increase the chance of detection. Field staff had the liberty of setting the traps anywhere within the designated property but were instructed to space traps evenly. Thirty-five of Minnesota's 80 state parks were covered by the standard grid this year and had an additional 1-2 random traps placed at each. Eighty-eight moths were caught at state parks, but only 3 were outside of the STS Action Area.

Wholesale nursery dealers and nursery growers that report stock sources from gypsy moth-quarantined areas or have a history of pest problems are considered high risk. Each of these sites received 2-20 random traps depending on acreage in production. Nursery sites trapped in 2008 yielded less than 1% of the total moths captured this year. MDA staff set traps at 324 nurseries and moths were recovered from only 24 sites. Forty-three positive traps resulted in 81 moths caught; 27 positive traps outside of the STS Action Area contained 52 moths. Two nursery breaches were reported this year near the metro area, accounting for 33 moths between them. The substantial outreach campaign MDA has undertaken may have paid off as more nurseries are contacted and informed about proper sanitation of imported stock. MDA continues to work with the industry to minimize their risks of transporting gypsy moth into the state.

Sawmills and Pulp mills are considered high risk if it is known or likely that they have out-of-state sources and if they are within 100 miles of counties that trap fifty or more moths. These sites received two random traps. MDA trapped 55 mill sites in 2008 and 28 sites (15 in the greater Duluth area, four in the southeast Action Area and six in the northeast Action Area) returned

positive traps. One hundred sixty-eight moths were caught at the mills, 58 of which were found at one mill within the STS Action Area. The STS mill is not being investigated for regulatory concerns because the moths caught there simply reflect the overall high moth population in the larger landscape.

Compliance agreement sites are by nature high risk. Agreements for one mill and two nurseries in Minnesota were drafted and reviewed by both state and federal officials this year. The mill imports pulp logs from the gypsy moth quarantine area and was instructed in methods to mitigate the risk of introduction. One nursery under compliance was released from the agreement after successfully treating the property for gypsy moth in the spring of 2008 but the same business practice that resulted in the infestation last year caused similar problems this year. The compliance agreement was reinstated and they will be required to conduct treatments again next spring. The other nursery imported infested, though certified pest-free, stock from a Canadian supplier earlier this spring. Their staff underwent training to self-inspect stock and will also be required to treat the stock next spring.

Tourism and heavy recreational use by people living and vacationing on the North Shore puts the area at risk for artificial introductions of gypsy moth. A suspicion of moths blowing in from across Lake Superior adds to the possibility of natural introductions to this area. It has been noted from years past that most of the gypsy moth activity seems to follow closely along the shoreline and drops significantly farther inland. After consultation with STS officials, a 505,570-acre delimit along the shoreline of Lake and Cook Counties was trapped to determine the extent of a gypsy moth population. Two sections totaling 8,537 acres along the shoreline were delimited at a density of 500m during the 2008 trapping season. An estimated 138 traps were planned and 142 were set in this area. From 126 traps, 2,102 moths were collected. A larger 497,033-acre area that stretched 12-15 miles inland from the shoreline (not including 2008 treatment blocks) was delimited at 1k. An estimated 2,012 traps were planned and 1,889 were actually set. Within this area, 769 positive traps yielded 2,990 moths.

### ***Trap Results***

Trapping for the Asian strain of gypsy moth continued in 2008. One hundred fifty-four traps from pathway sites (ports of entry, warehouses or sites that receive/store containers), and around sites where heterozygous strains were identified previously were sent to OTIS Laboratories for DNA analysis. The traps contained a total of 465 moths to be tested. No Asian gypsy moths have been identified in Minnesota at this time.

Both the Forest Service and APHIS were able to contribute funds to trap all National Forest and Bureau of Indian Affairs land within MDA's standard trapping grid. Superior National Forest and Grand Portage, Fond du Lac and Boise Forte Reservations were within the state's standard detection grid in 2008. The Superior National Forest lands received 2,777 total traps. Of those, 751 were positive and yielded 3,272 moths. Three traps were set on Vermilion Lake Reservation, catching one moth and 114 traps were set on the Fond du Lac Reservation, collecting 132 moths. However, Grand Portage Reservation, within the STS Action Area, had 170 traps set and only 180 moths caught. Grand Portage, in the extreme northeast tip of Minnesota, was the only Reservation covered under STS Foundation funding in 2008.

Moth numbers were much higher in the southeast part of the state where 3 counties (Houston, Winona, and Wabasha), accounted for a substantial 2,481 moths (20% of the statewide total and 78% of the southern total). In recent years, moth numbers there have been extremely low and the rapid increase may be attributed to increasing population pressure from western Wisconsin.

Two areas of concern, apart from the two nursery sites now under compliance, arose out of the southern trap data. The nursery sites will be treated by the companies and delimited by MDA in 2009. Two other sites are located in Hennepin County, in the suburbs of Richfield and Minnetonka. After alternate life stage searches last year yielded nothing at either site, they were delimited in 2008. Egg masses were recovered at both sites this year. Traps in Richfield caught 105 moths and those in Minnetonka trapped 69 moths.

In 2007, St. Louis, Lake and Cook counties in the northeast corner of the state accounted for 84% of the moths in the entire state with 3,031 found there. The percentage dropped to 64% in 2008 with 7,862 moths caught, indicating that the population front is moving closer to Minnesota. This year ushered in the first wave of moths into areas previously trapped with low moth catches. Specifically, the shoreline of St. Louis County, south to Carleton and Pine counties experienced an unprecedented number of moths, accounting for a 66-fold increase in some places. MDA will be working closely with the land stewards within these areas to align management strategies with increased moth populations. Many of the isolated positive traps will be further delimited and treatments will be proposed for these counties in 2009.

APHIS staff coordinated trap placement on several federal and tribal land sites not included in the program area. Cooperators around the state set 253 traps that yielded 12 moths. Positive catches will be followed up in 2009 as part of a delimit site.



### **General Treatment Program**

The Minnesota Department of Agriculture coordinated the treatment of 85,038 acres within the STS Action Area. One regulatory site in Wright County was treated as a condition of a compliance agreement. As the gypsy moth front moves closer to Minnesota, treatment acreage is expected to increase to meet the statewide objective of decreasing spread rates from 15 miles per year to less than 6 miles per year.

### **Treatment Monitoring**

One 4,959-acre treatment block on the Grand Portage Reservation was evaluated in 2008. The area was delimited at a 500-meter grid density. Sixty-seven delta traps were set, 11 positive traps caught 14 moths in the entire area. The STS Decision Algorithm calculated the treatment success at .98 and colony presence at .13, both indications of a successful treatment.

### **2008 Regulatory Treatments: (30 acres)**

One nursery site west of the St. Paul/Minneapolis metropolitan area conducted an eradication treatment this year. Life stages were discovered there last summer and the stock was subsequently quarantined. As a consequence, the nursery was required to treat their holding yard and the surrounding environs this spring using their own funding sources. The holding yard totals 10 acres but susceptible habitat surrounding the yard was treated for a total of 30 acres. A late wet spring delayed treatments by nearly two weeks. Dimilin was aerially applied to the nursery stock for the first time on May 21, 2008. The second application was made on May 28 and the stock was released for sale while a delimit traps were placed around the site. Nursery staff reported gypsy moth life stages in late July where after 2 male moths were caught in traps on the property.

Site Name	Acres	Product	Rate/Acre	Application Equipment	Date of First Application	Date of Second Application	Cost/Acre
Nursery Holding Plot	30	Dimilin	2 oz.	Aerial-Helicopter	5-21-08	5-28-08	unknown

### **2008 STS Treatments: (85,038 acres)**

Six treatment blocks along the north shore were identified and treated based on historic trap catches in the area. Minnesota hosted the largest operational trial of SPLAT on nearly 12,000 acres of the Grand Portage Reservation. Treatments were in response to a record trapping year in 2007. Most of the high populations skirted the lakeshore so all treatment boundaries bordered the shoreline. One area of high moth concentrations appeared inland nearly overlapping a previous treatment in 2006.

Site Name	Acres	Product	Rate/acre	Application Equipment	Date of Application	Application Cost/Acre
Illgen City	16,848	Disrupt II	6 g	Aerial-Fixed Wing	July 22-24, 2008	\$7.50
Little Marais	28,680	Disrupt II	6 g	Aerial-Fixed Wing	July 22-24, 2008	\$7.50
Grand Marais	10,096	Disrupt II	15 g	Aerial-Fixed Wing	July 22-24, 2008	\$13.59
Marr Island	12,456	Disrupt II	6-15 g	Aerial-Fixed Wing	July 22-24, 2008	\$7.50
Grand Portage	11,999	SPLAT	15g	Aerial-Fixed Wing	July 29-30, 2008	STSF End-Product Contract
Mineral Center	4,595	Btk	24 CLU x 2	Aerial-Fixed Wing	June 18, 2008 (1 <sup>st</sup> ) June 26, 2008 (2 <sup>nd</sup> )	\$24.37

Three separate Environmental Assessments were completed with three separate decision notices. One for both Btk and mating disruption treatments on the Grand Portage Reservation, one for mating disruption on 7,332 acres of the Superior National Forest, and a third to cover all other public and private lands.

### **Egg mass surveys**

Three surveys were planned in 2008. On August 5, 2008 a small informal search was conducted in Richfield. Staff were able to quickly identify and collect a dozen females and their egg masses. On September 12, several agencies responded to a high number of moths (69) trapped in a delimit in the Minneapolis suburb of Minnetonka. Five egg masses were found at the site. Both urban sites have been identified for eradication treatment in 2009.

In addition to the egg mass surveys conducted in the Twin Cities metro area, sites surrounding high-find locations were surveyed along the North Shore. The third survey took place on October 15 in Lutsen along a .25 by 6-mile stretch between Highway 61 and the lakeshore. Several traps in this corridor caught over 50 moths. No egg masses or alternate life stages were identified.

**2008 Summary Tables:**

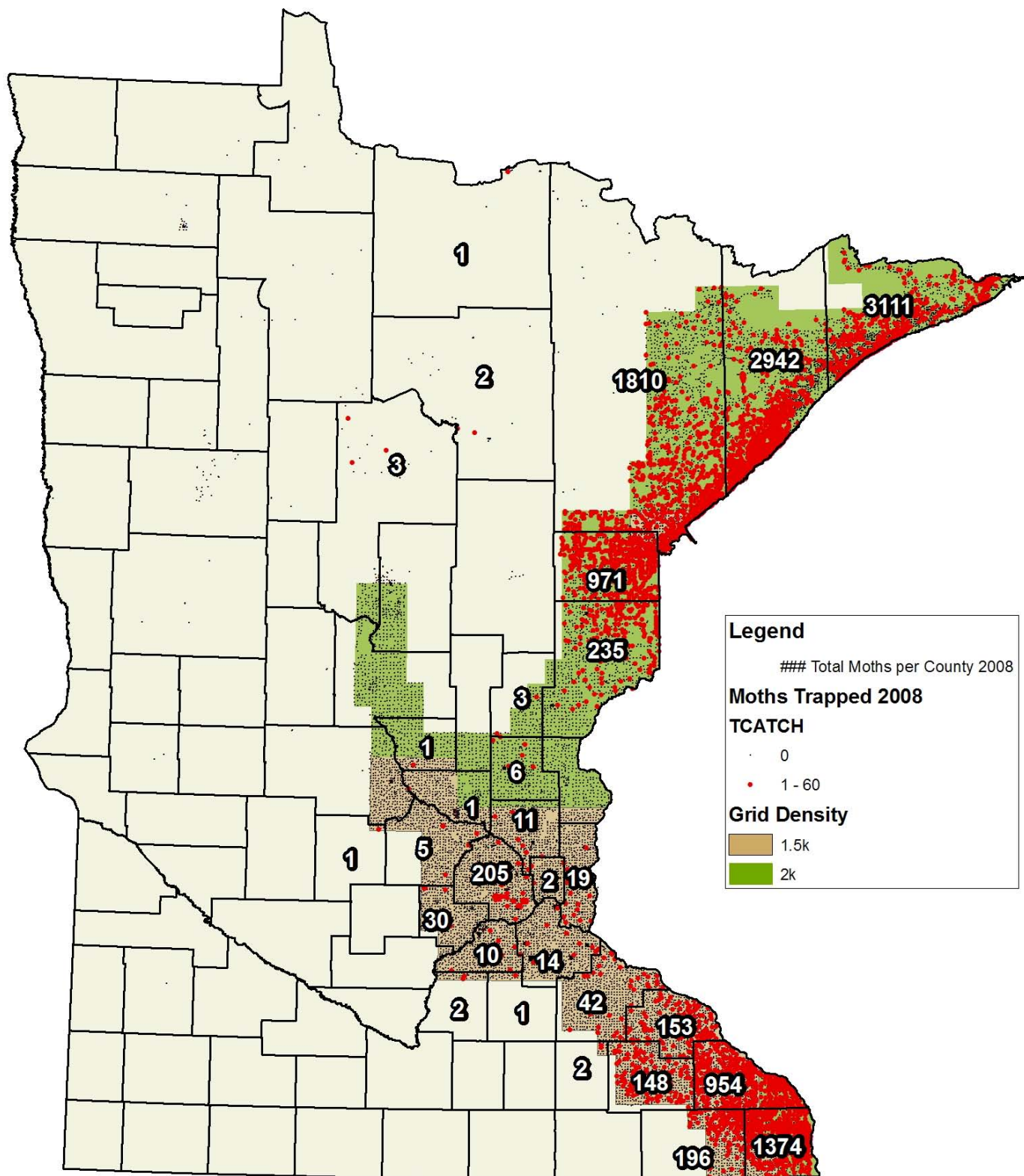
Management Zones	Total Traps	% of Total Traps	Total Moths	% of Total Moths
Eradication Area	16,319	81	4,864	41
STS Action Area	3,869	19	7,391	59
TOTAL	20,188	100	12,255	100
Traps set by agency	Traps Set	Positive Traps	Moth Count	
MDA	19,888	4,375	12,243	
Three Rivers Park District	47	0	0	
APHIS	253	11	12	
Trap Type				
Standard	15,934	3,258	7,617	
Delimit	2,271	877	4,001	
High Risk Sites	1,983	247	637	
TOTAL	20,188	4,382	12,255	
High Risk Sites	Note that these figures are spatial and may duplicate trap and moth counts. These numbers are not to be incorporated into totals.			
Nursery	1,129	39	81	
Mill	186	61	168	
State Park	78	19	88	
Campground	339	65	131	
Firewood Dealer	2	2	2	
Reactive	105	43	129	
Random	320	23	63	
Reservations				
Fond Du Lac	114	74	132	
Grand Portage	170	49	180	
Vermillion (Boise Forte)	3	1	1	
Leech Lake	30	4	4	
Prairie Island	20	1	1	
Red Lake	12	0	0	
Rice Lake	6	0	0	
White Earth	20	0	0	
Federal Lands				
Agassiz National Wildlife Refuge	30	0	0	
Tamarac National Wildlife Refuge	15	0	0	
Pipestone National Monument	7	0	0	
Voyageurs National Park	16	0	0	
Big Stone Wildlife Refuge	4	0	0	
Other	93	6	7	

**2008 Gypsy Moth Results by County:**

County	Trap Set	Moth Catch	% of Statewide Moth Total
Aitkin	6	0	0.00%
Anoka	561	11	0.09%
Becker	25	0	0.00%
Beltrami	8	0	0.00%
Benton	283	1	0.01%
Big Stone	2	0	0.00%
Carlton	796	971	7.92%
Carver	496	30	0.24%
Cass	104	3	0.02%
Chisago	335	0	0.00%
Clay	2	0	0.00%
Clearwater	5	0	0.00%
Cook	1,676	3,111	25.39%
Crow Wing	225	0	0.00%
Dakota	990	14	0.11%
Dodge	21	2	0.02%
Fillmore	499	196	1.60%
Goodhue	822	42	0.34%
Hennepin	1,114	205	1.67%
Houston	871	1,374	11.21%
Hubbard	4	0	0.00%
Isanti	359	6	0.05%
Itasca	37	2	0.02%
Kanabec	144	3	0.02%
Koochiching	31	1	0.01%
Lac Qui Parle	2	0	0.00%
Lake	1,781	2,942	24.01%
Lake of the Woods	13	0	0.00%
Le Sueur	56	2	0.02%
Lyon	2	0	0.00%
Mahnomen	7	0	0.00%
Marshall	30	0	0.00%
Meeker	13	1	0.01%
Mille Lacs	119	0	0.00%
Morrison	368	0	0.00%
Olmsted	708	148	1.21%
Otter Tail	8	0	0.00%
Pine	885	235	1.92%
Pipestone	7	0	0.00%
Ramsey	251	2	0.02%
Rice	39	1	0.01%
Roseau	2	0	0.00%
Saint Louis	2,141	1,810	14.77%
Scott	551	10	0.08%
Sherburne	498	1	0.01%
Sibley	18	0	0.00%
Stearns	430	0	0.00%
Stevens	6	0	0.00%
Todd	2	0	0.00%
Wabasha	687	153	1.25%
Washington	651	19	0.16%
Winona	836	954	7.78%
Wright	661	5	0.04%
<b>TOTAL</b>	<b>20,188</b>	<b>12,255</b>	<b>100.00%</b>



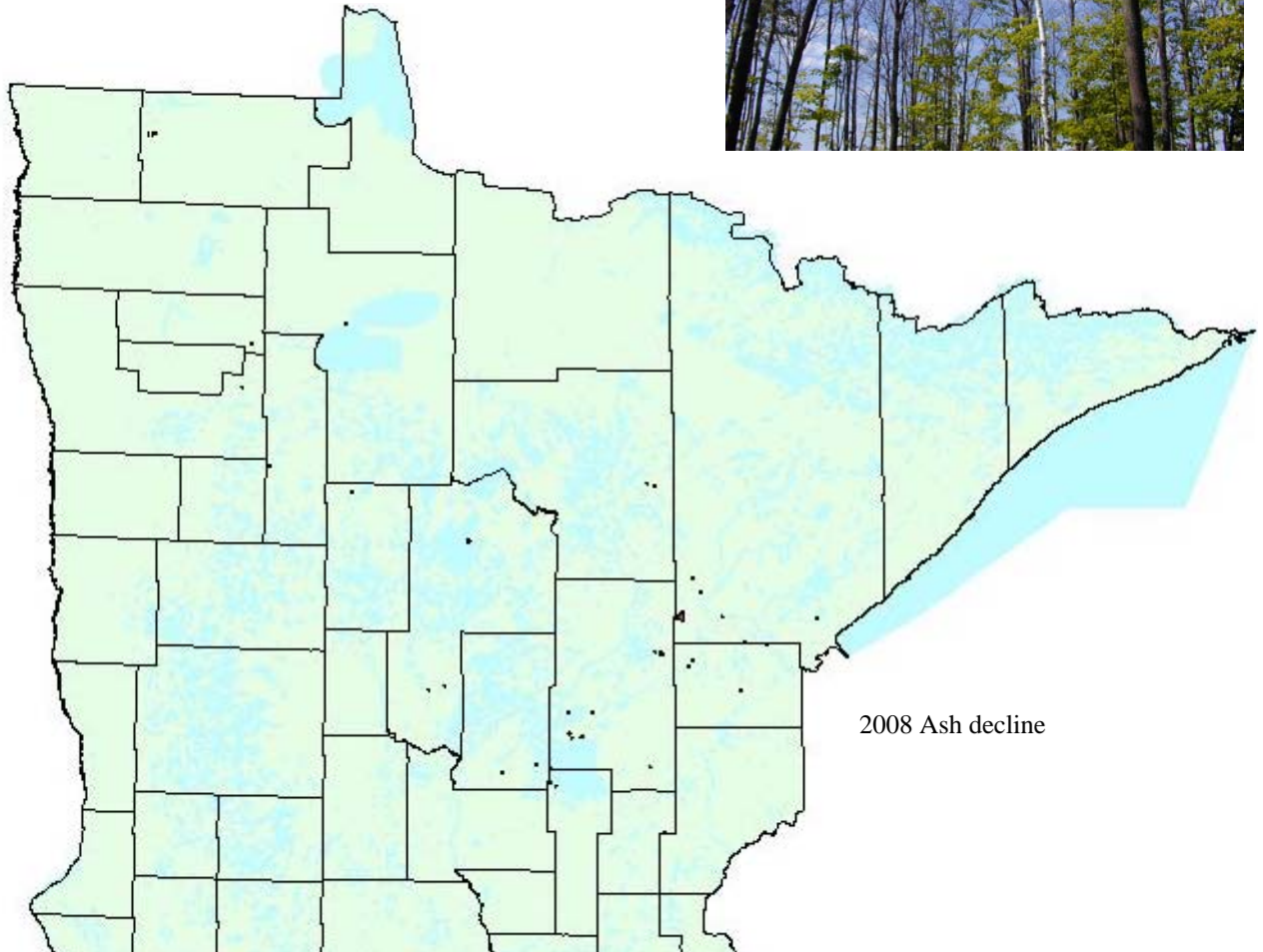
2008 Gypsy Moth Pheromone Trapping Results by County:



# Abiotics and Declines

## Ash decline

Fluctuating water tables during the last few years is thought to be playing a major role in ash decline in flood-plain plant communities. There are a number of other factors involved with some variation from site to site. Ash decline occurred on 2,274 acres, a 4-fold decrease from last year's acreage.



## Dieback and mortality of aspen: Cause(s) unknown

For the past several years, aerial survey crews have detected thousands of acres of defoliation, discoloration, dieback and mortality of aspen. Again this year, defoliation and dieback were mapped. See table below.

Dieback is the most common symptom but tree mortality has also occurred. Mortality can vary from scattered trees throughout a stand to patches of 30 to 40 dead trees scattered through stands. Trees with dieback also exhibited small off color (yellowish) foliage in the live parts of the crown. Serpentine galleries were abundant under the bark on dead trees as well as on trees with extensive crown dieback. *Agrilus*-like larvae were common in serpentine galleries in recently dead trees and in trees with extensive dieback. These are assumed to be *Agrilus liragus* (bronze poplar borer) but further work is needed to confirm this.

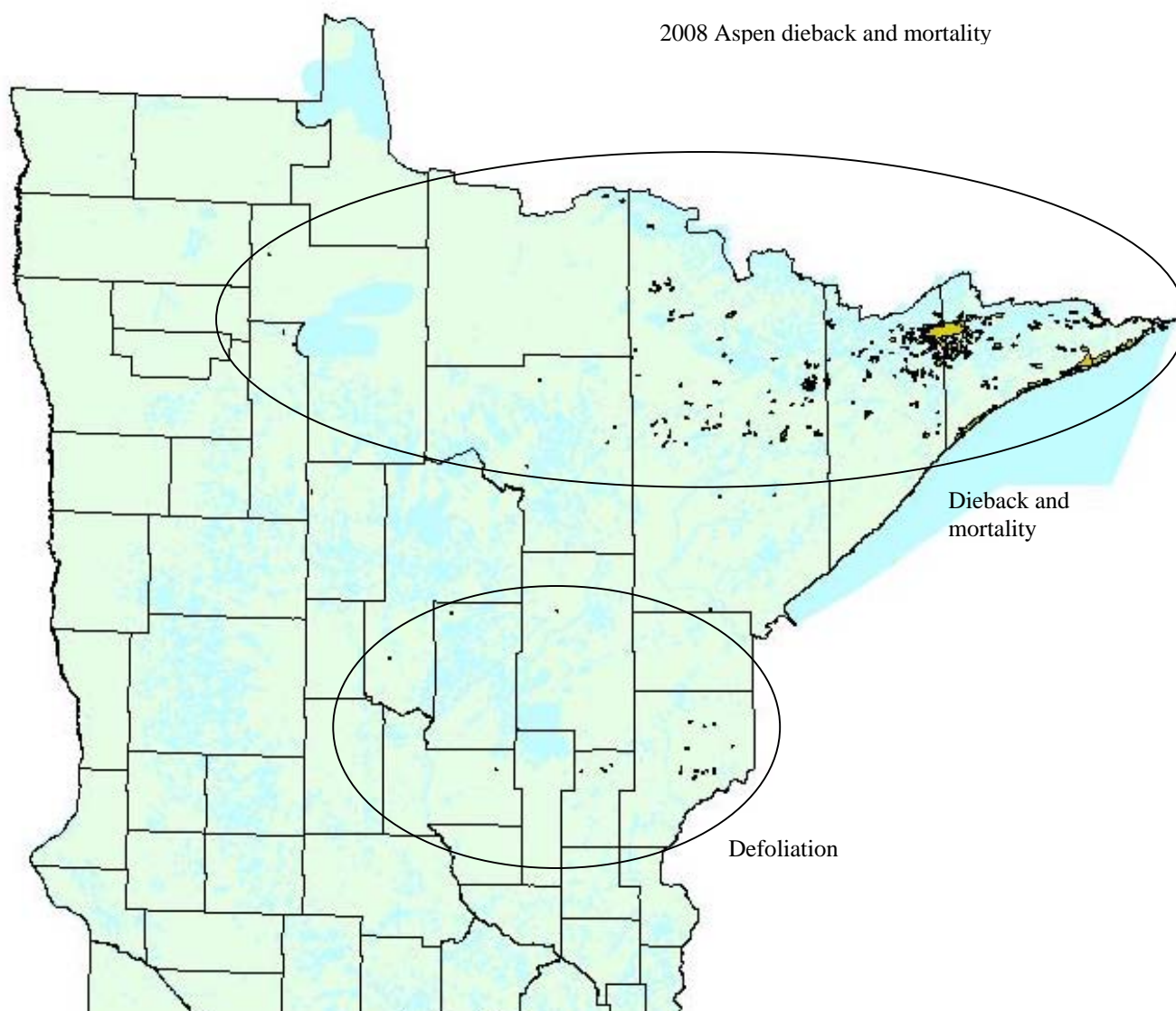
Poplar borer, *Saperda calcarata*, populations appear to have increased in some locations but are much less common than the *Agrilus*. So far *Armillaria* has not been found in the root collar area of examined trees.

Most of the dieback and mortality was mapped in northern St Louis, Lake and Cook Counties in northeastern Minnesota. Severe droughts occurred in these areas in 2002 and 2003 and again in 2006 and 2007. Much of the aspen in these areas also experienced 2 to 3 years of heavy forest tent caterpillar defoliation in 2001-2003. It is likely the dead and dying aspen were stressed trees being attacked by secondary pests.

Acres of aspen damage by symptom, causal agents unknown. 2004 to 2008				
	Defoliation	Mortality	Discoloration	Dieback
2004	14,570	27730	0	24,356
2005	407,606	658	423	4,381
2006	2,217	635	0	1,309
2007	73,284	613	0	16,666
2008	5,598	85	570	151,022

To verify the identification of the larvae as *Agrilus liragus*, dying trees with evidence of insects in the trunks were cut down in two stands in Sec 36-T64N-R3E along Otter Lake Road in Cook County on July 22, 2008. These were stored in an unheated garage until January 22, 2009 at which time they were placed in a rearing box in a heated building. Any insects that emerge will be collected and identified.

Further study will be required to look at causes and extent of damage to determine whether the aspen dieback and mortality continue to intensify in these locations.





# Hail injury

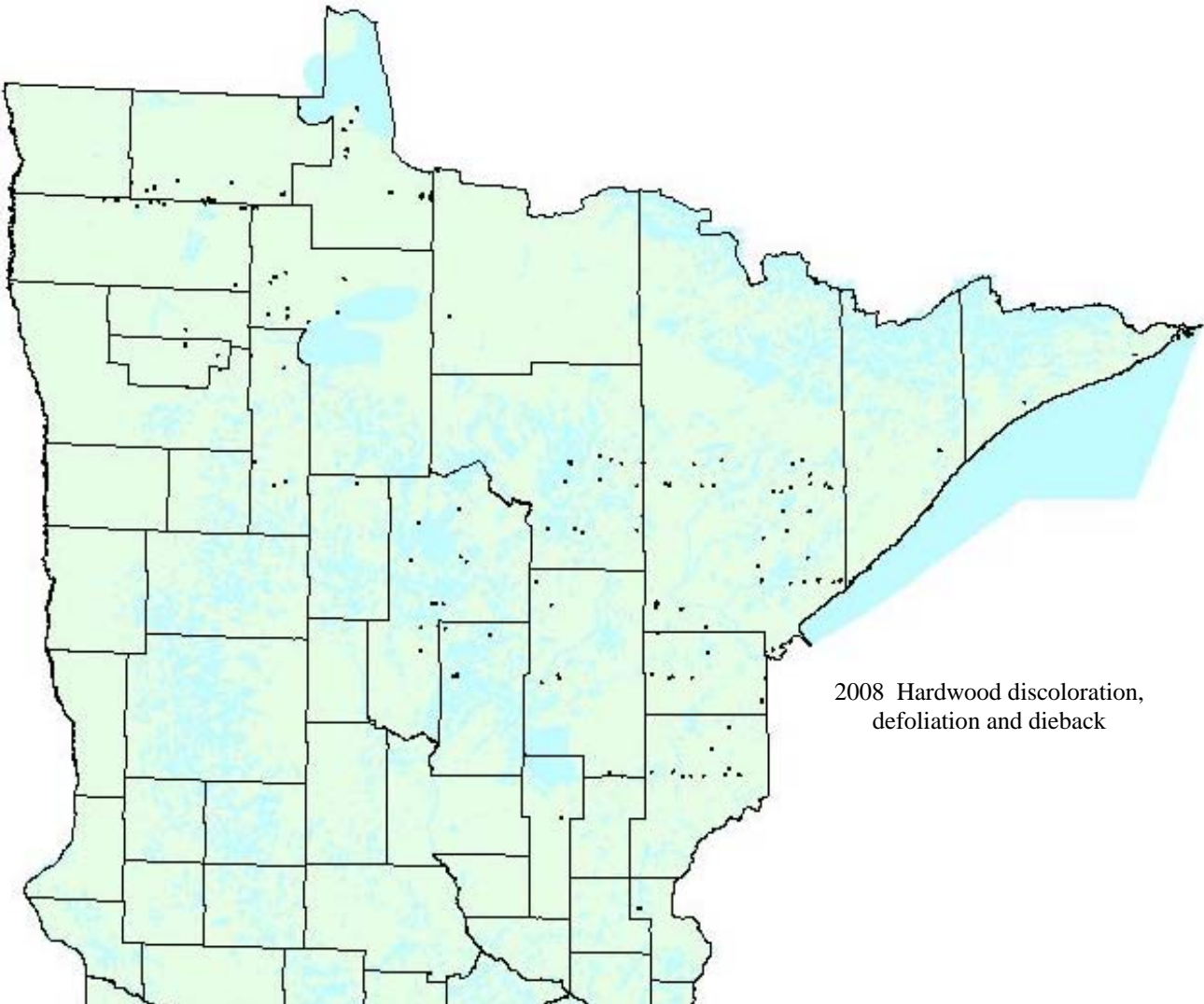
The land manager noticed dark staining on north and northwest side of aspen trees along with cankers and was concerned about tree health and long-term consequences. Hail injured 10 to 15 year old aspen in sec 9-T62N-R21W east of Togo. Investigation found many impact wounds from hail on the aspen as well as on other tree species on the site. It appeared that *Hypoxylon* had entered some of the wounds which caused further damage.

# Hardwood discoloration, defoliation and dieback : Cause(s) unknown

18,678 acres of hardwoods had dieback symptoms this year. Most foresters feel that drought over the past three growing seasons has played an important role in hardwood dieback by reducing tree vigor. Again this year, biotic agents were not found to be causing dieback during ground-truthing.

Discoloration and defoliation occurred on 2,937 and 1,349 acres, respectively. Neither insects nor pathogens were found to be causing symptoms during late summer site visits during ground-truthing of the aerial survey.

<i>Acres of symptomatic hardwoods, cause unknown in 2008.</i>	
Defoliation	2937
Mortality	212
Discoloration	1349
Dieback	18678
Other	187



## Incidental insects and pathogens

<i>Species</i>	<i>Location</i>	<i>Notes</i>
Aspen flea beetles <i>Ciepidodera nana</i>	East side St Louis Co, along Hwy 16	Leaving small holes in aspen leaves on branch tips.
Springtails	Near Lake Vermillion St Louis Co.	Entryway tile floor covered with them.
Springtails	Jay Cooke St Park, Carlton Co.	Campers asking questions about springtails in tents.
Dog vomit fungus <i>Fuligo septica</i>	Itasca Co.	Found in lawn. A slime mold.
Yellow-necked caterpillar <i>Datana ministria</i>	Lake Co.	Bothering rednecks in Two Harbors.

## Phenology 2008

<i>Date</i>	<i>Event/ Observation</i>	<i>Location</i>
5 April	24 inches of snow in Grand Rapids; 32 inches in Virginia (St. Louis Co.).	Itasca Co.
14 May	Aspen leafed out. This is about 2 weeks behind the normal date (May 2).	Itasca Co.
22 May	Forest tent caterpillars are in 1 <sup>st</sup> instar (2mm long). On basswood leaves. Birch Lake.	Todd Co.
28 May	Linden looper 2-4mm long on oaks. Near Madden's Golf Course.	Crow Wing Co.
	Peak of dandelion, marsh marigold, pussy toes bloom. Past peak for <i>Amelanchier</i> . Maple leaves are 1 and ½ inch long, red oak 1 inch and big tooth aspen has just broken bud.	Northern Aitkin Co.
28 May	Large-flowered Trillium in bloom. Hoary puccoon just beginning to bloom, yet jack pine staminate cones are too small to check for jack pine budworm larvae.	Cass Co.
1 June	Aspen seed dispersal today.	Itasca Co.
3 June	Linden looper are mostly 10mm long with some as long as 15mm. Fall cankerworms are 5-10 mm long. Near Baxter.	Cass Co.
3 June	FTC in Meeker County.	Meeker Co.
10 June	No pine pollen is being shed yet (2 weeks late). Young ash trees are budding out. <i>Trillium</i> are fading, some marsh marigolds still blooming. In bloom: chokecherry, cotton grass, hoary puccoon, <i>Trientalis</i> , mountain rice grass, apples and some pin cherries.	Cass and Beltrami Cos.
16 June	Lots of fall cankerworms and very few linden loopers. Cankerworms > 1 inch long, will spin down if disturbed and some starting to pupate.	Crow Wing Co.
18 June	Close to peak pollen shed of Scots and red pines. Leaves on mature ash trees are out. Bigtooth aspen leaves still expanding. Lilacs and tulips are still blooming. In bloom: goat's beard, crowfoot, yellow water lilies in Mississippi River, pink honeysuckle, high bush cranberry, and beginning of oxeye daisies. Dandelions are fluff balls.	Itasca and Cass Cos.
18 June	Same as above. In bloom: hoary puccoon, columbine, red-osier dogwood and Canada mayflower.	Beltrami Co.
18 June	Noted a few FTC near Big Sandy Lake. Near Mille Lacs Lake: observed a few FTC (13-33 mm long) and very few linden loopers (18mm long) FTC on basswood and bur oak. Linden loopers on basswood. Defoliation of trees is None to Trace. Lots of fish flies on shrubs.	Crow Wing and Aitkin Cos.
19 June	FTC are 1 and ½ inches long in Alexandria.	Douglas Co.
19 June	Abundant linden loopers and fall cankerworms on shrubs and hardwood trees. Baxter. A few FTC observed in Brainerd.	Crow Wing Co.
26 June	Lots of FTC everywhere in Ottertail Co. Some linden loopers and green fruitworms on basswoods.	Ottertail Co.
8 July	Jack pine budworm is 30% pupated at Esquagama Lake. A few, scattered trees have moderate to heavy defoliation, for example, N47.44439 W92.37395.	St. Louis Co.
8 July	Spruce budworm in 100% pupated with about 10% having emerged. N47.48721 W92.39181.	St. Louis Co.
17 October	Linden looper moths (males) caught near outdoor lights. Brainerd.	Crow Wing Co.
4 Novemb.	On caragena, a single flightless moth (probably female cankerworm) was found.	Itasca Co.

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## Adaptive Forest Management Projects

DNR division directors Epperly, Pfannmuller, and Schad directed staff to establish a set of “adaptive forest management projects” over the next 2 years. This directive came as a follow up to the regional “Forest Management for the Future” workshops held in winter 2008. “Adaptive forest management projects” aim to find ways to improve sustainable forest management in the face of emerging challenges such as climate change, invasive species, changing demographics, and a globalizing economy. Each project will develop a core set of sustainability questions along with management and monitoring actions designed to answer those questions. The projects will provide focused, on-the-ground forums for cooperation and coordination among DNR disciplines and staff at all levels (e.g., area, regional, and division director levels).

Each of the Region Forest Health Specialists were assigned to the teams along with Regional Forest Silviculturists, Regional Forest Ecologists, Regional Plant Ecologists and Regional Wildlife Forest Coordinator. Here are the Regional project plans. Projects for Regions 2 and 3 will be reported in the next Annual Report.

The NW Regional Implementation Team, Jana Albers, Mike Locke, Becky Marty, Erik Thorson, & Harvey Tjader, selected two projects on which to apply adaptive forest management practices and evaluate their effectiveness. The two projects address critical issues in our region and are in geographically dissimilar areas. We will explore two hypotheses relative to natural jack pine regeneration, and one relative to variable density thinning in young red pine stands. Site-specific objectives will be designed and applied at each selected site.

### A. Jack Pine Natural Regeneration Project

**Background:** All three Divisions have interests and concerns related to jack pine management in north-central Minnesota. Past management efforts have not been particularly successful in establishing young jack pine stands and new approaches have been suggested that should be evaluated. Our long-term goal is to evaluate methods to re-establish jack pine in woodland communities of the central floristic region. We plan to build upon efforts from the jack pine SWAT team, MFRC North Central Landscape Committee, and SFRMP planning.

**Proposal:** The team plans to explore three key issues related to natural jack pine regeneration, that fall under two main hypotheses.

**Objective 1:** A site will become adequately stocked by year ten following treatment from a persistent viable seed source. This will be addressed by (1) investigating the effect of seedbed type on regeneration success over time in the presence of natural seed sources. Various seedbeds will be evaluated including ones with exposed mineral soil, those created by traditional harvests, and ones dominated by prairie grasses/forbs. And (2) evaluating the effectiveness of various seed sources including scattered seed trees, clumps, adjacent stands, and aerial seeding. Information for all of these will be collected through regular regeneration surveys and seedbed assessments.

**Objective 2:** Mechanical treatments (such as roller chopping) can adequately control brush and reduce sod formation compared to traditional herbicide treatments. Annual surveys will be conducted to document the changes in abundance and cover of brush and sod-forming grasses on the sites.

**Study area and sites:** Suitable FDC23 and FDC24 sites will be chosen primarily on state lands in the Chippewa Plains and Pine Moraines-Outwash Plains subsections. Two sites have been selected and others will be chosen through resource manager suggestions and data queries. These sites will include areas where treatments can be set up next to good seed sources. They will also include those with past management treatments and good documentation that compliment this project.

### B. Red Pine Variable Density Thinning Project

**Background:** A variety of DNR staff are interested in the management of LUP lands, especially the use of active forest management to help meet wildlife habitat goals. In the past, area staff has used non-traditional pine management approaches to improve wildlife habitat and enhance biodiversity. Palik has studied management of older red pine plantations in the Red Lake WMA area, but the current interest and opportunities exist in thinning younger red pine plantations on LUP lands.

**Proposal:** The team plans to use variable density thinning as a first entry in young red pine plantations.

**Objectives:** Increase horizontal and vertical stand structure, and general biodiversity, while maintaining similar or increased fiber production, as compared to standard uniform thinning. Variable density thinning practices will be implemented to achieve the objectives, as described by Franklin and others. Information for stand structure and biodiversity analysis will be collected through relevés. Resource Assessment will be asked to do growth and volume projections.

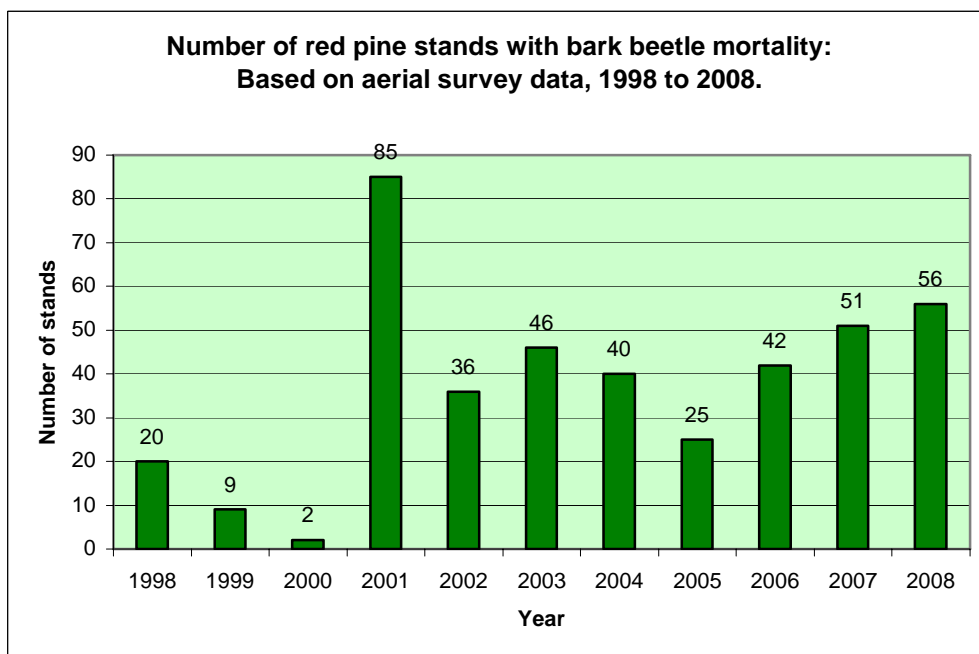
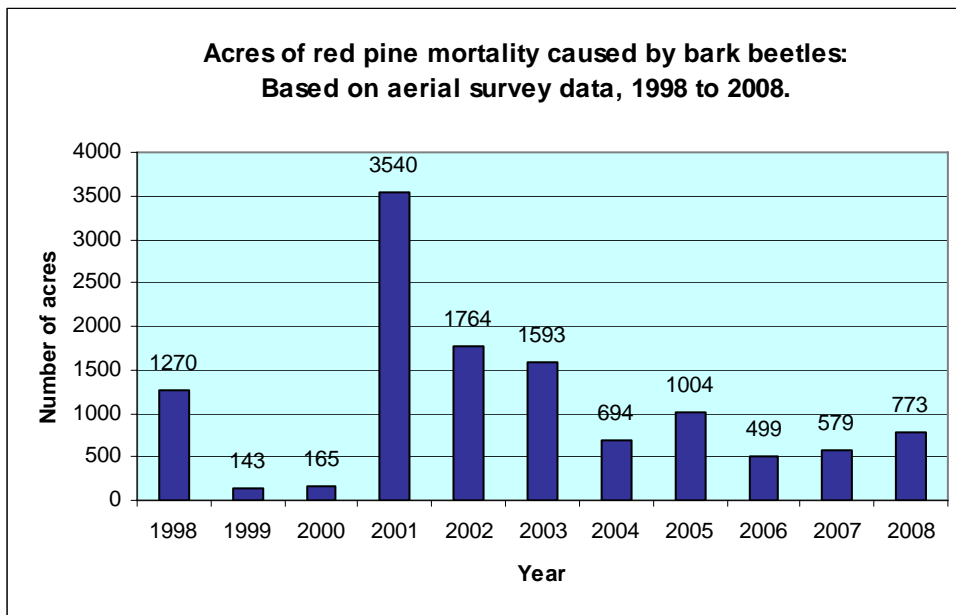
**Study area and sites:** There are currently several hundred acres of young red pine plantations on LUP lands in need of a first thinning. These red pine plantations likely occur on FDN12 and FDN33 native plant communities. One site has been chosen and others will come from Baudette and Warroad Forestry’s Annual Stand Exam Lists and Annual Plan Additions so they are compatible with Agassiz Lowlands SFRMP.

## Bark beetles of red pines: Outbreak history from 1995 to 2008

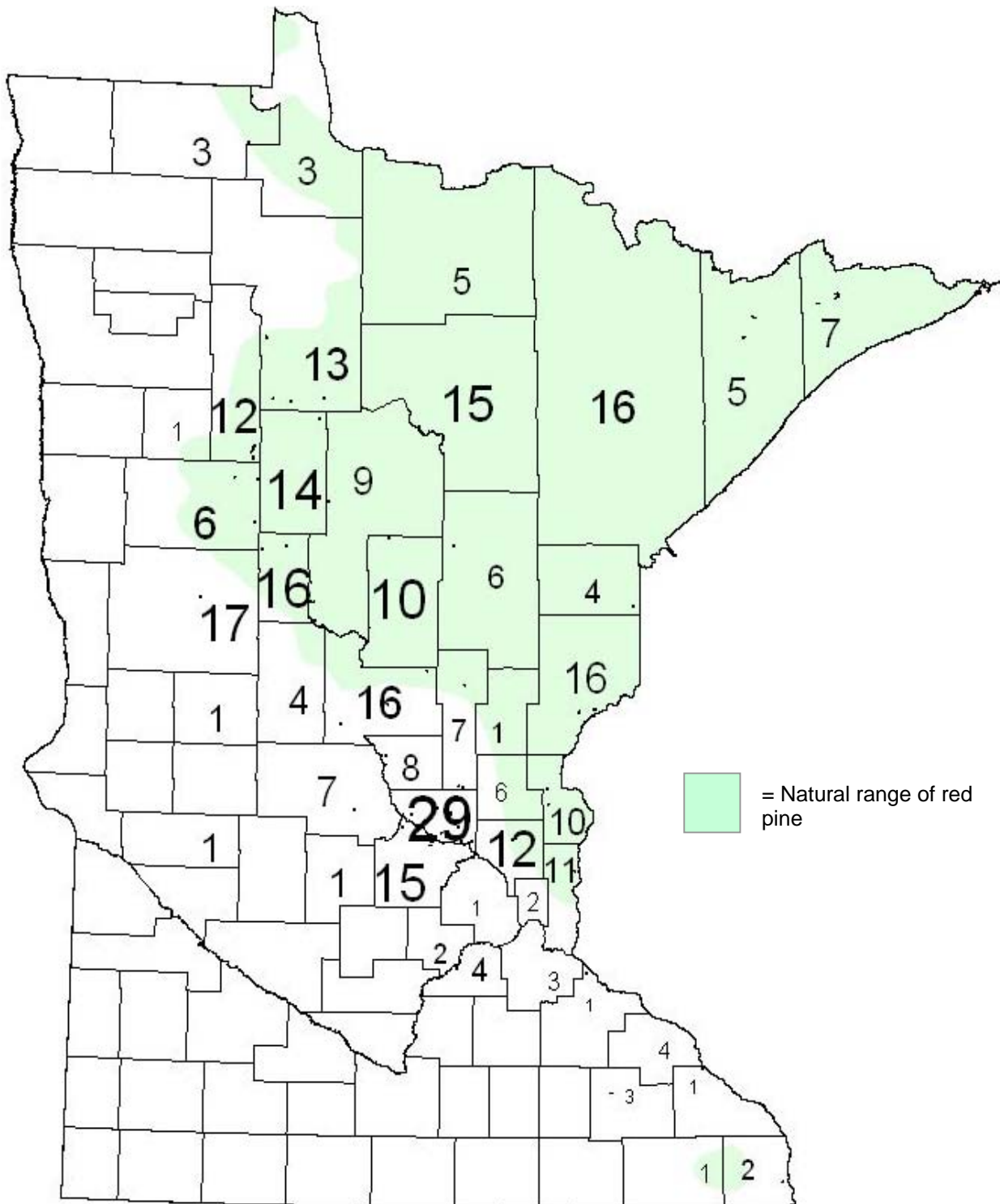
The serious and prolonged drought from the summer of 2006 to the fall of 2007 created stress conditions favorable for bark beetle build-up and damage in 2007 and 2008. Aerial survey data bears this idea out. Due to the timing of aerial survey, not all bark beetle infestations are mapped, especially small or incipient infestations. These are usually detected and informally reported by field foresters.

For the past eleven years, bark beetles have averaged 1,093 acres of mortality per year and, in 2008, bark beetle mortality occurred on 773 acres. Similarly, bark beetles have infested and caused mortality in an average of 37 stands per year. This year, mortality was mapped on 56 stands. See charts.

On a geographical basis, red pine stands located outside the natural range of red pine and those near the edge of the natural range seem to have higher incidences of bark beetle-caused mortality. See map.



Number of bark beetle outbreaks by county:  
1998 to 2008 Aerial survey data.  
All ownerships.





## **Bark beetles: New sales specifications for pine thinnings**

In October, changes were made in the Division of Forestry's Timber Sale Module that affected pine thinning sales specifications: three new statements replace older ones. They are:

### **TSM Category: Season of Operations**

1. For all pine thinnings, the Timber Sale Administrator (TSA) has authority to delay the start-up of operations or halt all operations until unacceptable damage due to bark slippage and soil conditions conducive to root damage are mitigated, or the risk of bark beetle infestations are reduced.
2. For pine thinning operations from August 1 to March 10<sup>th</sup>, or the onset of spring road restrictions, all cut pine products and all pine slash >3 inches in diameter must be hauled from the pine sale area or destroyed (debarked, chipped, or burned) before spring road restrictions are implemented.
3. For pine thinning operations from March 11<sup>th</sup> to July 31<sup>st</sup>, all cut pine products and all pine slash >3 inches in diameter must be hauled from the pine sale area or destroyed (debarked, chipped, or burned) within 3 weeks of their creation.

We anticipate that foresters will use the new specifications. In addition to this, foresters have more latitude in where and how to use them:

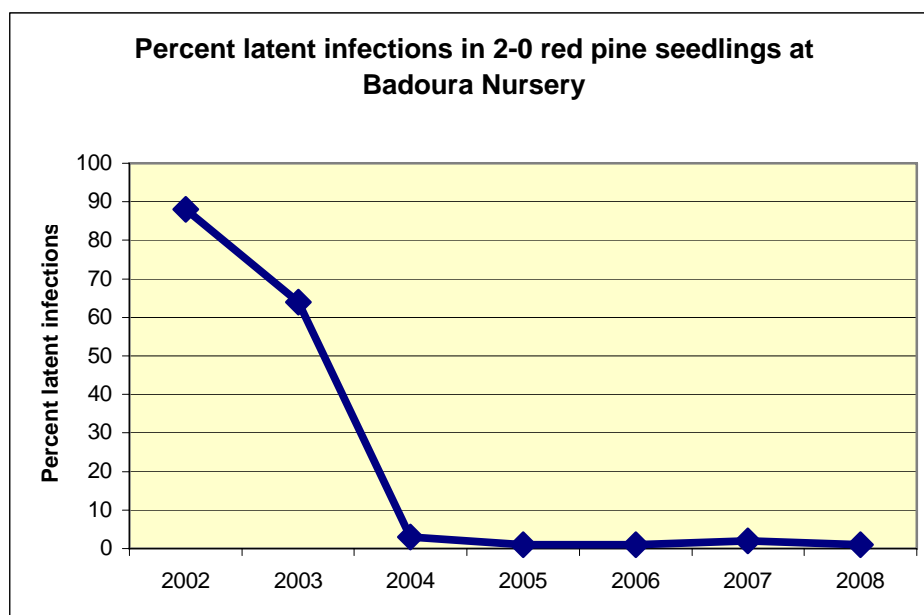
- Thinnings can occur year-round; there are no mandatory black-out periods.
- The use of new sale specifications is optional; they are not mandatory on all pine sales.
- Foresters can still customize specifications to reflect local conditions and timber and other values.
- Specifications can still be used to cover pine bark beetles, root damage and bark slippage that can develop from or occur during pine thinning operations.

## Latent *Diplodia* infections in red pine seedlings from Badoura and Gen. Andrews Nurseries in 2008

In an effort to monitor the amount of latent *Diplodia* infections that occur in red pine seedlings produced by the State Nurseries, surveys were completed at Badoura and Gen. Andrews Nurseries. The 2-0 and 3-0 seedlings were sampled in a systematic design and were assayed for the presence of *Diplodia* spp. by Dr. Stanosz's lab at the University of Wisconsin.

From Badoura Nursery, 260 seedlings were collected on October 20<sup>th</sup>; 120 were 2-0 seedlings and 140 were 3-0 seedlings.

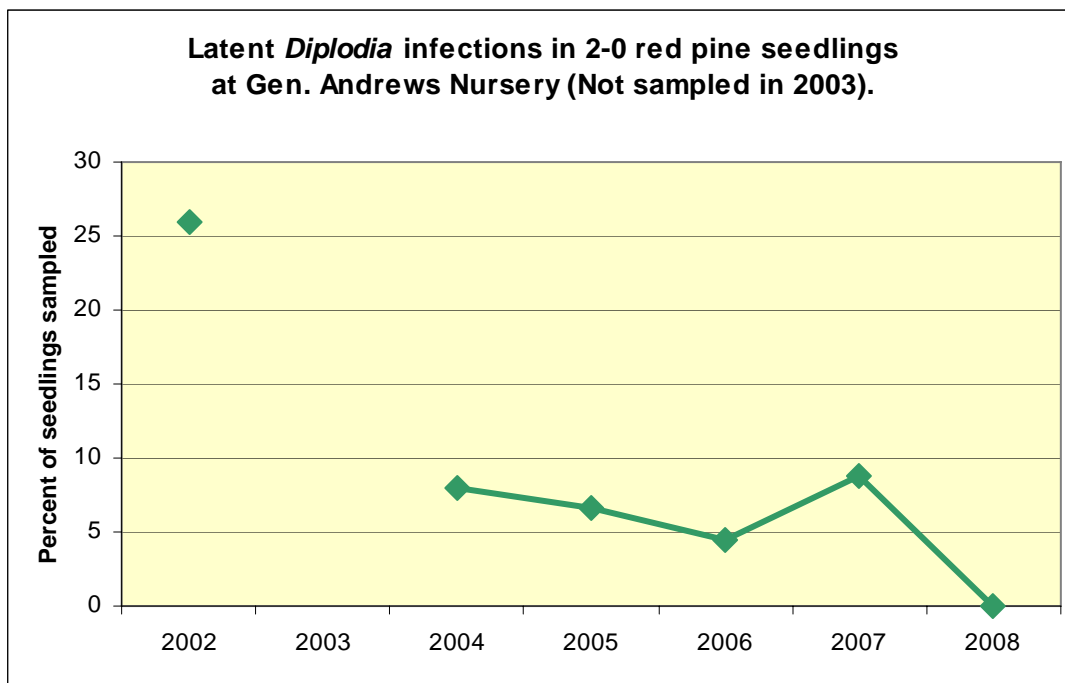
Badoura	# positive	# sampled	% infected
2-0	1	120	0.8
3-0	5	140	2.8
All RP	6	260	2.3



Badoura Nursery: 260 seedlings collected and assayed						
Field	Beds sampled and location in bed	Number of seedlings assayed	Seedling size and season of sowing	Location of positive seedlings	Total # positive	Ave. percent latent infection per seedling size
A-7	11N, 14S	10	3-0 spring			2.8
A-10	1N,3M,6S,8N,10M	25	3-0 spring			
A-12	9N,11M, 14S	15	3-0 spring	14S	1	
B-3	4N,7M,9S	15	3-0 fall			
B-7	1N,3M,5S,8N,10M, 12S,14N,16M,19S, 21N	50	3-0 fall	3M	1	
				14N	1	
				21N	1	
B-10	15N,17M,19S, 22N	20	3-0 spring	22N	1	0.8
C-6	1N,3M,5S	15	2-0 fall	5S	1	
C-7	3M,5S,8N,10M, 12S,14N,16M,19S, 21N	45	2-0 fall			
C-8	1N,3M,5S,8N,10M, 12S,14N,16M,19S, 21N	50	2-0 spring			
C-10	2M,4S	10	2-0 spring			2.3
Totals		260			6	

From Gen. Andrews Nursery, 240 seedlings were collected on October 21<sup>st</sup>; 135 were 2-0 seedlings and 105 were 3-0 seedlings.

Gen. Andrews	# positive	# sampled	% infected
2-0	0	135	0
3-0	12	105	11.4
All RP	12	240	5.0



General Andrews Nursery: 240 seedlings collected and assayed						
Field	Beds sampled and location	Number of seedlings assayed	Seedling size and season of sowing	Location of positive seedlings	Total # positive	Ave. percent latent infection per field
C-4	2N,4M,14S,16M,18N,20S,22M,24N	40	3-0	14S	3	11.4
				16M	1	
				18N	1	
				24N	1	
C-5	1N,3M,5S,7N,11M,13S,15N,17M,19S,21N,23N	55	3-0	1N	1	11.4
				3M	1	
				7N	1	
				15N	1	
				23N	2	
E-8	1E,3M,5W,7E,9M,11W,13E,15M,17W,19E,21M	55	2-0 fall		0	0
	23W,25E,27M,29W,31E,33M	30	2-0 spring			
E-6	17E,19M,21W,23E,25M,27W	30	2-0 spring			
	29E,31M,33W,35E	20	2-0 fall			
Totals						5.0

## Red pine outplanting study for stock derived from Badoura Nursery: Planted in Region 1 during 2008

As a part of our on-going effort to assure red pine regeneration from bare-root seedlings, we did a small *Diplodia* mortality survey in Region 1 during the late fall of 2008. In 2008, ten plantations were chosen and visited by the Region Forest Health Specialist. Plots were tallied and dead seedlings were dug up and brought to the lab for further examination. In the lab, each dead seedling was inspected for the presence of *Diplodia* pycnidia with conidia and other causes of damage.

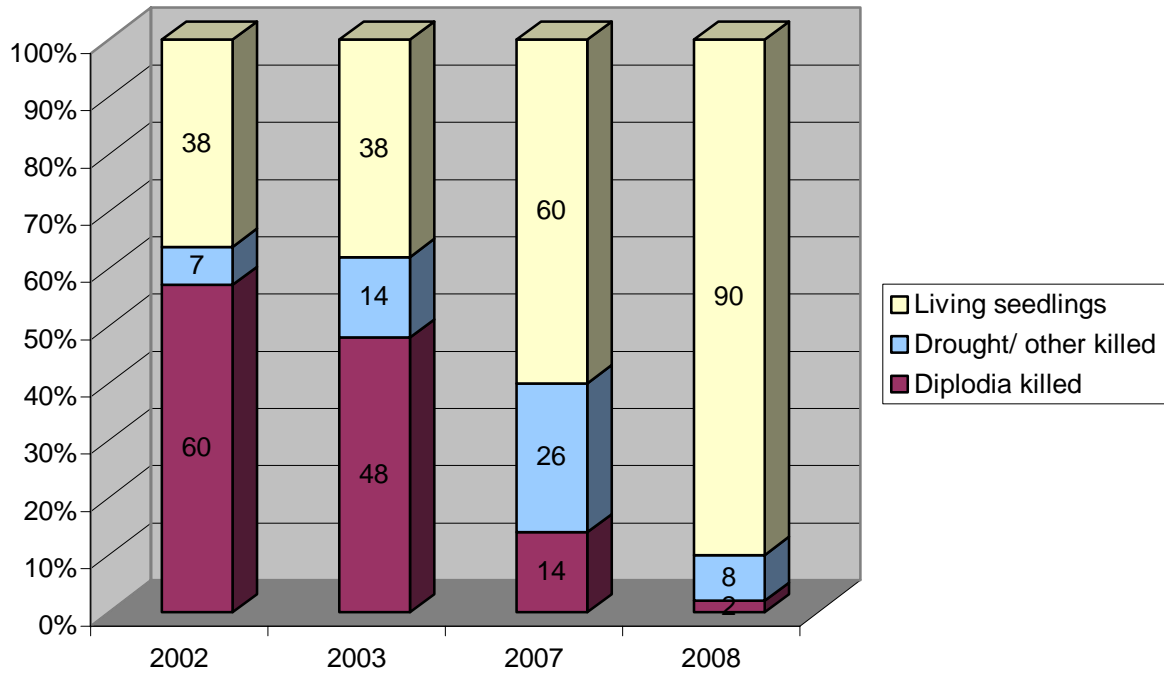
Of the 901 seedlings tallied on the ten sites, only 89 seedlings were dead. This amounts to 9.9% mortality of the tallied seedlings. *Diplodia* pycnidia with spores were found on 22 of the dead seedlings (2.4%) and 67 seedlings (7.5%) died from other causes. See table below. Other mortality causes included large root collar or stem wounds and insect mining of inner bark in root collars and/ or stems. Only one stem was obviously J-rooted.

Red pine outplanting study for stock derived from Badoura Nursery: Planted in Region 1 during 2008										
Area and Plantation	Acres	Date planted	Number of trees/acre	Date lifted	Seed source	Seedling Size	Total number seedlings in plots	Number dead seedlings	Number dead seedlings with <i>Diplodia</i>	Number dead seedlings due to other causes
<b>Bemidji Area</b>										
t14735w1020074	34	5/15/08	900	5/15/08	104	2-0	90	22	1	21
t14834w1310079	16	5/14/08	1000	5/9/08	104	2-0	100	2	1	1
t14835w1350044	12	5/14/08	890	5/9/08	104	2-0	89	1	0	1
t14734w1070028	24	5/14/08	930	5/9/08	104	2-0	93	2	0	2
<b>Park Rapids</b>										
36-140-32	18	5/1/08	920	-	102	2-0	92	25	9	16
2-139-37	19	5/8/08	1050	5/6/08	104	2-0	105	4	4	0
36-140-33 north	32	4/30/08	810	-	102	2-0	81	9	3	6
26-138-33	4	5/3/08	820	Freezer	102	2-0	82	10	1	9
27-141-36	39	5/5/08	840	Freezer	102	2-0	84	5	1	4
36-140-33 south	23	4/30/08	850	-	102	2-0	85	9	2	7
Average							81	8.9	2.2	6.7
<b>Percent of sampled trees</b>								<b>9.9</b>	<b>2.4</b>	<b>7.5</b>

Similar studies were conducted earlier in 2002, 2003 and 2007, however, droughty summer weather was much more severe in those three years than in 2008. Seedling survival continued to increase in 2008 and the level of *Diplodia* caused mortality also continued to decrease. See chart below. Levels of *Diplodia* latency in red pine stock to be planted in 2008 averaged 2.1%. The finding of 2.4% losses due to *Diplodia* in pine plantations this year meshes nicely with expected mortality due to latent infections in our red pine seedling stock.



**Comparison of mortality causes in new red pine plantations**



# Distribution of *Diplodia pinea* and *D. scrobiculata* in red and jack pine forests of Minnesota

J. Albers (1), D. R. Smith (2), G. R. Stanosz (2)

(1) Division of Forestry, Minnesota Department of Natural Resources, Grand Rapids, MN;  
(2) Department of Plant Pathology, University of Wisconsin-Madison.

## INTRODUCTION

*Diplodia* shoot blight, canker, and collar rot diseases have severely damaged native red pine (*Pinus resinosa*) and jack pine (*P. banksiana*) trees in nurseries, plantations, and natural forests of the Great Lakes region of the USA. Two similar and closely related fungi, *Diplodia pinea* and *D. scrobiculata*, are associated with damage to each species in this region. Each pathogen can infect pines directly or through wounds, rapidly colonize susceptible organs, and sporulate abundantly on killed needles, stems, and cones.



Fig. 1. Crown dieback resulting from *Diplodia* shoot blight and cankers on mature red pines.

*Diplodia pinea* and *D. scrobiculata* pathogens have been widely collected in this region. These two fungi also are reported to co-occur in the same stands, individual trees, and even single shoots. However, the landscape scale distribution and abundance of *D. pinea* and *D. scrobiculata* in this region has not been studied.

Munkc (2008) demonstrated the utility of cones from the forest floor or tree crowns as a tool for use in surveys for these fungi. This survey was undertaken to examine the geographic distribution and relative abundance of *D. pinea* and *D. scrobiculata* in red pine and jack pine forests in Minnesota.

## METHODS

Mature, naturally regenerated or planted red and jack pine stands were selected to represent a range of conditions over much of their commercially important range in Minnesota. 100 cones were collected from each of 109 red pine stands and 28 jack pine stands. In each stand, arbitrarily selected cones were collected from the forest floor within a transect approximately 20 m wide by 200 m long (25 in each of four 50-m-long sections of the transect). Cones were stored in paper bags until examination using a dissecting microscope for pycnidia. If none were found the cone was considered negative. If pycnidia were found, slides were made and the contents from up to five pycnidia per cone were examined using a compound microscope. If conidia typical of those of *D. pinea* or *D. scrobiculata* were found, the cone was considered positive for *Diplodia* spp.

Up to 10 arbitrarily selected positive cones per stand (if available) were used for determination of the *Diplodia* species present. These cones were stored at -20 C until processing. Each of these cones was individually washed in a beaker with deionized water plus Tween 80 (2 drops l<sup>-1</sup>) on a rotary shaker at 110 rpm for 1 to 1.5 hr. Cones were then removed from beakers and the debris (including conidia) allowed to settle at least 5 min. 100 µl liquid and debris were removed from the bottom of the beaker and placed in a 1.5 ml tube containing 500 µl potato dextrose broth with streptomycin sulfate (100 mg l<sup>-1</sup>). Two cultures were started for each cone and were incubated for 7-8 days. DNA was extracted from mycelium immediately or after storage of cultures at -20°C. *Diplodia pinea* and *D. scrobiculata* were then identified by amplification with species-specific mt SSU rDNA primer pairs DpF and BotR and DsF and BotR, respectively (Smith and Stanosz 2006).

## RESULTS

Pycnidia were abundant on scales of many cones (Fig. 2). Positive cones (based on visual inspection for *Diplodia* spp. pycnidia and conidia) were obtained from 106 of 109 red pine stands and from all 28 jack pine stands (Fig 3). Mean frequencies of positive red pine and jack pine cones respectively, were 27% (range 0-84%) and 12% (range 2-41%).

The frequency of detection of either *D. pinea* or *D. scrobiculata* varied by location and host species (Figs. 3, 4, and 5; Table 1). *D. pinea* was detected from cones collected at 102 of 109 red pine stands (69% of all red pine cones tested), and 18 of 28 jack pine stands (18% of all jack pine cones tested). In contrast, *D. scrobiculata* was detected from cones collected at only 26 of 109 red pine stands (7% of all red pine cones tested), but 26 of 28 jack pine stands (79% of all jack pine cones tested). These fungi sometimes co-occurred in stands of either host, and occasionally both were detected from individual cones of either host.

Table 1. Numbers (and percentages) of red pine and jack pine cones collected from the forest floor of stands in Minnesota from which *D. pinea* (Dp) and/or *D. scrobiculata* (Ds) were confirmed.

Host	Number of cones tested	Only Dp confirmed	Only Ds confirmed	Both confirmed	Neither confirmed
Red pine	941	614 (65%)	31 (3%)	35 (4%)	261 (28%)
Jack pine	202	21 (10%)	144 (71%)	16 (8%)	21 (10%)

All tested cones were positive for presence of *Diplodia* spp. based on visual inspection for pycnidia and conidia. Species-specific mt SSU rDNA primers were used to confirm the identity of the pathogen(s) present.



Fig. 2. Abundant pycnidia of *Diplodia* spp. emerging from the end of a pine cone scale.

Fig. 3. Percentages of 100 cones per stand that bore *Diplodia* spp. pycnidia (inset indicates location of Minnesota).

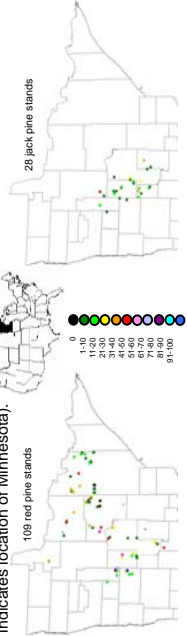


Fig. 4. Percentages of up to 10 cones per stand from which *D. pinea* was confirmed.

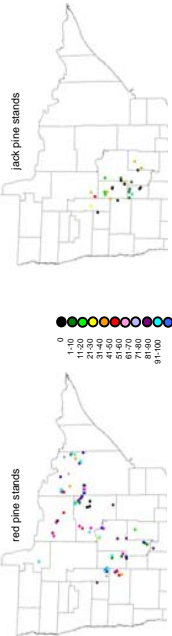
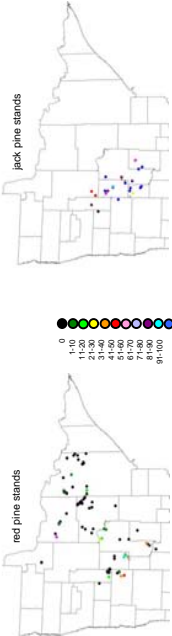


Fig. 5. Percentages of up to 10 cones per stand from which *D. scrobiculata* was confirmed.



## CONCLUSIONS and IMPLICATIONS

Although cones positive for *Diplodia* spp. were collected from almost all stands, the percentages of positive cones varied greatly from stand to stand, for both red pine and jack pine. This suggests that the abundance of *Diplodia* spp. may differ from location to location for either host species.

Both *D. pinea* and *D. scrobiculata* are distributed across the study area, but not uniformly. A stand may be occupied by one pathogen species, but not the other. Differences in host association are apparent, with *D. pinea* much more frequently detected from red pine stands and cones and *D. scrobiculata* from jack pine stands and cones.

Knowledge of the identity of the pathogen(s) present and their relative abundance may help forest managers predict the risks posed by *D. pinea* and *D. scrobiculata* to health of red pine and jack pine stands.

## REFERENCES

Munkc, I.; 2008. Influence of pine host species, geographic location, and site history on inoculum produced by *Diplodia pinea* and *D. scrobiculata* . Ph.D. thesis, Dept. Plant Pathology, Univ. Wisconsin-Madison.  
Smith, D.R., and Stanosz, G.R. 2006. A species-specific PCR assay for detection of *Diplodia pinea* and *D. scrobiculata* in dead red and jack pines with collar rot symptoms. Plant Disease 90:307-313.

## **Emerald ash borer: Minnesota agencies train volunteers to help educate and identify emerald ash borer**

Emerald ash borer (EAB) is a wood-boring beetle from Asia that has killed millions of ash trees in Michigan as well as nine other states and in Ontario, Canada. While detection surveys in Minnesota have not found EAB so far, the insect is notoriously difficult to find in the beginning stages of an infestation and can easily be moved to new areas in firewood or other ash material. If EAB has already been or is introduced to Minnesota, it will be important to find it as soon as possible.

In Minnesota many ash trees were planted in urban and rural areas to replace elm trees killed by Dutch elm disease in the 1970's. Minnesota also ranks among the top states in the country for ash abundance on forestland, and the loss of ash in Minnesota will be devastating - economically, environmentally and socially.

In March 2008, the University of Minnesota Extension Service, Minnesota Department of Agriculture, and the Minnesota Department of Natural Resources trained nearly 180 volunteers to help protect Minnesota's forests and landscapes by serving as "EAB First Detectors." The role of an EAB First Detector is to serve as a public contact for EAB information and to help resolve reports of potential EAB infestations in Minnesota. Volunteers attended one-day training sessions on EAB in Andover, Cloquet, Fergus Falls, Mankato, Marshall or Rochester.

## **Emerald Ash Borer Preparedness Plan in development**

The Forest Health Unit has begun the development of an Emerald Ash Borer Preparedness Plan for Minnesota, to be completed in spring, 2009. The purpose of the plan is to use our expertise and the experience of states that have EAB to make recommendations for DNR forested lands, urban areas and private forests before and after the discovery of EAB. These recommendations will be incorporated into existing Subsection Forest Resource Management Plans.

The five to ten-year plan will focus in large part on outreach and education of the public, private land managers, DNR staff, communities and the "green industry," in order to facilitate early discovery and rapid response to EAB. Knowledge of Minnesota's ash inventory and controlling the movement of firewood will also feature largely in the plan.

## **Exotic species: Minnesota participates in simulated invasive species find**

In August, the Minnesota Department of Agriculture (MDA) invited the Forest Health Program Coordinator to a "table-top" ICS exercise in St. Paul to simulate response to the discovery of an invasive insect species in firewood. USDA Animal and Plant Health Inspection Service (APHIS) presented a mock scenario, and Pennsylvania, South Carolina and Wisconsin participated with Minnesota by phone.

The scenario presented was that in July, a camper at a campground in Clay County, MN bought a bundle of firewood from the campground and found a "suspicious beetle" in the bundle. The camper submitted the beetle to the Clay County Extension Office, where it was forwarded to the Minnesota Department of Agriculture and identified as *Agrilus biguttatus* (oak splendor beetle). This pest is not known to occur in North America so the sample was sent to the USDA Systematic Entomology Lab in Beltsville, MD. The Minnesota State Plant Regulatory Official and State Plant Health Director were notified. The USDA APHIS Plant Protection and Quarantine (PPQ) Eastern Region Director confirmed the positive identification of the beetle.

The assembled ICS team consisting of MDA, DNR and PPQ staff began working on an action plan. In the scenario, they were notified that the bundle of firewood came from an individual in Pennsylvania. The Pennsylvania Department of Agriculture is also in ICS working with Area Command on the situation. The day after this notification, the Pennsylvania Department of Agriculture again contacted MDA with the information that the PA individual had distributed two loads of wood to Minnesota in July. He also sends firewood, sold in 12 cord loads, to WI and SC.

The goal for the MN, PA, WI and SC teams was to go through and fill out all the many complex ICS forms in order of the scenario events to get a feel for what this will be like once EAB is discovered in MN.

## **Division of Forestry Report on the Firewood Restriction Law: 2007- 2008**

### **Background**

In April 2007, Governor Pawlenty signed into law legislation restricting the movement of firewood into state parks, forest recreation areas and day-use areas, making it unlawful to bring in firewood not purchased from a DNR “approved firewood” vendor. Approved firewood is currently defined as firewood purchased at a state park, harvested in Minnesota not more than 100 miles from the state land where it will be burned, kiln-dried lumber or firewood accompanied by proof that it has been treated to be free of insects. A Commissioner’s Order to be used in the State Register accompanied the legislation.

The Division of Forestry along with other agency divisions (Ecological Resources, Enforcement, Fish and Wildlife, Bureau of Information and Education, Trails and Waterways and Parks and Recreation) were involved in the early stages of the firewood initiative. A technical working group made up of staff from these divisions met regularly to develop and present firewood management recommendations, draft legislative language, draft the Commissioner’s Order and coordinate interagency implementation efforts.

Regional Forestry staff implemented regional meetings and mailings where the primary audience was each Region’s major partners and stakeholders. The purpose of the meetings was to present the implications and provide a forum for discussion of the firewood restrictions, to garner support for the restrictions and explore ways in which all stakeholders could work together to address the threat of invasive species being moved in firewood. Regional staff contacted recreation personnel at the Chippewa and Superior National Forests, Voyageurs National Park, U. S. Army Corps of Engineers, over 90 per cent of the regions’ private campgrounds, and all counties and chambers of commerce to enlist support for the firewood legislation and the DNR’s attempt to change public behavior.

A firewood communications team was formed of members from the Bureau of Information and Education and divisions of Forestry, Fish and Wildlife and Parks and Recreation to develop a firewood restrictions communications plan and to coordinate education and outreach efforts between the DNR and outside agency groups.

In addition to the DNR groups, interagency firewood management and interagency firewood communications committees met regularly to explore opportunities for partnerships and to identify and provide coordination of outreach efforts and products being used in other agencies.

### **The 2007 Season**

Division of Forestry developed a process to approve firewood being sold by vendors for use in state-administered facilities as well as a database to maintain the list of vendors that was kicked off before Memorial Day in May. Numerous calls were fielded throughout the 2007 season from potential vendors, and at the end of the season the database of approved firewood vendors had grown to more than 400 vendors. The Forest Health Unit conducted a survey at the end of the year to determine area foresters’ impressions of the firewood approval system and to solicit their suggestions and comments. We received feedback from ten out of 20 area supervisors, including one that remarked that the system to approve firewood vendors was the simplest he’d used in 20 years. Issues raised about the system:

- Develop a way for individuals to bring from their own woodlots within 100 mi.
- Individuals have vendor approval for personal use – how to restrict to actual vendors
- Should loggers give proof of 100 mi. radius when selling to vendors?
- Renew public campaign and include all public lands
- Better system for firewood use in state forest campgrounds
- Continue emphasis on transport of more than just emerald ash borer
- People without approval might copy receipt tickets
- Prohibit firewood from out of state
- Prohibit moving *any* firewood, not just on state lands, more than a determined distance
- How to monitor the 100 mi provision
- How to monitor the vendors

Division of Parks and Recreation reported few concerns. Staff concentrated on educating the public about the risks of bringing in firewood as opposed to 100 per cent enforcement. Having said that, 220 bundles of wood were surrendered at 22 parks in 2007. The majority of firewood complaints focused on the poor quality of wood for purchase at some of the parks. There was an increase in firewood revenue at Lake Carlos and Gooseberry State Parks. The average cost in a sample of 26 parks for labor to do minimal enforcement and educate the public was reported to be \$522.00.



Division of Fish and Wildlife focused on education for staff and providing educational posters to the field to inform and educate the public. They also prepared a draft directive on firewood restrictions on WMA/AMA that has been reviewed internally.

Division of Enforcement reported no incidents.

#### Bureau of Information and Education: Firewood Communications Campaign Elements January through April 2007

1. Q&A/fact sheets/backgrounders/talking points
2. Web site/pop-ups/banner ads
3. Minnesota Conservation Volunteer field note for May-June issue
4. Posters & signage – State Parks/State Forest campgrounds
5. MDA/DNR poster
6. Regional partner/stakeholder/government meetings
7. Generic newsletters article (sent to camping organizations, lakes associations, magazines, newsletters, etc.)
8. Direct mail and reservation piece from State Parks
9. Northwest Sports Show – poster, parks fact sheet, bookmarks, bumper magnets
10. Living Green Expo – poster, parks fact sheet, bookmarks, bumper magnets
11. Vehicle bumper magnets (1000) – DNR Parks and Forestry vehicles, and distributed to public at events and through DNR regional offices.
12. DNR Information Center Packets – bookmarks and fact sheet direct mail pieces inserted in all mailings of State Parks information.

#### Elements May through December 2007

1. Video News Release (Seven out-state commercial broadcast stations and local cable channel 6) – August 2007
2. Cybernews notices to electronic mailing list – Information Center – May-August
3. DNR State Fair exhibit on forest pests and firewood issue – August/September
4. News release issued when firewood law passed
5. Media event at Fort Snelling State Park just before Memorial Day weekend.
6. Radio: DNR Minutes on 78 Minnesota News Network radio stations– April-August
7. Radio: Radio Bites (staff quote with script for radio station news) – May
8. Radio Public Service Announcement (PSA) aimed at hunters sent to stations statewide – September
9. Sports shows/fairs/Farm Fest, etc. – bookmarks, fact sheet, displays, bumper magnets
10. State Parks newsletter/publications articles – all season.

Voyageurs National Park adopted the DNR firewood restrictions, voluntary in 2007 and mandatory in 2008. Chippewa and Superior National Forests amended regulations to include the prohibition of firewood from any state other than Minnesota.

The U.S. Army Corp of Engineers, St. Paul district, issued a new firewood policy that prohibits the possession, transportation, use or storage of firewood originating more than 100 miles from St. Paul district project lands, or the current State limit, whichever is more restrictive.

A few counties, including Aitkin, Anoka and Olmsted, also adopted DNR firewood restrictions in their parks.

#### **Conclusions from 2007**

The overall opinion from Parks and Forestry perspectives is that the first season of firewood restrictions went remarkably smoothly, especially considering the short amount of time between bill enactment in April and implementation in May. There are still loopholes in the law/Commissioner's Order that need to be addressed. We continued to refine the procedures of approved firewood application where possible and to educate the public on the risks of moving firewood.

#### **The 2008 Season**

By the end of season, firewood from over 600 vendors was approved for use on state lands, and lists of vendors were more easily available to the public on the DNR firewood web page and on each of the state park web pages. We began the process of developing "tailgate wraps" for DNR Forestry (and perhaps Parks) trucks to help spread a "don't move firewood" message.

Three Rivers Park District and several county parks adopted the DNR restrictions.

The divisions of Parks and Recreation and Forestry developed a firewood brochure mainly for use in state parks. Parks also distributed updated, detailed guidelines to staff regarding the implementation of the firewood restriction law.

The DNR, Minnesota Department of Agriculture and USDA, APHIS, PPQ developed a letter that was sent to 100,000 out-of-state residents who applied for Minnesota hunting or fishing licenses. The letter informed visitors of the risks of moving firewood and cautioned against bringing firewood into Minnesota. The mailing was funded by USDA, APHIS, PPQ. The Minnesota Department of Agriculture developed a timeline for a process to certify firewood kilns to begin in January and potentially be rolled out in May 2009.

### **Conclusions from 2008**

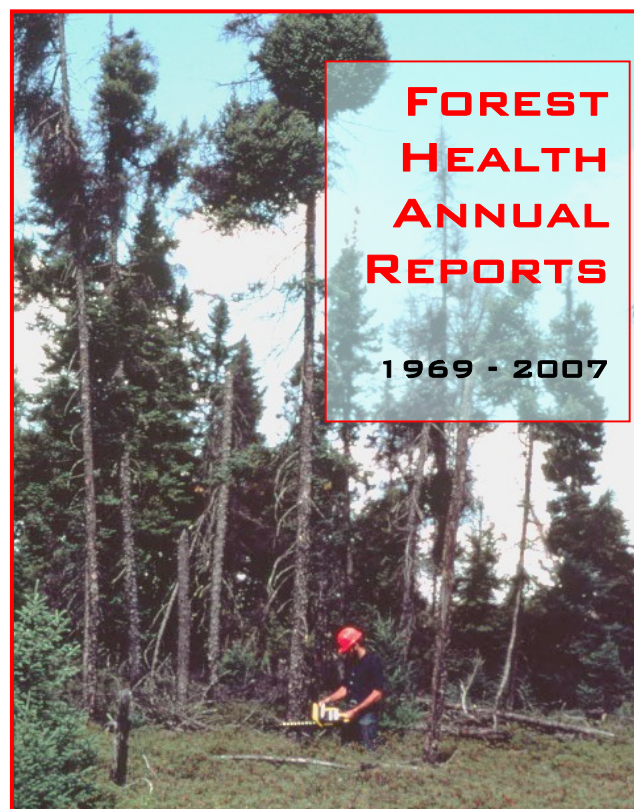
In 2008 we concluded that it would be desirable to revise the Commissioner's Order early in 2009 to reflect what we learned in 2007 and 2008. The Forest Health Unit has drafted a revised order, and the agency-wide technical committee will convene early in 2009 to discuss the revision and workable options.

### **Looking ahead to 2009**

- We will continue to approve firewood vendors, although the volume of applications decreased considerably in 2008. In addition, we are researching a process to renew approved firewood vendors.
- Tailgate wraps to be deployed by the start of camping season.
- Discover ways to reach out to private campground owners.

## **Historic Annual Reports on-line**

Minnesota Forest Health Annual Reports, from 1969 through 2007, are now available on the web. They are searchable. Go to [http://www.dnr.state.mn.us/treecare/forest\\_health/annualreports.html](http://www.dnr.state.mn.us/treecare/forest_health/annualreports.html) .



## **Invasive species management on DNR-administered lands**

In May 2007, the Department of Natural Resources (DNR) adopted a new operational order regarding the management of invasive species on DNR administered lands. The intent was to provide a coordinated approach to invasive species management consistent with state and federal statutes. Research and case studies have shown that prevention and appropriate pest management is cost effective when compared to the losses associated with lost business revenue and/or resources impacted by invasive species. So the objective of the order was to minimize the risk of introducing invasive pests into areas where they didn't already occur and/or spreading existing infestations of invasive pests. While invasive species are fast becoming a major issue on all lands, public and private, the operational order does not apply to any but those lands administered by the DNR.

The operational order directed each division to develop a set of guidelines specific to their operations. The reason behind separate division guidelines was to provide the flexibility needed to address varying state mandates. For instance, the division of Forestry has been charged with the responsibility of producing an income on school trust lands (administered by the division) to support county school districts. That requires practices and contract specifications that may not be appropriate on a Scientific Natural Area (SNA). And likewise, protecting a critical habitat such as an SNA, requires a level of care that may not be feasible in a working forest. However, separate division guidelines do create the potential for discrepancies between the Divisions. So development of division guidelines was coordinated through an oversight committee where ideas and approaches were shared and in many cases borrowed to facilitate shared fieldwork. Within that context, Forestry division guidelines were completed this summer. Implementation began in August.

### **Implementation**

Division of Forestry's "[Guidelines for Invasive Species Management](#)" were finished and approved in July 2008. Now that they are complete, attention can turn to developing the tools needed to effectively implement the guidelines. There are a number of tools needed that are not yet in place. These include among other things: equipment wash stations, species occurrence data, survey and monitoring protocols, reporting methods, management practices and priorities. Because many of the needed tools are not yet in place, division guidelines will be implemented slowly with an emphasis on outreach for the first year.

Division staff will be expected to begin to incorporate these guidelines into their day-to-day operations, much like they do practices meant to ensure their personal safety. That means identifying where the guidelines apply to their operations, what actions they need to take and what procedures and tools are needed to support those efforts. But this first year will be largely used as an education opportunity for both staff and program administrators. As a new endeavor, we are all learning what it takes to meet these objectives. And feedback on what doesn't work is as important as what does. This is especially true when working with contractors and vendors. Unless there is a regulatory issue, following division guidelines will be voluntary and will not be incorporated into contract specifications for some time.

### **Outreach Efforts**

The most critical of the tools needed is the materials and means to reach out to and educate division staff and cooperators. Initial training was accomplished through three regional workshops hosted in August and September 2008. But more is needed. Audiences and their concerns need to be identified. Partnerships need to be explored. And materials and trainings are needed for key interest groups. One of the first efforts undertaken was to develop a brochure for loggers working on DNR administered lands. The brochure, [Timber Operations on DNR Lands, Invasive Species Guidelines](#), released in November, outlines the voluntary actions being asked of loggers working on state administered land. Primarily the requests are to 1) arrive on any job site for the first time with clean equipment. Then on a regular basis, walk around any equipment being taken off site to knock off dirt clods and plant debris. A second effort undertaken with the Minnesota Logger Education Program (MLEP) involves developing curriculum for their annual logger certification training. The first presentation is scheduled for April 2009.

The US Forest Service funded a third larger project. The proposal includes two phases, 1) to develop an education plan and 2) to design an interagency web site on terrestrial invasive species. The education plan is meant to integrate outreach and education with social marketing techniques. The goal is to interrupt pathways by which invasive species spread across the landscape, focusing on those pathways associated with recreational activities. In 2008, an interagency core team was initiated to outline project goals, decision processes and time lines. A larger advisory committee was organized with their first meeting scheduled for January 2009. With a broad range of representatives, the committee brings to the project expertise and knowledge about recreation groups within the state and the social sciences needed to effectively reach them. Besides assisting the planning process, members of the advisory committee can pre-test ideas and help explore avenues of audience research. A focus group study and a baseline survey, scheduled later in 2009, will help more fully describe key audiences, their current understanding of invasive species, their attitudes, motivations, values and concerns to help ensure an education plan capable of positively influencing public behavior.

## **Surveys and Occurrence Data**

In part because there was no reporting mechanism in the past, there is little information available to describe where invasive species, particularly plants, occur on Forestry administered lands. So besides developing those mechanisms, beginning to fill in our understanding of where invasive species occur and where they might pose management issues will be one of the major tasks undertaken. To begin that process, a road-based survey was initiated summer, 2008. Using software developed by Ecological Resources, the survey includes all roads within state forest boundaries in the central and northern parts of the state. Completing that survey and a survey of all DNR managed gravel pits is scheduled for 2009.

Another project initiated in 2008 was a comparison of 5 different methods used to map the occurrence of buckthorn in order to evaluate their capability of detecting low levels of infestation. Interpreted photographs taken at three different resolutions are being compared to data obtained through aerial sketch mapping and ground surveys. The study results, expected spring 2009, will help guide detection efforts in other parts of the state. With grant funds provided through Ecological Resources, these surveys and several smaller projects will begin to give us the information needed to prioritize future survey and management efforts.

Reporting systems are being evaluated with plans to modify and adapt existing systems to manage invasive species data. A system of quality control is being added to the software used in our road-based survey. Utilizing handheld data recorders, the system provides a ready means to record and report populations of invasive plants. Two other reporting systems, SRM and FIM, used within the division to manage forest stand inventory data and management projects are being modified to include invasive species information. Overtime, the combination should provide the basis for future planning and management needs.

## **Management Practices and Priorities**

While there is a lot of information out there about how to identify invasive species, the information about how to control them at an operational level is lacking. Often multiple plant species occur on a site and the management recommendations for one plant may actually favor another. And in some areas, invasive plants are so widespread and well established, that controlling them seems impossible. Trying to manage or even report each and every infestation isn't feasible. So where do we start?

While the population dynamics of some species may not be fully understood, in general, the highest priorities for both reporting and active management are as follows:

- When a new infestation is discovered with the potential to cause long-term damage. Management is much more likely to succeed during the early stages of an infestation.
- When small infestations occur outside the current range of that pest, or occur only in small isolated pockets away from larger well-established infestations. Again, management is much more likely to succeed when infestations are small and isolated.
- When infestations are discovered that can be effectively managed during planned operations, such as during a timber harvest or site preparation.
- Where state and county regulators require invasive species management due to the potential impact on adjacent farm and/or range lands.

Tackling large well-established infestations can consume large amounts of time and money. They also may not be effective in the long run because of the likelihood of repeated reintroductions from adjacent land. Rarely would such infestations be considered a high priority except in an area of exceptionally high value and/or visibility. Examples might include high use parks or historical sites or developed areas used for educational purposes.

## **Future plans**

Because this first year of implementation is a learning process for all involved, our division guidelines will likely evolve over time. As we try various practices out and see what works and what doesn't, protocols will be developed and/or fine-tuned to support division needs. As outreach efforts progress and division cooperators become more familiar with the practices needed, contract specifications will be more and more common to protect the resources being managed. We will also begin to explore how best to pass this information onto private land owners and share it with our other partners.

In December 2007, the division of Forestry created a new position, the Invasive Species Program Coordinator, thus simultaneously establishing the Forestry Invasive Species Program. Sue Burks, previous Central Region Forest Health Specialist took the position. The next year or two of the new program will focus on implementing the division guidelines and establishing a long-term vision for invasive species management within the division. Feel free to contact her at [susan.burks@dnr.state.mn.us](mailto:susan.burks@dnr.state.mn.us) with your concerns, ideas and suggestions on how best to protect our forest resources in the face of the ever-increasing threat posed by invasive species.



For more information, see:

DNR Invasive Species Pages

<http://www.dnr.state.mn.us/invasives/index.html>

DNR Invasive Species Program & Links

<http://www.dnr.state.mn.us/invasives/links.html>

Forestry Division Invasive Species Guidelines

[http://files.dnr.state.mn.us/assistance/backyard/treecare/forest\\_health/invasiveGuidelines.pdf](http://files.dnr.state.mn.us/assistance/backyard/treecare/forest_health/invasiveGuidelines.pdf)

Timber Operations, Invasive Species Guidelines

[http://files.dnr.state.mn.us/assistance/backyard/treecare/forest\\_health/timberInvasiveBrochure\\_web.pdf](http://files.dnr.state.mn.us/assistance/backyard/treecare/forest_health/timberInvasiveBrochure_web.pdf)

## **Oak wilt suppression: 2008 Monitoring of 2007 Minnesota oak wilt prevention and suppression projects**

In 2008 the Minnesota Department of Natural Resources began intensively monitoring all 2007 grant administered oak wilt suppression projects in cooperation with the USDA Forest Service, NA, State and Private Forestry and the following Minnesota communities; Andover, North Oaks, Maplewood, Ham Lake, Lino Lakes, Shakopee, the Chicago County Soil and Water Conservation District, City of Columbus, Mahtomedi, Lake Elmo, Blaine, and Isanti County.

Inspectors from the above communities were instructed to inspect all 2007 treatment sites using the U. S. Forest Service field protocol. Infection centers were considered successfully treated if (1) there were no failures in the root graft barrier (RGB) line and (2) all potential spore-producing trees (PSPT's) were properly removed and disposed of.

Efficacy data was collected 126 treatment sites. As determined in 2008, treatment success was roughly 98% with only a few sites to follow-up on. All totaled, 32,505 feet of RGB line were installed in 2007 in the above communities and subsequently 519 PSPT's were removed on a timely basis. Treatment success on these sites will be followed through 2010.

Within the communities of Andover, North Oaks, Maplewood, Lino Lakes, City of Columbus, Mahtomedi, Lake Elmo, and Isanti County, additional grant dollars were used in the fall of 2008 to install an estimated 200 additional treatment sites. These additional sites will also be followed annually through 2011.

The balance of the oak wilt cost share program to Minnesota communities is now over with the exception of the City of North Branch. We will continue to monitor treatment success through 2012.

# Oak wilt history in the Cambridge Forestry Area

By Mike Peltier, Cambridge Area

Oak wilt, *Ceratocystis fagacearum*, was first diagnosed in the 1940's in Wisconsin. The disease was found in Anoka County prior to its arrival during the early 1980's in the Cambridge Area. It is thought that the disease spread mainly by power line trimming in the spring while insect vectors were active. In 1982, oak wilt was found along the power lines in Elk River on Burkhart-Chetek gravelly soils. It wasn't bad because of the mixed forest found on these forest soils. Shortly after that there was an infection center in Big Lake on fine sand soils. About 1984 there was an infection center in section 29-T34- R27 in the Sand Dunes State Forest near Eagle Lake. There, the oak wilt fungus spread like wildfire; 25 feet per year via root grafts in the pin oak monoculture on fine sand soils.

There was no treatment; rather oak stands affected by oak wilt were simply harvested. There were no restrictions on the timing of timber sales except for spring restrictions due to road conditions.

Oak wilt is also spread via asexual spores multiplying and spreading through vascular systems, notably red oak-to-red oak or white oak-to-white oak root grafts. By the late 1980's, we were instructed about oak wilt control by vibratory plowing. We learned that the fungus travels via root grafts about 25 feet per year. There were now two new infection centers in Lake Ann Campground. We realized that oak wilt would not stop until it ran out of oak. So, in 1989, we started vibratory plow contracts. We used a primary and a secondary line, about 60 feet away from the primary line. The secondary line was to save valuable landscape trees in places like a campground. Secondary lines or single primary lines sometimes stop OW from spreading via root grafts.

One of the first OW vibratory plow projects was in stand 234 in Sec 29. OW had not spread to the entire stand yet. The SE 1/2 of stand 234 had oak stump sprouts that were still alive. A line was flagged with at least one healthy stump sprout between the advancing oak wilt. The other side of the line was to remain free of OW. This single line in stand 234 worked and oak wilt stopped spreading through the stump sprout oaks at the control line. Later in the 1990's vibratory plowing again near the north edge of the stand controlled a line jump.

In the mid 1990's, Paul Kujawa, private consultant for Kunde Company, started the "Double Primary Line" in forest stands. A single line is supposed to last 4 to 7 years before fine roots re-graft. We had many line jumps because of roots re grafting beyond a single line. The double primary lines, parallel and at least 1 foot apart, actually kills segments of roots and it take 8 to 10 years before fine roots can re-graft. By then the oak wilt inside the plowed line has burned out and line jumps do not occur.

We had good success with double primary line controlling root graft spread. Greater than 90% of oak wilt infection centers were easily controlled. Firewood cutters would cut to the line (CTL). We marked potential spore producing trees (SPT's) with an orange band and date the tree wilted. Firewood cutters were not allowed to transport SPT's. Over land spread was not much of a problem except where humans had injured an oak tree. OHV trails and the camp ground were areas where infections were common, due to human activities causing injury to oak trees. OW on scattered state lands is very often associated with OHV trails.

Oak wilt also spreads by asexual spores produced in pressure pads under the bark. Insects are attracted to the sweet smell of OW spore mats. The same insects are also attracted to the smell of freshly injured trees. Insects are a known vector transporting OW spores to injured oaks, up to 500 meters, and probably further. The odds of an oak tree sustaining bark injury in the woods in the spring is not a great risk. We averaged controlling 6 to 10 small sites per year until 1997.

When smokechaser firefighters were available in March we cut and covered the remaining SPT's with plastic. We found that only 1 of 3 potential SPT's marked in the fall was still a potent SPT in March. The other 2/3 of SPT's were actually no longer potent because the fungus had progressed beyond the ability to produce a spore mat. We also found that only the large diameter



First stand harvested due to oak wilt 1984.  
Red outline 11 acres, now FIM stand 234.

stem wood in the lower 20 feet, or less, of the oak tree was still capable of producing a spore mat after March. Unfortunately, in most years, there were no personnel available to cut SPT's and cover them with plastic.

In 1996, we found that timber harvest could spread oak wilt if there were oak trees in the stand being harvested. Up until then there were few OW infection centers but they were now becoming more widespread. We then limited the season of operation in stands with oak trees so timber harvest was not allowed from April 1<sup>st</sup> to July 15<sup>th</sup> without written permission from a state forester. Sometimes it snows in April and, sometimes, dry weather occurs in July which causes summerwood formation to start early. So, in these cases we make exceptions to the season of operation, on either end.

During May of 1997 and again in May of 1998, there were two major windstorms. Both windstorms were centered on the Big Lake and Monticello area. Tree damage was widespread for miles north and south of the Mississippi River Valley. In 1998, it became apparent, in Sherburne County, that it was hopeless to control oak wilt in certain townships. Residents could try to save yard trees if they wished. Most of the OW control effort was redirected, by the Sherburne County Forester, to northern townships where use of limited funds was more efficient. Oak wilt became ubiquitous in most of Big Lake Township and eastern Elk River. The Sand Dunes State forest was on the northern damage fringe of the windstorms. Sherburne County had cost sharing for oak wilt control but concentrated control work on the northern townships and less in the storm damaged southern townships. Oak wilt control from then on was a much larger work-load.

About this same time in the late 1990's, civic volunteers cut firewood on the Sherburne National Wildlife Refuge (SNWR) and stored the wood for later sale NE of Princeton, in Sec 25-36-26. Almost immediately 8 infection centers were found on a detection flight. About this same time numerous infection centers were found on Kunkel WMA NW of Princeton, in Sec 3-35-27 and in Sec 34-36-27. The Kunkel sites probably resulted from OW overland spread from SNWR to adjacent private lands, and then to the adjacent oak stands of the WMA. Most of the pine had been removed from the Kunkel WMA, leaving pin oak and aspen monocultures. OHV on trails may have injured oaks in the spring, resulting numerous infection centers.

SNWR policy had an effect on OW control in the SDSF and surrounding private lands. The SNWR plan is to replicate the surveyor's notes and Marschner's map of the 1849 to 1853 land survey. Activities to accomplish this trip back in time have been harvesting pine and burning on all lands including islands in order to revert sites to oak savanna. In the early 1980's, SNWR began to burn tracts of 1000 to 2000 acres so the vegetation would shift to oak savanna as it may have been at the end of the Fur Wars, as the Little Ice Age ended, and following the initial pine logging. The land survey occurred after the initial pine logging of the 1840's. The 1837 treaty included timber lands in part of Sherburne County; hardwoods were not considered timber trees then. On the SNWR, prescribed burns in the mature oak stands cracked bark and exposed the cambium layer on oaks. Oak wilt had spread to all corners of the SNWR by the early 1990's. Aspen has replaced some former oak stands, on SNWR. Landowners within 500 meters of the SNWR boundary have OW, and now the landowners within ½ mile of those landowners are being severely affected. Places where OW has stopped spreading, due to repeat burning, are Santiago and Blue Hill townships. In these areas, oak stands have been systematically been replaced by aspen. 25 to 30% of OW infections are in the white oak group. OW infections on white oak group trees are less of a problem to neighboring lands because spore mats do not develop. White oak group trees are infected the same way but can only spread the fungus via root grafts. Bur oaks take longer than a week to completely wilt due to OW infection.

The SDSF and SNWR boundary is mainly oak forest. Twice we have agreed with them to control root graft spread of oak wilt where an infection center is on both sides of the boundary. But overland spread is constant within 500 meters and probably beyond.

Sherburne County OW control has an effect on OW control in the SDSF. Since 2006 cost sharing has not been available to Sherburne Co residents. The average cost of OW infection center control is about \$600. Many people have stopped controlling OW due to the end of cost sharing (state and federal grants). Several other counties in the Cambridge Area have the same situation.

Virtually all state lands in the fine sand area of the Cambridge Area have OW infections spreading or are high risk for oak wilt infections. Wild River and Wm O'Brien State Parks have the same situation as the SDSF. CAWMA is heavily infected with OW.

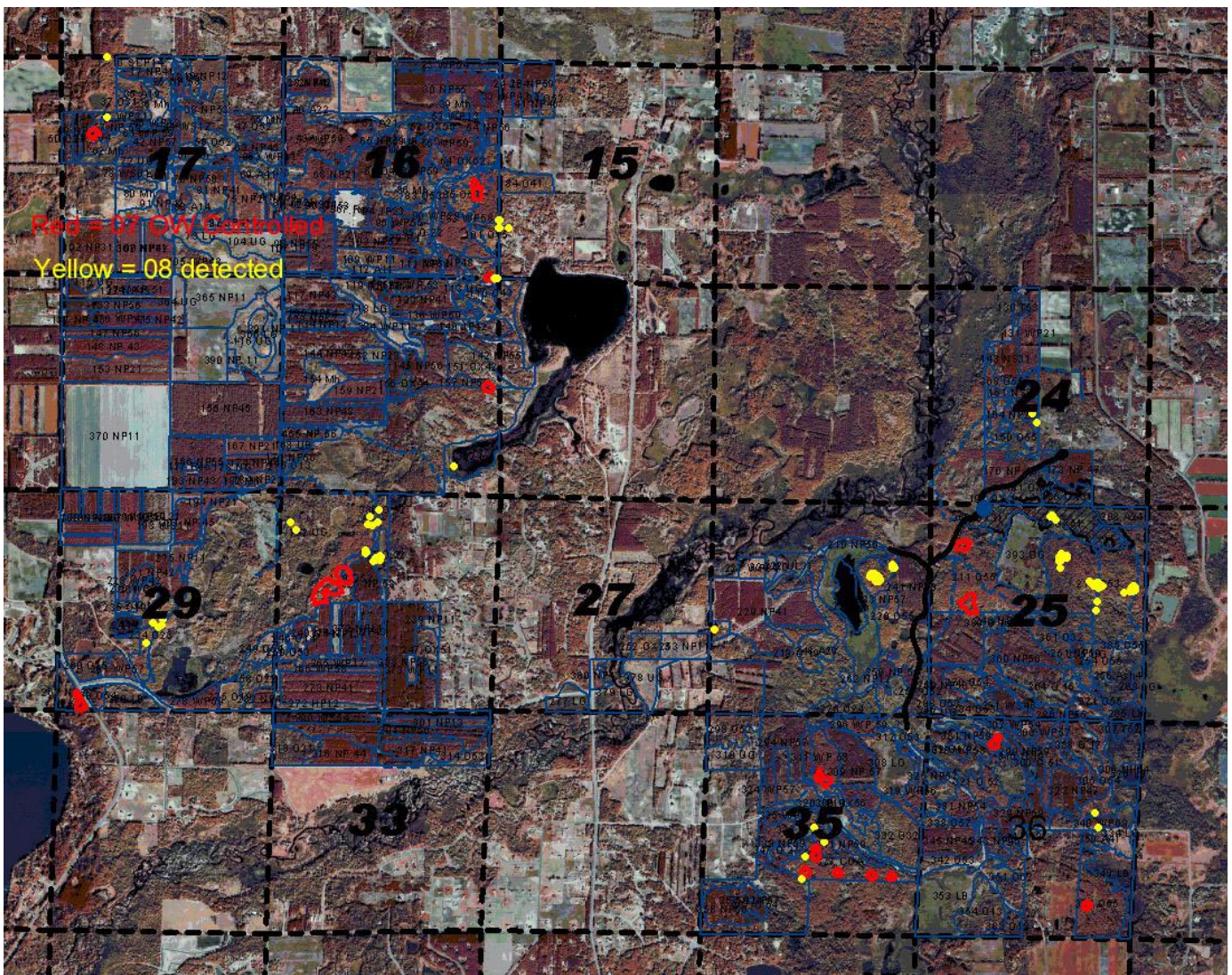
Since it's discovery in 1940's, oak wilt extends from Minnesota to Texas to Pennsylvania. The extent of OW in MN is SE MN north to Wright, Stearns, Benton, Mille Lacs, Isanti, and Chisago Counties ending at the fine sand limit. The Mississippi outwash valley has red oak group trees near the river where alluvial fine materials are deposited by river flooding. OW is found in the City of St Cloud. OW extends into Benton Co north of the Briggs Lake chain in the HWY 25 area. Between the Benton County infections to Mille Lacs Co the soils are mainly Milaca, Ronneby, and Mora Loams of the Mille Lacs subsection. Oak is not a common tree species in northern Santiago Township and adjacent townships of Benton CO. The Mille Lac Co Kunkel WMA and NE Princeton firewood infections are the northern limit of dense clusters of OW. This continues across east across



the fine sand areas of Isanti Co to around Cambridge and North Branch in Chisago County to Wild River State Park. The northern part of Wild River State Park is mixed hardwood forest but the fine sand southern portion has numerous OW infections. The line of OW infections across this northern tier of counties is wavy to the extent of fine sand soils, except for swamp forest, and other wetlands. Insects carry the fungus about 500 meters each season in random directions. It appears with the help of people the average travel is > 1 mile per year, on fine sand soils.

#### Where do we stand on state lands in the Cambridge Area?

Forest stands with upland fine sand soils are mainly pin oak monocultures and have scattered bur oaks and other associate tree species. These soils are Entisols (forest origin) not Mollisols (prairie origin). Coarse sands of the Mississippi Valley area are Mollisols (prairie soils). The outwash sands of the Anoka Sands do not have an OW problem because they are mainly bur oak. Trees in the white oak group do not produce spore mats. Outwash sands have only scattered pin oak, except along river edges where soils have fine particles so that red and pin oak can exist. Pine grew along some of the river valley soils before and during the government land survey. We are finding infection centers at an increasing rate on the fine sand areas. We know how to stop the disease from spreading through root grafts but we are not stopping the progression of the disease due to overland spread from multiple infection centers inside and outside state land boundaries. It seems we are plugging the holes with our fingers when the whole dike is crumbling around us.





Recent Oak Wilt Control on Cambridge Area State Lands		
<i>Year</i>	<i>Sites controlled</i>	<i>Linear Feet of Double Line *</i>
2004	14	6800
2005	15	5800
2006	22	9840
2007	10	15,820
2008	22	17,297
Totals	83	55,557 feet = 10.5 miles

\* Double this figure for linear feet of single lines.

**What about pin oak monocultures?** I recommend that we may better off to not control oak wilt in monoculture pin oak stands. Stands never treated for oak wilt regenerate back to oak (by acorn seeding), but the new stands are mixed with a variety of other tree species.



Remember Stand 234? Stand harvested 1984, but no oak wilt control. Plenty of oak but mixed with other species. 2008



Stand 234. OW in the south part was controlled. Late 1980's. Note this part of the stand is now a pin oak monoculture again. Just what we don't want! 2008





Oak stand in Big Lake. The second known OW IC in Sherburne Co. 1982. No control resulted in junk hardwood regeneration at first, but oaks are still important species in this mixed stand. Soil is Hubbard Mosford Complex, a mix of fine and coarse outwash sand. Photo fall 2008

**What about burning?** Burn it and they will come. The following photos show the results of fire on fine sand soils.



Repeat burning on Entisol fine sand soils resulting in OW mortality of all mature oaks, including bur oak. The acorn reproduction is mainly by pin oak, which get viable acorns by age 15. Bur oak produces viable acorns about age 35. Once growing the pin oak survive in a sprout forest. Continued burning perpetuates the pin oak sprout forest. If burning would stop a pin oak monoculture would again repeat, as it did after the 1930's when grazing and forest pasturing and burning stopped. These are Entisols soils not prairie soils.





Is this oak savanna? Entisols are not prairie soils. These fine sand soils are not prairie soils. However, if you spend enough money for about 700 years perhaps a Mollic horizon would begin to develop.



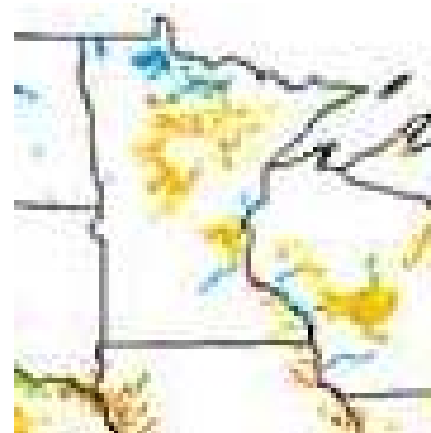
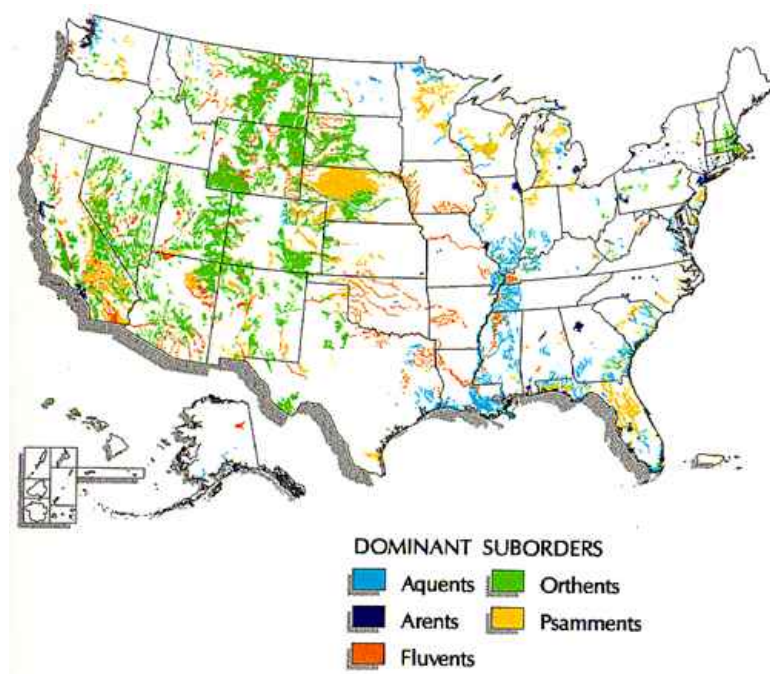
Outwash coarse sand soils of the Mississippi Valley. Bur oak stands grow in the Mississippi outwash valley. This is Hubbard loamy sand. These coarser sands are classified as Mollisols (prairie soils), due their darker color. The dark soil color indicates a long history of grass cover. This soil development is not deep. Perhaps these soils were savanna soils for thousands of years. The shifting mosaic of vegetation was probably most often have been some grass cover. Prairie soils are not threatened. They cover the largest proportion of North America.



### **A shifting patchwork of forest, savanna and prairie.**

The disease is considered to be exotic that was first documented in 1942. OW spread would be a slow crawl in the Cambridge Area and may or may not have spread if not for power line trimming. Pin oak monocultures may not have developed without the 1930's dust bowl and financial crisis. Without the fur wars the Anoka sands may have remained mixed pine lands, as found on all Entisol Psamment soils. When burning was more widespread would oak forests be as extensive if OW was present earlier in history? Would all oak species still be present in the in the Midwest US?

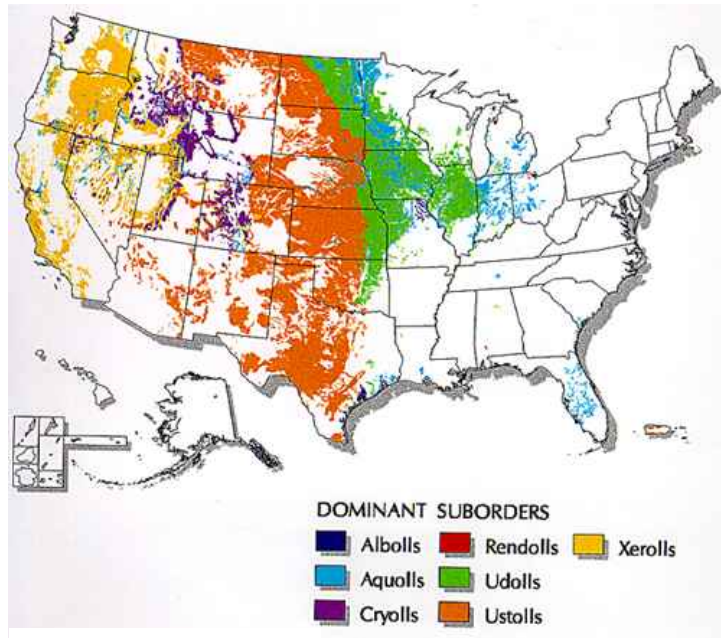
The Anoka Sand area has been a shifting mosaic of vegetation for thousands of years. Indian prairies would always center on river valleys and lakes. There are Indian prairies far north in Ontario, but soils are not prairie soils. The entire landscape of the Anoka Sands was not forest, savanna, or prairie, at any given time. Interior forest areas would be furthest away from water and agricultural mud flats. The vegetative cover has changed and continues to change mainly according to human activities. The soils are the denominator. Soil formation is a result of parent material, climate, and vegetative cover. Soils take 700 to 2000 years to develop. Maps below show major soil types.



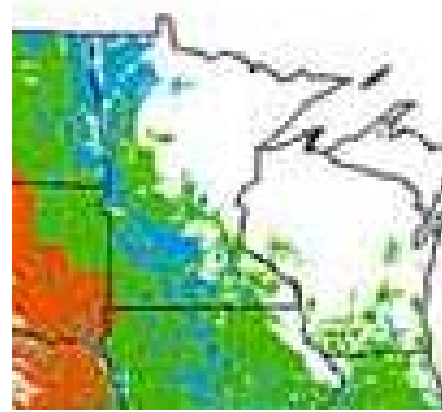
**Psamment Entisols soils of MN. Most of the Anoka sands soils are Entisols with smaller proportions of Alfisols (northern forest soils) and Mollisols (prairie soils).**

Psamments,,yellow map color, are a type of Entisol where vegetative cover is pine and oak. Yes there is pine and oak in the Nebraska Dunes.





Mollisols in the US



**Mollisols in MN. Note they are a part of the Anoka sands along the Mississippi Valley. These were most likely places for Indian peoples' campsites and agriculture on mud flats. Rapids would have been a good source of water in the winter. These soils indicate more frequent Indian Prairie**

## Summary

What does all this have to do with oak wilt? History is history and there is no time travel. We need to work with what we have and make the best of it. OW control to stop the spread is now becoming futile in our Area. Changing Entisols into Mollisols is futile. We need to do what works. OW control is no longer working to control overall spread or incidence.

It appears that although oak wilt is not a native disease, there may be an opportunity to find out if OW improves forest composition by disrupting the monoculture of pin oak on fine sand soils. Pine would be an important wildlife and timber species to encourage in mixed stands. Historically and presently pine is at least an associate tree on Psamment Entisols, everywhere these soils are found. The pin oak monoculture forests are no more natural than oak wilt disease.

Harvest by clear cut with reserves, even with OW uncontrolled, seems to diversify the tree species better than controlling OW with harvesting, and much better than repeat burning. Repeat burning on the fine sands appears to result in a more pure pin oak monoculture, than other options. Extensive burning could result in a repeat of the 1930's starting over again.

This may seem a very wordy explanation but being familiar with this history is important to avoid repeating mistakes. Snap decisions to continue to control OW or to stop controlling OW need to be based on facts and not on whims.

### **To be determined:**

Will OW continue to spread northward up the Mississippi River Valley in the red oaks on the alluvial soils near the river? If so management options could begin now, upstream, based on our experiences.

Should we attempt to purposely allow OW to spread into harvested sites with oak regeneration to document the impact?

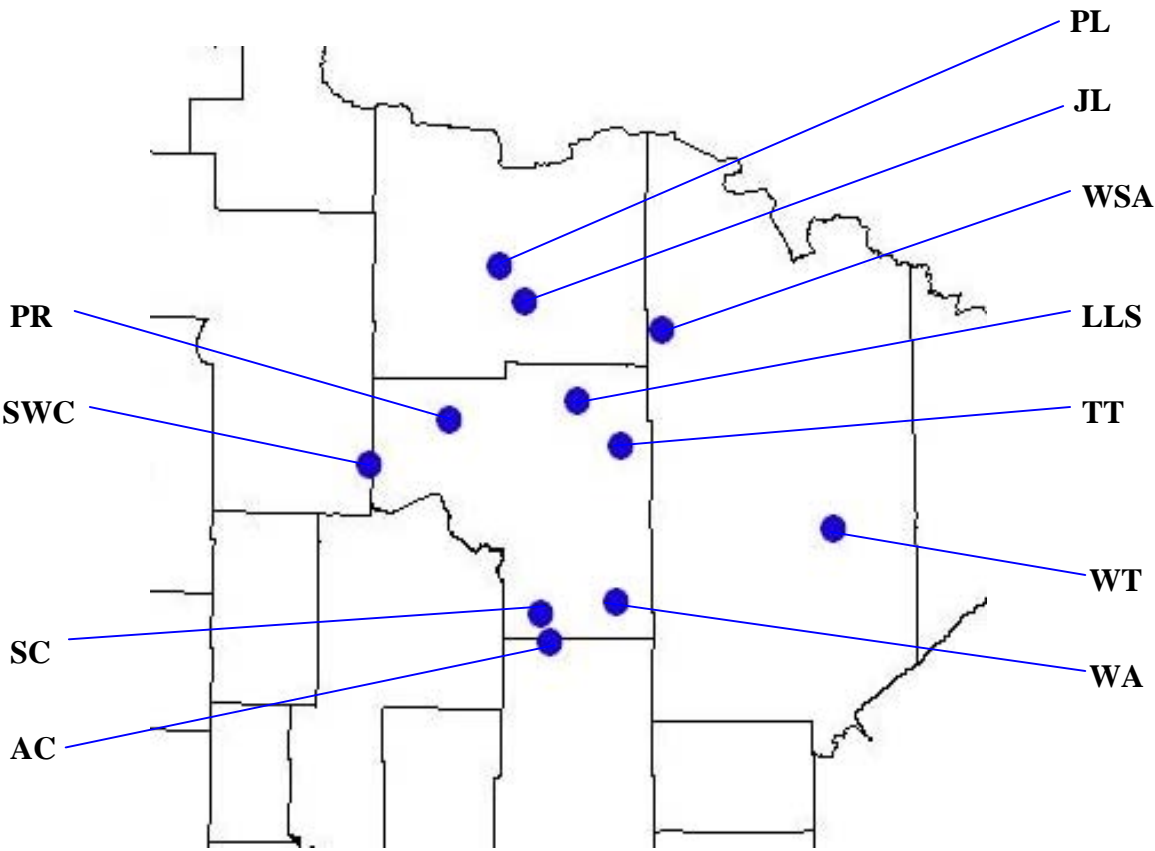
Are we already beyond the point of controlling OW? Has the decision already been made for us to start working with this new species mix?

# White spruce/ spruce budworm/ thinning study update

This study was started in 1998 with a USFS Focus fund Grant in order to study the interrelationship of white spruce growth in plantations with spruce budworm and thinning. The project was started with Dr Klaus Puettmann , U of MN- Forestry, as the principal investigator and Mike Saunders, his graduate student at U of MN.

There are 11 plantations on State, Federal and Blandin Paper Company lands included in the study. Stands were thinned between 1998 and 2002. A portion of each stand was thinned and a portion left unthinned as a control. Each stand has 6 permanent plots established with rebar as the center points. All stands in the study are visited yearly to evaluate spruce budworm defoliation. Resource Assessment crews collected tree measurements after the first thinning, 5 growing seasons later and, starting this winter, will begin the 10 year post-thinning remeasurement. Dr Tony D’Amato, U of MN-Forestry, has agreed to take over as principal investigator. Currently, he and his graduate student, Stacy Troumbly, are analyzing the 5 year data. This will be used to develop some white spruce thinning recommendations.

The locations of white spruce plantations in this study are shown on the following map.



Native plant community classification of the white spruce stands in the study can be found in the following table.

<i>Name of site</i>	<i>Label</i>	<i>Native Plant Community</i>	
WS Aitkin Co	AC	MHn47	
WS Smith Creek	SC	MHn44	
WS Warba	WA	MHn44	
WS Johnson Landing	JL	MHn44	
WS Larson Lake	LL	MHn44*	* The NPC classifications of Larson Lake, Plantation Road and Sam Welch’s Corner are tentative because on the ground visits have not been made to these sites to determine the NPC at this time.
WS Power Line	PL	MHn44	
WS Plantation Rd	PR	MHn35*	
WS Sam Welch’s Corner	SWC	MHn35*	
WS Taconite Trail	TT	MHn44	
WS White Spr Alley	WSA	MHn44	
WS White Twp	WT	MHn44	

Spruce budworm defoliation levels are shown in the following table.

Spruce budworm defoliation rating for white spruce thinning project												
Location	Tmt.	Date thinned	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Plantation Road PR	Thinned	Oct-98	L	L	O	O	O	O	O	L	O	O
	Reserved		H	L	L	O	O	O	O	L	O	O
Sam Welch Corner SWC	Thinned	Jul-99	L	L	O	O	O	O	O	O	O	O
	Reserved		L	L	L	O	O	O	O	L	O	O
Aitkin Co AC	Thinned	Nov-99	O*	O	O	O	O	L	M	L	L	L
	Reserved		O*	O	O	O	O	O	L	L	L	L
Smith Creek SC	Thinned	Nov-99	L	L	L	H	M	H	M	O	O	O
	Reserved		L	L	L	M	M	H	M	O	O	O
Johnson Landing JL	Thinned	Feb-00	M	L	O	O	O	O	O	O	O	O
	Reserved		M	M	L	O	O	O	O	O	O	O
Power Line PL	Thinned	Feb-00	L	L	O	O	O	O	O	L	O	O
	Reserved		L	L	O	O	O	O	O	L	O	O
Larson Lake Salvage LLS	Thinned	Mar-00		L	L	M	M	L	M	L	O	O
	Reserved			L	L	L	L	L	L	O	O	O
Taconite Trail TT	Thinned	Jan-01			O*	O*	O*	O	O	O	O	O
	Reserved				O*	O*	O*	O	O	O	O	O
Warba WA	Thinned	Jan-02				O*	O	O	O	O	O	O
	Reserved					O*	O	O	O	O	O	O
White Spruce alley WSA	Thinned	Aug-02				O*	O	O	O	O	O	O
	Reserved					O*	L	O	O	L	O	O
White Township WT	Thinned	Aug-02				O*	O	O	O	O	L	O
	Reserved					O*	O	O	O	O	L	O

\* = no defoliation rating done on the ground on this site, rating based on aerial survey data

O = no current needles missing

L = 1 to 33% defoliation of current year needles

M = 34 to 66% defoliation of current year needles

H = 67 to 100% defoliation of current year needles