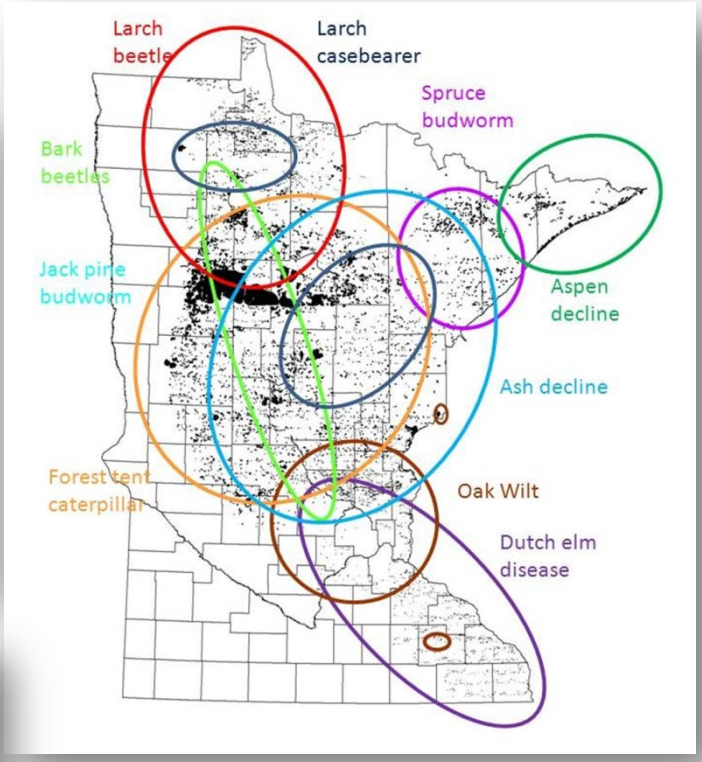
2013 Forest Health Highlights



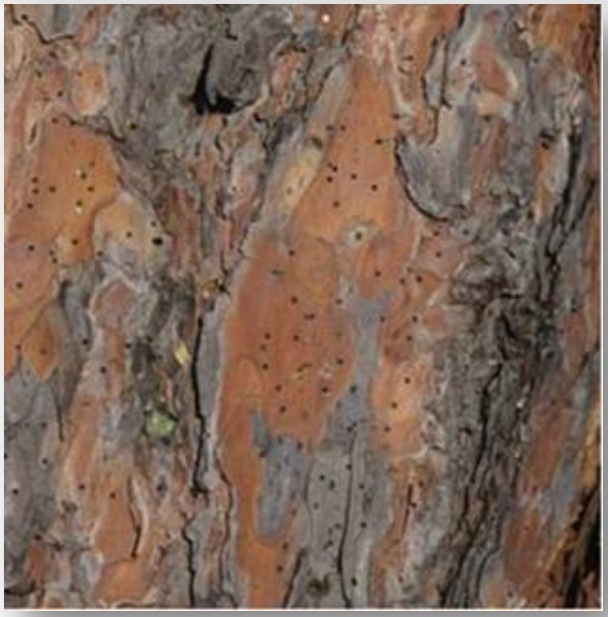
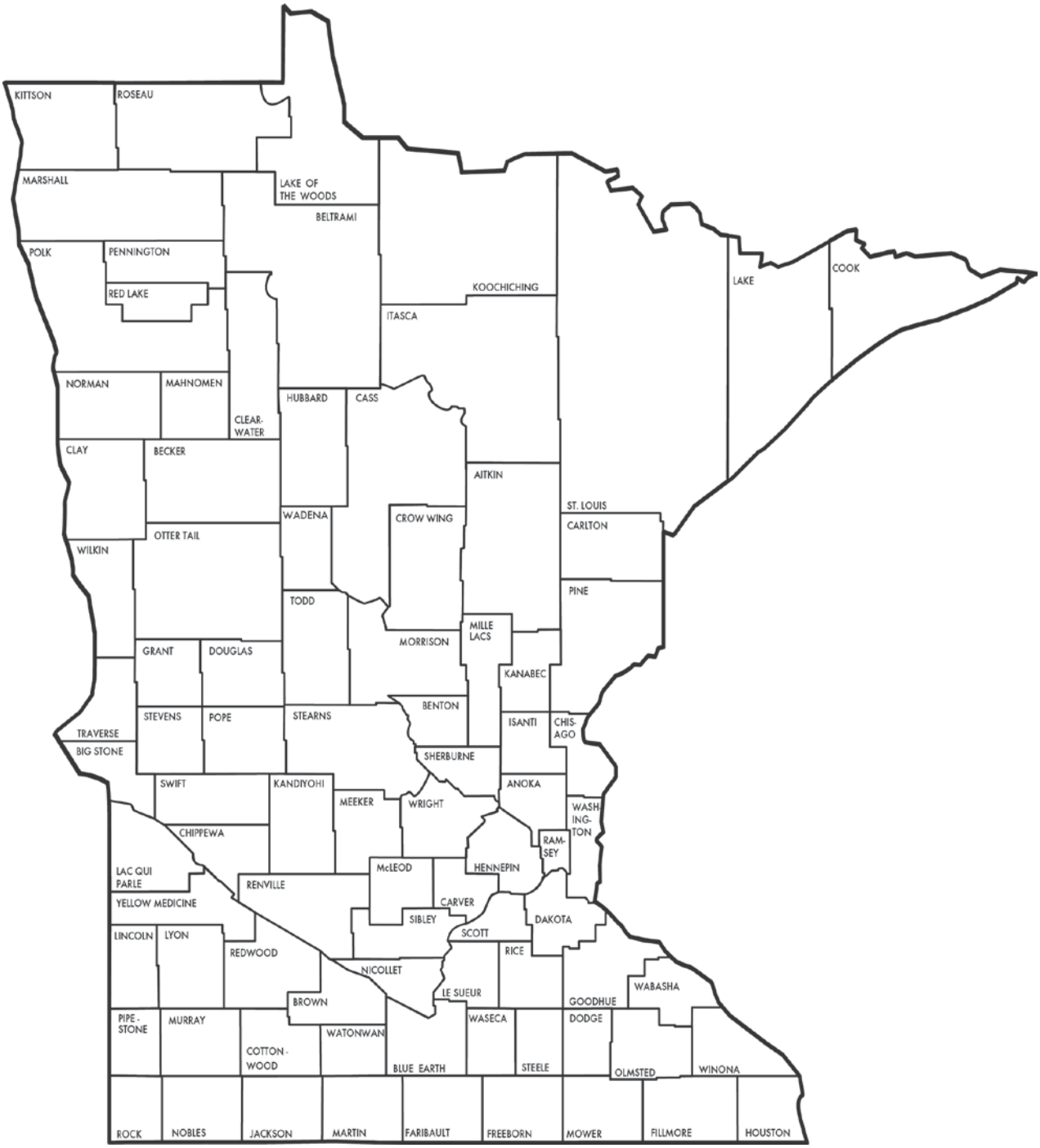


Photo credits: Photos are from DNR forest health staff unless indicated otherwise.

Projects were funded in whole or in part through a grant awarded by the USDA Forest Service, Northeastern Area State and Private Forestry.

Contents

Minnesota County Map



Division of Forestry Forest Health Staff

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

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

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

E. Hwy. # 2
Grand Rapids, MN 55744
(218) 327-4234

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

Ryan Blaedow*
Central Region Forest Health Specialist
1200 Warner Rd.
St. Paul, MN 55106

*February 2012-July 2013

Aerial survey results

Since the early 1950s, 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 fifteen years, these surveys have been accomplished through the collaboration of the Minnesota Department of Natural Resources (DNR) Forest Health and Resource Assessment Units and USDA Forest Service (USFS) Northeastern Area State and Private Forestry (SPF).

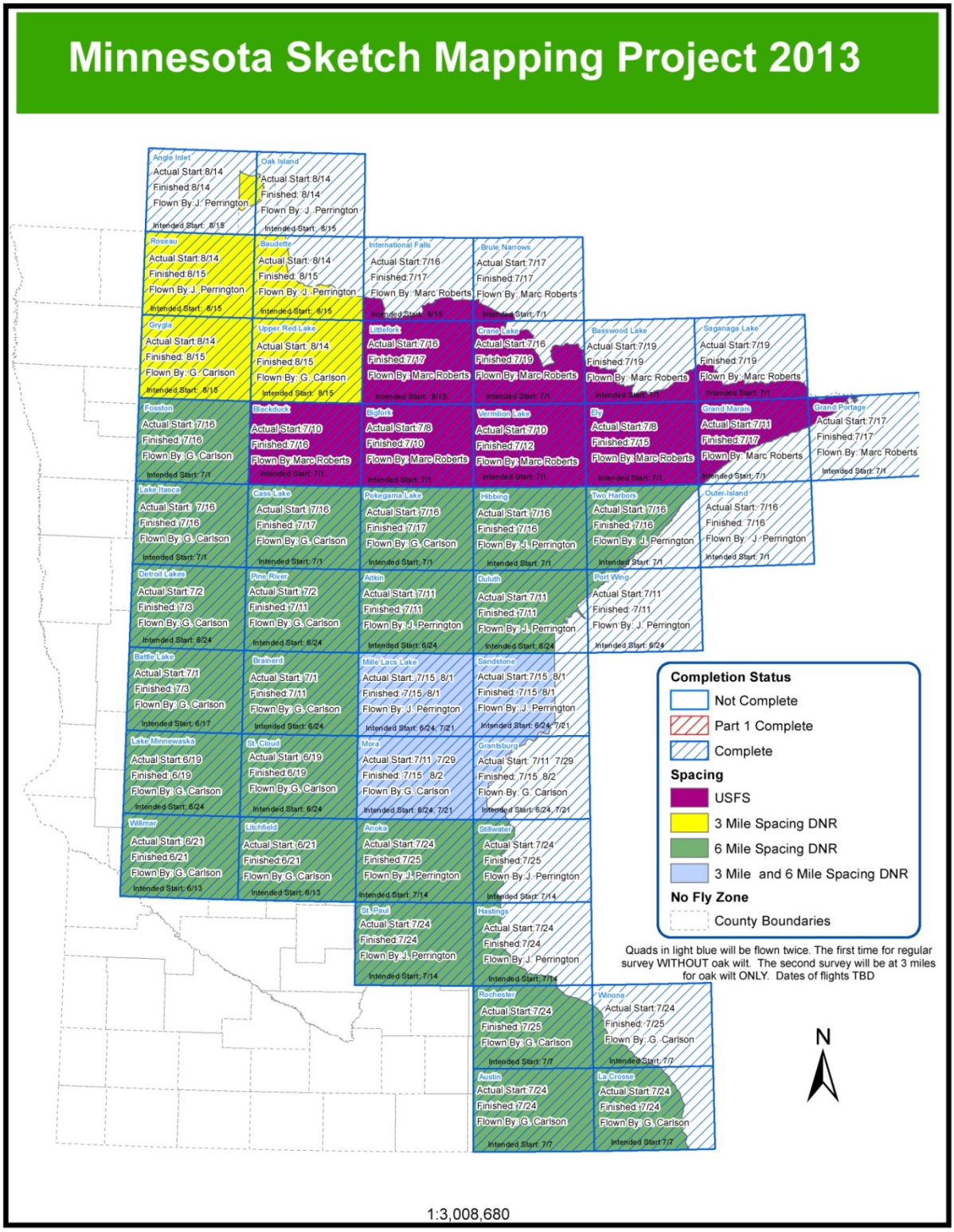
The DNR Forest Health staff plans the scope, timing and intensity of the surveys, trains Resource Assessment staff, provides ground-truthing, analysis, and dissemination of survey data. Resource Assessment staff conducts aerial sketch-mapping on the state quads, digitizes the data and produces digital shape files. For each polygon mapped there are five attributes (informational features) that must be coded and recorded in the air. State and Private Forestry conducts aerial sketch-mapping on federal land, post-flight map rectification, and holds the final review meeting. Aerial survey results are incorporated into the USFS national database since our procedures and products comply with national standards.

The state portion of the survey began on June 19 and was completed on August 14. The federal portion of the survey began on July 8 and was completed on July 19. Thanks to Resource Assessment's sketch-map team Gentry Carlson and Joel Perrington, who accomplished the aerial survey and data processing. Thanks also to Marc Roberts, S&PF, for mapping the federal portion of the survey and to Quinn Chavez, S&PF, for post-flight map rectification and the final review meeting. The following three maps illustrated the survey results.

On the following page is a table of damage agents, number of polygons associated with that agent, and the number of acres affected in 2013's aerial survey.

Damage-causing agent	Number of polygons	Number of acres
Ash decline	736	30,707
Aspen decline	341	62,136
Other decline	32	1,990
Bark beetles on pines	56	707
Dutch elm disease	1,105	823
Fire	8	4,491
Flooding	87	2,095
Forest tent caterpillar	2,831	1,073,056
Jack pine budworm	2	324
Larch beetle	2,259	20,624
Larch casebearer	145	16,933
Large aspen tortrix	5	2,552
Leaf rollers of aspen	112	27,928
Oak wilt	1,975	1,473
Spruce budworm defoliation	358	38,029
Two lined chestnut borer	30	22
Fire	8	4,491
Wind damage	34	5,695
Unknown	403	4,839
Grand Totals	**10,519**	**1,294,437**

Aerial Survey Plan Map by Quad



Pest Conditions Report

This report contains pest information on all of the "Major Forest Insects and Diseases" that occur within the state (from a national list) and any other pest that causes significant host damage during the year. The report contains pest data that will be entered into the federal Pest Event Reporter database used to produce the National Forest Insect and Disease Conditions Report.

Insects

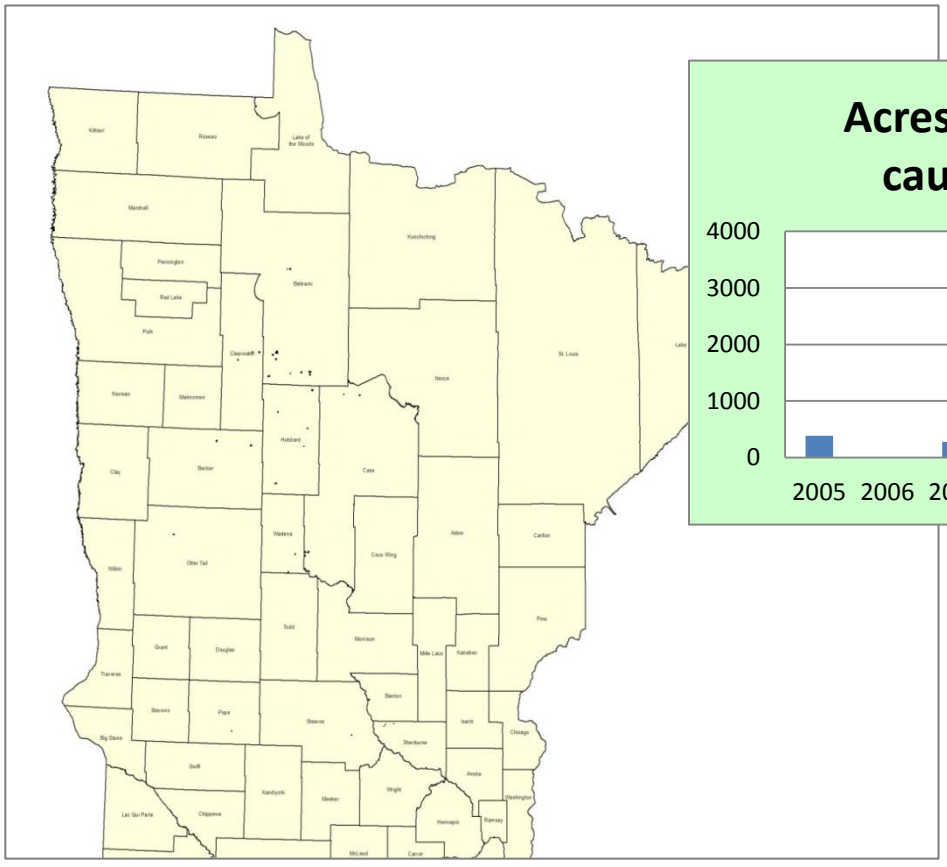
Bark beetles

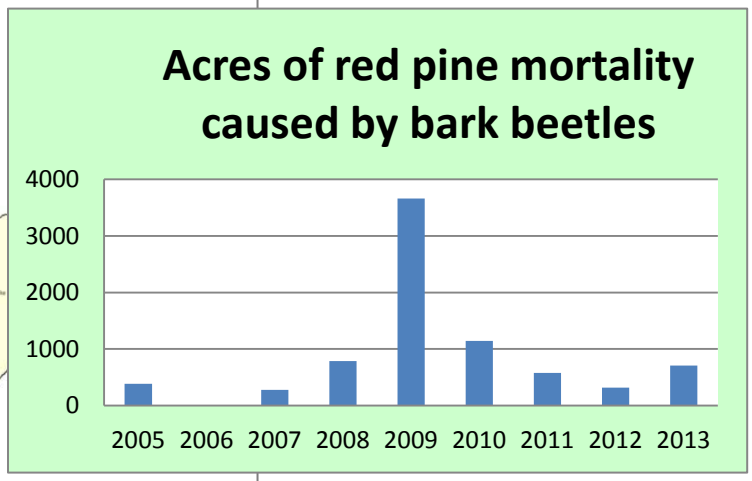
Ips species, *Dendroctonus valens*

Hosts	Red pine and, rarely, jack and white pines
Setting	Rural forests
Counties	See map
Survey method	Aerial detection
Acres affected	707 acres
Damage type	Mortality

More than double the acreage that occurred in 2012. This is likely due to the continued droughty weather in the forested portions of the state, particularly near the forest-prairie border.

Ips exit holes





Pityogenes hopkinsi bark beetles

Top-killed white pine was frequently reported around the southern half of the state. Driving from St. Paul to Hinckley to St. Cloud and back revealed hundreds of afflicted white pines. The damage was caused by a very small bark beetle, *Pityogenes hopkinsi*. White pine infested by *Pityogenes hopkinsi* will have lots of resin dripping from tiny, pin-sized holes. Gently peeling back the bark will reveal the small chestnut-brown beetles and their galleries. These beetles prefer to attack the smooth bark of stressed pines, and it would appear that drought triggered an outbreak. Fortunately, only young pines less than 20 feet were being attacked.

Symptomatic white pines

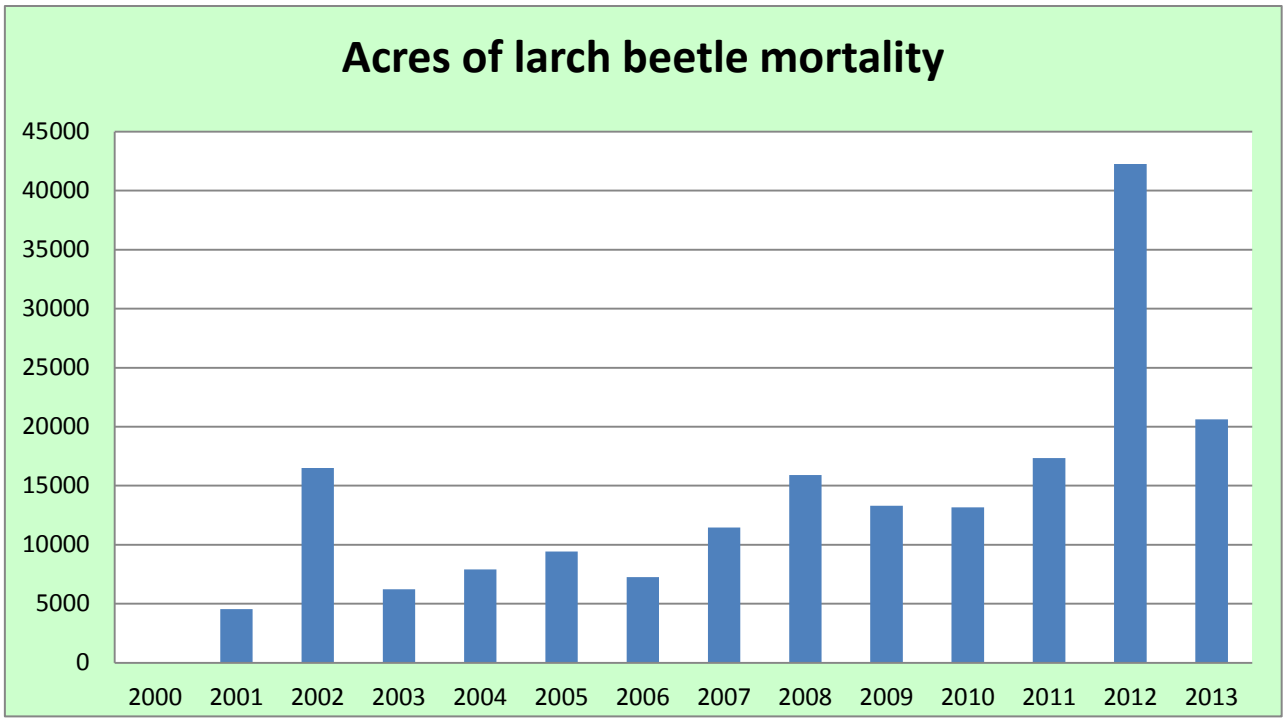
Eastern larch beetle

Dendroctonus simplex

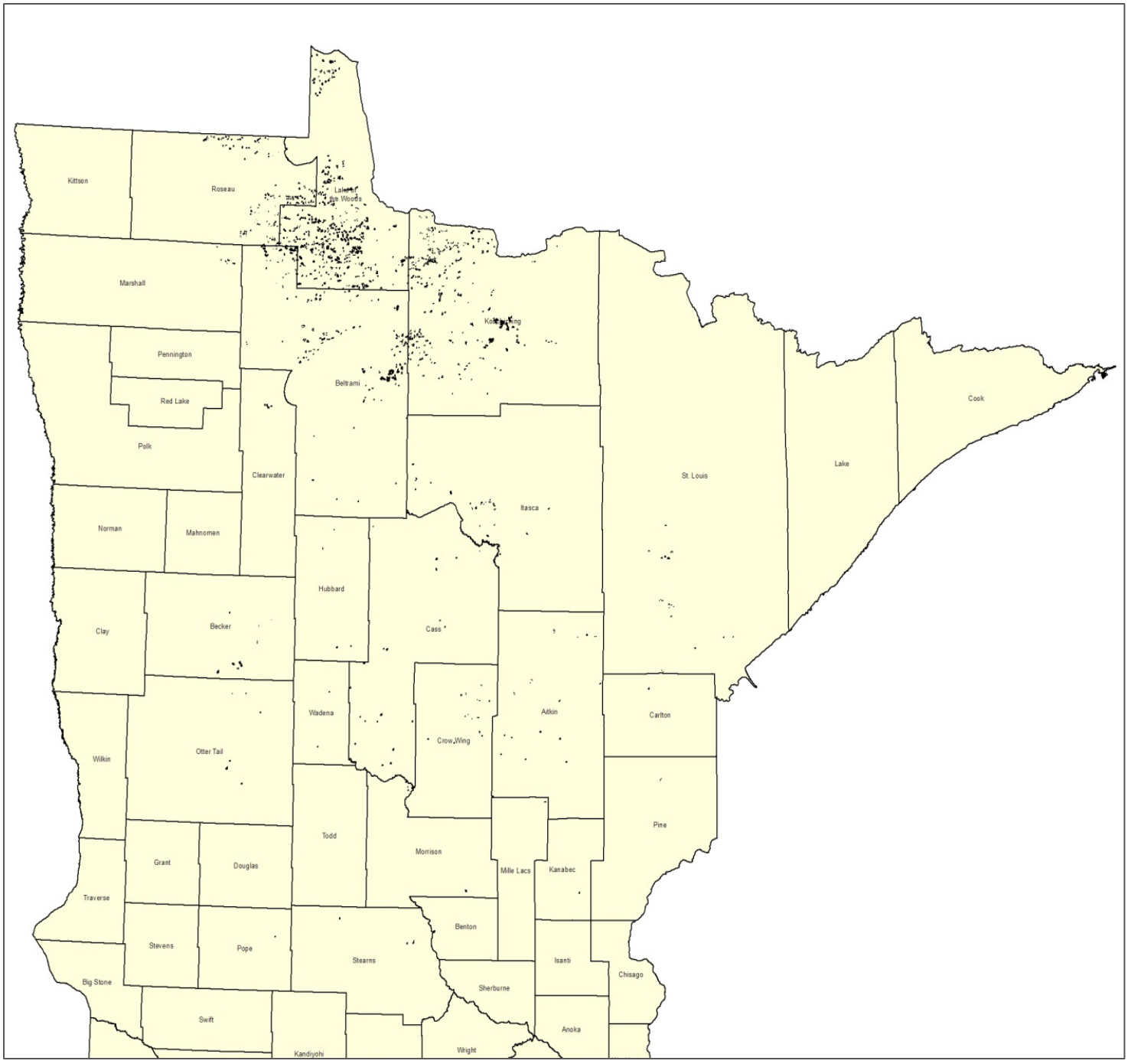
Host	Tamarack
Setting	Rural forests
Survey method	Aerial survey
Acres affected	20,624 acres
Damage type	Mortality

This is the fourteenth consecutive year of the first known outbreak of eastern larch beetle in Minnesota. As of this year, 18 percent of the tamarack acreage is dead due to larch beetle attacks. Most damage has occurred in Lake of the Woods, Roseau, and Koochiching counties. Foresters report that within five years of aerial or ground detection, more than 95 percent of the tamaracks are dead in the stands.

Egg-laying galleries



2013 Locations of Eastern Larch Beetle



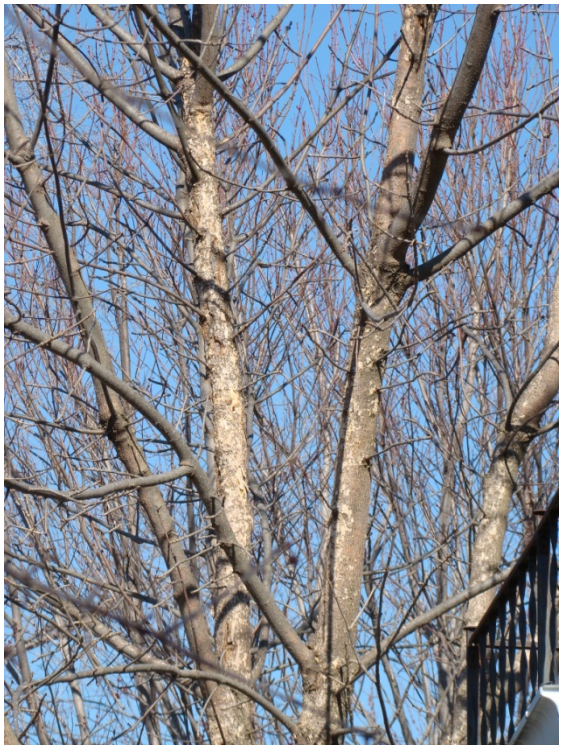
Emerald ash borer

Agrilus planipennis

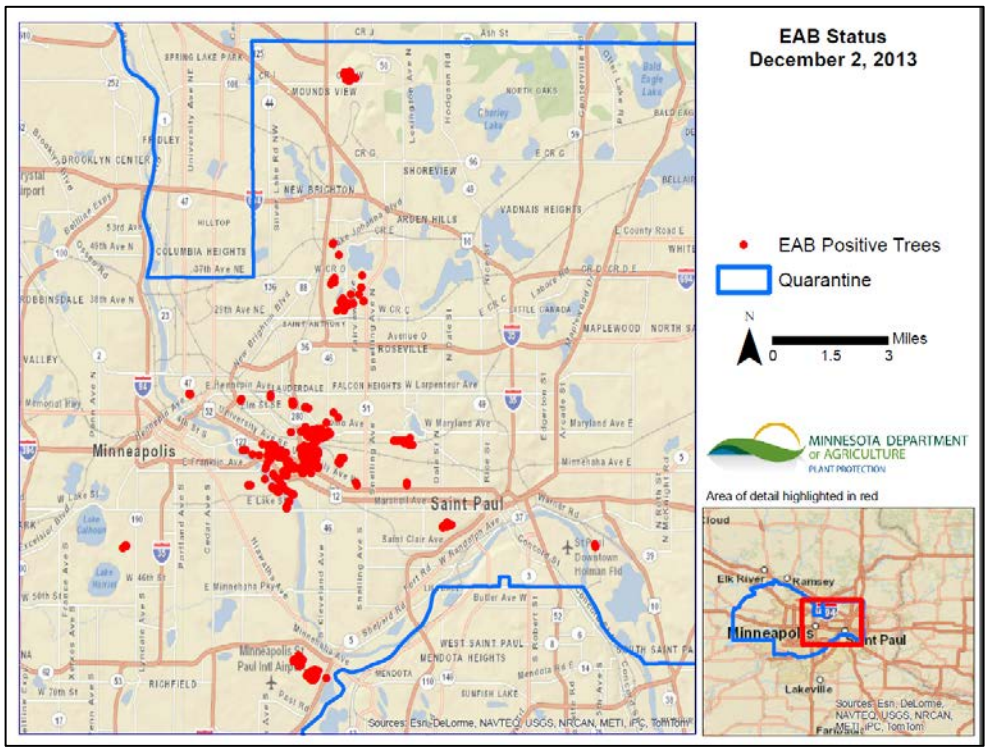
Hosts	Ash species
Setting	Urban and rural forests
Survey method	Ground survey
Acres affected	Not determined
Damage type	Mortality

No new counties were added to the emerald ash borer (EAB) quarantine this year. However, surveys within existing infested counties indicate that EAB is slowly expanding its range. For example, recent finds in the metropolitan area indicate that EAB occurs across a slightly larger area than previously mapped (see map below). In Winona County, tree mortality as a result of EAB infestation indicates that EAB population numbers are increasing in that area.

The only new infestations found were in New Brighton (in Ramsey County and already under quarantine) and in Superior, Wisconsin. Douglas County in Wisconsin is now under quarantine as a result of that infestation. Preliminary surveys in the Duluth area across the bridge from Superior failed to produce any signs of EAB. A more intensive survey will be conducted later this winter when woodpecker damage may be more noticeable.



Woodpecker damage to trees



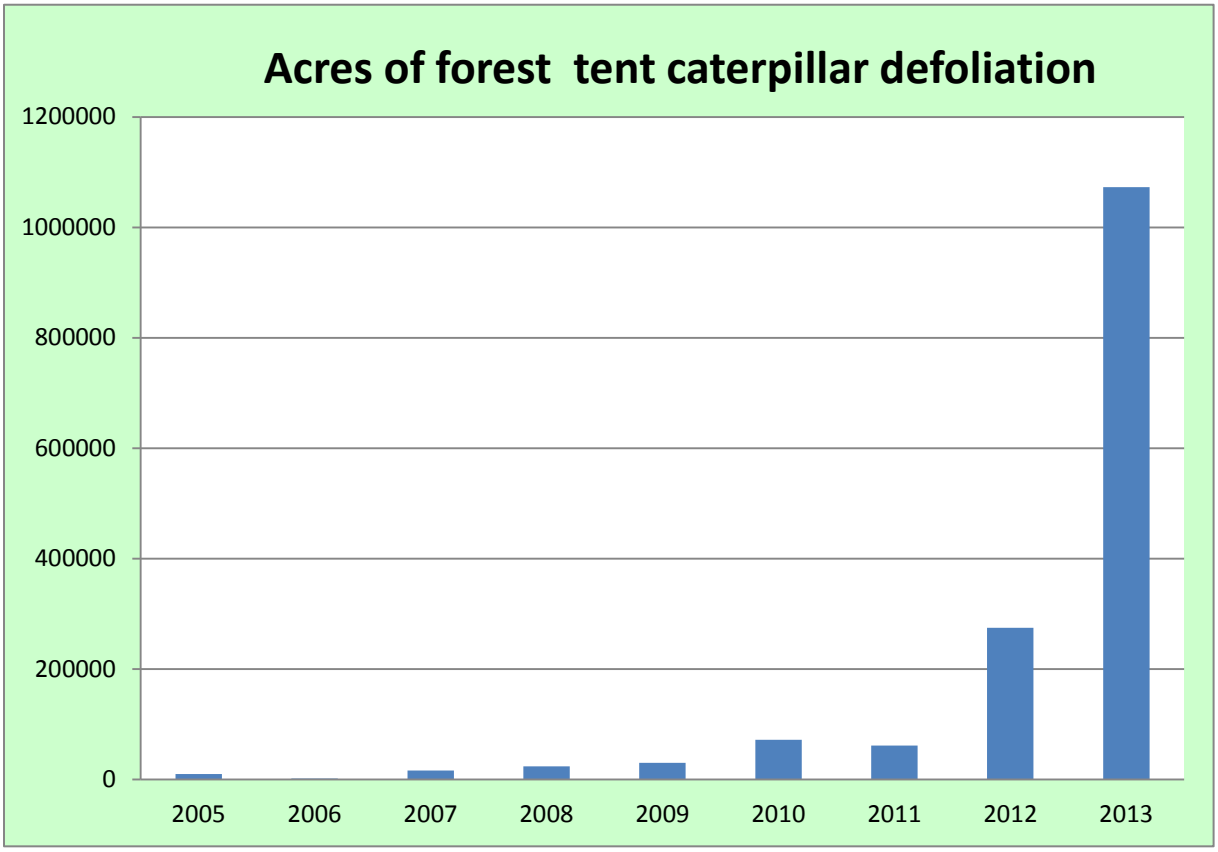
Forest tent caterpillar

Malacosoma disstria

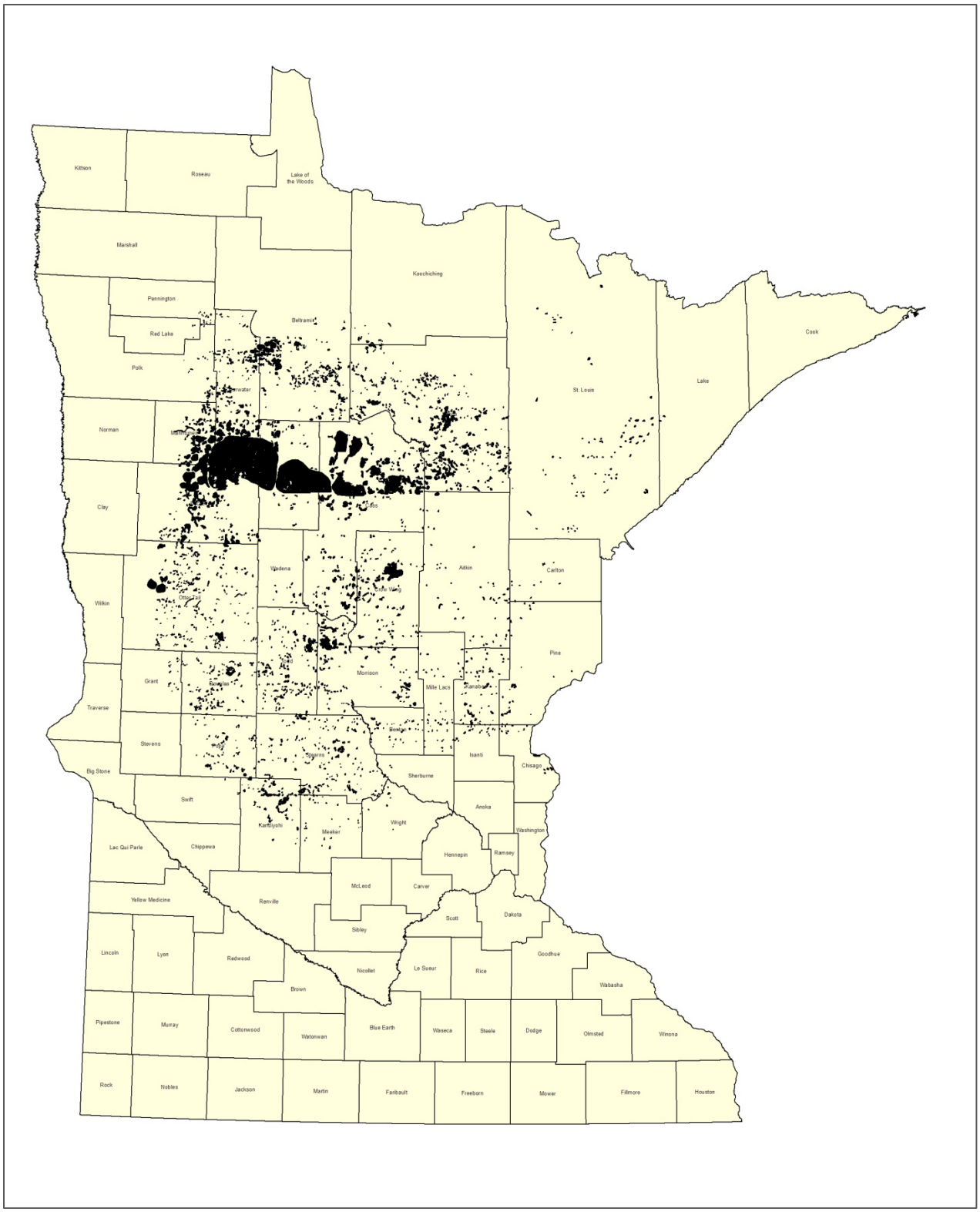
Hosts	Aspen, oak, basswood, birch, willow, other hardwoods, tamarack
Setting	Rural forests
Survey method	Aerial survey
Acres affected	1,073,056 acres
Damage type	Defoliation light, less than 25 percent

Forest tent caterpillar (FTC) populations peak every ten to sixteen years in Minnesota. Looking at recent patterns, 2013 was a building year pointing to a peak in 2014 or 2015. All but one of the forested counties in the state had defoliation by FTC in 2013 (see map on following page). Defoliation nearly quadrupled from 2012, when 274,000 acres were defoliated. The last FTC outbreak peaked in 2002 at more than 7 million acres.

FTC masses on aspen stem



2013 Locations of Forest Tent Caterpillar



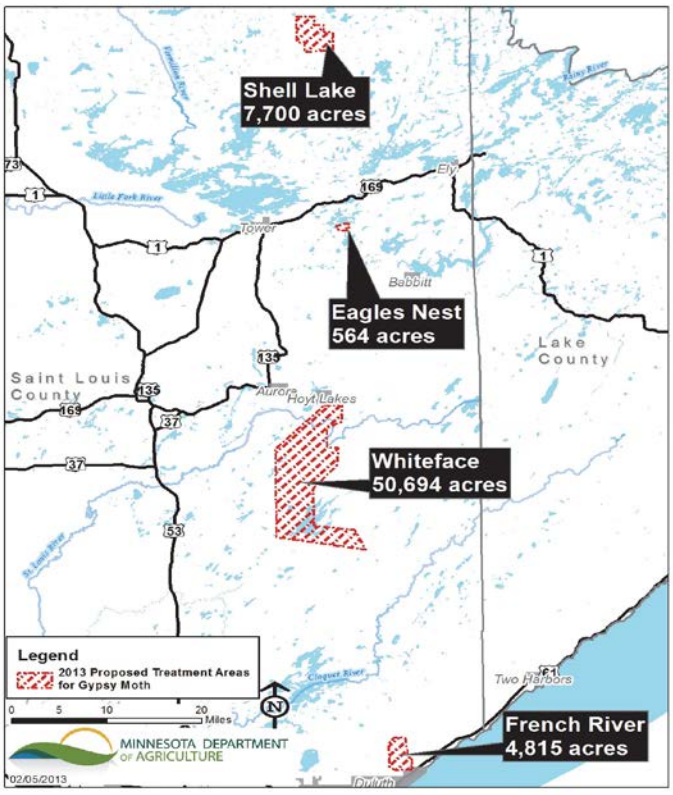
Gypsy moth

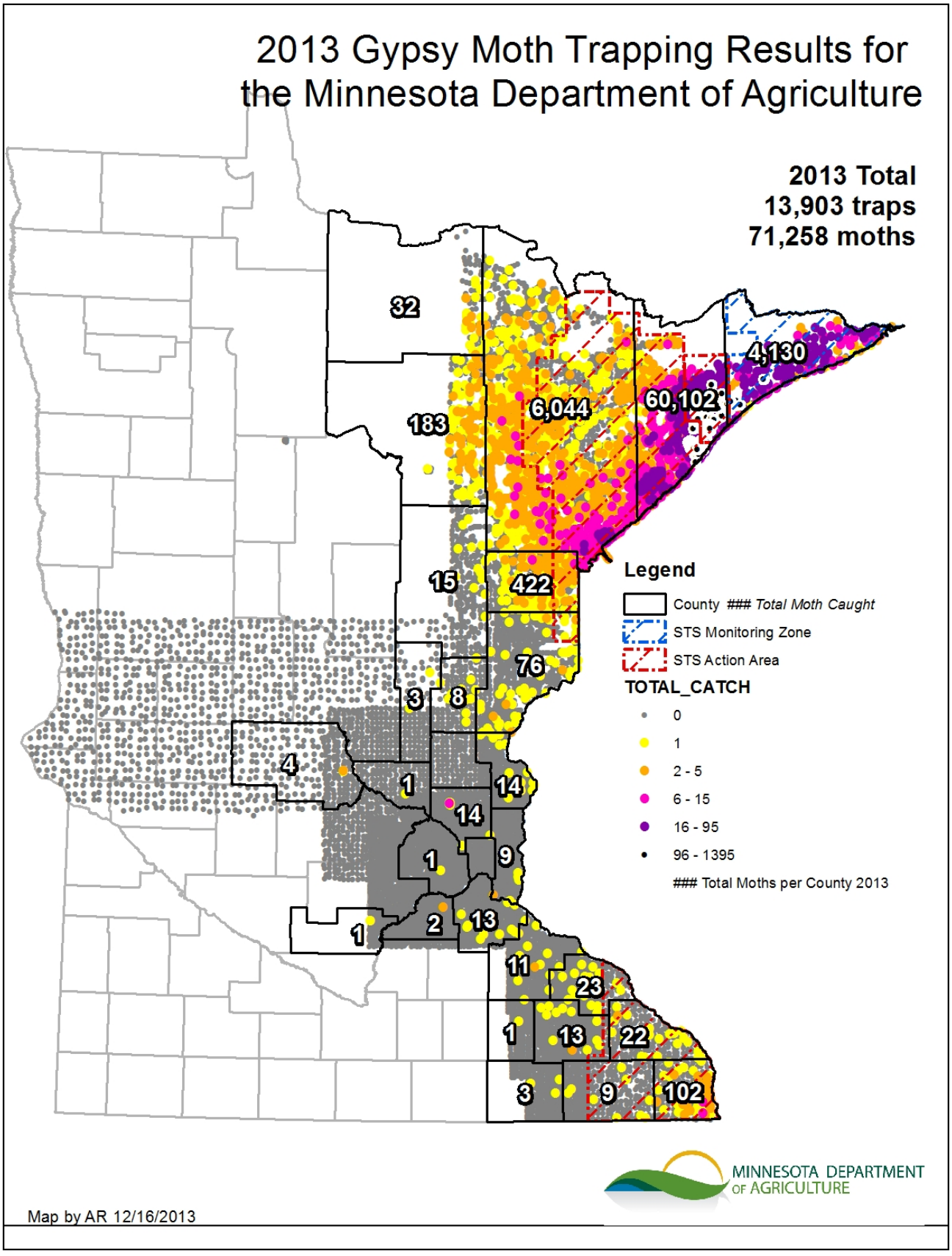
Lymantria dispar

Hosts	Oaks, aspen; other hardwoods
Setting	Rural and urban forests
Survey method	Trapping, ground survey
Acres affected	None
Damage type	None observed

Lake Superior on day of egg mass survey near Split Rock Lighthouse, October 2013

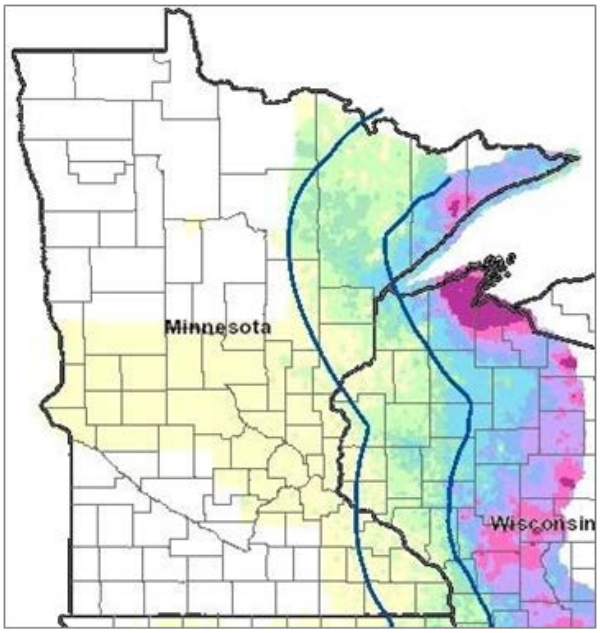
Based on trap captures and life stages found in 2012, the Minnesota Dept. of Agriculture (MDA) treated 57,773 acres from July 23-25 using mating disruption. Treatment blocks are shown in map below.
In 2013, MDA and partners placed13,903 traps across the state and caught 71,258 moths, almost three times the previous record of 28,000 caught in 2009. The presence of a high number of male moths suggests a reproducing population. Nearly all of those caught this year were trapped along the North Shore (see map on following page).

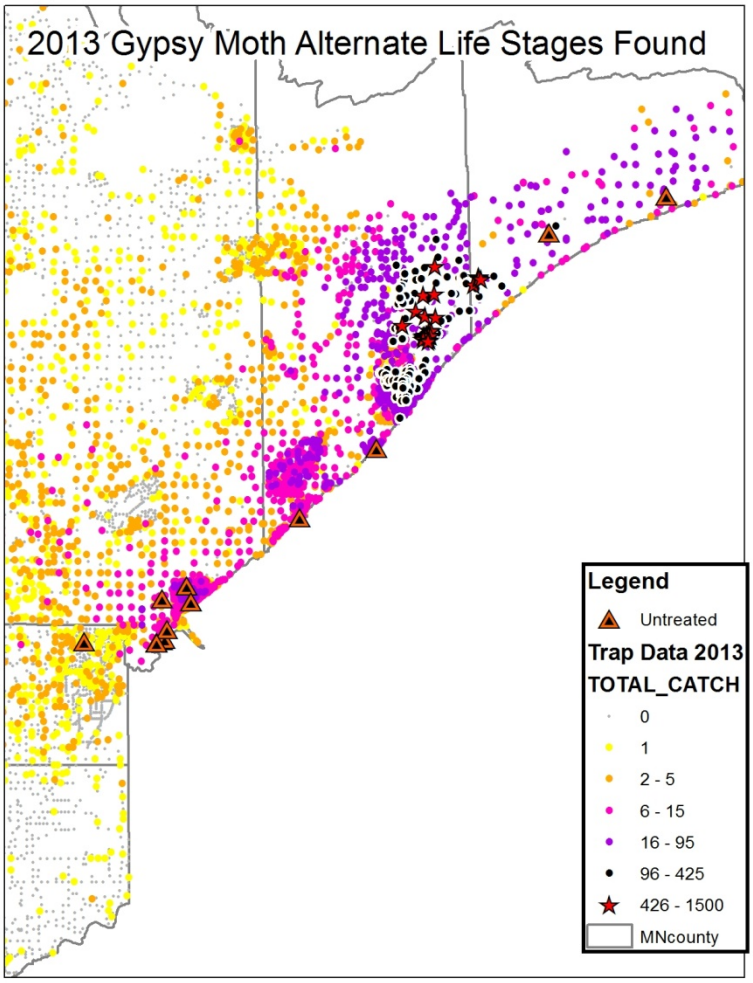



2013 Gypsy Moth Trapping Results for the Minnesota Department of Agriculture
2013 Total
13,903 traps
71,258 moths
32
183
6,044
60,102
4,130
15
422
76
3
8
4
1
14
14
1
9
1
2
13
11
23
1
13
22
3
9
102
Legend
County ### Total Moth Caught
STS Monitoring Zone
STS Action Area
TOTAL_CATCH
0
1
2 - 5
6 - 15
16 - 95
96 - 1395
Total Moths per County 2013
MINNESOTA DEPARTMENT OF AGRICULTURE
Map by AR 12/16/2013

Pockets of high moth captures (map at right) were inspected for signs of alternate life stages. Egg masses, pupae, one adult female moth, and one larva were found at 17 sites.

The combination of high moth captures and alternate life stages along the North Shore prompted two responses. First, the national gypsy moth Slow-the-Spread program adjusted its Action Zone boundaries (see below). The Action Zone has been present in St. Louis County since 2007. This is the zone in which future treatments designed to disrupt gypsy moth mating are most likely to occur. The second response is a recommendation from MDA that Cook and Lake Counties be quarantined in 2014.





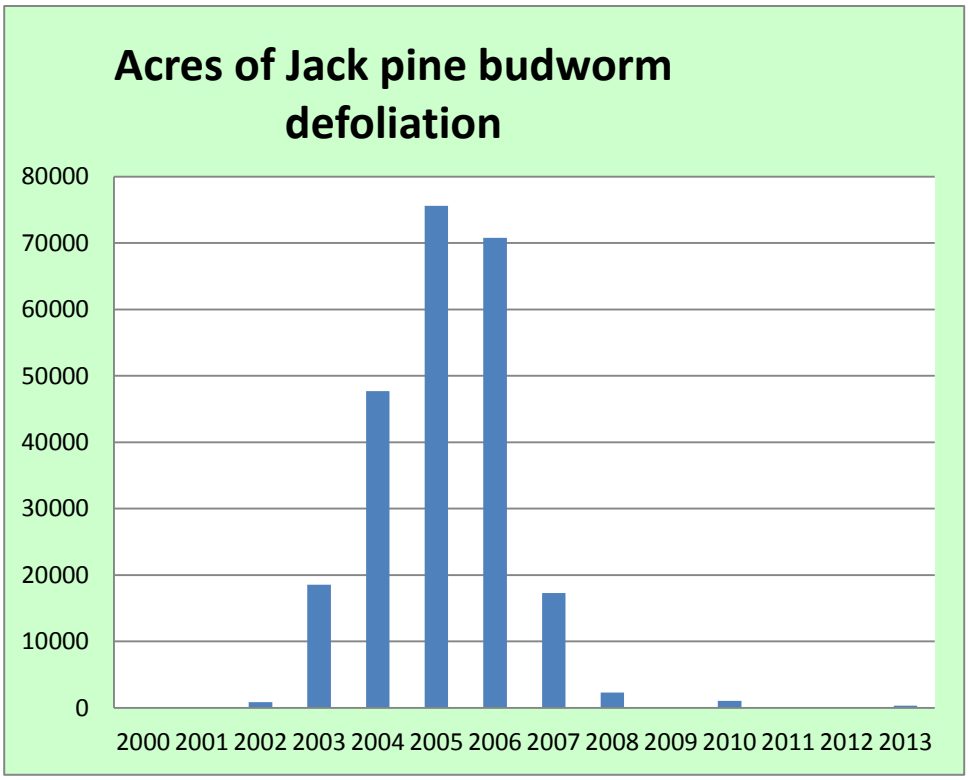
Jack pine budworm

Choristoneura pinus pinus

Hosts	Jack pine, red pine
Setting	Rural forests
Survey method	Aerial survey
Acres affected	324 acres
Damage type	Defoliation

We have had virtually no defoliation caused by jack pine budworm since 2007. The small population detected this year (see map, below right) is expected to build over the next few years, primarily in jack pine stands from Beltrami County to Crow Wing County.

Jack pine budworm pupal cases



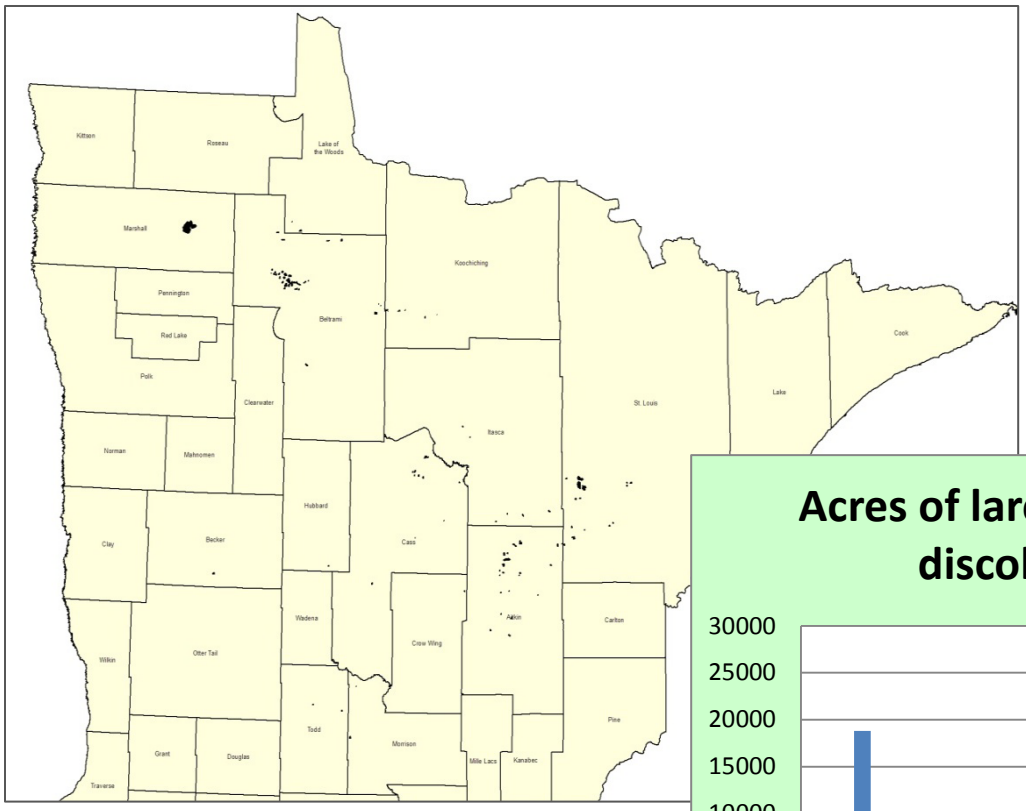
Larch casebearer

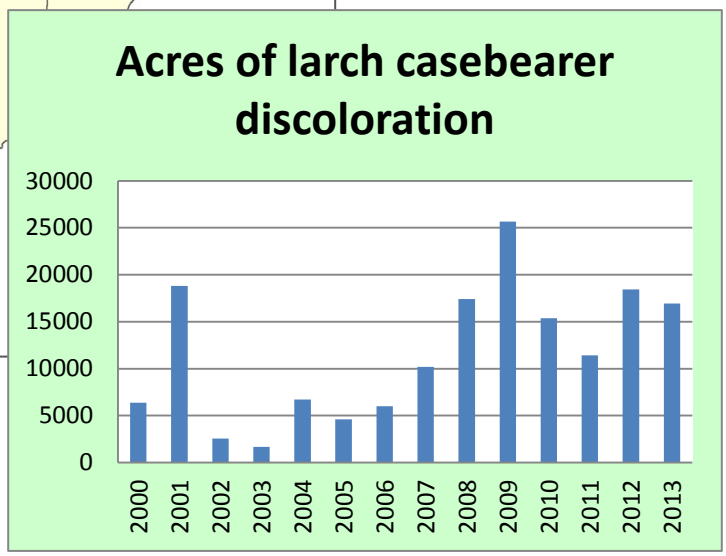
Coleophora laricella

Hosts	Tamarack
Setting	Rural forests
Survey method	Aerial survey
Acres affected	16,933 acres
Damage type	Discoloration

Defoliated acreage is down 1000 acres compared to 2012 (see map below). Larch casebearer defoliation has been mapped on the aerial survey every year since 2000, but no mortality has been observed. Between 1977 and 2000, casebearer damage was not noticeable or mapped and was only occasionally found on isolated trees. The reason for the increase starting in 2000 and its persistence has not been determined.

Orange needle discoloration caused by larch casebearer





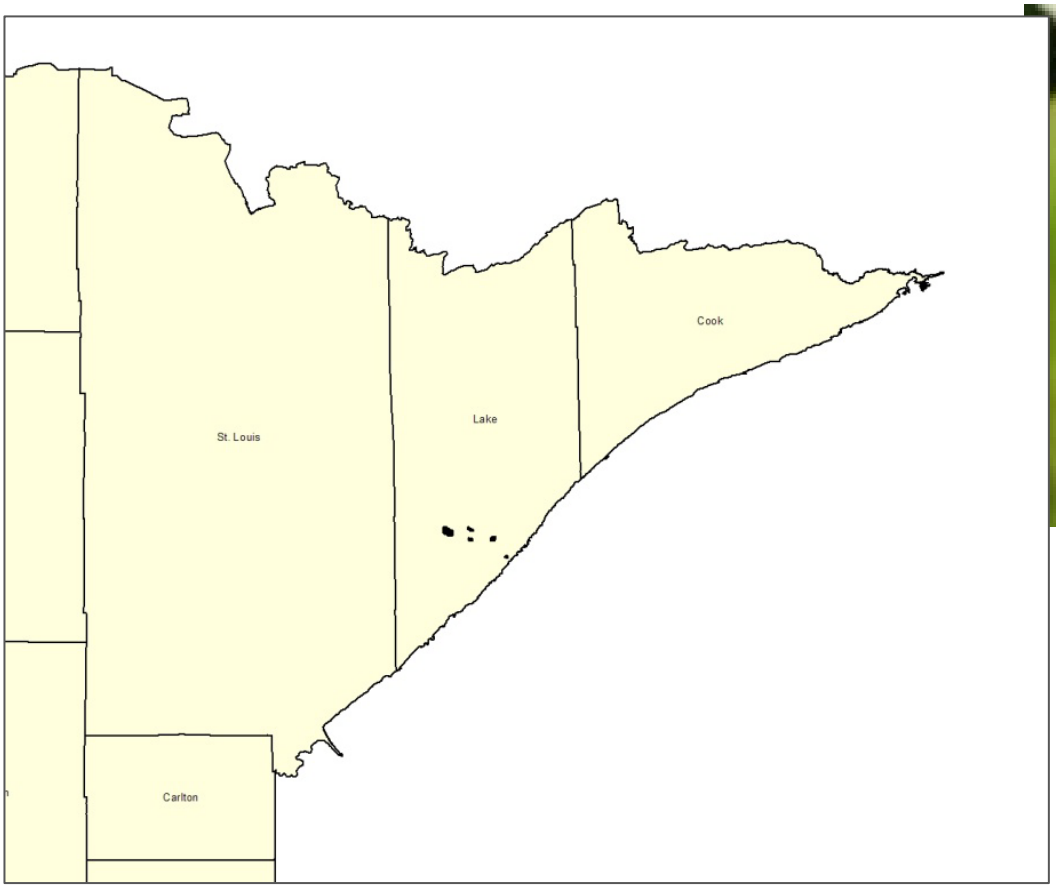
Large aspen tortrix

Choristoneura conflictana

Hosts	Aspen
Setting	Rural forests
Counties	Lake
Survey methods	Aerial and ground surveys
Acres affected	2,552 acres
Damage type	Defoliation

Defoliation by large aspen tortrix was observed only in Lake County (see map below). It periodically causes severe defoliation of trembling and big-tooth aspen across North America. With the exception of forest tent caterpillar, no insect is more widespread or consumes more aspen leaves. The last large outbreak of tortrix in Minnesota was in 1999 when 336,000 acres of defoliation were reported primarily along the north shore of Lake Superior.

Aspen defoliated by large aspen tortrix



Large aspen tortrix pupal case

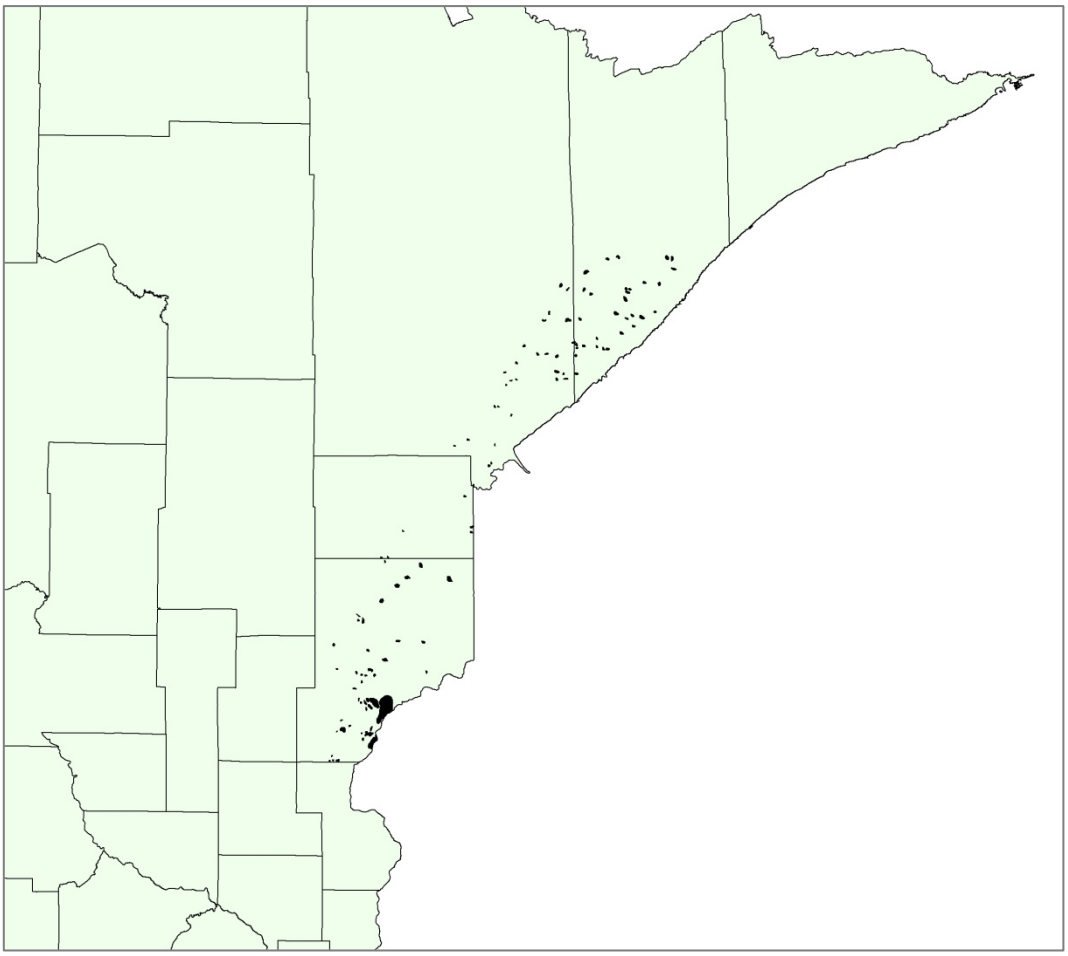
Leaf rollers of aspen

Likely *Epinotia*, *Anacampsis*, *Pseudexentera*, and *Pseudosciaphila* species

Host	Aspen
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	27,928 acres
Damage type	Defoliation

Commonly, when forest tent caterpillar populations build up into outbreak phase, several other caterpillars do likewise. In this case, leaf rollers were abundant enough and caused enough aspen defoliation to be aerially mapped, below.

Rolled aspen leaves. Ron Kelley, Vermont Forestry



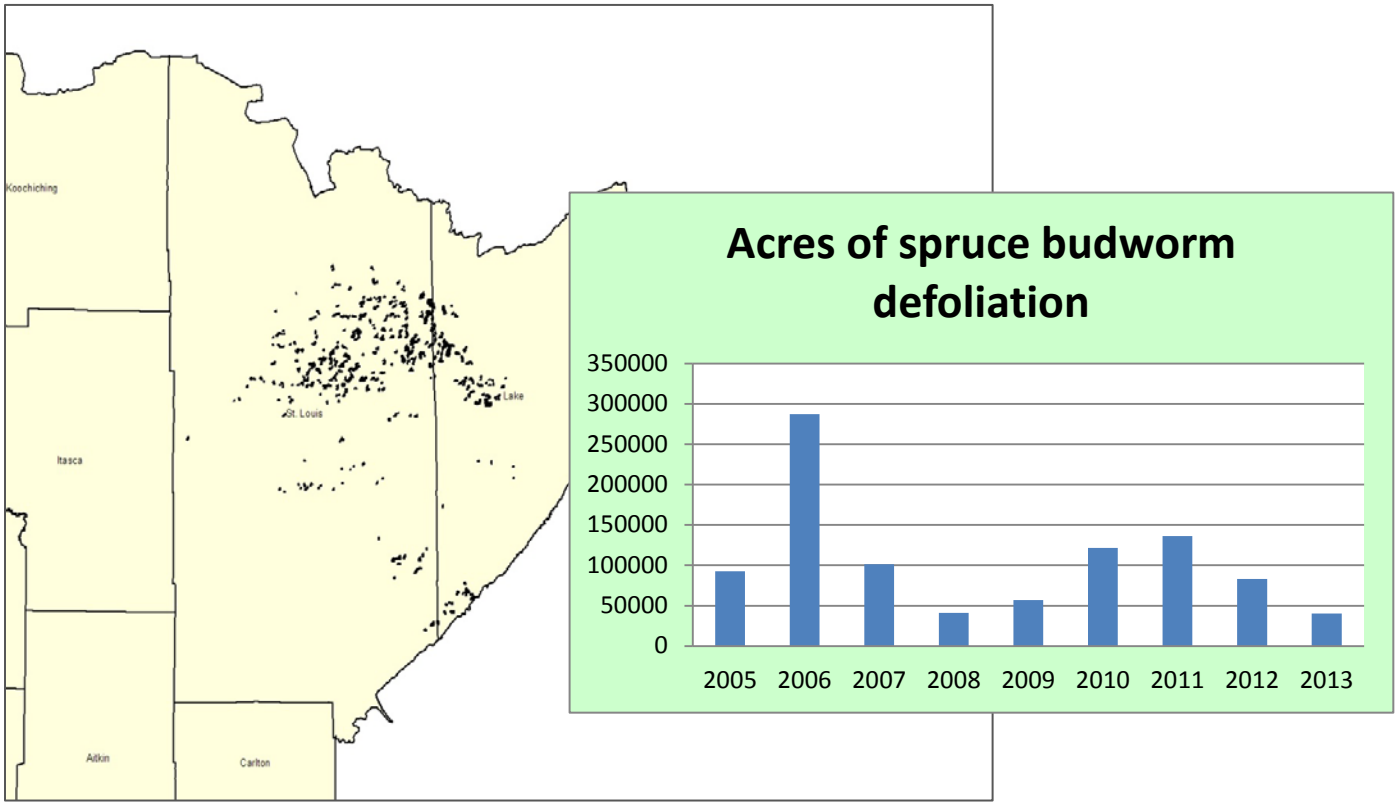
Spruce budworm

Choristoneura fumiferana

Hosts	Balsam fir and white spruce
Setting	Rural forests
Method	Aerial survey
Acres	Defoliation: 38,029
	Mortality: 34,672
Damage type	Defoliation and mortality

A continuous infestation of spruce budworm has occurred since 1954 in the Arrowhead counties. Most polygons mapped in 2013 had both defoliation and mortality (map below). The acreage trend is decreasing in both defoliation and mortality; however, new areas of defoliation are occurring near the North Shore, a location which has not seen budworm defoliation for more than 30 years.

Defoliation (red crowns) and mortality (grey crowns) of budworm-infested balsam fir



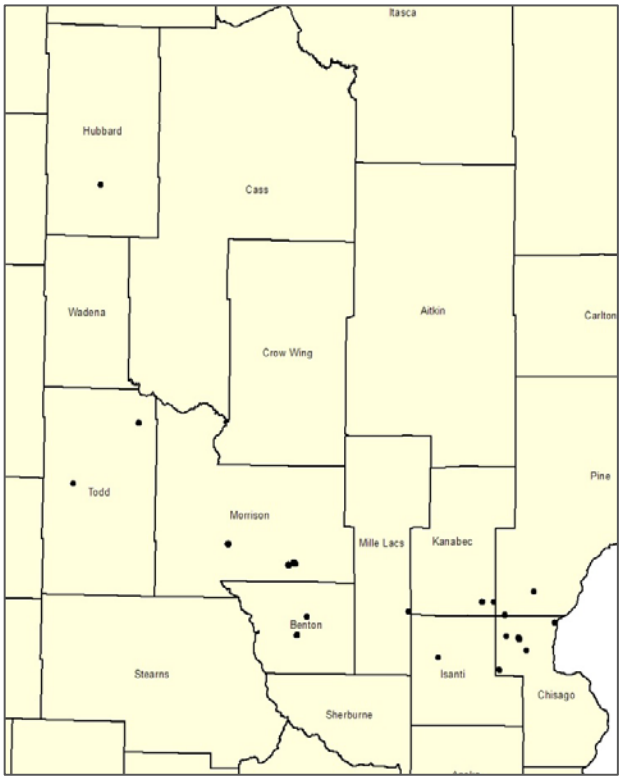
Two-lined chestnut borer

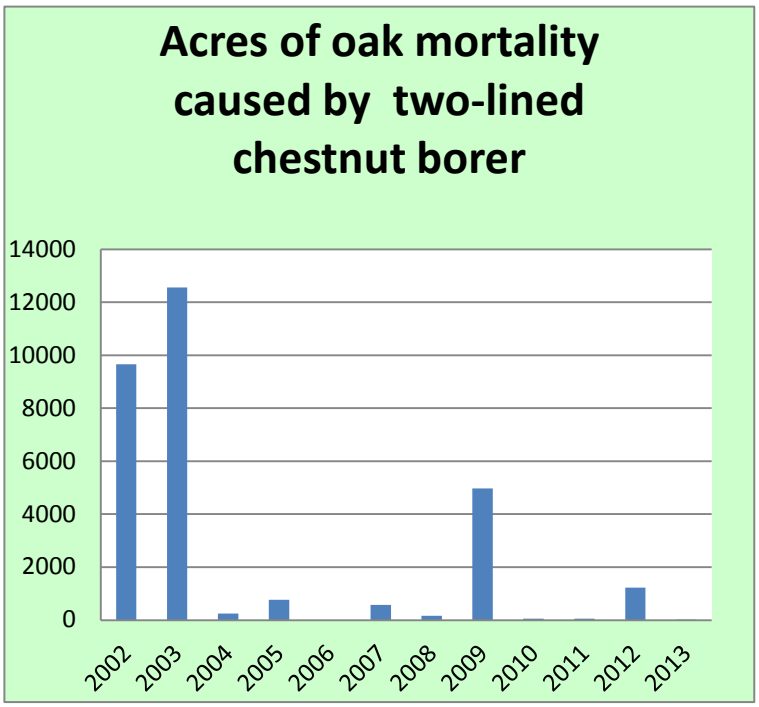
Agrilus bilineatus

Hosts	Oaks
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	22 acres
Damage type	Mortality

In 2012, two-lined chestnut borer caused 1200 acres of mortality (see map below) in oaks, a 20-fold increase over mortality levels caused in 2011. In 2013, mortality levels have dropped back down to nearly undetectable levels.

Crown death after two-lined chestnut borer infestation





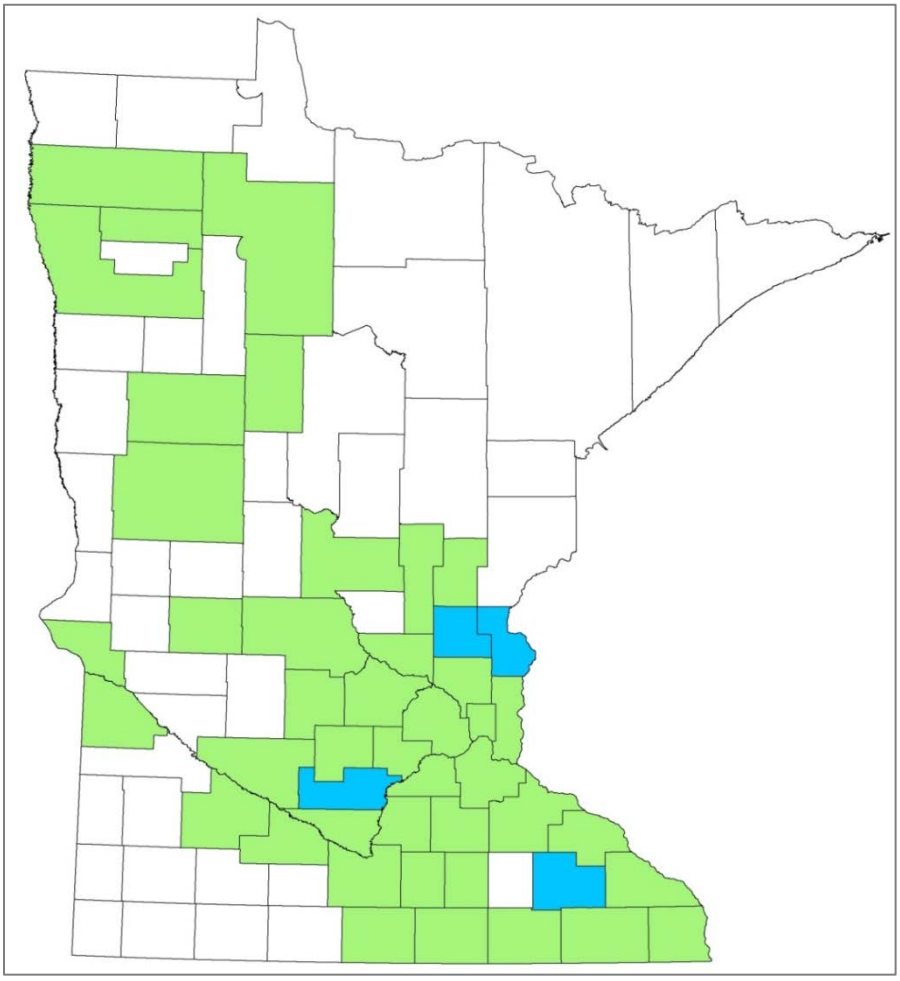
Bur oak blight

Tubakia iowensis

Hosts	Bur oak
Setting	Rural forests
Survey methods	Ground survey
Acres affected	Unknown
Damage type	Discoloration, decline, dieback

Bur oak blight is a recently-named disease and we are in the midst of establishing its range. Four new counties were added in 2013: Chisago, Isanti, Olmsted and Sibley (see map).

Wedge-shaped lesion



Bur oak blight
Blue counties found in 2013
Green counties found from 2010 to 2012

Butternut canker

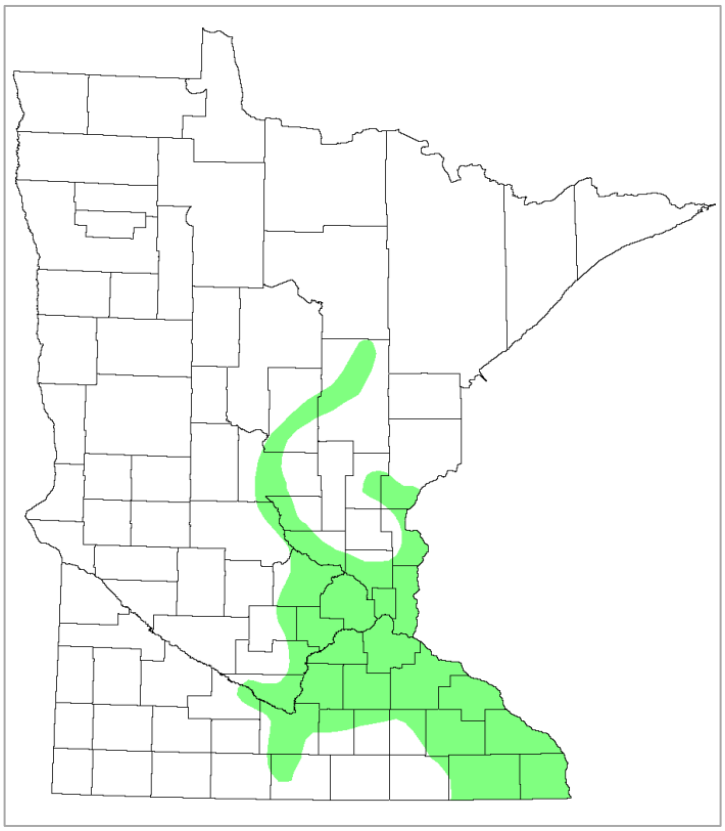
Ophiognomonia clavigigneti-juglandacearum

Hosts	Butternut
Setting	Rural forests
Survey methods	Ground survey
Acres affected	Unknown
Damage type	Mortality

Butternut canker, an exotic fatal disease, has spread throughout the range of butternut species in Minnesota (map below) with the exception of a few outlier locations in Aitkin County. It is generally estimated that more than 99 percent of all butternut trees currently are infected or dead. There is a statewide moratorium on the harvesting of live butternuts and butternut was recently moved up to the Threatened/ Endangered species level.

Crown dieback symptoms due to hundreds of cankers on twigs, branches, and stem

Inky stain on bark above canker in cambium



Range of butternut and butternut canker

Dutch elm disease

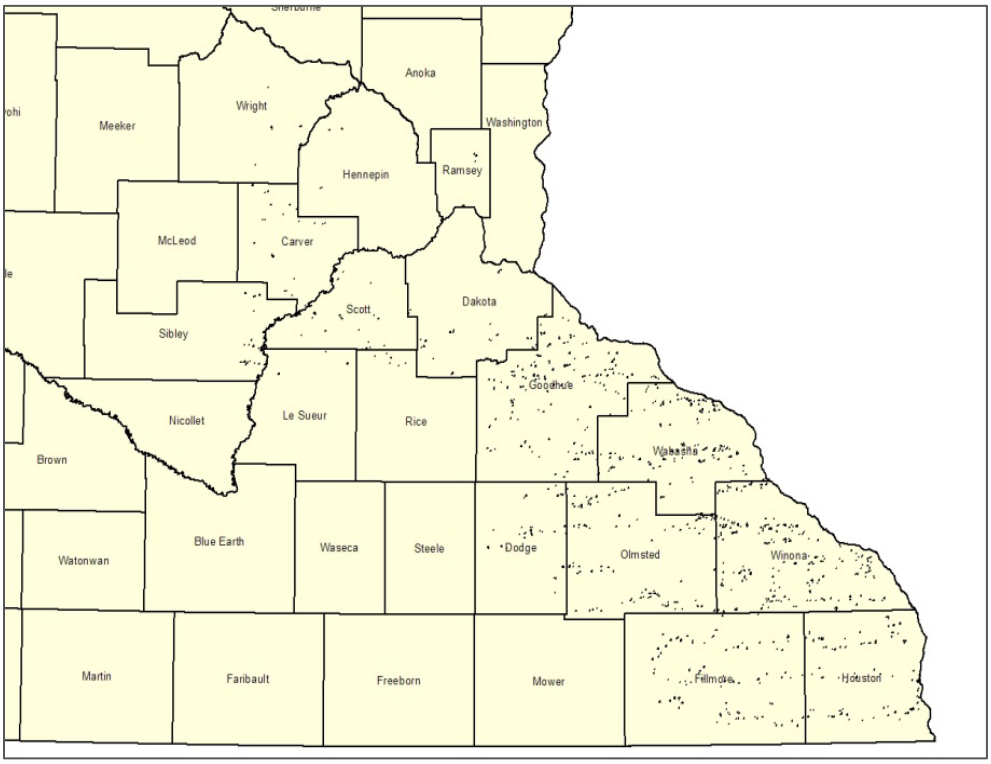
Ophiostoma ulmi

Hosts	All elm species
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	823 acres
Damage type	Discoloration and mortality

Victims of Dutch elm disease

First reported in Ramsey County in 1961, the disease initially spread slowly through the state, possibly due to poor cold tolerance of the most common vector, the European elm bark beetle (*Scoytus multistriatus*). While the disease spread rapidly in the southern third of the state where the European elm bark beetle was more prevalent, the native elm bark beetle (*Hylurgopinus rufipes*) slowly assisted in northward spread. By the early 1980s, Dutch elm disease had been recorded in 84 of Minnesota's 87 counties. Today, all counties have Dutch elm disease. The map below shows areas in southeast Minnesota where Dutch elm disease was mapped in 2013.

Since that time, losses in urban and suburban areas have decreased substantially, due in part to a drastic decrease in the number of surviving trees, but also due to community Dutch elm disease management programs and the development of systemic fungicide injections for remnant, high-value landscape trees. While most large specimens have disappeared from the natural landscape, losses in rural and forested areas continue steadily as elm regeneration seems to keep pace with the disease. Today, Dutch elm disease incidence is highest in the southeastern part of the state where *Ulmus* species are most abundant.



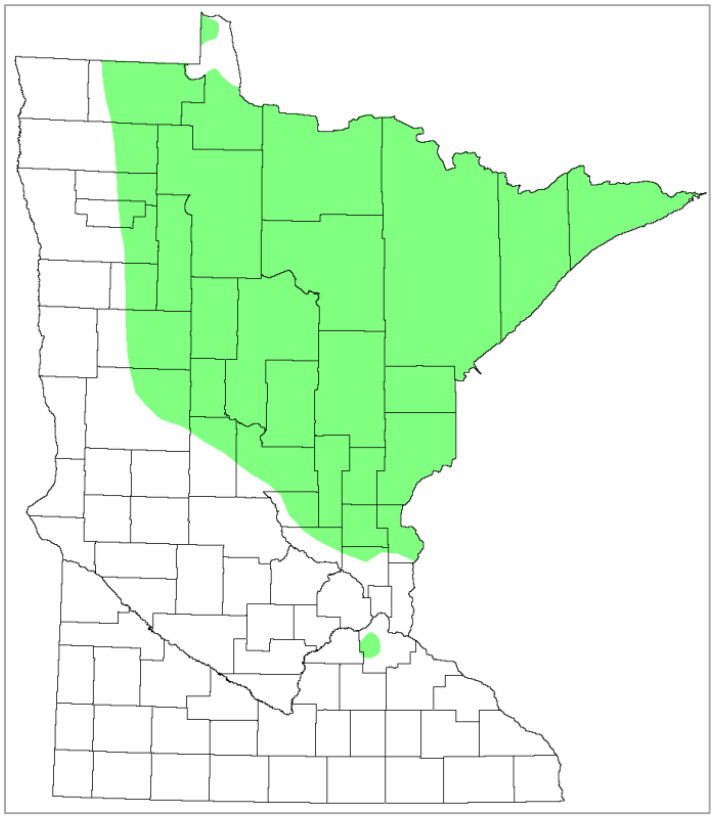
Eastern dwarf mistletoe

Arceuthobium pusillum

Hosts	Black spruce, rarely white spruce and tamarack
Setting	Rural forests
Survey methods	Ground observations
Acres affected	Unknown
Damage type	Mortality

Eastern dwarf mistletoe is a native disease and unlike its western counterparts is always fatal. Timber losses range between zero and 2 percent annually. There are approximately 1,551,000 acres of black spruce in the state and the literature suggests 11 to 25 percent of the black spruce cover type in Minnesota is infested. Losses are not spread equally over the cover type. Infections can be found in unmerchantable stands and along stand edges where the disease has been active for decades or centuries and in new infection centers in timber stands that are roughly circular.

Declining spruce with dwarf mistletoe brooms.



Range of black spruce and eastern dwarf mistletoe

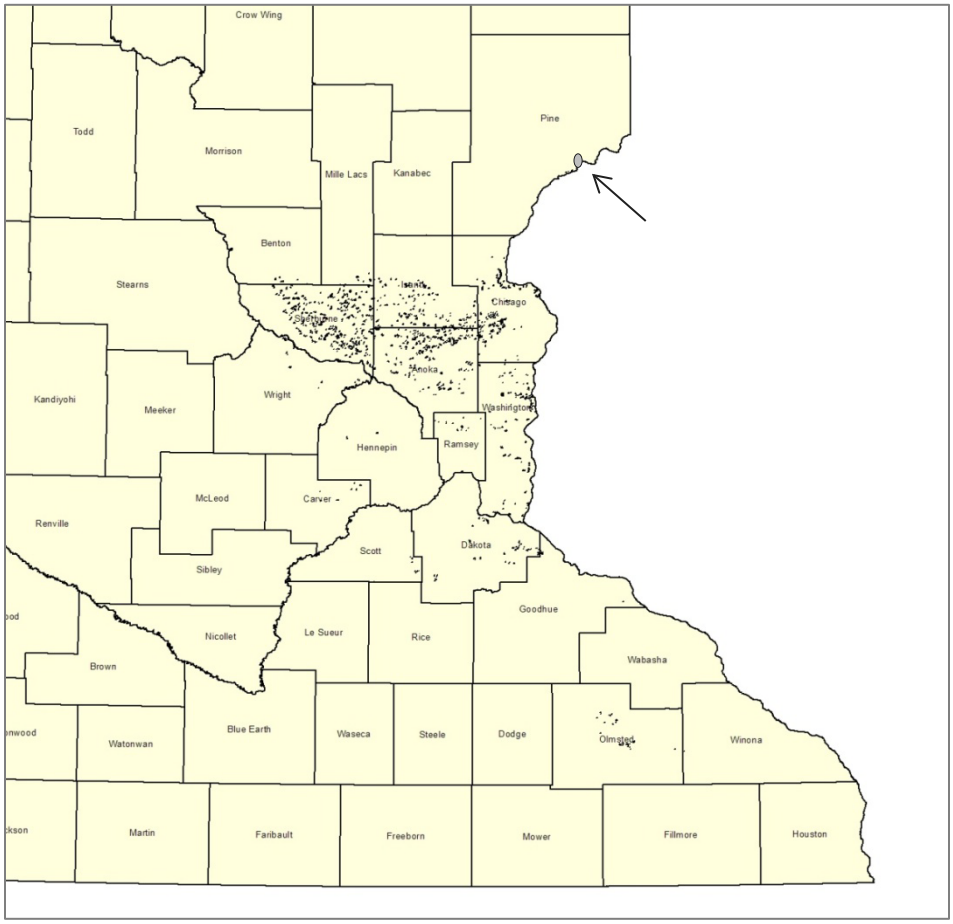
Oak wilt

Ceratocystis fagacearum

Hosts	Red, rarely white oak
Setting	Rural and urban forests
Survey methods	Aerial survey
Acres affected	1473
Damage type	Mortality

Oak wilt was discovered in St. Croix State Park in Pine County in 2012, after the blowdown event in July, 2011 (arrows points to St. Croix State Park). Otherwise, oak wilt's distribution is the same as it was in past years.

Oak wilt pocket on edge of stand. Orange trees indicate the leading edge of oak wilt expansion throughout root systems. Photo, Joseph O'Brien, USDA Forest Service



Scab and black canker of willow

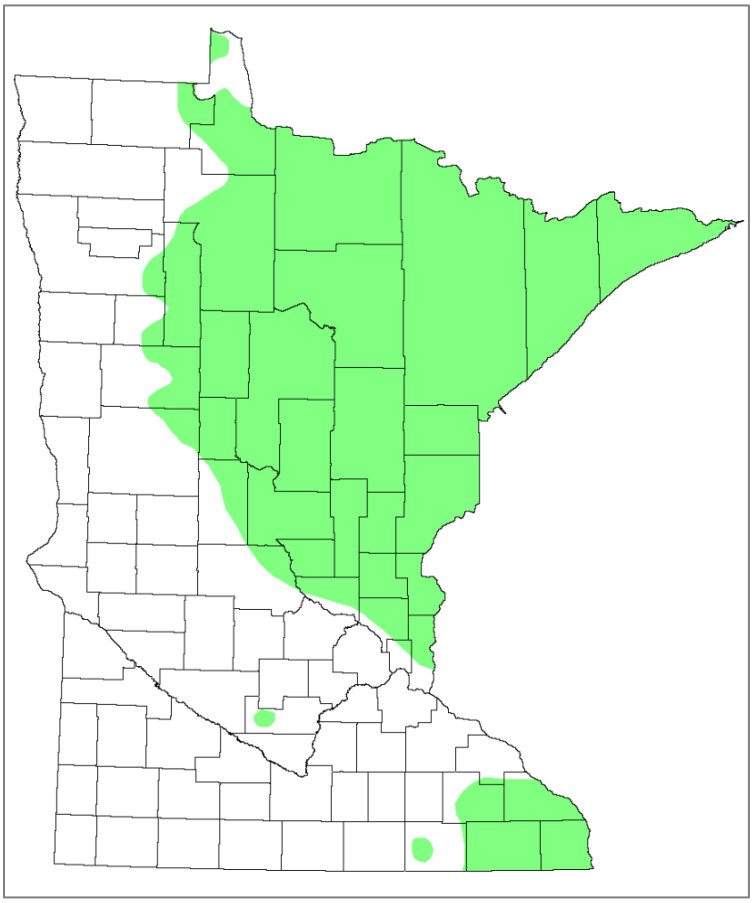
We haven't seen this for a while, since the mid-1980s to be more specific. That's when these two exotic diseases swept into and through Minnesota, having been introduced into New York before 1920. Native willow species are rarely affected, so it's the European species that bear the brunt of these diseases. The diseases were widespread and devastating on willows in Cass, Itasca, Crow Wing, Lake of the Woods, Hubbard and Beltrami counties. Two sites in Cass County had 20 to 80-year-old willow trees that looked like the diseases had been active for at least two years before this. Every twig and branch is dying back and the foliage is 99 percent dead. These diseases can kill anything from seedlings to over-mature willow trees, so the prognosis is not good, especially with cool and rainy spring weather.

Symptomatic willows in June, 2013

White pine blister rust
Cronartium ribicola

Hosts	White pine
Setting	Rural forests
Survey methods	Ground survey
Acres affected	Unknown
Damage type	Decline, dieback and mortality

An introduced, invasive species, this fungus has disrupted, and in many places, crippled natural and artificial regeneration of white pine, and caused topkill in mature white pines since the 1930s. If climate change predictions are correct, less white pine blister rust could be expected all across the range of white pine in the future.



Most blister rust mortality occurs in seedlings and saplings due to stem cankers

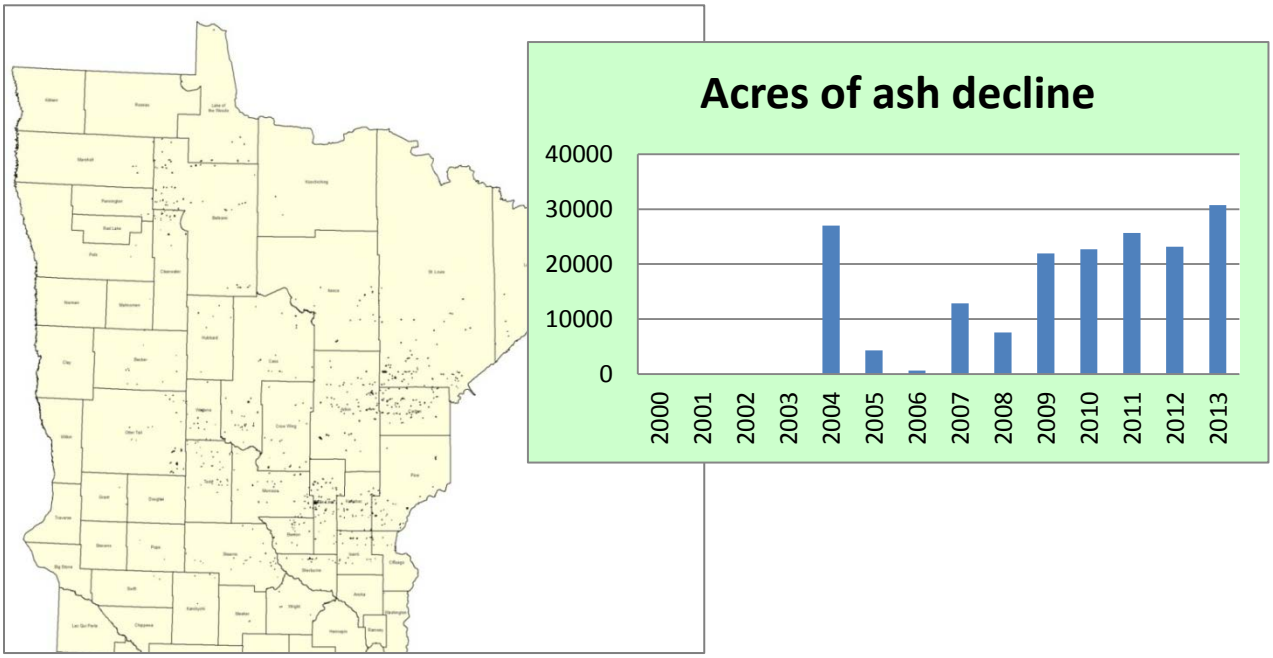
Ash decline

Hosts	Black and green ash
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	30,707 acres
Damage type	Crown decline and dieback

Typical black ash decline symptoms

The incidence of black ash decline increased by7,000 acres compared to 2012 (map below). Decline in ash crowns is reversible with the return of favorable growing conditions on the site. Decline symptoms range from small leaves and discoloration through dieback and top-kill to eventual mortality.

Ash decline is an ongoing problem in Minnesota. The most significant damage occurs on black ash in closed depressions and is thought to be related to the rise and fall of the water table that occur on these sites, affecting rooting depth and availability of water for the trees. No significant insects or fungi are consistently found associated with declining ash trees.

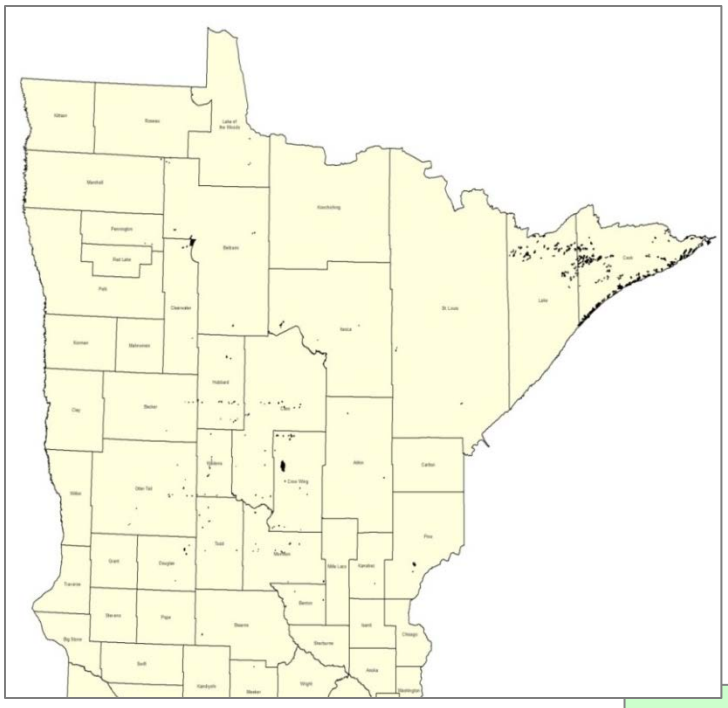


Aspen decline

Hosts	Trembling and bigtooth aspen
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	62,136 acres
Damage type	Crown decline, dieback, and mortality

Aspen dieback and mortality in Cook County

Since 2004, aspen with symptoms of decline have been mapped during the insect and disease aerial survey in northern Minnesota, especially in the Northern Superior Uplands in Lake and Cook counties. Symptoms included a combination of defoliation, discoloration, thin crowns, small leaves, branch dieback, and most often, tree mortality. Mortality varies from scattered individual dead trees to patches of 30 to 40 scattered dead trees to almost 100 percent mortality of the oldest cohort of trees. Ground surveys have found bronze poplar borer as well as Armillaria root disease on many of the dead and dying trees. Stands of trees affected are 30 years and older with most being 45 or more years old.

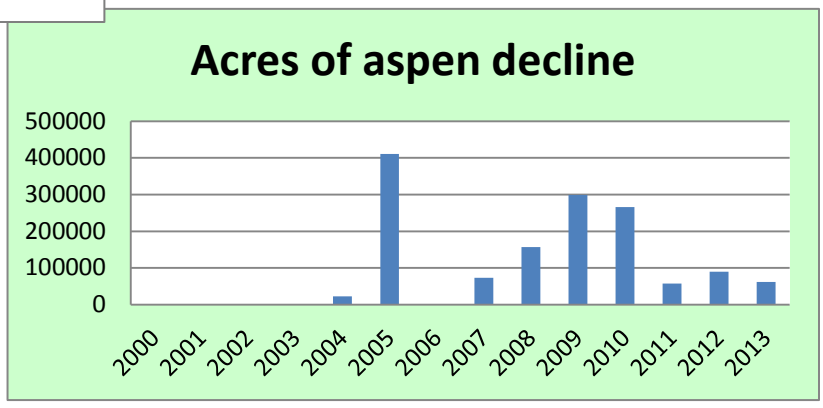


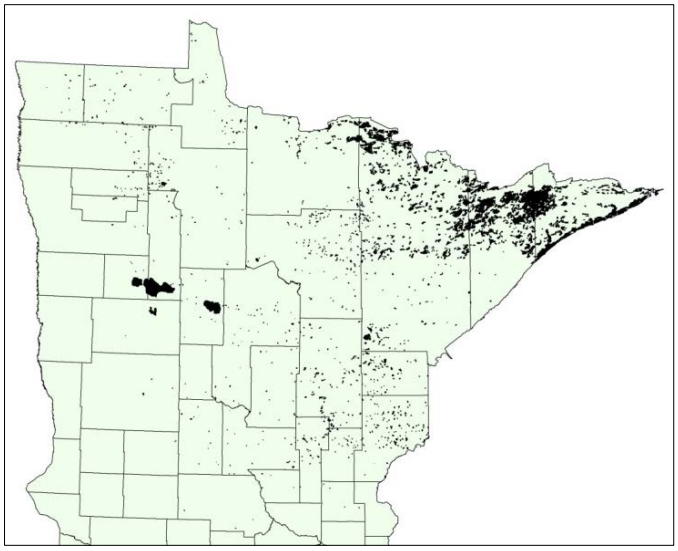
Aspen decline 2013

Many of the affected stands between 2000 and 2003 were stressed by three or four years of heavy defoliation by forest tent caterpillar. They were also stressed by severe summer drought every year from 2003 to 2009.

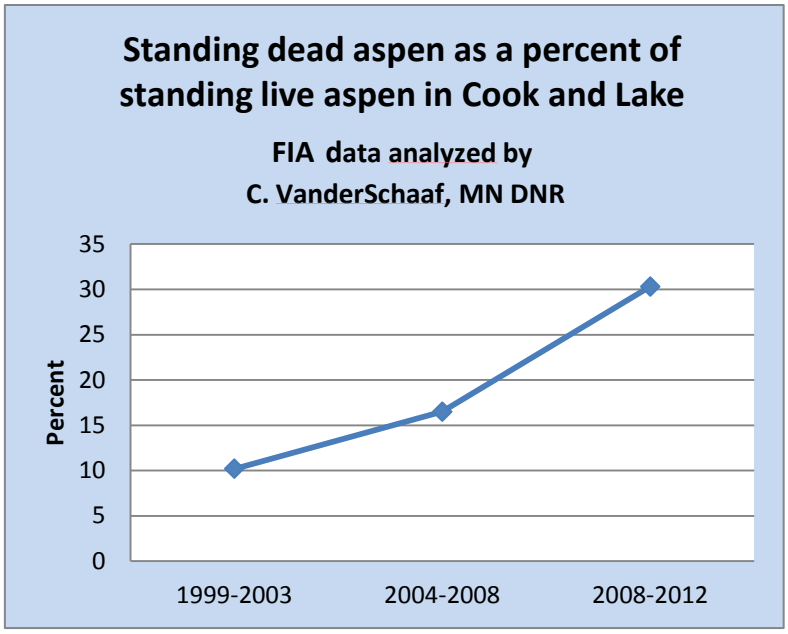
Much of the northern portion of the Northern Superior Uplands occurs on the Canadian Shield, where soils are often shallow over bedrock. These sites have limited water-holding capacity and are affected by changes in climate, such as longer growing seasons that put higher demands on soil moisture and warmer temperatures resulting in more evapotranspiration.

Additionally, more localized summer thunderstorms releasing higher volumes of rain in shorter periods of time create more runoff, resulting in trees having less moisture available during the growing season. Insects and fungi such as bronze poplar borer and Armillaria then attack and kill the stressed trees.





Aspen decline, 2004-2013



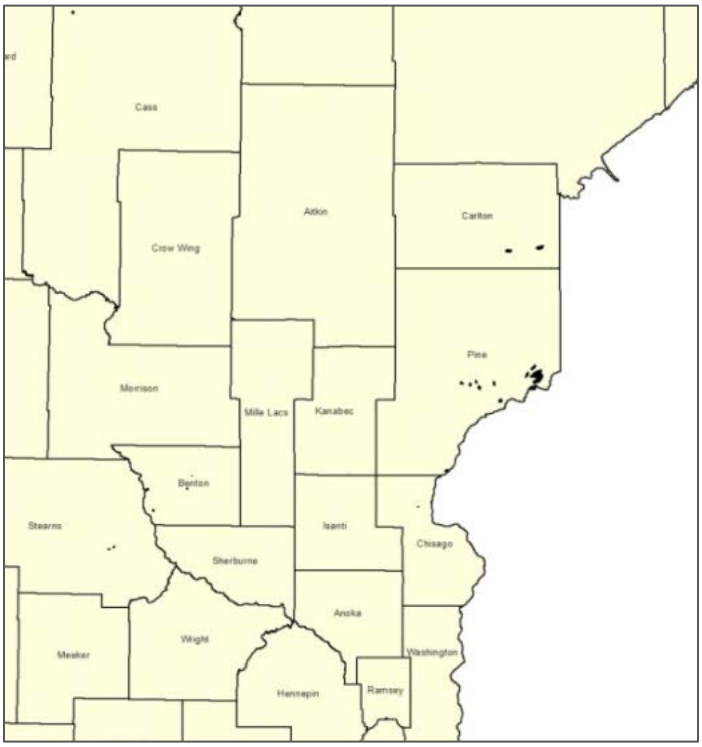
Additional information about aspen decline can be found in Worrall, J. J., G. E. Rehfeldt, A. Hamann, E. H. Hogg, M. Michaelian, S. B. Marchetti, and L.K. Gray (2013). Recent declines of ***Populus tremuloides*** in North America linked to climate. *Forest Ecology and Management 299*:35-51.
This journal article can be accessed at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5426938.pdf

Blowdown

Hosts	All species
Setting	Rural forests
Survey methods	Aerial survey
Acres affected	5,695 acres
Damage type	Stem breakage, up-rooting

In areas affected by wind storms, the build-up of opportunistic insects for the two years following the event could cause mortality in pine, aspen, oak and birch. Rapid and thorough salvage of the downed trees and snapped-off trees is recommended.

Blowdown damage in a pine stand. Photo by M. Lichter, DNR



Area of blowdown in St. Croix State Park

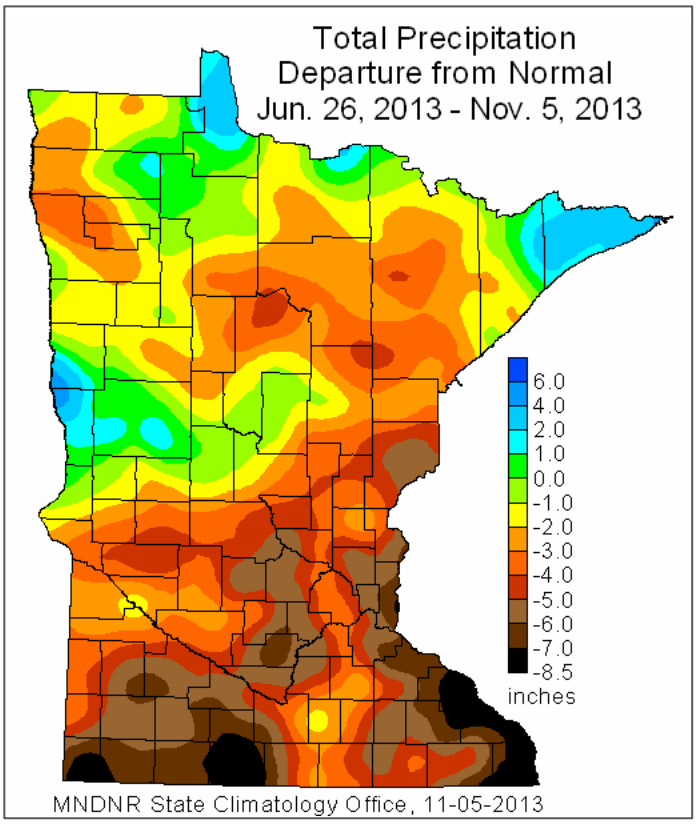
Drought

Hosts	All species
Setting	Rural and urban forests
Survey methods	Ground survey
Acres affected	Statewide
Damage type	Decline, dieback, mortality

2013 was the third year of record-breaking drought and warm temperatures during the winter, spring and summer. Rainfall was abundant in early spring and late fall, but very low during the growing season in the forested parts of the state.

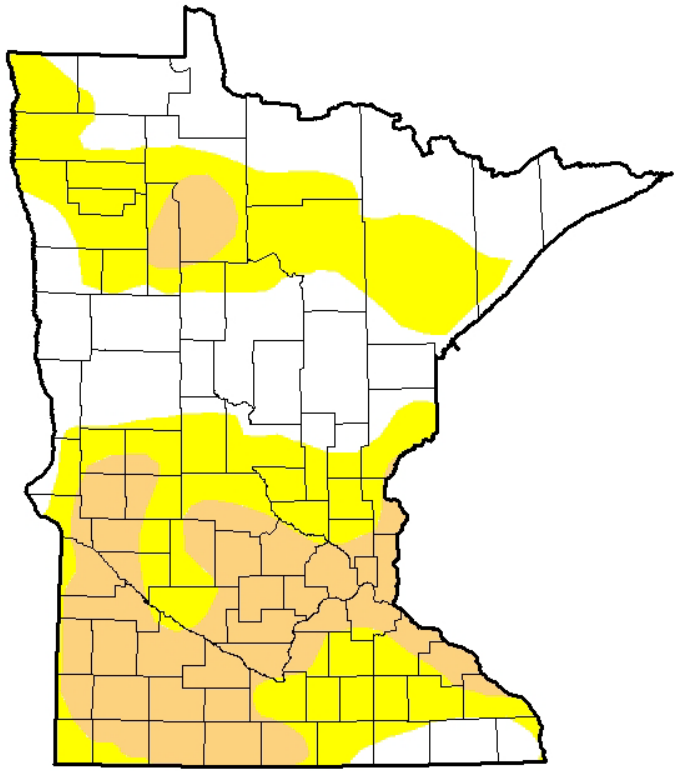
Spruce and balsam fir dying due to droughty weather

Late June to early November precipitation totals were highly variable across Minnesota. Spring and early-summer precipitation totals were ample to excessive in many locations, especially southeast Minnesota. Precipitation totals from the last week of June through early-November were substantially below average in most counties. The seasonal precipitation map (at right) offers a patchwork pattern of values above and below historical normal.



The Drought Monitor on the following page shows that lingering drought occurs in a broad swath across the northern part of the state and in the south-central forests.

U.S. Drought Monitor
Minnesota



November 26, 2013
(Released Thursday, Nov. 28, 2013)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	38.21	61.79	25.12	0.00	0.00	0.00
Last Week *11/19/2013*	38.21	61.79	25.12	0.00	0.00	0.00
3 Months Ago *8/27/2013*	14.64	85.36	54.90	0.00	0.00	0.00
Start of Calendar Year *1/1/2013*	0.00	100.00	97.84	83.44	25.17	0.00
Start of Water Year *10/1/2013*	27.29	72.71	46.69	8.94	0.00	0.00
One Year Ago *11/27/2012*	0.00	100.00	97.91	83.44	25.25	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Richard Heim
NCDC/NOAA

http://droughtmonitor.unl.edu/

List of exotic insects and pathogens not known to be in Minnesota

Asian long-horned beetle
Beech bark disease
Dogwood anthracnose
Fusiform rust
Heterobasidion root disease
Hemlock wooly adelgid
Laurel wilt disease
Sirex wood wasp
Sudden oak death
Thousand cankers disease of walnut