Minnesota Department of Natural Resources
Division of Forestry
Forest Health Unit

2015 Forest Health Highlights

The Minnesota Department of Natural Resources Forest Health Report was created by the Division of Forestry Forest Health Unit.

Cover photo: Top, four-eyed spruce beetle in galleries; right, fall webworm damage; bottom left, oak leaf showing oak wilt.

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

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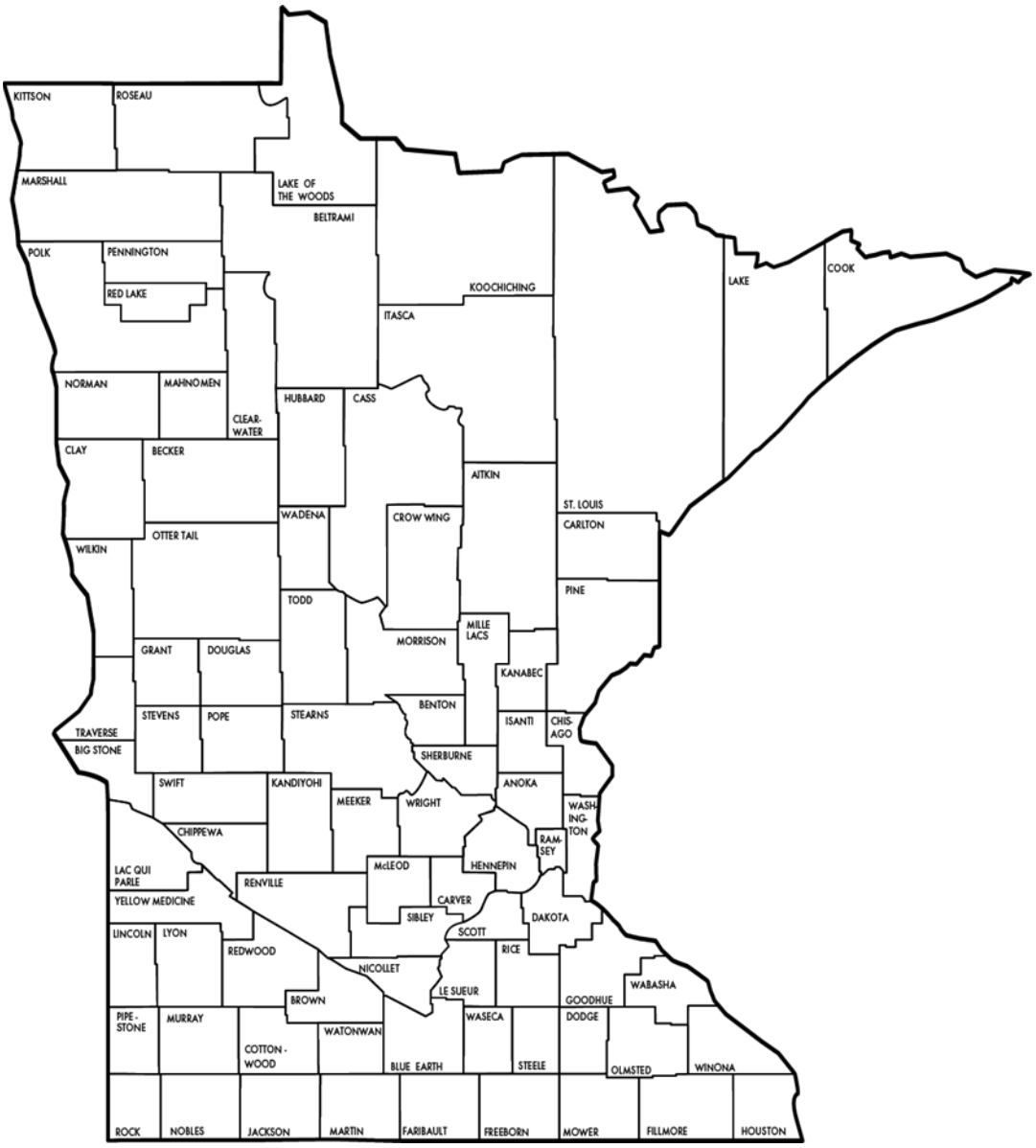
Minnesota County Map



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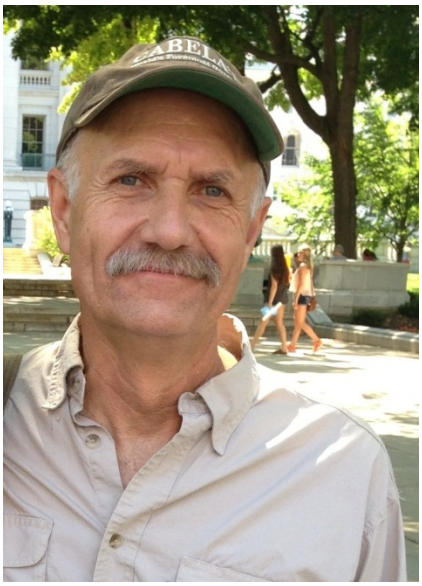
Retired, June 2015

Mike Albers, Northeast Region Forest Health Specialist
Retired, June 2015

Thank you, Mike and Jana Albers

The DNR forest health staff was reduced by two-thirds this year when Mike and Jana Albers bid farewell and entered the world of retirement. Recognized leaders in Midwestern forest health issues, Mike and Jana provided state service for a combined total of 71 years: Mike, 38 years, and Jana, 33. Probably their most significant contribution was in staff training, from entry-level foresters to seasoned field foresters at all levels. Highly sought-after as speakers, they went beyond DNR borders to make presentations to a wide variety of interest groups and partner agencies wanting information about current forest pest issues.



It's difficult to summarize all their good works in a few paragraphs, but I'll list a few accomplishments for which the Albers are well-known. Jana and Mike contributed much of what we currently know in Minnesota about forest pests and their management. Collaboration with cooperators at the University of Minnesota, the US Forest Service, and the Minnesota Department of Agriculture, for example, resulted in important discoveries and many published studies.

Mike led the annual aerial insect and disease surveys, interpreted the data, and reported results in a variety of venues. It has been said that he collected more data on spruce budworm defoliation than anyone in the world! Mike was also instrumental in establishing timber sales guidelines for managing bark beetle populations during pine operations, and for managing dwarf mistletoe in black spruce.

Jana was the editor of the much-loved *Forest Insect and Disease Newsletter* editor for more than 25 years, leading it from the familiar yellow paper copy to a more efficient on-line delivery. Jana's work with *Diplodia* red pine disease in the state nurseries eliminated the disease there, and she developed guidelines to minimize further losses from the disease. Jana also authored work on hazard trees for both state and federal guidelines.

Work accomplished by the Albers is a legacy in the DNR Division of Forestry that will continue to inform program decisions for many years to come. Jana and Mike, we thank you for your dedication, service to Minnesota, and your friendship!

Val Cervenka
MNDNR Forest Health Program Coordinator

Minnesota Forest Resources Summary

Minnesota is home to three major ecosystems: prairies in the west, boreal forests in the northeast, and hardwoods running between the two from the Canadian border to the southeastern area of the state. The forests of Minnesota are many and varied.

Changes in the early years of the 21st century pale compared to the dramatic changes of the late 1800s and early 1900s. During that period, nearly half of Minnesota's forest land was converted to agriculture and other land uses in the wake of widespread logging that peaked in 1905. Since then, the state's forests have been a remarkable story of resiliency and recovery. However, demands on forest resources will continue to increase along with biological threats from native and nonnative diseases, insects, and plants. Minnesotans face the challenge of managing forests to make them available for use and enjoyment today as well as in the future.

Minnesota's forests sustain damage from a combination of abiotic stressors and native and nonnative pests. Many of the native pests are recurring and cyclic and play an integral role in the ecology of Minnesota forests. With the increasing effects of climate warming, some native pests are causing more losses in both hardwood and softwood forests.

Historically, invasive insects and pathogens have had a large impact on Minnesota's forest health. Diseases such as white pine blister rust and Dutch elm disease greatly altered the health and makeup of Minnesota's forests in the 20th century. Oak wilt has proven difficult to manage even though we have the tools available to prevent and control this tree killer.

The early detection and treatment of gypsy moth outbreaks and emerald ash borer, both exotics, have slowed the introduction and spread of these two destructive insects in our state. More threats loom in the continuing fight against nonnative diseases such as *Diplodia* shoot blight and nonnative insects such as mountain pine beetle and Douglas-fir beetle. Monitoring forest damage and surveying for insects and pathogens are crucial to predicting the quantity and quality of Minnesota's future forest resources and to devising ways to manage them.

The U.S. Department of Agriculture Forest Service, through its Forest Inventory and Analysis program and in partnership with the Minnesota Department of Natural Resources Division of Forestry, inventoried Minnesota's forest resources in 1935, 1953, 1962, 1977, 1990, 2003, and 2008. Starting in 1999, annual inventories have been conducted in which a portion of field plots is inventoried each year and a full inventory is completed after five years. Minnesota's first full inventory was completed in 2003, covering 1999 to 2003. The second full inventory, completed in 2008, covers 2004 to 2008. With complete re-measurement of annual inventory plots, we are able to produce better estimates of growth, mortality, and removals, and produce detailed reports on ground land use change.

Results of the 2015 Aerial Survey

Since the early 1950s, aerial survey has been a valuable tool for monitoring forest insects and pathogens across the 16 million acres of forest land in Minnesota. For the past sixteen years, these annual surveys have been accomplished through the collaboration of the Minnesota Department of Natural Resources (DNR) Forest Health and Resource Assessment Units and the U.S. Forest Service (USFS) Northeastern Area State and Private Forestry (S&PF). The Forest Health staff plans the scope, timing, and intensity of the surveys, trains Resource Assessment staff, provides ground-verification and analysis, and disseminates survey data. Resource Assessment staff conducts aerial sketch-mapping on the state lands, digitizes the data, and produces digital shape files. State and Private Forestry conducts aerial sketch-mapping on federal land, does post-flight map rectification, and holds the final review meeting. Aerial survey results are incorporated into the USFS national database. The summary table below shows the amount of acres of damage caused by various insects, disease, and other factors.

Damage agent	Acres affected	# Polygons	Notes
Abiotic cause	55	7	
Armillaria	30	3	
Aspen and birch decline	38,948	303	
Bark beetles	3,150	444	Excludes bark beetles of hardwoods and tamarack
Black ash decline	30,483	793	
Eastern larch beetle	33,786	2,917	
Emerald ash borer	156	625	Includes ¼-acre buffered points from 2013-2015
Fire	7,507	3	
Flooding	1,066	19	
Forest tent caterpillar	65,750	515	
Jack pine budworm	5,210	47	
Larch casebearer	14,220	211	
Northern hardwood decline	4,768	17	includes mixed forests of primarily maple and basswood with components of oak, birch, and aspen
Oak wilt	1,145	1,256	includes 3/4 acre buffered points from 2014 and 2015 (but not overlapping territory)
Spruce budworm	105,520	567	
Two-lined chestnut borer	106	63	
Unknown agent	905	60	
Wind damage	3,232	31	

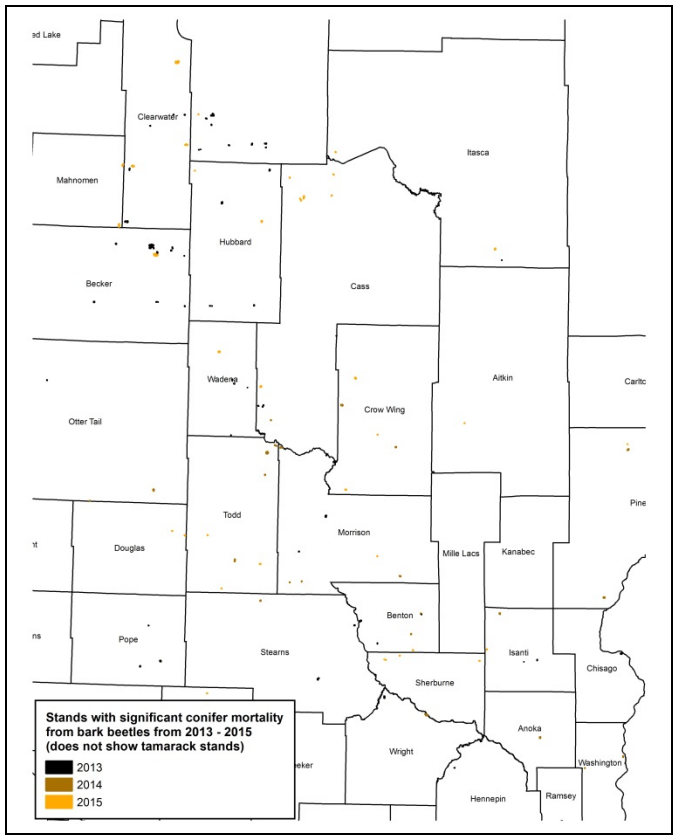
Forest Pest Conditions Report

This report contains pest information from a national list of the major forest insects and diseases that occur within the state and any other pests that cause recordable host damage during the year. Data collected from the aerial survey is entered into the federal Pest Event Reporter database used to produce the National Forest Insect and Disease Conditions Report.

Insects

Bark beetles

Bark beetles included in this article are red turpentine beetle (*Dendroctonus valens*), engravers (*Ips* species), balsam fir bark beetle (*Pityokteines sparsus),* four-eyed spruce bark beetle (*Polygraphus rufipennis*), and spruce beetle (*Dendroctonus rufipennis*).

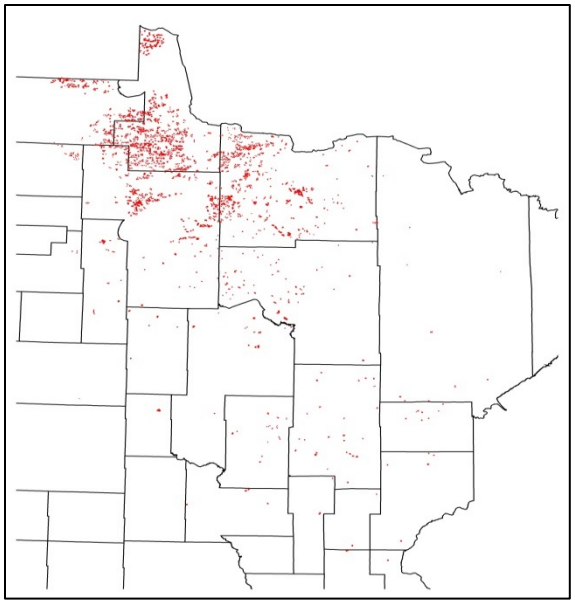


Rarely do conifer bark beetles cause significant damage in a stand or across the landscape. Significant damage from bark beetles can occur after a lengthy drought or after consecutive years of defoliation; damage in an isolated stand is usually due to management activity. For example, thinning pines in summer and leaving logs decked in or near the stand for more than five weeks could result in many residual pines killed by the pine engraver (*Ips pini*) after they have fed on the decked logs.

In 2015, our aerial surveys recorded roughly 2000 acres of coniferous forests (not including tamarack) that sustained significant mortality from bark beetles. We define significant mortality as over 25 percent of the affected conifer species killed in a continuous pattern.

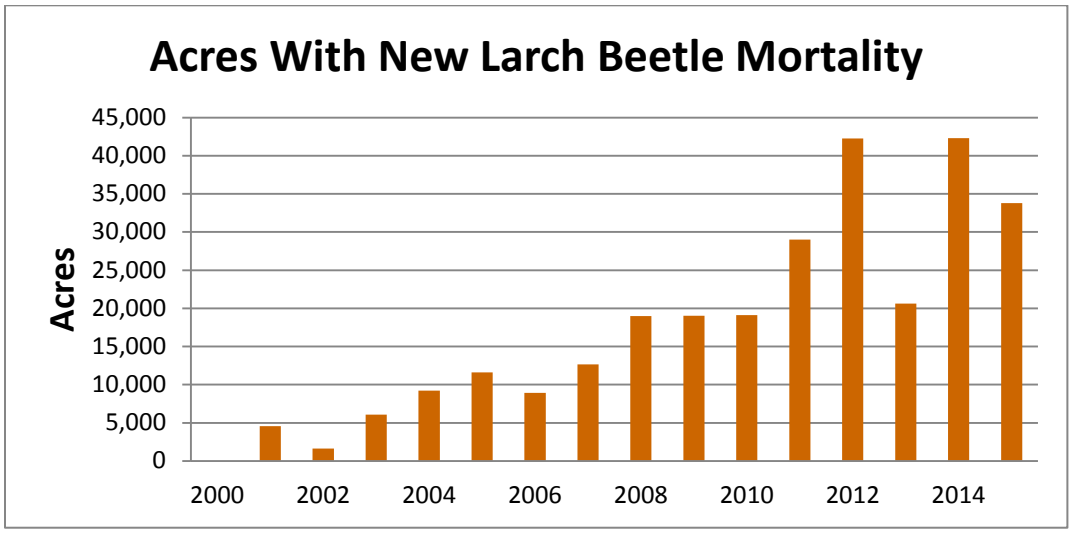
Only 40 percent of the total area impacted by bark beetles in conifers (excluding larch beetle) in 2015 was continuous and moderate or heavy in severity on the impacted host. Bark beetle damage was clustered in a few areas of the state (map above). The total amount of acreage impacted by bark beetles in 2015 is down 30 percent over 2014. Total precipitation from April through September was slightly lower than average in 2015 and 2013 for the generally affected areas, and was considerably below average in 2012. It is likely we are seeing bark beetle damage due to these drier-than-normal growing seasons, and infestations could be tapering off as we get further away from the serious 2012 drought.

Eastern larch beetle continues its assault on Minnesota's tamaracks



Heavy losses of tamarack due to eastern larch beetle (*Dendroctonus simplex*) continued for the 16th consecutive year in Minnesota, primarily in the north-central part of the state (see map, right). Seventy percent of the total area impacted by larch beetle was scattered or patchy in distribution. Since 2001, aerial surveys have mapped 237,000 acres affected by eastern larch beetle in Minnesota, 65 percent of which is on state land. In 2015, more than 50 percent of mature trees on 12,500 acres of forests were killed by eastern larch beetle.

Aerial surveyors mapped twenty percent fewer acres of larch beetle damage in 2015 than in 2014 (see chart below), but it's doubtful this is a trend. According to University of Minnesota researchers, the likely reason eastern larch beetle was abundantly active over the last 16 years is because warm springs and summers allowed them to increase the number of generations they produced in a year, increasing their population and adding intolerable pest pressure to tamaracks. It's likely these conditions will continue. We recommend that currently un-infested mature tamarack stands be regenerated before they are infested, aiding in seed production for future regeneration. Fortunately, very young tamarack is not susceptible to eastern larch beetle.



Emerald ash borer

There was a significant increase in the number of known EAB-infested counties in Minnesota during 2015, from six counties at the end of 2014 to 11 at the end of 2015 (Anoka, Chisago, Dakota, Fillmore, Hennepin, Houston, Olmsted, Ramsey, Scott, Washington, Winona, and Park Point in St. Louis County). This has been particularly notable after a long period with no new EAB finds. The recent expansion of known infested counties is troubling because this pattern of slow growth followed by rapid population growth and spread is a recurring pattern for EAB.

The Minnesota Department of Agriculture (MDA) identified emerald ash borer (EAB) in ash trees on Park Point in the city of Duluth this year. The find was discovered as part of a three-year branch-sampling study the MDA is conducting in partnership with the city. MDA staff found evidence of EAB in four of 35 trees sampled in this way. The trees were lightly infested and did not display any visual symptoms of EAB. The oldest tunneling found on any of the trees was likely from 2014. Due to the unique location of the find, the MDA implemented an emergency state quarantine of Park Point in Duluth.

MDA also conducted a visual survey from January through April in areas considered high-risk for EAB infestation bordering known infested areas. A total of 289 points were visited in the Duluth area, and 16 trees were marked as suspect and re-evaluated at a later date. No EAB-infested trees were found during the survey. Two hundred ten points were visited in the Twin Cities area, and one new EAB infestation was discovered near Lebanon Hills Regional Park RV Campground in Dakota County. This was the first documented occurrence of EAB in Dakota County and the quarantine was expanded as a result. Visual survey was also conducted in southeast Minnesota, and an EAB infestation in Rushford was discovered, expanding the quarantine to Fillmore County.

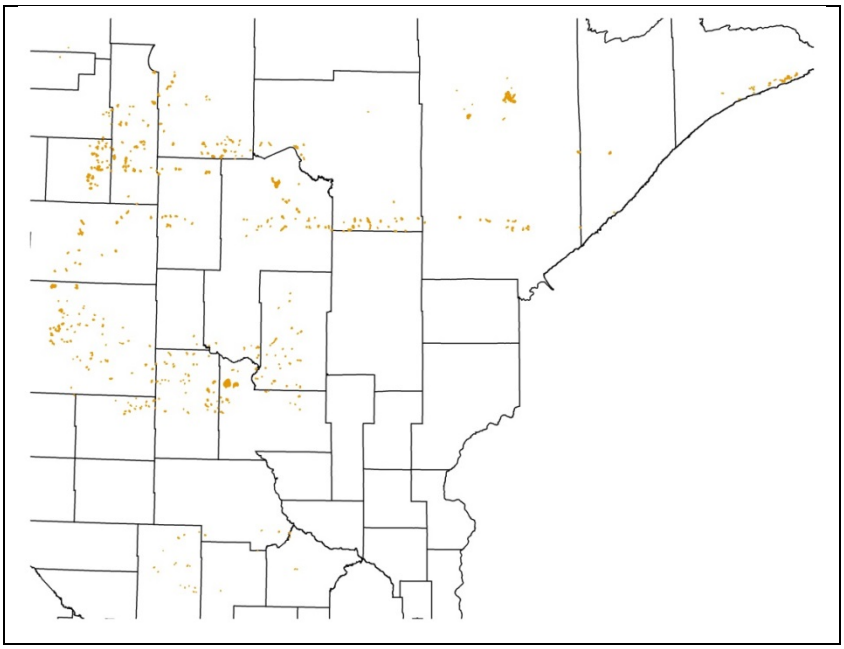
Survey staff set 1,196 purple prism traps in 63 counties, and seven EAB adults were trapped in six traps. It was the first time EAB infestations were discovered in Chisago and Washington counties and both counties were added to the quarantine.

During 2015, MDA released 182,512 parasitoid wasps (151,022 *Tetrastichus planipennisi*; 31,490 *Oobius agrili*) at eleven sites located in the Twin Cities and southeast Minnesota. Of the eleven sites, seven were in the Twin Cities and four in southeast Minnesota. 2015 marked a significant increase in release numbers from past years, with 5,000 more parasitoid releases than the previous four years combined. Recoveries of *T. planipennisi* continue to be made through branch sampling efforts at Great River Bluffs State Park where releases ended in 2013. Branch sampling efforts in the fall of 2015 resulted in 29 recoveries of *T. planipennisi*, 24 more than the previous year. These finds are significant, as this is evidence that the parasitoid wasps are attacking EAB, reproducing, increasing in numbers, and able to overwinter successfully in Minnesota.

Forest tent caterpillar

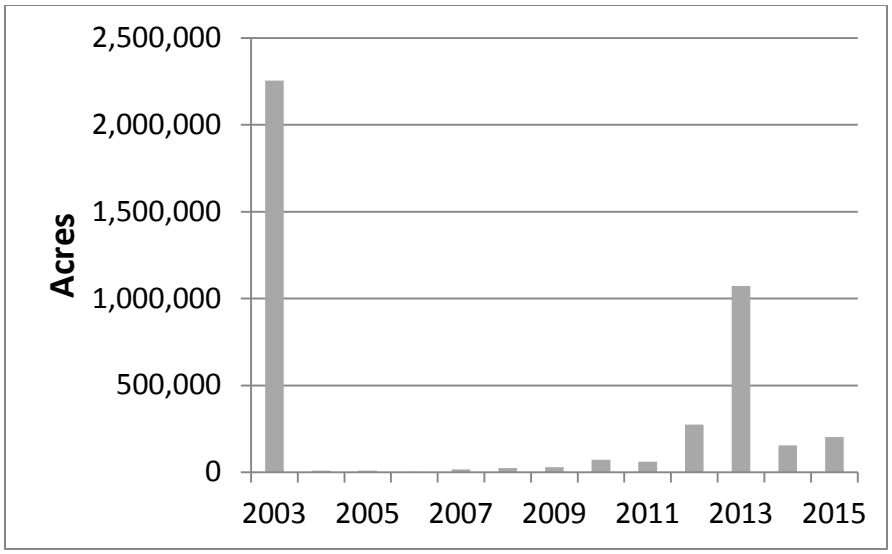
Approximately 205,000 acres were defoliated by forest tent caterpillar (FTC) in 2015. Nearly 70 percent of those acres were labeled with trace levels of defoliation, meaning less than 25 percent of the canopy was eaten. Trembling aspen is the primary species affected by forest tent caterpillar, and losing 25 percent or less of its leaves is not a significant problem for it (or deciduous trees in general). About 50,000 acres of forests affected by FTC were labeled with moderate to heavy levels of defoliation (see map below), or more than 50 percent of the canopy eaten. When a deciduous tree loses over half of its leaves early in the growing season, it will produce a second set of leaves, an energy-intensive process that is stressful to the tree if it happens for several years in a row.

About 2000 acres of forest have been defoliated by FTC at a moderate or higher severity for the last three years. Seventy-five percent of the heavily-impacted forest is on private land in Vermillion Lake Township in north-central St. Louis County. The remainder is in southern Beltrami County.



In forests managed for timber and pulp production that are approaching typical rotation age, forest managers should consider regenerating stands that have been defoliated by forest tent caterpillar for three or more years in a row. By doing this, they will salvage the value of timber that will otherwise die with additional defoliation or stress such as drought.

Forest tent caterpillar populations can be predicted on a stand level with egg mass surveys. Surveys during the winter of 2014-2015 accurately predicted 2015 FTC defoliation 80 percent of the time. The total amount of defoliation in 2015 increased from 2014 by 30 percent, so the general population trend is likely increasing. However, it was still far from any peak typically seen with forest tent caterpillar outbreaks.



Gypsy moth

The Minnesota Department of Agriculture (MDA) captured approximately 1,049 adult gypsy moths this year in traps around the state, up from last year's 523 moths but still a major shift from a 2013 count of over 71,000 moths. Researchers say the 2014 population drop reflected a severe winter, especially in northern Minnesota. However, predictions of a warmer-than-average winter this coming season bring concern that gypsy moth numbers could once again surge. Fluctuating insect populations are not uncommon. Since 2002, MDA trapping data shows gypsy moth numbers have swung up and down across the state.

"Populations often take some time to rebound after drastic crashes such as the one caused by the winter of 2013-14," said Dr. Brian Aukema of the forest insect laboratory at the University of Minnesota. "But while moth populations may be knocked down, they are not knocked out. They have doubled in the past year, for example, and a normal winter will provide the cold requirement egg masses need to hatch in the spring without killing them."

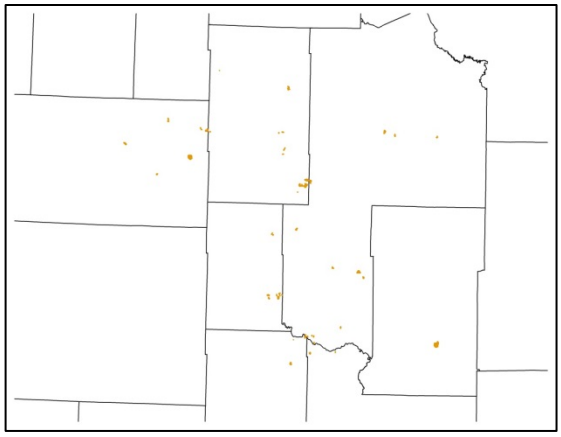
State and federal officials implemented a quarantine of gypsy moth in 2014 for Lake and Cook counties after data showed a low-level reproducing population in the area. The quarantine helps ensure gypsy moths aren't being transported by human activity. Outdoor items in the quarantined counties that could be infested with gypsy moth, such as logs, firewood, camping equipment, and patio furniture, must be inspected and certified as gypsy moth-free before moving to a non-quarantined area.

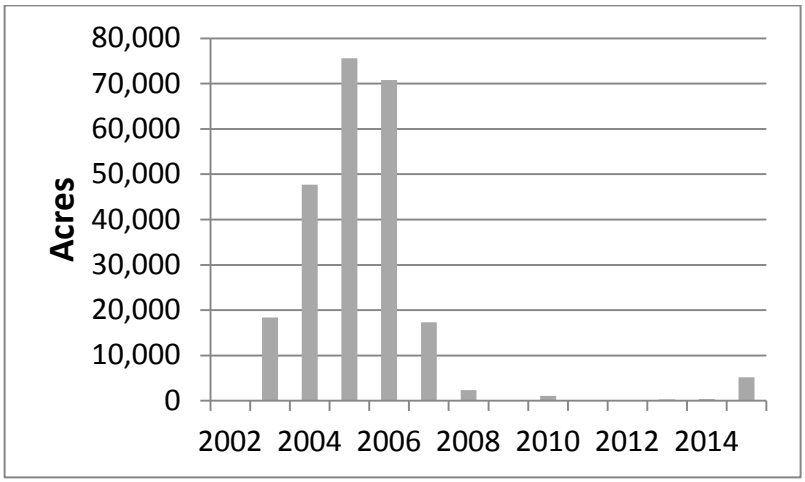
Jack pine budworm on the upswing in western Minnesota

Jack pine budworm heavily defoliated trees in Minnesota's west-central counties in 2015 (see map below). The number of acres of defoliation in 2015 drastically increased from the 2014 total and likely indicates the first year in a multi-year outbreak. In some spots in northwestern Morrison County, budworms consumed all new needles and some 2014 needles. Some of these heavily defoliated jack pines will have dead tops in 2016.

Eighty-five percent of the defoliated areas lie in the ecological subsection called the Pine Moraines and Outwash Plains. The last time this area experienced jack pine budworm defoliation was in 2008. Historically the period between outbreaks is eight years in most of the ecological systems in that subsection. Forest managers can expect most of the defoliated jack pine stands in this part of Minnesota to be further damaged by jack pine budworm for two to three more years. Some stands, particularly those approaching 50 years old, will experience mortality and provide management opportunities for regeneration.

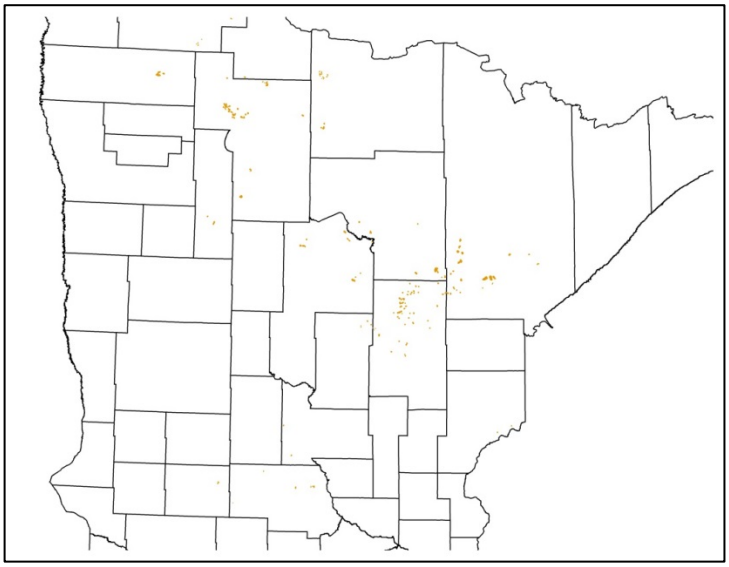
The graph below at right shows the acreage affected by jack pine budworm based on aerial surveys since 2002. The increase in population in 2015 was expected, based on historical population cycles in west-central Minnesota.





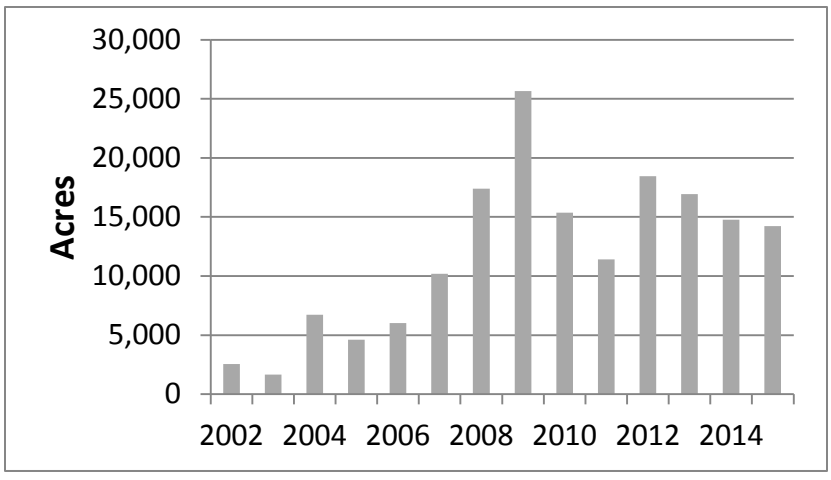
Larch casebearer

2015 represents the 16th consecutive year where larch casebearer noticeably defoliated tamaracks in Minnesota. About 70 percent of the 2015 larch casebearer defoliation was in Beltrami, Aitkin, and southwest St. Louis counties (see map, right). The total amount and locations of larch casebearer defoliation this year was nearly identical to that of 2014. About 20 percent of this defoliated acreage was defoliated by larch casebearer for the last four years.

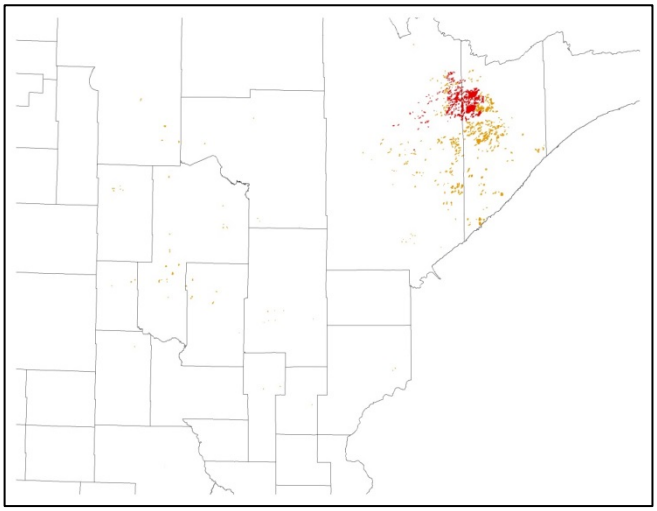


If a tamarack loses a large percentage of its needles from feeding in the earlier summer, it will produce a second flush of foliage to replace the foliage that was lost. That is an energy demanding process, but tamaracks can do it for some consecutive years. About 1000 acres of tamarack heavily affected by larch casebearer in 2015 were also heavily impacted the previous year. These areas are in eastern Marshall and southwestern Koochiching counties. Any such stands near typical rotation ages ideally would be set up for a regeneration harvest, since they are weakened by defoliation and threatened by impending eastern larch beetle infestation.

The graph below illustrates acres of defoliation by larch casebearer from 2000 to 2015.



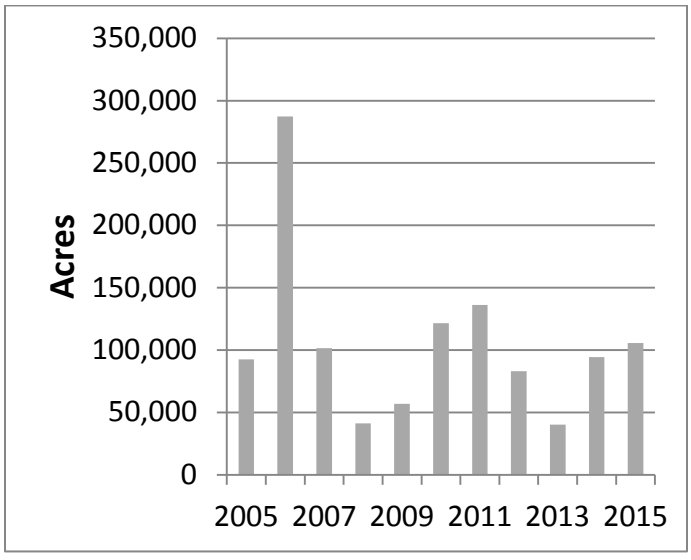
Spruce budworm



Defoliation by spruce budworm has been mapped in northeast Minnesota since 1954, and 2015 was not an exception. Almost 95 percent of the 105,520 acres of the 2015 spruce budworm defoliation was in Lake and St. Louis counties, as it was in 2014. Areas shown in red on the map at right represent defoliated spruce and fir plus trees that died from previous defoliation. Areas in orange show only defoliated trees. Mortality from past defoliation was noted on 45 percent of the impacted acreage in 2015, and approximately 15 percent of the 2015 acreage was defoliated by spruce budworm in each of the last six years. The total amount of defoliation in 2015 was up about 10 percent over that in 2014, and the same area will likely experience significant defoliation next year.

Since 2014, the densest area of spruce budworm activity has been southeast of Ely in west-central Lake County (Stony River Township). Managers should expect spruce budworm to be in this area for about eight years. The majority of mature balsam firs will die eventually from repeated defoliation. Mortality in a given spruce-fir stand will not begin until the new shoots of firs have been significantly defoliated for about 5 years in a row. This predictable mortality suggests timber managers should start establishing regeneration harvests in the area's spruce-fir stands to capture timber value before it diminishes due to projected mortality.

The graph below illustrates acres of spruce budworm since 2005 based on aerial survey data.



White-spotted sawyers abundant in northwestern Minnesota

At the end of June and early July 2015, concerned citizens made a rash of calls to the DNR reporting unprecedented and annoying numbers of longhorned beetles. Most reports came from Roseau County, but these beetles were noticeably abundant in Park Rapids too. Photographs showed at least some of these longhorned beetles were white-spotted sawyers (*Monochamus scutellatus scutellatus,* photo at right). A widespread event creating abundant freshly-killed or stressed conifers in 2013 or early 2014 could have promoted numbers of white-spotted sawyers; the eastern larch beetle outbreak has certainly produced large amounts of stressed and dead tamarack and could have produced the abundant food necessary for a build-up of white-spotted sawyers. Alternatively, a winter storm in 2014 may have damaged conifers widely to provide abundant food for the beetles.

Photo by W. Ciesla, Forest Health Management International, Bugwood.org

White-spotted sawyer larvae feed in recently-killed or dying conifer trunks and limbs, and they mature in one or two years. Adult white-spotted sawyers may feed on conifer shoots, which can kill the tips of the branches. This feeding damage is almost never problematic for mature trees. In past years, abundant branch flagging from this feeding has been reported, but no such reports were made in 2015.

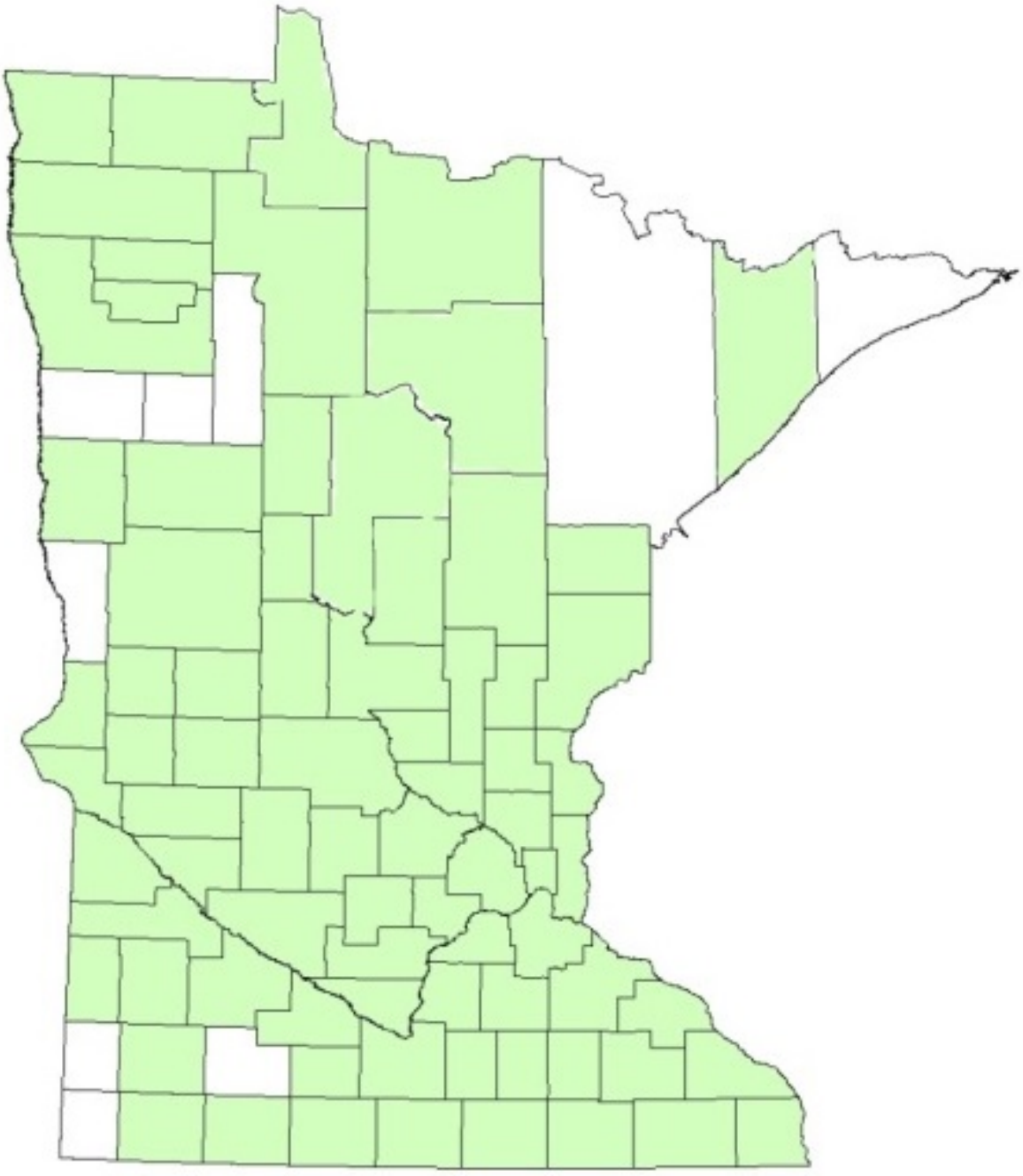
Diseases

Bur oak blight has another banner year

Bur oak blight (BOB) is a common, native disease of bur oak over most of its range in Minnesota. In 2015, the US Forest Service State & Private Forestry at the St. Paul Field Office confirmed BOB for the first time in Cass, Itasca, and Lake of the Woods counties, leaving just nine of 87 counties unconfirmed (see map, next page). In some areas of the state, BOB appears to be causing severe symptoms on a noticeable portion of the bur oak population. Severe symptoms include more than 60 percent premature leaf-drop, scattered production of a second set of leaves, abundant epicormic sprout development, and dieback. Severe symptoms appear after at least five consecutive years of severe leaf infection. DNR staff noticed heavily impacted areas around St. Cloud and Albert Lea; there are likely other areas in the state where a noticeable percentage of bur oaks are showing severe symptoms of BOB.

There are other areas in Minnesota with little visible damage from BOB. Even in areas sustaining abundant disease, many bur oaks were minimally impacted. Forest and savannah managers should preserve bur oaks that do not appear infected in heavily impacted landscapes. Ornamental bur oak owners and managers should know that a given bur oak can tolerate heavy infection for several consecutive years before the tree becomes weakened and susceptible to other disease and insect problems. Bur oak blight can be successfully managed in healthy bur oaks as the city of Hutchinson and Iowa State University demonstrated in a 2013 study. In theory, control can be achieved on city trees with injections once every several years.

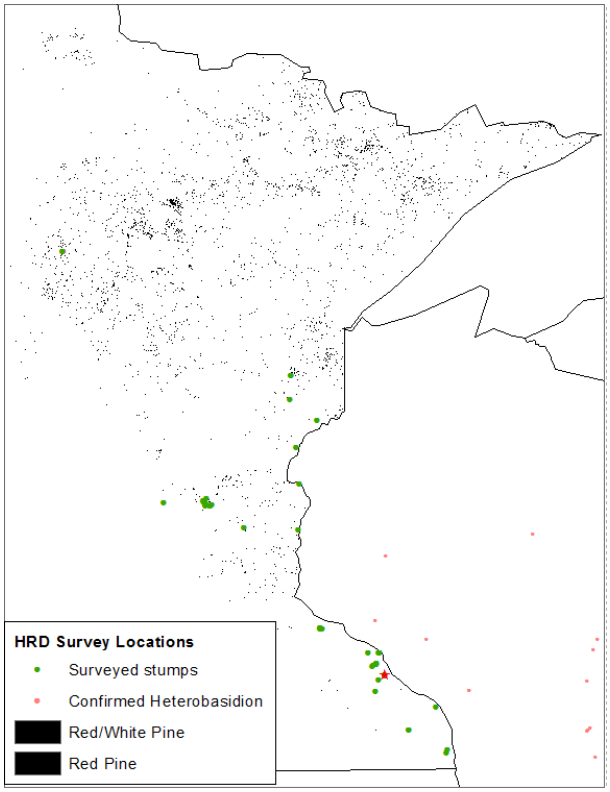
The impact of BOB to Minnesota's bur oak resource is unknown. As long as Minnesota continues to have above-average precipitation during leaf emergence in the spring, the disease will probably continue to weaken many of the state's bur oaks. To better understand the tolerance bur oak has to BOB, DNR Forest Health has established long-term monitoring plots at Sibley State Park and Sand Dunes State Forest. As shown in the photos below of a but oak in Sibley State Park, bur oaks can tolerate heavy leaf loss for at least two years in a row (and likely many more). The photo at left was taken in 2014; the photo on the right is from 2015. Bur oak blight seems to be more severe on bur oaks growing on edges of forests.



Minnesota counties confirmed for bur oak blight

Heterobasidion root disease

Heterobasidion root disease (HRD) was first confirmed in Minnesota in 2014 (See map below. Green dots represent areas surveyed in 2015; the red star is the only confirmed location of HRD in Minnesota. Black specks are susceptible pine forests). It is a root disease that kills pine, balsam fir, spruce, and eastern red cedar. It is most devastating on sandy soils in plantations that have been thinned. The disease enters a plantation when spores land on and infect freshly cut stumps. Once it is at a site, it remains for decades in decaying stumps and roots, killing a portion of susceptible seedlings and saplings regenerating on the site.



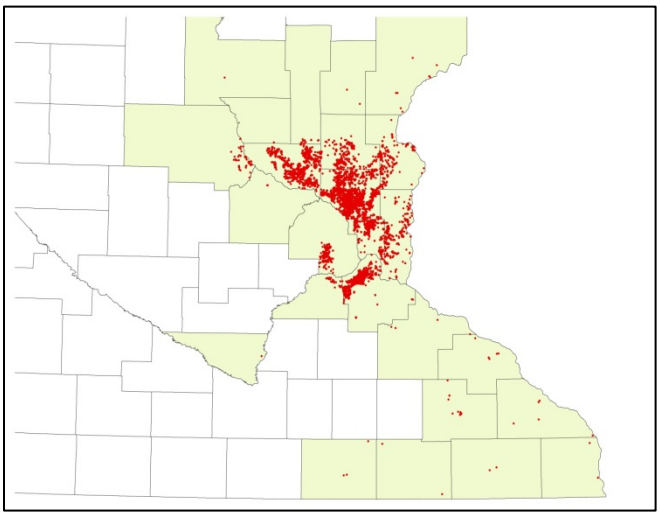
The DNR, University of Minnesota (UM), and University of Wisconsin (UW) surveyed for this disease in 2015 over a large part of Minnesota, using three techniques. No additional confirmed locations of the disease were found in 2015. A confirmed HRD location requires discovery of the fruiting body (conk) or a successful Heterobasidion culture isolated from tree tissue.

We did not find additional locations of the disease, but some concerning findings arose from these surveys. One concern was the UW study (unpublished) showed that many infective spores of Heterobasidion were in the air at four sites in Goodhue, Wabasha, and Winona counties in Minnesota. Since the survey implied that infective spores are present throughout much of southeast Minnesota, we recommend that land managers prevent Heterobasidion during thinnings in southeast Minnesota if they desire to preserve pines or grow pines in the future on a current plantation site. See our forest health website to learn how to prevent this disease. On state land in southeast Minnesota, we are currently not preventing Heterobasidion since most, if not all, current pine plantations will be converted to more natural forest cover types (i.e., deciduous trees) in the future, which are not susceptible to HRD.

In addition to the surveys, DNR forest health staff created a new informational webpage on HRD, including an identification guide for foresters. We also wrote an outreach article about HRD and delivered several trainings on HRD status, identification, and prevention to forest managers.

Oak wilt creeps north

Oak wilt is a non-native, fatal disease to all oak species in Minnesota. It was first discovered in Minnesota around 1950 in the Twin Cities area and has been spreading naturally and with the help of humans ever since.



Oak wilt was confirmed in two previously unconfirmed counties in Minnesota in 2015: Morrison and Mower (map, right). The Morrison Co. oak wilt center has been there for at least two years. It's concerning as it is part of 2,500 acres of nearly continuous red oak canopy into which houses have recently been built and in which two-lined chestnut borer is causing significant dieback and mortality. Abundant two-lined chestnut borer infestation in the landscape camouflages oak wilt symptoms well. There is ample two-lined chestnut borer infestation in northern Morrison and southern Crow Wing counties, so oak wilt could be in those locations for several years without detection.

There were several other noteworthy oak wilt confirmations in Minnesota in 2015:

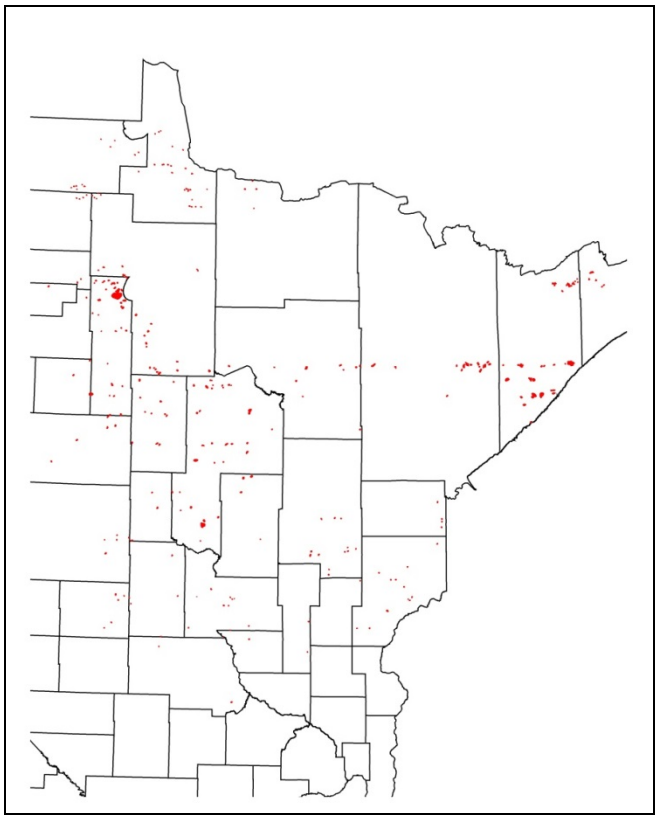
- Oak wilt was confirmed in Pine Co. north of state highway 48. One of these Pine Co. oak wilt centers was approximately 0.5 acre in size, demonstrating how oak wilt had been in this part of Pine County for several years.
- A visual oak wilt confirmation by DNR staff was made at a location in Kanabec County about six miles farther north than the previously confirmed spot in that county. Fortunately, it is not greatly threatening as it was on a bur oak in a city with ample tree species diversity.

- Oak wilt was confirmed in a bur oak forest in Myre Big Island State Park in Freeborn County. Large mortality centers and lots of dead oaks indicated oak wilt had been causing substantial mortality in the park for several years.
- There is little documentation of oak wilt severely impacting white oaks (*Quercus alba,* photo). Oak wilt was found causing substantial dieback and mortality in a cluster of 15 white oaks north of La Crescent.

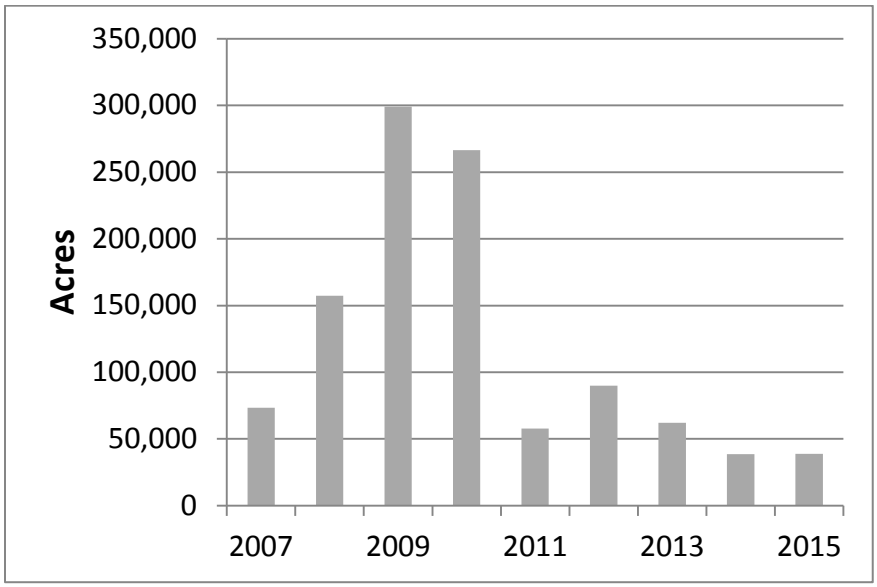
Environmental stress agents

Aspen and birch decline

Decline in aspen and birch is usually caused by a combination of drought, insect pests, and diseases to trees that are predisposed from unfavorable site conditions or old age. Symptoms of decline include a combination of stunted leaves, dying twigs, dying limbs, and dead trees. Decline in aspen crowns is reversible with abundant rainfall. The amount of aspen and birch decline and locations impacted (see map, right) were roughly the same in 2015 as in 2014. Aspen makes up roughly 85 percent of this area on state lands, and the remaining acreage is birch.

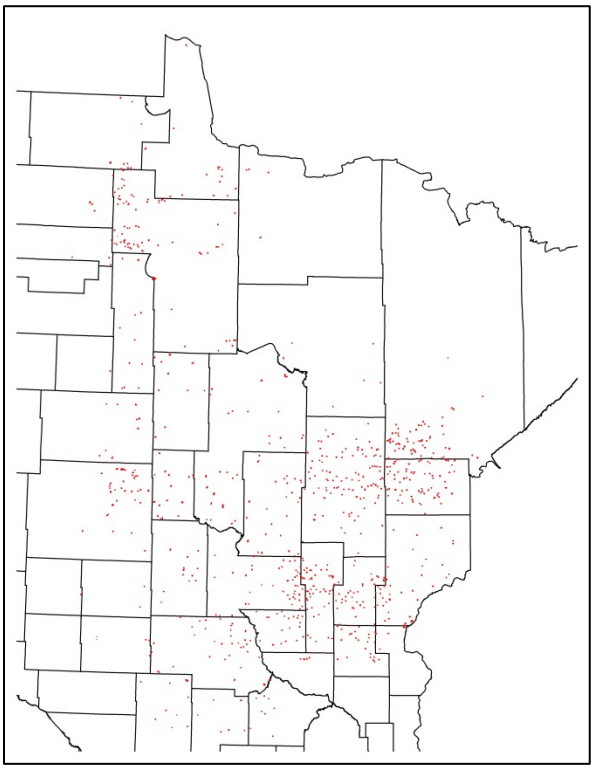


The graph below shows acres with declining ash and birch based on aerial surveys since 2007.

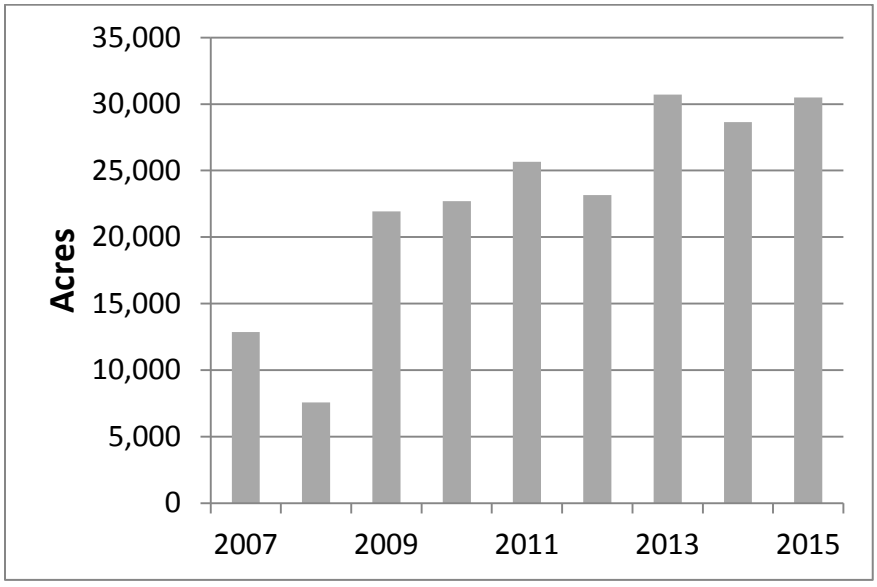


Black ash decline

Decline in black ash is common on trees growing in extremely wet conditions, and is caused by a combination of weather events, insect pests, and diseases. Symptoms include a combination of stunted leaves, dying twigs, dying limbs, epicormics shoots, and dead trees. The 30,480 acres of black ash decline and locations impacted (see map, right) were roughly the same in 2015 as in 2014 and 2013. Black ash decline is so common in the northern two-thirds of Minnesota that future early detection of emerald ash borer (EAB) in rural black ash swamps will be almost impossible. Only after EAB has been in a black ash swamp for many years will it become apparent through aerial surveys that EAB is present.

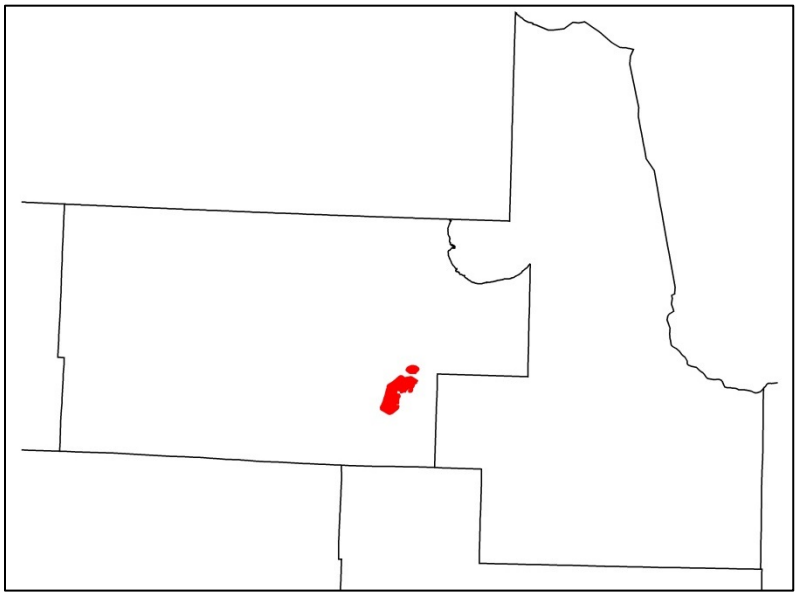


The graph below shows acres of black ash decline from 2007 to the present.



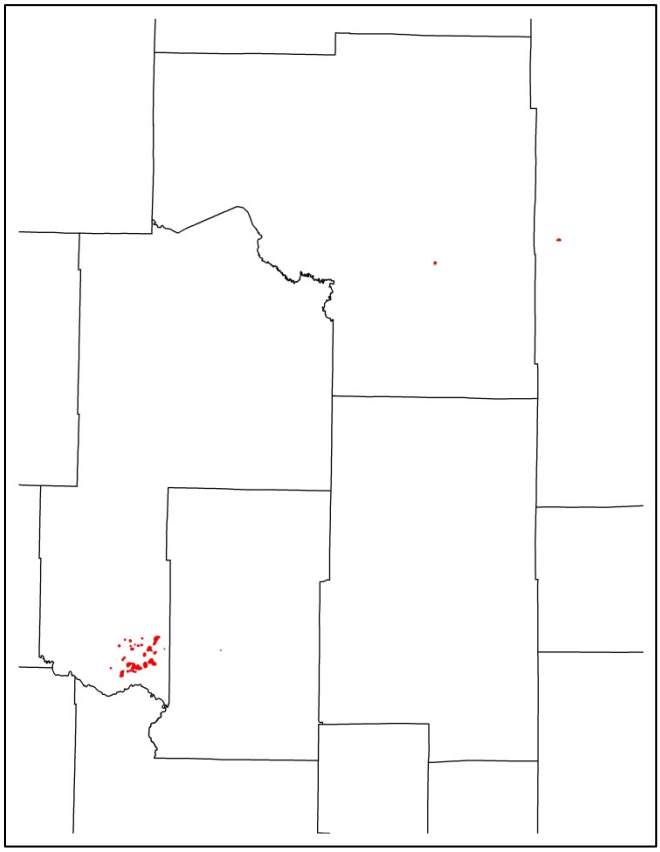
Fire damage

The Palsburg Fire burned 4,550 acres in Roseau County in April (see map below). This fire started from a slash pile burned the previous autumn that escaped with weather conditions favoring fire. Unsalvaged, damaged pine could provide a large food source for population growth of the white-spotted sawyer (already abundant in the area) and pine engraver in 2016.



Wind damage

Large hail and straight-line winds likely reaching more than 100 miles per hour significantly damaged 3,320 acres of forest in far southern Cass Co. in early July (see map below). This storm was responsible for 95 percent of the wind damage mapped from the air by the DNR. Oaks weakened by this storm that weren't removed could be targets of attack in 2016 by local populations of two-lined chestnut borer, whose damage was noticeable before the wind event.

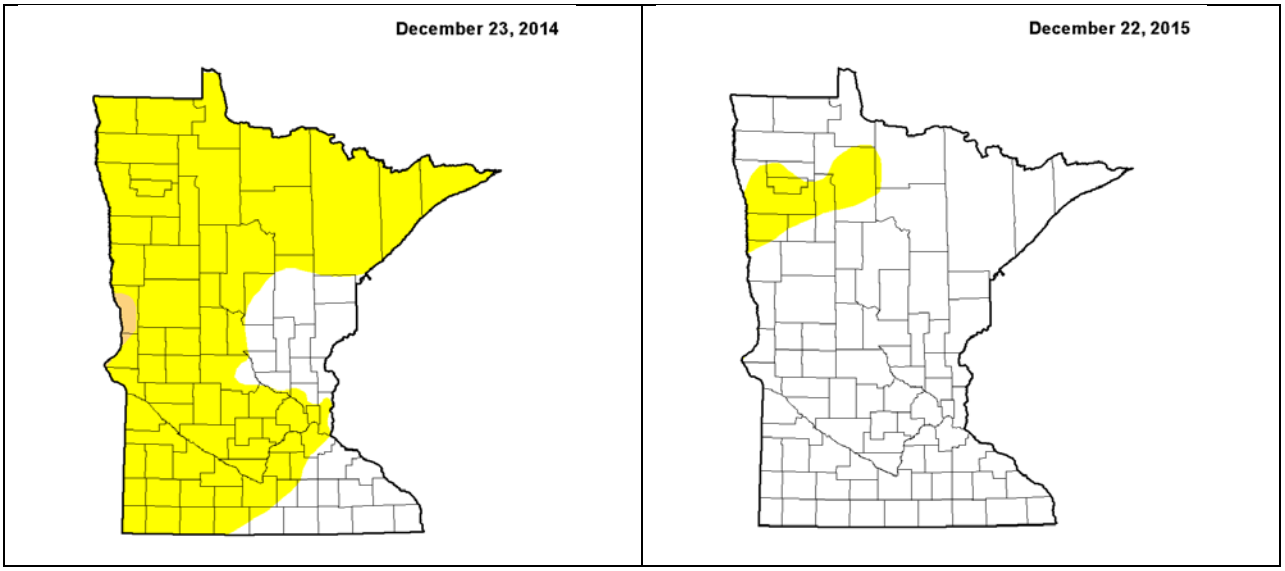


Drought

As of April 2015, Minnesota was still "abnormally dry" over much of the state (left, below), due to a dry 2014 autumn, below-average snowfall during the 2014-2015 winter, and a dry spring. Only Wilkin County was placed in the drought category. During May, however, precipitation totals were above historical averages across most of the state, ending a dry pattern originating in mid-summer 2014 and continuing into early spring 2015. In some communities the precipitation totals were one to three inches above historical average. Only a small portion of northern Minnesota was placed in the drought category in May.

In July, no counties in Minnesota fell into the drought category and only a few in the "abnormally dry" category (below right); hat trend continued through November. In November, precipitation totals were again above average over most of the state. Preliminary data indicate that state-averaged precipitation totals for November will rank among the 10 wettest on record. Autumn, 2015 will also rank among the warmest ever.

Climate information comes from the HydroClim Minnesota newsletter published by the DNR State Climatology office. Maps are taken from US Drought Monitor from December 23, 2014 and December 22, 2015.



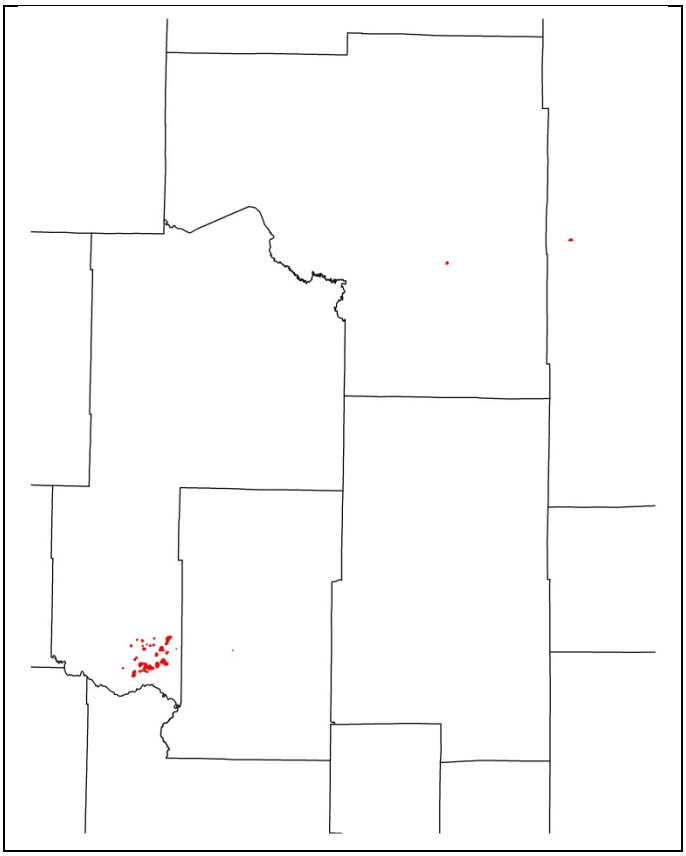
Silver maple and Siberian elm seed production stressed trees

Scattered silver and red maples and Siberian elms across a large geographical area produced an immense seed crop in 2015, leaving them partially leafless with dead branches. This phenomenon occurred from Minnesota to at least Ohio on silver maples. Though no one knows what caused this widespread seed production, it is known that some of the silver maples in the Twin Cities area that produced the most seed were stressed in recent years from physical root damage. That stress may have contributed to abundant seed production. Almost all the affected trees should survive. Some of their branches died because the individual tree put all growth into flower buds and not vegetative buds. Some of their canopies will look sparse for a few years. They will be stressed while recovering the leaves they normally have.

The photo below left shows a silver maple in St. Paul in June, after an immense seed production. The same tree is shown on the right in October; some canopy has died. The tree sustained significant root damage in 2013.

Wind damage

Large hail and straight-line winds likely reaching more than 100 mph significantly damaged 3,230 acres of forest in far southern Cass Co. in early July (see map below). This storm was responsible for 95 percent of the wind damage mapped from the air by the DNR. Oaks weakened by this storm that weren't removed could be targets of attack by local populations of two-lined chestnut borer in 2016, already noticeable before the wind event.



Phenology of tree pests and tree health events in 2015

Date	Pest or Event	Pest Stage or Cause	County
April 16	white pine blister rust	aecial blisters	Sherburne
May 5	*Ips* species	adult females laying eggs	Wabasha
May 5	pine bark adelgids	eggs	Wabasha
May 11	oak wilt	fresh spore mats	Ramsey
May 13	*Ips* species	adult females laying eggs	Houston
May 16	forest tent caterpillar	early instar caterpillars	Itasca
May 26-27	sudden ash leaflet drop	anthracnose (likely)	Dakota, Fillmore, Isanti, Kanabec, Kandiyohi, Morrison, Sherburne,
May 28	June beetles	adults	Dakota
June 2	Lecanium scale species	adult females	Kandiyohi, Meeker, Wright
June 3	tortricid defoliator on black locust	caterpillars	Ramsey
June 5	tortricid defoliator on black locust	caterpillars	Kanabec
June 9	*Ips* species	pupae	Pine
June 9	jack pine budworm	second or third instars	Pine
June 10	forest tent caterpillar	later instars (1 – 1 ½ inches long)	Pine
June 11	forest tent caterpillar	later instars	Becker
June 15	forest tent caterpillar	later instars	Crow Wing
June 18	spruce budworm	later instars (½ – ¾ inches long)	St. Louis
June 29	bur oak blight	leaf vein and wedge-shaped leaf tissue death	Benton
June 30	white-spotted sawyer	adults	Roseau
June 30	giant ichneumon wasp	adults mating and laying eggs	Ramsey
July 1	forest tent caterpillar	pupae	Pine
July 2	white-spotted sawyer	adults	Hubbard
July 13	forest tent caterpillar	adults	Itasca
July 30	hickory bark beetle	female adults laying eggs	Mower
August 3	fall webworm	caterpillars	Ramsey
Sept. 1	giant ichneumon wasp	adults	Steele
Sept. 1	oak wilt	spore mats	Freeborn
Dec. 3	leaf emergence from a boxelder	above-average autumn temperatures	Houston
Dec. 14	leaf emergence from an elderberry	above-average autumn temperatures	Sherburne
Dec. 21	leaf emergence from honeysuckles	above-average autumn temperatures	Kanabec, Ramsey

Other 2015 Accomplishments

Updated pine thinning specs on state lands to minimize bark beetle problems

The Forest Health and Timber programs improved a specification in the DNR's harvest guidelines to minimize bark beetle damage. The revised specification better addresses the biology of the pine engraver (*Ips pini*), our most threatening pine bark beetle. It also reduces constraints on logging companies during certain periods in the year. The new specification for all pine thinning operations on state lands is as follows:

"The Timber Sale Administrator (TSA) can allow or stop permit operations to minimize rutting, root damage, bark slippage, beetle infestations or wildfire risk. If excessive damage is occurring, the TSA will stop operations until site conditions improve. For pine thinning operations, the following restrictions apply to cut pine greater than 3 inches diameter:

- December 1 to May 31: Pine cut in this period must be hauled or destroyed by June 1.
- June 1 to August 31: Pine cut in this period must be hauled or destroyed within 3 weeks.
- September 1 to November 30: No special restrictions for pine cut in this period."

Presentations on-line

Oak wilt versus bur oak blight, MyMinnesotaWoods webinar delivered by Brian Schwingle, March 24, 2015. May also be accessed on YouTube.

News Releases

Silver maple trees showing signs of stress, June 4, 2015

DNR offers advice for dealing with storm damaged trees, July 20, 2015

Oak wilt confirmed in Morrison County for the first time, August 24, 2015

New DNR Forest Health Internet Outreach Material

Heterobasidion root disease, added March 2015

Heterobasidion root disease (a picture guide), added March 2015

Diplodia shoot blight webpage, added May 2015

Contributions to Scientific Papers

Russell MB, D'Amato AW, Albers MA, Woodall CW, Puettmann KJ, Saunders MR, VanderSchaaf CL. 2015. Performance of the forest vegetation simulator in managed white spruce plantations influenced by eastern spruce budworm in northern Minnesota. For. Sci. 61(4):723-730.

Smith DR, Stanosz GR, Albers J. 2015. Detection of the Diplodia shoot blight and canker pathogens from red and jack pine seeds using cultural methods. Can. J. of Plant Pathol. 37(1): 61-66.

Stanosz GR, Smith DNR, Albers J. 2015. [presentation abstract] The shoot blight and canker pathogen *Diplodia scrobiculata* and asymptomatic seedlings in natural stands of *Pinus banksiana*. Joint IUFRO Working Party Meetings, June 7-12, Uppsala, Sweden.