Forest Health Annual Report 2024

Minnesota DNR Forest Health Team

DEPARTMENT OF
NATURAL RESOURCES

The Minnesota Department of Natural Resources Forest Health Annual Report was created by the Forestry Division's Forest Health Program.

Cover photo: Emerald ash borer (EAB) larval feeding galleries on a black ash near Remer, MN in February 2024. This area was first confirmed with EAB in fall 2023. DNR Forest Health staff provided training to many professionals at this site in 2024.

Back cover photo: Severe leaf disease on a quaking aspen in August 2024.

Photo credits: Photos and other images are from DNR staff unless indicated otherwise.

Some projects were funded in whole or in part through a grant awarded by the USDA Forest Service, St. Paul Field Office, State, Private, and Tribal Forestry.

Contents

Minnesota DNR Division of Forestry Forest Health Program

Regional forest health specialists investigate tree health problems, trouble-shooting concerns for professional foresters and sometimes setting up field trials for further investigation. The Forest Health team also monitors overall tree health across Minnesota's forests. Data is analyzed and summaries are compiled in reports and presentations. This team plays a key role in training professional foresters in tree health diagnostics and influencing forest health management.

Annual reports from 1969 to the present, and informational resources on a wide variety of forest threats, are available on the forest health webpages.

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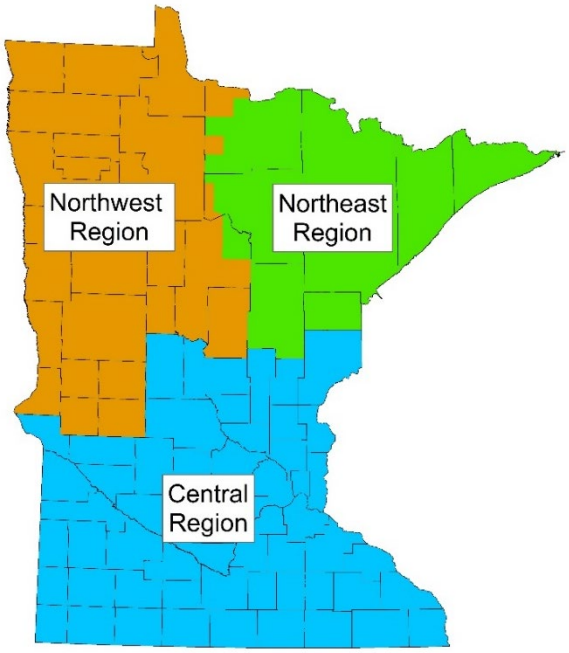


Forest Health Highlights in 2024

- August Kramer was hired in April into the Central Region Forest Health Specialist role.
- Forest health staff collaborated with the DNR Resource Assessment unit to aerially survey 17.5 million acres of Minnesota for damage to forests. The U.S. Forest Service (USFS) provided funding and survey software.
- In federal fiscal year 2024, staff directly responded to over 1,330 requests for forest health assistance, including in-depth field investigation requests, emailed inquiries, media interviews, training requests, and requests for assistance from researchers. Over 3,450 people attended our many presentations or trainings.
- The state received above-normal precipitation in growing season 2024 for the first time in five years, assuaging oak mortality from twolined chestnut borer and Armillaria root disease.
- May through June 2024 was the wettest May through June on record in Minnesota, resulting in rampant fungal leaf disease on poplars across Minnesota. Many poplars were mostly defoliated by the end of August.
- Elm zigzag sawfly was confirmed for the first time in Minnesota in 2024, with several positive discoveries across the Metro area by the end of the year. This insect can cause intense defoliation on elms.
- Spruce budworm damaged more acres than it has since 1961. Since 2021, spruce budworm has impacted over 2,000 square miles (1,330,000 acres), over 90 percent of which is in St. Louis, Lake, and Cook counties.
- Eastern larch beetle killed tamaracks on over 100,000 acres for the 8th consecutive year in 2024. We have mapped damage from this native bark beetle since 2001, and almost 1,800 square miles (1,140,000 acres) of forest have been severely damaged since then.
- Emerald ash borer was confirmed for the first time in 5 additional counties in 2024, increasing the number of counties with known EAB infestation to 53.
- Oak wilt was confirmed for the first time in Carlton and Kandiyohi counties in 2024, increasing the number of counties with known oak wilt to 33.

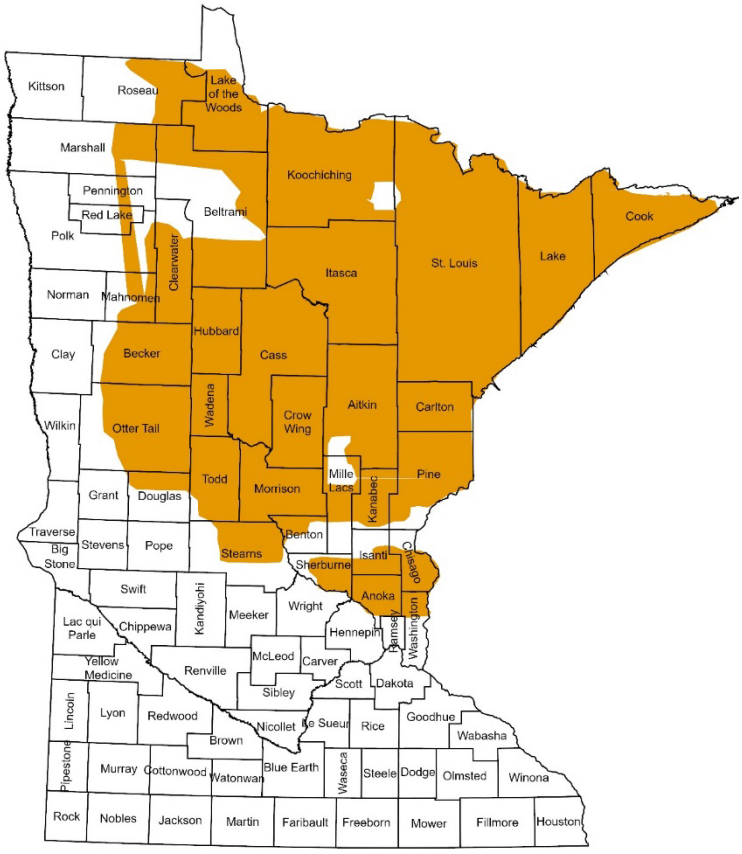
Annual Aerial Survey of Forest Canopy

Since the early 1950s, aerial survey has been a valuable tool for monitoring forest canopy health across the approximately 17.7 million acres of forestland in the state. Surveys consistently record events like large defoliating insect outbreaks and wind events. Other problems, such as root diseases, wilts, and tree declines cannot be consistently detected from the air and are not reliably recorded in surveys. Aerial surveys provide data used in forest management planning, research, prioritization of research topics, and they occasionally provide early detection of threatening issues like oak wilt and emerald ash borer.

A major change happened in 2023 with aerial survey. Leadership for Eastern Region U.S. Forest Service (USFS) decided to end forest health aerial surveys performed by USFS surveyors. Traditionally, USFS forest health surveyors surveyed the bulk of northeastern Minnesota, covering all of Superior National Forest, Grand Portage Reservation, Bois Forte Reservation, and much state, county, and private forestland. Those surveys covered anywhere from 17 to 35 percent of the total forest health survey in Minnesota, and DNR employees covered the remainder. Since 2023, DNR has attempted to maintain the level of forest health survey coverage without the federal survey assistance, although the USFS continues to fund forest health surveys by states.

Another change in 2024 was both USFS State, Private, and Tribal Forestry and DNR Forest Health wanted to ensure we were respecting Native American tribal sovereignty when it came to collecting survey data from tribal lands. That resulted in Red Lake and Bois Forte reservations not being surveyed. It will also result in some survey data only being shared with tribal government and not being made available to the public.

Survey results for 2016–2023 can be found in the Minnesota Geospatial Commons (keywords “forest health”), although no aerial survey occurred in 2020 due to COVID-19-related restrictions. Data from 2024 will be posted to the Commons early in 2025.



Area covered by aerial survey in 2024 is shaded.

Comparison of aerial survey results, 2023-2024

Damage agent	Acres affected* in 2023	Acres affected* in 2024	Comments
Aspen and birch decline	4,600	12,600	The 2024 figure is an underestimate due to not surveying the Northwest Angle, Red Lake Reservation, or Bois Forte Reservation.
Pine bark beetles	1,300	210	
Basswood leafminer	840	0	
Eastern larch beetle	262,000	232,000	The 2024 figure is an underestimate due to not surveying the Northwest Angle, Red Lake Reservation, or Bois Forte Reservation. The trajectory from 2023 to 2024 is still slightly downward.
Flooding	3,300	6,700	The 2024 figure is likely an underestimate due to not surveying Red Lake Reservation.
Forest tent caterpillar	13,300	79,100	The 2024 figure is likely an underestimate due to not surveying Mille Lacs Reservation.
Jack pine budworm	0	580	The 2023 figure is an underestimate, since jack pine budworm was active in some Beltrami County stands.
Larch casebearer	42,600	44,800	The most annual damage mapped on record was in 2023 and 2024.
Spruce budworm	665,000	712,000	The most annual damage mapped since 1961 was in 2023 and 2024.
Twolined chestnut borer	2,300	710	Both 2023 and 2024 figures are underestimates of the area impacted.
Wind	1,600	6,400	

*Mapped acreages are rounded. The 2024 figures cannot be finalized until after this report is published due to a delayed rollout in a Geographical Information Systems tool.

Forest Health Report

The annual forest health report provides information about significant damage to forests recorded in our aerial and ground surveys and highlights staff accomplishments. The report is of special interest to foresters and land managers who can use it to learn what is threatening the forests they manage.

Insects

Boxelder defoliation in southeast Minnesota

In May 2024, we received numerous reports of heavy defoliation on boxelder trees in Wabasha and Winona counties caused by the larger boxelder leafroller (*Archips negundana*). Boxelder leafroller is a native lepidopteran whose larvae feed on boxelder, raspberry, birch, elderberry, elm, and other shrub species in Minnesota. Larvae of this species emerge from eggs in early spring and feed on foliage through June before pupating into adults.

Boxelder leafroller is capable of cyclical outbreaks over the course of decades, and it's possible that heavy defoliation will occur again next spring. Anecdotal evidence suggests that defoliation was quite severe in reporting counties; however, given the hardiness of boxelder any lasting impact on tree health is expected to be negligible.

Boxelder trees in Winona County showing thin, defoliated crowns due to larval feeding by boxelder leafroller.

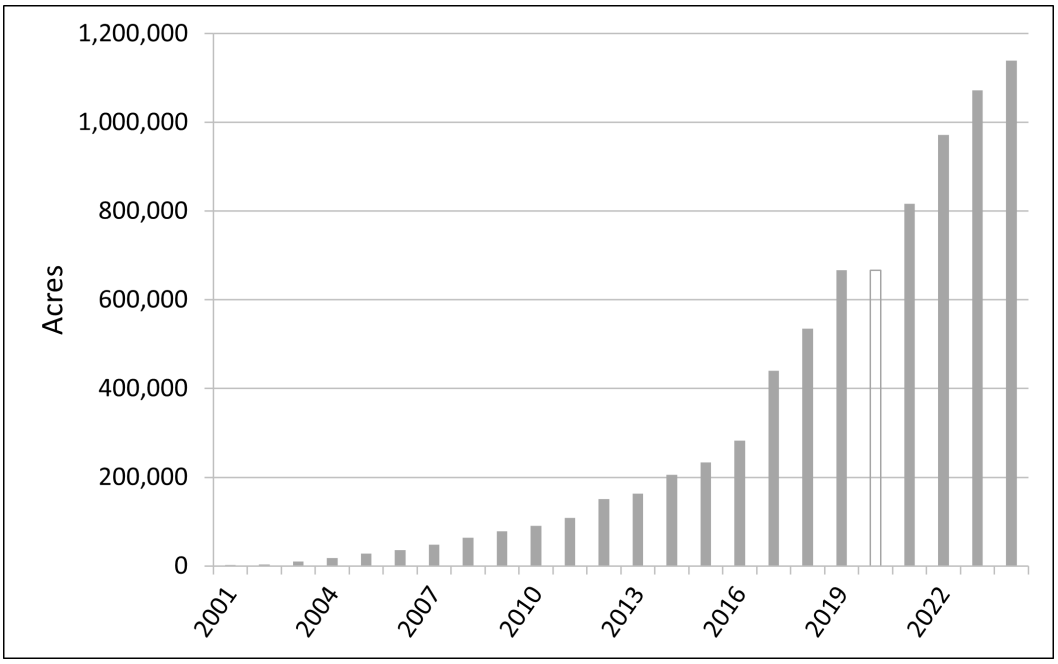
Eastern larch beetle continues to damage tamarack

Eastern larch beetle (*Dendroctonus simplex*) is a small native beetle. Since 2001, it has caused widespread mortality in tamarack trees across Minnesota. As an adult, it is about 4 millimeters long and dark brown. These beetles spend most of their lives under the bark of tamarack trees. Due to abundant, larger tamarack trees; stress on these trees from floods and droughts; a lengthening spring, summer, and fall due to climate change; and the beetle's ability to reproduce quickly, their populations have been able to overwhelm tamarack trees. The result has been significant mature tamarack mortality on over a million acres.

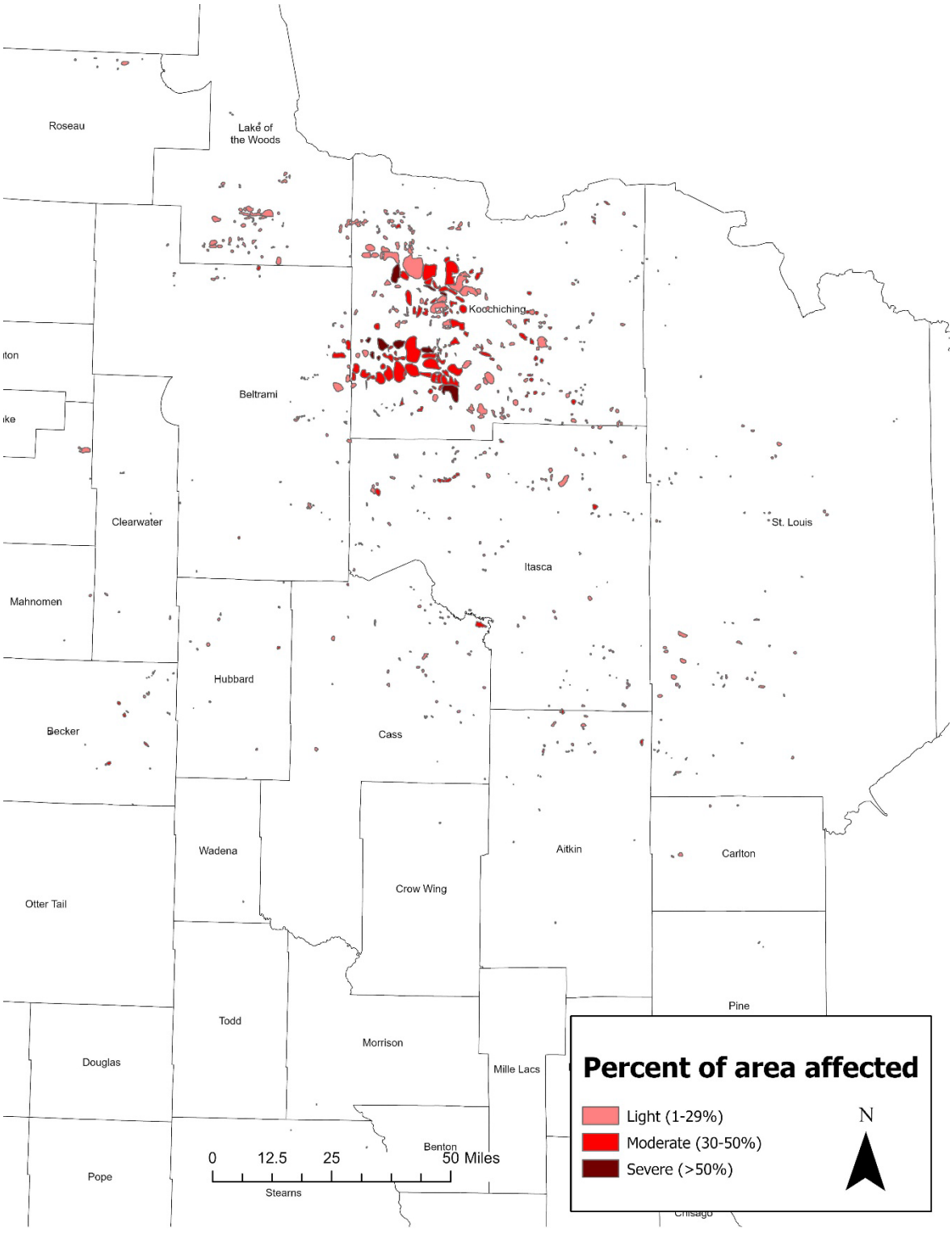
In 2024 we mapped about 232,000 acres of tamarack impacted by eastern larch beetle (ELB). This is down slightly from last year. Since 2001, an area equivalent to almost 90% of Minnesota's tamarack resource has been affected by ELB, and there are no signs of the outbreak stopping anytime soon. It is possible that all older tamarack stands will at some point be impacted by ELB.

While ELB cannot be controlled across the landscape, the MN DNR continues to manage tamarack stands in a sustainable manner, for both timber salvage and sustained future forest cover. The DNR has offered for sale 13,700 acres of tamarack timber permits over the past five years. Of these offered acres, 4,500 acres have been managed. Timber operations in tamarack stands are complicated by a variety of factors including climate change. Soils in tamarack stands often require frozen ground for harvesting. If the ground does not freeze, management may not be completed before ELB causes significant damage to the stand.

Fortunately, in several studied stands where active management has not happened, tamarack and other tree species are naturally regenerating, and small-diameter tamarack are not susceptible to ELB. Even though ELB will continue to kill larger tamarack, this species is still well suited for Minnesota forests.



Accumulated area impacted by eastern larch beetle. Aerial survey data was not collected in 2020 due to the COVID-19 pandemic. The 2020 value is an estimate based on the midpoint between 2019 and 2021.



Areas with eastern larch beetle damage in 2024.

Elm zigzag sawfly confirmed for the first time in Minnesota in 2024

Elm zigzag sawfly (*Aproceros leucopoda*) is a non-native defoliator of elm trees that was reported for the first time in Minnesota in July 2024 in St. Paul. Elm zigzag sawfly was first identified in North America in Quebec, Canada in 2020 and has since spread throughout the northeastern and upper-midwestern United States. Native to Asia, including parts of Russia, this insect feeds on the leaves of elm trees. Elm zigzag sawfly overwinters in the pupal stage, adults then emerge in spring and lay eggs along leaf margins. Eggs typically hatch within four to eight weeks, and larvae feed on the leaves for 15-18 days before pupation. In warmer climates, elm zigzag sawfly can have as many as five generations per season, but it is unknown how many generations per season occur in Minnesota.

The arrival of elm zigzag sawfly in Minnesota has been anticipated for several years. The impacts of this pest are yet unknown in Minnesota but based on the extent of elm in the state and the observed damage in other states, we do not anticipate that elm zigzag sawfly will be a significant forest pest.

An elm zigzag sawfly larva (yellow arrow) with characteristic defoliation pattern on an elm leaf in St. Paul.

Emerald ash borer discovered in five more counties in 2024

Emerald ash borer (EAB) (*Agrilus planipennis*) is an invasive beetle that feeds on ash trees' inner bark and cambium, killing them after several years of feeding. It was first discovered in North America in 2002 and Minnesota in 2009. Since that time, it has become entrenched throughout most of southeastern Minnesota and the Twin Cities Metro, and 53 of Minnesota's 87 counties have at least one confirmation of EAB infestation. Five counties were confirmed with EAB for the first time in 2024 (Jackson, Pine, Pope, Renville, and Rock). There was also a large jump in Lake County of about 25 miles from Two Harbors to Silver Bay.

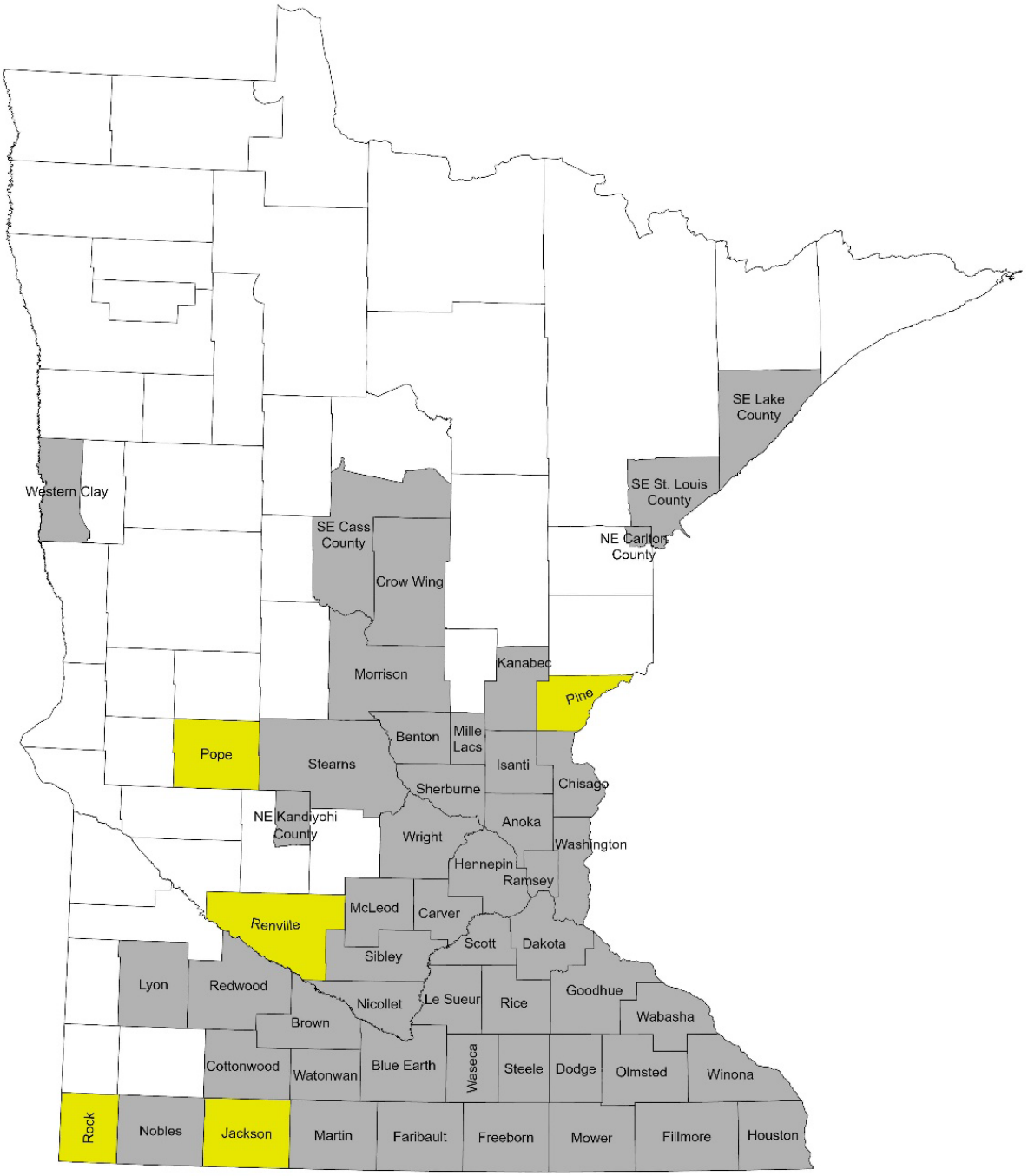
We aerially mapped about 6,100 acres of forest significantly impacted by EAB across Anoka, Chisago, Isanti, Sherburne, and northern Washington counties in 2024. Since 2016, we have mapped a total of almost 31,000 acres of forest with a high degree of EAB damage. This figure is an underestimate for Minnesota, since we don't survey all forested areas, and we do not map light and scattered damage from EAB.

Besides tracking overall damage to forests, the DNR Forestry Division is engaged in a wide array of activities related to EAB:

- Outreach to various professionals and landowners on EAB management
- Support for research on EAB
- Distribution of community forestry grants from federal and state government
- Published silvicultural guidance for professional foresters
- Cost-share for forest management in privately-owned forests
- Tree diversification projects in ash-dominated stands in DNR-managed state forests
- Tree seedling production for forest diversification projects on both public and private forests
- Increased timber permit sales in ash-dominated state forests, facilitating diversification projects, and utilizing timber prior to EAB infestation
- Market analysis and market outreach for facilitating management of ash forests

Many other groups play key roles with EAB too, including private tree care companies, other units of government, Minnesota Department of Agriculture (MDA), researchers at universities, private landowner groups, natural resources non-profits, and others. Some key activities related to EAB:

- MDA released over 14,000 wasps in 2024 to serve as biological controls for EAB
- MDA quarantined five new counties for EAB in 2024
- MDA certifies treated firewood so consumers avoid spreading EAB and other tree threats



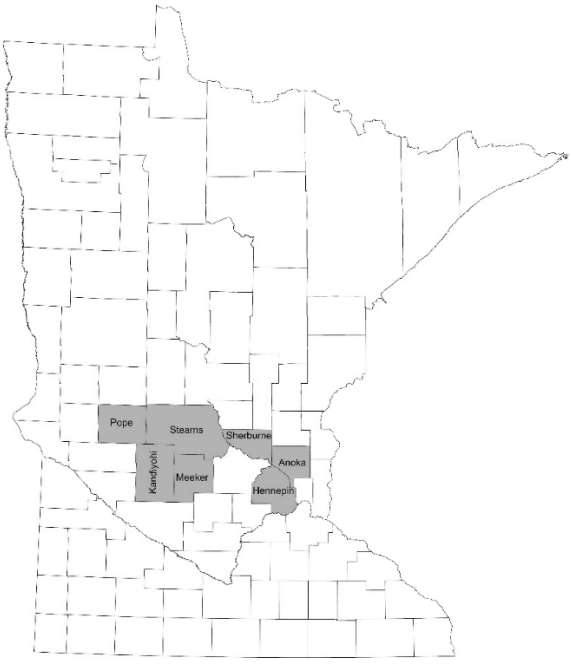
Emerald ash borer quarantine counties. Yellow counties or areas were quarantined for the first time in 2024.

European pine sawfly pine feeding activity up in central Minnesota

In spring of 2024, we received numerous reports of defoliation and crown reddening in many red, Austrian, and Scots pine due to larval feeding of European pine sawfly (*Neodiprion sertifer*). European pine sawfly is a non-native insect related to bees and wasps, first reported in eastern North America in 1925. Since its introduction, European pine sawfly has spread throughout eastern North America, where it primarily feeds on two and three-needle pines. It is also capable of infesting five-needle pines when populations are high or when they are growing adjacent to their preferred host type. Larval feeding by European pine sawfly begins in spring and occurs only on the previous year's needles, while new growth is uneaten. As such, mature, healthy pines typically survive even heavy feeding by this sawfly.

European pine sawfly larvae exhibiting a defensive posture while feeding on pine needles.

The range and severity of sawfly damage in 2024 was notably higher than in 2022 and 2023. In prior years, small pockets of defoliation were observed in red pine growing on the Anoka Sand Plain. In 2024, reports of damage from this pest were on red, Austrian, and Scots pines throughout central Minnesota, with notable hotspots occurring in Stearns and Sherburne counties. Despite increased larval feeding, we do not anticipate any lasting or significant damage to pine forests due to this pest.



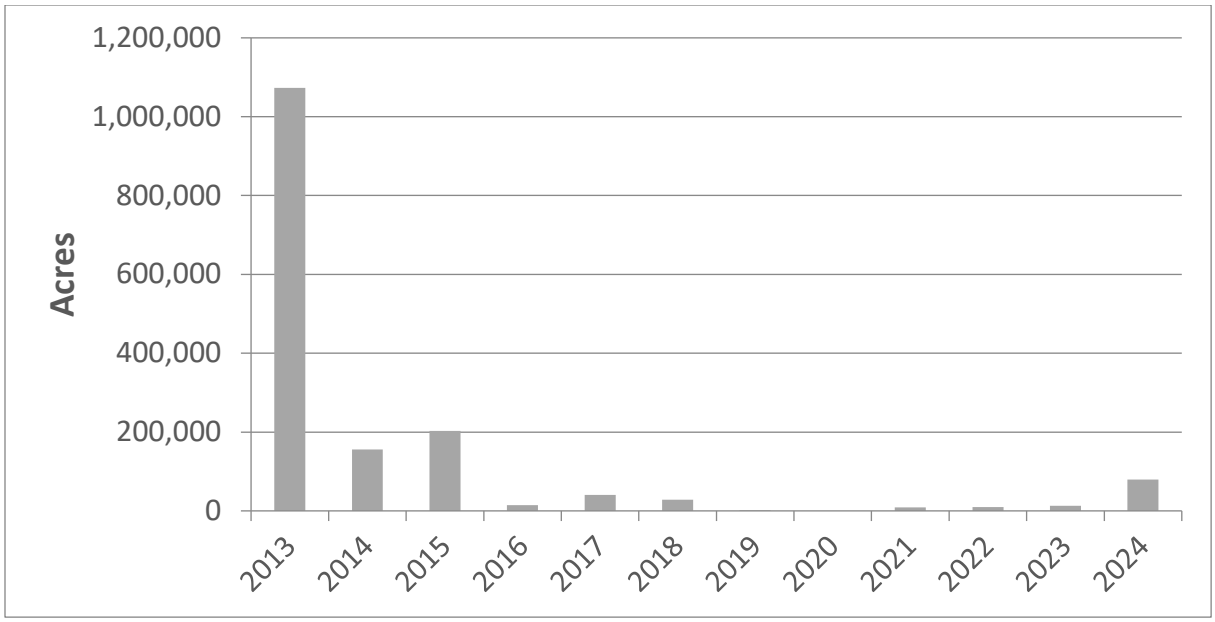
Map of Minnesota counties with reports of European pine sawfly damage in 2024.

Forest tent caterpillar more noticeable in 2024

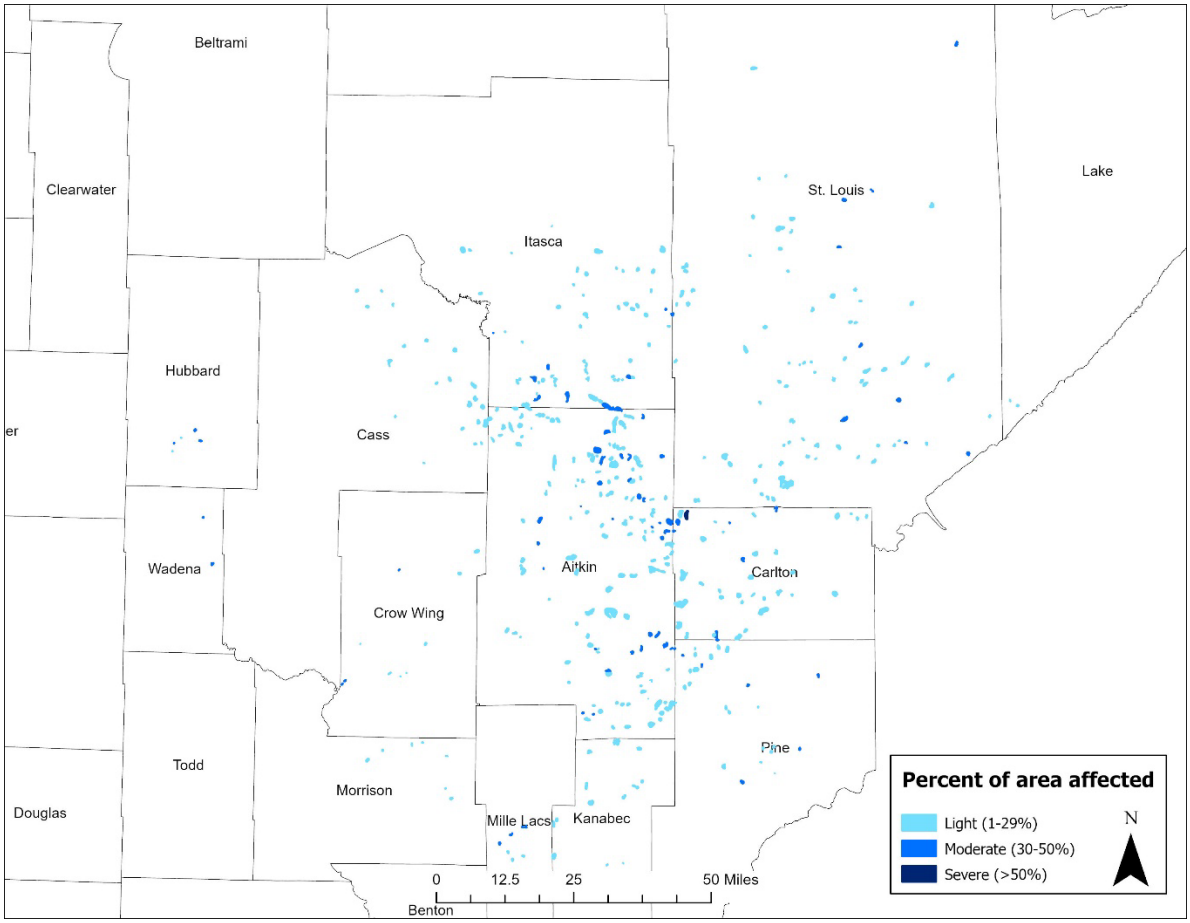
Forest tent caterpillar (*Malacosoma disstria*) is a native caterpillar that feeds on a variety of deciduous trees. Common host species include aspen, oak, birch, and basswood. Defoliation appears to be the greatest on basswood compared to other species (see photo below). We recorded approximately 79,100 acres of defoliation in 2024, almost a sixfold increase from 2023. There has been an upward trend in forest tent caterpillar defoliation since the population crashed in 2019, mostly in northeast Minnesota. The last year with a significant amount of acres of defoliation was 2013, but the majority of that defoliation was very light. Forest tent caterpillar populations peak about every 10-15 years in Minnesota, thus the population could be gradually nearing a peak in the next few years. However, there is a possibility that aerial surveyors in 2024 attributed some defoliation to forest tent caterpillar when it was actually leaf disease on poplars (see poplar leaf disease article). The appearance from an airplane of both of these issues is similar and may have resulted in overestimating defoliation by forest tent caterpillar in 2024.

Most of the mapped defoliation was in Aitkin, Carlton, Itasca, and St. Louis counties. Additional counties that had defoliation recorded included Benton, Cass, Crow Wing, Hubbard, Kanabec, Mille Lacs, Morrison, Pine, and Wadena. This is a big jump in the activity of forest tent caterpillar from 2023, as it was mapped more in western and northern counties in 2024.

A basswood tree completely defoliated by forest tent caterpillar in early June in Aitkin County.



Acres with forest tent caterpillar defoliation from 2013 to 2024. No aerial survey was conducted in 2020.



Areas with defoliation from forest tent caterpillar in 2024.

Hickory bark beetle continues infesting hickory in Houston County

Hickory bark beetle (*Scolytus quadrispinosus*) is a bark beetle native to Minnesota that infests shagbark and bitternut hickories. For several years, Minnesota DNR has received reports of hickory mortality in Houston County, a trend which continued in 2024. Hickory bark beetle typically attacks trees that are stressed by defoliation, disease, drought, or floods, but can successfully invade healthy trees when beetle numbers are high. In Houston County, we theorize that extreme precipitation could be a significant factor in hickory mortality – the three wettest growing seasons (April through September) recorded in Houston County history were 2018, 2016, and 2010, respectively. In 2023, the growing season was the 12th driest. In 2024 Houston County recorded slightly above-average precipitation again. Such inconsistencies in precipitation could be contributing to the reduced tree vigor and subsequent infestation by hickory bark beetle.

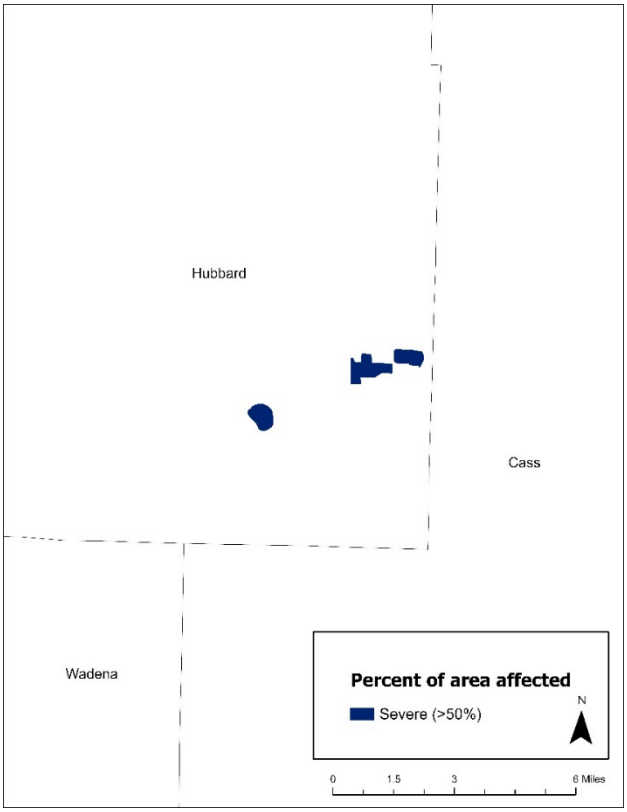
In 2024, professional foresters estimated the damage caused by hickory bark beetle was as bad as, if not worse than, the damage recorded in 2023. We will continue to monitor the health of hickories in southern Minnesota, but the long-term threat posed by this insect is likely small, since it will not attack seedlings and smaller saplings.

A small diameter shagbark hickory killed by hickory bark beetle, evidenced by bark beetle galleries on the wood surface.

Jack pine budworm activity detected in Hubbard County

Jack pine budworm (*Choristoneura pinus*) is a native moth that periodically defoliates jack pine when populations reach outbreak levels. In 2024 we mapped 600 acres of jack pine budworm defoliation and mortality during our aerial survey. We also did early instar surveys to predict budworm populations across the northern part of the state, finding few or no larvae.

Over the past two years there has been a noticeable uptick in jack pine budworm defoliation within the Badoura Jack Pine Woodlands Scientific and Natural Area (SNA) located in Hubbard County. This SNA contains jack pine stands ranging from just a few years old to over 60 years old. The DNR forest health team along with DNR foresters and DNR Ecological and Water Resources staff have done multiple site visits to assess the damage. Older jack pine in the SNA fostered a spike in jack pine budworm populations, which defoliated jack pine for multiple years. A timber sale has been planned to remove some of the most impacted stands with plans to conduct a prescribed burn after the harvest to facilitate jack pine regeneration.



Hubbard County was the only county known to have jack pine budworm damage in 2024.

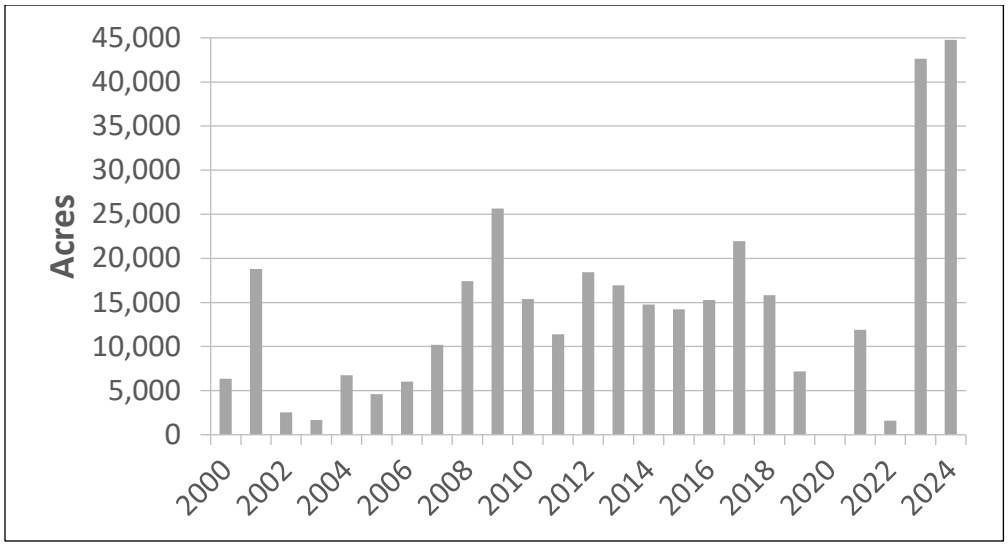
DNR staff discuss management for a heavily damaged jack pine stand in Hubbard County.

Larch casebearer defoliates more forest than ever before

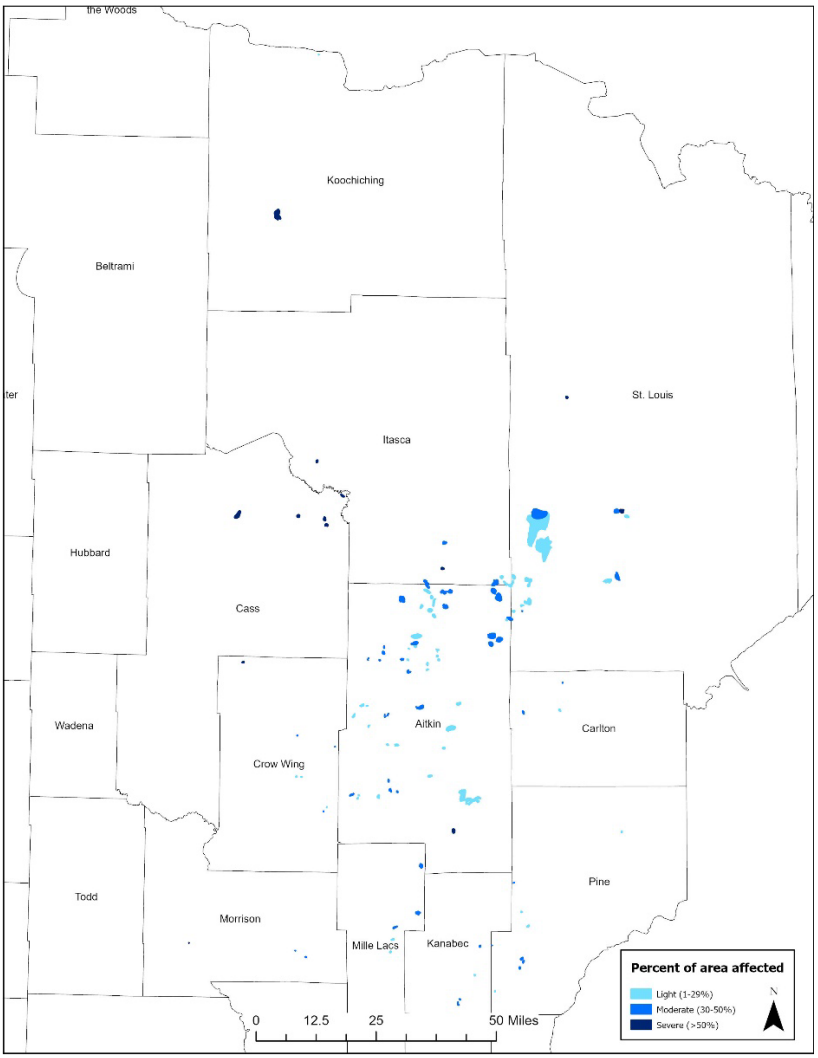
Larch casebearer (*Coleophora laricella*) is a non-native caterpillar that feeds on tamarack needles and can cause extensive defoliation when populations are high. Defoliation started to be recorded for larch casebearer in 2000, and 2024 had the highest amount of defoliation mapped thus far at about 44,800 acres. This total surpassed 42,600 acres mapped the prior year. Similar to 2023, the majority of defoliation in 2024 was mapped in Aitkin County followed by St. Louis County.

Defoliation the past two years is a significant increase over all prior years. This may be due to higher temperatures the prior growing season, higher precipitation in spring, and warmer late falls and winters. According to recent research, these climatic factors, along with decreasing natural enemy populations, may have resulted in the recent larch casebearer population increase.

Larch casebearer feeding damage on a tamarack in Aitkin County.



Acres with larch casebearer defoliation from 2000 to 2024. No aerial survey was conducted in 2020.



Areas with larch casebearer damage in 2024.

Minimal defoliation from large aspen tortrix in 2024

Large aspen tortrix (*Choristoneura conflictana*) is a native defoliator and leaf roller of aspen. Defoliation of about 3,200 acres from this insect was aerially mapped in 2022 in Cook County, but no defoliation has been mapped the past two years. Caterpillars, pupae, and moths of large aspen tortrix were observed in 2024 in Cook, Lake, and St. Louis counties, but minimal defoliation was seen from the ground.

Defoliation from this insect was too light to be observed via aerial surveys but it is being detected in minimal amounts during ground surveys. This insect will be monitored in 2025, as historically it has resulted in a significant amount of defoliated acres. The last time large acreages were impacted by large aspen tortrix was from 1998 to 2000, where 336,000 acres of defoliation was mapped in 1999 alone, mostly along the north shore of Lake Superior.

Large aspen tortrix caterpillar in an unrolled aspen leaf, Cook County, 2024.

Pine bark beetles not a big problem in 2024

Pine bark beetles (*Ips* spp.) are common pests of pine, and in Minnesota the eastern five-spined ips (*Ips grandicollis*) and the pine engraver (*Ips pini*) are common in pine stands throughout the state. *Ips* spp. tend to be non-aggressive, preferring trees that are stressed by drought, disease, overcrowding, or other insects. When conditions are right, *Ips* beetle populations can achieve regional outbreaks, at which point they are capable of killing patches or pockets of host trees.

Because symptoms of bark beetle infestation often don't become visible until autumn (after aerial surveying is conducted), newly infested pines usually cannot be detected by aerial survey until the following year. While outbreaks often occur during years of extreme drought (1976, 1987, 1988, and 2021 were all drought years with increased *Ips* activity), no extensive pine bark beetle damage was recorded in 2023 despite heightened drought conditions. From 2022-2023, recorded acres of pine bark beetles fell by 50 percent, and from 2023-2024 recorded acres fell again by 84%. In 2024, approximately 200 acres of pine bark beetle damage was recorded, mostly in central Minnesota.

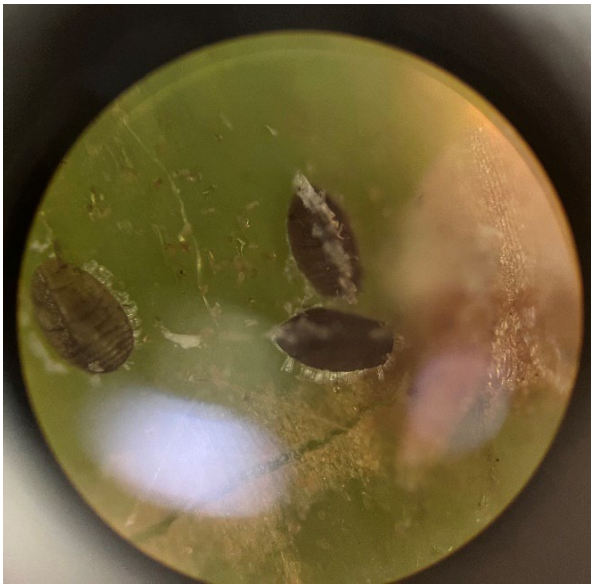
Ips grandicollis*, viewed through a microscope, collected from an infested pine in Pine County*

Pine leaf adelgid hanging out on white pines in Two Harbors vicinity

Pine leaf adelgid (*Pineus pinifoliae*) is a native insect that can cause shoot damage on white pine. The primary host for this insect is black spruce where galls are formed, but no worrisome damage results. The adelgids then feed on the alternate white pine host, which results in drooping or twisted, distorted growth. If outbreaks persist, growth can be severely impacted and compromised saplings could even die. Damage seems to be most common on younger white pine trees.

Damage from this insect has been sporadically observed in northeast Minnesota since 2019, but a rather severe infestation was observed on planted white pine trees a little northeast of Two Harbors this year. This infestation likely has been occurring for consecutive years, because shoots are very distorted and twisted. In addition to this site, a few infested white pine were observed north of Two Harbors. Populations of pine leaf adelgid will be monitored around the Two Harbors area in 2025.

Distorted growth of a planted white pine tree.

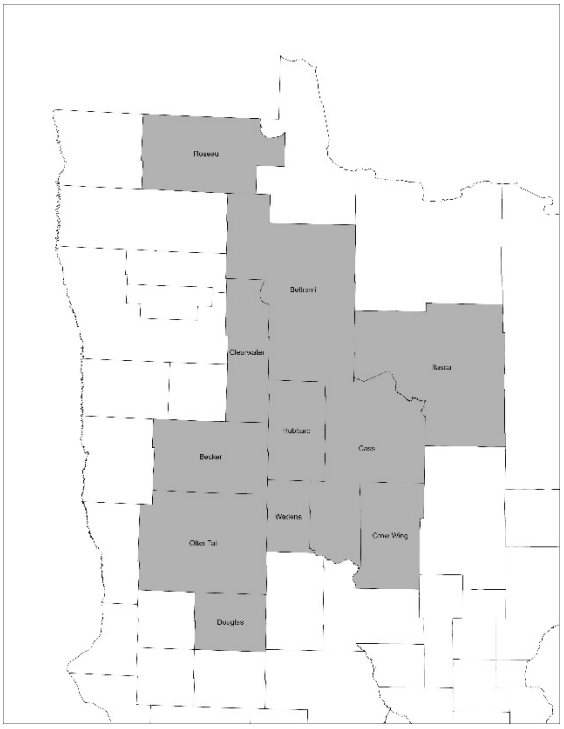


Larvae of pine leaf adelgid at 10X magnification.

Red pine shoot moth feeding on pine shoots for a fifth consecutive year

Red pine shoot moth (*Dioryctria resinosella*) has continued to experience an outbreak that started in 2020. Previously, the outbreak extended across much of the state, but it is now only located in central and northern Minnesota. Caterpillars solely damage the current year's shoot and don't kill branches, so red pines can tolerate red pine shoot moth attack for a number of years without significant impact to their health.

Populations have fluctuated over the past few years, with a noticeable decrease in damage this year. Generally, red pine shoot moth has damaging populations for 2-3 years, so we expect parasites and other factors will continue to lower populations.



Shoot killed by red pine shoot moth (left). Counties where damage from red pine shoot moth were observed in 2024 (right).

Spongy moth trapping and treatment summary

Spongy moth (*Lymantria dispar dispar*) is an invasive forest pest that feeds on many plant species, including aspen, oak, and birch. Populations of this invasive are slowly encroaching upon Minnesota from the east, but they have not yet established to defoliate large forested areas. However, very small pockets of defoliation have been discovered. One location was at Palisade Head along the North Shore in 2021. Once populations are large enough, outbreaks can occur every 8 to 12 years. Defoliation stresses trees, and heavy and repeated defoliation kills trees.

A female spongy moth laying an egg mass in Wisconsin (photograph from Wisconsin DNR).

Minnesota Department of Agriculture (MDA) implements a national program in Minnesota to slow the advancing front of the spongy moth population. Program details, including survey results and proposed treatment zones, can be found on MDA's spongy moth website.

Trapping surveys

MDA catches male moths in traps to estimate spongy moth population spread. Fewer moths were caught in 2024 statewide, but a major reason for that was trapping efforts were drastically reduced in Cook and Lake counties, where male spongy moths have been caught at high frequencies previously. MDA caught more moths per trap in all the southeastern counties of Goodhue, Wabasha, Winona, and Houston counties in 2024 than in 2023.

The MDA, DNR, and others are finding higher frequencies of egg masses in northeast Minnesota over time, which indicates northeast Minnesota could experience outbreaks in certain areas. The DNR Forest Health Program utilizes aerial surveys and reports from forestry professionals to detect outbreaks. If there were larger outbreaks, we would report them here.

Slow the Spread treatments

The MDA aerially applied treatments to suppress spongy moth populations in 2024 as part of the national Slow the Spread program. They applied *Bacillus thuringiensis* variety *kurstaki* in 6 spray blocks in Carlton County and 1 block in St. Louis County, totaling about 4,500 acres, in mid-June 2024. They treated populations with mating disruptor in 35 spray blocks, totaling about 165,500 acres, across Houston, Fillmore, Chisago, Isanti, Pine, Carlton, and St. Louis Counties from later June to mid-July.

Spruce budworm is a major problem in northeast Minnesota

Spruce budworm (*Choristoneura fumiferana*) is a native caterpillar that defoliates balsam fir and white spruce. It affected more acres in 2024 in Minnesota than it has since 1961. In just the last four years, this insect has impacted over 2,000 square miles (1,330,000 acres), primarily in northeast Minnesota. The resulting fir and spruce death have caused major concerns with wildfire potential and the inability to efficiently manage the forest.

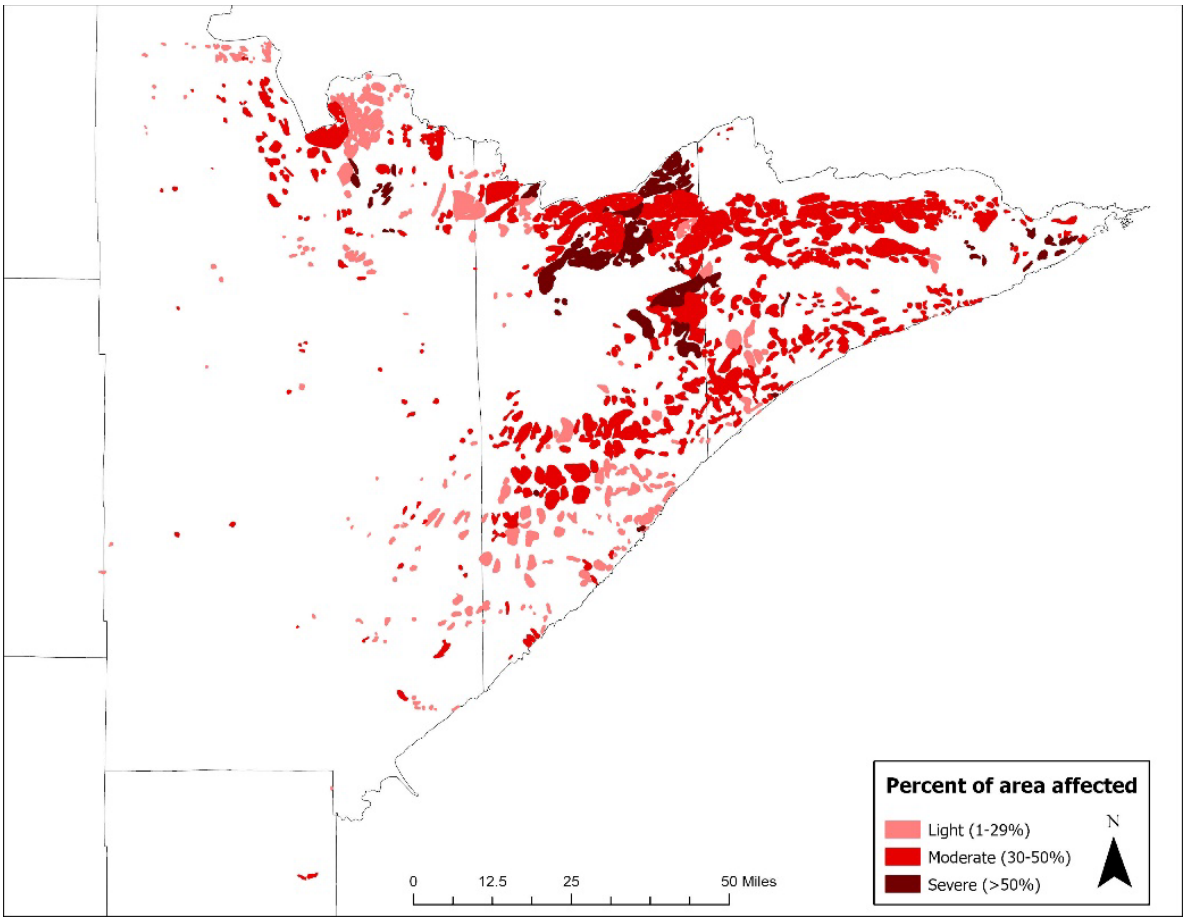
The DNR received funds in 2024 from the Lessard-Sams Outdoor Heritage Council to diversify and regenerate budworm-impacted land. A wide variety of landowners and managers are working on this issue, but limited staffing, limited market demand, not enough loggers and contractors, diverse land ownership patterns, and the sheer extent of the outbreak all add up to make dealing with spruce budworm a big challenge.

The majority of the 712,000 acres impacted by budworm in 2024 were defoliated, while about 33,400 acres were mostly killed spruce and fir trees. The average annual impact from spruce budworm in the last five years is 519,000 acres, which is just slightly less than the size of Lower and Upper Red Lake, Leech Lake, and Mille Lacs Lake combined. The main outbreak has been located mostly in northern St. Louis, Lake, and Cook counties for the past handful of years. No defoliation was mapped in northwest Minnesota this year, unlike in 2023, but lighter defoliation could still be persisting in Beltrami, Lake of the Woods, and Roseau counties.

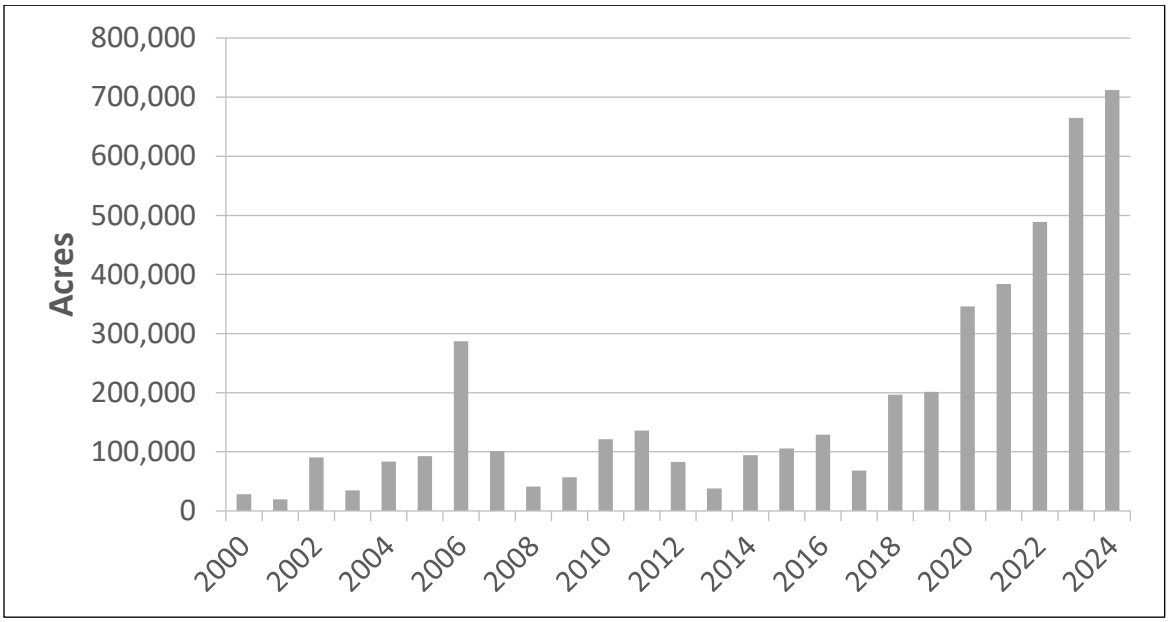
Outbreaks in a specific area in Minnesota typically last 6-10 years, which is about the amount of time balsam fir and white spruce can withstand feeding. After outbreaks subside in specific locations, budworm will cycle back about 30-60 years later. Outbreaks of spruce budworm occurred in the past and now may be exacerbated by 20th and 21st century fire suppression. Fire suppression allows fir and spruce forests to grow denser and older, benefiting spruce budworm.

Spruce budworm will likely continue to cause extensive defoliation and mortality in Lake and Cook counties in the upcoming years. Some small populations outside the Arrowhead, such as in Itasca County, also seem to be persisting.

Old mortality from spruce budworm north of Two Harbors in 2024.



Spruce budworm defoliation and mortality in 2024.



Acres with spruce budworm defoliation and mortality from 2000 to 2024.

Diseases

Anthracnose common on several hardwood species in northwest Minnesota

Anthracnose is a fungal leaf disease that affects many tree species and is promoted by cool, wet weather. In 2024, anthracnose was common on maple, basswood, oak, and ash in northwest Minnesota due to abundant precipitation during leaf emergence and elongation. Anthracnose causes brown, irregular spots to form on leaves and can lead to curling, cupping, and other leaf distortions. Symptoms are usually most severe on lower tree branches but can sometimes progress upward through the canopy in severe cases. Anthracnose can also cause ash trees to suddenly drop their leaves in May.

While anthracnose and other fungal leaf diseases appear concerning, they typically do not cause significant harm to trees. Control is not usually required; it is best to keep ornamental trees healthy and growing vigorously with proper watering, mulching, and pruning.

Anthracnose infection on a maple tree in Crow Wing County.

Minimal bur oak blight in 2024

Bur oak blight was more widely reported in 2024 than in 2023, especially in the northwest part of the state, but was not a significant tree health concern. Above-normal precipitation throughout much of the state in May and June produced conditions conducive for extensive bur oak blight development. We have observed heavy bur oak blight infection defoliate individual bur oaks over many consecutive years without causing mortality. In every case, bur oaks produce healthy leaves the following spring. It is possible though that severe and repeated infections could make trees more susceptible to lethal problems. It is also possible, and has been our observation, that previously weakened bur oaks (e.g., due to construction damage) are more susceptible to bur oak blight than their neighbors.

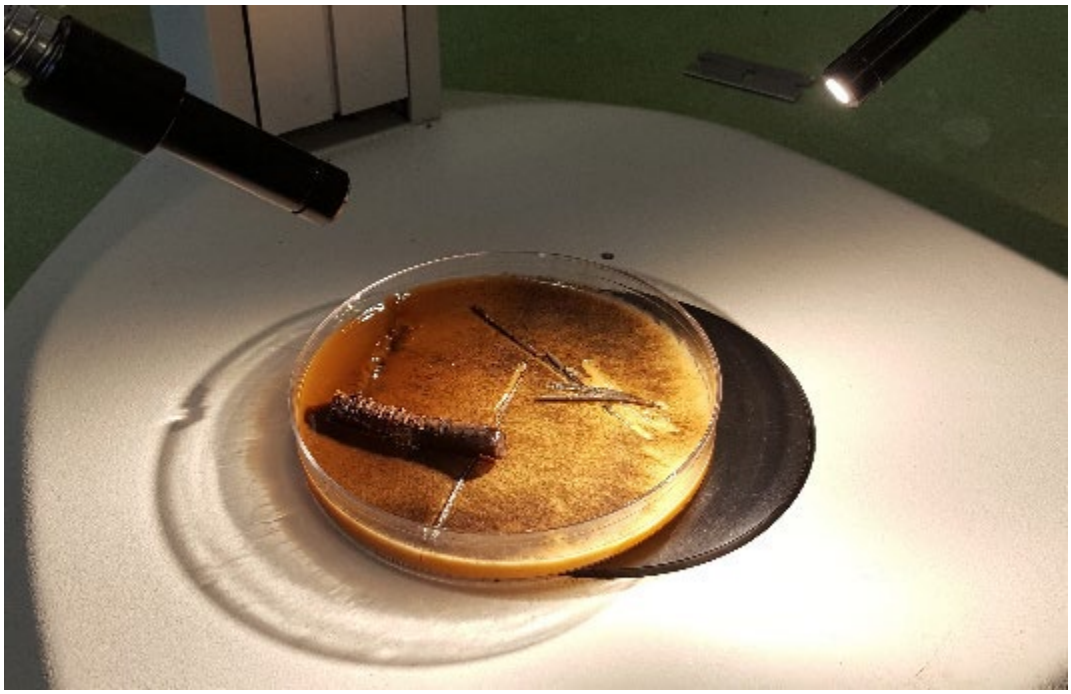
Tree with bur oak blight in Beltrami County.

No latent Diplodia found in red pine in 2024 at the Minnesota State Forest Nursery

Diplodia sapinea is a fungal pathogen that can kill red pine seedlings and saplings. On extremely stressed, old red pines it can cause dieback. Diplodia can also cause latent, or hidden, infections that do not result in disease until trees become stressed.

The Minnesota State Forest Nursery tests for latent Diplodia infections to avoid distributing stock with too much disease, and it does not sell seedlings when latent Diplodia infections exceed 10 percent of the crop. Infected seedlings at the nursery surpassed this threshold in 2016, due to highly favorable regional weather conditions for disease infection and development, and 400,000–500,000 red pine seedlings were destroyed to avoid potential widespread mortality from Diplodia after planting.

The Minnesota State Forest Nursery, DNR Forest Health, and University of Minnesota Plant Disease Clinic have assessed levels of latent Diplodia infections in state nursery stock since 2016. No samples tested positive for latent Diplodia infections in 2024 for the second consecutive year. Since 2017, we have found an average of 0.24% of tested seedlings with latent Diplodia. As this disease is abundant in Minnesota's landscape and cannot be avoided, this is well below an acceptable level for planting seedlings from the state nursery.



A piece of red pine seedling being examined for latent Diplodia infection at the University of Minnesota Plant Disease Clinic.

Good news again: No Heterobasidion root disease centers found in 2024

Heterobasidion irregulare is a fungal pathogen that causes a root disease of conifers called Heterobasidion root disease (HRD). It is particularly threatening to pine and spruce plantations. This disease was confirmed at one site in Winona County in 2014, but DNR staff eradicated it from that site in 2017. Minnesota DNR Forest Health staff surveyed for it this year at several sites and found none. University researchers also monitored for it and have not reported any disease centers.

Like other tree root diseases, once established at a site, HRD is very difficult, if not impossible, to get rid of, so prevention is important if HRD is nearby. That's why we are always monitoring for it.

University of Minnesota researchers in the Department of Plant Pathology have been extremely helpful with surveying for Heterobasidion. They have deployed Heterobasidion spore traps for a number of years, including this year where they had spore traps at Itasca State Park and at six other locations, from William O'Brien State Park in Washington County down to Great River Bluffs State Park in Winona County.

Heterobasidion fruiting bodies on a red pine stump.

Oak wilt found in Carlton and Kandiyohi counties

Oak wilt is a non-native, fatal oak disease that has spread slowly northward in Minnesota since the 1940s. We estimate that the disease covers almost 50% of the state's red oak range (northern red, northern pin, and black oaks). It is common in east-central and southeast Minnesota (black area in map below). As an invasive species, oak wilt is very unique in that it spreads very slowly across the state, and there are several different ways to control it on individual sites.

To slow the spread of oak wilt northward into uninfected forests, we prioritize early disease detection, outreach efforts, and management in Crow Wing, Cass, and the northern three-quarters of Pine and Morrison counties.

Early Detection

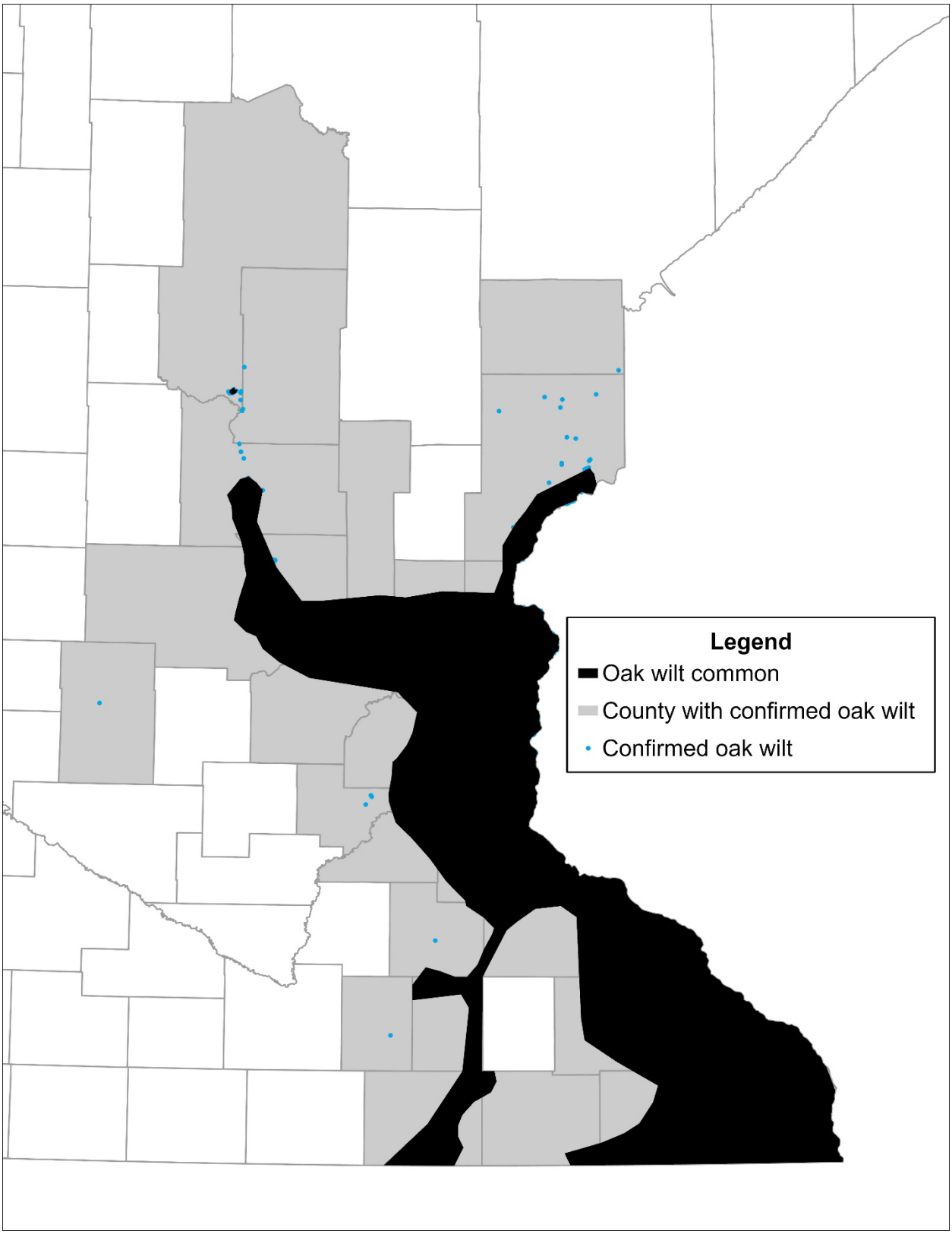
Oak wilt was confirmed for the first time in Carlton and Kandiyohi counties in 2024. The Carlton County disease center was found by DNR Forestry staff within the Nemadji State Forest, and it was about 8.5 miles northeast of the closest confirmed oak wilt. The Kandiyohi County spot was found by an arborist on private land and was about 40 miles southwest of the closest confirmed oak wilt. Another key discovery in 2024 took place in Crow Wing State Park, its first oak wilt confirmation and 4 miles to the nearest confirmed oak wilt.

Management

The isolated oak wilt discoveries in Carlton County and Crow Wing State Park were controlled by DNR Forestry and Parks staff, and the isolated Kandiyohi County spot is being considered for control in 2025. Besides those very isolated oak wilt centers, DNR Parks staff controlled over 10 pockets of oak wilt in St. Croix State Park, and DNR Forestry staff and Pine County Land Department managed oak wilt in relatively isolated locations in the northern three-quarters of Pine County on public land. Much of this public land disease control was partly funded with a grant from the USDA Forest Service (USFS).

Rapid response project

Minnesota DNR Forest Health continued to partner with the USFS, Michigan DNR, and Wisconsin DNR on research to evaluate the effectiveness of a rapid control procedure for single, isolated oaks infected aboveground by oak wilt. Twenty-two treatments were applied in 2024, increasing Minnesota's total treatments for the project, which began in 2021, to 36. We will monitor the effectiveness of these treatments through 2029. Preliminary results show the treatment is not nearly as effective as we had hoped.



Oak wilt is common in the black zone. Points represent oak wilt disease centers outside the black area. Many of these spots have been controlled and are being monitored.

Heavy poplar leaf disease statewide in 2024

Leaf disease impacted poplar trees across much of Minnesota, resulting in sparse crowns with stunted leaves, leaf spots, and leaf blotches. We estimate that 10–20% of the state's poplars were mostly defoliated by the end of August. Since poplar trees are clonal, symptomatic trees with sparse crowns and small leaves were often in clumps or clones. A *Marssonina* species was correlated with leaf spots and blotches on trembling and bigtooth aspen, and a *Septoria* species was correlated with leaf disease on balsam poplar. These leaf pathogens benefited from rainy conditions during leaf emergence and elongation. Most places in Minnesota had precipitation totals in May that were well above average, and June was the fourth-wettest June and fifth-wettest month ever recorded in Minnesota. Spring frost damage to poplars that leafed out early may also have contributed to sparse and sickly crowns. We do not anticipate any significant harm to poplars from these diseases alone.

Two clones of aspen trees, one of the clones has symptoms of poplar leaf disease (left), and the other does not (right).

Septorioides needle blight on white pine predicted for 2025

In 2023 a needle pathogen was commonly observed on white pine in northeast Minnesota. All the samples sent to the University of Minnesota's Plant Disease Clinic yielded the fungal pathogen *Septorioides strobi*. This pathogen is one of several responsible for white pine needle damage, which has been problematic in northeastern parts of the United States.

Symptoms were observed again in 2024 but were much less noticeable compared to the previous year. Trees displaying symptoms were in the same counties as 2023, which included Aitkin, Itasca, Koochiching, and St. Louis. This disease causes chlorotic (yellowing) older needles. New needles become infected, but they don't display symptoms until the next year. Older, diseased needles can also drop after symptom development.

The observed increase of this pathogen in 2023 was likely due to drought and above-average precipitation early in the 2022 growing season. Excess precipitation in 2022 resulted in infection, and then drought in 2023 allowed disease development. Early season precipitation was below normal in 2023, which most likely resulted in less infection and thus less symptoms in 2024. Since early season precipitation was well-above normal in 2024, this disease may be abundant in 2025.

Generally speaking, needle diseases like Septorioides needle blight are not concerning unless they cause severe infection for several consecutive years.

Symptomatic white pine needles infected by Septorioides strobi *in St. Louis County.*

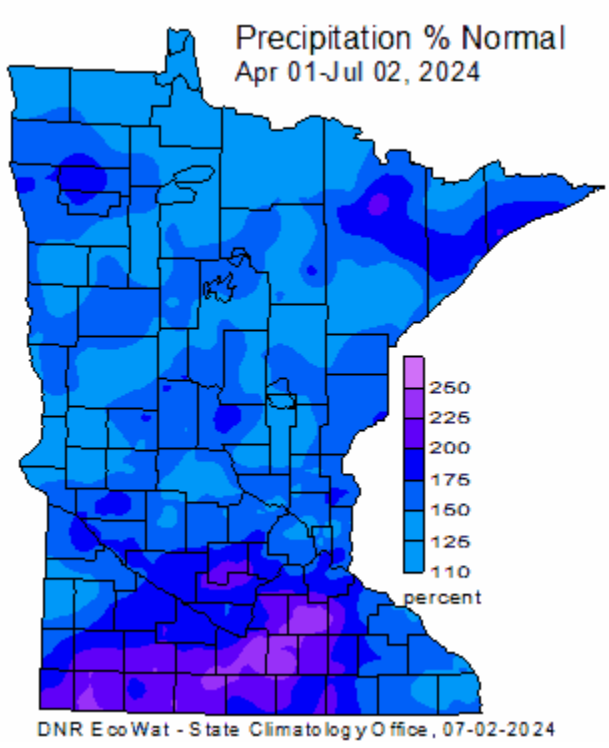
Declines and Abiotic Problems

Weather summary for 2024 and how our forests fared

There were major swings in temperature and precipitation in 2024. Overall, the return of above-normal precipitation benefited many forests.

The three-month period of December 2023 through February 2024 was the warmest such period on record for the state. It was almost twice as warm as the mean winter temperature for 1991–2020. Lots of precipitation fell in December as rain, but January and February were drier than normal, and there were concerns that little to no snowpack would result in frozen tree roots and subsequent dieback. We did not receive or observe any tree damage from this warm winter with low snowpack.

Precipitation that falls from just before general leaf-out in May to peak fall colors in early October is critical for forests to stay resilient to infection and attack by opportunistic diseases and insects. For the entire state, average precipitation from April through October was above normal, which hasn't happened since 2019. Precipitation from May through June 2024 was the most for that two-month period on record. In great contrast, September 2024 was the third-driest September on record. Due to all of the fungal leaf disease promoted by the wet early growing season, and the decreased photosynthesis from the extremely dry September, fall leaf colors were perceived by many as sub-par in several locations around the state.



Percent of normal precipitation from April through June 2024. All of Minnesota experienced above-normal precipitation in this period.

Besides abundant leaf disease and possibly diminished fall color brilliance, the only other obvious impact from the weather in 2024 was outright flood damage. We mapped about 6,700 acres of forests with flood damage in 2024. This is up almost 30% from the ten-year running average. As for the extremely dry September and October, we anticipate not seeing negative consequences unless there is additional multi-month serious drought in growing season 2025.

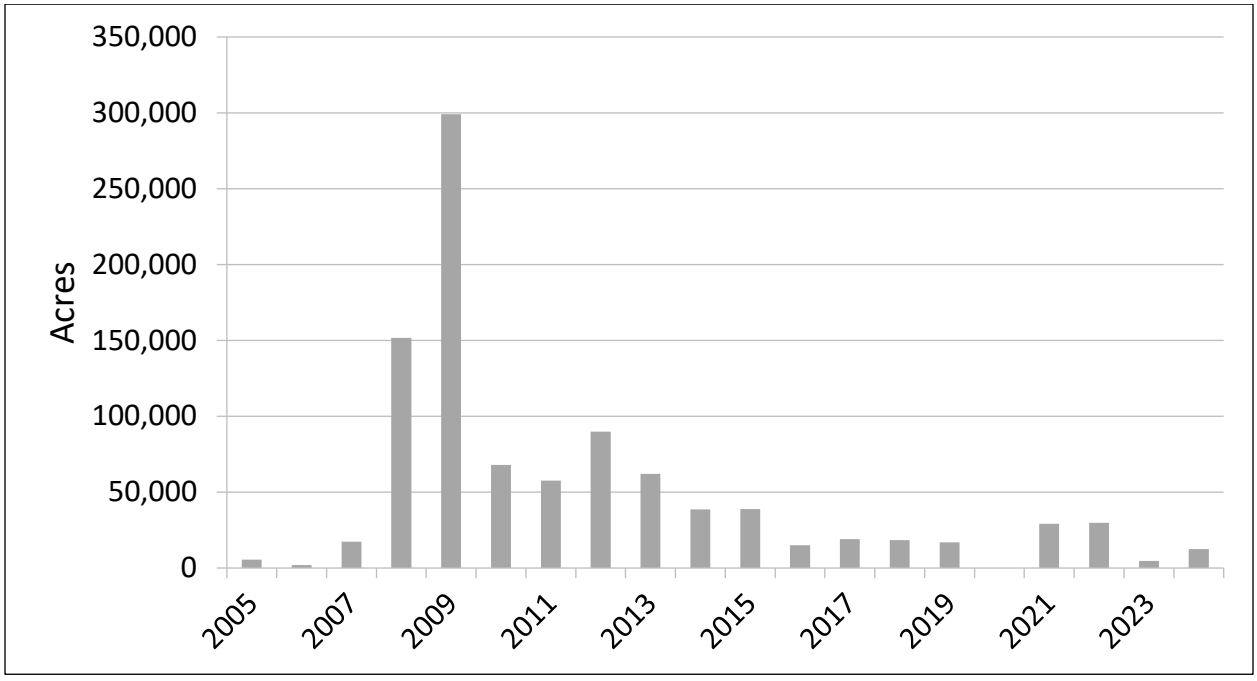
Aspen decline remains at low levels

Forests dominated by aspens are Minnesota's most common, representing almost 30 percent of our forests. Aspen decline was not a significant problem in 2024. We mapped about 13,000 acres of aspen decline this year in aerial surveys, an increase from 2023, but well below the average for the last 10 years.

The causes of aspen decline are varied and cannot be attributed to one factor. Most fatal aspen declines occur in forests that are predisposed by older age or sub-optimal soils, incited by drought or heavy defoliation, and exacerbated by attack from opportunistic diseases and insects.

The large aspen decline event that took place in 2008 and 2009 was isolated to a location straddling the border between northern Lake and Cook counties and along the shore in Cook County. Aspen decline in that zone spiked two years after a severe growing season drought as well as after five straight years of below-normal precipitation during the growing season (2002–2006). The spike in decline also came five years after four consecutive years of defoliation by forest tent caterpillar and large aspen tortrix (2000–2003).

The more recent 2021 growing season drought in northeastern Minnesota was more intense than the one in 2006, but below-normal precipitation during the growing season only lasted for two consecutive years (2020–2021). Also, there has been no recent outbreak of any aspen leaf-feeding insect. The last such outbreak in northeastern Minnesota ended in 2003.



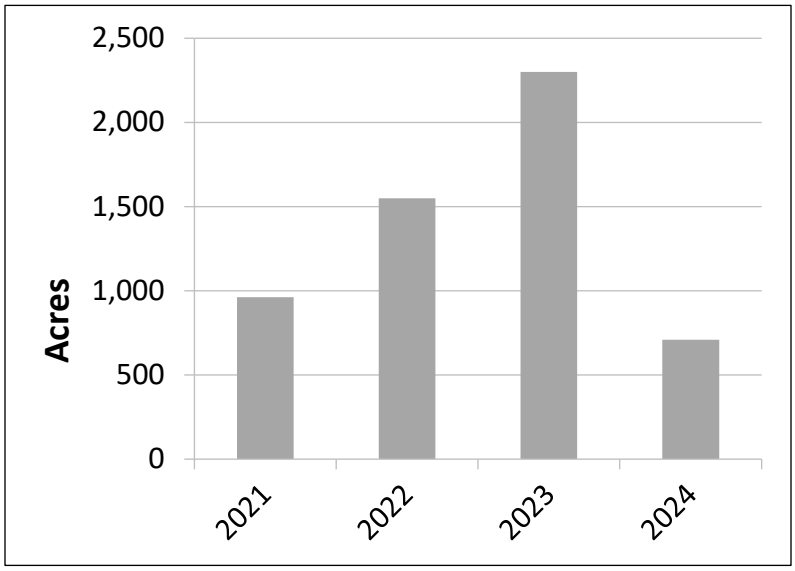
Acres mapped with aspen decline from 2005 to 2024. No aerial survey was conducted in 2020.

Oak decline slows in 2024

General decline of oak forests increased substantially in Minnesota following the severe statewide growing season drought in 2021. Decline is characterized by scattered tree dieback and mortality developing over a number of years across large areas. It happens to forests that are predisposed to stress. Once a stressful event occurs, like a severe drought, pests and diseases are able to overcome tree defenses and damage or kill them. Armillaria root disease and twolined chestnut borer, both native organisms, are largely responsible for killing off stressed oaks in Minnesota.

Many of Minnesota's oak forests are predisposed to decline, in part, because they are quite old. According to USFS Forest Inventory and Analysis data, almost 50 percent of oak forests in Minnesota are over 80 years of age. That ranks as the second oldest forest type over 80 years old in the state. Many of these forests are also quite dense, resulting in trees competing with one another for scarce resources like water.

Severe drought in 2021 kick-started oak decline, symptoms became visible and abundant in 2022, and they peaked in 2023. The upward or downward trend in aerial and ground observations of twolined chestnut borer serves as a proxy for the amount of declining oak forest. A nearly 70 percent drop in mapped twolined chestnut borer damage occurred in 2024, likely due to the return of abundant rains in early growing season 2024 and subsequent oak tree recovery from stress. For both years, twolined chestnut borer damage is significantly underestimated due to the high difficultly in mapping the scattered damage.



Acres mapped with twolined chestnut borer damage, an underestimate for Minnesota, but reflective of the trend in general oak decline (left). An oak dying after about three years of twolined chestnut borer infestation (right).

Even though we mapped significantly fewer acres of declining oak forest in 2024, that doesn't mean the trees have fully recovered. Frequently, oaks remain compromised after severe stress for a few years. There was severe drought in 2023 in many parts of Minnesota. That drought last year, plus the near-record dry September through October 2024, may cause additional forest decline in 2025.

Estimating mortality in oak forests from the 2021 drought using TreeCAP

New techniques and technologies are appearing that may someday improve, or even replace, largescale forest health surveys performed out of airplanes. Our aerial survey is a very economical tool that roughly estimates broadscale trends over time. For pests and problems like twolined chestnut borer and declines, aerial survey is not able to detect much of the damage because it is scattered and develops over a number of years. One newer technique for estimating forest damage was developed by Sarah Wegmueller with USFS's Forest Health Protection program. It is called the Tree Condition and Analysis Program (TreeCAP). TreeCAP is able to more accurately detect dying trees on a much finer scale than a surveyor mapping damage from an airplane. It uses aerial photographs, LiDAR, and machine learning algorithms. Current drawbacks with TreeCAP are that it offers little to no insight on tree species affected or causal agents – human interpretation and/or ground verification is required. It also was designed to use National Agriculture Imagery Program (NAIP) imagery and is not as timely as aerial survey. However, for historical analysis, TreeCAP can be a useful tool.

A TreeCAP analysis of 10 oak stands selected by forest health specialists, ranging from Minnesota's southern border up to Pine and Cass counties, found that the average area of mortality in these stands increased 1.5 percent from before to after the 2021 drought, with the two most severely impacted stands exhibiting over a 3–5 percent increase. If we extrapolate this small assessment to all 1.6 million acres of oak forest in Minnesota using the average increase in mortality, that is over 24,000 acres of mortality that developed after the 2021 drought.

Declining oak, August 2024, in a Cass County stand.

Spruce decline happening in central Minnesota

This summer our aerial surveys detected ample mortality in several white spruce plantations in central Minnesota. Between these aerial surveys, in-depth site investigations in recent years, and analysis of past years' aerial photographs, we've concluded that many white spruce plantations from central to east-central Minnesota have been in serious decline for several years. In some cases, well over 50% of the trees have died the past few years. There were large spikes in spruce death during and after extremely rainy growing seasons (2014, 2016, 2017, 2019) and extremely dry growing seasons (2021 and 2023).

Armillaria root disease, a ubiquitous opportunistic root pathogen, was ultimately responsible for finishing off these spruce. This is a classic decline, where white spruce were predisposed to stressors due to being planted on sub-optimal sandy soils, and extreme weather started decline that was perpetuated by disease. A key point is that matching site characteristics, like soil type and sun exposure, to natural tree preferences is critical for maximizing long-term tree health.

In addition to severe Armillaria infection, many of the observed declining spruce were host to a variety of secondary, opportunistic bark beetle species. Examples of bark beetle genera that have been identified on these dead or dying spruce are *Dryocoetes, Orthotomicus*, and *Polygraphus.* While the identified beetles are generally considered non-aggressive and their presence in stressed stands is unsurprising, the diversity and abundance of these beetles in spruce stands will be monitored by Minnesota DNR into the future.

White spruce that mostly died in 2023 in southwest Cass County.

Mycelial fans produced by Armillaria growing beneath the bark of a dying white spruce in Sherburne County.

DEPARTMENT OF NATURAL RESOURCES