Wisconsin Forest Health Highlights

Division of Forestry
WI Dept of Natural Resources

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This year, both native and exotic insects and diseases presented challenges for the Forest Health Protection personnel. Populations of the jack pine budworm dramatically increased in northwest Wisconsin, causing over 222,000 acres of defoliation. This insect is also on the rise in west-central Wisconsin, feeding primarily on jack pine but also occasionally on red pine. Surveys for exotics including sudden oak death, emerald ash borer and beech bark disease were all negative for the presence of these organisms. Defoliation of oak by the gypsy moth was rare; no large-scale defoliation was detected. A biological control survey for gypsy moth was initiated in cooperation with the US Dept. of Agriculture. A cooperative research project on red pine pocket mortality entered its second year. Ash yellows was confirmed in 2 new counties: Taylor and Burnett, and Annosum root rot was confirmed in Waushara County. A survey of tamarack stands in eastern Wisconsin revealed scattered mortality. A summer deficit in precipitation continued to stress trees in localized areas.

THE RESOURCE

—Forests are important to the economy of Wisconsin, not only in the form of wood products, but also for recreation and tourism. The primary and secondary wood products industry is one of the five largest employers in the state and puts Wisconsin first in the nation in the production of fine paper, sanitary paper products, children's furniture, and millwork. The value of shipment of these products is about $20 billion. Forest and water resources in Wisconsin are a primary tourism attraction for both residents and visitors. The variety of Wisconsin's forest ecosystems support a great diversity of wildlife species, while recreational use of the forests continues to grow and expand. The area of forestland in Wisconsin has been steadily increasing in recent decades and currently stands at almost 16.0 million acres, representing 46 percent of the total land area. The state now has the most forest land that it has had at any time since the first forest inventory in 1936. Wisconsin's forests are predominately hardwoods, with 84 percent of the total timberland area classified as hardwood forest types. The primary hardwood forest type in the state is maple-basswood, which makes up 5.3 million acres (34%) of Wisconsin's timberland area. Conifer types represent 16% of the total timberland area (pine forests: 8%, spruce-fir: 6%, and swamp conifers: 2%).

In this issue:

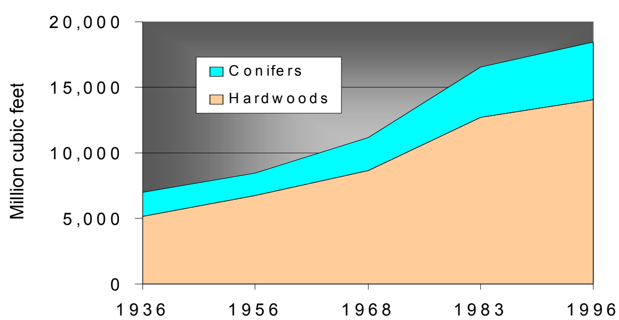


Figure 3. Growing stock volume (in million cubic ft) on timberland in Wisconsin, 1936-96. Data taken from 1996 FIA survey.

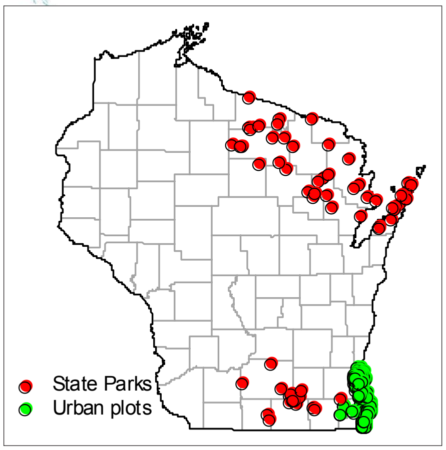
EXOTICS

Emerald Ash Borer:

Visual Survey of Campgrounds

Adult emerald ash borer

During the summer of 2005 we continued to survey for the presence of emerald ash borer (EAB) in Wisconsin. Prior to 2005 we conducted a visual survey of Wisconsin's ash resource in state park and state forest campgrounds (see map on the next page). This summer, the target survey area was expanded to include detection of EAB in private and county campgrounds. Due to the large number of private campgrounds in Wisconsin, we chose to focus our survey efforts in the northeastern and southeastern parts of the state where risk of EAB introduction is highest. We plan to survey campgrounds in the remainder of the state in subsequent years. The survey objectives were twofold: 1) to detect any emerald ash borer infestations and 2) to determine the overall health status of the ash resource.



The survey targeted ash trees in campgrounds because the risk of emerald ash borer infestation is increased for areas where firewood is frequently transported. EAB dispersal is accelerated beyond its natural range by the inadvertent transportation of larvae in logs, firewood and nursery stock. Data were collected by visual inspection of the tree's overall health (signs of stress included branch dieback, yellow foliage and epicormic sprouting) and by looking for signs of EAB (larvae, adults, bark cracks, serpentine galleries, D-shaped exit holes). In addition, observations of other ash pests and diseases were noted. Due to the large number of ash trees encountered, only a maximum of two trees per campsite were surveyed to allow us to survey a greater number of campgrounds overall.

As a result of our surveys, we detected no emerald ash borer infestations. A total of 101 campgrounds were visited and 2,447 trees surveyed in Dane, Door, Forest, Green, Jefferson, Langlade, Marinette, Oconto, Oneida, Rock, Vilas, Walworth and Waukesha counties. Overall, nearly 96% of the trees surveyed were seemingly healthy. A small percentage of trees exhibited symptoms commonly (but not definitively) associated with an EAB infestation; branch dieback (12.5%), epicormic sprouting (7.8%) and yellow foliage (0.2%). Thirteen of the trees surveyed were dead. Additionally, a small percentage of trees exhibited signs often associated with EAB; bark cracks (2.1%), woodpecker feeding (1.2%) and D-shaped exit holes (0.1%, 2 trees). **No emerald ash borer larvae, galleries, or adults were detected.** Although no EAB were found, 92 trees displayed a combination of at least 3 or more of the EAB associated symptoms and signs, and were therefore flagged for follow-up in 2006. As reported in Michigan, it is common for EAB to be present in a tree 3-4 years before visual inspections will detect the infestation.

The overall health of the ash resource in Wisconsin's private and county campgrounds is good. As reported, 96% of the trees surveyed were seemingly healthy. This result is similar to what we saw last year when looking at the ash resource in state park and state forest campgrounds. Few minor pest and pathogen infestations were observed during the survey. The foliar disease anthracnose was reported on 1.9% of the ash surveyed. Less than one percent of the trees surveyed had ash bark beetles, scale insects, ash plant bugs or ashleaf gall mites. Just over one percent of the ash trees had ash flower gall mites.

Urban Ash Surveys in Southeast Wisconsin

During June and August of 2005, visual surveys for emerald ash borer were conducted in urban areas of Kenosha, Milwaukee, and Racine Counties (see map on this page) Work was done by personnel from the University of Wisconsin under the direction of Dr. Chris Williamson.

Ash trees were examined for general signs of vigor in addition to signs of emerald ash borer infestation. A total of 2,323 trees were examined (nearly all were black, green, or white ash). Only one tree was dead. Of live trees, 60% showed no sign of weakness or injury, 32% exhibited branch dieback, 11% epicormic branching, 3% had a bark crack, and 2% had yellow leaves. (Numbers add to greater than 100% because trees may have multiple symptoms). One tree had a D-shaped exit hole that was attributed to an insect other than emerald ash borer. **No emerald ash borer larvae, galleries, or adults were detected by these surveys**

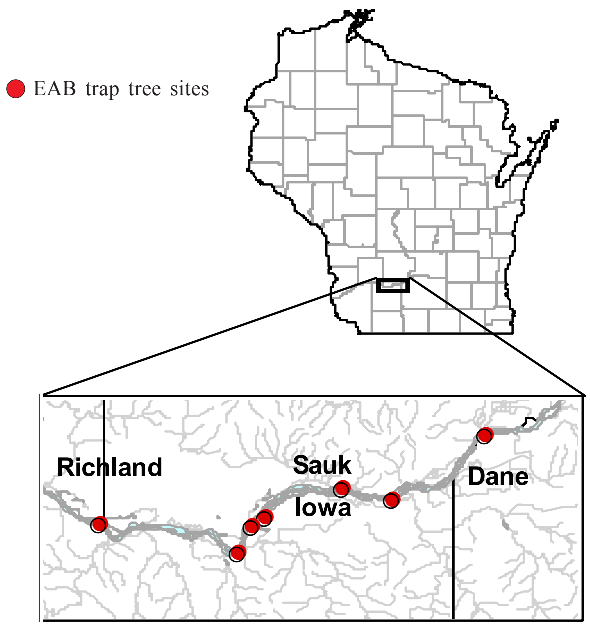
Signs of reduced vigor were attributed to several causes. In order of importance, these included wound damage, girdling, recent or improper planting, and water stress. The most common insect and disease problems were due to other woodboring insects, galls, ash flowergall mite, anthracnose, white peach scale, European fruit lecanium, and wooly ash aphid.

Emerald Ash Borer Detection Tree Survey 2005

In addition to conducting visual surveys for emerald ash borer (EAB) (*Agrilus planipennis*) in 2005, we set up and monitored ash EAB detection trees along the Lower Wisconsin Riverway (LWRW) with the help of LWRW forester Brad Hutnik. The LWRW is a flood plane forest scattered with numerous sandbar islands. This area is frequented by recreational canoe use and overnight camping. Due to the nearly nonexistent supply of firewood for campers, firewood is often brought into the area. It is through this gateway that EAB could possibly be introduced into Wisconsin.

Site selection

We selected seven sites for detection tree placement along a 23 mile stretch of the LWRW between Mazomanie Beach in Dane County (latitude N 43.23463°, W -89.80737°) and Long Island in Richland County (N 43.16723°, W -90.19702°). Detection tree placement was based on four criteria to opti-



mize our sampling efforts (most to least important): 1) Close proximity to camping, 2) Declining ash trees nearby, 3) Open-grown trees, and 4) Site accessibility. Two detection trees were placed at each of the seven sites. Sites were 1-5 miles apart and trees within a site were placed 100 – 200 feet apart. Detection tree construction consisted of girdling an ash tree (6-10" DBH) at waist height and placing a band of tangle trap above the girdle. The tangle trap was monitored biweekly from late May to early August. Monitoring consisted of looking for EAB and other wood boring insects and removing them for identification. It has been found from past work in Michigan that tangle trap alone cannot always detect a low density EAB infestation, therefore detection trees will be felled during late winter 2006 and their bark peeled to look for EAB larvae.

Detection tree construction

Insect catch from detection trees 2005

There were no EAB findings from the tangle trap on our detection trees in 2005. However, numerous other wood borers were collected. Of particular interest were two longhorn beetles (Cerambycidae), the redheaded ash borer (*Neoclytus acuminatus*) and the banded ash borer (*Neoclytus caprea*). Both were collected from the majority of detection trees and are commonly associated with stressed ash trees. In addition, numerous metallic wood borers (Buprestidae) were collected, with none being EAB. A species of *Chrysobothris* was collected as well as four species of *Agrilus*. Emerald ash borer is part of the genus *Agrilus*. All Buprestidae are of interest and are being processed for identification.

Insect catch from detection trees 2004

A similar detection tree survey was completed in Wisconsin's state forest campgrounds in 2004. As in 2005, there were no EAB findings. We did however collect eight other species of Buprestidae. Four of the species are not classified in the same genus as EAB and include *Chrysobothris femorata, Anthaxia viridifrons, Anthaxia inornata* and *Dicerca divaricata*. The remaining four species identified were *Agrilus,* and include *A. granulatus liragus, A. cephalicus, A. masculinus* and *A. crataegi*. Identification of the Buprestidae collected is beneficial to understanding our native beetle fauna for two reasons: 1) we have little knowledge regarding Wisconsin's native Buprestidae fauna and 2) it will allow us to discern the impact EAB's presence will have on our native species in the future.

EAB Firewood Inspection Blitz at Ferry Docks

The United States Dept. of Agriculture Animal, Plant, Health Inspection Service (APHIS) conducted a special inspection for firewood (referred to as a blitz) at the two ferry docks preceding the Fourth of July weekend to enforce the quarantine against movement of hardwood firewood out of Michigan's Lower Peninsula. Wisconsin sent people from the Wisconsin Department of Natural Resources, and University of Wisconsin to assist with this firewood blitz. Two ferries cross Lake Michigan, bringing vehicles that could be carrying regulated firewood out of Michigan to other states. Wisconsin is at particular risk for infested firewood since Wisconsin is the destination for many of the ferry travelers. The ferries were already screening vehicles for fireworks, explosives, and weapons, we simply

Inspection for ash firewood at ferry docks.

added to this with the question "do you have any firewood". For those people who wanted more information about EAB we provided them with the brochure Emerald Ash Borer The Green Menace for their reading pleasure during the ferry crossing.

The SS Badger, which leaves twice daily from mid-May through mid-October, holds 180 vehicles and 620 passengers and is large enough to take semi-trailers, recreational vehicles, motorhomes, and farm equipment, as well as standard passenger vehicles. The Lake Express, located in Muskegon, Michigan, departs 3 times daily during the summer season and holds 47 vehicles with no space for large or oversized loads.

There was no firewood found at the Lake Express terminal, but two seizures of hardwood firewood occurred at the SS Badger site. No signs or symptoms of EAB were found in the wood that was seized. APHIS also conducted a firewood blitz at the ferries on the weekend prior to Labor Day and no firewood was confiscated at that time. Based on these inspections it appears that the ferries are not a high risk route for EAB infested firewood to enter Wisconsin.

Sudden Oak Death

Since the mid 1990's mortality of several species of oak has been detected in northern California. A new disease caused by a fungus-like organism *Phytophthora ramorum* has been identified and is now know to occur in 14 coastal California counties from Monterey to Humboldt, as well as in Curry County, Oregon.

Bleeding canker associated

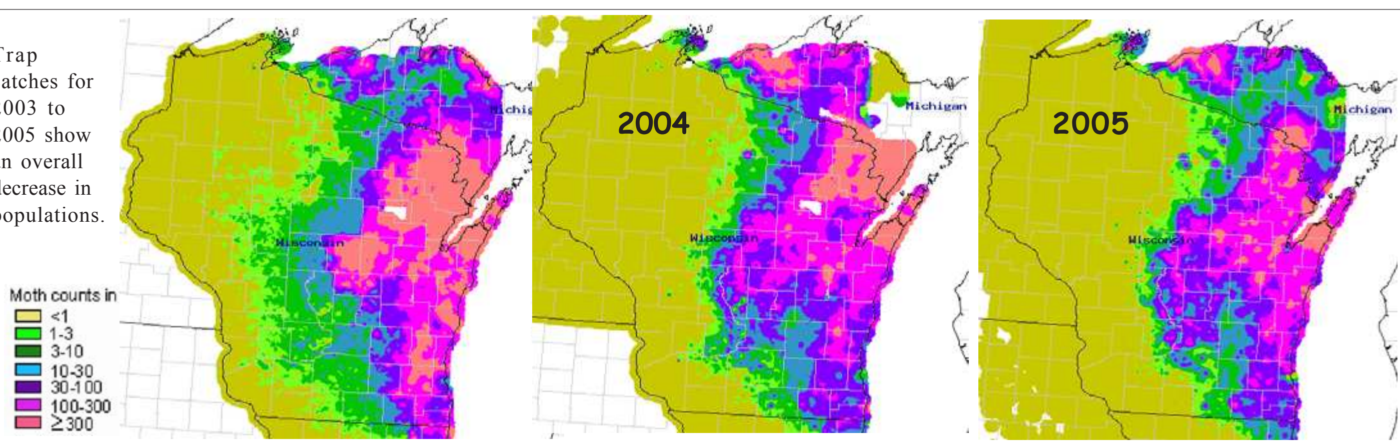
The origin of this disease is unknown. It causes bleeding cankers on several trees including tanoak, coast live oak, California black oak, Shreve oak, and canyon live oak. Infected trees typically die several years after infection. This disease also causes leaf spots, and branch tip dieback on a wide variety of understory plants; in June 2005, the number of genera known to be susceptible to this disease was up to 39. Pathogenicity tests have shown that northern red oak, Quercus rubra is susceptible.

In 2003, plant inspectors found that nursery stock had been shipped from an infected nursery in southern CA to several states, including WI. This prompted a national survey in 2004 and 2005 of nurseries receiving this stock and the oak woodlands surrounding these nurseries. Dr. Neil Heywood, a UW Stevens Point professor from the Department of Geography & Geology and his students conducted this survey. In 2005, DATCP surveyed nurseries and Dr. Heywood surveyed oak woodlands within .25 mile of 22 selected nurseries and 8 oak woodland sites. Samples (75) included understory vegetation with leaf spots resembling those caused by *P. ramorum* and tissue from bleeding oak cankers. Samples were sent to Ohio State and Mississippi State for analysis. All samples were negative for *P. ramorum.* Wisconsin will continue to participate in the national survey in 2006.

Gypsy Moth

Gypsy moth populations remained well below their 2002-03 highs because of a population collapse in 2004 (see maps at the bottom of the page). As a result, the 2005 suppression program was a fraction of its size the previous year. Approximately 2,700 acres in 5 counties were successfully treated. This compares to about 51,000 acres in 20 counties treated in 2004. There was no large-scale defoliation this year, compared to 20 acres in 2004 and approximately 65,000 acres in 2003. Scattered trees in Armstrong Eddy Park, Beloit, were heavily defoliated.

Trap catches for 2003 to 2005 show an overall decrease in populations.



The summer of 2005 was warm and dry, leading to increased caterpillar survival and increased average egg mass size. As a result, caterpillar numbers are expected to increase several-fold in 2006. The greatest impacts are expected in Adams, Columbia, Dane, Marathon, and Sauk Counties. In eastern Wisconsin, populations are also expected to increase, but widespread outbreaks are not expected.

Trapping data (available at http://da.ento.vt.edu/results0.html) indicated that the generally infested area did not increase in size. Juneau and Sauk Counties were added to the list of counties quarantined for the gypsy moth.

A biological control survey was initiated in cooperation with the USDA-ARS Beneficial Insects Introduction Laboratory in Newark, Delaware. Weekly collections of larvae and pupae, and a fall collection of egg masses, were made in 6 counties from Rock County in southern Wisconsin to Marinette County in northern Wisconsin. Seven insect species were found to attack larvae and pupae: *Cotesia melanoscela*, *Compsilura concinnata*, *Pimpla disparis* (see photo), *Parasetigena silvestris*, *Lespesia aletiae*, *Theronia atalantae atalantae*, and *Brachymeria compsilurae*. *Ooencyrtus kuvanae* (see photo) was the only egg parasitoid recovered. *O. kuvanae* is best adapted to southern Wisconsin, but was found as far north as Marinette County. The gypsy moth-killing pathogens *Entomophaga maimaiga* and Nucleopolyhedrosis Virus were found at an outlying infestation in western Oneida County.


Pimpla disparis wasp reared at Peshtigo

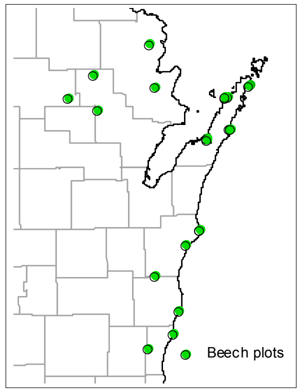

Ooencyrtus kuvanae parasitoid on egg mass

Beech Bark Disease

During the summer of 2005, visual surveys were conducted to detect beech bark disease caused by the beech scale (*Cryptococcus fagisuga*) and the fungi, *Nectria fagisuga* and *N. galligena*. Beech bark disease, which can cause extensive beech mortality, was first detected in upper and lower Michigan in 2000, and has spread dramatically in Michigan since.


Beech bark scale

Survey sites (see map) were scattered across the distribution of beech, and were selected on the basis of local abundance and likelihood of accidental introduction on firewood. Most survey sites were in parks and campgrounds. At each site, at least 20 trees (usually much more) were examined for the presence of the scale and disease. Beech scale and beech bark disease were **not** detected.

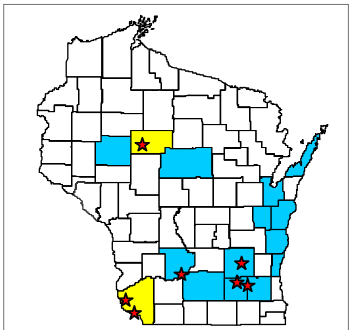


MTE (Menominee Tribal Enterprise) has also been surveying for the disease and scale on the Menominee Reservation but, to date, has not found either.

HARDWOOD PESTS

Ash Yellows

Ash yellows, caused by a phytoplasma, was confirmed in Grant and Taylor Counties in 2005 (shown in yellow on the map). Confirmation was made by a genetic analysis using a PCR (polymerase chain reaction) test. This summer, samples were collected from 8 locations where ash dieback had been reported in order to test for ash yellows through the genetic analysis. The analysis revealed the existence of the organism for 7 out of 8 locations (positive sites are shown as a star on the map). Some of the sampled trees that were positive for ash yellows were not showing the characteristic symptoms of ash yellows, such as a witches' broom, yellowing foliage, or deliquescent branching. However, all of the sampled positive trees exhibited branch dieback (or mortality) and epicormic branches. Positive locations included a campground, yard, woodlot, and forest.


County distribution of ash yellows as of November 2005.


Branch dieback caused by ash yellows

Hickory decline/mortality

Severe decline and mortality of hickory has been observed from southern to northeastern Wisconsin. Most of the mortality was of bitternut hickory, but there was some mortality of shagbark hickory as well. The symptoms progress from thinning crowns to branch mortality to complete tree mortality. Epicormic branches often sprout from the main stem only to wilt and die later. Some of the pests that have been associated with dying hickory trees include a bark beetle, a flatheaded borer, and possibly fungi that cause canker and wilt diseases. The hickory bark beetle (*Scolytus quadrispinosus*) is believed to introduce a canker fungus (*Ceratocystis smalleyii*), which creates oblong sunken cankers with discoloration under the bark. A flatheaded woodborer (*Agrilus otiosus*) was also observed attacking these declining and dying trees although it is not clear if this flatheaded woodborer is the primary cause of decline or is secondary. Additionally, there may be a fungal disease associated with dying trees that causes wilt (*Ceratocystis caryae*), in which the affected trees have dead crowns with wilted epicormic branches. Armillaria root disease was also found in the roots of dead hickory trees in some sites, but in other sites, there was no Armillaria. Armillaria was not found in the northeast part of the state where hickory in Calumet, Shawano, and Oconto counties were most affected.

Thinning and dead hickory crowns

Wilting leaves on hickory

Exit hole of *A. Otiosus*

Oak Wilt:

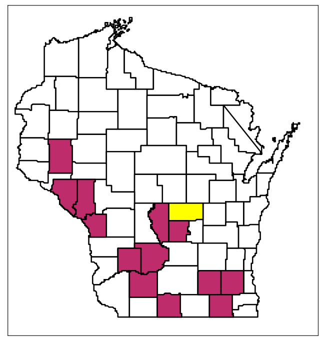
Oconto/Marinette Cos. project update

This summer, private properties within and near the Lakewood/Laona Ranger District, Chequamegon-Nicolet National Forest were surveyed to detect oak wilt. Based on the ground survey, 104 oak wilt pockets were identified in the surveyed areas. The survey was conducted as part of a cooperative project between the Wisconsin Department of Natural Resources and the Forest Service in an effort to manage oak wilt in the Lakewood/Laona Ranger District, Chequamegon-Nicolet National Forest area. A cost-share program is scheduled to be offered to private property owners in the area in 2006, if funding is available.

CONIFER PESTS

Annosum Root Rot

In 2005, Annosum root rot was found in a red pine stand in Waushara County (in yellow on the map). This brings the total number of counties with this disease to fourteen (Adams, Buffalo, Dunn, Green, Iowa, Jefferson, LaCrosse, Marquette, Richland, Sauk, Trempealeau, Walworth, Waukesha, and Waushara Cos.). Annosum root rot is caused by the fungus, *Heterobasidion annosum*. The fungus causes a decay of the roots and butt and often kills infected trees. In Wisconsin, Annosum root rot has been found primarily on red pine, and occasionally in white pine. The primary mode of infection is through freshly cut stumps. Spores land on the stump, grow through the root system, and infect adjacent healthy trees. Fruit bodies may be found at the root collar of dead/dying trees and stumps of infected trees. A publication outlining the symptoms/signs and management recommendations can be obtained at http://www.dnr.state.wi.us/org/land/forestry/fh/fhissues/annosum.htm



Tamarack mortality

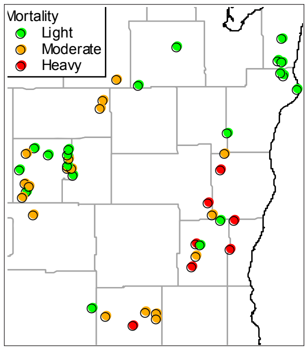
This spring, defoliation by the larch casebearer was observed scattered throughout the state. In some areas where heavy infestation occurred, defoliation was near 100%. Severely defoliated trees started to re-foliate soon after insect feeding was over. Larvae of larch casebearer mine the needles, which then curl and turn light brown. They spend their larval and pupal stages in brown cases. Generally, tamarack can tolerate one year of defoliation. However, repeated years of needle loss together with adverse weather factors or conditions that induce the fluctuation of a water table could weaken the trees to allow attacks from other pests and lead to tree mortality.

Tamarack Mortality Aerial Survey Update

Aerial surveys were conducted to determine the level of tamarack mortality in stands in southeastern and northeastern

Wisconsin. Surveys were conducted on October 26th in southeastern Wisconsin and on November 2nd in northeastern Wisconsin (see map). Needles had started turning yellow but had not dropped. Over 7,000 acres comprising 48 different stands of tamarack were surveyed by air and rated for percent mortality using visual estimations. A rating system was established using the following codes for mortality:

A= 0-5%
B= 6-25%
C= 26-50%
D= 51-75%
E= 76-100%



Of the 48 stands the summaries by category are:
14 stands, ~1,670 acres, A =0-5% mortality
18 stands, ~2,765 acres, B= 6-25% mortality
8 stands, ~840 acres, C=26-50% mortality
3 stands, ~245 acres, D=51-75% mortality
5 stands, ~2,130 acres, E=76-100% mortality

The stands with highest percent mortality were located in Sheboygan, Washington, and Ozaukee Counties. Within these three counties a few small stands of tamarack looked healthy.

Jack Pine Budworm

West Central Wisconsin

Counties where JP Budworm is currently active.

- Adams – varies from light to heavy defoliation.
- Eau Claire – varies from light to heavy defoliation.
- Jackson – very light defoliation, not really noticeable.
- Juneau – varies from light to moderate defoliation.
- Marathon – light defoliation.
- Wood County – from light to moderate defoliation.

Observations – Based on jack pine budworm late larval and egg mass surveys, populations are increasing in some counties. Budworm is also feeding in red pine stands that are 20-30 years old and 35+ years old. In both jack pine and red pine, there is top kill and entire tree mortality. Bark beetles are also killing severely stressed trees.

The budworm in red pine acts in a manner opposite to its activity in jack pine. Normally, budworm does not feed in young jack pine stands (20-30 year old), but it is widespread in this same age class of red pine. In older jack pine stands (30+ years old) you may observe one or two jack pine which look fine surrounded by trees that have been heavily defoliated. In older red pine stands (35+ year old), however, a single red pine may be heavily defoliated and surrounded by trees that are not defoliated or are lightly defoliated.

This is the second year that jack pine budworm has been observed in red pine in Adams County with budworm spreading further into these stands (younger and older). Budworm has also been observed in young red pine stands (20-30 year old) in Eau Claire, Juneau, and Wood counties and in older red pine in Wood County. In Minnesota budworm has been observed in red pine for the past 3 years.

Based on egg mass surveys, defoliation is expected in Adams, Eau Claire, Juneau, Marathon, and Wood counties again in 2006 and should vary from light to heavy. Based on late larval and egg mass surveys, very little defoliation is expected in Clark, Jackson, and Monroe counties.

Northwest Wisconsin

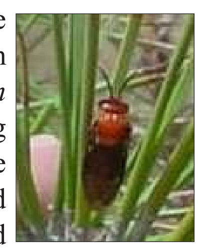
Budworm populations skyrocketed in 2005 in northwest Wisconsin. Acreage defoliated increased from 36,700 acres in 2004 to 222,500 acres in 2005. Defoliation was widespread and higher than last year in all 6 counties that have jack pine.

County	2004 acreage	2005 acreage
Polk	0	4,000
Burnett	4,100	10,000
Sawyer	0	3,000
Washburn	6,400	48,000
Douglas	23,700	113,000
Bayfield	2,500	44,500
Total	**36,700**	**222,500**

There were only mild surprises in the 2005 outbreak. The 4,000 acre spot in Sterling township appeared a year earlier than expected based on surveys. The defoliation in Burnett County was less extensive and less severe than anticipated. Washburn County was severely affected, more than expected. Defoliation was light to moderate in the Minong area; much of the severe defoliation with associated mortality occurred in Springbrook township. The extent and severity of jack pine budworm defoliation is expected to decline in 2006 in northwest Wisconsin.

Sawfly activity on Conifers

In the Northeast Region, sawflies were quite common this year. Repeat defoliation from Redheaded Pine Sawfly (*Neodiprion lecontei*) began to cause mortality of young red pine in Marinette County. European Pine Sawfly (*Neodiprion sertifer*) defoliated red pine in Marquette County and defoliated red and scotch pine and Manitowoc County.



Red-headed pine sawfly

White pine in Marinette County and Manitowoc County were defoliated by Introduced Pine Sawfly (*Diprion similis*). Yellowheaded Spruce Sawfly (*Pikonema alaskensis*) defoliated spruce trees in Door County.


Yellowheaded Spruce sawfly

The only elevated sawfly activity in this region was due to the spiny oak sawfly (genus Pericita) which caused widespread defoliation of small bur oak in Washburn, Burnett, and Douglas counties

Red Pine Pocket Mortality

The second year of a collaborative study between the University of Wisconsin-Madison and the Department of Natural Resources on Red Pine Pocket Mortality included the following: 1) tree assessments for insect damage and tree mortality, 2) establishment of 3 new asymptomatic controls, 3) continuation of trapping on the 31 study plots focusing on three primary insect culprits in red pine demise and their predators, and 4) establishment of traps to study insect biodiversity in and around the pockets. The upcoming year will involve two new studies with two more collaborators.

In the first quarter of 2005, tree evaluations for mortality and insect damage were completed along with the establishment of three new asymptomatic control plots in the Black River State Forest. The evaluations involved checking each tagged tree on all sites in the study (13 root severed sites, 8 symptomatic pockets with no treatment and 10 asymptomatic controls) for *Ips spp* and *Monocamus spp* exit holes, and *Dendroctonus valens* pitch tubes (number of tubes recorded). *Hylobius radicis* sampling was performed using a stratified random sample of 24 trees. Eight trees within three zones, inside of the pocket, root sever edge and outside the sever line, were sampled for damage below the soil on the tree. Root weevil damage typically manifests as a tar-like appearance of pitch in the soil along the base of the tree. All trees were rated as healthy, declining or dead.

Trap deployment to monitor bark beetles, wood borers and lower stem feeding insects were placed near the end of March. Lindgren funnel traps were strung eight feet above the ground and baited with aggregation pheromones; two traps with ipsdienol and lanerione bubble caps and two traps with ipsenol to monitor *Ips spp* and *Monocamus spp*. Twelve milk-jug traps and twelve PVC pitfall traps baited with monoterpenes were positioned two rows outside of root-severed sites (~10m from the pocket in control sites) and four of each trap type were placed at all other controls and used to monitor lower stem or root feeding insects such as *Dentroctonus valens* or *Hylobius spp,* respectively. Capture numbers for 2005 are currently being tabulated. In 2004, *I. pini* and *I. grandicollis* trap numbers totaled approximately 54, 000.

The insect biodiversity study was executed simultaneously with the aforementioned monitoring. Two flight-intercept traps (one trap placed in the center of the plot and one trap set ~5 m outside of the pocket) and six unbaited pitfall cups (three cups placed ~ 5m inside the pocket and three cups ~ 15m outside the pocket spaced equidistant) were positioned in all sites. Identification of captured insects is in progress. The insect biodiversity portion of the study concluded in 2005.

All traps in both studies were sampled approximately every two weeks. The milk jug and PVC pitfall traps were sampled until mid-July and all other traps until mid-September.

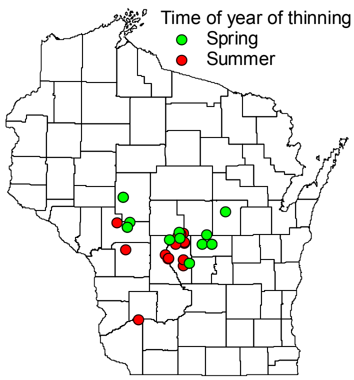
Tree evaluations for damage and mortality were again performed this fall. Results for tree mortality over the past two years show that, in the13 root severed sites (approximately 2800 total trees), 106 trees have died. Only one of the dead trees occurred outside the root graft sever line. This tree was heavily damaged during the severing process. The remainder of the year will focus on finishing the spatial mapping of each red pine in all study sites.

The deployment of funnel, milk-jug and PVC pitfall traps will be replicated next year. Two other studies will be launched in 2006. Beginning in March, an insect predator-prey dispersal study will begin in collaboration with Southern Illinois University. The second study on red pine defense responses will be conducted approximately in mid -June in collaboration with Ohio State University.

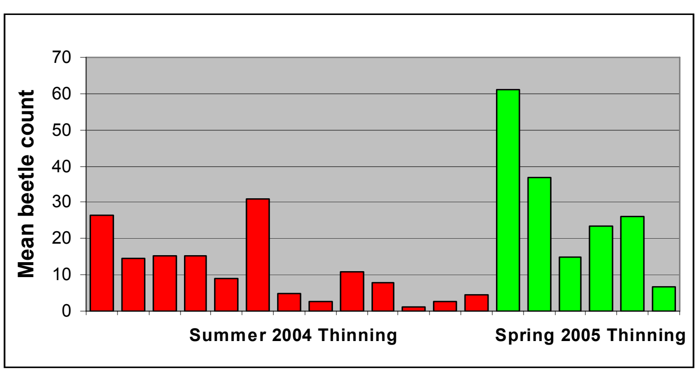
Time of year of thinning and populations of *Dendroctonus valens*

Red turpentine beetle (*Dendrotonus valens*) in combination with fungi of the *Leptographium* genus are thought to play a decisive role in the initiation of red pine pockets. Studies from the western US indicate that stand disturbance or thinning is correlated with the presence of bark beetles and infection with black stain fungi and that the time of year of thinning corresponds to the number of beetle attacks in Douglas fir stands.

We decided to test this hypotheses in Wisconsin: would the time of year in which a red pine stand was thinned make a difference in the number of turpentine beetles recovered in traps the following May. We selected roughly equal numbers of stands: 13 thinned in the summer (June through September 2004) and 10 stands thinned in the spring (February through April 2005) located mainly in the central part of the state (see map). Traps were made of gallon plastic milk jugs cut on 3 sides. A pheromone lure containing the chemical delta-3-carene was wired inside the jug and a plastic cup containing a pesticide strip was screwed to the mouth. The milk jug was then turned upside down and wired to the base of a red pine tree in the vicinity of a freshly cut stump. Traps were placed between April 18th and April 21st and collected between June 13th and June 17th. Counts of red turpentine beetles were averaged over all intact traps (several traps were destroyed presumably by animal activity).



The average number of turpentine beetles per trap for the stands harvested from June through November 2004 was 11.2 (stdev 9.2) and the mean for stands harvested February through March 2005 was 31.1 (stdev 29.3, see chart). A studentized t-test comparing the mean for the 2 groups showed a t-statistic of 2.068 with a 2-sided *p*-value of 0.065, a fairly significant difference between the two groups. There was much higher variance between the stands thinned in the spring of 2005 than those from the summer-fall of 2004. Part of this may be due to trap placement. Traps that were placed near edges that were exposed to open areas such as roadways and fields were more likely to have high beetle counts than those that were placed either in the stand interior or on edges which abutted forested areas. These traps may have been more likely to attract beetles entering the stand on strong wind currents.

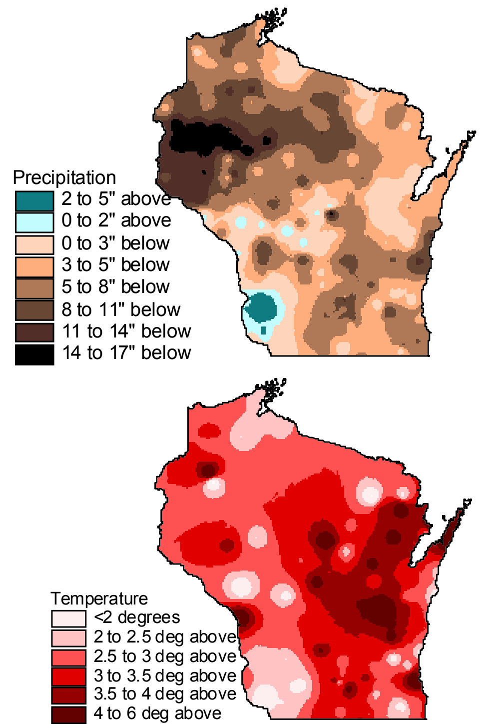


Trapping results show higher numbers in the spring 2005 harvested stands.

In conclusion, time of year of thinning seems to be correlated with the number of red turpentine beetles (*D. valens*) attracted to these stands the following flight season, however trap placement may also play a significant role, especially in stands thinned in the spring before beetle flight. Further study on the influence of trap placement on beetle abundance will be done in 2006.

WEATHER DAMAGE

Two striking deviations from normal weather conditions occurred during the summer of 2005. Most prominent was the rainfall deficit that affected the entire state outside of pockets in southwest and central Wisconsin. The northwest region, especially Polk and Barron counties were hardest hit with precipitation deficits of 15" below normal. Crawford and Jackson counties, on the other hand, received from 1-4" above normal rainfall but the rest of the state experienced a precipitation deficit.



Departure from normal precipitation (above) and temperature for June-August 2005

The other unusual occurrence was above normal temperatures, from 1.1 degrees in isolated spots in northern Wisconsin to 5.7 degrees above normal in the east and southeast. This combination of hot and dry conditions may have caused high levels of stress on trees, especially if defoliating insects were present.

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