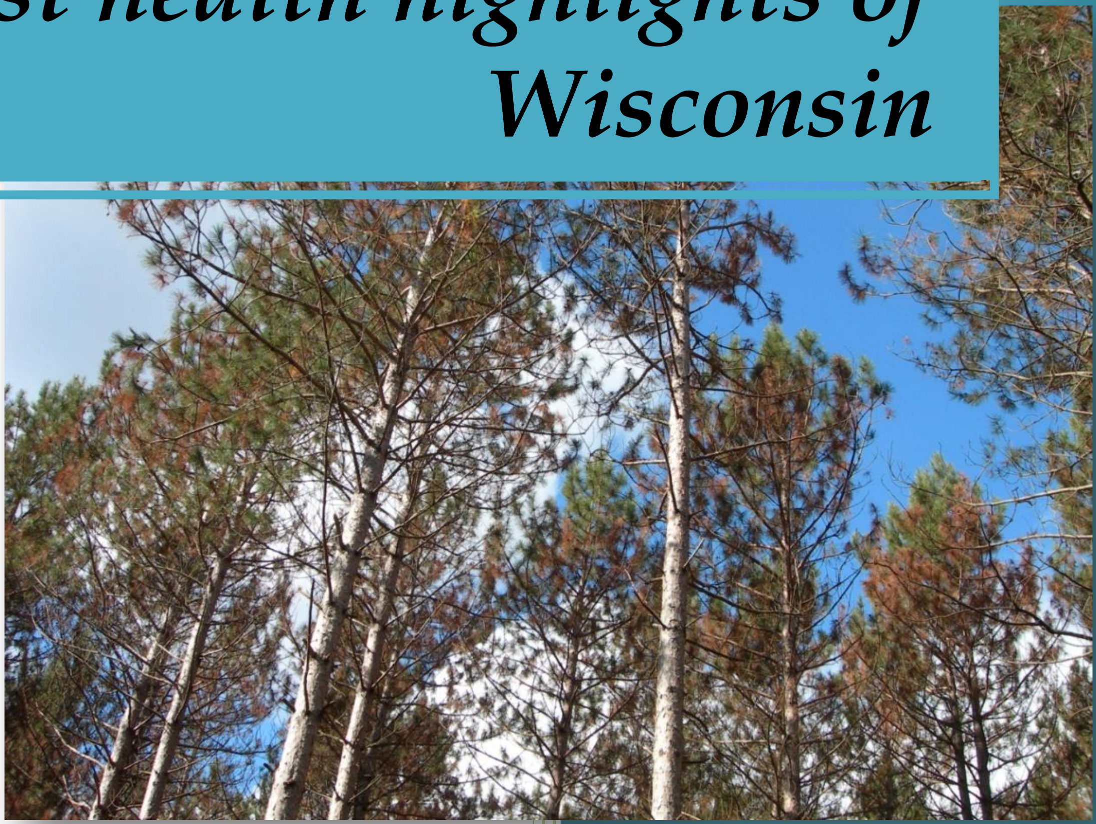
2007

Forest health highlights of Wisconsin



Wisconsin Forest Health Protection Program
Division of Forestry
WI Dept of Natural Resources
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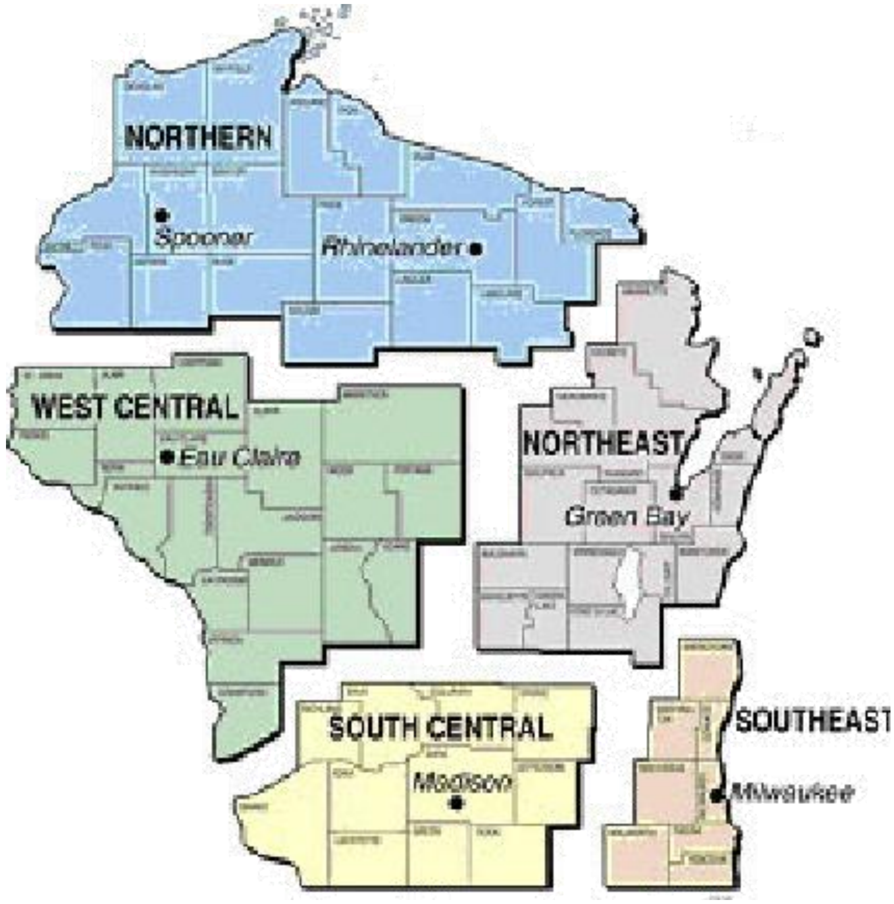

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Resource update

Wisconsin's forests are critical for providing wildlife habitat, clean air and water, managing erosion, and improving our quality of life in urban and rural areas. Forests are also 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 supports a great diversity of wildlife species, while recreational use of the forests continues to grow and expand.

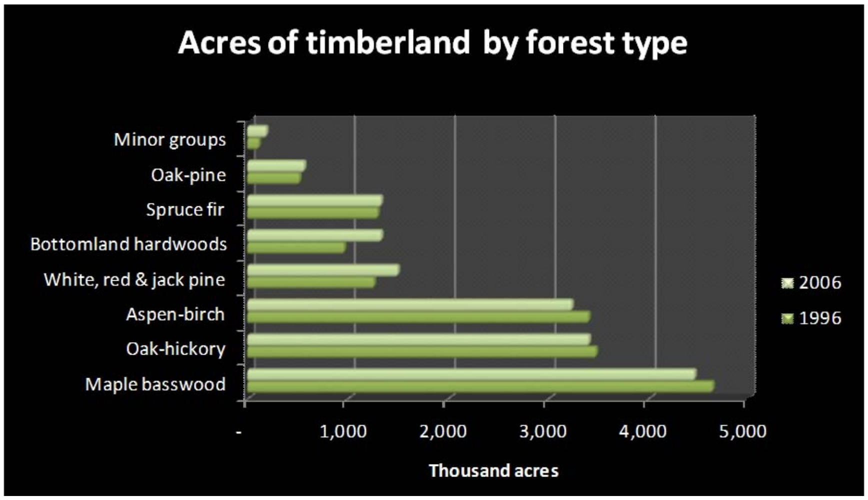

Figure 1. Thousand acres of timberland by forest type group, 1996 and 2006. (FIA data USDA Forest Service)

The area of forestland in Wisconsin has been steadily increasing in recent decades and currently stands at approximately 16 million acres, representing over 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 81% of the total timberland area classified as hardwood forest types (Figure 1). The primary hardwood forest types in the state are maple-basswood, with 28% of all timberland, oak-hickory at 22% of total acreage, and aspen-birch which covers 21% of Wisconsin's timberland area. Conifer types, mainly red, white and jack pines and spruce-fir represent about 19% of the timberland. In addition, our forests are becoming middle-aged (Figure 2) with less acreage in young and very old stands and a sharp increase in stands 60 to 100 years old.

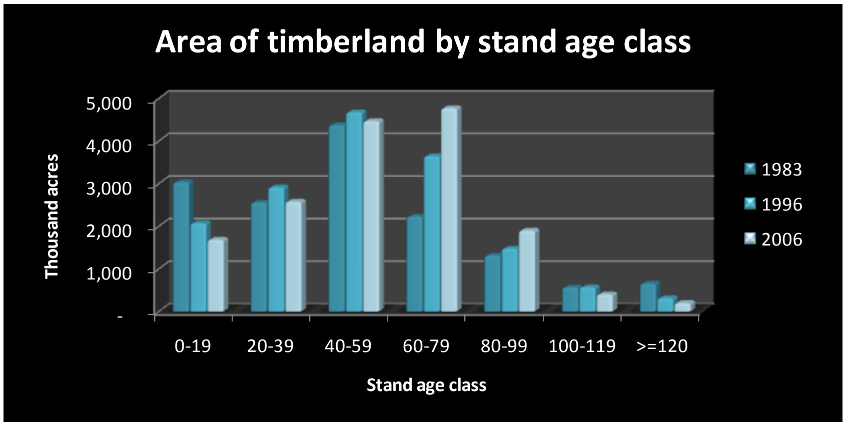

Figure 2. Thousand acres of timberland by stand age class 1983, 1996 and 2006. (FIA data USDA Forest Service)

Exotics

Emerald Ash Borer

The end of 2007 draws near and we have not yet found the emerald ash borer in Wisconsin. The insect's path of destruction has continued, however, with new infestations in the states of Pennsylvania and West Virginia and numerous additional infestations just south of Wisconsin in the suburban Chicago area. During 2007, the Wisconsin DNR emerald ash borer survey program conducted its fourth year of detection surveys for this highly destructive insect pest. Three survey methods were used for emerald ash borer detection including visual surveys, detection tree surveys and purple panel traps.

Visual surveys

Visual surveys were conducted in private and county campgrounds and recreational areas in 2007 (Figure 3). Private and county campground lands were the target survey area due to their increased risk for emerald ash borer introduction by way of firewood transportation. Currently, only state lands are monitoring the origin of incoming firewood and have constituted a permanent ruling requiring that all firewood originate from within a 50 mile radius of the camper's destination and from within the state of Wisconsin. For more information on the firewood ruling or the pests that it transports please visit:
http://dnr.wi.gov/invasives/firewood/.

Survey sites and results

Visual surveys were conducted in 78 private and county campgrounds throughout southeastern Wisconsin and in Marinette County near the border with Michigan. Over 5600 campsites were surveyed, leading to the evaluation of 2625 ash trees for the presence of the emerald ash borer and for other ash health issues. Characteristic symptoms of an emerald ash borer infestation when present in ash are epicormic sprouting, branch dieback, and woodpecker feeding. Characteristic signs include D-shaped exit holes, serpentine galleries beneath the bark and the presence of emerald ash borer larvae or adults. Our visual survey efforts detected no emerald ash borer infestations in the private and county campgrounds surveyed.

However, other commonly encountered, but non-threatening ash insect pests and diseases were detected during the surveys. Insect pests observed included the ash bark beetle, the ash borer clearwing moth, and the redheaded ash borer based on exit hole evaluation. Foliar and bud insects such as the ash flower gall mite, ashleaf gall mite, and ash plant bug were observed as well. Diseases observed included anthracnose on the foliage and ash yellows brooms on the main stem. Anthracnose was widespread across all survey sites, however, just a handful of trees exhibited the brooming associated with ash yellows.

Detection tree surveys

Upon completion of four years of visual survey work looking for the emerald ash borer in state parks and private campgrounds, it has not yet been detected in Wisconsin. However, scientific research has determined that visual survey methods are not effective at detecting emerald ash borer infestations unless the insect population is at a very high density. Therefore, scientific research recommends the use of detection tree surveys for detection of low density emerald ash borer infestations. In 2007, WI DNR extended its contract with Michigan Technological University for a second year of establishment, monitoring and peeling of ash detection trees in Wisconsin's state parks and recreation areas. Private campgrounds did not have any detection trees established.

Survey sites and results

A total of 141 detection trees were established in 26 state parks and recreation areas during May 2007 (Figure 3). Each of the 26 sites had 2-4 previously established detection trees in place from our 2006 detection tree survey, resulting in a total of 5-7 detection trees at each site. Detection trees consist of a girdle around the main stem at waist height and the placement of an 18 inch wide sticky band just above the girdle. The sticky band is used to catch emerald ash borer adults during their flight season. Sticky bands were inspected for emerald ash borer adults biweekly June through August. During the fall, after the adult flight season has ended, detection trees are felled and peeled in search of emerald ash borer larvae and galleries. During the fall of 2007, a minimum of four trees per property were cut and peeled. Trees selected were a combination of those girdled in 2006 and 2007. The remaining 2-3 trees per site were left standing for a second year and will be felled and peeled during fall 2008. No emerald ash borer life stages were found during detection tree surveys in 2007.

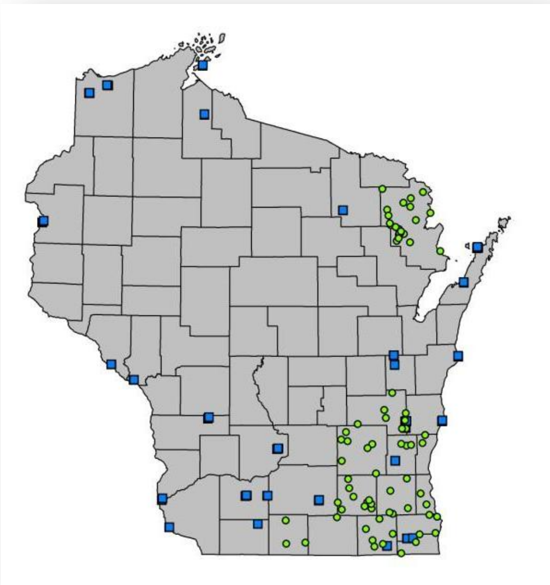

Figure 3: WI DNR 2007 emerald ash borer detection tree and visual survey locations. Blue squares = detection tree survey (4-7 trees established per location); Green circles = visual survey of private or county campground.

EAB Purple Panel Traps

Purple panel traps were used as a survey tool in Wisconsin for the first time during the 2007 survey season. To date, researchers still consider the use of detection trees to be the best detection method for low density emerald ash borer infestations, however, there are situations in which panel trap use may be favored over detection trees in order to prevent the loss of the tree. Such situations include surveying in areas where the tree may be considered a prized urban or campground shade tree or when surveying where the ash resource is limited, but risk still exists, such as near firewood piles, mills and nurseries.

Trap description

Emerald ash borer panel traps are purple in color and made of a corrugated plastic board (Figure 4).

Figure 4: Emerald ash borer purple panel trap

Traps are triangle with an open center. Each panel of the trap measures 14 X 24 inches and is coated with glue on its exterior. Trap hanging is recommended on an open grown or edge ash tree at a height of 33-40 feet above ground (Figure 5). Research suggests that the emerald ash borer is visually attracted to the color purple used for the traps.

Figure 5: Installation of emerald ash borer purple panel trap.

Trap locations

Purple panel traps were hung in 17 locations across central and southern WI. Trap locations included nine state parks and forests (Governor Dodge, High Cliff, Interstate, Kettle Moraine – North, Mirror Lake, Peninsula, Peshtigo River, Richard Bong Recreational Area and Rocky Arbor), two Dane County parks (Riley Depee and Fish Camp) and seven municipalities (Beloit, Fitchburg, Madison, Monroe, Oak Creek, Sheboygan and Stevens Point). Two traps were hung at each location early June through late August. After trap removal, traps were checked for emerald ash borer adults.

Figure 6: Four species of metallic wood-boring beetles were collected from the purple panel traps. Identification is in process

Trap catch summary

No emerald ash borer adults were detected on the purple panel traps. Other insects of interest that were collected include four other species of metallic wood-boring beetles (Figure 6) and another commonly encountered ash pest, the redheaded ash borer.

For more information on Wisconsin DNR emerald ash borer survey efforts, both past and present please visit: *http://dnr.wi.gov/forestry/FH/Ash/index.htm*.

Gypsy Moth

Population increase was greatest in Marinette County and the central Wisconsin counties of Adams, Green Lake, Juneau, Marquette, Marathon, Portage, Waushara, and Wood. Dry soils and contiguous forests dominated by black and northern pin oaks in these counties provide favorable habitat for the gypsy moth even under normal weather conditions. This summer's drought provided an ideal situation for the pest and it responded. Population increase was also seen in Dane, Sauk, Colombia, and Rock counties, often in areas with a high amount of human activity. Recreational and residential use typically leads to park-like stands with little cover for the small mammals that are the most important predators of gypsy moth. These areas are often the first in an area to develop outbreaks and suffer from defoliation. A population of gypsy moth at Rocky Arbor State Park exploded this summer causing severe defoliation on approximately 75 acres. Population density of the larvae was so high it prompted a ten day closure of the park to campers.

Aerial surveys mapped a total of 22,994 acres of defoliation. Most of the defoliation visible from the air was in Marinette County in the Township of Stevenson. It is the same area that was severely defoliated in 2002-2003. There have also been many reports of nuisance levels of larvae and localized defoliation from the central counties of the state (Marathon, Adams, Wood, Portage, Juneau, Colombia, Marquette, Green Lake, Sauk, Dane, and Rock).

Defoliation mapped in aerial survey

Adams Co. - 176 acres
Green Lake Co. – 37 acres
Marquette Co. – 11 acres
Juneau Co. – 80 acres
Marinette Co. - 22,690 acres (mostly light but some patches of moderate and heavy defoliation).

Gypsy moth suppression program

The 2007 gypsy moth suppression program was small, treating 1,235 acres at 24 sites in 8 counties. A total of 950 acres were treated with

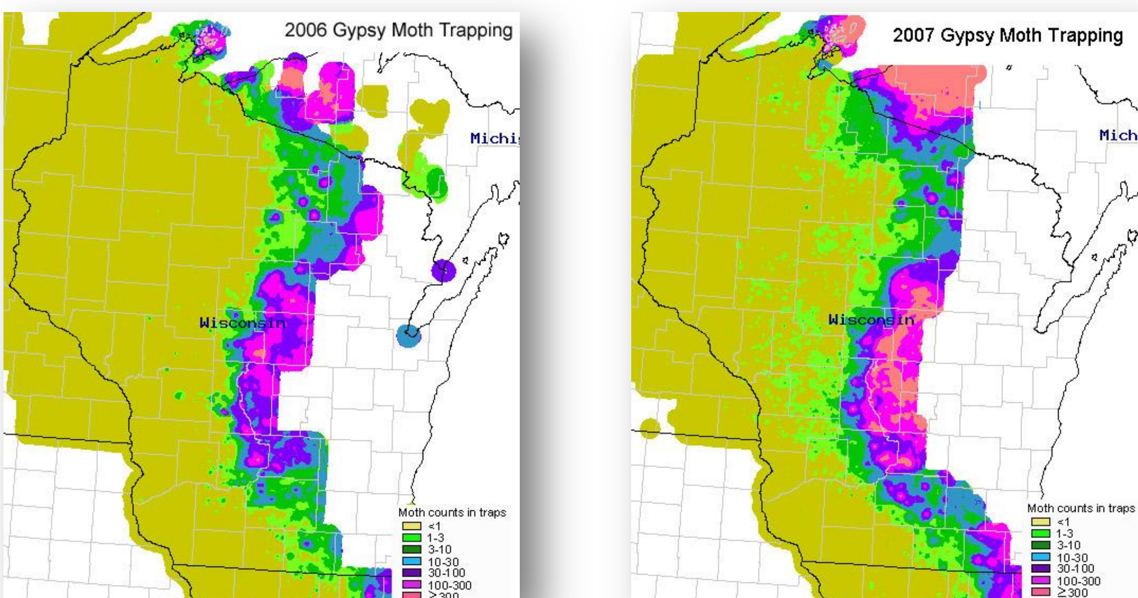

Figure 7. Trap catches for gypsy moth: 2006 and 2007.

Btk and 285 acres were treated with Gypchek during May 2007. Treatments were conducted by Al's Aerial Spraying of Ovid, Michigan, and all treated blocks provided satisfactory foliage protection.

Slow-the-spread

Wisconsin's Slow-the-Spread (STS) program is directed by the Department of Agriculture, Trade, and Consumer Protection (DATCP). In 2007, the STS Program treated 99,671 acres at 65 sites in 17 counties. Aerial treatments of Btk totaled 25,229 acres, *Nucleopolyhedrosis* virus (NPV) treatments totaled 3,501 acres, and pheromone flakes totaled 70,941 acres. Applications began on May 10 and were completed by June 30. The strategy is to eradicate the most critical populations west of the "STS Action Zone" and to slow the spread of the gypsy moth within the "STS Action Zone" to 10 km per year. The average rate of spread across Wisconsin in 2007 has not yet been determined, but the rate was 11.45 km (7.11 miles) in 2006, 16.04 km (9.97 miles) in 2005, 6.34 km (3.94 miles) in 2004 and 45.06 km (28 miles) in 2003.

Extensive trapping in 52 counties of gypsy moth males was done from the central counties and westward to support the STS program. Trapping was not done in the eastern counties of Wisconsin in 2007. Results of this monitoring program reflected the development of outbreaks in the central counties but also indicated a localized buildup of a population in northern Vilas County (Figure 7). No nuisance reports have come out of this area so far but that may change in 2008. Moths were trapped further west and in greater numbers than in recent years. Some of the moths found in the western counties may have been blown from high populations in the central part of the state. The traps that had several moths in them, however, are more likely to reflect a local population that benefited from higher survival due to the hot, dry conditions this summer.

Trapping in 52 counties revealed a population increase for the first time in three years in the counties surveyed. The total number of gypsy moths captured was 293,160 as of November 20, which compares to 121,355 male gypsy moths in 2006, 316,220 moths in 2005, and 373,656 moths in 2004. The state record of 703,060 gypsy moths was set in 2003. A total of 30,836 traps were placed this season. For the first time in a decade, no counties reported a zero moth count. In addition to the state trapping program, cooperators caught 63,123 moths in 342 traps, mainly in the Apostle Islands (50,100 moths).

Predictions for 2008

Egg mass surveys indicate that populations will continue to increase in 2008 in the central counties of Wisconsin from Marathon in the north to Rock in the south. Outbreaks in this area may be most severe and extensive in Adams County though localized defoliation is expected in all of these counties. Outbreak levels are predicted to continue in Marinette County. Populations in the

Figure 8. Gypsy moth defoliation at Rocky Arbor State Park.

southeastern counties of Milwaukee, Kenosha, Racine, and Walworth are increasing for the first time since 2004 when the last regional outbreak collapsed.

Applications to the suppression spray program surged upwards for 2008. Seventeen counties have applied to have 13,709 acres treated to prevent defoliation from gypsy moth outbreaks. Rocky Arbor State Park (Figure 8) along with Devils Lake State Park, Mirror Lake State park, Lake Kegonsa State park, and the Dells of the Wisconsin River State Natural Area are proposing acreage for treatment in 2008.

Beech Bark Disease

Beech bark disease, caused by a combination of an exotic scale insect (*Cryptococus fagisuga*) and a fungus (*Nectria coccinea var. faginata* or *N. galligena*), has not been found in Wisconsin, but continues to advance westward through the Upper

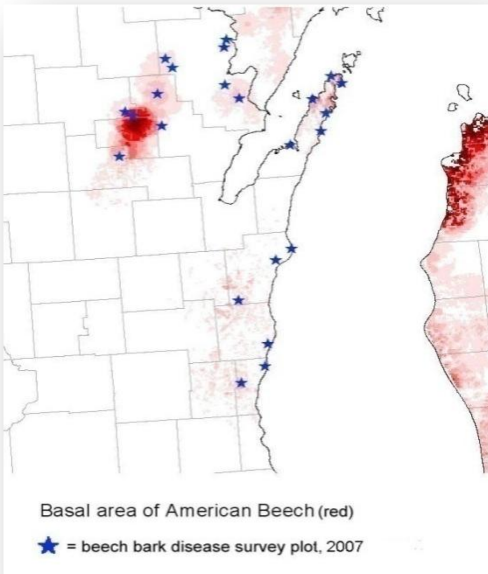

Figure 9. Map of survey sites for Beech Bark Disease

Peninsula of Michigan. Survey plots in eight Wisconsin counties did not find beech scale or beech bark disease in October 2007 (Figure 9). Thirty to fifty trees at each site were examined for the presence of the scale and disease. All survey sites were on state, county, city, or private land. Survey sites were the same as in 2006 surveys, and were selected by incidence of beech (FIA data) and likelihood of human transport to the site.

Hemlock Wooly Adelgid

Sampling for hemlock wooly adelgid on state and privately-owned land was completed in May and June 2007. Survey sites (Figure 10) were identified through modeling that chose areas that are at a high risk for introduction of this organism based upon hemlock abundance, tree nursery locations, and housing density. Modeling was conducted by Shane Lishawa, former DNR Forest Health

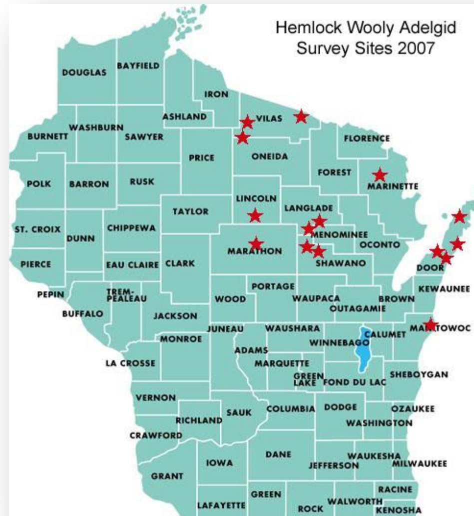

Figure 10. Location of Hemlock Woolly Adelgid survey sites.

Technician. Within each identified risk area, 1-2 likely introduction sites, such as campgrounds and residential neighborhoods, were selected for examination. At each site, two branches from

opposite sides of 30-50 hemlock were examined for the presence of egg sacs. No signs of hemlock wooly adelgid were found.

Sudden Oak Death

Surveillance surveys in 2007 again sought the fungus-like organism *Phytophthora ramorum*, the pathogen associated with "sudden oak death" (SOD). Prompt containment measures so far continue to appear to have prevented spread of this pathogen into Great Lakes area wildlands. Monitoring by survey samples within this region, from 2004 to 2007, has still yielded ***no confirmed positives***. However, this pathogen persists and may be spreading along the US west coast, and detections occurred closely outside of a few nurseries on the US Gulf coast. Therefore, monitoring and public vigilance continue to be necessary activities.

Latest updates regarding symptoms, control, and distribution remain available through the USDA Forest Service's web site for Forest Health Monitoring: *http://www.na.fs.fed.us/spfo/pubs/pest_al/sodeast/sodeast.pdf*

National sampling procedures were altered from terrestrial foliage collection during 2007. Instead, UW Stevens Point faculty N. C. Heywood and students from the Department of Geography & Geology in cooperation again with WDNR, DATCP, and USDA Forest Service personnel immersed susceptible host foliage (*Rhododendron*) "baits" for up to two weeks at stream sites (Figure 11) within nine of the watersheds surrounding southern Lake Michigan. Most of these watersheds, including three draining Wisconsin, contained nurseries that received stock from a known infected California wholesaler in 2003. Two laboratories tested leaf samples by culturing and molecular DNA analysis, and detected no *Phytophthora ramorum* from any of the nine stream sites after five months of sampling. Tentatively, this sampling procedure will continue during 2008.

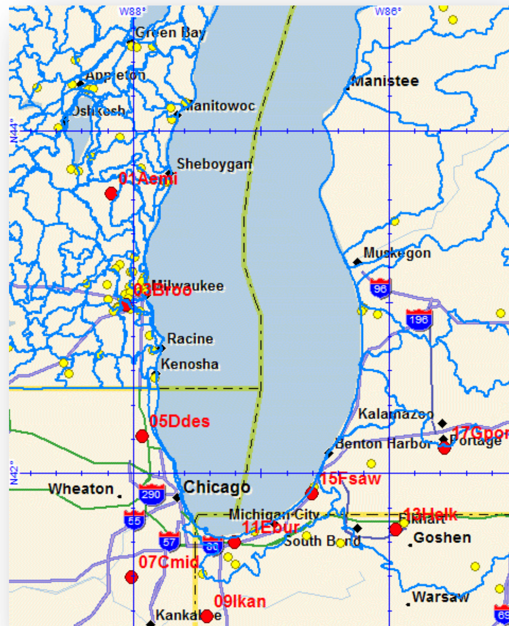

Figure 11. Sites where baits were placed (red dots). Watersheds are indicated by blue lines and nurseries by yellow dots.

Sirex noctillio

Overview

Wisconsin is currently considered low risk for establishment of and susceptibility to *Sirex noctillio* but is at a higher risk for possible introduction in or near Milwaukee and Green Bay. The primary goal of this survey was to test and compare three detection methods for the presence of Siricid wasps. The three methods (Figure 12) tested were a) Sircid intercept panel trap (from Advanced Pheromone Technologies) also baited with a Siricid lure (70%alph/30%beta pinene from Advanced Pheromone Technologies) using a water kill collection cup with 50% antifreeze, b) Lindgren funnel traps (from Pherotech) baited with a Siricid lure (70%alph/30%beta pinene from Advanced Pheromone Technologies) using a dry collection cup with a pesticide kill strip, and c) detection tree stressed by frill cut with herbicide treatment. No *Sirex noctillio* species were detected during this survey.

Figure 12a. Intercept Panel Trap b. Lindgren Funnel Trap c. Frill cut and herbicide detection tree

Survey description

Three sites (Figure 13) were located in the Kettle Moraine State Forest Northern Unit in southeast Wisconsin. The three sites were mature red pine plantations with some level of stress due to insect, disease, invasive

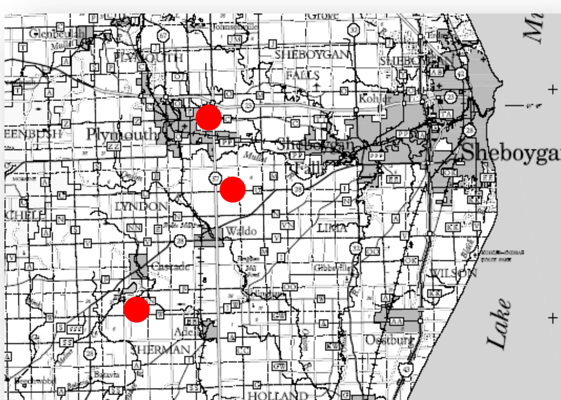

Figure 13. Three sites were located in the Kettle Moraine State Forest Northern Unit in southeast Wisconsin.

plant competition, and/or overstocking. Within each site, five repetitions of the three survey methods were randomly set up in a grid pattern. Each repetition was set up ~ 1 chain apart. Traps were checked every three weeks and any Siricids caught were collected and stored in 90% rubbing alcohol.

Final Results of intercept panel

Lindgren funnel traps and detection tree surveys:

In 2006, 17 woodwasps were collected and sent to USDA APHIS for identification. In 2007, detection trees were cut into ~18' sections bagged and checked for woodwasps in the fall. No woodwasps were detected in detection trees in 2007.

Totals (for all three sites):

Intercept panel trap - 15 Siricids
Lindgren funnel trap - 2 Siricids
Detection tree - 0 Siricids

Species and numbers identified:

Urocerus albicornis Fabricius – 3 total (2 panel, 1 funnel, 0 detection tree)
Urocereus cressoni Norton –11 total (11 panel, 0 funnel, 0 detection tree)
Sirex edwardsii Brulle – 1 total (1 panel, 0 funnel, 0 detection tree)
Tremex columba Linnaeus – 2 total (1 panel, 1 funnel, 0 detection tree)

Comments:

Intercept panel traps seemed to outperform the Lindgren funnel traps in catching Siricid woodwasps. Some of the variation could be due to kill cup method. Peak catch occurred between July 12 and July 31st. Detection trees were frill girdled and treated with approximately 10-20 ml of 41% glyphosate herbicide per tree. This amount of herbicide readily killed trees instead of just weakening the trees. Due to complete tree mortality and the likelihood of not detecting siricids in these trees, only 2 of 5 trees per site were removed, sectioned, and bagged on site for fall sampling in 2007. No siricids of any species were detected in the fiberglass screen bags from these 6 trees. Using a greatly reduced amount of herbicide would be strongly recommended in any future detection tree surveys.

Hardwood Health Issues

Oak Wilt and Timing of Harvest Activities

New Guidelines

It has long been known that fresh wounds act as an infection court for *Ceratocystis fagacearum*, the fungus that causes oak wilt, and that overland infection is more likely during spring and early summer. Woodland owners, foresters and harvesters have asked for a fresh look at the

factors that influence overland spread. Thus, in 2006, a team was formed to evaluate the latest research and develop guidelines that do a better job of predicting the risk of overland infection. The guidelines were released in March 2007.

Research by Dr. Jennifer Juzwik, scientist with the USDA Forest Service, Northern Research Experiment Station, has shown that several factors, including proximity to active oak wilt infection centers, soil type, site topography, and density of oak, are critical to determining risk of overland infection and subsequent spread. The new guidelines lead the reader through a series of questions related to these factors and result in a recommendation as to what time of year is best for harvest activities.

The new guidelines can be downloaded or used directly on line at the following link:

http://dnr.wi.gov/forestry/fh/oakWilt/guidelines.asp

Thank you to the members of the oak wilt guidelines team for their commitment to this project: Dr. Jennifer Juzwik (USDA Forest Service); Juris Repsa (Domtar industries); Kyoko Scanlon and Jane Cummings Carlson (DNR forest health protection); Ron Jones (DNR forestry area leader); Tim Tollefson and Dan Peterson (Stora Enso); John Morgan and Scott Wessel (consulting foresters); George Howlett (Environmental science consultant); and Rick Dailey (Clark County Forester).

Monitoring Oak Wilt: 2007 Update

A four year study on overland infection of oak during summer and fall began in 2006. The risk of the oak wilt fungus spreading via insect vectors has been shown to peak from mid-April through early

to mid-July. As a result, pruning and cutting of red oaks in the spring is highly discouraged. Following early July, the risk of infection has been shown to significantly decrease. However, there is still an uncertain level of risk associated with cutting and pruning oak in the summer and early fall.

In response to concern from land managers, a study was crafted to quantify the relative risk of cutting during this moderate risk time period. Study sites, where harvesting of oak occurred between July 15th and October 15th of 2006, were sampled to determine the species composition, oak wilt presence and abundance, and the location of oak wilt pockets. These stands were revisited in 2007 in order to compare the number of new oak wilt pockets in sites with pre-existing oak wilt to the number of new pockets in stands without previous disease.

Six thinned stands were revisited in 2007; two in oak wilt positive stands and four in stands with no disease. Five unthinned or control stands were also revisited in 2007. Of the six thinned stands, three had new mortality that was either located in stands with no previous oak wilt or located too far from pre-existing pockets to be considered below-ground extension of previous disease. One stand in Clark County had 12 new dead trees. All new mortality was sampled for oak wilt but confirmed negative – oak wilt was not confirmed as the cause of this new mortality. Because of the possibility of false negative samples, these trees will be monitored in the spring of 2008 for the production of fungal mats, which would confirm oak wilt as the cause of death. All of the controls were negative for new mortality.

The survey was continued this year with a total survey of 12 oak stands. Seven of these stands were thinned between July 15th and October 15th of 2007 and five were control or unthinned stands. Of these 7 thinned stands, three had been positive for oak wilt prior to thinning and four had been disease-free. Of the five control (unthinned) stands, three had oak wilt and two were negative. These stands will be revisited during the summer of 2008 to monitor for new oak wilt mortality.

Information from this study will be used to determine if there is a variable level of risk associated with cutting oak between July and October and to refine the oak harvest guidelines as they pertain to oak wilt.

Post Oak Locust

Reports of the post oak locust (*Dendrotettix quercus)* defoliating oak trees in Adams and Wood counties started coming in the last week of June. This is about one month earlier than when they normally feed in west-central WI. During the week of July 9, parts of Adams, Jackson, and Wood counties had millions of insects feeding and causing 100% defoliation of under and overstory trees. By the end of September, very few live post oak locusts could be observed. In Wood County (south of WI Rapids) post oak locusts were actually chewing on the wood trim and paint of a house in the Town of Saratoga (Figure 1). The homeowner used duct tape (sticky side out) as traps around the house.

Figure 1. Duct tape is used to trap locusts chewing on wood trim and paint.

Post oak locust prefers oaks, but in the Lake States they will feed on pines as well. Locusts were found on pines, but there was not any evidence of feeding damage. Reports did come in of locusts feeding on birch and other hardwoods.

The male post oak locust has bright red bands on their hind legs, and the females will have a dull red band on their hind legs (Figure 2).

Figure 2. Male post oak locust with red bands on legs.

Oak Dieback and Mortality.

Branch dieback and mortality of white and bur oaks have been observed in southern Wisconsin in recent years. It is suspected that affected trees were stressed by one or multiple factors, such as frost, oak tatters, Anthracnose, Tubakia leaf spot (*Tubakia dryina*), mites, and drought then attacked and killed by secondary pests such as the two-lined chestnut borer (*Agrilus bilineatus*) and Armillaria root disease. In some cases, oak wilt (*Ceratocystis fagacearum*) was involved in dieback and mortality. This year, we received many reports and samples of the jumping oak galls. Jumping oak galls are caused by a cynipid wasp (*Neuroterus saltarius*), and commonly seen on white and bur oaks. Small seed-like round galls are formed on leaves to cause discoloration. In northwestern Wisconsin, bur and white oaks were attacked by *Neurotirus saltatarius*. Populations in Polk and Burnett counties were so high that entire tree crowns were initially discolored and then totally defoliated in July and August. There did not appear to be any substantial two-lined chestnut borer invasion after attack.

Hickory Dieback and Mortality

Dieback and mortality of hickory continued to be a problem throughout the natural range of bitternut and shagbark hickory in Wisconsin in 2007. This summer, mortality was observed as far north as Langlade and Taylor counties. In some stands, mortality of bitternut hickory was close to 100 percent. The symptoms progress rapidly from thinning crowns to branch mortality to complete tree mortality (Figure 3). Epicormic branches often sprout from the main stem only to wilt and die later and sunken cankers or bleeding cankers can often be found on main stems of these trees. Dieback and mortality occur on both bitternut and shagbark hickory, although mortality appears to be more prevalent on bitternut hickory.

Figure 3. Symptoms of hickory decline progress rapidly from thinning crowns to branch mortality.

Historically, hickory mortality was attributed to attacks by the hickory bark beetle (*Scolytus quadrispinosus*) following periods of drought. More recent research, however, indicates that hickory mortality is due to a complex of biotic and abiotic factors, including the hickory bark beetle and other insects, and the fungus *Ceratocysis smalleyi*. A study that was initiated by the USDA Forest Service in 2006 continued in 2007 to investigate this problem. Stands in Wisconsin, Iowa, and Minnesota were surveyed for the frequencies of declining and dead hickory and the level of hickory regeneration. In the surveyed stands, percentages of hickory mortality ranged from less than 10% to more than 80%. Abundant hickory regeneration was observed in 12 out of 14 stands. The majority of stands experiencing dieback and mortality were overstocked. Wood samples were also collected from the surveyed stands and several fungi including *C. smalleyi*, *Fusarium solani*, and *Phomopsis* spp. were isolated from those samples. Currently, the recommended management practice to minimize impact is limited to removal of trees harboring overwintering hickory bark beetles during winter and spring.

Ash Yellows

Ash yellows is caused by a phytoplasma, a wall-less bacteria-like microorganism. Symptoms of ash yellows include yellow/sub-normal size foliage, slow twig growth, thin crown, branch dieback, and vertical cracks on the trunk near the ground, as well as brooms (Figure 4).

In the summer of 2007, leaf and wood samples were collected from trees that were showing dieback from 3 campgrounds (Columbia, La Crosse, and Rock counties), 1 urban woodlot (Milwaukee County), and 1 forest stand (Kewaunee County). All of the sampled trees exhibited crown dieback and epicormic sprouting. Some sampled trees also exhibited yellow/subnormal size leaves, slow twig growth, and/or brooms. Samples were tested for the presence of phytoplasma through genetic analysis (using a PCR or Polymerase Chain Reaction test) by Dr. Glen Stanosz, University of Wisconsin, Department of Plant Pathology. Results were positive for the presence of phytoplasma for the samples from 4 out of 5 sites. All of the samples taken from trees with a broom were positive as well as one sample without a broom.

Figure 4. Brooms may be a sign of ash yellows.

Based on the existence of brooms and results of the genetic analysis, in 2007, La Crosse, Milwaukee, and Rock counties were added as counties confirmed with ash yellows. In Wisconsin, ash yellows is currently found in 20 counties (Brown, Calumet, Chippewa, Columbia, Dane, Dodge, Door, Grant, Jefferson, La Crosse, Manitowoc, Marathon, Milwaukee, Ozaukee, Rock, Sauk, Shawano, Sheboygan, Taylor, and Waukesha counties).

Cicadas

A large brood emergence of 17-year periodical

After spending 17 years underground, a large brood of cicadas (Figure 5, *Magacicada* spp.) emerged from the soil in the Midwest region including southern Wisconsin and parts of Illinois, Iowa, and Michigan in late May of 2007. Thousands of cicadas and characteristic buzzing sound were noted by residents in southern

Figure 5. Cicada (*Magacicada* spp.)

Wisconsin, including Iowa, Rock, Sauk, and Walworth counties. Adult female cicadas cut slits in small branches that are about the size of a pencil and lay eggs in straight rows. This process caused many small branches to wilt and die or break off (Figure 6). Dead or broken twigs (flagging) were commonly observed on larger trees and some seedling mortality occurred in the affected areas.

The egg-laying damage was seen on a variety of

Figure 6. Branch damage caused by cicada egg-laying on large oak trees.

deciduous trees such as oak, birch, hickory, ash, and elm.

Softwood Health Issues

Hemlock Dieback

Hemlocks north and east of Phelps, Vilas County, are showing symptoms of stress. A long drought in this area has stressed these hemlocks to the point

Figure 1. Drought-stressed hemlocks lose previous years' needles, giving tufted appearance.

where they are losing previous years' needles. This gives the foliage a tufted appearance (Figure 1). Another drought-related symptom on hemlocks is branch dieback in the upper canopy. Drought conditions favor many insects; bark beetles are causing stress to large sawtimber-sized trees, and hemlock borers are infesting dead hemlocks. These insects may occasionally reach outbreak proportions and infest living stressed trees. For

Figure 2. Insects, like the hemlock lopper, may devastate stressed hemlock trees.

this reason, monitoring for hemlock borer will be conducted in the spring of 2008. Another insect that can devastate hemlock stands is the hemlock looper (Figure 2). At this time, there is no evidence the looper has caused any of the symptoms on hemlocks in Vilas County, but there have been recent outbreaks of this insect in the eastern Upper Peninsula of Michigan. Monitoring for this defoliator will also be conducted next spring.

Jack Pine Budworm

Northwest

The jack pine budworm (Figure 3, *Choristoneura pinus)* outbreak continued its decline in northwest Wisconsin in 2007. Total acreage of defoliation dropped to 48,900 acres from 110,700 acres in 2006. The current outbreak reached its zenith in 2005 with over 220,000 acres of defoliated jack pine.

The budworm decline was not uniform across the region. The southern counties saw a near total

Figure 3. Jack pine budworm larvae.

collapse of budworm populations; only 2,000 acres were defoliated in Polk, Burnett, and Washburn counties and pupal survey results revealed pupal counts less than half of the 2006 level. The northern counties had higher populations; over 80% of the acreage defoliated occurred in Highland township in Douglas County and Barnes Township in Bayfield County. Pupal surveys showed 67% of the 2006 numbers in Douglas County and 80% of the 2006 count in Bayfield County.

Pupal parasitism – approximately 40% in 2007 - was unchanged from the previous year. There was a shift from *Itoplectes*, an early outbreak opportunist, to *Pteromalids*, a hyperparasite common to old outbreaks.

West Central Wisconsin

Jack pine budworm has now been found in 12 counties in west-central Wisconsin in both jack and red pine stands. The counties where budworm is

Figure 4. Jack pine budworm defoliation on red pine.

known to be defoliating and laying eggs on needles of jack and/or red pine are Adams, Clark, Dunn, Eau Claire, Jackson, Juneau, Marathon, Monroe, Pierce, Portage, St. Croix, and Wood counties.

Budworm was confirmed for the very first time in Pierce and St. Croix counties. In these two counties, budworm is found only in red pine stands. This is also the first year budworm has been confirmed in red pine stands in Jackson and Monroe counties. Only two infested counties, Clark and Marathon, in west central Wisconsin remain where budworm is found strictly in jack pine.

In Dunn and Portage counties, jack pine budworm expanded into more red pine stands. This is following the same pattern as it did in the other counties where budworm was first found in red pine stands. The first year, budworm was found in a small area, and then in the second year, budworm expanded out into the county.

Jack pine budworm seems to prefer red pine stands that are 20-30 years old, but is also found in older red pine (35+ year old). The pattern of defoliation in the 20-30 year old red pine stands is typical of jack pine budworm. Feeding starts at the top and continues down the crown (Figure 4). Open grown trees are defoliated more heavily than interior trees. Conifer species that are associated with red pine on the edge of the stand (jack pine, white spruce, etc.) will be defoliated as well. However, if jack pine is found in the interior of a red pine stand, that tree will have either very light defoliation or no defoliation at all. Jack pine budworm prefers the red pine over the jack pine in this situation.

The pattern of defoliation in the 35+ year old red pine stands is very different from typical budworm defoliation in the same age class of jack pine. In the older red pine, budworm picks out an individual tree and causes heavy defoliation. The surrounding red pine will have light to moderate damage. This pattern is scattered throughout the stand. In a jack pine stand of similar age, the majority of trees will be defoliated and only a few scattered trees will remain unaffected by budworm feeding.

In Adams, Eau Claire, and Wood counties, a small number of 20-30 year old red pine stands were thinned during the winter/spring 2006-2007 on industrial lands. Every third row with selective tree removal in the remaining two rows was harvested. These stands had light to moderate defoliation this year. Either a few or no egg masses were found in these harvested stands, indicating a very low level of expected defoliation. These stands will be surveyed in 2008 to determine what effects, if any, the harvesting will have on budworm populations.

Based on egg mass counts, the potential for damaging defoliation in 2008 of both jack and red pine exists in Adams, Dunn, Jackson, Juneau, Pierce, Portage, and Wood counties. Top dieback and mortality can be found in the defoliated jack pine and red pine stands. Pine bark beetles (*Ips pini*), and red turpentine beetles (*Dendroctonus valens*) are helping to add to tree mortality. Pine sawyers (*Monochamus spp*.) can also be found in these stands.

Adult jack pine budworm moths.

Jack pine budworm is surviving well in red pine stands in west-central Wisconsin; it appears that red pine is able to support high jack pine budworm populations longer than the jack pine can. The red pine stand in Adams County, where budworm was first observed in 2004, is still supporting a budworm population with no signs of decrease. Based on egg mass counts, the potential for damaging defoliation exists again for 2008. Next year will be the 5th consecutive year that jack pine budworm will have the potential to cause moderate to heavy defoliation in this stand.

Red Pine Pocket Mortality Study 2007

Year four of the five year study in partnership with Dr. Kenneth Raffa, University of Wisconsin-Madison Department of Entomology, on Red Pine Pocket Mortality, saw the completion of field work for insect trapping, insect dispersal study, and the one year study comparing vegetation found throughout the 31 study sites. With the information from these studies, we hope to better understand the interactions of below and above ground herbivory and pocket development.

Insect sampling using Lindgren funnel traps, inverted jug traps, and pitfall traps was conducted in mid-April to mid-September. Tree-killing vectors of fungi - the engraver beetles, red turpentine beetle, and root weevils - and their predators were monitored biweekly. Numbers from this year's catch are currently being tabulated. In 2006, we captured nearly 25,000 engraver beetles, 1,000 red turpentine beetles, 3,000 root weevils, and 9,000 clerids (predators). Statistical analyses of the previous four years are in the early stages.

The second year of the mark-recapture experiment concluded in early fall of 2007. The study, conducted in collaboration with Southern Illinois University, focuses on the dispersal distances of three beetles associated with pockets, an engraver beetle, red turpentine beetle and their predator, the checkered beetle. Two sites were set up in Black River State Forest. At each site, four transects were established with funnel traps set at equal distances along each transect to two kilometers from the center point. Insects were marked with paint and released from the center. The study will be repeated next summer.

A third element of the study, implemented in early August, examined flora found in the 31 study sites. We hypothesized that vegetation within pockets will differ from unaffected parts of the stand due to below ground herbivory and fungal movement from red pine to red pine via root grafts and subsequent tree mortality. Vegetation plots (Figure 5) were set up in four general directions from the pocket epicenter with measurement points every five meters to 20 meters outside the pocket edge. At each five meter interval, vegetation was identified, a light meter reading taken, and percent ground cover estimated. All woody species greater than 1.5 meters in height within 2.5 meters of the transect were also sampled; tree height, diameter at breast height, and species were also noted.

Figure 5. Blackberry in pocket center.

In Kettle Moraine Southern Unit (six study plots), nearly 70 plants have been accounted for to date, of which, nearly one-quarter are considered invasive species. Flora composition of all sites was broken down into categories (Figure 6).

Average woody vegetation size has been nearly cut in half in symptomatic areas versus healthy portions of the stand (Figure 7). This size difference is due to an increased number of deciduous species, such as buckthorn sp., cherry sp. and honeysuckle sp., regenerating in the pockets and less stressed trees in the healthy control plot. The data for the other regions in the study are currently being analyzed. For more information on this study, please refer to previous DNR Forest Health Highlights.

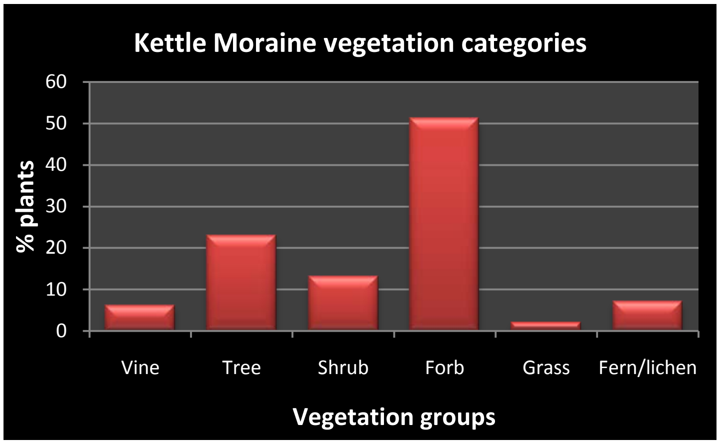

Figure 6. Percent floral composition of six Kettle Moraine sites.

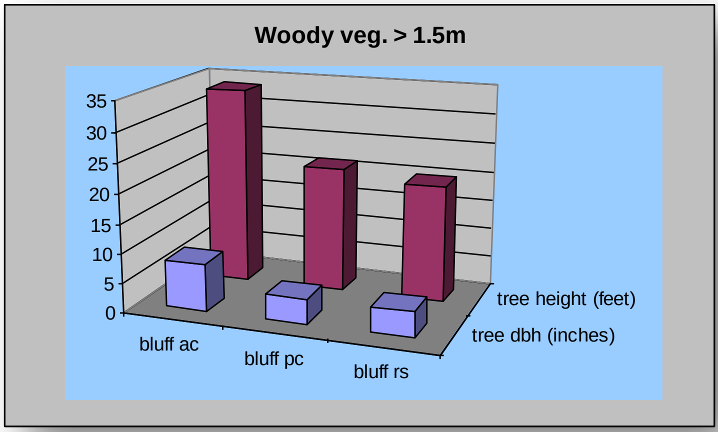

Figure 7. Tree size comparison between asymptomatic control

Thank you to all landowners and managers who continue to support this research.

Trapping *Dendrotonus valens*: Year 4

The fourth year of trapping for the red turpentine beetle (*Dendrotonus valens*) was conducted both in the central sands area of Adams and Wood counties and in Jackson County. Areas trapped were chosen to compare the number of turpentine beetles trapped from stands thinned during the previous summer/fall to the number trapped from stands thinned February to mid-April of the trapping year. Results from stands thinned in 2006-2007 showed a total of 14,485 beetles captured from 280 traps in 28 stands (Figure 8) for an average of 52 beetles per trap. Nine stands were located in Jackson County, mostly on the Black River State Forest and Jackson County land, and 19 were located in the central sands area of Adams and Wood counties, mostly on Plum Creek lands. Twelve stands were thinned in the summer to fall of 2006 and 16 were thinned during February to mid-April 2007.

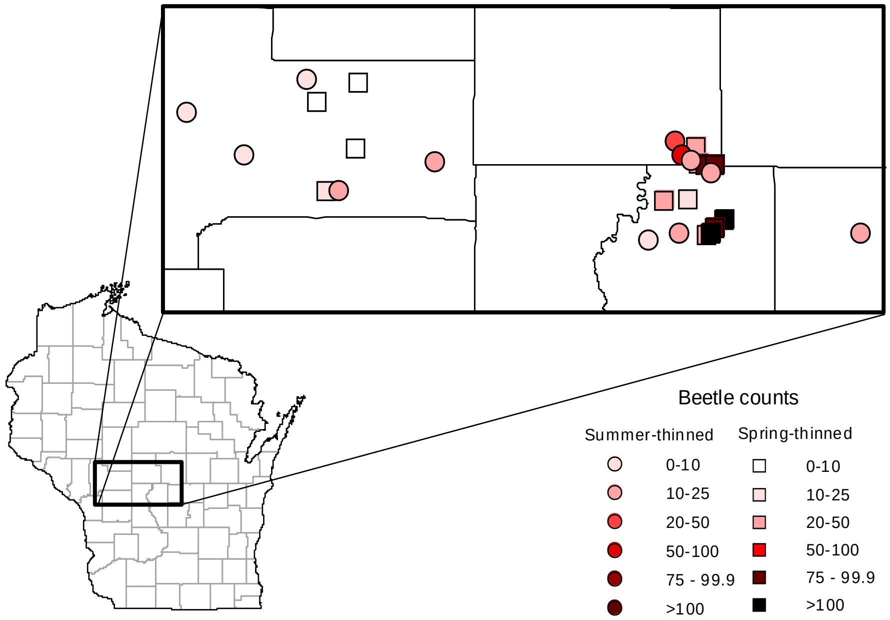

Figure 8. Map of site locations for trapping turpentine beetles showing the number of beetles trapped and when the stand was thinned.

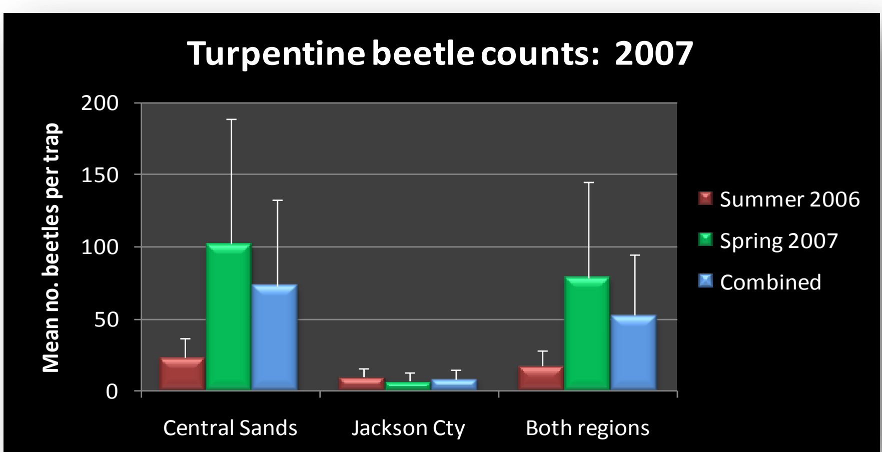

Figure 9. Average beetle counts by thinning period and general region.

Turpentine beetle counts on the Jackson County stands averaged 8 beetles per trap (the value for each stand count is the average of 10 traps) with no difference between summer 2006 and spring 2007 thinning dates (Figure 9). Counts on Plum Creek land, on the other hand, averaged 102 beetles per trap for the spring-thinned stands and 21 for the summer-thinned stands. The *p*-values (two-sample t-test with unequal variance) comparing counts for spring-thinned and summer-thinned stands were very significant for the Central Sands (p=0.005) and all regions combined (p=0.009), but not for Jackson County (p=0.57). One possible explanation for the differences between regions is the much higher density of red pine and greater thinning activity on the Plum Creek stands. This harvest activity creates a strong attractant for beetles already located in the vicinity of newly thinned stands.

In 2008, we will continue trapping newly thinned stands as well as monitor stands with high beetle populations in previous years, but will concentrate trapping to the Plum Creek lands of Adams and Wood counties. We will also monitor previously thinned stands for the presence of beetles on stumps and trees (pitch tubes) and for any symptom of tree stress.

We would like to acknowledge Joel Aanenson of Plum Creek Timber Company as well as Juris Repsa and Joe Kies of Domtar Industries, Inc. for their commitment to this project.

Annosum Root Rot

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 on 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. Fruiting bodies may be found at the root collar of dead/dying trees and stumps of infected trees.

In 2007, a statewide survey of Annosum root rot was initiated. Counties where this disease had not yet been confirmed were prioritized for the survey based on the proximity to counties where Annosum root rot is found and red pine is present. Pockets of red pine mortality that had been previously identified by a forestry professional in priority one counties were visited and surveyed for the existence of Annosum root rot. Decayed wood samples were collected and examined for the growth of the pathogen. Based on the survey, as of December 11, 2007, 3 additional Counties (Juneau, Portage, and Wood counties) were confirmed with Annosum root rot.

In two sites where Annosum was confirmed in Portage County, understory balsam fir was found infected and killed by the disease (Figure 10). Fruiting bodies were frequently found immediately above the soil line of balsam fir as well as at the base of nearby overstory red pines. This is the first report of infection on balsam fir in Wisconsin. With the three additional counties from 2007, Annosum root rot is currently confirmed in eighteen counties: Adams, Buffalo, Columbia,

Figure 10. Annosum root rot on balsam fir seedlings.

Dunn, Green, Iowa, Jefferson, Juneau, La Crosse, Marquette, Portage, Richland, Sauk, Trempealeau, Walworth, Waukesha, and Waushara, and Wood

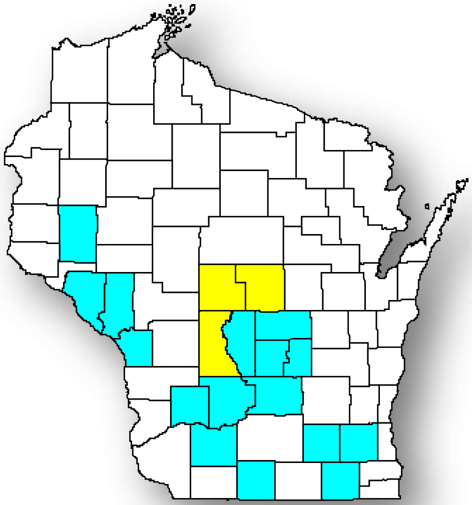

Figure 11. New counties in 2007 (yellow) and previously reported counties (blue) positive for annosum root rot.

(Figure 11). The survey will continue this winter and in 2008.

A publication outlining the symptoms/signs and management recommendations for Annosum root rot can be obtained at:

http://dnr.wi.gov/forestry/Fh/annosum/

Diplodia on Red Pine Seedlings in State Nurseries

Over the last few years, the state nurseries have implemented an aggressive management plan to monitor and control Diplodia shoot blight and canker. The disease is caused by the fungus, *Diplodia pinea* and most often infects red pine although infection has also been observed on other field-grown pine species. Recent research revealed that the fungus could persist in or on the seedlings without showing symptoms, and become active once a tree is stressed, primarily from moisture deficit.

Figure 12. Working with red pine samples in the lab

In 2006, in conjunction with windbreak sanitation efforts to control any possible sources of contamination, the state nurseries and Forest Health Protection began an intensive sampling and testing protocol to monitor for Diplodia spores on red pine seedlings. In 2007, this effort continued, and the forest health lab processed 800 apparently healthy red pine samples to test for asymptomatic infection (Figure 12). Samples were collected from all of the 3 state nurseries. The results of the lab test proved that the infection rate on nursery-grown red pine seedlings was very low. Sampling of nursery-grown red pine seedlings will continue in 2008 to ensure that only the highest quality seedlings are shipped to their customers.

ABIOTIC

Quad County Tornado

On June 7, 2007, an F3 tornado touched down in Shawano County and continued through Menominee, Langlade, and Oconto counties in Northeastern Wisconsin (Figure 1). It traveled on the ground for 36 miles,

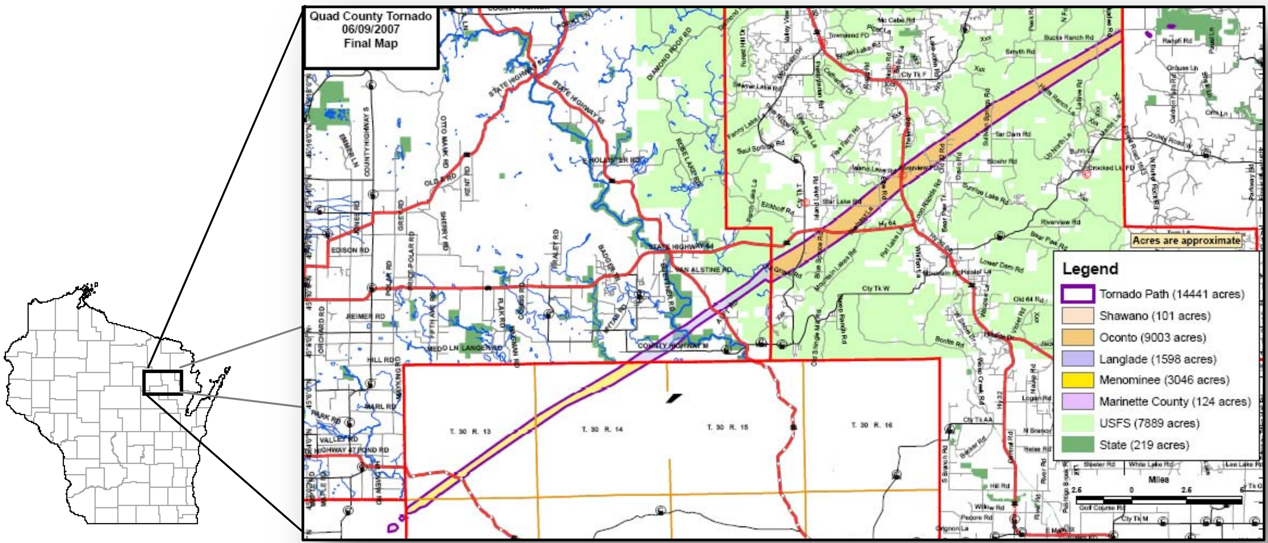

Figure 1. Map of the path of the tornado on June 7, 2007 across 5 counties and federal, state, county , Indian reservation, and private lands (map by Raquel Sanchez, Wisconsin DNR).

clearing a ½ mile wide path. More than 14,000 acres were directly in the path of the tornado; accompanying 3-4 inch hail and strong winds did further damage outside the immediate path of the tornado. The path of the tornado was so long, wide, and straight that it was easily visible from the air and in satellite images (Figure 2).

Figure 2. Aerial and satellite images of the tornado track reveal a long and straight path about 1 mile wide.

Incident management teams responded within hours and all roads and driveways were open and power was restored within days. Clean-up of the forested lands took a bit longer (Figure 3). Forest lands, , with a wide variety of cover types including mature pine plantations and hardwood stands, were impacted and included National Forest, state-owned forests, tribal, and private forests. Foresters from the affected counties held informational meetings to help landowners manage their damaged timber.

Figure 3.   The tornado impacted a wide variety of cover types including pines and hardwoods (left). Cleanup crews worked to clear away slash in hopes of preventing the outbreak of fire or bark beetle infestation (right).

As the summer turned hot and dry, there were concerns about wildfires occurring in the downed material, but ad campaigns and news interviews helped educate the public about this risk. With the hot dry summer, bark beetles were also a great concern and the mature pine stands that were damaged were the first to be salvaged. Other forest health issues of concern in the damaged stands include new oak wilt infections, stain and decay in damaged trees, and diplodia shoot blight and canker.

Summer 2007: Climate Contrasts in Wisconsin

The drought in Wisconsin persisted throughout much of the summer of 2007, particularly in the northern counties. Figure 4 shows the cumulative drought effects across the state. By mid-July, almost the entire state was suffering from some degree of drought with the far north experiencing severe drought. By September, the south had received record rainfalls, but the north remained dry with much of Bayfield, Douglas, and

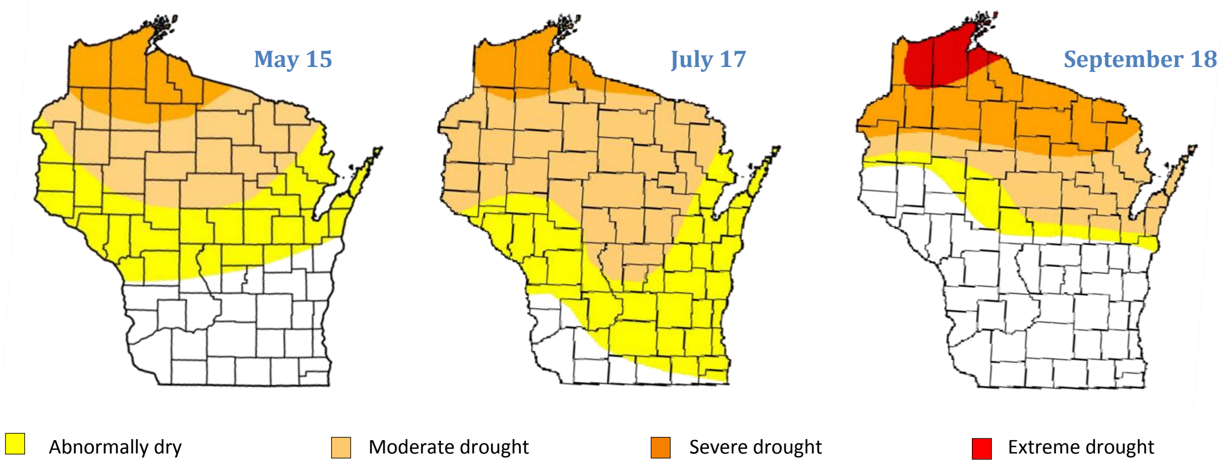

Figure 4. Cumulative drought intensity in Wisconsin in 2007: May, July and September (National Drought Mitigation Center -Univ. Nebraska http://drought.unl.edu/dm/archive.html.

Ashland counties under extreme drought conditions.

The disparity in rainfall between northern and southern parts of the state is illustrated in Figure 5. The northwest (on the left) was experiencing a cumulative deficit of about five inches until some rain in October helped alleviate the situation. In the southwest (on the right), the cumulative deficit in July was less than two inches. This was followed by record rainfall in August (c. 12 inches in many areas) which led to flood conditions so severe that Governor Doyle declared several counties disaster areas.

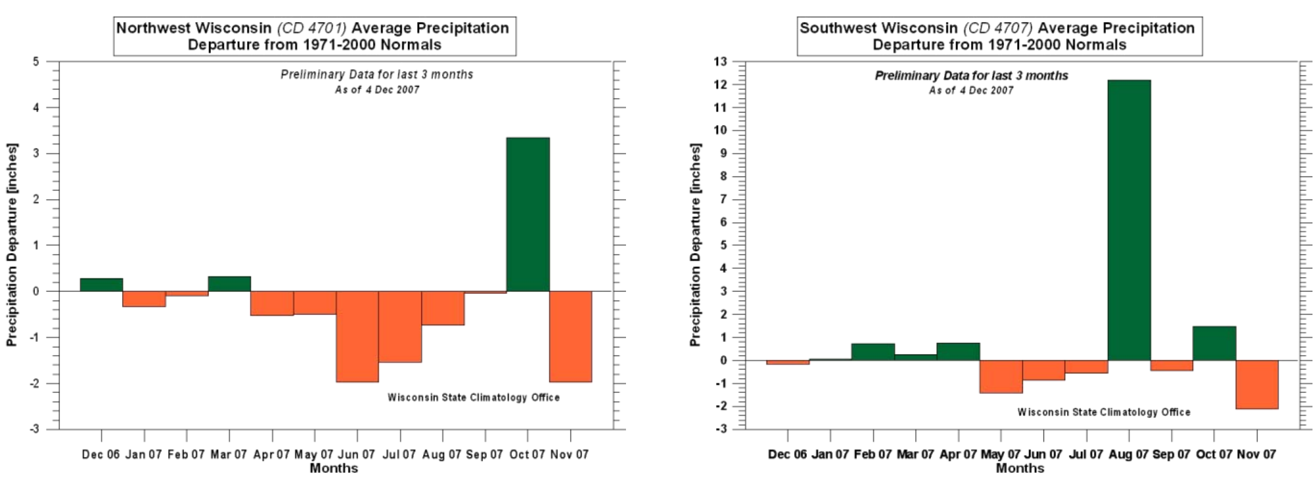

Figure 5. Departure from normal precipitation by month for northwest Wisconsin (left) and southwest Wisconsin (data from the Wisconsin State Climatology Office , http://www.aos.wisc.edu).