Wisconsin Forest Health Protection
Annual Report 2010

Compiled and edited by Forest Health Protection Program Staff

Premature color change in beech trees affected by beech scale in Door County, September, 2010.
Photo by Bill McNee

Wisconsin Forest Health Protection Program
Division of Forestry
Department of Natural Resources

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Wisconsin DNR Forest Health Protection Staff

Staff update

In 2010, the forest health team implemented a few changes to address the ever-growing workload associated with forest health protection. Regional staff have transitioned or are transitioning from specialists (where some staff work primarily with gypsy moth) to generalists, where staff handle all insect and disease issues, including the gypsy moth suppression program.

This transition included a change in the territories covered by each forest health specialist (Figure 1) and the addition of a forest health position in Wisconsin Rapids.

We are pleased to welcome Michael Hillstrom to the forest health team! Michael is a forest health specialist stationed in Wisconsin Rapids. He will be working in a nine-county area of central Wisconsin, which includes Clark, Marathon, Wood, Portage, Juneau, Adams, Waushara, Marquette, and Green Lake counties.

Hillstrom's first day on the job was November 8. He received his 2003 Bachelor's and 2009 Doctoral degrees in Entomology from the University of Wisconsin-Madison. Mike's Doctoral research focused on the impacts of elevated CO2 levels on forest insect communities. He has been enthusiastic about insects since he was a youth and was actively engaged in the UW-Madison Insect Ambassadors Outreach Program.

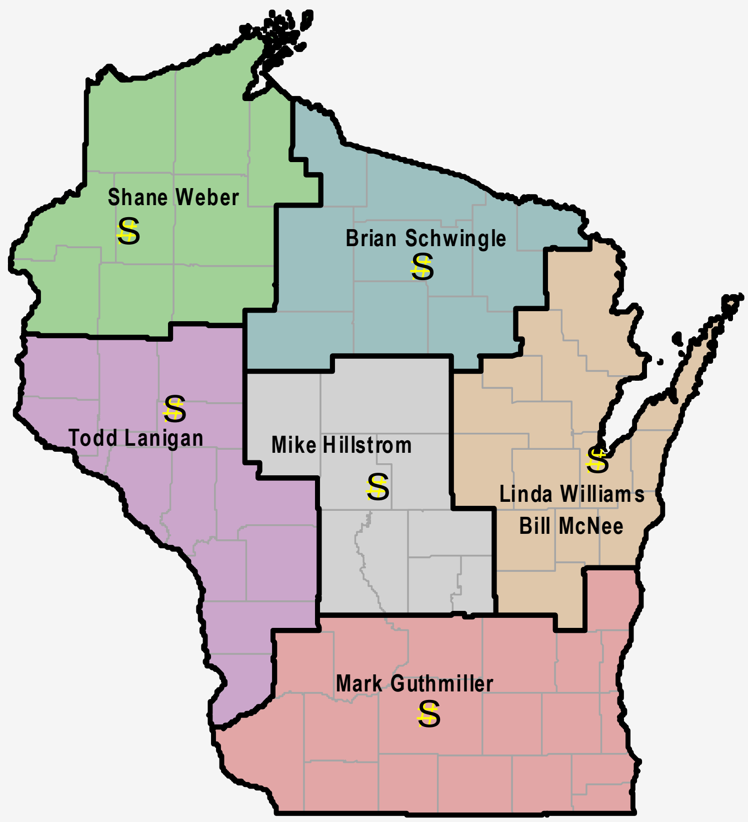

Figure 1. Forest Health Protection regional staff locations and territories.

Staff Directory

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Wisconsin's Forest Resources

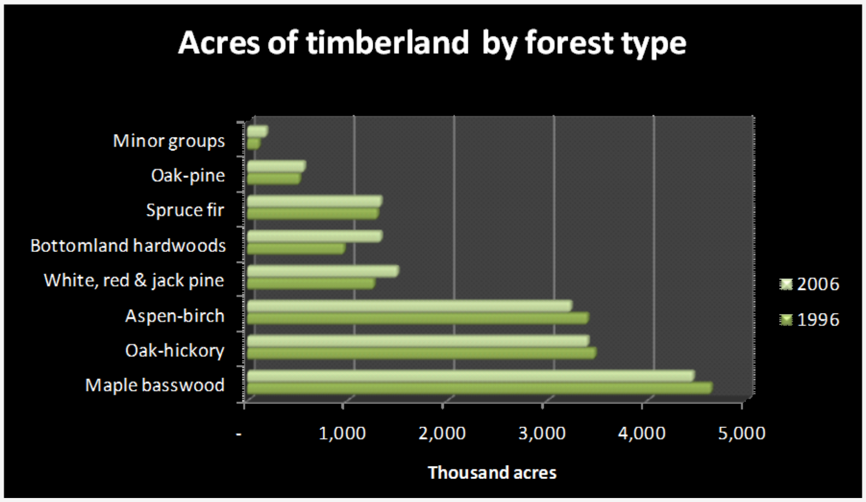


Figure 1. Thousand acres of timberland by forest type group, 1996 and 2006 (FIA data from USDA Forest Service).

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 increase.

Area of forests by type and age class

The area of forest land in Wisconsin has been steadily increasing in recent decades and currently stands at approximately 16 million acres, representing over 46% 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, (28% of all timberland), oak-hickory (22%), and aspen-birch (21%). Conifer types, mainly red, white and jack pines and spruce-fir, represent about 19% of the timberland. In addition, Wisconsin's 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.

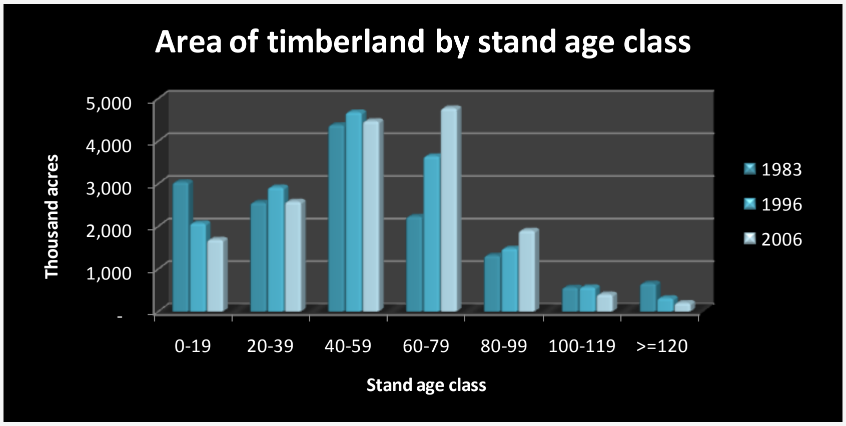


Figure 2. Thousand acres of timberland by stand age class 1983, 1996 and 2006 (FIA data from USDA Forest Service).

Volume and trends in major species

Since 1983 there have been some dramatic changes in growing stock volume of major species groups (Figure 3). The greatest volume of any major species in 2007 was in the red oak group (northern red oak, black oak, northern pin oak) and the volume in this group has increased 27% since 1983. This increase is important to note because this group is affected by several insects and diseases including gypsy moth, Armillaria root disease, two-lined chestnut borer and oak wilt. The second highest volume is in soft maples (red and silver maple). Volume in this group has seen the most dramatic increase of all species groups, up 98% in the last 23 years.

The greatest percentage volume gains since 1983 have been in white pine, soft maple, red pine, ash and the white oak group (white oak, bur oak, swamp white oak).

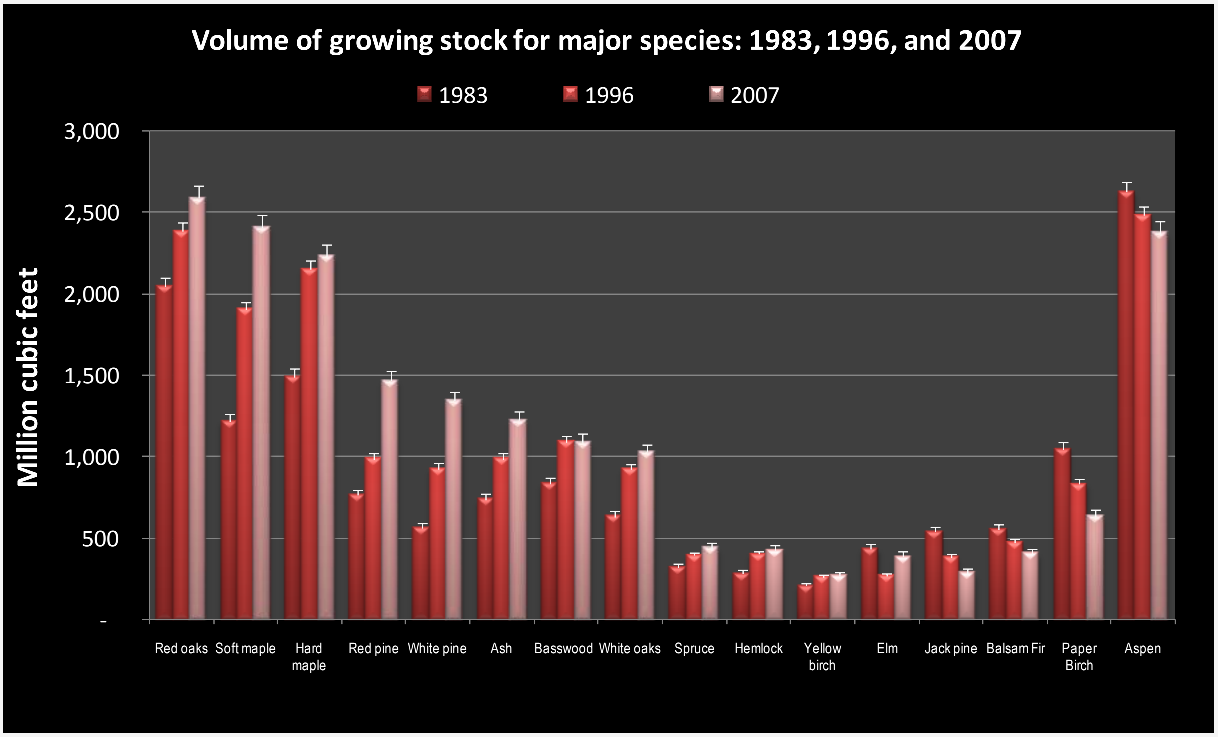


Figure 3. Trends in volume of growing stock by species group (FIA data from USDA Forest Service).

The greatest percentage volume losses since 1983 have been in jack pine, paper birch, balsam fir and aspen. This change is due to a combination of natural succession, drought-induced decline and mortality (specifically paper birch) and harvest losses that have not been replaced. The volume of elm (American, slippery, rock and Siberian) decreased between 1983 and 1996, but has increased 45% since 1996.

Exotics[1]

Emerald Ash Borer – *Agrilus planipennis*

For additional information, visit http://www.emeraldashborer.wi.gov/

Current status of EAB in Wisconsin

This exotic insect was first detected in Wisconsin in August, 2008. There are currently three known infestations and two locations (Brown County and Kenosha County) where adult beetles have been detected on a trap but no infested trees have been found (Figure 1). The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) is the lead agency in Wisconsin for detecting populations of EAB. Eight of the approximate 7,800 purple panel traps set by DATCP in 2010 caught an adult EAB. All eight traps were located in counties where EAB had already been detected. Some of the positive traps provided additional information on the extent of known infestations. (Figures 2-4).

Notable new finds for 2010 include the City of West Bend, where infested trees were detected by city forestry staff and the City of Cudahy, where an adult EAB was found on a DATCP trap.

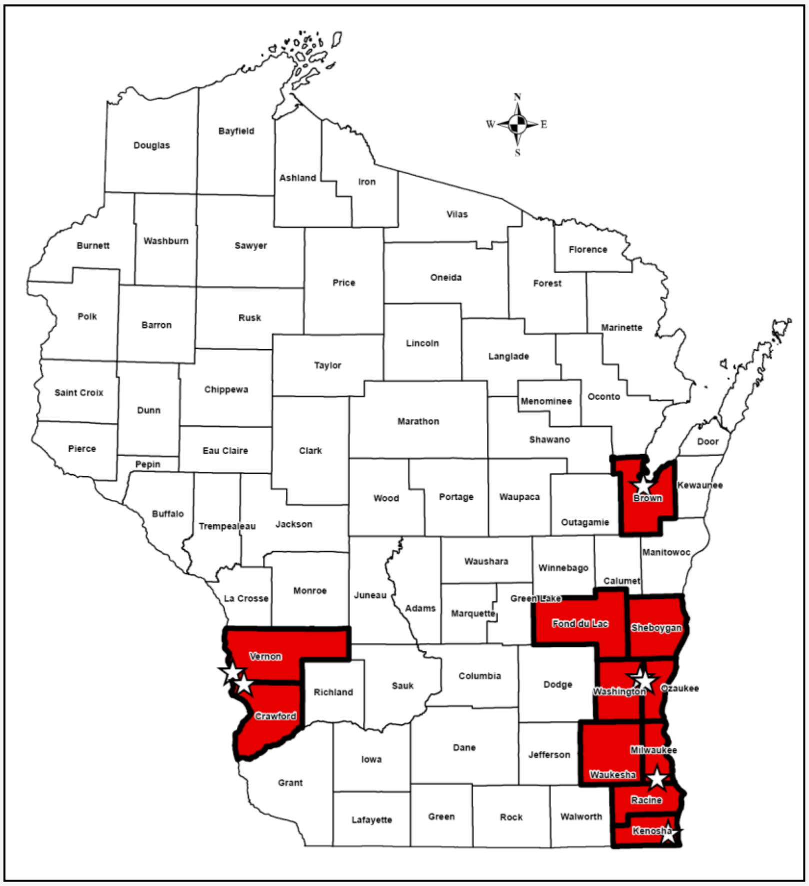


Figure 1. Counties quarantined (red) for EAB as of November, 2010. Locations of known infested trees or positive traps (star). Map courtesy of DATCP.

[1] This section includes information on exotics recently discovered in Wisconsin. Other exotic organisms that have been in WI for several years (such as oak wilt) are covered elsewhere in the report.

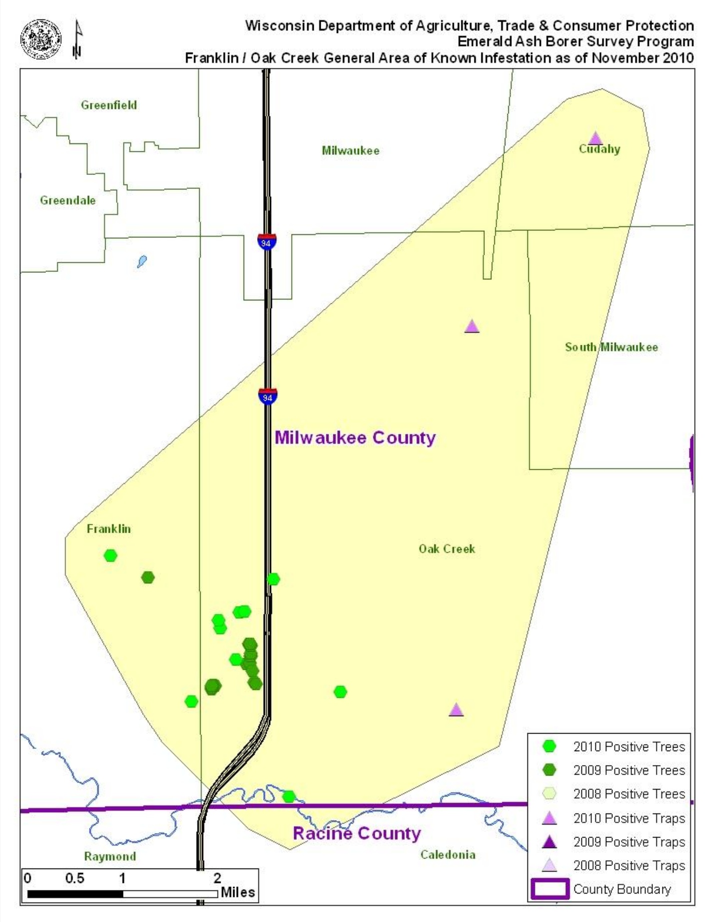


Figure 2. Location of EAB positive trees or traps in Milwaukee County. Area considered infested (yellow). Map created by Tracy Schilder, DATCP

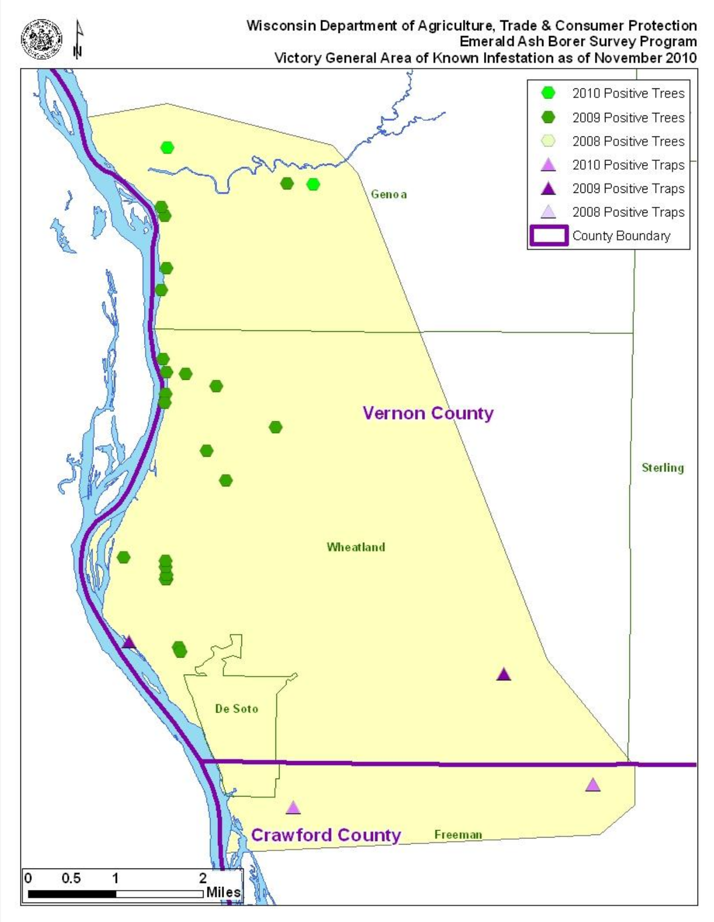


Figure 3. Location of EAB positive trees or traps in Vernon and Crawford counties. Area considered infested (yellow). Map created by Tracy Schilder, DATCP

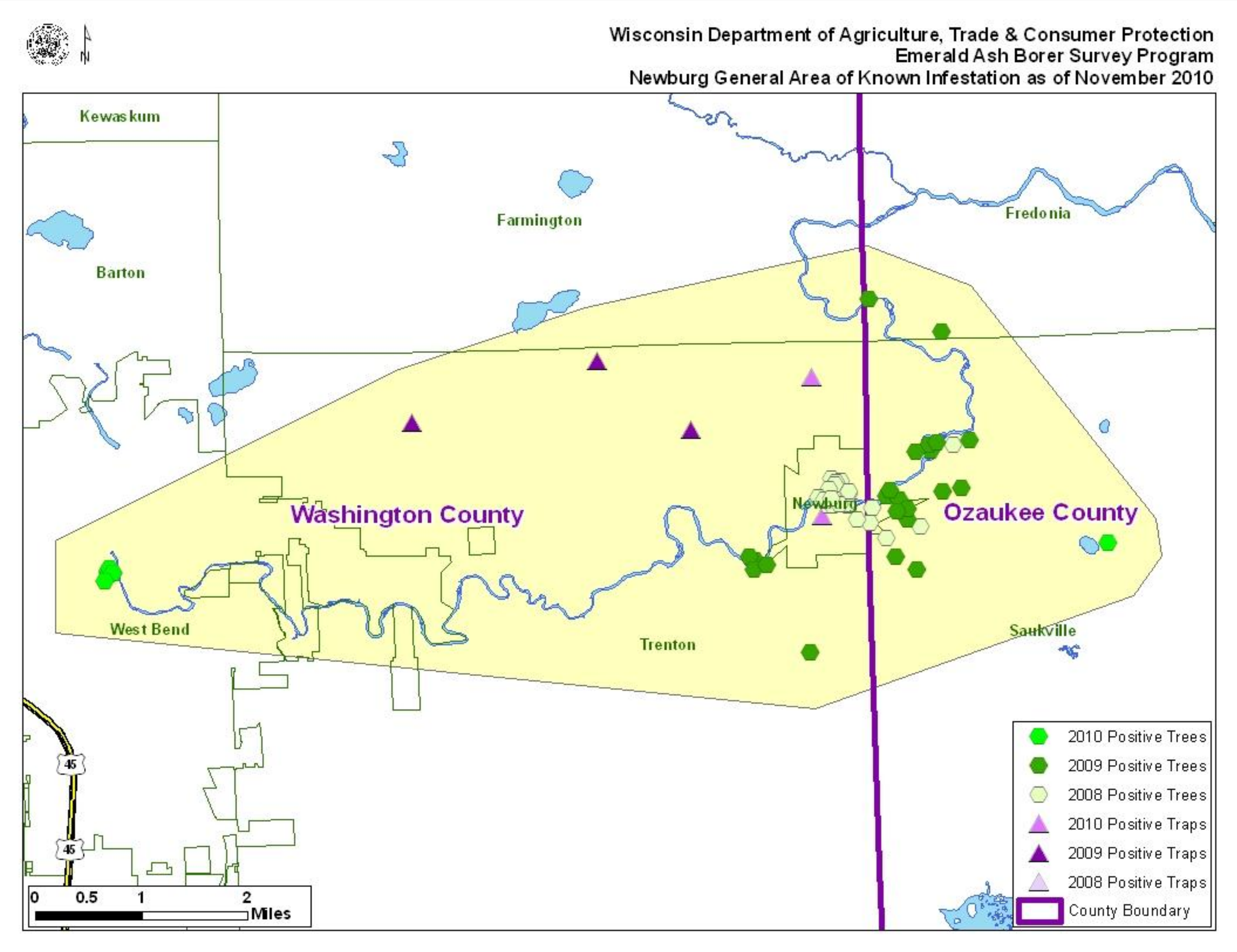


Figure 4. Location of EAB positive trees or traps in Washington and Ozaukee counties. Area considered infested (yellow). Map created by Tracy Schilder, DATCP

Management Strategies

Local Response Units: The state EAB Operations Group provided guidance and assisted with implementation of a multi-site response strategy. To view the response strategy, visit:

http://www.emeraldashborer.wi.gov/articleassets/EAB_Multi-Site_Response_Guide.pdf

This strategy was developed to transition from one statewide Incident Management Team overseeing all infestations to multiple response units, organizing at the local level and coming together for one year to develop and begin implementing a response. The four components of the response unit include: survey, management, outreach and education and regulation. Plans are to review this strategy and change as needed.

Salvage and Preemptive Removal of Ash in Rural Woodlands: Grant funds obtained from the USDA Forest Service supported hiring staff for the Town and Country Resource Conservation and Development (RC&D) and the Southwest Badger RC&D to implement salvage and preemptive removal of ash through sustainable forest harvests. Through these programs, RC&D staff, together with DNR forestry personnel, have contacted woodland owners in and around infested areas to offer services including a forest inventory and harvest plan. The abundance of small woodlots in the Ozaukee/Washington county infestation often requires coordination of landowners to effectively carry out a timber sale. In addition to mailings providing information on management options, several workshops were given for landowners in the Ozaukee and Washington county-area to inform them of their options for management.

Silvicultural Guidlines: The silvicultural guidelines prepared in 2008 were updated to reflect recommendations for woodland managers in and around infested areas. To view these guidelines, visit: http://www.emeraldashborer.wi.gov/articleassets/Management_Guidelines_for_Wisconsin_Forests.pdf

Urban Ash Guidelines: A set of guidelines was developed for managing ash in Wisconsin's urban forests to reduce the impact of EAB. To view these guidelines, visit: http://www.emeraldashborer.wi.gov/articleassets/Managing_Urban_Ash.pdf

Outreach and Education: Two new credit card-sized cards that focus on ash tree identification and signs and symptoms of EAB were developed in 2010. These products are easy to carry and use in the field. The state EAB website was updated as needed and numerous trade shows and landowner meetings were attended where updates on EAB were provided. One workshop, coordinated by the Forest Industry Safety Training Alliance (FISTA), brought together loggers and foresters in southwest Wisconsin to discuss sustainable management options. Colleagues from Iowa also travelled to southwest Wisconsin to meet with DNR forestry staff and share ideas related to EAB management. The City of Oak Creek partnered with DNR, USDA APHIS and Forest Service and UW Extension to hold a workshop on removal and utilization of urban ash. This workshop, funded by a grant from the Wood Education Resource Center, showcased mechanized felling and options for utilization of urban ash trees. A focus on the "don't move firewood" message continued throughout the year and was a significant part of informing the public of the change in the DNR firewood rule (see separate report on firewood rule).

Biological Control: DNR has been pursuing the possibility of releasing two-three parasites of EAB in 2011. This effort is in cooperation with the Department of Entomology at the University Of Wisconsin-Madison. This year was devoted to surveying several sites for determining the best location to release biological control agents. Infested sites in eastern and western Wisconsin were evaluated and several meetings were held with partners in DATCP, APHIS and colleagues in Minnesota to determine the best strategy for facilitating a successful release.

Insecticide Treatments: The focus of this management option was on providing information for tree-care professionals and government officials on the insecticide products and practical aspects of utilizing insecticides. DNR partnered with UW Extension to host four workshops that provided "how to" sessions on insecticide application and cost. These workshops were funded by a USDA Forest Service grant.

Emerald Ash Borer: Using Sink Trees to Slow Population Spread

Introduction

“Sink” trees, when used as part of an EAB program, are ash trees that have been girdled in spring or early summer to induce the production of volatile chemicals that attract EAB. Preliminary research has shown that sinks may influence the movement of adult emerald ash borers by attracting them more effectively than surrounding healthy ash. Trees selected for the sink tree project were within 200 meters of the most heavily infested trees in the Newburg infestation and were meant to draw the beetles towards the center and away from the edges of the infested area (Figure 5).

Sink trees are being tested as part of a landscape-level management tool to influence the movement of EAB back into the center of the infestation. Sink trees can also be used to reduce the number of insects in an infestation if the infested portions of the tree are cut and destroyed or utilized before adult insect emergence in the spring.

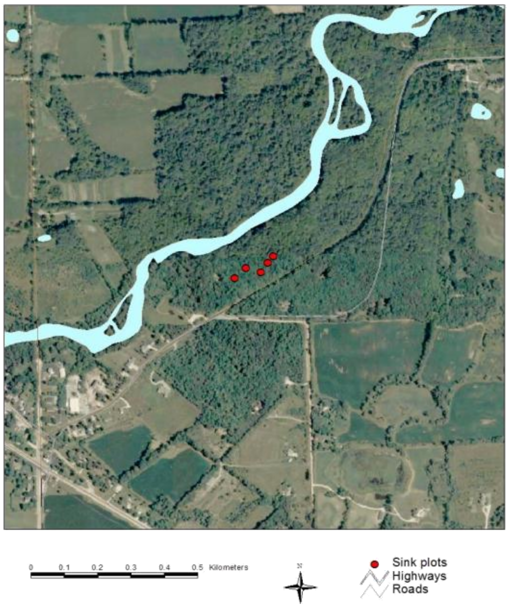


Figure 5. Location of sink trees on the Riveredge Nature Center property.

Methods

Sink trees were established in the Newburg infestation on Riveredge Nature Center property) on June 3, 2009. Five groups of three trees each were girdled. Trees were selected using the following criteria:

1. Located within 20 meters of a walking trail. This was requested by the property manager as the property management plan includes felling ash trees close to walking trails to reduce hazards to visitors. The sink location was chosen to remain close to (within 0.8 kilometer) the most heavily infested trees but in an area where there was phloem available for EAB feeding.
2. Trees were among the largest in diameter, in the localized area and had full crows receiving sunlight. The average girdled tree had a diameter of 35.8 cm at breast height. (Table 1).
3. Trees were grouped in clusters.

Table 1. Diameter (dbh) and number of 2.4 meter or 8 foot logs in sink trees.

Cluster ID	Tree Number	Dbh (cm.)	Logs (2.4m or 8'long) (no.)
A	1	29	1
A	2	39.4	4
A	3	32.8	2
B	1	43.2	6
B	2	30.7	2
B	3	30	1
C	1	32	3
C	2	37.1	4
C	3	24.1	0
D	1	34.5	3
D	2	38.1	3
D	3	32	2
E	1	46.2	3
E	2	40.9 codominant	5
E	3	46.7 codominant	4

In February, 2010, all sink and control trees were cut when the ground was frozen. The harvest was used as an opportunity to showcase the use of horses to skid logs in an area where the use of logging equipment and access would have been difficult due to tight corners and small working spaces. (Figure 6) The limited impact of horse-logging on the trail and residual trees was also evident on the site. Frozen-ground conditions facilitated minimizing impact to the site. A portable sawmill was set up on site so that logs could be processed into lumber. Over 4.7 cubic meters (2,000 board feet) of lumber was sawn for future projects at the nature center.

Figure 6. Horse-logging demonstrated by John Adametz of A to Z Percerons. (Photo by DNR).

Potentially-infested material (slab wood and pieces too small to provide lumber) was either chipped or used as firewood on the property. Riveredge Nature Center and Town and Country RC&D coordinated the field day and over 100 members of the public attended to watch the horse logging and portable sawmill in action. Small-scale logging equipment and methods for detecting EAB were also showcased on the field day.

Three, one-meter in length log samples were cut from each sink and control tree. These samples were collected from the base of the crown, mid-crown and upper crown, in accordance with guidance provided by Michigan State University researchers. Samples were peeled and data were collected on the number of larvae and stage of larval development (early instar - requiring another year for development or late instar - emerging in 2010) (Figure 7). Data were also collected on the number of EAB adult exit holes and number of larvae preyed upon by woodpeckers.

Figure 7. Larvae were counted and classified as early or late instar . Photo by Linda Williams

Results and Discussion

A total of 34.8 square meters of phloem was debarked and examined for EAB on the 20 study trees. Results indicate that clusters of girdled trees functioned well as population sinks along the edge of the known, low-density population. Sink (girdled) trees had significantly more EAB per square meter of phloem than nearby non-girdled ash trees (P=0.1) (Figure 8). EAB density on sink trees averaged 3.4 +/- 1.0 EAB larvae per square meter; density on control (non-girdled) trees averaged 0.6+/- 0.6 per square meter of phloem. Two out of every three (67%) sink trees had EAB infestations that were detectable at this sampling intensity, while only one of five (20%) control trees was found to be infested. In the sink trees, the number of live larvae per square meter ranged from 0 – 10.09, with an average of 3.33. In the control trees, the number of live larvae per square meter ranged from 0 – 3.10, with an average of 0.62. Only one dead larva was detected in all 20 sample trees. Nine trees had no larvae; 11 trees had larvae.

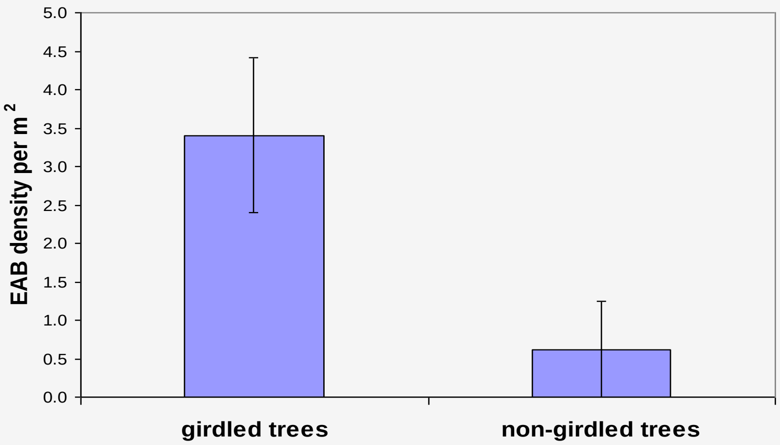
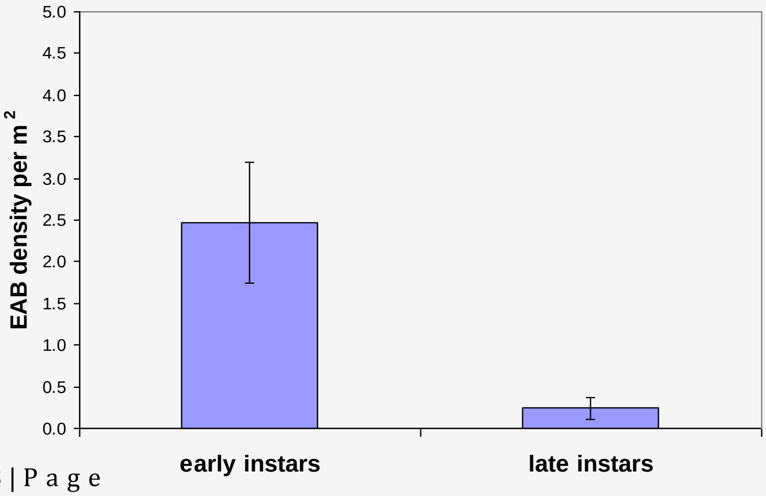


Figure 8 (top). Number of EAB larvae per square meter on girdled and non-girdled trees.
Figure 9 (bottom). Number of early and late instar EAB larvae per square meter.



There were significantly higher densities of early instar EAB larvae than late instar EAB larvae on the sample trees (P<0.01) (Figure 9). More than 90% of the larvae were early instars. The average number of early instar larvae per square meter in all study trees was 2.4. The average number of late instar larvae per square meter in all trees was 0.24. No exit holes or predation by woodpeckers was observed due to the extremely low density of late instar larvae.

After review, it was determined that the benefit of the sink trees for attracting and destroying EAB was minimal due to the low number of EAB larvae detected. The low number of larvae found in the samples could be a result of several factors:

1. Adult EAB were not attracted to the sinks due to the availability of ash closer to the infestation. Ninety percent of EAB adults travel within 100 meters of their emergence sites if host material is present close by.
2. The stress level of ash in the area is high enough to overwhelm the sink tree volatiles.
3. The population of adult EAB remains low in the area due to a high level of predation by woodpeckers. Data collected in the spring of 2009 from heavily infested trees showed heavy predation by woodpeckers of late instar larvae with only an average of 2.14 late instar larvae/square meter surviving.

Although the sink trees functioned as attractants, the destruction of the infested material probably did not make a significant decrease in the EAB population.

Double-Decker Traps for Detecting EAB

Detecting emerald ash borer is difficult when populations are very low, especially since these beetles do not utilize long distance pheromones. However they do have certain traits that can be used to detect low-level populations. For instance, EAB have been shown to be strongly attracted to certain colors (especially purple), sunlight, open grown trees, and volatile odors emitted from ash leaves, bark and wood.

Figure 10. Double decker trap placed in the open and mimics an ash tree. Photo by Jane Cummings Carlson

The double-decker traps were designed with these factors in mind. Visually they mimic a tree with two purple panels. The panels are two feet tall and covered with a sticky substance (Pestick) to capture landing insects. A leaf blend lure containing a green leaf alcohol (2 cis-3-hexenol in bubble caps) is hung from the top panel to simulate the tree crown. A bark blend lure (manuka oil) is hung from the bottom of the lower panel to mimic the bole. The panels are hung from three-meter PVC pipes placed over a two-meter steel post driven into the ground (Figure10). The traps are placed in open areas about 10 meters from a forested area that contains ash trees, in order to be highly visible and warmed by the sun.

Field studies conducted from 2006 to 2008 by D. McCullough from Michigan State University and T. Poland from the USDA Forest Service, have shown that the baited purple double decker trap consistently attracts more adult EAB beetles than other trap designs.

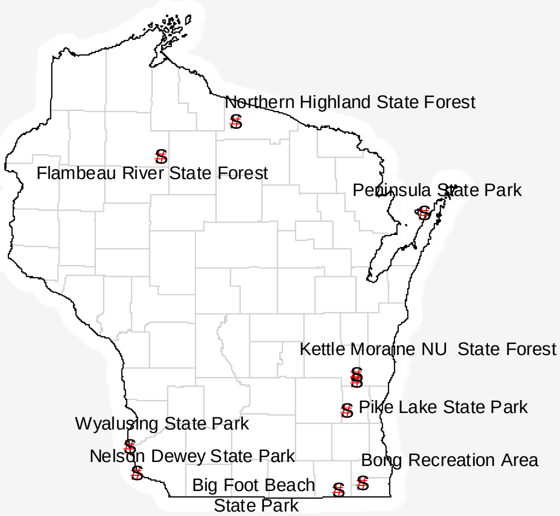


Figure 11. Double decker traps were placed in campgrounds on ten state properties. Map by Sally Dahir

Trap placement and checking

Ten state properties known to contain a high volume of ash were chosen for this initial survey (Figure 11). The double decker traps were placed in open areas of campgrounds where several ash trees were located in the adjacent woods. The traps were placed during the first week of May, 2010, and checked monthly beginning June 18. No emerald ash borers were detected.

Increased understanding of *Cerceris fumipennis*, the beetle hunting wasp, in Wisconsin

The emerald ash borer (EAB) continues to destroy the North American ash resource, with infestations of this destructive pest now firmly established in 15 states and two Canadian provinces (Figure 12). Current methods used to detect EAB include purple panel traps baited with a bark attractant, visual surveys, double-decker purple panel traps baited with leaf and bark compounds, destructive tree peeling and girdled detection trees. Despite the abundance of detection tools available, there continues to be a sizeable lag time between when EAB first appears in an area and when it is first detected. Both the Newburg and Victory EAB infested areas in Wisconsin have been dendrochronologically aged and each infestation has been estimated to have been present four to five years prior to its first detection.

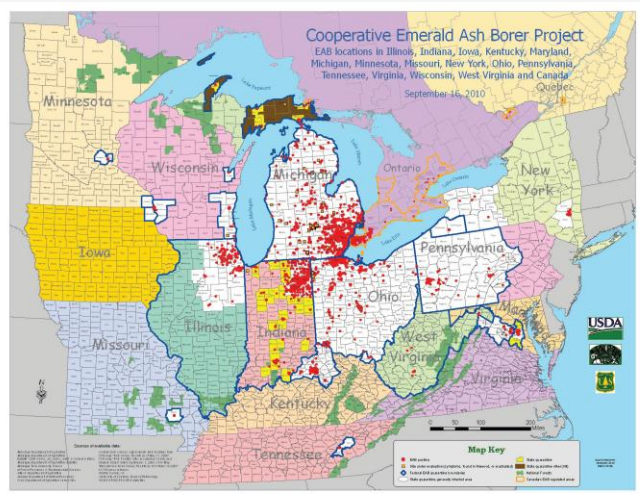


Figure12. Map of currently know emerald ash borer infestation locations in North America. Red indicates known EAB populations and blue outlines quarantined states and counties for EAB. Map provided by Cooperative EAB Program.

The sensitivity and reliability of each detection method varies, with none seemingly able to detect EAB infestations that are in their infancy. In an effort to improve upon the survey tools available to us for EAB detection, we are exploring the use of the beetle-hunting wasp, *Cerceris fumipennis*, to aid us in EAB detection. The work we did with *C. fumipennis* in 2010 is a continuation of similar work that was conducted with the wasp in 2009. Our efforts in 2010 focused on further identification of naturally occurring *C. fumipennis* colonies in Wisconsin, monitoring a select number of the colonies for EAB using biosurveillance and investigating the potential to transform the naturally occurring wasp sites into mobile colonies that can be moved around to desired locations for EAB detection.

Figure 13. *Cerceris fumipennis* nests commonly found in hard packed sandy soil. Soil is often sparsely vegetated and nests are aggregated in direct sunlight

Figure 14. *Cerceris fumipennis* at rest while on its way back to its nest with Buprestid beetle prey. Photos by Matt Carpenter, (WI DATCP)

Cerceris fumipennis is a solitary, ground nesting wasp that relies solely on Buprestid beetle prey as a food source for its offspring. Individual wasp nests are often aggregated in open areas of hard packed sandy soil that is frequented by human disturbance (Figure 13). Vegetation is often sparse where nesting grounds occur, with nests frequently found at under-maintained baseball diamonds, informal parking areas, sand and gravel pits and around campfire rings. *Cerceris fumipennis* forages for beetle prey in nearby wooded areas, sedating them by its sting before bringing the prey back to its nest (Figure 14). Beetle prey are stored in an earthen cell in the below ground nest and serve as food for future developing wasp larvae. *Cerceris fumipennis* collects a wide diversity of Buprestid beetle prey, including the exotic pest EAB, to provision its nest (Marshall *et al*., 2005; Careless *et al*., 2009). Despite the use of the wasp's stinger to paralyze its beetle prey, the wasp does not sting humans.

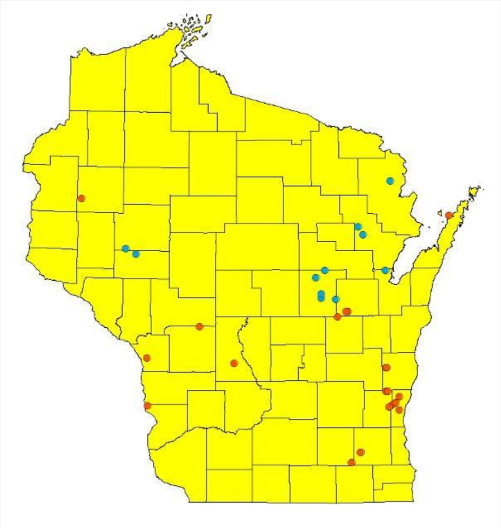


Figure 15. Map of Wisconsin depicting locations of *Cerceris fumipennis* wasp colonies. Colonies designated by a red circle indicate a wasp nesting ground identified in 2009 and those designated by blue indicate a nesting ground identified in 2010.

Location of Cerceris fumipennis nesting grounds in Wisconsin

Cerceris fumipennis nest detection work in 2010 was a partnership between WI DNR and the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). Eleven new wasp nesting grounds were discovered between July 9 and August 5 (Figure 15). The 11 nesting sites accounted for a total of 312 nests and the number of nests per site ranged from 1-169, with an average of 28 nests per site. Nine of the 11 nesting grounds contained ≤ 20 individual nests.

Table 1. Location of Cerceris fumipennis nesting grounds identified in 2010. Detailed information describes date of discovery, site description, number of nests present and number of Buprestids collected during colony observation

DATE DETECTED	COUNTY	SITE	SITE DESCRIPTION	# NESTS	# TOTAL BUPRESTIDS COLLECTED
07/09/2010	Chippewa	Eau Claire Regional Airport	Dirt road	10	0
07/19/2010	Eau Claire	Tower Ridge County Park	Frisbee golf course	10	1
07/20/2010	Waupaca	Hatten Park	Baseball diamond	20	1
07/20/2010	Waupaca	Conroy's Bear Lake Campground	Dirt road	1	0
07/26/2010	Oconto	Suring Community Park	Baseball diamond	12	0
07/26/2010	Brown	Brown County Reforestation Camp	Baseball diamond	15	0
07/26/2010	Waupaca	Hoffmann Memorial Park	Parking lot	5	0
07/27/2010	Oconto	Breed Family Park	Baseball diamond	42	0
07/27/2010	Waupaca	Marion Athletic Park	Baseball diamond	8	0
07/29/2010	Marinette	Amberg Kiwanis Park	Baseball diamond	169	4
08/05/2010	Waupaca	Little Fall Ballpark	Baseball diamond	20	0

The 11 *C. fumipennis* nesting grounds were first records for the wasp in six Wisconsin counties, including Brown, Chippewa, Eau Claire, Marinette, Oconto and Waupaca (Table 1). The results of this survey bring the total number of Wisconsin counties containing *C. fumipennis* nesting grounds to 19. For details on nesting grounds located in

2009, please refer to Wisconsin Forest Health Protection Annual Report 2009, found online at http://dnr.wi.gov/forestry/fh/AnnualReport/AnnualReport2009.pdf .

Positive identification of *Cerceris fumipennis* nesting grounds was based on visual identification of the wasp and not solely by its nests. The wasps were often observed with Buprestid beetle prey in flight and were found at a variety of public use areas, including seven nesting grounds discovered at baseball diamonds, two on dirt roads, one at an informal parking area and one at a Frisbee golf course (Table 1).

Cerceris fumipennis biosurveillance

Biosurveillance of *C. fumipennis* has the potential to be a useful tool to aid in the detection of EAB. Biosurveillance consists of monitoring the wasp colony by waiting for the wasps to return back to their nest with prey and identifying if the prey they are carrying is EAB. Because the wasps quickly enter their nests upon return, it is helpful to place a clear plastic cup over the entrance of the nest so that you are able to regulate when the wasp can enter the nest (Figure 16). Before letting the wasp enter its nest, the surveyor can either collect the beetle prey with a sweep net or spot identify for EAB when practical.

Figure 16. Plastic cup with a screen top used to regulate *C. fumipennis* activity in and out of its nest during biosurveillance work. Photo by Renee Pinski.

Biosurveillance was conducted at two *C. fumipennis* nesting grounds in Wisconsin. One site was located at Peninsula State Park, which is not infested by EAB to date, and the second site was located in DeSoto, just outside the outermost edge of the Victory area EAB infestation. Each of these sites was also previously monitored for EAB using biosurveillance in 2009.

Surveyors were able to closely monitor the DeSoto site and recorded wasp emergence during the last week of June. On June 29, wasps were observed mating and females were actively provisioning their nests with beetle prey. Multiple biosurveillance visits were made at each of the two sites, with two and three monitoring dates at the Peninsula State Park and DeSoto sites, respectively. A total of 25 beetle prey were collected during biosurveillance from the Peninsula State Park site and 72 beetles from the DeSoto site. None of the beetles collected from either site were EAB, however one EAB was collected on a baited purple panel trap just one mile away from the DeSoto site. Research has shown that in order to accurately account for a representative sample of the beetle diversity within the foraging area of the nesting grounds, it is important to collect a minimum of 50 beetles (Careless, 2009).

Figure17. Diversity of beetle prey collected from *C. fumipennis*. Genres identified include *Agrilus*, *Brachys*, *Chrysobothris* and *Dicerca*. Identification to species is ongoing. Photo by Renee Pinski.

A total of 97 beetles were collected from the two sites monitored for EAB using biosurveillance. Collected beetles have been identified to their respective genres and comprise the following makeup; 27 *Agrilus*, 35 *Dicerca*, 24 *Chrysobothris*, 5 *Brachys* and 6 undetermined specimens (Figure 17). Further identification of the specimens to the species level is being conducted in collaboration with Dr. Daniel Young and Nathan Hoftiezer, Dept of Entomology, University of Wisconsin- Madison.

Using *C. fumipennis* to collect Buprestidae is a novel approach to recording the biodiversity of this beetle family in Wisconsin (Marshall *et al*., 2005). To date, the Buprestidae of Wisconsin has not been cataloged in great depth due to the difficulty in collecting the beetles. Adult beetles are often found high up in the tops of trees and the larvae are hidden beneath the bark. All beetle prey collected during our biosurveillance work with *C. fumipennis* have been preserved and sent out to various experts for identification. Once specimens are identified, all prey records will be deposited in the Wisconsin Insect Research Collection at the University of Wisconsin- Madison.

Cerceris fumipennis mobile colony work

Our search for *C. fumipennis* nesting grounds over the past two field seasons has proven that the wasp is not always found where we would like it to be, for example at specific locations where we are interested in surveying for EAB. In an effort to address this issue, we investigated a technique used by a researcher working with *C. fumipennis* in Ontario, Canada to make the wasp colonies mobile (Careless, 2009). In order to make *C. fumipennis* colonies mobile, wasps are collected from naturally occurring nesting grounds and placed in indoor terrariums where they are kept until acclimated to their new nest. Once acclimated, the wasps are set out in the field as a mobile colony. Ideally, one hopes that the wasps will stay with their new colony and provision it with beetle prey just as they would their natural nest.

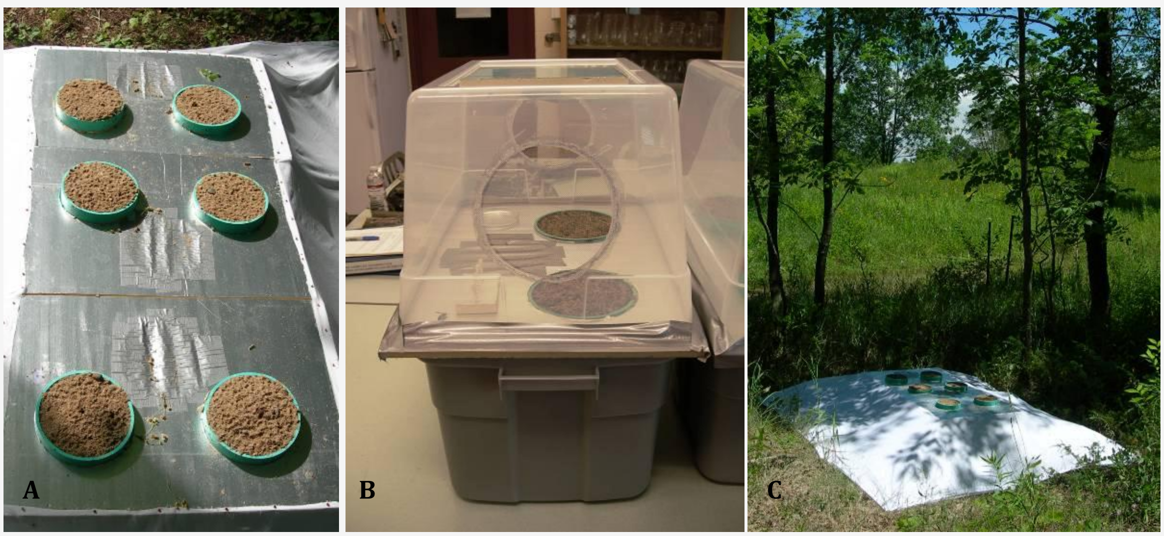


Figure 18. *Cerceris fumipennis* mobile colony project. **A)** Mobile colony construction consisted of PVC tubes filled with sand and placed in Rubbermaid bins. A light weight foam board was placed over the tube nests to secure the nesting area. **B)** A lid was placed over the mobile colony to create a wasp terrarium. Wasps were placed in the terrariums and allowed to acclimate to their new nest for 48 hours. **C)** Once wasps were acclimated, the mobile colonies were placed in the field at select sites, lids were removed and the mobile units were monitored. Photos by Renee Pinski.

Wasp terrariums were constructed by filling six-inch diameter PVC pipe cut to eight-inch length with sandy soil. The sandy soil used to fill the PVC pipe (tube nests) was collected from a site where a naturally occurring *C. fumipennis* colony existed. The tube nests were stood vertically and a plastic drain cover was attached to the bottom. On the top end of the tube nests, five, two-inch deep holes were punched into the soil with a number two screwdriver to simulate wasp nest entrances. Two tube nests were then placed in a Rubbermaid bin and foam insulation board was placed over the top of the Rubbermaid bin to enclose the soil tubes. The foam board had circular cutouts that allowed for the soil tubes to pass through and extend just above the surface (Figure 18A). In order to fully enclose the colony and create a terrarium, a second Rubbermaid bin was then turned upside down and placed over the top of the tube nests (Figure 18B). Holes were cut out and screen was placed on each end of the terrarium lid to allow for air circulation. Inside the terrarium, wasps were fed honey and water to sustain them.

Wasps seemed to readily take to their new indoor terrarium environments. *Cerceris fumipennis* actively consumed honey and water and accepting the man-made nests. Within the first 24 hours the majority of wasps had entered the man-made nests and plugged the entrance with soil.

After the wasps had been given 48 hours to acclimate to the indoor terrariums, the terrariums were taken out of the laboratory and set out as mobile colonies at select sites (Figure 18C). Once colonies were set on site, the terrarium lids were removed and the wasps were allowed to move freely to and from the mobile nests. A total of four mobile colonies were set up, with each mobile colony consisting of three Rubbermaid bins set next to each other. A white sheet was then placed around the mobile colony in an effort to keep the temperature of the soil tubes from getting too warm and also to act as a ramp for the wasps to fly up as they returned to the colony.

One mobile colony was placed at each of four sites between July 13 and July 27. Two of the colonies were placed at sites within the Victory EAB infested area, Blackhawk Park and the Halpin property. The other two sites were located within and just outside the Newburg EAB infested area, one at Cedarburg Bog University of Wisconsin – Milwaukee Field Station (uninfested to date) and the other at Riveredge Nature Center. Once the mobile nests were set-up on site and the terrarium lids were removed, the wasps seemingly left their artificial nests in a hurry. Mobile colonies initially contained 8 to 11 wasps each, but only two wasps were ever observed returning back to the mobile colony. In fact, few of the wasps even took the time to circle the colony and perform an orientation flight as they left.

Mobile colonies were left unattended on site for four days on average. Upon returning to the site and retrieving the mobile colony, the soil tubes were emptied in the laboratory and the contents were processed for the presence of either *C. fumipennis* or beetle prey. The results of our mobile colony effort were minimal, with just one wasp being retrieved (dead) at the end of the study and no beetle prey. One issue that negatively affected the results of our study was the rather harsh weather our mobile colonies experienced while out at the field sites. All of the mobile colonies experienced severe rain events that nearly drowned out the nests entirely. Future work with mobile colonies will need to address why the wasps did not feel any attachment to the mobile colony and thus did not return or spend any time provisioning the nests. Secondly, we will need to limit the amount of time the colonies are left on site in order to address a number of environmental extremes that affect the colonies, such as rainfall and high temperatures.

Thank you and appreciation

This project would have not been possible without the help of numerous people and organizations. Thank you to DATCP, especially the EAB trapping crew, for their help with locating new *C. fumipennis* nesting grounds. Thank you also to Greg Edge and Joel Jepsen, WI DNR, for helping with site selection and obtaining landowner permission for the *C. fumipennis* mobile colony work in Victory. We would also like to extend our thanks to Gretchen Meyer, Cedarburg Bog UW- Milwaukee Field Station, and Riveredge Nature Center personnel for their assistance with site selection for mobile colony work in the Newburg area. Additional thanks to Bill McNee and Robert Murphy, WI DNR, who conducted biosurveillance at Peninsula State Park and the DeSoto *C. fumipennis* sites, respectively. Lastly, we are very gracious for the expertise of Dr. Daniel Young and Nathan Hoftiezer at the University of Wisconsin - Madison, Department of Entomology for their help with insect identification.

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Firewood as a vector of Invasive Pests and Diseases:

Modeling the risk and adjusting regulation to reduce it

Firewood is recognized as one of the most important ways invasive pests and diseases of trees are being moved in North America. It is also one of the hardest to address as large amounts of wood are moved by the public. In the past five years, the Wisconsin DNR has tried to reduce the risk of introduction of invasive pests and diseases to state lands by regulating the wood that may enter state parks and forests. The initial decision to limit wood that may enter to that harvested within 50 miles of the campground where it would be used was based on a survey of small firewood vendors by the Department of Agriculture, Trade and Consumer Protection that found that most of them cut and sold within a 50-mile radius. At the time there was no information on the risk of invasive species

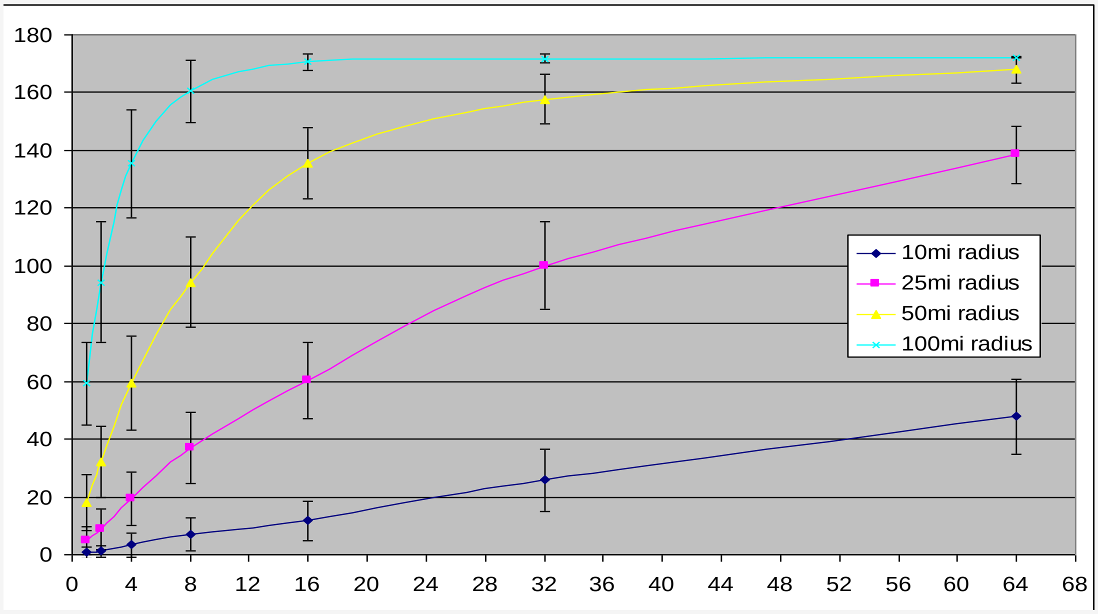


Figure 19. The number of Wisconsin state campgrounds that are at risk of introduction of invasive X on allowable firewood (Y axis) varies with the number of populations of invasive X (X axis).

introductions with distance though it was commonly assumed that the greater the distance the wood was allowed to come in from, the greater the risk of its carrying an invasive species not already present on the property.

In late spring 2009, Drs. Andrea Diss-Torrance (Wisconsin DNR) and Patrick Tobin (USDA Forest Service) developed a model of the changing risk to Wisconsin state-owned campgrounds with increasing number of populations of an invasive in the state and differing distances from which firewood was allowed (Figure 19). This model took a map of Wisconsin with state-owned campgrounds and randomly placed the selected number of populations of invasive X on the map. The model then determined the state campgrounds that would be within 10, 25, 50 or 100 miles of each randomly placed invasive population and recorded the total campgrounds at risk of an introduction on allowed firewood for each distance. This model was then repeated 100 times for each selected number of populations to calculate a mean number of campgrounds at risk for each combination of number of populations of invasive X and distance firewood could travel.

The model showed a significant effect of both the number of populations of invasive X in the state and the distance from which firewood was allowed onto a property in the proportion of state campgrounds at risk of an introduction of invasive X. What was most striking was that as the allowable distance increased the proportion of campgrounds at risk increased logarithmically with increasing numbers of populations but as the distance for allowable firewood decreased the relationship became more linear (Figure 19). From this model it was clear that at the then allowable distance of 50 miles that over half of the state campgrounds could be at risk of an introduction with as few as eight populations of an invasive in the state. This result was discussed with parks and state forest managers and it was decided that this level of risk was too high and that the distance from which firewood could be brought should be reduced. Not allowing any untreated wood, only wood harvested from within 10 miles or with 25 miles were all considered and reducing the limit to 25 miles was recommended because managers thought that was the lowest they could go and still be certain of being able to provide enough firewood for campers. This recommendation was taken to the Natural Resources Board and the proposal to reduce the allowable distance to 25 miles was approved for implementation in spring of 2010. The model has since been expanded to a four-state area of the Midwest (Minnesota, Wisconsin, Illinois, and Iowa) and for New England and New York. The results have been published in the Journal of Economic Entomology 103(5): 1569-1576 2010.

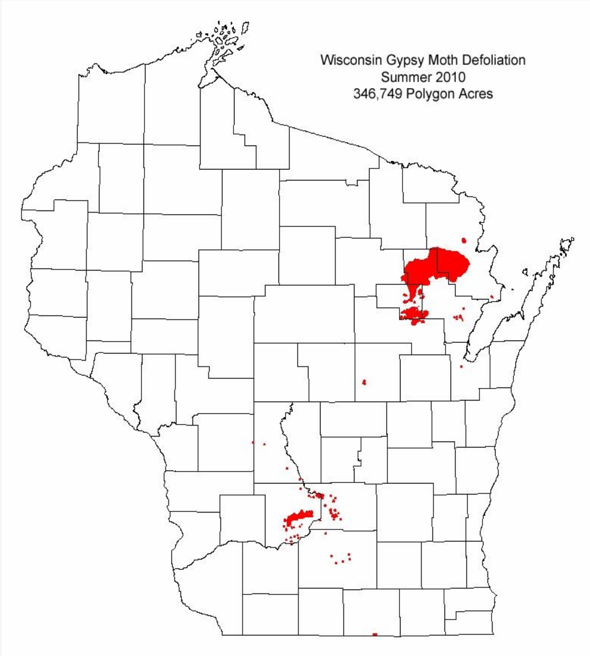


Figure 20. Areas defoliated by the gypsy moth.

Gypsy Moth Suppression

Defoliation and population trends

In 2010, populations of gypsy moth caterpillars were high in northeastern Wisconsin as well as in scattered areas in Dane, Columbia and Sauk counties (especially in the Baraboo hills) (Figure 20). Staff conducting aerial surveys in early July mapped nearly 347,000 acres of defoliation, up from 3,620 acres in 2009 and 8,659 acres in 2008. About 320,000 acres of the defoliation were classified as moderate and 25,000 acres were classified as heavy. Mortality from diseases caused by *Entomophaga maimaiga* and Nucleopolyhedrosis virus, was heavy statewide. In most areas, the gypsy moth population had collapsed by the end of the larval period. Egg mass counts remained high enough to qualify for the 2011 suppression program in many areas of northeast Wisconsin, as well as scattered sites in southern counties.

Suppression Program

This was the tenth year for the cost-shared gypsy moth suppression program in Wisconsin. In 2010, 5,574 acres were sprayed with insecticide to prevent defoliation by out-breaking populations of gypsy moth, at a cost of $32.85 per acre. The 2010 program was about half the size of the prior year. The suppression program treated 83 sites in 11 counties: Brown, Dane, Menominee, Milwaukee, Oconto, Outagamie, Racine, Rock, Sauk, Washington, and Waukesha (Figure 21). About 25% of the acres treated were on public lands, and about 75% were on private, mostly residential lands. Of these acres, 5,347 at 82 sites were treated at 36 CLU's of Foray 48B at ¾ gallon/acre and 227 were treated at one site with Gypchek at $4x10^{11}$ OB/acre in 1 gallon of Carrier 38A/acre. Treatments on all blocks were successful at keeping defoliation below 50% on 80% of the trees in the block, which is the Wisconsin suppression programs goal to prevent stress to trees.

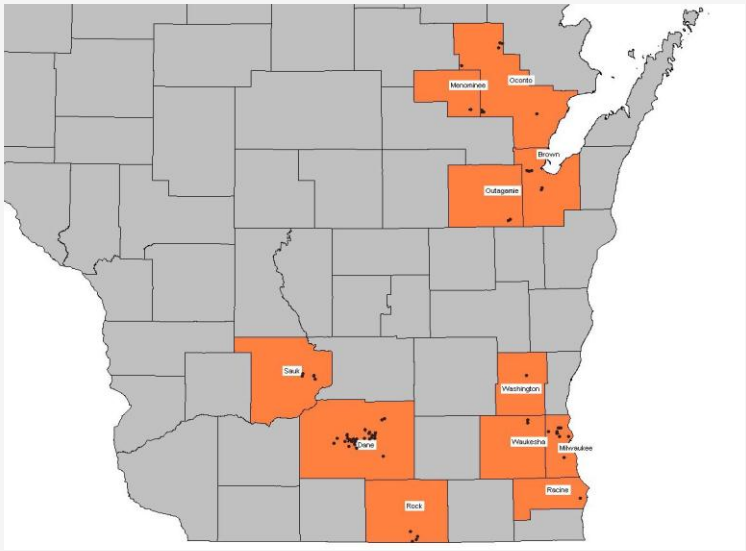


Figure 21. Locations of 2010 gypsy moth suppression sprays.

Gypsy Moth Outreach

In spring 2009, the Federal Aviation Administration required the use of a twin engine plane in the Fond du Lac, Madison and Milwaukee areas. These planes are much louder and make more passes to apply the same treatment than single engine planes. In 2009, the louder, slower planes generated hundreds of calls to 9-1-1, law enforcement and direct calls to the DNR gypsy moth information line. "We heard a lot more complaints and concerns from residents in these areas than ever before," said Colleen Robinson-Klug, forest health educator in the Division of Forestry. Public response was the same as historically in areas using the single engine planes. The typical media coverage, information line, email notification list, and websites http://gypsymoth.wi.gov/ weren't sufficient outreach in light of the aircraft change.

In 2010, twin engine aircraft were required in the Madison, Milwaukee and Racine areas and a special effort was made to personalize the service provided to public service agencies. In addition to the usual email or letter to hospitals, day care centers, emergency management agencies, schools, etc. in spray areas, Virginia Mayo Black, communications specialist for the forestry program, directly contacted specific individuals at these agencies to emphasize the issue of using the twin engine airplane. Especially important were 9-1-1 centers. As a result of these contacts, subscriptions to the list serve doubled from last year with over 2,000 subscribers signing up for daily spraying updates.

Forest health educator, Colleen Robinson-Klug created a DNR Media Kit regarding the suppression program in 2010. This kit offered a one-stop shop for reporters who need information about the program to help spread the word on local news broadcasts. Media outlets had access to information about the Suppression Program goals, treatment locations, spray activities, planes, schedules, updates and more, right at their fingertips. This helped get media attention for an issue or story that had become "old hat" for outlets where gypsy moth spraying has occurred in the past.

In addition, Robinson-Klug recruited the assistance of DNR's regional public affairs managers to reinforce the newsworthiness of our suppression program activities to local media outlets in areas where we sprayed. Often that local connection makes a difference. Video was provided directly to news outlets to make it as easy as possible for them to cover a story about upcoming spray activities, in an effort to alert the public.

The 2010 suppression program concluded with:

- twice as much pre-spraying media coverage;
- no calls to 9-1-1;
- only a couple of direct calls to the DNR Call Center and the gypsy moth information line

As in previous years, it was recognized that a team effort both from inside and outside of the agency was required to make outreach on gypsy moth activities a success. Staff were especially encouraged by the decline in concerned callers from hundreds to zero in one year and were also proud of the new tools and resources developed for reaching the public. The program will continue to improve outreach efforts, making them more cost effective and accessible.

Banded Elm Bark Beetle - *Scolytus schevyrewi*

Samples of suspected banded elm bark beetle (Figure 22), collected from the Dane County Township of Pleasant Springs, were confirmed positive by USDA APHIS on December 19th, 2009. In March of 2010, sample beetles from Siberian elm in Brookfield, Wisconsin were also confirmed positive for banded elm bark beetle by Phil Pellitteri, UW-Madison Department of Entomology, Extension entomologist.

Figure 22. Adult banded elm bark beetle about 1/8th inch long. Photo by Mark Guthmiller

Banded elm bark beetle, *Scolytus schevyrewi,* is an exotic beetle native to northern China, central Asia and Russia. The host range in the U.S. appears to be American, Siberian, English and rock elm. These are the first confirmed reports of this species in Wisconsin. It has previously been confirmed in many other states in the U.S. and it was anticipated that it would be detected here in Wisconsin. These infestations appear to be at low levels and intermixed with higher populations of another common exotic elm bark beetle, the smaller European elm bark beetle, *Scolytus multistriatus*. Banded elm bark beetle is also suspected to vector the Dutch elm disease fungus, *Ophiostoma novo-ulmi.*

Management would include sanitation by removing and destroying infested trees. Infested material should be debarked, chipped, or burned. Old dead trees with bark off are no longer a threat. Avoid moving firewood and cover freshly cut elm firewood with plastic sealed at the bottom with dirt. This will prevent new attacks to fresh cut wood and may reduce emergence from infested firewood. During a prolonged dry spell watering yard trees is recommended to help the tree fend off invasion.

For more information, visit: http://na.fs.fed.us/pubs/palerts/banded_elm_beetle/beb.pdf

Thousand Canker Disease (TCD)-*Geosmithia morbida and Pityophthorus juglandis*

Thousand Canker Disease has two principal agents involved: a newly identified fungus (*Geosmithia morbida*) and the walnut twig beetle (*Pityophthorus juglandis*). Cankers are formed when the adult bark beetles introduce *Geosmithia morbida* into the phloem. This disease causes dieback and mortality of eastern black walnut and has been detected in eight western states CA, OR, WA, ID, UT, AZ, NM, CO, and in Knoxville, TN. The potential impact of this disease to the black walnut resource could be significant. All indications are that the fungus and beetle can survive Wisconsin's climate. Injury to black walnut is caused by an overwhelming number of small (circular to oblong) cankers forming in the phloem.

Walnuts infected with TCD show the following symptoms: branch mortality, numerous small cankers on the braches and main stem and signs of Pityophthorus beetles (numerous tiny round exit holes in the bark and galleries under the bark). Visual inspections are currently the best way to detect TCD. For more information, visit: http://www.thousandcankerdisease.com/

Beech Bark Disease - *Cryptococcus fagisuga and Neonectria spp.*

Beech bark disease, a disease of American beech (*Fagus grandifolia*) caused by a scale insect (beech scale, *Cryptococcus fagisuga*) and one of several species of canker-causing fungi (*Neonectria* sp.), was detected in Door County in 2009. The disease was found several miles east of the city of Sturgeon Bay, in a woodlot and a lakeshore residential area. Many trees were heavily infested with beech scale, and beech trees had been dying for several years prior to the discovery. The method of scale introduction into this area is unknown.

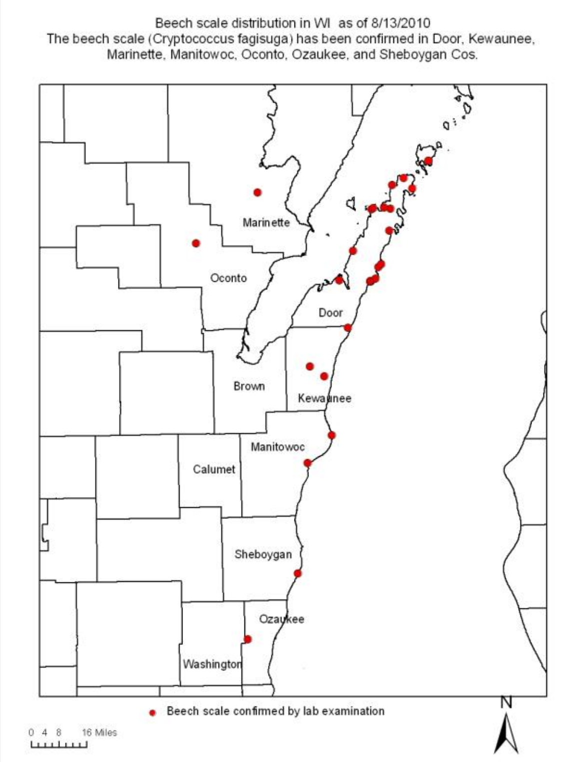


Figure 23. Known distribution of beech scale. Map by Kyoko Scanlon.

Figure 24. Premature color change (September) and mortality caused by beech scale. Photo by Bill McNee

Surveys to determine the distribution of beech scale and beech bark disease have continued since the initial detection. Surveyors looked for characteristic white, woolly wax on the bark of beech trees and the scale species was identified by Phil Pellitteri, UW-Madison Department of Entomology, Extension entomologist. Beech scale has been found in Door, Kewaunee, Manitowoc, Marinette, Oconto, Ozaukee, Sheboygan and Washington counties as of November, 2010 (Figure 23). Scale populations were very low at all sites away from the initial detection area. It is believed that these low populations are recent introductions. Wind and birds are likely dispersing immature beech scales from the Sturgeon Bay detection area, the generally-infested area of western Lower Michigan, and from isolated infestations in the Upper Peninsula of Michigan.

In early September, it was noticed that beech bark disease-impacted trees in Michigan were turning color prematurely because of the additional stress placed on the trees. Based on this observation, an aerial survey was conducted to see which areas of Door County were showing disease impacts. Premature color change was only seen where beech bark disease or high beech scale populations were already known (Figure 24).

As a follow-up to the public notification efforts undertaken in 2009, a public information meeting was held in July, 2010 in Sturgeon Bay for residents of Door County. In addition, the Wisconsin Department of Agriculture, Trade and Consumer Protection has been working with the wood products industry to reduce the risk of spreading beech scale by following best management practices. Training on beech bark disease identification and management was held for DNR and consulting foresters in late 2009 and in late 2010.

In 2010, DNR Forest Health staff produced 3 factsheets and brochures:

- 'Beech Bark Disease - Best Management Practices for Reducing Movement of the Beech Scale'
- 'Homeowner's Guide - How to Detect and Control Beech Bark Disease'
- 'How to Identify the Beech Scale in the Field'

These documents are available online at: http://www.dnr.wi.gov/forestry/FH/bb.htm. Revisions to the DNR silvicultural recommendations for managing beech bark disease are expected to be completed in early 2011.

A small study was conducted in Door County to determine whether beech scale could mature on firewood cut during the winter. In mid-March , two live trees that were heavily infested with live beech scales were cut and split into typical firewood pieces and piled in small piles in either an open, exposed site or a shaded site. During an examination in early June, the scales were nearly gone from the piles in the open site, but were still very abundant on the wood in the shaded site (Figure 25). At the end of the study in August, live adult scales could not be found on the wood in the sunny location, but a few live adult scales could still be found on the wood in the shaded location. At the shaded site, it was estimated that the survival rate of the scales was well below 1%. Young scales ('crawlers') and eggs were not seen in the field or in samples sent to the University of Wisconsin for identification, but could have been present. The survival of adult scales, although poor, suggests that beech firewood should not be moved until the bark has become loose or has fallen off. In addition, movement of this wood should be restricted to between November 15 and July 15, when the scale 'crawlers' are not present.

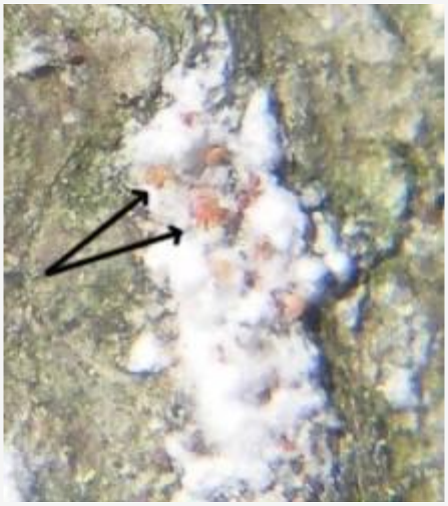


Figure 25. Live beech scales seen in early June on firewood cut in mid-March and piled in a shaded area. Scales are the yellow, orange and red dots inside the scales' wooly wax. Photo by Bill McNee

Beech bark disease results when beech scale colonizes beech trees and makes them susceptible to invasion by fungi, including *Neonectria coccinea* var. *faginata* and/or *Neonectria galligena*. A third species of fungus, *Neoneoctria ochroleuca,* has been found in association with beech bark disease in Pennsylvania, West Virginia and Ontario, Canada. Research has shown that less than 5% of American beech are resistant to the disease and another small percentage are partially resistant. The majority of beech trees are susceptible and will die from beech bark disease. Decay fungi and wood-tunneling insects structurally weaken infected trees, and make them very susceptible to trunk breakage during high winds. Thus, infected trees should be removed from areas where they are a safety hazard.

If beech scale or beech bark disease is suspected on trees, contact a DNR Forest Health specialist. For more information on beech bark disease, visit: http://www.dnr.wi.gov/forestry/FH/bb.htm.

Hemlock Wooly Adelgid - *Adelges tsugae*

Surveying for hemlock wooly adelgid (*Adelges tsugae*) on state, county and privately-owned land was completed in May and June 2010 (Figure 26). Survey sites were chosen with consideration of detecting this insect in areas that were at high risk of introduction - tree nurseries, campgrounds and seasonal homes. At each site, two branches from opposite sides of 30-50 hemlock were examined for the presence of the adelgid's white, wooly egg sacs (Figure 27). If present, the egg sacs would be most easily seen from late fall through early summer. No signs of hemlock wooly adelgid were found in 2010. For more information on hemlock wooly adelgid, visit: http://www.dnr.wi.gov/forestry/FH/hwa.htm.

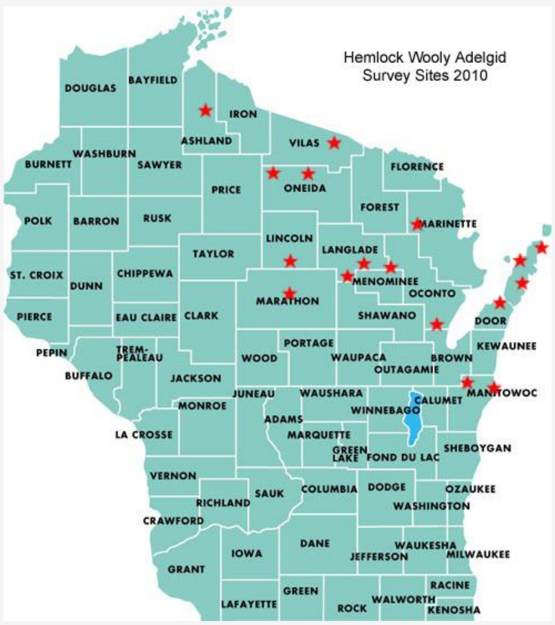


Figure 26. Hemlock wooly adelgid survey sites. Map by Bill McNee.

Figure 27. Hemlock wooly adelgid egg sacs in the eastern U.S. Photo by Linda Williams.

Invasive Plants and Earthworms

Best Management Practices (BMPs)

With the completion of the four tracks of Best Management Practices for Invasive Species, which include: Forestry BMPs, Recreation BMPs, Urban Forestry BMPs, and Transportation and Utility Corridor BMPs, outreach has become the main focus. Many training sessions were developed to focus specifically on the Forestry BMPs. Many more talks were given throughout the year for all the tracks to dozens of audiences with great success. All four tracks are finalized and can be found at: http://dnr.wi.gov/forestry/Usesof/bmp/

NR40- Invasive species identification, classification and control

Since the adoption of administrative rule, NR40, education has been the focal point and as mentioned above, personnel spoke at many conferences and conducted trainings across the state. Educational materials and resources are currently being developed by DNR staff and will be available in 2011 to educate citizens and stakeholders about the rule. For additional information about NR40, go to http://dnr.wi.gov/invasives/classification/

Outreach and education

As stated above, 2010 presented the opportunity to hit the streets and provide many people across the state with a better understanding of invasive plant issues. The obvious marriage of the BMPs and NR40, with the common goal of prevention, has made the outreach effort more effective and efficient. However, prevention is not possible without some level of understanding the impacts of invasive plants and the ability to identify them.

Field guide

"A Field Guide to Terrestrial Invasive Plants in Wisconsin" was developed by DNR staff to assist in identification (Figure 28). The guide also includes basic information for controlling invasive plants. In addition, several other handouts were developed for general audiences to assist in the identification of invasive plants. (Figure 29)

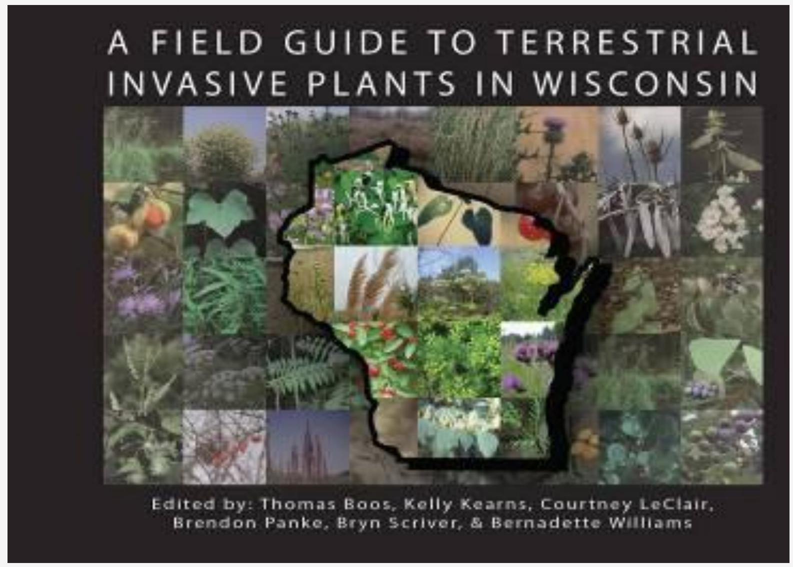


Figure 28. A "Field Guide to Terrestrial Invasive Plants in Wisconsin" was developed by staff to assist in identification.

Wisconsin State fair

Invasive plants, insects and diseases were the focus of several displays at the State Fair, which reaches many 1,000s of people.

Website revisions and updates

Many DNR staff have been working to enhance the DNR website with accurate and consistent information on invasive plants. It is recognized that the DNR website is a strong and effective education tool. Ongoing website revisions and updates are also occurring for the NR40 site and the herbicide use site.

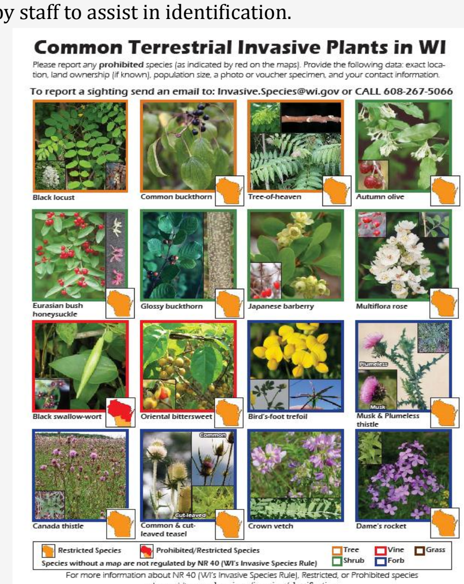


Figure 29. Example of guide to identification of terrestrial invasive plants.

Suppression

Funds were received from the USDA Forest Service for control and suppression of invasive plants that threaten forests. The funding allowed us to continue the effort of controlling plants that are detected early (before they become widely established) and those plants that impact high quality sites. These treatments are critical for slowing the spread of highly invasive species.

State forests invasive plant management plans

The Invasive Plant Management Plans that were written for each of the Northern State Forests have been functioning as intended. The plans are being used as a means to prioritize the control efforts based on the proximity of infestations to high quality natural areas, limitations to tree regeneration, and level of distribution. Along with site visits and outreach efforts, the state forests are able to have a better foothold on invasive plants. Plans have been developed for several of the southern state forest properties.

Earthworms

Non-native worms that invade forests are found throughout the northeast and Midwest regions of the United States; they are easily spotted by the lack of leaf litter, and often by the presence of invasive plants. In deciduous forests, dead leaves falling to the forest floor decay slowly, so that a layer of slightly, to partially, or mostly decayed leaf material builds up on the surface of the soil. This layer plays a crucial role in the forest. Its loose, spongy surface stores moisture, supplies nutrients for native plants, and provides an ideal environment for seeds to germinate. This layer also supports a diversity of other soil organisms, which in turn provide food for invertebrates and vertebrates alike. Non-native worms have been transported to the United States through all types of commerce and activities that move soil. Worms may travel on horticultural plants and garden plants, in dirt on the wheels of vehicles, the tread of shoes and of course through use as fishing bait. While there is no way of ridding the forests of worms once they are established, they can be kept from spreading to forests that are free of the invaders. DNR staff are setting up worm survey sites throughout Wisconsin to observe the level of worm establishment in hardwood stands as well as documenting soil types, proximity to water, and presence of invasive plants to help determine if there are native species that may act as a barrier to slow the spread of worms.

Hardwood Health Issues

New Oak Wilt Detections

Oak wilt confirmed in Oneida County

Oak wilt was discovered for the first time in Oneida County (Figure 1) in July, 2010 on a single northern red oak. Laboratory confirmation of the fungal cause of oak wilt, *Ceratocystis fagacearum*, occurred in August. The infected tree is about four miles southeast of Eagle River and three miles west of the Chequamegon-Nicolet National Forest.

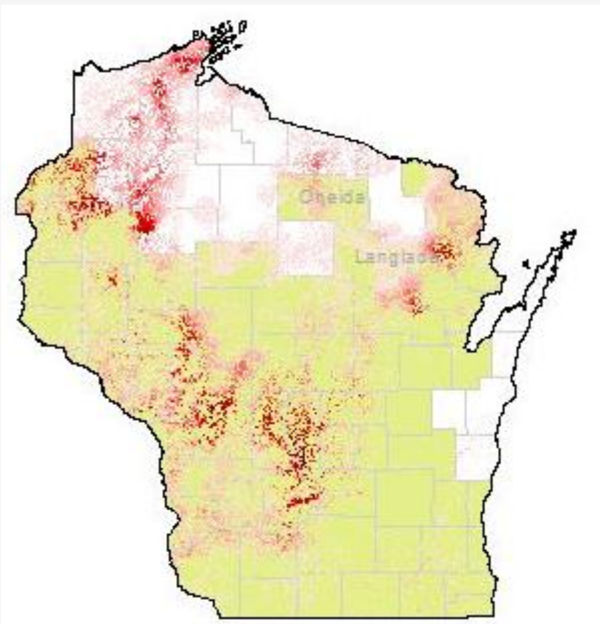


Figure 1. Counties where oak wilt has been confirmed (green). Red shading illustrates basal area of oak. Map by Sally Dahir.

The property owner first alerted USDA Forest Service personnel that her oak was wilting in mid-July (Figure 2). In late July, 50% of the tree's crown was wilted, and over the following 17 days, the tree lost essentially all its leaves. The oak was pruned in May, which likely provided the infection court for the oak wilt pathogen.

Figure 2. Brown, green, and bicolored oak leaves falling in mid-July from an oak tree infected with oak wilt. Photo by Brian Schwingle

All the roads within ½ mile of the infected oak, and roads up to three miles away, were used to survey all dead and dying oaks. No oaks were found that wilted in 2010. However, two oaks, one 100 yards away from the infected oak, and another 300 yards away, may have died from oak wilt in 2008 or 2009. Unfortunately, the wood of these oaks was decayed and unsuitable for *C. fagacearum* isolation, and there were no indications of mycelial mats that had formed on the bark. Oaks surrounding these two dead oaks will be monitored over the next two years to ensure no disease is potentially passed on to neighboring oaks. Besides these two oaks, the survey revealed four areas, totaling 180 acres, where over 50% of the oaks had light to moderate dieback, presumably from stress instigated by several years of forest tent caterpillar defoliation followed by several years of drought. An additional 50 oaks were identified in the survey that had died in the last two years. Signs of two-lined chestnut borer were found on some of these dead oaks, and none of the surrounding living oaks showed signs of wilt. These 50 oaks will also be monitored over the next two years to ensure they pass no potential oak wilt onto their neighboring oaks.

The owner of the oak wilt-infected tree plans on removing the oak in the winter of 2010-2011 and destroying the material to reduce the risk of overland spread. There are 11 oaks that are likely root-grafted to the infected oak on adjacent property. The owners of those 11 oaks plan on severing the roots between them and an additional eight oaks. They will monitor the 11 oaks that are root grafted over the next several years and hopefully remove/destroy them before the April following potential wilt.

This first discovery of oak wilt near the Northern Highland American Legion State Forest threatens approximately 15,000 acres of oak forest and 14,500 acres of northern hardwood forest (i.e. the northern red oak component) on that property. Forest managers in Vilas, Oneida, and Forest counties should restrict harvesting in oak forests from April 15 to July 15 to avoid potential overland oak wilt introduction into those forests.

Second oak wilt center found in Langlade County

Oak wilt was first confirmed in Langlade County in 2008 in the southeastern corner of the county. A second oak wilt location was confirmed in the county in 2010. This spot is in the central part of the county on Langlade County Forest land, 4.25 miles southwest of Pearson, in the eastern part of Upham Township.

In this recently discovered oak wilt-positive stand, two northern red oaks died from oak wilt this year, and four adjacent oaks died, presumably from oak wilt, in either 2008 or 2009. The infected oaks will be cut and destroyed before next April to prevent overland spread. There are several oaks that are root grafted to the infected oaks, so root graft disruption must happen to prevent this oak wilt pocket from enlarging. Unfortunately, it will not be possible to sever root grafts with a trencher or vibratory plow, so stumps will have to be removed with an excavator or root grafts will have to be killed with herbicides, which is currently an experimental control tactic.

This new discovery of oak wilt in central Langlade County substantially increases the risk of overland transmission of this disease to nearby Lincoln, Oneida, Forest, and Marathon counties.

Oak Wilt Regeneration Study: 2010 Update

During the summer of 2007, permanent plots were established in 10 recently harvested oak stands in central Wisconsin (Figure 3). Plot setup is described in a previous report (Forest health highlights of Wisconsin 2008).

The primary objective of the long-term study is to compare the survival of oak stump sprouts and oak seedlings between plots that had been established in oak wilt centers and plots in non-diseased areas. The plots have been examined annually since establishment and the number of sprouts, saplings and seedlings recorded. The study will be conducted over a 12-year period. This year marks the third year of remeasurement.

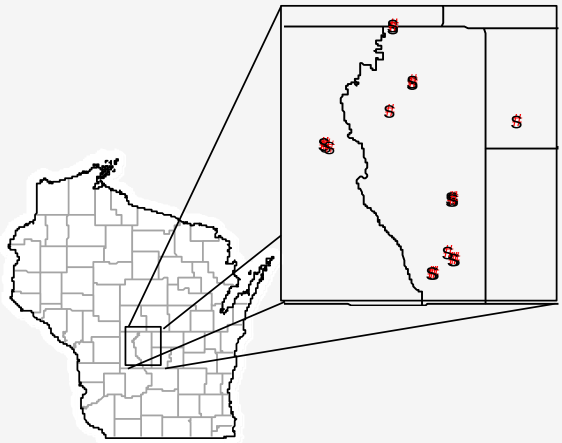


Figure 3. Location of ten permanent plots monitoring oak regeneration on oak wilt sites.

2010 Results

Seedling numbers

There were far more red oak seedlings per acre than white oak (Figure 4). The difference in seedlings per acre between control and oak wilt pockets was not significant for either red or white oak.

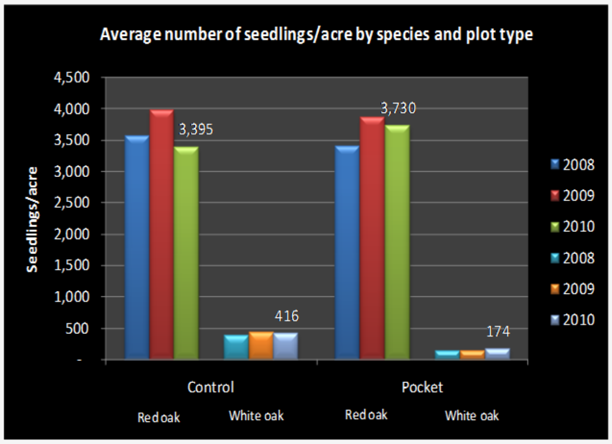


Figure 4. The average number of red oak seedlings per acre in oak wilt pockets and control sites.

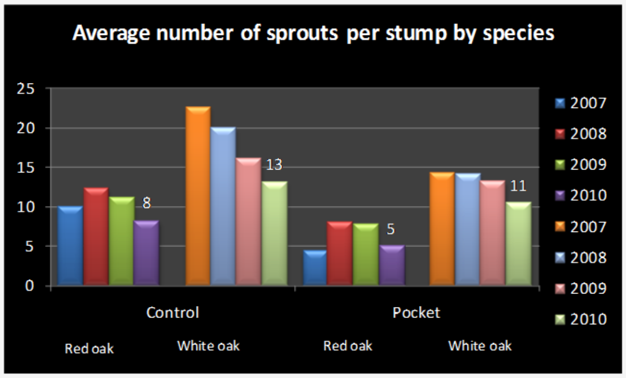


Figure 6. Average number of sprouts per stump by species in oak wilt pockets and control sites.

Sprout numbers

This year some of the stumps in the oak wilt centers showed significant sprout mortality (Figure 5). The average number of red oak sprouts per stump was 8.2 in the control plots and 5.0 in the oak wilt pockets (Figure 6). This difference is significant at $p = 0.01$. Since 2009, the average number of red oak sprouts per stump has decreased by 0.2 on the control plots and by 0.32 in the pockets. For white oak, there were more sprouts in the control plots compared to the disease centers but this difference was not significant ($p=0.64$)

Figure 5. Left. Red oak stumps in disease plot with dead and dying sprouts. Right. Healthy red oak stumps on control plot. Photos by Sally Dahir

Field Studies to Evaluate the Risk of Overland Spread of Oak Wilt

July 15 – October 15, 2006 to 2009

Introduction

Oak wilt, a disease that affects the vascular system of susceptible oak species, is caused by the fungus *Ceratocystis fagacearum.* The two most common dispersal pathways for the fungus are below ground through inter-tree vascular connections provided by root grafting and overland via insect vectors which move the fungus between infected and freshly wounded healthy trees. Prevention of pathogen introduction through overland spread is best achieved by pruning and cutting oak in late fall and winter during the dormancy period of vectors. Risk of overland infection 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 observed, though not quantified, risk of infection when cutting and pruning oak in the summer and early fall. The objective of this study was to determine the relative risk of overland oak wilt infection associated with cutting oak from July 15 to October 15.

Methods

Site Selection

Stands in central Wisconsin (Adams, Clark, Jackson, Waupaca, and Wood counties) were selected. Topography in this region is generally flat to slightly rolling. To control for effects of topographic heterogeneity, only the stands with slopes less than 20% were selected. Twelve stands greater than 10 acres in size were selected for the study. Four sites were located in areas where oak wilt was already confirmed. Two of the four sites were thinned during 7/15-10/15, and the other two sites were monitored as control (non-thinned). Additionally, eight sites were selected in areas where oak wilt didn't appear to be present. Five sites were thinned between July 15 and October 15 and three sites were used as controls (non-thinned). Plot setup was conducted in 2006 and 2007.

Field Sampling

The size and shape of the sites were evaluated using aerial photos in Arc GIS prior to field visits. Prior to the cutting, basal area and soil characteristics were recorded for each study site. Additionally, a survey of all northern red oak (*Quercus rubra*) and black oak (*Quercus velutina*) was conducted to determine the presence and distribution of oak wilt in the study site. Oak wilt-positive trees were identified, numbered, and marked with tree paint. The diameter at breast height (DBH) of each infested tree and GPS coordinates were also recorded. Data from this portion of the study were used to assess the extent of infection in oak wilt-positive stands prior to cutting. Oak basal area and soil data were used to determine if root grafting and below ground fungal movement were likely between trees.

Following cutting, all sites were surveyed for two years to determine the presence and distribution of oak wilt. When a newly wilting or recently killed tree was observed, the distance between the closest oak wilt-positive tree prior to cutting and the newly identified tree was measured. A minimum inter-tree distance table, based on Bruhn's best fit model (Bruhn and Heyd, 1992), was used to determine whether the newly wilting tree or recently killed tree was most likely infected with the pathogen through root graft or through overland infection. This decision is based on the diameters of two trees, distance between them, and soil type. If the newly identified tree was outside of the root graft distance, a wood wedge sample was collected and tested for oak wilt. Wood chips were cultured aseptically on acid-PDA agar medium to detect the growth of *C. fagacearum*.

All of the collected wood samples were separated into two sets. One set was sent to the University of Wisconsin Extension, Plant Disease Diagnostics Clinic (UW EX PDDC), and the other set was used for culturing in the WI Dept of Natural Resources, Division of Forestry, Forest Health Protection Lab (WI DNR FHP). Data were analyzed to look for correlations between the cutting period and new oak wilt infection in oak wilt-positive and oak wilt-negative stands.

Results

The locations of each plot and the results of the observations are shown in Table 1. Although many newly wilted trees were found after thinning, the lab testing found that none of the trees outside of the root graft distance were positive for oak wilt. The lab results between the UW EX PDDC and WI DNR FHP were consistent. Many trees showing oak wilt-like symptoms had been attacked by the two-lined chestnut borer, (*Agrilus bilineatus*).

Conclusions

The study showed no evidence that the pathogen *Ceratocystis fagacearum* initiated infection as a result of harvest activities from July 15 to October 15. However, the data from this study should not be used to give blanket permission to conduct oak cutting in forests after July 15. There are many variables that affect the risk level of oak wilt overland introduction. These variables include natural phenomena (storms, hail, etc), harvest level, and different inoculum levels. For example, more than half of the sites were in Clark County where oak wilt distribution appears to be localized. Attempts to adapt observations in one localized area to other areas when inoculum level or intensity of oak wilt distribution varies significantly could be misleading. Thus, use of the risk assessment guidelines will continue to be recommended when deciding if oak cutting should be conducted during the July 15 to October 15 time period. The risk assessment guidelines provide relative risk of introduction, impact, and combined risk of oak wilt based on time of year of harvesting, pre-harvest basal area of oak, terrain and soil type. Currently there is no restriction on cutting after July 15 in the new WI DNR oak harvest guidelines for the forest setting. The results of this study will not change the recommendations of the guidelines.

Future Plans

A possible new project was suggested by Dr. Jenny Juzwik, research plant pathologist, USDA Forest Service, as a follow-up to this study. The project would further address questions about the risk of harvesting between July 15 and October 15. In the proposed study, after harvesting oak trees, a wood cookie would be placed on a stump to create dark crevices where oak wilt-vectoring beetles can hide. Two weeks after the harvest, beetles would be collected and tested for contamination with *C. fagacearum* spores. When fungus-positive beetles are found on a particular stump, attempts would be made to isolate the pathogen from that stump.

Literature cited

Bruhn, J.N., and Heyd, R.L., 1992. Biology and control of oak wilt in Michigan red oak stands. Northern Journal of Applied Forestry 9(2): 47-51.

Table 1. Study plots and final results

Stand No.	Type	County	Pre-Thinning Oak wilt	Thinning periods	Field observations & lab test results 2007 - 2009	Final Results
1	Harvest	Clark	Negative	Thinned - 7/16-8/12/06	12 newly wilting trees were tested negative in 2007. 21 samples taken and tested negative in 2008	OW[2] NOT confirmed
2	Harvest	Clark	Negative	Thinned - 8/29-9/15/06	2 newly wilting trees, sampled and tested negative in 2007. Couldn't access the site in 2008 because roads were too muddy. Re-visited in July 09. Scattered mortality due to TLCB. No tree suspicious of OW.	OW NOT confirmed
3	Harvest	Jackson	Negative	Thinned – 7/15-8/15/06	No new mortality in 2007 and 2008.	OW NOT confirmed
4	Control	Clark	Negative	Not thinned	No new mortality in 2007 and 2008.	OW NOT confirmed
5	Control	Clark	Negative	Not thinned	No new mortality in 2007 and 2008.	OW NOT confirmed
6	Control	Clark	Negative	Not thinned	No new mortality in 2007. 4 dead red oak trees in a cluster, tested negative.	OW NOT confirmed
7	Harvest	Adams	Positive	Thinned - 9/1 - 9/15/07	3 large pockets to be coalesced. No new mortality in 2008. Two newly dead trees in 2009. One was within grafting distance; the other was already too dry. No sample taken.	OW NOT confirmed
8	Harvest	Wood	Positive	Thinned – 8/15 to 9/10/07	3 dead trees within grafting distance, no sample taken. Visited in July 09. No new mortality.	All OW within grafting distance
9	Harvest	Clark	Negative	Thinned - 8/1 to 8/15/07	No new mortality in 2008. 6 trees left in the plot, mostly clearcut. No new mortality in 2009.	OW NOT confirmed
10	Harvest	Clark	Negative	Thinned - 7/15 to 7/30/07	Many dead trees, 5 samples taken, tested all negative in 2008. Visited July 09. Some newly dead trees. Two samples were taken. Lab results were negative.	OW NOT confirmed
11	Control	Waupaca	Positive	Not thinned	No new mortality in 2008. Samples were taken from 3 trees that were recently killed or dying in 2009. Lab results were negative.	OW NOT confirmed
12	Control	Adams	Positive	Not thinned	All newly dead were within grafting distance in 2008. Samples were taken from 3 trees that were recently killed or dying in 2009. Lab results were negative.	OW NOT confirmed

[2] OW is an abbreviation of Oak Wilt

Anthracnose – Several Fungi

Figure 7. Symptoms of anthracnose on ash. Photo by Mark Guthmiller

Cool, wet spring and early summer weather was favorable for a number of fungi (*Gnomoniella fraxini, Venturia acerina, Gloeospourium* spp.) that cause spots on the leaves of hardwoods. Anthracnose was very common this year and was widely reported from southern, west-central and northeast Wisconsin. Leaf spots were reported occurring on maple, oak and ash (Figure 7); these spots were sometimes more common on the lower portion of the crown. Early symptoms included black or brown spots on leaves but as the disease progressed, additional spots formed and in some cases coalesced, causing whole leaves to curl and die. Premature defoliation was also observed. The production of new leaves was noted on some severely affected trees.

Oak defoliation – suspected to be caused by June beetles

Figure 8. Defoliated oak in Portage County. Photo by Linda Williams

Figure 9. Adult June beetles feeding on oak leaves. Photo bv Linda Williams

Oak was defoliated at a site in eastern Portage County (Figure 8). Red oak was preferred over white oak, and other species in this mixed hardwood stand were not defoliated at all. The oaks in this stand had been defoliated quite rapidly, and experienced a similar defoliation last year. It is suspected that adult June beetles were to blame. No insects or diseases could be found during the site visit but the rapid defoliation, timing of defoliation, preference for red oak, lack of feeding on anything else, and lack of signs of any other insects or diseases, supports the possibility of feeding by adult June beetles. Adult June beetles emerge after dark on warm spring nights, feed during the night (Figure 9). The beetles then burrow into the soil and leaf litter before dawn, spending the day hidden. This forest was next to a cattle pasture heavy to sod which is a favorite place for June beetles to lay their eggs and for the white grubs to complete development.

Ash Yellows – Phytoplasma

Figure 10. Brooms at base of ash infected with ash yellows. Photo by Kyoko Scanlon

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 on the stem or at the base of the tree (Figure 10). Mortality of infected white ash in the forest setting has been observed.

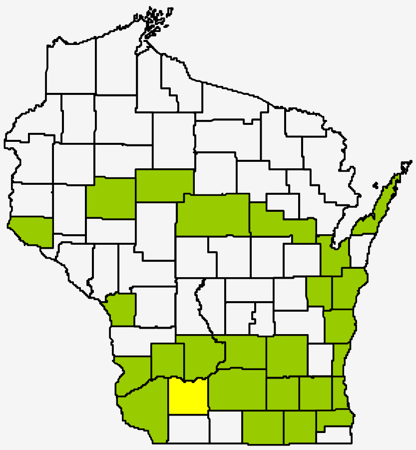


Figure 11. Counties where ash yellows has been confirmed. Iowa County (yellow) was confirmed in 2010.

In 2010, ash yellows was confirmed in Iowa County (Figure 11) for the first time based on the presence of witches' brooms and a genetic test that was performed by Dr. Glen Stanosz, University of Wisconsin Department of Plant Pathology. The stand in Iowa County had a high component of white ash (60-70%) and was experiencing mortality of ash. The majority of ash in the stand were harvested in the summer of 2009, including dead, dying and apparently healthy trees. By the summer of 2010, brooms were prominent on many of the stumps. Plant samples were taken from brooms on stumps to confirm ash yellows. Ash yellows has now been confirmed in 26 counties.

Columbian Timber Beetle - *Corthylus columbianus*

Extensive staining in silver maple

Some silver maple stands in the Northeast region have been affected by significant staining which was caused by Columbian Timber Beetle (*Corthylus columbianus*) (preliminary identification). This staining causes logs to be reduced in grade.

Columbian Timber Beetle does not kill the tree or weaken it, but does cause staining (Figure 12). Any new wood put on after an attack will be clear wood, although the staining caused by beetle attack will remain in the tree.

Figure 12. Characteristic staining of wood caused by Columbian timber beetles. Photo by Linda Williams

A site visit was conducted in June, 2010, to try to determine how to easily identify when a stand is affected by this insect which causes significant staining. After trying several methods, it was found that the only reliable method was to cut down a small tree and check both a horizontal section and a vertical section to look for the characteristic staining (Figure 13). Insect samples were sent to Phil Pellitteri, UW Extension Entomologist, and were identified as Beech Timber Beetle.

Our hypothesis is that both the Beech Timber Beetle and Columbian Timber Beetle were present in the stand and that timing is important when collecting samples. The staining patterns match Columbian Timber Beetle activity as opposed to Beech Timber Beetle, which causes a lesser amount of staining.

A follow-up site visit with Phil Pellitteri is being planned to further examine this problem, which has only recently (four-five years) been reported as causing significant levels of staining. Previous reports indicated only a minor staining impact.

Figure 13. A horizontal section is checked for characteristic staining caused by the Columbian Timber Beetle. Photos by Linda Williams

Hickory Mortality - 100 Canker Disease – *Ceratocystis smalleyi and Scolytus quadrispinosus*

Dieback and mortality of bitternut and shagbark hickory have been observed scattered throughout Wisconsin during the last five years. Iowa, Indiana, Minnesota, New York and Ohio have also reported this issue. Symptoms include dieback, wilting or browning of leaves and mortality two-three years after initial appearance of symptoms. Dr. Jennifer Juzwik, research scientist with the USDA Forest Service recently confirmed the fungal pathogen, *Ceratocystis smalleyi* as being a virulent pathogen and causing small cankers on affected trees. The cankers reduce sap flow, causing a limited vascular wilt. Both the hickory bark beetle and *C. smalleyi* are currently associated with hickory mortality although hickory bark beetles are not always associated with *C. smalleyi* and vice versa.
For more information, visit http://www.nrs.fs.fed.us/pubs/jrnl/2010/nrs_2010_park_001.pdf

Aspen Blotchminer - *Phyllonorycter apparella*

While northern Wisconsin's aspen stands escaped the onslaught of forest tent caterpillars in 2010, they were not so lucky concerning damage from the aspen blotchminer in mid to late summer (Figure 14). Aspen stands north of U.S. Highway 8 from the St. Croix to the Pelican River, and down into Lincoln County, exhibited moderate to heavy damage from tiny aspen blotchminer caterpillars. The initial symptom was small pale green blotches appearing on aspen leaves. As the larval feeding continued between the upper and lower epidermis, the blotches enlarged, coalesced and faded to brown (Figure 15). The tiny moths appear to be weak flyers as the damage is usually confined to the bottom 30 feet of the crowns. The ultimate appearance of aspen trees suffering heavy damage involves a two toned crown – green on top and nasty, grungy brown below. Even in the lower crown new leaves out on branch tips will be green as they were grown by the tree after the moths finished laying their eggs. Because the feeding is heaviest along stand edges and in the bottom ½ to ⅔ of the crown, the trees rarely suffer any significant damage.

Figure 15. An aspen leaf infested with aspen blotchminers. Photo by Brian Schwingle

Figure 14. Cutting open an aspen leaf blotch in mid-July reveals a small caterpillar or darker colored pupa. Photo by Brian Schwingle

Alder Flea Beetle – *Macrohaltica ambiens*

Figure 16. Extensive feeding damage by alder flea beetle larvae. Photo by Brian Schwingle

Pockets of severe defoliation of tag alder were scattered across northern Wisconsin from Washburn County to Langlade County in 2010. The culprit was the alder flea beetle, which skeletonizes the upper and lower leaf surfaces of this common lowland shrubbery (Figure 16).

Figure 17. Alder flea beetle larva. Photo by Brian Schwingle

Both the black larvae and the cobalt blue adults of this native Chrysomelid beetle feed on alder leaves (Figure 17). As their feeding progresses the leaves turn brown and curl up. Although very few people (other than avid woodcock hunters) care much about tag alder, Shane Weber did receive his first complaint about this damage - in his 30 years with DNR. The alders will recover from this feeding.

Introduced Basswood Thrips - *Thrips calcaratus*

This exotic insect affected approximately 7,000 acres in northwest Wisconsin in the spring of 2010 (Figure 18). Developing leaves are injured by feeding before and during bud break in the spring. Affected leaves will emerge with many holes and may curl up and die rapidly. Most of the defoliation was moderate to heavy, affecting more than 50% of the foliage on individual trees. In Polk County, defoliation levels were light (less than 50% of the

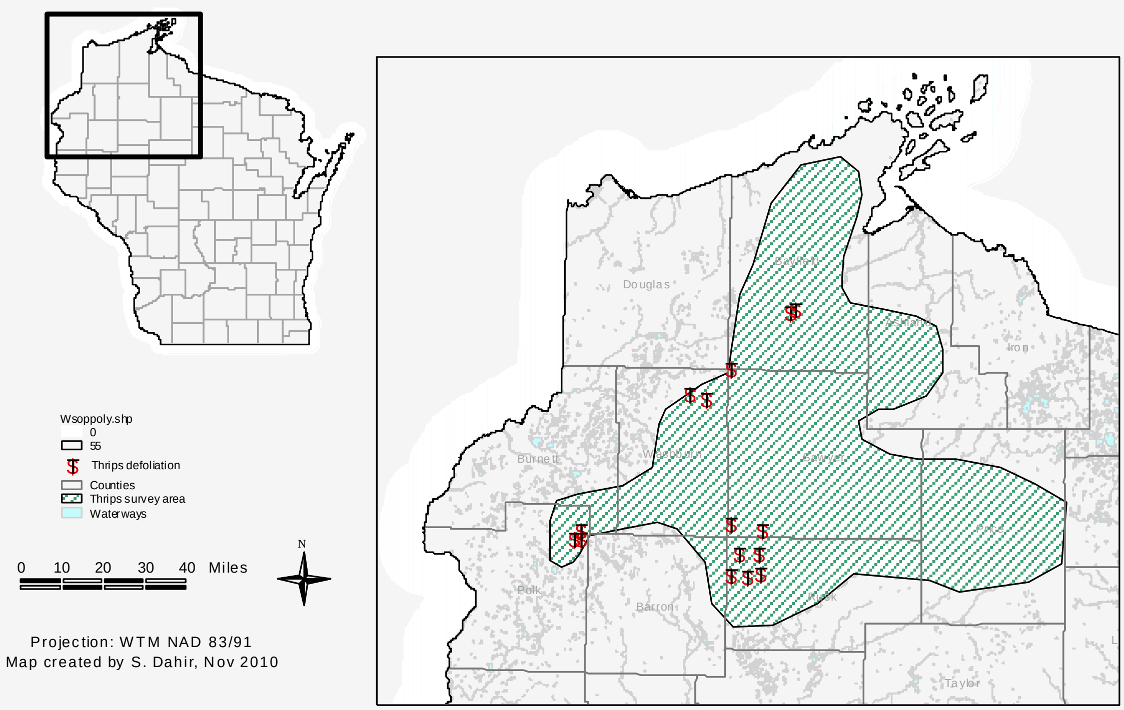


Figure 18. Defoliation caused by introduced basswood thrips.

foliage affected). The injury caused by this insect will minimally impact the health of the basswood in 2010. It is too early to predict if this is the beginning of an outbreak of introduced basswood thrips. Research has shown that repeated defoliation can lead to growth loss.

Fall Cankerworm - *Alsophila pometaria*

Fall cankerworm caused heavy defoliation of about 40 acres of box elder in Dane County, near Oregon, in May 2010 (Figure 19). Fall cankerworm has a very closely synchronized hatch (most eggs hatch about the same time) and apparently a synchronized pupation period as well. By the time damage was observed at this location, the caterpillar phase was over. The larvae burrow into the soil to pupate leaving little evidence of their presence, except for a few shed larval skins attached to leaves (Figure 19, center) For more information on cankerworms visit: http://learningstore.uwex.edu/assets/pdfs/A3178.pdf

Figure 19. Left. Low area with boxelder defoliated by fall cankerworm. Center. Shed skin of fall cankerworm. Right. Fall cankerworm on oak. Photos by Mark Guthmiller

Eastern Tent Caterpillar – *Malacosoma americanum*

The eastern tent caterpillar (Figure 20), a common native insect defoliating species in the genera of *Prunus* and *Malus*, was widespread in northeast, northwest and southern Wisconsin. Although this insect favors these hosts, they may also feed on other deciduous trees.

Eastern tent caterpillar is found every year but occasionally its population increases and the characteristic "tents" are very common (Figure 21). Counties where tents were very common included Columbia, Dane, Green Lake, Iowa, Marquette, Sauk, Waupaca, Waushara and most counties in northwest Wisconsin. This is the second year in a row this insect's population was at this higher level.

Tents are formed by the larval stage and are most often created at a branch union. Since feeding occurs early in the growing season, injury to the tree is mitigated through production of new foliage.

Figure 20. Eastern tent caterpillar larva. Photo by Mark Guthmiller

Figure 21. Eastern tent caterpillar tents. Photo by Mark Guthmiller

The production of new leaves will stress trees so if additional stressors such as drought or subsequent defoliation later in the season occur, dieback could be observed.

Forest Tent caterpillar – *Malacosoma disstria*

Forest tent caterpillar severely defoliated a number of forested areas in Waupaca County east of the city of Waupaca. This defoliation looks nearly identical to gypsy moth defoliation which was present in many areas of the state. Other areas affected by forest tent caterpillar are outlined in the following report.

Forest defoliator complex - several species of defoliators

Figure 22. Forest tent caterpillar.
Photo by Mark Guthmiller

In the spring and early summer of 2010, several species of tree-defoliating insects (forest tent caterpillar, gypsy moth, elm spanworm and eastern tent caterpillar) affected hardwoods in portions of the Baraboo range in eastern Sauk and western Columbia counties. An estimated 5,000 acres of aspen, oak, and other hardwoods were defoliated over a 10,000 acre area by this insect complex. (Figure 23 A-D) The primary defoliator of oak and aspen in this area was the forest tent caterpillar, *Malacosoma disstria* (Figure 22). Gypsy moth, *Lymantria dispar,* was also present in lower numbers in this area and caused moderate defoliation in other parts of the Baraboo range. A small area in northwestern Dane County also had defoliation by both forest tent caterpillar and gypsy moth. *Entomophaga maimaiga* and the NPV virus caused a collapse of the gypsy moth population in the late instar phase throughout the Baraboo range.

Several species of spanworm were also present in the Baraboo range. The adult phase of the "fringed looper" (pale beauty), *Campaea perlata* were present at one location. There also were high numbers of elm spanworm caterpillars, *Ennomos subsignari,* in many parts of the Baraboo range. Elm spanworms were causing moderate defoliation primarily to maples, ironwood, and ash. They feed on a number of tree species including ash, birch, elm, hickory, ironwood, maple, oak, and poplar. Elm spanworm caterpillars have two color phases (yellow-green to brown). The dark phase larvae are apparently more common during population outbreaks. Eastern tent caterpillars, *Malacosoma americanum,* were present in some areas affected by the other defoliators but caused minimal impacts.

For more information on forest tent caterpillars, visit:
http://dnr.wi.gov/forestry/FH/FTC/

For more information on spanworms, visit:
http://ento.psu.edu/extension/factsheets/elm-spanworm

For information on identification of gypsy moth, eastern tent caterpillar, and forest tent caterpillar, visit:
http://web2.msue.msu.edu/bulletins/Bulletin/PDF/E2299.pdf

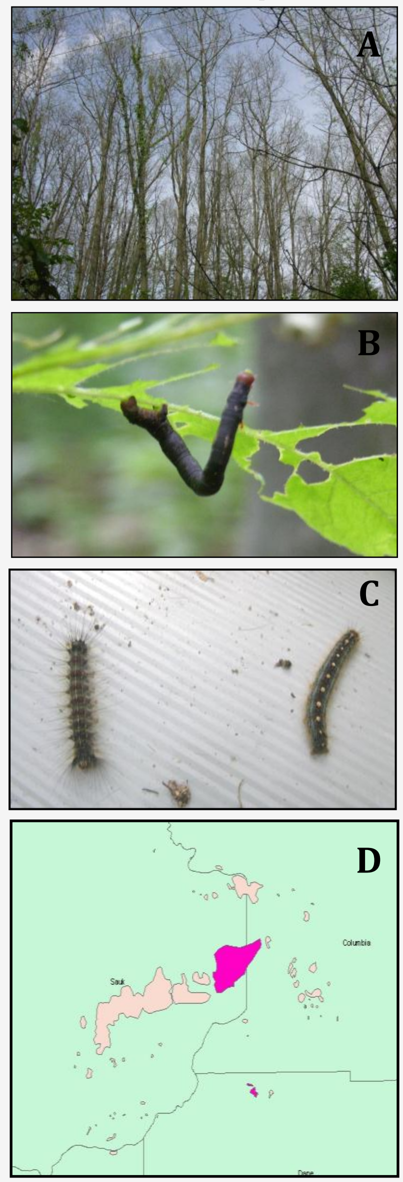


Figure 23 A : An estimated 5,000 acres in a 10,000 acre area suffered heavy defoliation by Forest tent caterpillar, and to a lesser degree gypsy moth and spanworm.
B: Dark phase of elm spanworm. C. Gypsy moth (left) and forest tent caterpillar (right) side by side.
D: Pink: Primarily Forest Tent Caterpillar – caused defoliation Salmon: Primarily Gypsy Moth-caused defoliation. Elm spanworm was present in portions of both of these areas. Photos and map by Mark Guthmiller

Butternut Project Update 2010

The year 2010 represented the 16th year of the butternut project in Menominee County. Plot design and location are described in detail in previous reports (Wisconsin Forest Health Protection Annual Report). The hypothesis being tested is whether growth rate and survival to reproductive age are affected by site fertility, which is represented by three habitat type classes (dry, dry mesic and mesic), and light exposure, which is represented by five opening sizes (0.03, 0.25, 0.5, 1.0 and 2.0 acres).

Survival and cankering have been recorded annually since 2004. Height and diameter, on the other hand, have not been remeasured since 2004. In April, we surveyed the plots for height, diameter, survival and cankering. (Figures 24, 25).

Figure 24: Butternuts averaged 31 ft in height on the dry mesic site. Photo by Jane Cummings-Carlson

Height and diameter growth

To date, the study has shown that both average height and diameter are highest on the half acre openings and on the dry mesic habitat type (AQVib(Ha)), (Table 1). There were only seven live trees on the PMV(Q) habitat type with a high degree of variability among tree sizes.

Table 1. Height (mm) and diameter (cm) for butternuts on three site types and five opening sizes- 2010.

	Dry mesic			Mesic			Dry			All sites		
Opening size (acres)	**Ht (cm)**	**Dbh (mm)**	**N**	**Ht (cm)**	**Dbh (mm)**	**N**	**Ht (cm)**	**Dbh (mm)**	**N**	**Ht (cm)**	**Dbh (mm)**	**N**
0.03	87	6	8	284	40	3	.	.	.	141	15	11
0.25	900	93	15	885	111	23	.	.	.	891	104	38
0.5	1072	137	74	943	124	74	.	.	.	1008	131	148
1	842	108	17	739	71	75	428	31	5	741	75	97
2	.	.	.	715	77	85	605	48	2	713	76	87
All openings	**946**	**118**	**114**	**797**	**91**	**260**	**479**	**36**	**7**	**836**	**98**	**381**

Height growth rates

Annual height growth from 1994 to 2009 was highest on the dry mesic (AQVib(Ha)) site and on the 0.25 and 0.5 acre openings. There was no difference between these two gap sizes but they were significantly higher than growth rates in all other openings (Figure 26). Growth rates on the smallest opening (0.03 acre) were very low but not significantly so due to high variance between trees. The dry site had too few trees to analyze

Figure 25. Butternut canker on stem. Photo by Jane Cummings-Carlson

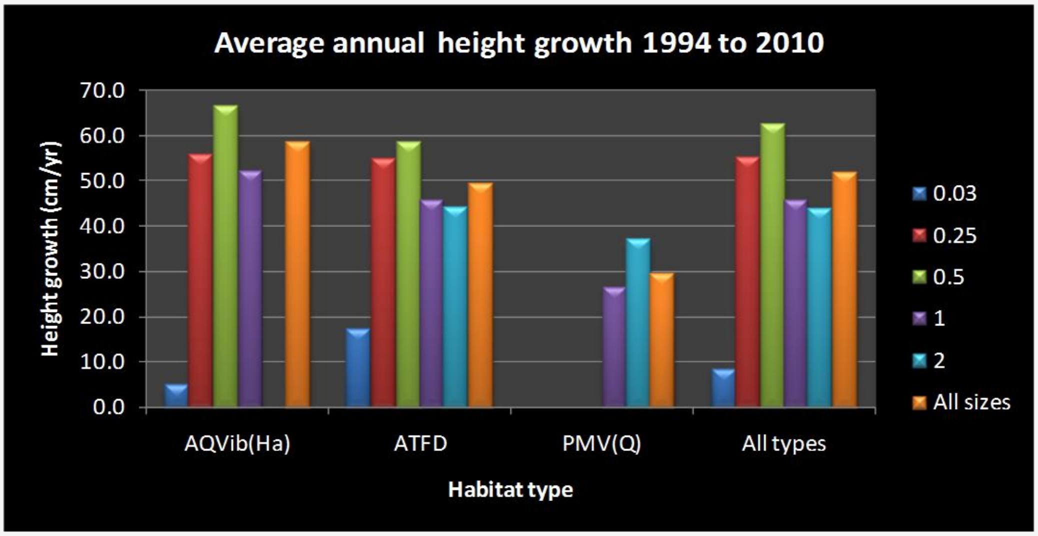
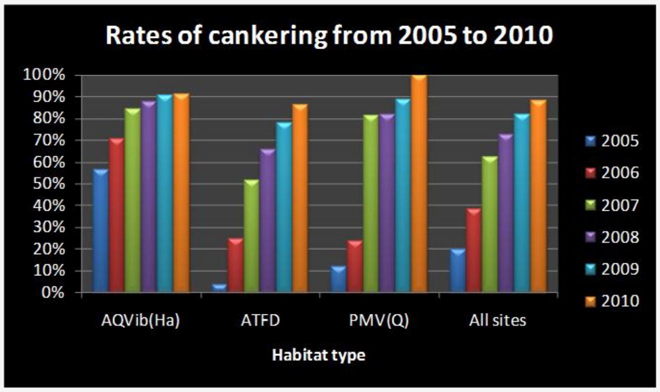


Figure 26. The AQVib(Ha) or dry mesic site and the half acre opening had the highest height growth rates.

Percent cankering

The percentage of live cankered trees has increased dramatically since 2005, especially on the mesic (ATFD) site (Figure 27). Starting at less than 5% in 2005, the percentage of cankered trees on the these plots (87%) is now approximately equal to the dry mesic AQVib(Ha) sites (91%). All of the seven surviving butternuts on the dry (PMV) site are now cankered. This initial discrepancy in canker occurrence may be due to the prevalence of diseased butternuts in the woods surrounding the dry mesic site.

The 0.5 acre and 0.25 acre openings had very similar cankering rates in 2010 (95% and 99%, respectively). Interestingly, rates of cankering are highest in plots where growth rates are also highest.



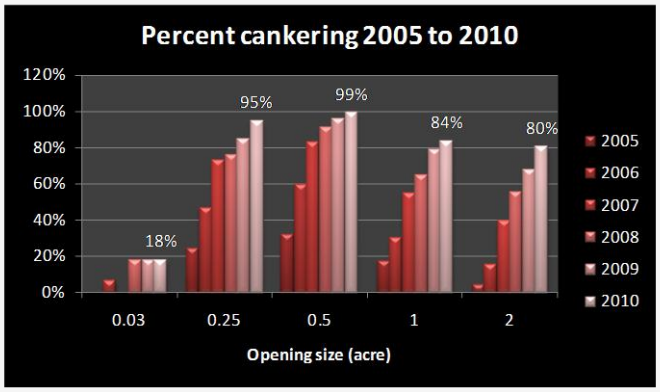
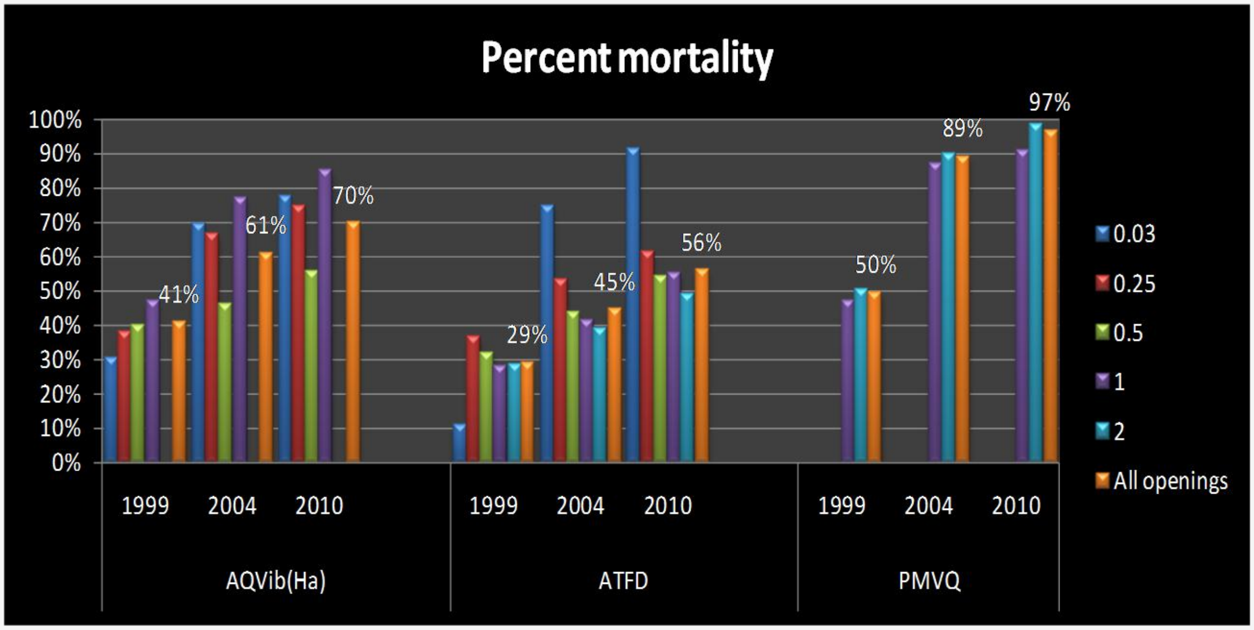


Figure 27 . Percent of live trees that are newly cankered 2005 t o2010 by site type (top graph) and by opening size (bottom graph)

Percent mortality

The more mesic ATFD site had much lower mortality rates for all size openings except the smallest gaps (Figure 28). Mortality rates for all opening sizes are 14% higher on the dry mesic (AQVib(Ha) site. This most likely reflects rates



F igure 28. Percent mortality of butternut on three habitat types and in 5 different sized openings.

of cankering since the dry mesic site had far more cankered trees in 2005 (cankering wasn't measured before 2005) than the mesic (ATFD) site. The dry (PMV(Q)) plots have experienced a 97% mortality rate, which is a doubling since 1999. Site quality is probably too low for good butternut growth on these dry sites. Mortality was lowest on the half acre plots, (55% on all sites) and did not differ between the two habitat types.

In summary, some interesting trends have emerged in 2010. Absolute height growth and diameter growth and growth rates are highest on the dry mesic site and on the 0.5 acre openings. However, these 0.5 acre plots also have the highest rate of cankering (99% compared to 88% for all trees) but the lowest rate of mortality (55% compared to an average 68% for all trees).

Conifer Health Issues

White pine needle loss

Figure 1. Tan foliage on white pine in late May and early June. Photo by Linda Williams

In a number of northern counties this spring it was noticed that some mature white pine had extremely thin crowns. In late May and early June affected trees had off-color foliage that rapidly turned a shade of tan (Figure 1). Those tan needles then dropped, leaving the trees with very sparse foliage resembling the damage caused by pine false webworm.

Closer examination of these trees found no insect or disease issues. The symptoms occurred in all parts of the crowns - being no more common in the lower crown than the upper crown. Symptoms could appear to be worse on certain branches, giving the crown a patchy appearance or the crown could be evenly affected. Affected trees were observed growing immediately next to trees that had full crowns and appeared unaffected (Figure 2).

The symptoms appeared primarily on mature white pine in low areas, although affected trees could be found on a variety of sites. Current year's growth appeared unaffected even in trees that were heavily affected by this problem.

Similar symptoms were observed in southern and western Wisconsin during prolonged periods of drought (late 1980's) but it is not clear if the symptoms observed this year are directly related to drought.

Figure 2. Sparsely needled white pine were seen growing next to trees with healthy crowns. Photos by Linda Williams

Jack Pine Budworm - *Choristoneura pinus pinus*

Northwest Wisconsin

Surveys of this native defoliator of jack pine produced some interesting results. The acres of defoliation dropped from over 4,500 acres in 2009 to under 1,000 acres in 2010 (Figure 3). This was the result of a sizable pocket of defoliation in 2009, west of the Minong Flowage (Washburn and Douglas counties) subsiding and breaking into small pockets of light feeding. However, the budworm population, which had a 19% decline from '09-'10 in the early larval survey, exhibited a 12% increase (2009-10) in the pupal survey. This result was the product of a largely healthy jack pine forest where the trees had an abundance of male flowers providing superb habitat for budworm larvae. The pupal survey (page 49) also revealed numerous pockets of moderate to marginally high budworm populations widely scattered across the sand plains. This population provides considerable difficulties for predicting its fate in 2011. Jack pine forests in all of Polk County and south of State Highway 77 in Burnett and Washburn counties should have significant feeding by jack pine budworm in 2011.

The jack pine budworm population in the rest of northwest Wisconsin's jack pine type, could go in one of three directions: 1) The budworm population continues on the downward trend of the past few years as indicated by the early larval and defoliation surveys. The upward trend in the pupal survey could be a one-year anomaly caused by the excellent larval habitat. The probability of this delightful scenario is roughly 30% as populations are too high to consider this outcome probable. 2) The budworm population remains basically static, producing scattered small spots of light to moderate defoliation imbedded in a sea of healthy green jack pine. The likelihood of this outcome is estimated at 50%. 3) The budworm population follows the rise seen in the pupal survey with the scattered spots of defoliation enlarging, intensifying, and coalescing to produce 20,000+ acres of moderate or heavier defoliation. This outcome is unlikely for two reasons: the 2010 budworm numbers are not quite high enough and we should be several years away from the next major outbreak according to long-range trends. The likelihood of this outcome is estimated at 20% .

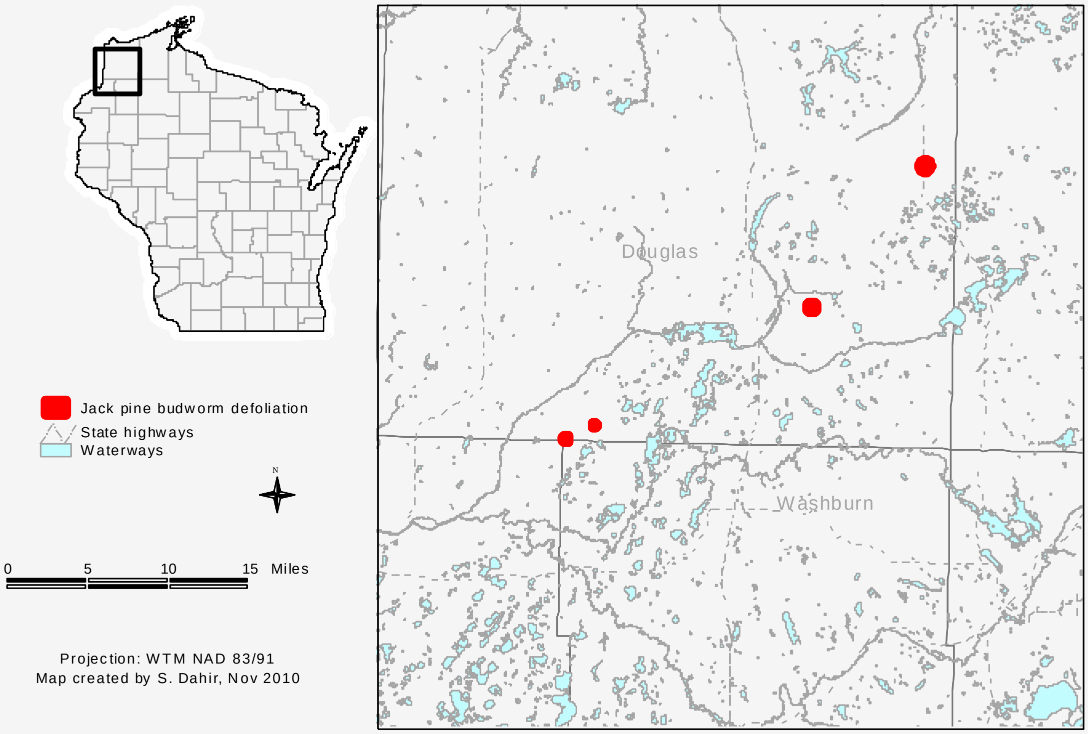


Figure 3. Areas of jack pine in northwest Wisconsin, defoliated by jack pine budworm. Map by Sally Dahir.

West Central Wisconsin

Jack pine budworm larval surveys were conducted in the following counties: Adams, Dunn, Eau Claire, Jackson, Juneau, Monroe, Pierce, Portage, St. Croix and Wood (Figure 4). Budworm populations were building in jack pine stands in Jackson, Juneau, and Monroe counties. There was also one area in Jackson County where the budworm population remained high where there could have been potential for severe damage this year in jack pine, as there was in 2008 - 2009. This area did have light to moderate defoliation, but no new top dieback and/or mortality was observed.

Jack pine budworm egg mass surveys were conducted in the same counties as the larval surveys. The populations that appeared to be building earlier this year in Jackson, Juneau, and Monroe counties collapsed. The population in Jackson County where there was potential for severe damage, also collapsed. No jack pine budworm egg masses were found in those locations. The wet spring and summer may have aided in the decline of the jack pine budworm populations.

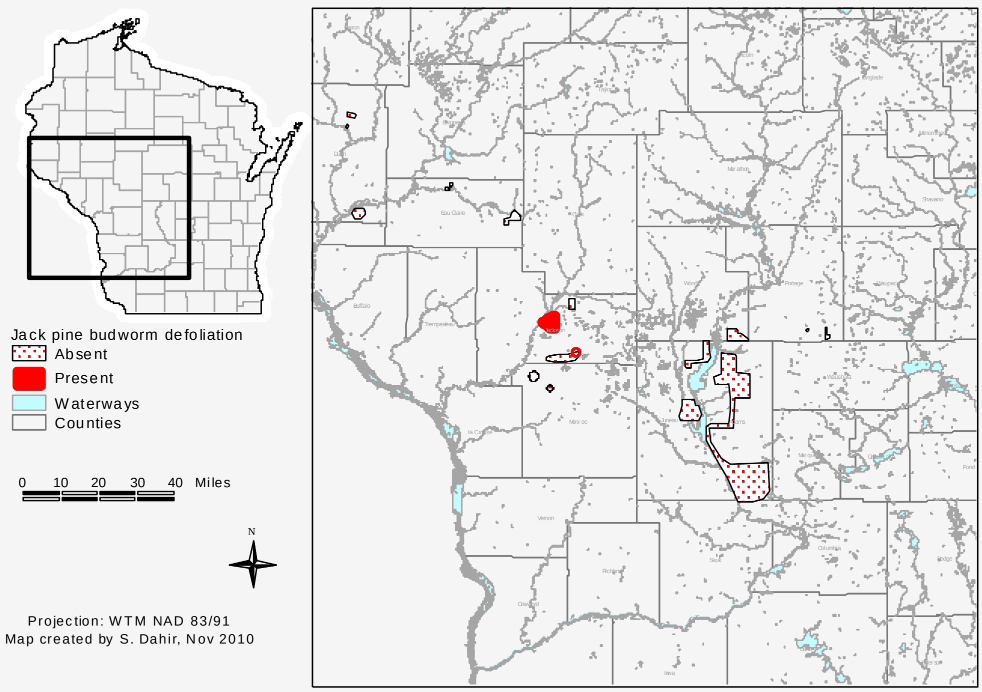


Figure 4. Jack pine budworm areas surveyed and area of know activity. Map by Sally Dahir

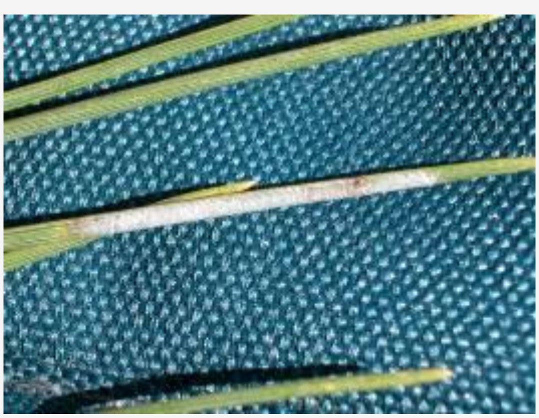


Figure 5. Eggs of Jack pine budworm on needles. Photo by Todd Lanigan

However, jack pine budworm egg masses were found once again in red pine plantations in Adams, Juneau, and Wood counties (Figure 5). Just like in 2004 -2007, the egg masses were found in younger red pine plantations (20-30 years old). In Adams County, the red pine plantation where two egg masses were found is the same plantation where budworm was first detected in red pine back in 2004, (Town of Big Flats, section 14). In Juneau County, (Town of Armenia, section 32), two egg masses were also found on red pine. In Wood County, (Town of Saratoga, section 36), one egg mass was found on red pine. The significance of this finding is unknown. It is interesting that after two years of not finding any egg masses in red pine, they are starting to show up once again. Monitoring efforts will continue in 2011.

Jack Pine Budworm Survey in Northwest Wisconsin: Procedures and Results 2010

Early larval survey

This survey is done on a yearly basis and is a key indicator of the presence of destructive budworm populations. Thirty shoots and staminate flowers that can be reached from the ground are checked for larvae. Since staminate flowers are often scarce, a majority of the samples are shoots. A high plot, considered sufficient to cause moderate to severe defoliation, is defined as any plot with a count of ten or more infested shoots and flowers.

Table 1. Populations of jack pine budworm found in early larval surveys in northwest Wisconsin, 2010.

County	Number of plots	Number of infested shoots	Infested shoots/plot	Number of high* plots	Percent high plots
Polk	15	6	0.40	0	0
Burnett	24	11	0.46	0	0
Washburn	21	24	1.14	0	0
Douglas	54	112	2.07	2	3.7
Bayfield	32	89	2.78	1	3.1
District	**146**	**242**	**1.66**	**3**	**2.1**

*High plots are defined as any one plot which contains 10 or more infested shoots or flowers.

Table 2. Populations of jack pine budworm found in early larval surveys in northwest Wisconsin, 2006 - 2010.

	Infested shoots per plot						Percent high plots				
County	**2006**	**2007**	**2008**	**2009**	**2010**	**Percent change 2009-2010**	**2006**	**2007**	**2008**	**2009**	**2010**
Polk	7.53	3.33	0.27	0.40	0.40	**0**	26.7	6.7	0	0	0
Burnett	6.42	4.75	1.42	0.63	0.46	**-27**	25.0	16.7	0	0	0
Washburn	8.14	2.95	2.10	1.57	1.14	**-27.4**	38.1	0	0	4.8	0
Douglas	8.63	5.24	4.76	2.91	2.07	**-28.9**	38.9	20.4	14.8	3.7	3.7
Bayfield	12.50	11.34	7.19	2.81	2.78	**-1.1**	68.8	68.8	28.1	0	3.1
District	**8.93**	**5.97**	**3.90**	**2.06**	**1.66**	**-19.4**	**41.8**	**26.0**	**11.6**	**2.1**	**2.1**

Pupal survey

This survey is also conducted annually and gives a good indication of the kinds and numbers of pupal parasites in the population as well as next year's population of jack pine budworm. It is done in July when most insects are in the pupal stage. Some adults may already have emerged, but empty pupal cases are collected and counted as emerged moths. At each stop, pupae are collected on a time basis. If five pupae are not found in five minutes, the collection is terminated. If five pupae are found in five minutes or less, the collection is continued until 25 pupae are found or until 15 minutes have elapsed. The time required to find 25 pupae is then recorded. Adults, parasites and non-emergence are recorded for each pupae.

Table 3. Populations of jack pine budworm found in pupal surveys in northwest Wisconsin, 2010.

				Moths		Parasites		Not emerged	
County	**Total Pupae**	**Total Minutes**	**Pupae/ Min**	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**
Polk	10	75	0.13	4	40	4	40	2	20
Burnett	48	130	0.37	28	58.3	17	35.4	3	6.3
Washburn	124	139	0.89	60	48.4	43	34.7	21	16.9
Douglas	416	383	1.09	238	57.2	130	31.3	48	11.5
Bayfield	202	214	0.94	104	51.5	71	35.1	27	13.4
District	**800**	**941**	**0.85**	**434**	**54.3**	**265**	**33.1**	**101**	**12.6**

Table 4. Populations of jack pine budworm found in pupal surveys in northwest Wisconsin, 2007 – 2010

County	2007 Pupae/min	2008 Pupae/min	2009 Pupae/min	2010 Pupae/min	Percent change 2008-2009
Polk	0.12	0.03	0.05	0.13	**+150**
Burnet	0.75	0.45	0.22	0.37	**+68.2**
Washburn	0.72	0.55	0.77	0.89	**+15.6**
Douglas	1.14	1.05	0.96	1.09	**+13.5**
Bayfield	1.74	1.25	0.91	0.94	**+3.3**
District	**1.12**	**0.88**	**0.76**	**0.85**	**+11.8**

Parasite and Predator Complex

This survey involves a careful examination of all the budworm pupae collected from which no moths emerged. (Table 5). Adult specimens are compared to a reference collection and any unknown adults are sent to UW-Madison for identification. Pupal cases from which nothing emerges are dissected to determine the cause of failure.

Table 5. Number of parasites and predators of jack pine budworm detected from pupae collected in 2010.

Parasites and Predators: 2010

Parasite/ Predators	Polk	Burnett	Washburn	Douglas	Bayfield	Total	Percent of Parasitized	Percent of Total
Itoplectes	0	9	17	50	27	103	38.9	**12.9**
Scambus	0	0	4	17	9	30	11.3	**3.8**
Phaogenes	2	1	7	12	12	34	12.8	**4.3**
Pteromalids	0	0	0	1	0	1	0.4	**0.1**
Tachinids	1	2	5	21	10	39	14.7	**4.9**
Unknown	0	0	0	2	1	3	1.1	**0.4**
Predators	1	5	10	27	12	55	20.8	**6.9**

Total	0	4	25	90	60	265	100	33.3

Pine spittlebug - *Aphrophora parallela*

Populations of pine spittlebug on white pine trees were very high in many areas around the state with frothy spittle masses on nearly every branch of some understory white pine (Figure 6).

Figure 6. Spittle masses on white pine. Photo by Linda Williams.

These insects suck the sap of the white pines, as well as some other pines, spruces, and firs. They produce a frothy mass that they live within until they complete their development and turn into adults, at which time they can leave the protection of the frothy mass.

Generally the damage from feeding is minimal although some branch tip dieback may be noticed when populations are high (as was observed in 2010). This damage doesn't typically kill the tree, although if you compound high populations with long term drought conditions it can put additional stress on the trees.

Jack pine gall rust surveys in Wisconsin state nurseries update: 2010

Stem and branch galls are occasionally detected on jack pine seedlings at the time of lifting in the three Wisconsin state nurseries. Surveys to evaluate and monitor the incidence of gall rusts on jack pine seedlings in the Wisconsin state nurseries were initiated in 2008 and continued into 2009 and 2010.

One-thousand seedlings from each age class were randomly selected at the time of spring lifting between late March to mid-April. At Hayward and Griffith Nurseries, both 1-0 and 2-0 seedlings were lifted and used in the study. At Wilson Nursery, only 1-0 seedlings were lifted and used in the study. Each seedling was thoroughly examined for the presence of swelling or galls. The number of galls per seedling and the locations of galls were also recorded. At Hayward Nursery, there were no galled 1-0 seedlings and 34 galled 2-0 seedlings. At Griffith Nursery, 24 1-0 seedlings exhibited a gall or galls, and 326 2-0 seedlings had a gall or galls. At Wilson Nursery, there were five galled 1-0 seedlings. A summary of three years of results is shown in Table 1.

Table 1. Incidence of seedlings with visible galls at the time of lifting

Nursery	Seedling age	2008	2009	2010
Hayward	2-0	0.7%	-	3.4%
Hayward	1-0	-	0.0%	0.0%
Griffith	2-0	7.3%	-	32.6%
Griffith	1-0	-	4.2%	2.4%
Wilson	2-0	-	-	-
Wilson	1-0	-	0.0%	0.5%

At Griffith Nursery, there was a dramatic increase in the incidence of galled 2-0 seedlings in 2010 (32.6%), compared to 2008 (7.3%). A small increase in the 2-0 seedling gall incidence was also observed at Hayward Nursery between 2008 (0.7%) and 2010 (3.4%). Effects of specific local weather conditions, such as precipitation, wind velocity, and temperatures on gall incidence are being analyzed. In all of the state nurseries, symptomatic seedlings are culled from graded stock before shipping. For bulk orders, nurseries include an information sheet with sorting guidelines to encourage landowners to remove galled seedlings before planting. Thus, the number of galled seedlings that are shipped and out-planted should be less than the incidence in this study.

Seedlings that appeared healthy (with no galls or swellings) were planted on nursery properties in the spring of 2010 in order to evaluate the incidence of gall formation after planting on irrigated and non-irrigated sites. The number and age of seedlings planted were as follows: Wilson Nursery: 200 1-0 seedlings; Griffith Nursery: 200 1-0 and 200 2-0 seedlings; Hayward Nursery: 200 1-0 and 200 2-0 seedlings. Half of the seedlings at each nursery received irrigation and half did not. Planting dates were as follows: Wilson Nursery - March 29; Griffith Nursery - April 12; Hayward Nursery - May 10. The purpose of irrigating the seedlings was to maximize the survival rate by eliminating water deficiency as a potential factor in causing seedling mortality. Planting on a non-irrigated site was considered to represent a situation similar to typical planting in the field. Herbicides were used on non-irrigated sites to reduce grass competition. Each seedling was examined in the fall for the development of galls or swellings. (Table 2).

Table 2. Incidence of galled seedlings (galls developed during summer, 2010) on irrigated and non-irrigated sites.

Nursery	Seedling age	Galled seedlings (%) In irrigated bed	Galled seedlings (%) In non-irrigated bed
Hayward	2-0	2	0
Hayward	1-0	1	0
Griffith	2-0	3	3
Griffith	1-0	5	7
Wilson	1-0	1	0

The incidence of galled seedlings was two percent or less in Hayward and Wilson Nurseries, and three-seven percent in Griffith Nursery. Unfortunately, the seedlings in Griffith Nursery were heavily infested with the redheaded pine sawfly (*Neodiprion Lecontei*) in mid-July through September. The majority of seedlings were completely defoliated by the end of September. In the irrigated bed, three out of five 2-0 seedlings and all of the three 1-0 seedlings that exhibited galls were almost completely defoliated by September. In the non-irrigated bed, two out of three 2-0 seedlings and all of the seven 1-0 seedlings were almost completely defoliated and many of them appeared dead.

In addition to the nursery plantings, 100 apparently healthy 2-0 seedlings and 100 apparently healthy 1-0 seedlings were randomly collected from lifted stock at Griffith Nursery in the spring of 2010. These seedlings were potted on May 4 and 5, 2010, and placed in the greenhouse to limit additional inoculum exposure. The number of galls per seedling and the locations of galls were recorded in July and October. Interestingly, the percentage of galled seedlings was higher in the greenhouse than the field. Seven percent of the 2-0 seedlings and 17% of 1-0 seedlings exhibited galls when the examination was conducted on July 30, 2010. Additional examination on October 20, 2010 revealed an additional one 2-0 galled seedling and six 1-0 galled seedlings, totaling eight 2-0 and 23 1-0 seedlings that exhibited a gall or galls during the summer in the greenhouse.

Prior to the study, it was anticipated that the seedlings in the greenhouse would have lower disease incidence than out-planted seedlings since out-planted seedlings will have longer periods of exposure to pathogen spores. However, the disease incidence in the greenhouse was much higher than that of out-planted seedlings at Griffith Nursery. This result was consistent with the observations in 2009. One hypothesis to explain the results is that disease incidence may be enhanced or discouraged by growing conditions of the host. Vigorously growing seedlings may be favorable for the exhibition of galls. This would explain a slightly higher incidence in the irrigated bed compared to the non-irrigated beds at Hayward and Wilson Nurseries. At Griffith Nursery, the results were mixed, possibly due to stress caused by the redheaded pine sawfly defoliation. Further data analysis of gall location and size is currently in progress.

Out of 62 galled seedlings potted in 2008 and 2009, 13 sporulated in the spring of 2010. The majority of sporulation occurred between late April and mid May. Microscopic examination of germ tubes to distinguish *Cronartium quercuum* (eastern gall rust) from *Peridermium harknessii* (western gall rust) was conducted (Anderson and French, 1964). Aeciospore germination rates varied from less than five percent to more than 95 percent per seedling. Three plates were prepared for each seedling. Thirty germ tubes (10 germ tubes per petri plate) were randomly selected for each galled seedling and the length of each germ tube was recorded after 24 hours of incubation at 18.5C. Average germ tube lengths for all tested seedlings were within the range of *Cronartium quercuum*. For the detailed results of the jack pine gall rust study in 2008 and 2009, please refer to the Forest Health Conditions of Wisconsin Annual report 2008 and 2009.

Reference: Anderson G.W. and D.W. French. 1964. Differentiation of *Cronartium quercuum* and *Cronartium coleosporioides* on the basis of aeciospore germ tubes. Phytopathology: 55:171-173.

Eastern Hemlock Tip Blight – *Sirococcus tsugae*

In 2009, a fungus, *Sirococcus tsugae*, was confirmed as causing tip blight of eastern hemlock in Maine (Figures 7, 8). This disease is known to occur on western hemlock in western United States. This is the first report of this disease on eastern hemlock; *it has not been observed in Wisconsin*. The potential impact to eastern hemlock is currently unknown, although preliminary observations in Maine indicate the injury to eastern hemlock may be light.

For additional information visit:
http://na.fs.fed.us/pubs/palerts/tip_blight/tip_blight_lo_res.pdf

Figure 7. Tip dieback on eastern hemlock infected with *Sirococcus tsugae.* Photo by Maine forest service.

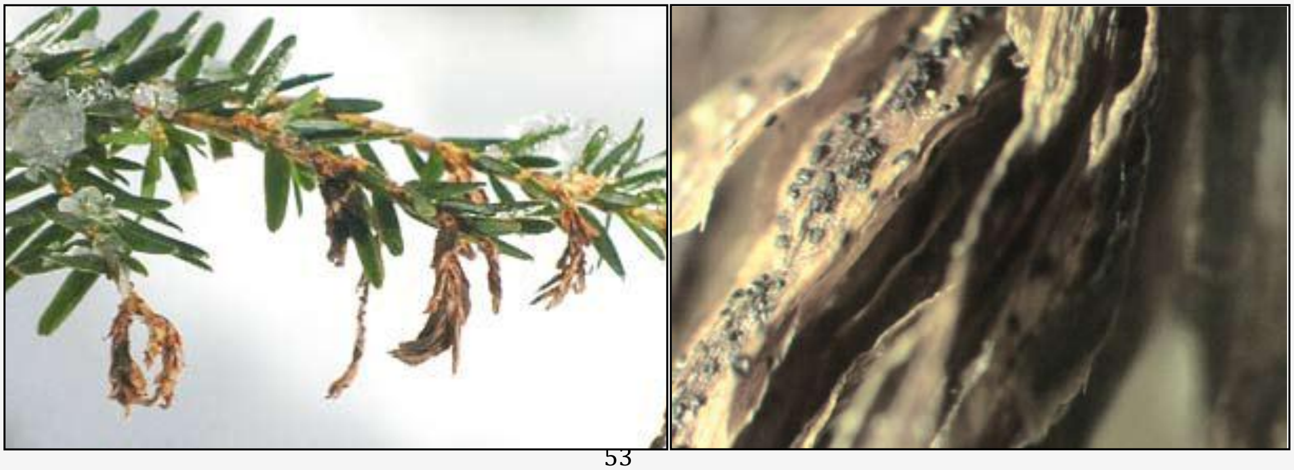


Figure 8 left. Tip dieback on eastern hemlock infected with Sirococcus tsugae.
Figure 8 right. Infected needles with spore-producing structures of *Sirococcus tsugae.* Photos by Maine Forest Service.

Sirococcus Shoot Blight – *Sirococcus conigenus*

Sirococcus shoot blight is a disease caused by the fungus *Sirococcus conigenus*, that can cause symptoms similar to Diplodia shoot blight. The Sirococcus fungus infects the newly emerging shoots and needles, causing a shepherd's crook. Red pine seedlings that are under a red pine overstory can become infected with Sirococcus and die. This threatens the health of red pine when managing in a multistoried stand or in a shelterwood. Diplodia shoot blight poses the same threat. Sirococcus has been confirmed in 20 Wisconsin counties (Figure 9). Hosts of Sirococcus include red pine, spruce and fir. Known counties and hosts positive for Sirococcus are listed in Table 1.

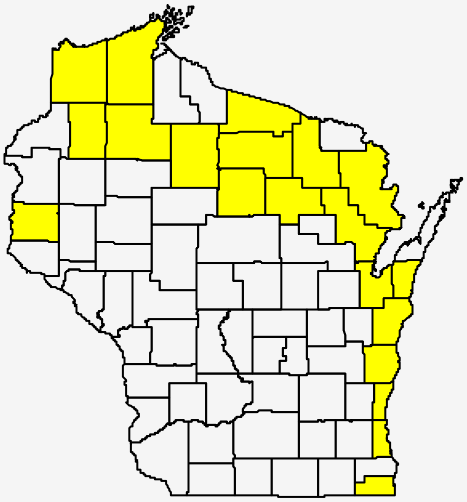


Figure 9 . Counties where Sirococcus shoot blight has been confirmed (yellow).

Table 1 . Known counties and hosts positive for Sirococcus shoot blight.

County	Red Pine	Spruce	Fir
Bayfield	X		
Brown		X	
Douglas	X		
Forest	X		
Kenosha	X		
Kewaunee		X	
Langlade		X	
Lincoln		X	
Manitowoc		X	
Marinette			X
Milwaukee		X	
Oconto	X		
Oneida	X	X	
Ozaukee	X		
Price		X	
Sawyer	X		
Sheboygan		X	
St. Croix		X	
Vilas	X	X	
Washburn	X		

Red Pine Pocket Mortality Landowner and Manager Update[3]

Red Pine Pocket Mortality is a problem landowners and managers face with increasing frequency throughout Wisconsin, particularly in the southern half of the state. Previous work at UW-Madison indicated that root- and basal-stem feeding beetles, other bark beetles that attack the main stem (pine engravers), and their associated fungi may be involved. This long term study, funded by the National Science Foundation, was initiated with two goals: To test whether pockets are associated with increased populations of the above insects, and to test whether severing the root grafts through which these fungi grow could slow the spread of this syndrome within affected stands.

The field sampling component was conducted from 2004 to 2008. At the beginning of the study several sites were selected for an experimental root sever treatment. It was hoped that the fungus, which moves through root grafts, would be contained within the sever zone. Thirteen sites had the roots severed approximately ten meters outside of the pocket's edge, ten sites were unsevered pocket controls and eight sites were healthy controls (see Figure 10 for regional locations of 31 study sites).

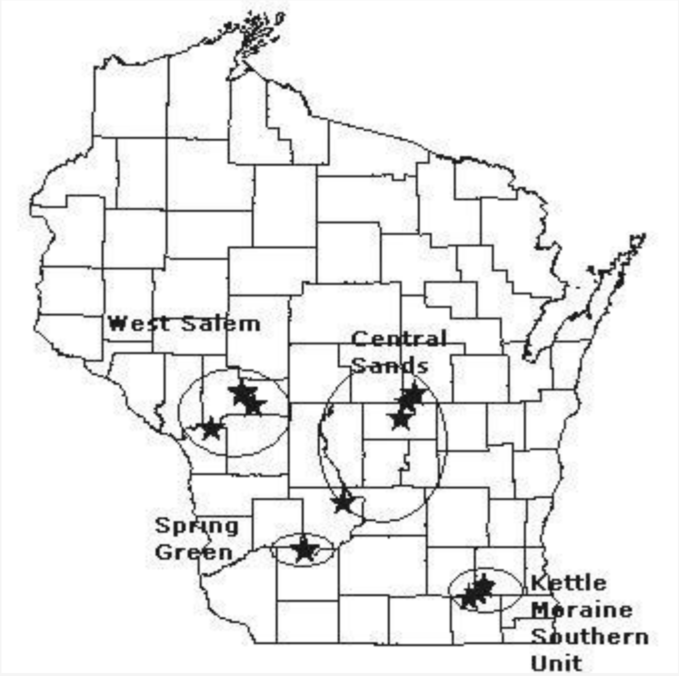


Figure 10. Locations of study sites.

Red pine pocket mortality study regions

Throughout the study's duration three types of traps were used to monitor the insect populations associated with red pine pocket mortality. Pitfall traps sampled root weevil populations, inverted jug traps sampled lower stem feeding insects (turpentine beetles) and funnel traps sampled bark beetles (pine engravers) and their predators (checkered and hister beetles).

Each fall trees were evaluated for insect damage and health. During the course of the study a total 826 trees died. In untreated pocket controls, mortality beyond the same distance at which root severing was conducted in treated sites averaged 7%. In treated pockets, tree mortality beyond the root-sever lines was only 1.7%. The background mortality in healthy control sites was less then 1%. Thus, early indications suggest root-graft severing reduced pine mortality. However, in some of the root-severed sites the mortality had not yet reached the sever line, so continued monitoring is needed to evaluate overall success of the severing trial. Also, the total of 7% mortality in the pocket controls is still quite low due to the fact that this is a slowly progressing syndrome, and so continued follow-up is necessary.

[3] Contributed by Robert Murphy and Dr. Ken Raffa, UW-Madison Department of Entomology.

The insect trapping data are shown in Table 1.

Overall, insect populations were generally similar between asymptomatic and symptomatic sites, although pine engravers were slightly more abundant in the latter group. The main lesson is that pine engraver populations are ubiquitous, and so whether or not they kill trees depends more on site vigor than on whether or not they are present. Secondly, populations in the root sever sites were adequate for this treatment to provide a good test in the face of substantial pest pressure.

Over the course of the main study, a variety of complementary experiments and surveys were conducted. These included: 1) An insect dispersal study examined the distance that pine engravers, turpentine beetles and checkered beetles pine fly, helping us to better understand the connectedness of pockets; 2) A tree chemistry study focused on the defense physiology of trees inside, along the edge and outside of the red pine pocket; 3) A vegetation study determined alterations of flora within and surrounding these gaps; 4) A biodiversity survey examined how mortality influences insect communities; 5) A tick survey examined how flora changes in and around the pockets may provide sanctuary for tick-carrying animals, thereby creating elevated tick activity and a potential increase in human tick-borne diseases.

While the data from these studies continue to be analyzed, our hope is to return to the root severed sites to continue to observe the progression of mortality.

Table 1. Insect Capture Per Trap in the Red Pine Pocket Mortality Study

			Symptomatic			
Type of Insect	**Insect**	**Asymptomatic**	**Pocket**	**Root Sever**	**All Symptomatic**	**All Sites**
Bark beetles colonizing main trunk	*Ips pini*	682	701	778	740	720
	Ips grandicollis	455	517	518	518	497
Lower stem and root feeding insects	*Dendroctonus valens*	34	31	22	27	29
	Hylastes porculus	51	56	43	50	50
	Hylobius sp	45	25	38	51	36
Predators	*Thanasimus dubius*	356	308	259	284	308
	Platysoma cylindrica	100	95	84	90	93
	Platysoma parallelum	23	23	20	22	22

Diplodia pinea: Testing for Asymptomatic Infection in State Nursery Red Pine Seedlings

Over the last five years, the state nurseries have implemented an aggressive management plan to monitor and control Diplodia shoot blight and canker, caused by the fungus, *Diplodia pinea*. Some evidence suggests the presence of this fungus, coupled with increased seedling stress, could lead to seedling mortality. 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. To limit seedling exposure to the fungus and subsequent infection, nursery staff assisted by pathology staff, devised a series of management actions: removal of all mature red pine found in and around the nurseries' properties, increased applications of fungicides, and annual testing of nursery stock. These measures have helped limit the exposure and subsequent infection of our red pine.

Since 2006, the state nurseries and Forest Health Protection have tested asymptomatic red pine seedlings for Diplodia infection (for the details of the test, please refer to the Forest Health Conditions of Wisconsin Annual Report 2007, p33). In 2010, the forest health lab processed 547 apparently healthy 2-0 and 3-0 red pine seedlings to detect the presence of the pathogen. Samples were collected from all of the three state nurseries (Table 1).

Table 1. 2010 Diplodia asymptomatic seedling test of 2-0 and 3-0 red pine seedlings from State Nurseries

Nursery	Total number of seedlings tested 2010	Total positive for Diplodia infection 2010	Positive for Diplodia infection (%) 2010	Positive for Diplodia infection (%) 2009
Hayward	198	6	3.03%	1.77%
Griffith	260	10	3.85%	4.68%
Wilson	89	0	0%	1.90%

The infection rate was less than 5% in all nurseries for 2010. This is well below the 10% threshold tolerance level that has been used for management purposes. The overall asymptomatic infection rate has been consistently lower than the 10% threshold level since 2007 and lower than 5% for 2009 and 2010 in all of the three state nurseries. Plans to conduct the test in 2011 will be discussed with the DNR State Nursery Program this winter.

Annosum Root Rot – *Heterobasidion irregulare*

Annosum root rot is caused by the fungus, *Heterobasidion irregulare*. The fungus causes a decay of the roots and lower stem 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 through root contact. Fruit bodies may be found at the root collar of dead and dying trees and stumps of infected trees (Figure 11).

Figure 11. Fruit body of *Herterobasidion irregulare*. Photo by Mark Guthmiller.

In 2010, Annosum root rot was confirmed in two additional counties, Taylor and Oconto. With these detections, Annosum root rot is now known to occur in 22 counties, including Adams, Buffalo, Columbia, Dunn, Green, Iowa, Jefferson, Juneau, La Crosse, Marquette, Oconto, Portage, Richland, Sauk, Shawano, Taylor, Trempealeau, Walworth, Waukesha, Waupaca, Waushara, and Wood.

This year was the fourth year of a statewide survey to detect Annosum root rot. Sites that were reported by forestry staff as potentially infested were surveyed and samples collected for laboratory confirmation. Outreach efforts to promote preventative treatments continued throughout 2010 through workshops and articles. A pesticide applicator certification training was held in April, and a workshop focused on preventative application was held in May on the Menominee Indian Reservation. Regeneration field studies included planting a variety of native tree species in a clear cut stand infected with Annosum to evaluate the survival of artificial regeneration and establishing study plots in stands with Annosum to evaluate survival of natural regeneration. Greenhouse studies are also underway to conduct pathogenicity tests on a variety of species. Additional efforts on Annosum include several projects that are being funded by the USDA Forest Service. These include cooperative projects with USDA Forest Service and University of Wisconsin to:

1. Develop a sampling protocol for accurate, consistent and cost-effective detection of Annosum.
2. Develop a science-based risk analysis system and associated management guidelines for Annosum root rot in the pine-growing areas of the 20 states of the USFA Region 9.
3. Test methods to facilitate the application of preventative treatments that are effective when the temperature is below freezing.

The effect of Annosum infection on tree regeneration

In 2008, plots were established in six red pine stands that were infected with *Heterobasidion irregulare.* (Figure12). The purpose of these plots was to follow the progression of Annosum in seedlings and saplings in disease centers.

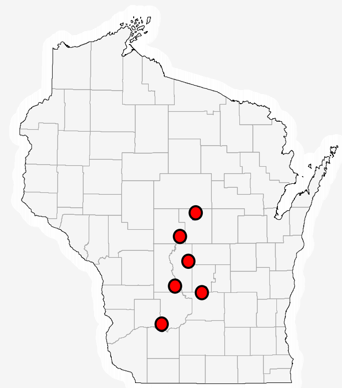


Figure 12 . Map of Annosum regeneration plot locations. Map by S.ally Dahir

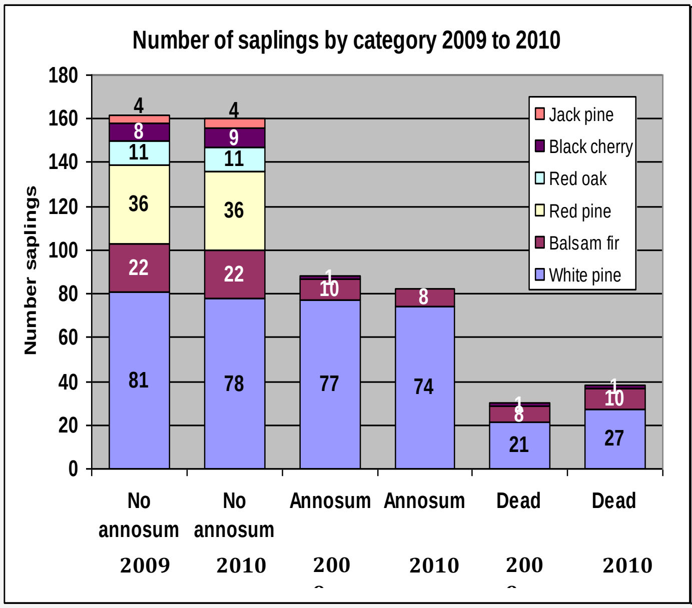
In five of the six stands, salvage harvesting removed the overstory in the plot area. In one stand, Sporax was used during harvest. Plot radius for recording saplings was 5 meters and for recording seedlings was 2-4 meters. Saplings were tagged and mapped whereas seedlings were flagged (Figure 13).

Results for 2010

Figure 13. Seedling plots were weeded and seedlings were flagged. Photo by Sally Dahir

Only about 33% of all seedlings and about 50% of the saplings are white pine but this species is disproportionately affected by Annosum root disease. The number of white pine seedlings per acre that died between 2009 and 2010 more than doubled for white pine and increased by 25% for minor species. The number of seedlings with Annsoum conks tripled for white pine and decreased for minor species as many trees with conks in 2009 were dead in 2010. Minor species include balsam fir, red pine, red oak, red maple, black cherry, white oak, hackberry, black locust, and aspen. Of these, only balsam fir was affected. Of seven fir seedlings in 2008, two had conks and three were dead in 2010. There were 40 fir saplings in 2008 and of these, 10 were dead and eight had Annsoum conks in 2010, roughly a 50% infection rate. It is difficult to determine with seedlings whether they died of infection or lack of light. Many seedlings would die in a non-infected stand.

The infection rate is 60% for white pine saplings and about 50% for balsam fir. Figure 14 shows the total number of saplings on the plots (not per acre since sapling plot size was fixed). About half the healthy saplings are white pine. However, 90% of saplings with conks are white pine and 70% of



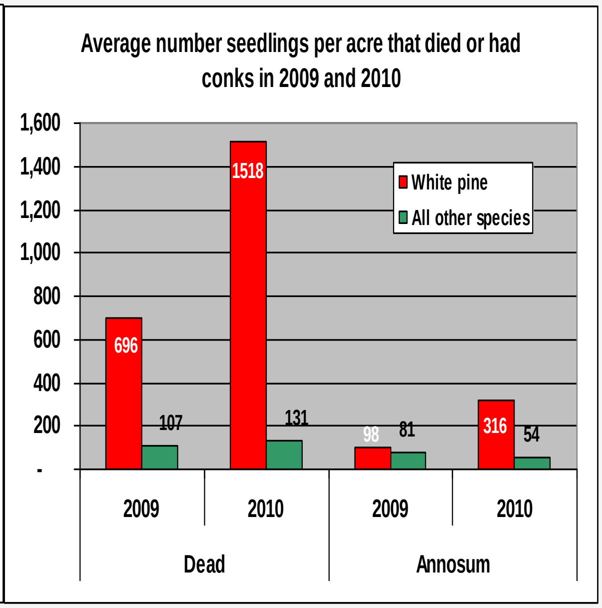


Figure 14 . White pine and balsam fir saplings were disproportionately affected by Annosum root rot.

dead trees are white pine, the remaining 10% of species with conks were balsam fir as were the remaining 30% of dead trees. To date, a much higher percentage of white pine seedlings and saplings have been affected by Annosum than any other species.

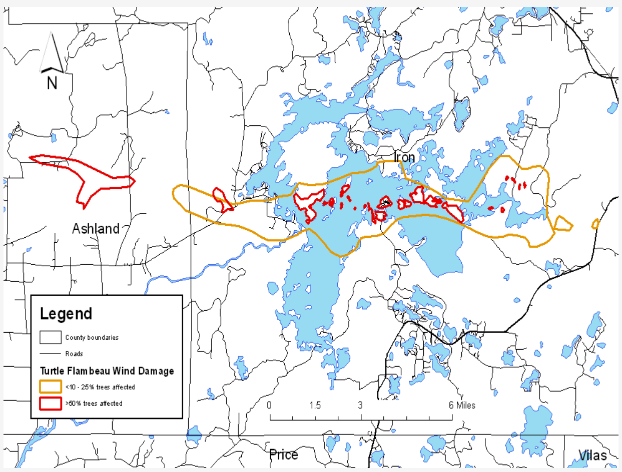
Abiotic-Caused Forest Health Issues

Tornado Damage on the Turtle Flambeau Flowage

A tornado ripped through the Turtle Flambeau Flowage state property on July 27. It was one of three tornados in the area that day. The other two, according to the National Weather Service, occurred in rural Ashland County.

The Turtle Flambeau Flowage tornado knocked down and damaged trees along an 8 mile long by 1-1.5 mile wide stretch (Figures1-3). It made some roads impassable and damaged about 35 campsites, 10 of which lost essentially every tree. Many of these campsites were on islands with red pines, and these pines were severely damaged, typically snapping 15 feet above the ground. Some roads were made impassable and several campers sustained injuries.

Approximately 1,675 acres were delineated in aerial surveys in southeastern Ashland and southern Iron counties that sustained >50% tree damage. Another 11,020 acres were surveyed and found to have sustained 10 – 25% tree damage. On the Turtle Flambeau Flowage property, most of the impacted forests were composed of aspen, paper birch, and northern hardwood stands (Figure 4).



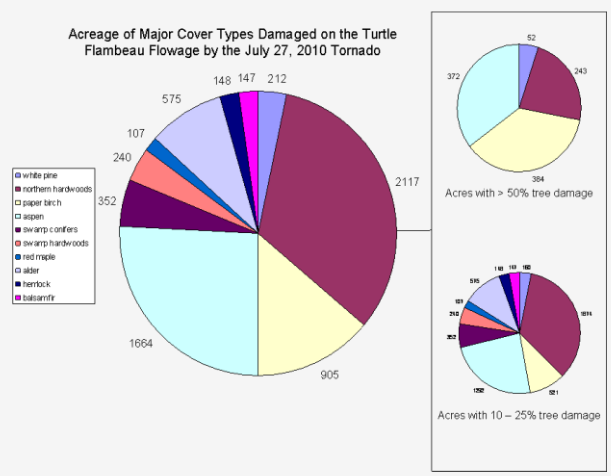


Figure 1 (upper left). Area of wind damage in Ashland and Iron counties.
Figure 1 (lower left) Many trees were blown down on the Turtle Flambeau Flowage state property during a July 2010 tornado.
Figure 2 (Upper right) . Damage from the July 2010 tornado. This popular campsite was amongst some very nice pines, but they no longer stand.
Figure 4 (lower right). Acreage of forest cover types affected by blow down.
Photos by Brian Schwingle

Freeze Injury

The weekend of May 8 and 9 produced several inches of snow and low temps below 25°F across much of northern and northeastern Wisconsin, killing developing shoots and leaves of northern pin oak, ash, spruce and aspen; freeze injury was uncommon on northern red oak.

Oak stands on the sand flats from Sterling Township in Polk County to Hughes Township in Bayfield County (Figure 5) went from bright spring green to jet black. As oak stands climbed ridges the brontosaurus browse line formed at about 35 feet leaving the tree tops a dainty green with the lower crown a stark, withered black.

The good news is that the damage was ephemeral as the second flush of foliage mitigated the injury. Though spectacular in appearance the frost damage should cause only minor growth loss (Figure 6). No freeze injury was observed on white ash in northern hardwood stands and black ash in swamps had not begun to flush at the time of the cold weather.

Figure 6. Freeze injury to developing spruce shoots. Photo by Linda Williams

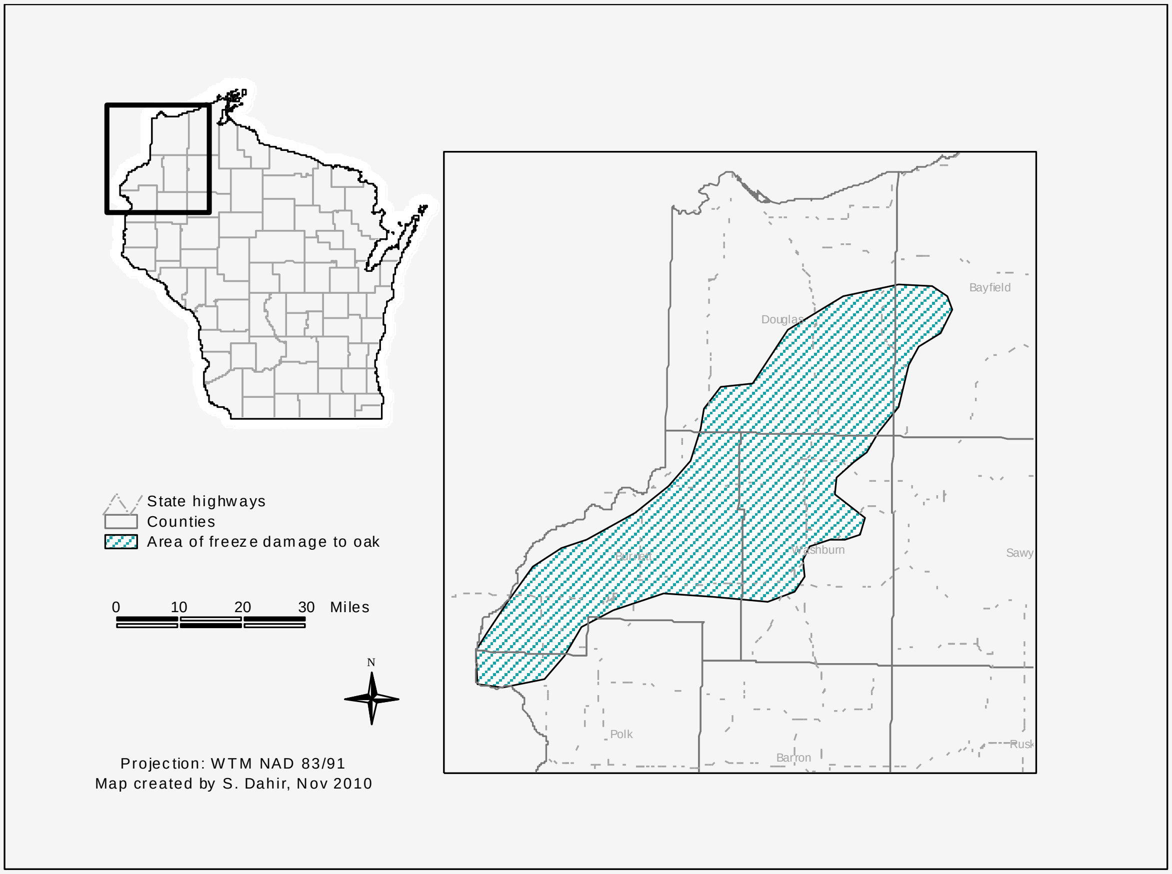


Figure 5 . Area of freeze damage to oaks in northwest Wisconsin. Map by Sally Dahir

Precipitation and drought in Wisconsin 2009 to 2010

For the past 6 years, the drought in northwest Wisconsin has caused stress in the forests, allowing pine bark beetles, two-lined chestnut borers and fungi such as *Armillaria* spp. and *Diplodia pinea* to successfully invade and kill forest trees (primarily oak and pine). Finally, in 2010, much needed precipitation, particularly in northwest Wisconsin, created a less favorable environment for conifer bark beetles and the two-lined chestnut borer (Figure 7). These insects are known to invade conifers and oak, respectively, during years when drought has reduced these species' ability to prevent insect establishment. In the fall of 2009, over 18% of Wisconsin, mostly the northern region, experienced severe to extreme drought. This dropped to 7% by the next spring and by fall 2010, the entire state was drought free. Precipitation for the two months of June and July 2010 was eight inches above normal (16.4 compared to 8.0 inches) for much of the state.

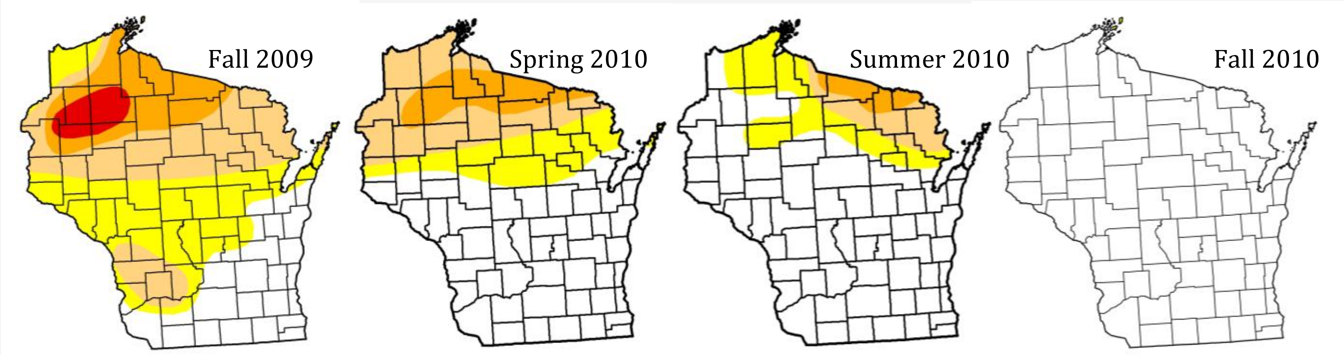


Figure 7. Drought conditions for the last 12 months. (U.S. Drought Monitor, http://drought.unl.edu/dm)

Table 1. Percent of state by area with various levels of drought from fall 2009 to fall 2010.

Date	No drought (White)	Abnormally dry (Yellow)	Moderate Drought (Pink)	Severe drought (Orange)	Extreme drought (Red)
Fall 2009	**23.6**	**29.5**	**28.3**	**14.3**	**4.3**
Spring 2010	**57.5**	**17.8**	**17.6**	**7.1**	**0**
Summer 2010	**76.9**	**14.3**	**5.4**	**3.4**	**0**
Fall 2010	**99.9**	**0.1**	**0**	**0**	**0**