Central States
Forest Health Watch

Current forest health information for land managers in Illinois, Indiana, Iowa and Missouri

July 17, 2009

This collaborative effort of the USDA Forest Service Northeastern Area, Missouri Department of Conservation, and Indiana, Iowa and Illinois Departments of Natural Resources provides technical updates twice a year on forest health issues of regional interest. Useful information can also be found in previous editions, which are available on the www here.

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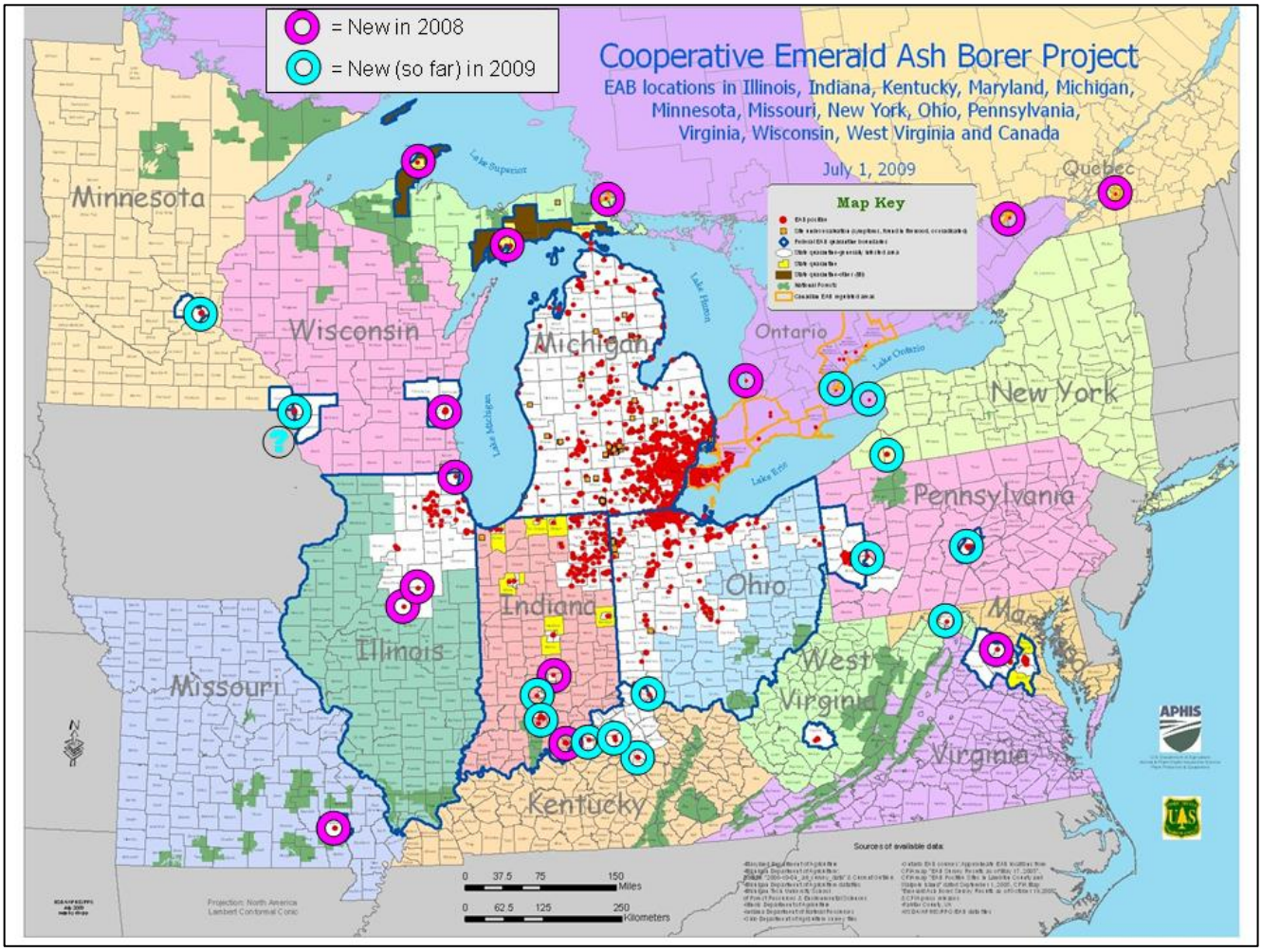
Important Regional Forest Health Issues

Nonnative insects and pathogens continue to be highly significant forest health issues in our region. In this edition you will find updates on emerald ash borer, gypsy moth, and sudden oak death.

Emerald Ash Borer (EAB)

Take a look at the map below, then take a deep breath and proceed to page 2 for discussion.

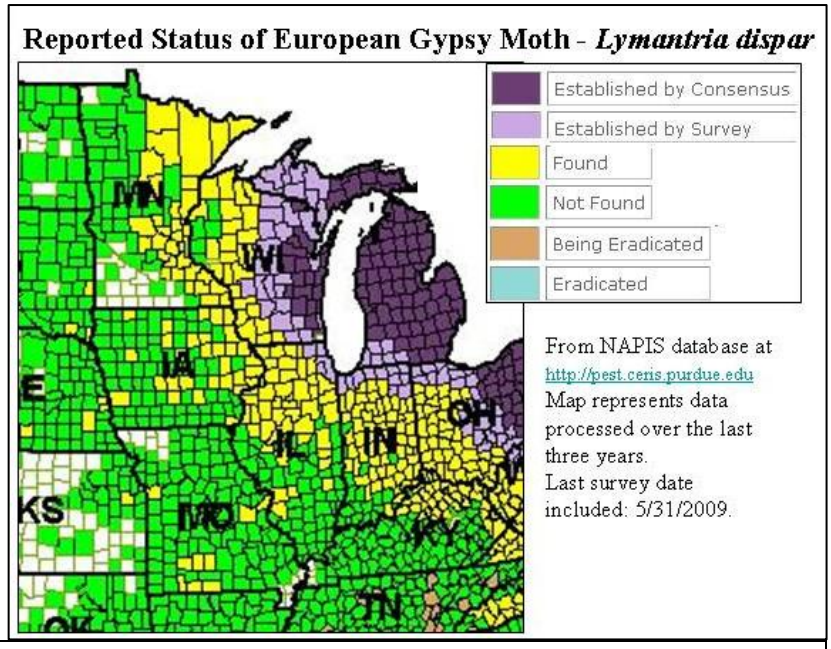


The known distribution of EAB has significantly expanded during 2008 and 2009. During 2008, Missouri and Wisconsin were added to the list of states with a known EAB infestation. So far in 2009, Minnesota, Kentucky, and New York have been added, and Iowa is a question mark (an EAB larva was identified from a trap tree in Clayton County, but no established infestation has been located yet). Along with new detections in southern Indiana, the Upper Peninsula of Michigan, southwestern Wisconsin, central Pennsylvania, eastern Ontario, and Quebec during the last 2 years, this map shows a losing battle to contain this pest. Many of the new detections are infestations that started at least 4-5 years ago. With this known time-lag between the initiation and the detection of an EAB infestation, one may speculate about the actual current EAB distribution; however, today's actual distribution probably won't be known until 2015 or later. This is frustrating and disconcerting, to say the least.

So, how do we respond in the Central States? Despite the increasing number of red spots on the map, we still have more uninfested areas than infested, and we want to keep it that way as long as possible. Strategies to minimize human-assisted movement of EAB are useful and should be implemented. However, it is becoming clear that EAB is not "someone else's problem", and you should prepare to deal with EAB sooner versus later. Your agency or organization should be developing a strategy to respond to EAB infestations as they are discovered in both urban and native forests. You should be vigilant in survey in order to increase your chances of detecting an infestation early. When EAB arrives in an area, you may be able to protect individual high value trees, but the vast majority of ash trees are going to die. Now is the time to consider what will remain after loss of most ash from your forest or community. You may consider proactive steps to shift species composition. In summary: Keep it out as long as possible, prepare a response plan, be diligent in surveillance, and be proactive in managing your forest.

Gypsy Moth (GM) Activities – Summer 2009

In areas near the leading edge of GM, treatment activities may be undertaken to reduce populations in order to "slow the spread" of the advancing front. In areas that are generally uninfested, eradication treatments are taken to eliminate these outlying populations. In areas where GM is established, suppression treatment activities may be undertaken to limit damage. GM continues to expand westward, with significant populations now established in eastern Wisconsin, northern Indiana and northeastern Illinois. The map at the right shows where GM has been trapped in the past 3 years. Iowa and Missouri have had some catches of GM in pheromone traps, but are still considered to be without established populations. Although no egg masses have been found in Northeast Iowa to confirm an established population, trap catches have been consistently high for the past few years. In 2009, Iowa joined the Slow the Spread program.



States without established populations:

	Treatment Activities	Trapping Activities
Iowa	None	In 2009, Iowa began to participate in the Slow the Spread program. Under STS funding, 2,189 traps were placed in the northeastern 9 counties. A joint effort of IA DNR Bureau of Forestry, USDA APHIS, IDALS, and City Foresters placed 1,227 additional gypsy moth detection traps across the remainder of the state.
Missouri	None	MO Dept. of Agriculture, MO Dept. of Conservation, USDA APHIS, U.S. Dept. of Defense and MO National Guard cooperated to set out an estimated 8,000 detection traps in Missouri. Delimit trapping is being conducted in 6 counties where gypsy moths were captured last year (Franklin, Jackson, Ozark, St. Louis, Webster & Wright).

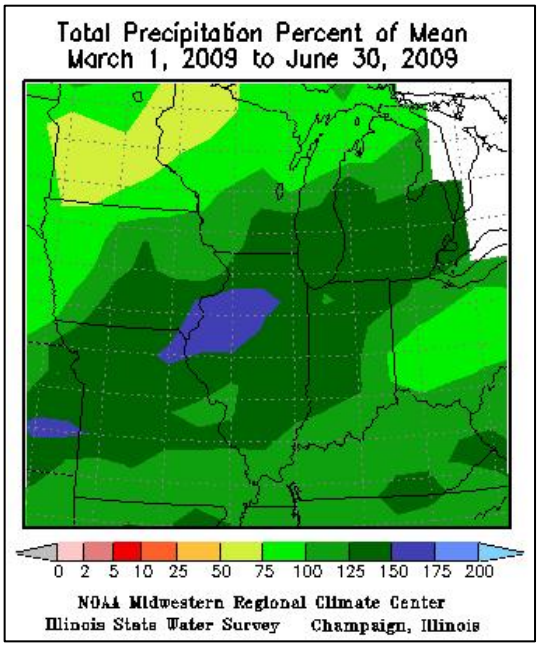
States with established populations:		
	Planned Treatment Activities	Trapping Activities
Illinois	Aerial application of Btk on 4 sites (approx. 1100 acres) and mating disruption on 7 sites (approx. 11,860 acres) in northern Illinois (LaSalle, Lee, Ogle and Stephenson Counties). The intent of the treatment of these sites is to slow the spread of gypsy moth by eliminating reproducing populations in the treatment sites. Note that much private GM suppression occurs in infested areas, but this is not reported to or monitored by the Forest Service.	Approximately 6,300 STS monitoring traps will be placed in the northern 1/3 of the state. USDA APHIS traditionally places detection traps in the portion of the state not covered by the STS program and delimit traps in areas where moths were caught the previous year. They planned to place approximately 5500 traps in 2009.
Indiana	Aerial spray of Btk on approx 7,166 acres (10 sites) and pheromone flakes on approx 3,520 acres (2 sites). The intent of these treatments is to slow the spread of gypsy moth in northern Indiana.	Approximately 8,800 STS monitoring traps were placed on 2K, 3K & 5K grids. An additional 3,200 traps set on a 3K grid over the portion of the state not covered by STS.

Sudden Oak Death

The latest information on sudden oak death (SOD) is available on the California Oak Mortality Task Force web page. New information is generally available in their current newsletter.

To date, *Phytophthora ramorum* (the SOD pathogen) has **not** been found widely throughout the Eastern US, despite the distribution of *P. ramorum* to many locations on infected nursery stock in 2001-2003. Early on, surveys of natural areas focused on testing foliage of symptomatic plants. Since 2007, a more efficient survey method has been used, in which streams are "baited" with rhododendron leaves to detect the presence of the pathogen in the watershed. In the Midwestern states, *P. ramorum* was not detected in the 16 watersheds monitored in 2007, nor the 12 watersheds monitored in 2008 (3 watersheds in Missouri, 6 in Illinois, and 3 in Indiana). Since the risk of *P. ramorum* establishment in the North is considered low, survey priorities have been shifted to the Southern and the Western USA and no stream-baiting is being done in the Central States in 2009. Using the stream-baiting methodology, *P. ramorum* has been found outside nurseries in four Eastern states: Mississippi, Alabama, Georgia, and Florida.

Weather Overview



The last edition of the CSFHW (January 2009) left off with the report that 2008's wild weather (tornados, excessive rains, hurricanes) had extinguished all remaining pockets of drought in the region. The late winter season of 2009 didn't throw anything too unusual at the Central States, except extreme cold in mid-January (we expect cold in January) and unseasonable warmth and excessive rain in mid-February (by February, we don't mind unseasonably warm). Spring 2009, however, did bring some noteworthy weather events. Excessive rain events occurred repeatedly across much of the Central States in March, April, May, and even into June. The map of cumulative rainfall in March-June, represented as a percent of normal, demonstrates how wet most of you have been. Sorry, Northwest Iowa, you missed out. But for those of you in that dark blue section of the map, your rainfall for the 4 month period is 8 to 10" more than average expected for March through June. The result of all this moisture is an increase in anthracnose and other foliar fungal diseases.

Some of the storm events that have brought this moisture have also caused severe damage. In southern Missouri, one particular system in early May spawned thunderstorms, tornadoes and extreme straight-line winds over thousands of acres, uprooting many trees. The Missouri Department of Conservation estimated the extent of the damage at 204 million board feet of timber on 113,000 acres. Although damage ranging from significant to severe occurred in 36 counties, three-quarters of the destruction fell on 6 counties: Reynolds (28,351 acres),

Madison (17,854 acres), Shannon (10,944 acres), Dent (9,920 acres), Iron (9,514 acres) and Bollinger (8,473 acres) counties. Damage affected private lands, the Mark Twain National Forest, and state conservation areas. The Missouri Forest Products Association said statewide damage from the May 8 storm equals approximately one-third of Missouri's annual timber harvest.

The Midwest Climate Watch webpage is a great help to identify broad scale regional weather events. This site is readily available to the public, and it includes statewide weather summaries for every state in the region. If you want to be able to focus in on specific time periods or even specific weather stations, data is available on-line by subscription to MICIS at the Midwestern Regional Climate Center.

What else is being reported across the Region

Unexpectedly high **mortality of Eastern Red Cedar** has been observed this spring and summer across parts of Iowa, Missouri, Illinois, and Kansas. The underlying cause has been difficult to pin down, but these state summaries reveal some commonality.

Missouri: Initial field visits showed that some trees were infected with *Heterobasidion annosum*, in Columbia and Piedmont, MO. In areas with annosum root rot, the disease appeared to follow a pattern typical of root disease, with an identifiable "center" and damage spreading outward from that center. Additional field visits to the Kansas City area and Kirksville, MO, showed no sign of root disease, and attempts to consistently isolate pathogenic fungi from affected trees proved inconclusive. The bulk of reports of mortality of eastern red cedar coming in from northern and western Missouri have been from the Kansas City/St. Joseph areas. The typical symptom on the trees affected by the "unknown agent" was simply a relatively healthy tree that would turn an olive green color and then within two weeks turn completely brown. Basal cankers, collar rots, or root rots on most trees were not observed. Trees tended to be random in distribution, where affected trees in windbreaks seemed to be in uniform soil structure, aspect, drainage, and compaction to healthy trees. In general, the pattern of mortality did not appear to be spreading to neighboring trees. The vast majority of cedars affected have been fairly young (5- to 20-year-old) in both planted windbreaks and natural stands. Relatively low percentage of trees are actually affected in most property situations (i.e. less than 1 percent), but some properties have higher mortality rates (i.e. up to 5 percent). The majority of the trees died early this spring, however recent trips to and reports from north central Missouri have revealed that red cedars are still dying. The only consistency found in affected trees was the presence of extremely high numbers of bark beetles. It appears that the bark beetle infestations may be the eventual cause of death, however we still suspect something else has incited their attack of apparently healthy trees.

Northeast Kansas: Mortality has affected primarily windbreak trees, generally <5 percent of trees affected on any given site. The condition initially showed up in late April/early May as "off" color and defoliation. Within a couple of weeks, the trees were totally dead. Excavated root systems look healthy, with no pathogens identified. Abiotic causes are suspected.

Iowa: Iowa Department of Natural Resources started receiving reports of eastern red cedar and white cedar (arborvitae) declining statewide in late April. The symptomatic trees started out healthy, turned a pale green color, and completely browned by the second week in May (about a 2-week time period). The decline has continued to be reported within the state. Several fungal infections have been identified on the declining trees, including: Pestalotia twig blight (*Pestalotiopsis* spp.), Berckmann's blight (*Seimatosporium berckmanssii*), Phomopsis twig blight (*Phomopsis juniperovora*), and Kabatina blight (*Kabatina juniperi*). These fungal blights were identified on the branchlets and foliage, but not on the established twigs. In addition, 12 of the 173 trees that were destructively sampled had Annosum root rot (*Heterobasidion annosum).*

The abrupt mortality, widespread distribution of the mortality throughout the state, and the fact that the declining trees did not have one pathogen uniformly found on the declining trees leads us to believe that other factors may be involved. Most of the destructively sampled trees had evidence of bark beetle activity. Typically bark beetles are considered secondary pest on junipers, but all of the affected trees did have some bark beetle activity. The damage we are finding seems sporadic where only a few trees may be affected in a windbreak planting. Iowa plans to continue looking into the problem and will begin scouring the roots and other plant tissues to see if there are signs of nematodes. Nematodes have not been identified at this time.

Conclusion and Recommendations: Some cedars are being killed by Annosum root rot, but a common cause of death appears to be bark beetle attacks following other stressors. If no other damaging agents are determined, the mortality may be a result of the various fungal diseases thriving during this cool

moist spring, along with bark beetle attack. Pathologists will continue to follow the problem, keeping in mind that the mortality could be a result of the unusual weather events and that the problem may subside once "normal" weather returns. The current management recommendation is to remove and completely destroy the dead and dying junipers. Trees that are already heavily infested with bark beetles will not recover, and this "sanitation" will reduce emerging beetle populations, as well as destroying the fungal pathogens that may be present on the foliage.

Thank you to Tivon Feeley (Iowa), Mark Schall (Missouri), and Megan Kennelly (Kansas) for sharing this information!

Japanese beetles have been reported to be on the rise throughout southern and central Iowa. Japanese beetles have been moving west for years, and they are now considered present everywhere east of the Mississippi River, plus Iowa and Missouri. However, populations are still building in many places, so the level of damage fluctuates widely. Japanese beetles cause damage in both the adult and larval stages. The larvae are white grubs that feed on the roots of grass and other plants. The adults feed on leaves of many herbaceous and woody plants, including basswood, cherry, apple, oak, and some maple. If you have increasing problems with Japanese beetle in your area, check out the USDA homeowner's handbook on managing Japanese Beetle.

Japanese Beetle adults and damage.
Photo by David Cappaert, Michigan State University, Bugwood.org

Japanese beetles should not be confused with Asian Multicolored Lady Beetles. People keep telling me those are a "beneficial" insect, despite the fact that I find them a huge nuisance and I'm convinced they're displacing the little red ones with spots that used to "bring me luck" when they landed on me.

They also should not be confused with Asian longhorned beetle (ALB), which are big black and white bugs with long antennae. ALB does kill trees, especially maples and elms. Report any ALB you see immediately, as we don't think that these are established in the Central States.

Granulate ambrosia beetle (GAB) attacks were reported on multiple host species in a central Missouri nursery and several walnut plantations in southwest Missouri this spring. In one plantation, one-third of walnut seedlings planted last fall were attacked and killed by the GAB. Missouri Department of Conservation began receiving reports of GAB attacks in 2002. The number of reports has fluctuated from year to year, but this spring saw an increase. GAB, also known as the Asian ambrosia beetle (*Xyolsandrus crassiusculus*), is one of the ambrosia species known for its production of "frass sticks" that extend out from the bark. Burgundy-colored sap ooze also seems to be characteristic of GAB attacks. Frass sticks can be produced by other ambrosia beetle species known to be in Missouri (*Xylosandrus germanus* and others), so presence of frass sticks is not a definitive indication that GAB is present. However, frass sticks were not reported prior to 2002, so it's likely that many frass stick reports are due to GAB. In Missouri, GAB has been confirmed in black walnut, oak (unknown species), plum, peach, and paper mulberry. Other species where frass sticks have been observed include red maple, sugar maple, Japanese maple, northern red oak, yellow poplar, American elm, Chinese chestnut, golden raintree, and mimosa.

"Frass sticks" from GAB attacks on a black walnut log.
Photo by Rob Lawrence, MDC

Bacterial Leaf Scorch (BLS), caused by the bacterium *Xylella fastidiosa*, is an emerging forest health concern in the Midwest. It affects the tree's water conducting tissues or xylem, resulting in symptoms of water deficit, or "scorch" beginning at the margin of leaves and progressing toward the midrib, often late in the growing season. Symptoms recur each year and spread over the tree's crown, often causing reduction in growth and dieback. BLS has been a significant shade tree problem in the eastern and southeastern U.S. for many years,

but the distribution and host range in the Midwest are still unclear. Dr. Gerry Adams of Michigan State University has been working to resolve this, with a comprehensive survey of symptomatic trees in the Midwest. In 2008, Dr. Adams confirmed the presence of BLS in Illinois, Indiana, Missouri, Wisconsin and Kansas. He hopes to receive samples from Iowa in 2009. Hosts in 2008 included: mulberry, swamp white oak, shingle oak, bur oak, red oak, pin oak, white oak, witchhazel, white ash, and *Acer* sp.

In 2009, Dr. Adams would like to receive additional samples from symptomatic trees. **This is where you can help.** If you would like to submit samples, contact Dr. Gerry Adams at gadams@msu.edu and he will provide a postage-paid tyvek envelope. Alternatively, you can submit samples directly to Dr. Gerry Adams, Department of Plant Pathology, Michigan State University, 107 Integrated Plant Systems Center, East Lansing, MI 48824-9902. The information needed with each sample includes:

- Whether the sample is urban, rural, or forest
- Tree species or common name
- Submitter's contact information
- Location of sample (state, country, city, street address)
- If possible, include GPS Coordinates WGS 84 (or indicate datum and format used)
- Crown symptoms (percent of foliage affected by scorch symptoms)
- Percent dieback (low [<5 percent], moderate [5-20 percent], or high [>20 percent])

Thousand Cankers Disease of black walnut – Throughout the western U.S. in recent years, a decline of walnut has manifested into a significant threat to eastern black walnut. The disease is primarily caused by a native bark beetle, the walnut twig beetle (*Pityophthorus juglandis*) and the likely exotic, unnamed canker fungus of the genus *Geosmithia*. Walnut twig beetles carry *Geosmithia* spp. spores on their bodies. When beetles begin to attack a tree, the fungus is introduced and grows in advance of bark beetle tunneling. On black walnut, walnut twig beetles almost always attack branches larger than 2 cm and sporadically attack large branches and stems. Lesions caused by the *Geosmithia* spp. cause small diffuse cankers which may not be visible until the outer bark is removed. Many beetle attacks result in many cankers. As those cankers coalesce, the branches and stems are girdled, resulting in branch dieback and death of trees. Due to the stress on trees from walnut twig beetle tunneling and *Geosmithia* cankers, a second opportunistic canker fungus, *Fusarium. solani*, begins to cause elongated cankers on the base of stressed trees.

Apparently, this destructive disease of black walnut is not in the native range of eastern black walnut; however the disease is expanding in California, Idaho, Oregon, Washington, Utah, Arizona, New Mexico, and Colorado. Infested walnut wood (logs, firewood, nursery stock, rootstock, etc.) leaving these states poses a significant threat to black walnut throughout the eastern U.S. and especially Midwest. An assessment is being planned by APHIS PPQ to determine various pathways that infested/infected walnut plant materials could be introduced to the Midwest.

Photos and more information can be found in Colorado State's 1000 cankers Pest Alert.

A Thousand Cankers meeting is being planned for this fall in St. Louis, MO. Researchers, forest health specialists, and various other stakeholders will be invited to raise the awareness and understanding of this disease. For more information about the meeting, contact Doug LeDoux, Missouri Department of Agriculture Douglas.LeDoux@mda.mo.gov.

(Thanks to Mark Schall, Missouri Dept. of Conservation, for this information.)

Other Resources and Sources of Information

Meet your Forest Health Specialists:

Iowa DNR: Iowa's Forest Health Specialist is Tivon Feeley. Tivon's office is in Des Moines, IA, and he can be reached at Tivon.Feeley@dnr.iowa.gov or (515) 281-4915.

Missouri Department of Conservation— Rob Lawrence continues as Forest Entomologist, located in Columbia, MO. Rob can be reached at Robert.lawrence@mdc.mo.gov, or (573) 882-9909 (ext. 3303). Missouri was pleased to welcome Dr. Mark Schall as Forest Pathologist in January 2009 (replacing Bruce Moltzan, who took a job with the Forest Service in Washington, DC). Unfortunately Dr. Schall will be heading to a different job in Pennsylvania in August, so Missouri will once again be temporarily without a pathologist.

Illinois Department of Natural Resources—Tom Wilson is the primary Forest Health Program contact. However, a contract agreement between the IL DNR and the Morton Arboretum allows Frederic Miller to provide some forest health assistance within Illinois. If a forest health question arises in Illinois contact Tom Wilson at tom.wilson@illinois.gov or (618)498-1627.

Indiana Department of Natural Resources—Phil Marshall continues to be the Forest Health Specialist in addition to his role as State Entomologist. Phil can be contacted at pmarshall@dnr.in.gov, or (317) 232-4189. Indiana's Forest Entomologist position in the Division of Forestry is currently vacant.

Extension Plant Clinics are also a diagnostic resource in your state. Check these clinics on the web:
Iowa State University Plant and Insect Diagnostic Clinic
University of Missouri Plant Diagnostic Clinic
University of Illinois Plant Clinic
Purdue University Plant and Pest Diagnostic Lab

The Northeastern Area of the Forest Service hosts a website with Forest Service publications on many important insect and disease problems.

From September 28-October 1, 2009, Manitoba will host the **North Central Forest Pest Workshop (**NCFPW) in Winnipeg, Manitoba. The NCFPW is an annual gathering of persons interested in forest health in the North Central portion of North America. It is usually attended by entomologists, plant pathologists, foresters, and other scientists and students. Each year it is held in a different location. This year's theme is "Protect What We Have," focusing on ways to protect our native forests from invasive pests. Additional information will be posted on the NCFPW website as it becomes available.

Do you find the information in the CSFHW useful? Does this format "work" for you? If so, please send a short e-mail to lhaugen@fs.fed.us. Your response will help guide whether we continue with this effort.

Feature Topic: Research results on hickory mortality

In recent years, higher than expected levels of decline and mortality of bitternut hickory (*Carya cordiformis*) have been observed in states of the North Central and Northeastern U.S.. Additionally, in 2005 two new pathogens of hickory (*Ceratocystis smalleyi* and *C. caryae*) were described by Iowa State University. In 2006, Dr. Jennifer Juzwik of the U.S. Forest Service Northern Research Station and Linda Haugen of the U.S. Forest Service Northeastern Area initiated a series of studies to survey for extent of damage and determine the role of the various pathogens in hickory decline.

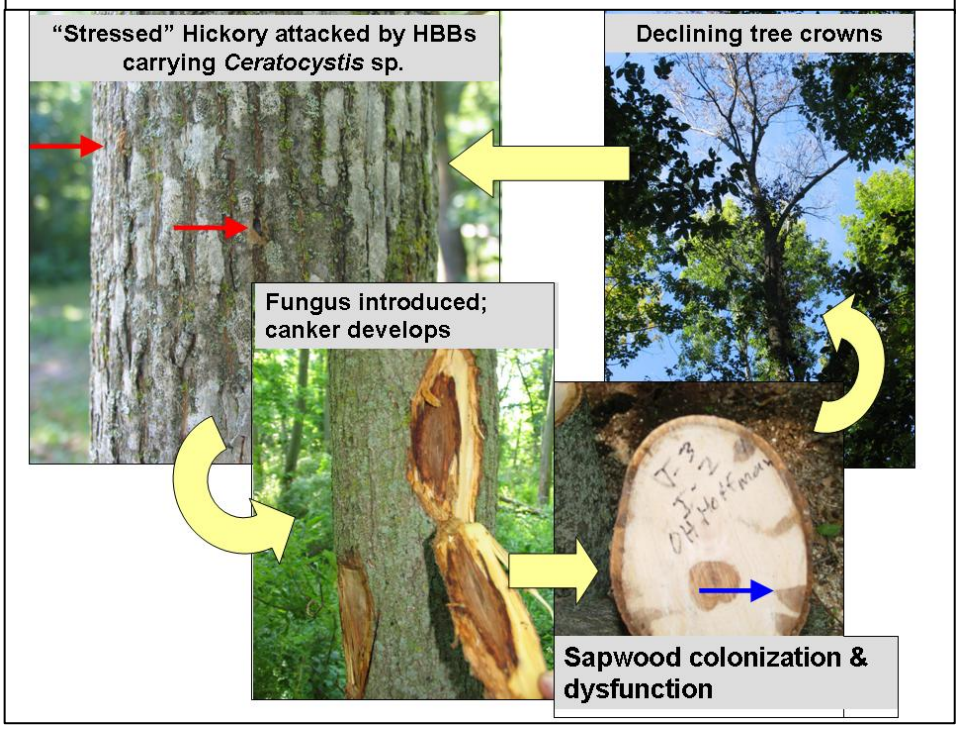
Field Surveys to define extent and sampling to determine primary causes of mortality.

Preliminary surveys of declining hickory in 13 stands in Iowa, Minnesota, and Wisconsin were conducted in 2006. We frequently isolated *Ceratocystis smalleyi* from diffuse cankers and *Fusarium solani* from sunken, annual cankers.

In 2007 and 2008 we conducted either reconnaissance (2- to 3-hour) or transect (6- to 8-hour) surveys on 25 sites in Iowa, Minnesota, Wisconsin, Indiana, New York and Ohio. In the reconnaissance surveys, qualitative and/or categorical data on stand characteristics and level of decline/mortality were recorded. In the transect surveys, quantitative data were collected from radial and point plots along three parallel transects. For both survey types, three trees exhibiting the most common types of damage observed on a site were felled. Four, 0.8 m long stem sections were cut from each tree and transported to the laboratory. Insects were emerged ($\leq$ 45 days) from two stem sections of each sampled tree and identified to genus or species. Fungal isolations were attempted from symptomatic sapwood associated with stem damage present on the other two sections.

The combined data from 2007 and 2008 indicate that **at least three scenarios of hickory damage were common. By far the most common scenario was rapidly declining crowns and foliar wilt symptoms, resulting in tree death within one to two years of first crown symptoms. These trees commonly had diffuse cankers from which *Ceratocystis smalleyi* was frequently isolated. The *C. smalleyi* cankers were often associated with attacks and galleries of hickory bark beetle (HBB) (*Scolytus quadrispinosus*).** The hickory timber beetle (*Xyleborus celsus*) was also fairly common (6 out of 14 stands in 2007, 13 percent and 9 percent of emergence in 2007 and 2008, respectively) on declining trees, but HBB was much more abundant on most sites (present in all stands; 74 percent and 91 percent of emergence in 2007 and 2008, respectively). The association of multiple insect pests and tree pathogens with declining hickories in the stands suggests that hickory mortality is not attributable to drought and HBB population increases alone. Our current working hypothesis is that stressed hickories are attacked by HBBs carrying viable spores of *C. smalleyi* on their bodies. During aborted and successful attacks, the fungal spores are dislodged, germinate and infect the attacked host. Diffuse cankers and sapwood infections resulting from the fungal colonization further stress the tree, leading to more beetle attacks. Current studies are underway to determine whether *C. smalleyi* can cause the rapid wilt, crown decline and tree death (1 to 2 years) observed during the field surveys.

Hypothesized progression of hickory mortality involving HBB and *Ceratocystis* spp.



Another common scenario was crown dieback with associated stem damage from multiple causes. In this scenario, dieback did not appear to be proceeding rapidly to tree death. The stems of these trees often had sunken, annual cankers. *Fusarium* spp. (all isolates were *F. solani* in 2007) was commonly isolated from discolored wood under these sunken cankers.

A third scenario was presence of globose galls and/or rough bark swellings. *Phomopsis* sp. was commonly isolated from discolored wood associated with globose galls.

<u>Field Pathogenicity Study</u> to determine the role of pathogens.

In order to determine the relative aggressiveness of several putative pathogens on hickory, we conducted a limited field pathogenicity study in 2007-08. We selected twelve pole-size (5 to 11 inch DBH) bitternut hickories in a mixed hardwood stand undergoing tree stand improvement in Northeast Iowa. We used two isolates of each of three fungal taxa (*C. caryae*, *C. smalleyi*, and *Fusarium solani*) obtained from other Iowa sites. Mycelial inoculum of each was placed aseptically in small, xylem-penetrating wounds. At six months following inoculation, we observed the responses and harvested two of the study trees for preliminary assessment. Twelve months after inoculation (May 2008), all remaining study trees were harvested and data recorded including canker incidence, extent of inner bark necrosis, and volume of sapwood discoloration. Re-isolation of the inoculated fungi was attempted. We also inoculated small branches of hickory saplings with *Phomopsis* isolates, but did not acquire any conclusive symptoms or results.

Simplified table of results of fungal inoculation to bitternut hickory stems, 12 months post-inoculation				
Fungal taxa	Number of stems with canker (out of 10)	Ave. area of bark necrosis (cm^2)	Ave. volume of sapwood discoloration (cm^3)	Number of stems from which inoculated fungus was recovered
C. smalleyi	9	22.4	38.2	5
C. caryae	7	6.2	6.0	8
F. solani	8	7.4	9.0	9
Sterile agar (control)	3	4.0	7.2	9 (we isolated *Fusarium spp*. out of the control inoculations)

Clearly *C. smalleyi* caused much greater damage to the stems of bitternut hickory. The amounts of necrosis and sapwood discoloration caused by *C. caryae* and *F. solani* were similar to the amounts caused by the sterile agar control treatment. We were able to re-isolate the pathogen from the cankers around many of the inoculation points. **Based on these results, *C. smalleyi* is a much more virulent pathogen on pole-sized bitternut hickory, and it is the species most likely to contribute to bitternut hickory decline and death.**

Further research is currently underway by Dr. Jennifer Juzwik and graduate student Ji-Hyun Park. These studies include determination of the impact on hickory health of introduction of *C. smalleyi* at multiple inoculation points (simulating introduction of the fungus by HBB attack) and isolations of fungi present on the bodies of HBB. Additional field studies will also help to determine the relative importance of *C. smalleyi* (vs. hickory bark beetles) in causing rapid decline and death of hickories.

Our Current Understanding

- Hickory Bark Beetle and *Ceratocystis smalleyi* are responsible for a distinct rapid decline and death of hickory. The relative roles of *Ceratocystis smalleyi* versus HBB are still under investigation.
- In addition, many other agents (including *Phomopsis* spp., *Fusarium* spp., and perhaps *C. caryae*) are involved in dieback of hickory.

This newsletter is also available on the WWW.

Northeastern Area

Indiana

For More Information:

Forest Health Protection
USDA Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
(651) 649-5029
lhaugen@fs.fed.us