Missouri Forest Health Highlights - 2012

Invasive Species

Emerald Ash Borer – The emerald ash borer (EAB), *Agrilus planipennis*, is a non-native forest pest that is causing devastating impacts on ash trees in North America. It has been detected in 18 US states and 2 Canadian provinces and has killed millions of ash trees. The first EAB population detected in Missouri was discovered in 2008 in Wayne County in the southeastern part of the state. That remained the only known Missouri population for the next few years in spite of annual detection (trapping) surveys and increased outreach efforts. In 2012, additional infested areas were detected in counties adjacent to Wayne County and on the other side of the state in Platte County near Kansas City.

Emerald ash borer adult
(David Cappaert, Forestry Images)

Detection surveys using EAB sticky traps are conducted annually in Missouri. In 2012, a total of 923 traps were monitored throughout the state. The Missouri Dept. of Agriculture (MDA) placed and monitored 283 traps in 21 counties and the City of St. Louis. The U.S. Dept. of Agriculture (USDA APHIS PPQ) was responsible for 640 traps in 93 counties.

Larval tunnels on first EAB-infested tree detected near Kansas City, Missouri.

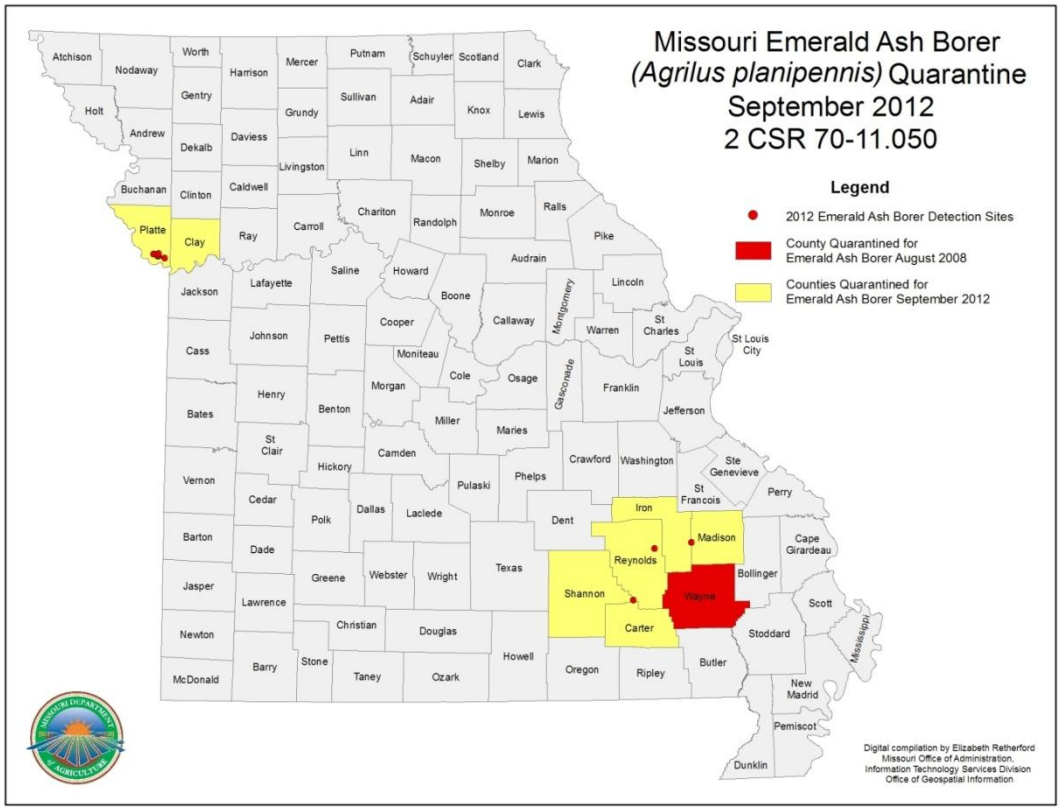
This year's survey resulted in the first detections of EAB in Reynolds and Madison Counties in southeastern Missouri. EAB adults were captured in traps at two sites in southwestern and eastern Reynolds County and one site in western Madison County.

The infestation in the Kansas City area was detected by an alert arborist who had been called to a residence to examine a dead ash tree. Staffs of the Missouri Dept. of

Conservation (MDC), MDA, and USDA APHIS PPQ cooperated in the initial investigation, outreach efforts, and delimit surveys in Platte, Clay and Jackson Counties. EAB-infested trees were detected in an area greater than 6 miles wide in southern Platte County, indicating the infestation has been present in the area for several years.

Some infested trees in Platte County are less than 5 miles from the Missouri River and the state border with Kansas. Subsequent investigations by the Kansas Dept. of Agriculture revealed an EAB infestation in neighboring Wyandotte County, Kansas.

Missouri and federal EAB quarantines were expanded in September 2012 in response to the new detections. Shannon, Carter, Reynolds, Iron and Madison Counties were added in southeastern Missouri, and Platte and Clay Counties were added in the Kansas City area.

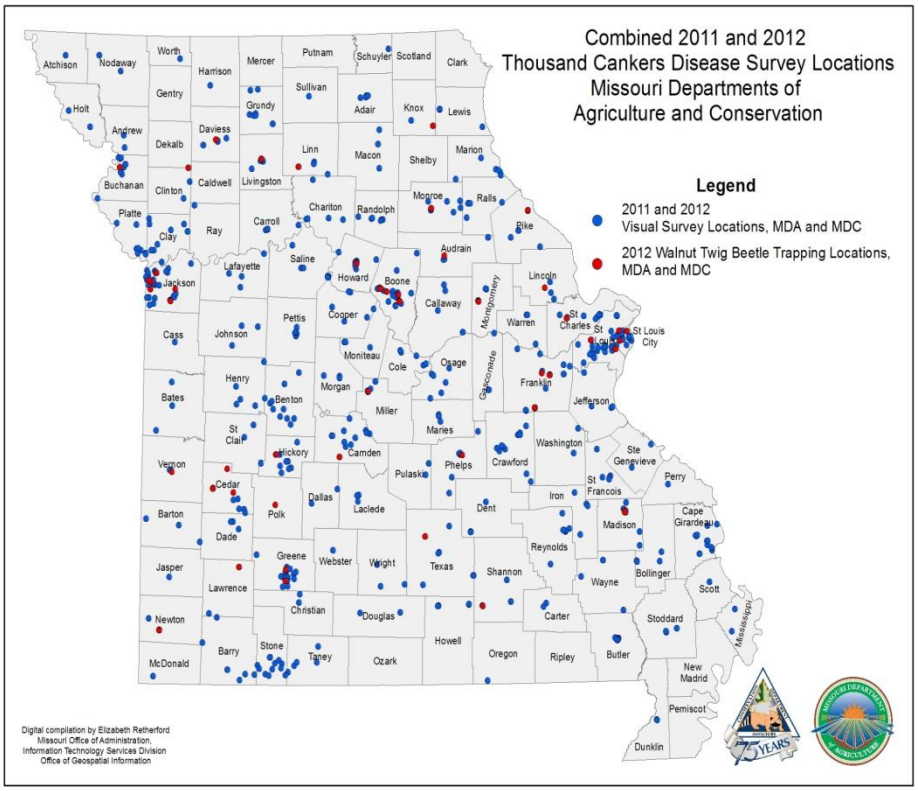


Outreach efforts by the Missouri EAB Program and its partners continue around the state. Workshops to educate community leaders and the green industry were held in Kansas City and St. Louis following the new EAB detections. Displays, presentations and other outreach activities occur at many workshops, fairs and other venues throughout the year, including a visit to a St. Louis Cardinals ballgame by a suspicious looking six-foot tall emerald ash borer. Missourians are encouraged to be alert for evidence of infestations and visit this web site to learn more and report suspect infestations: http://eab.missouri.edu

The MDA and the U.S. Army Corps of Engineers (USACE) have been involved in efforts since 2009 to monitor and slow the spread of the EAB population centered on the USACE Greenville

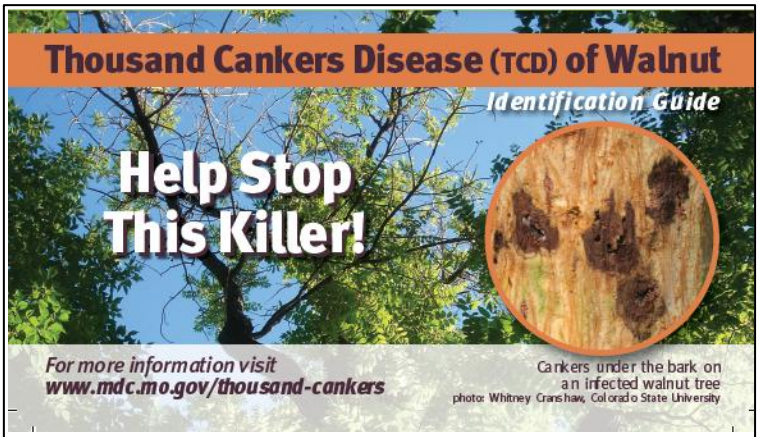
Recreation Area in Wayne County. Multiple tactics including ash tree removal and destruction, girdled trap trees, and insecticide-injected trap trees have been employed and described in previous years' reports. In 2012, biological control activities were begun. A total of over 38,000 adults of three species of parasitic wasps (*Oobius agrili*, *Testrastichus planipennisi*, and *Spathius agrili*) were released at the Greenville site in spring. These natural enemies are specific in using primarily the emerald ash borer as their host and will not sting humans, pets or livestock. They previously have been released in a number of other EAB-infested states. Further details are available at: http://www.emeraldashborer.info/biocontrol.cfm

Thousand Cankers Disease - Black walnut is ecologically and economically important to Missouri, and thousand cankers disease (TCD) represents a serious threat to this resource. TCD occurs when the walnut twig beetle (WTB), *Pityophthorus juglandis***,** attacks walnut trees, spreading the *Geosmithia morbida* fungus that causes small cankers in the phloem tissue under the tree bark, eventually causing tree decline and mortality. TCD has not been detected in Missouri; however there is concern that undetected TCD infestations could be present, or that spread may occur from western states or Pennsylvania, Tennessee and Virginia where it has



been detected. Potential long-distance spread of TCD through movement of infected walnut materials enhances this threat. Existing survey technology is not very sensitive, and TCD is unlikely to be detected until several years after introduction. Detection of well-established infestations makes eradication efforts difficult. It is important to conduct surveys for TCD as well as inform citizens about the disease and the risk of wood movement from areas with known infestations.

A visual survey was conducted in 2012 by MDC and MDA with USDA Forest Service and federal Farm Bill funds. Staff examined trees at 257 high-risk locations including campgrounds, mill sites, and urban areas. Sample branches were examined from symptomatic trees. When suspicious symptoms were observed under the bark, sample branch sections were triple-bagged, placed in a cooler with ice and transported to diagnostic facilities for evaluation and culturing as needed. WTB pheromone-baited Lindgren funnel traps were placed at 62 high-risk locations with declining walnut trees. Since 2010, more than 600 locations have been surveyed visually and no evidence of WTB or TCD has been detected in Missouri. Common walnut problems detected during surveys included drought stress, site-related issues, and infestation by several other wood-boring insects (primarily roundheaded and flatheaded borer larvae).



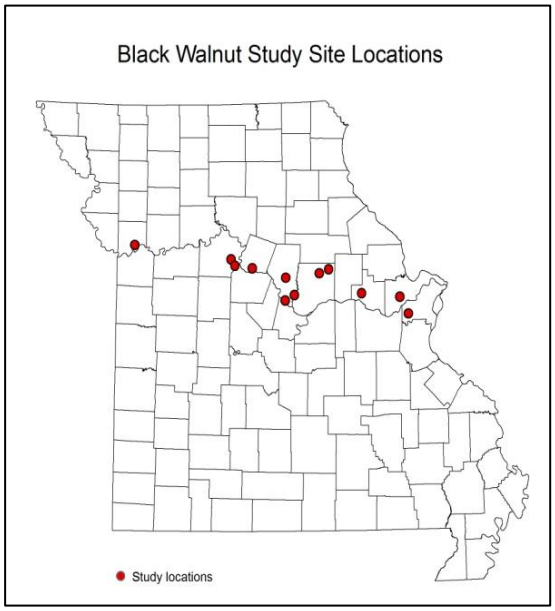
An identification card with key TCD messages

Outreach efforts were continued to raise public awareness about TCD. Messages included the potential impact of TCD, the threat posed by movement of infected walnut materials, and identification of suspect trees. Several state agencies and institutions including MDC, MDA, University of Missouri Extension, as well as stakeholder groups were involved in outreach. Efforts have included brochures, posters, a website at www.mdc.mo.gov/thousand-cankers, news releases, presentations, trainings, and displays at a variety of public and green industry meetings. An email address and online reporting form at http://extension.missouri.edu/scripts/eab/forestpestsreport.asp has been publicized as a place to email photos of suspect trees as a first step in determining what trees should be visited by trained personnel.

An action plan has been drafted to organize the Missouri response to the threat of TCD. The plan describes several efforts to slow the spread of TCD and prepare for a potential detection including continued outreach activities and monitoring of trees at high risk sites. It also describes a response to detection of an infestation and includes a list of key stakeholders to keep informed. This is an evolving document that will be updated as new information about TCD becomes available.

Thousand Cankers Disease Research – Research to improve our knowledge of TCD is critical to protect our walnut resource. Projects are ongoing in many states. In Missouri, research is addressing the role ambrosia beetles and bark beetles other than WTB could play in spreading *G. morbida* or other fungi involved in the decline of TCD-positive trees. University of Missouri researchers Dr. Sharon Reed and Dr. Jim English collaborated with USDA Forest Service

(USFS) Northern Research Station researcher Dr. Jenny Juzwik on a USFS Forest Health Protection-funded project to survey for WTB, identify bark and ambrosia beetles that attack stressed black walnut, and identify fungal associates of the beetles. Twelve study sites were established in walnut plantations, and urban and rural forests. Three months after girdling and treating trees with glyphosate herbicide, wood sections were collected from the main stem and canopy of 48 trees. Insects emerging from these sections were identified.



More than 90% of the beetle species collected from walnut log sections were exotic. Of 7,304 specimens collected, 7 ambrosia beetle, 2 bark beetle, and 6 weevil species were represented (Table 1). Four ambrosia beetle species were the most abundant species of all beetles collected (Table 2). Other species collected were: 1) ambrosia beetles *Ambrosiodmus rubricollis*, *Monarthrum mali*, and *Xyleborus ferrugineus*, 2) bark beetles *Hypothenemus eruditus* and *Hypothenemus interstitialis*, and 3) weevils *Himatium errans*, *Caulophilus dubius*, *Tychius picirostris*, *Plocamus hispidulus*, *Dryophthorus americanus*, and *Stenomimus pallidus*.

Table 1. Insect taxonomic groups collected from sections of girdled walnut logs.

Taxonomic group	No. of species collected	Percent of specimens collected
Ambrosia beetles (Scolytinae)	7	98.0
Bark Beetles (Scolytinae)	2	0.1
Weevils (Cossoninae)	6	1.6

Table 2. Four species were the majority of the beetles collected.

Species	Beetles collected (%)
Xyleborinus saxesenii	83.0
Xyleborus affinis	6.0
Xylosandrus germanus	5.5
Xylosandrus crassiusculus	3.0

Five beetle species (*X. saxesenii*, *X. crassiusculus*, *X. germanus*, *X. affinis,* and *S. pallidus*) were cultured to isolate fungal associates. Frequently cultured fungi were identified by DNA analysis. *Fusarium solani,* a species pathogenic to black walnut, and wood stain fungi such as *Graphium penicilloides* and *Scytalidum cuboideum* were regularly associated with beetles. *Geosmithia pallida*, a species not believed to be pathogenic, but is related to *G. morbida*, was also detected. Other fungi associated with 10% or more of the beetles were *Aspergillus niger*, *Penicillium sumatrense*/*P. meleagrinum*, *P. kloeckeri*, and *Scytalidium cuboideum*.

Many types of ambrosia and bark beetles attack stressed walnut in Missouri and would be expected to attack trees infected with TCD. These beetles regularly transport several fungal species. It is likely that these beetles would transport *G. morbida* after coming into contact with diseased tissues. It is unknown if transmission would lead to new TCD infections in stressed trees. *F. solani* was a common associate of ambrosia beetles and *Fusarium* infections may lead to further decline of TCD infected trees. Pathogenicity of fungal isolates is being tested.

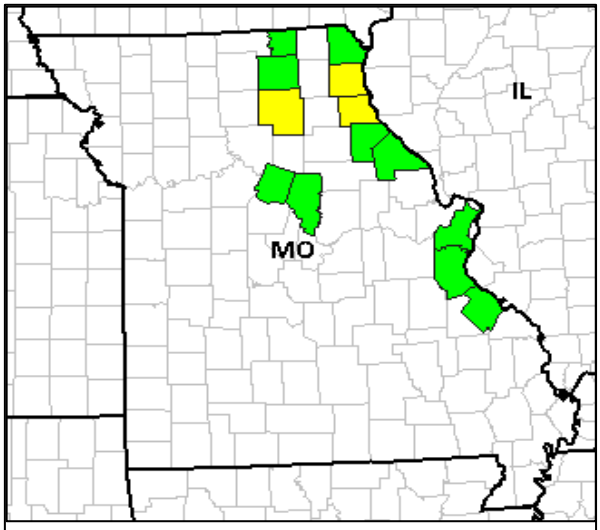
Pine Shoot Beetle – First Detection in Missouri - The pine shoot beetle (*Tomicus piniperda*), a bark beetle pest of pines in Europe and Asia, has been detected for the first time in Missouri. This beetle was first detected in the U.S. in 1992 and is now known to be established in 19 other Midwestern and northeastern states and two Canadian provinces. Pine shoot beetles (PSB) were collected in Missouri during summer 2012 in traps operated by the MDA in Macon, Marion and Lewis Counties. Additional traps were placed in north central Missouri (several survey sites ranging from Schuyler to Boone Counties) and eastern Missouri (from Clark to Ste. Genevieve Counties), but no PSBs were detected in those locations.

Pine shoot beetle adult in pine shoot
(Photo: Steve Passoa, Forestry Images)

Although not a severe forest threat like emerald ash borer or thousand cankers disease, the PSB has the potential to be a significant pest in stressed pine stands. Like other bark beetles, PSB reproduces in galleries under the bark of the main stem and major limbs. It is a secondary colonizer in that regard, because it only successfully attacks severely stressed, dying, or recently killed pines.

But unlike most bark beetles, PSB also has a shoot tunneling period during the adult stage. It is a primary colonizer for shoot tunneling; it readily attacks shoots of healthy pines. Where there are severely stressed or recently dead pines in which PSB populations can reproduce and increase, they can significantly damage shoots on healthy trees and reduce tree growth.

In North America, PSB is most commonly found in Scots pine (*Pinus sylvestris*), although it can successfully breed and shoot-feed in several North American pine species. PSB has been considered primarily a Christmas tree pest in North America because of its shoot feeding behavior. Nevertheless, since its first detection here, concerns have been raised about what impacts PSB will have when it eventually reaches the range of southern pines. There is a 20-year history of research, regulation and management experience in the U.S. upon which to draw guidance for managing and regulating PSB in Missouri. However, we have some unique challenges. Missouri is located on the southern edge of the PSB range in the U.S., although PSB's distribution worldwide extends to more southern latitudes elsewhere. As the PSB expands its range farther south, the warmer climate will likely affect the insect's biology and the annual timing of management activities for this insect. PSB is nearing the range of shortleaf



2012 Pine shoot beetle survey in Missouri
Yellow: Positive counties (PSB Quarantine)
Green: Negative counties
Map from NAPIS Pest Tracker (pest.ceris.purdue.edu)

pine (*P. echinata*). How this insect will behave in shortleaf pine stands with our Missouri climate is unknown. Studies in Ohio confirm that PSB can reproduce in shortleaf pine logs and can feed in shortleaf pine shoots. Another consideration is the occasional heavy defoliation by pine sawflies in southern Missouri. It's unknown if sawfly defoliation can stress shortleaf pines severely enough to allow PSBs to reproduce in them and thus build up damaging populations.

A federal quarantine and various state quarantines (county-by-county or statewide) have been implemented in states where PSB has been detected to prevent the spread of this pest. The Missouri Dept. of Agriculture implemented a quarantine in 2012 that initially affects only the three counties where PSB has been detected. Pine nursery stock, Christmas trees, lumber with bark attached, and other raw pine materials are regulated.

Gypsy Moth - The multi-agency Missouri Cooperative Gypsy Moth Program conducted its annual survey to detect the presence of gypsy moths (*Limantria dispar*) by placing and monitoring over 6,000 traps in 2012.

Delimit areas of intensive trapping were established around four sites in eastern and northeastern Missouri where gypsy moths were captured in 2011 (one moth each in Callaway, Jefferson, Lewis and St. Louis Counties).

Only one moth was captured statewide in 2012, in Cape Girardeau County in southeastern Missouri. No moths were captured in delimit areas. No reproducing populations of gypsy moths have yet been detected in Missouri.

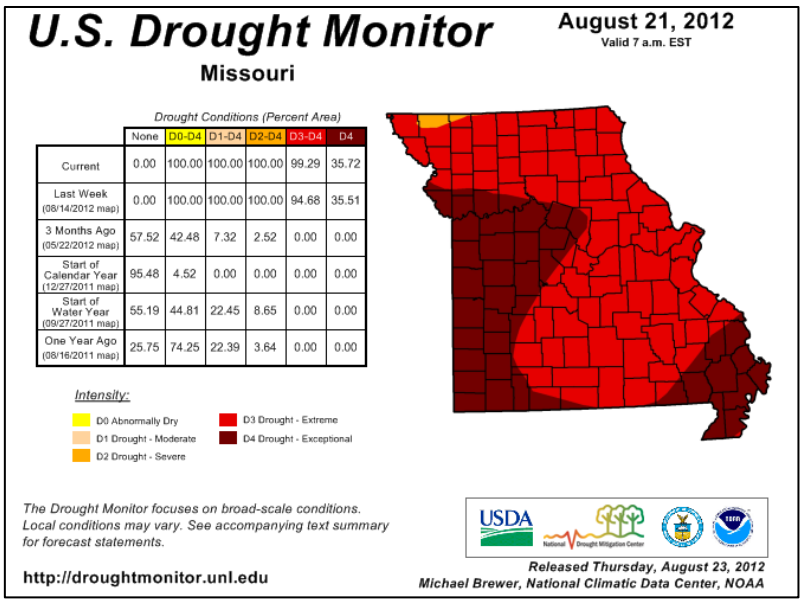
Weather-Related Issues

Extreme weather patterns were once again a major source of stress affecting forest health in Missouri in 2012. Impacts from this year's events will likely be seen for several years to come.

After above normal precipitation levels across much of the state during 2008 to 2010 and spring of 2011, the weather turned unusually hot and dry in July and August 2011. Those conditions were surpassed however by the extreme heat and drought that occurred in 2012.

Winter in 2012 was the warmest on record for Missouri. Spring arrived 3 to 4 weeks early with March temperatures averaging higher than typical April temperatures. Above normal temperature patterns continued through spring and summer. July was the hottest since 1980 and overall the January to September period was the warmest ever since records began in 1895. (Weather data provided by Pat Guinan, Missouri State Climatologist, http://climate.missouri.edu/)

Following near or above average precipitation in March in many locations, the weather turned very dry again, eventually developing into severe drought over most of Missouri by early July. By August 21, more than 99% of the state was in extreme or exceptional drought according to the U. S. Drought Monitor (http://droughtmonitor.unl.edu/). The summer period (June-July-August) was the third driest summer on record and driest summer since 1953. Conditions were eased at the end of August when rains arrived with remnants of Hurricane Isaac. But dry weather patterns continued through the fall. More than 90% of the state still had moderate to severe drought conditions by early December.



The extreme nature of this year's drought event and resulting stress on trees is expected to have impacts for several years, even if weather conditions moderate. Missouri's forests were already stressed by ice storms, wind storms, freeze events and extremes in precipitation that occurred within the previous five years. The incidence of red oak decline will likely increase in the Ozark forests of southern Missouri, as has occurred after previous droughts. The health of many ornamental trees that did not receive supplemental water is also expected to decline. Increased incidence of attacks by bark beetles, wood borers, canker diseases, and root

pathogens are likely. Surviving conifers are particularly at risk; most ornamental conifers are species not native to Missouri and not well adapted to Missouri's climate and clay soils.

Impacts of 2011 Flooding - Major flooding along the Missouri River in northwestern Missouri occurred throughout the summer of 2011. Impacts were most severe from the Iowa State line south to Kansas City. Early fall leaf color and leaf drop were present by late August 2011 on larger trees. Many smaller trees were totally brown. By summer 2012, tree mortality across all species was estimated at about 60% in the previously flooded bottomland. Greatest mortality occurred among elms, redcedar, walnut and cottonwood. Survival was higher among ash, silver maple, mulberry and sycamore.

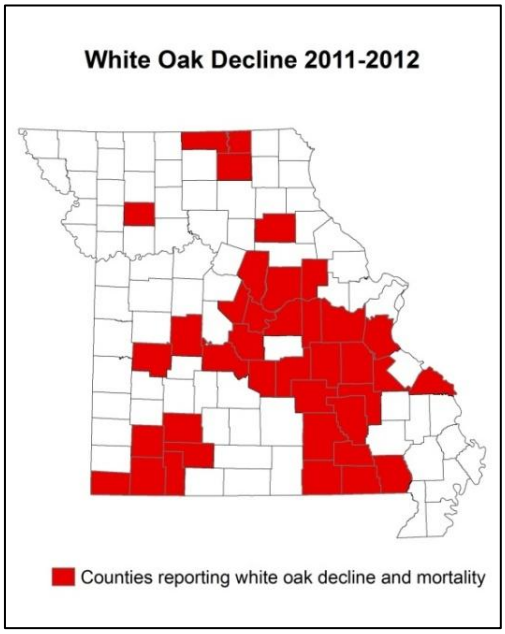
Other Forest Health Issues

Bur oak blight – In the upper Midwest, bur oak has been affected by bur oak blight (BOB), *Tubakia iowensis,* a serious leaf blight disease that has become more significant since the 1990s. Severely affected trees may die after severe blight over many years. BOB primarily affects a variety of bur oak*, Quercus macrocarpa* var. *oliviformis,* producing smaller acorns on upland sites. Iowa State University plant pathologists Tom Harrington and Doug McNew conducted roadside surveys across the northern two tiers of counties in Missouri and identified eight new positive counties, for a total of 10 positive counties in northern MO. While the number of infected trees was low, a few trees had severe symptoms. More information on bur oak blight is available at http://na.fs.fed.us/pubs/palerts/bur_oak_blight/bob_print.pdf

White oak decline – White oak is another ecologically and economically important species in Missouri, and increased decline and mortality represents a serious concern. Beginning in August 2011 and continuing through summer 2012, the MDC Forest Health staff received many reports of rapid white oak decline and mortality, often occurring within one growing season. While some reports were received from central and northern Missouri, a majority of reports came from east central and southeast Missouri. Additional reports from southwest Missouri involved multiple oak species and may be directly related to severe drought stress in recent years.

This syndrome has occurred on lower, wetter sites and north slopes with good soils as well as on ridges and with open-grown trees in managed landscapes. Some reports are solitary trees, but many reports are pockets of variable age to mature white oak. Other oak species are rarely affected. Hypoxylon canker, twolined chestnut borer and other native borers are frequently

observed. Some trees have evidence of Armillaria root rot. Depending on the location, white oak has been subjected to many stressors in recent years including multiple extreme weather events and jumping oak gall infestation in 2010. White oak decline continues to be investigated by state Forest Health staffs and University of Missouri researchers who hope to have additional information in the future.



Conifer problems – Reports of conifer decline and mortality have increased for a few years becoming quite significant in 2012. Pine, arborvitae, and spruce were severely affected. Many reports involve pine and arborvitae that rapidly turned brown and dried out during the growing season. Some Austrian pine samples were positive for pine wood nematode, while several white pine samples tested negative. Many spruce rapidly lost needles over a portion or the entire canopy. Some spruce samples were positive for Rhizosphaera needle cast, however other diseases were not detected. Most of these trees were impacted by the extreme environmental conditions over the past several years. Other predisposing factors such as poor site conditions and increasing competition for resources with other trees may play a role. Severe drought this year was the tipping point resulting in mortality.

Oak Pill Gall – In 2012, very heavy infestations of an oak pill gall were common on ornamental pin oaks across the state. Galls were caused by a midge believed to be *Polystepha pilulae*. Populations on some trees were so heavy that leaves were severely deformed, and in some cases the added weight caused branches to break and fall.

Oak pill gall on pin oak leaves

Leaf galls are not usually considered a serious concern for tree health, however the effects of heavy gall populations combined with the extreme drought stress this year could have impacts on pin oak health in the next few years. In 2010 a massive outbreak of the jumping oak gall caused browning of whole hillsides of Missouri forests. Populations on individual white oaks were so heavy that many leaves were deformed and dropped early. Damage severity was great enough that resulting tree stress may have played a role in the current white oak decline phenomenon.