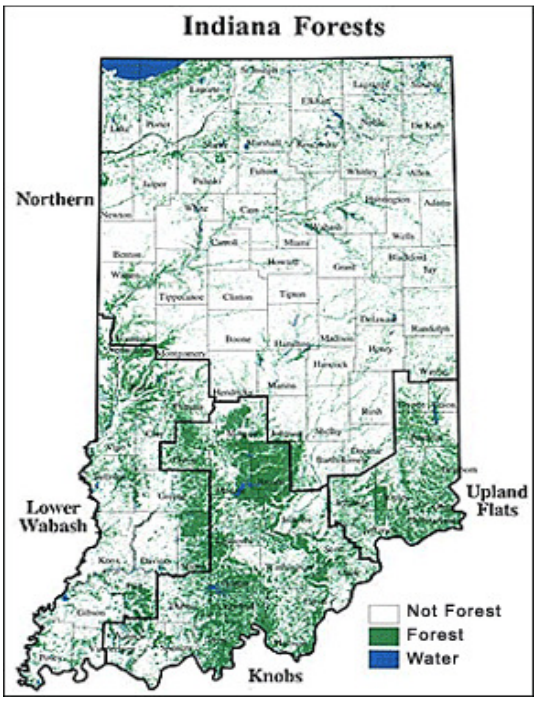
2008 Indiana Forest Health Highlights

1. Indiana's Forest Resources

Approximately one of five acres in Indiana — 4.7 million acres (including reserved or low-productivity land) — is covered in forest. Since 1950, forestland has increased more than 450,000 acres, and by nearly 52,500 acres between the last USFS Forest Inventory and Analysis (FIA) inventory (1998) and the current one (2003). Indiana has surprisingly diverse forests, encompassing northern maple / beech / birch types to southern bald cypress swamps. More than 85 different tree species grow in Indiana forests. Hardwoods occupied nearly 97 percent of this area, with the remainder classified as softwoods or nonstocked. Reflecting the effect of past glaciations, forests exist in large consolidated blocks chiefly in the hilly southern part of the state. In the northern two-thirds of the state, forests generally occupy scattered woodlots, wetlands, and riparian corridors.

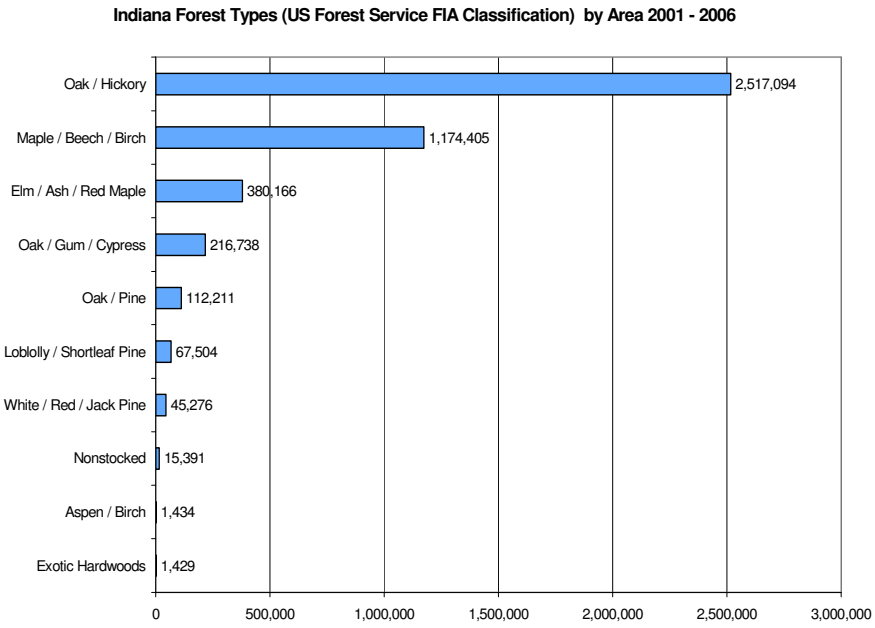


Indiana forest areas.

Growing Stock Volume

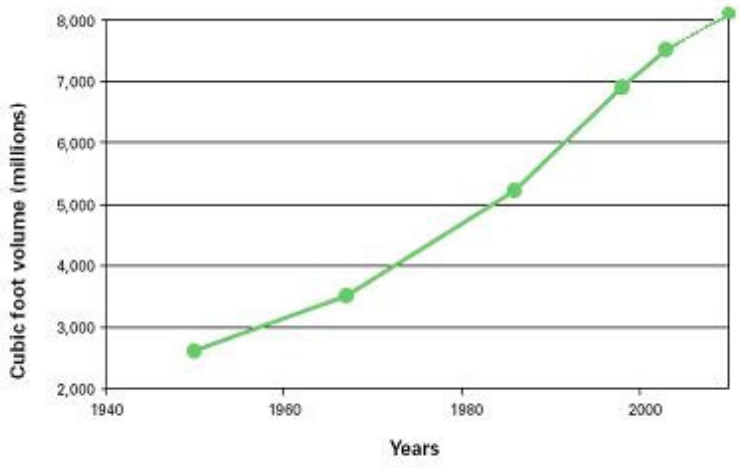
The total growing-stock volume on timberland has been increasing steadily. The net volume of growing-stock (trees with a DBH greater than or equal to 5 inches) on timberland in 2005 totaled 8.2 billion cubic feet, more than triple the 2.5 billion cubic feet estimated during the 1950 inventory. For the 1986, 1998, and 2003 inventories, the net volume was estimated at 3.6 billion cubic feet, 6.9 billion cubic feet, and 7.5 billion cubic feet respectively

Indiana Forest Types by Area



The net volume of hardwood species has increased over the last three inventories, except for white oak. Red oaks, followed by yellow-poplar and white oaks, have the largest growing-stock

Cubic foot volume of Indiana Forests 1950 - 2005



volume across Indiana with roughly 1 billion cubic feet growing stock each. Yellow-poplar, in particular, achieved the greatest gains in overall net volume since 1986. Most hardwood species have shown an increase in larger diameter volumes since 1986 and a stabilization of smaller diameter volumes. Currently, 5.9 billion cubic feet (or 72%) total growing-stock volume is sawtimber.

Acre per acre, Indiana's growing stock volume in 2003 was 11 percent greater than neighboring Michigan's, with board foot volumes 300 percent greater. Indiana's per-acre standing sawtimber volume dwarfs other states in the region, with nearly double the board feet volume per acre (4,380 board feet versus regional average of 2,328 board feet) of the average found in Michigan, Wisconsin, Minnesota, Illinois, Missouri and Iowa.

Annual Growth

Average annual net volume growth of Indiana's forests (growing-stock growth minus growing-stock mortality on timberland) has increased substantially since 1967 and is in 2006 estimated at 356.2 million cubic feet per year. Average annual net growth in 2006 continues to increase from last inventory cycle of 268.1 million cubic feet.

Forest Products

The contribution of forests to the Indiana economy is over $17 billion annually. In 2005, Indiana's primary wood-using industry included 212 sawmills, 13 veneer mills, two handle plants, one pulp mill, and eight mills producing other products. Forest harvest produces a stream of income shared by timber owners, managers, marketers, loggers, truckers, and processors. Direct employment within the industry accounted for over 38,000 people and indirectly, the industry supports over 90,000 jobs. Annual wages paid were $1.2 billion. More than two-thirds of the 84.2 million cubic feet of industrial roundwood harvested in 2005 came from south-central and southwestern Indiana. Saw logs accounted for 90 percent of the total harvest, with other minor products—primarily veneer logs, pulpwood, handles, and cooperage—making up the rest.

Other important contributions from Indiana's forests include recreation and non-timber forest products such as fuelwood, maple syrup, edible fruits berries, nuts and fungi, and medicinal plants. Income from recreation related to Indiana's forests is estimated to be $1 billion of the $6 billion in recreation dollars spent annually in the state.

Further information available at: Indiana's forests 1999-2003 – Part A and Part B and in Forests of Indiana: Their Economic Importance

2. State Forest Health Issues – An Overview

The **2008 growing season's major forest health problems** were mainly related to weather events, as in 2007. June flooding in central Indiana, a cool late spring throughout the state, and a hurricane – Ike- caused widespread injuries to state forest resources. Ike caused damages throughout the state, both in southern Indiana through sustained winds of 70 mph and through flooding in northwest Indiana. Weather damage manifested itself in uprooted and broken tree stems, nutrient deficiency from saturated soils, flood damage mortality, hail damage. Flood damage often takes several years to fully manifest in forest stands, and was not immediately visible except where trees where dislodged through supersaturated soils.

Gypsy moth and emerald ash borer continue to increasingly impact portions of the state's woodlands. Visible Gypsy Moth defoliation and EAB mortality over entire woodlots was visible through aerial survey this year, for the first time ever. Forest tent caterpillar, a native species with recent impacts in southeast Indiana, has begun to recede, leaving visible evidence of widespread stand mortality in southwest Indiana.

Additional Forest Health Issues: 2008 saw the observed effects of insects and spider mites, as forest health and landscape tree problems. The list of observed pests include: Fall Webworm, Tulip Tree Scale, Oystershell Scale, Spider Mites (Maple Mites, Two-spotted Spider Mites, European Red Mites, Honey Locust Spider Mites , Leafhoppers (Potato Leafhopper, others), Zimmerman Pine Moth, Mimosa Webworm, Bagworms, Japanese Beetles, Lace Bug, Aphids, Euonymus Scale, Pine Needle Scale, Pear Sawfly, Cypress Twig Gall Midge, Bronze Birch Borer, various pine bark beetles, Pales Weevil, Pine Shoot Beetle, Ambrosia Beetles (including Asian Ambrosia Beetle), periodical cicada (in south-central Indiana), Oak Leafminer , Oblique-banded Leafroller, Japanese Maple Scale, Whiteflies, Yellow-necked Caterpillars, Flea Beetles, Thrips, Ash Plant Bug, Lecanium Scale, Cottony Cushion Scale, Honey Locust Plant Bugs, White Pine Weevil, Holly Leafminer, Poplar Tentmaker caterpillar, Ash Bark Beetle, Red Headed Ash Borer, Ash Clear Wing Borers, Pine Bark Adelgid, Spiny Witch-Hazel Gall Aphids, Oak Leaf Skeletonizer, Imported Willow Leaf Beetle, Spittlebug, Tussock Moth Caterpillars, Eastern Spruce Gall Adelgid, Cooley's Spruce Gall Adelgid, woolly aphids, Horned Oak Gall, Gouty Oak Gall, Spiny Witch-Hazel Gall, Nipple Gall, Ocellate Leaf Gall, European Pine Sawfly, Spindle Gall, and Eastern Tent Caterpillar

Disease issues noted in 2008 include Sooty Mold, Cercospora Leafspot, Powdery Mildew, Apple Scab, Crown Gall, Septoria Leaf Spot, Cedar-Quince Rust, Cedar-Hawthorn Rust, Bacterial Leaf Scorch, Tarspot, Dutch elm disease, verticillium wilt, anthracnose in Sycamore and other hardwoods, Rhizosphaera Needlecast, Phytophthora Root Rot, Swiss Needlecast, Fire Blight, Armillaria Root Rot, Poplar-Hemlock Rust, Pseudomonas leaf spot, Phomopsis Tip blight, Thyronectria canker, and Diplodia tip blight,.

Recurring forest health issues continue with oak wilt, butternut canker, ash yellows, white pine root decline (*Procera* root rot), overstocked and aging pine plantation mortality, and pine shoot beetles. Other potentially major forest pests of concern (but not yet encountered) for Indiana in

2008 include the exotics – sudden oak death and *Sirex* wood wasp – and a native species – beech blight aphid.

Invasive plants have potential to affect Indiana forest regeneration and biodiversity. Japanese stiltgrass (*Microstegium vimineum)*, for example, has spread widely in many southern Indiana forests thereby reducing mineral soil exposure needed for hardwood regeneration and edging out native herbaceous layer plants. Treatment of invasive plants is supported through various cost-share programs such as the Indiana Woodland Restoration Program (IWRP). A system-wide attempt to identify populations and eliminate an invasive terrestrial plant has occurred only with kudzu (*Pueraria lobata*) in Indiana.

Finally, **continuing forest mortality** from extended droughts (1999, 2002, late 2005, 2007) and past defoliations (loopers, forest tent caterpillar, anthracnose, frosts and freezes) continue to affect forestlands years after the fact.

3. Exotic Insect Pests of Indiana Forests

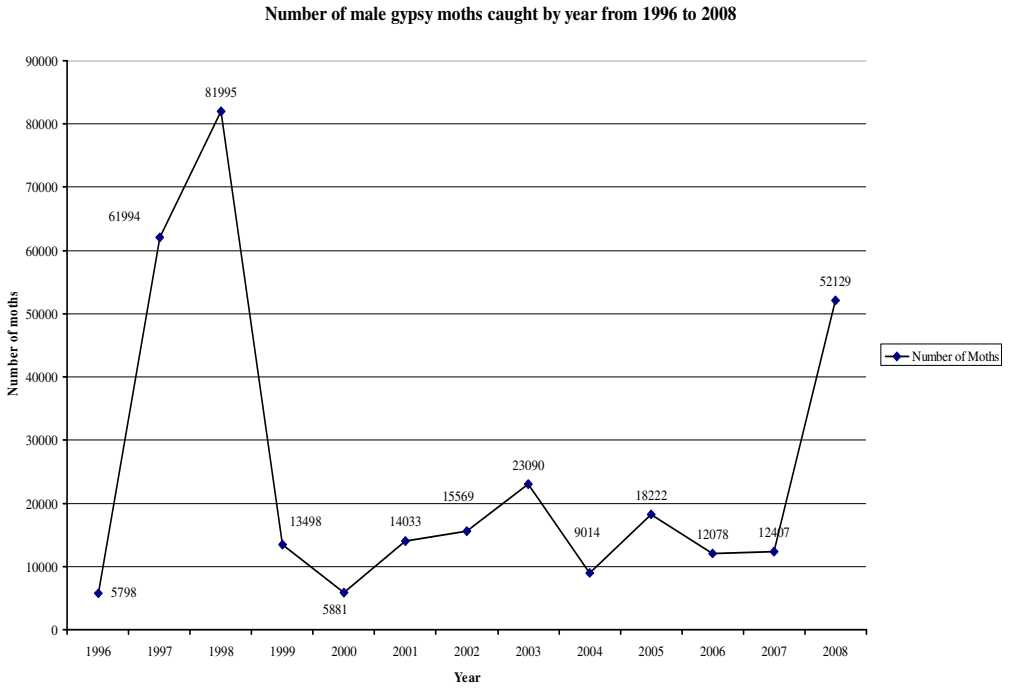
As our economy and current trade practices become increasingly global, so does the potential for more damage by exotic invasive insects. By conservative estimates, over 2,000 exotic insects are now in the U.S., with over 400 of them feeding on woody plants. Almost every tree genus in the U.S. is affected by at least one exotic insect. Currently, only five of the estimated 400 exotic woody plant pests are regulated by federal quarantine. These include the Japanese beetle, pine shoot beetle, Asian longhorned beetle, emerald ash borer, hemlock woolly adelgid, and Gypsy moth. Unfortunately, despite quarantine efforts, damage from these pests and other insect borers remains high.

Three exotic major insects of concern (Gypsy moth, emerald ash borer, *Sirex* wood wasp) currently utilize significant resources for monitoring and control activities. The former two are established in Indiana and important threats to the forest base. The latter was first detected in the USA in Indiana, and is known to be established in northern New York state and surrounding areas.

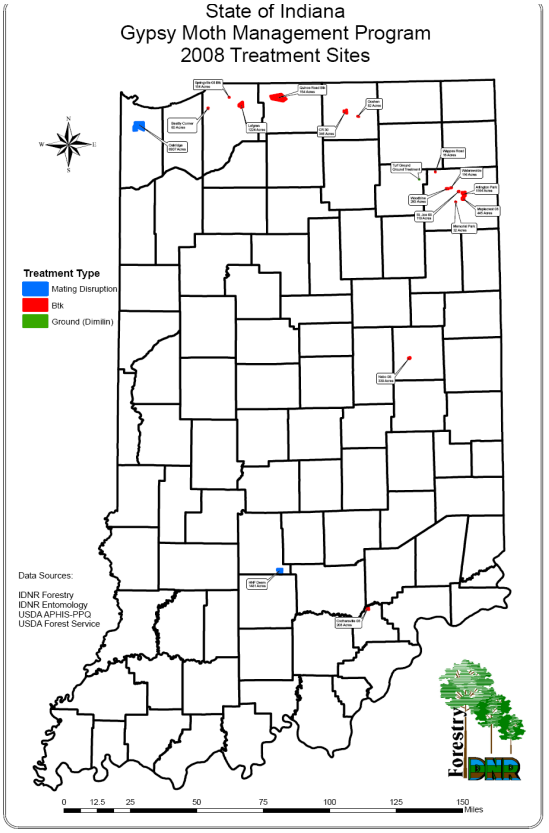
1. Gypsy Moth

Gypsy moth continues as the primary exotic invasive insect. In 2008, 14,981 traps were again placed over the entire state. The survey detected 52,129 moths from 47 counties ranging from 1 to 15,181 moths per county. This is the highest moth catch since 1998 (81,995) and 1997 (61,994) and 4 times the number of moths caught in each of the last two years (12,078-2006; 12,407-2007). The high total moth catch indicates a ‘moth blow’ event may have occurred in 2008.

Indiana efforts to control this pest, while mainly focused on detection, have seen a general trend towards mating disruption and insecticidal control as populations become established in northeastern Indiana.

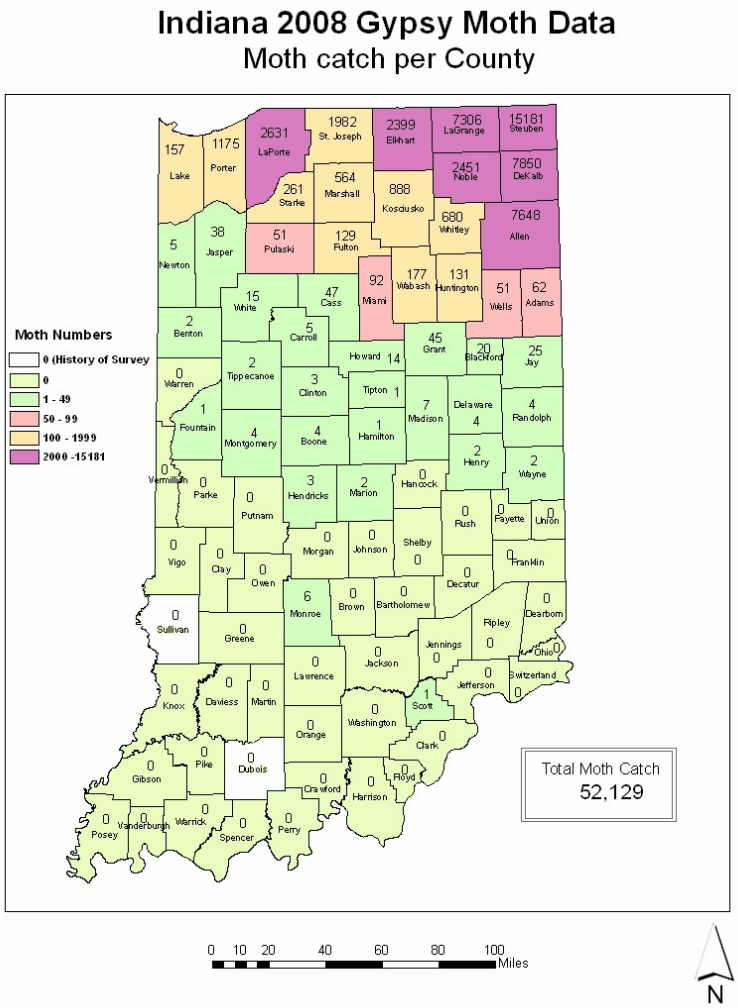


For Gypsy Moth management, Indiana is divided into 3 zones (Table 1). The "quarantine area" is the portion where gypsy moth is considered established. The "STS Action zone" is the portion of the state where treatment activities are undertaken to limit moth population, and thus "slow the spread" of gypsy moth. The remainder of the state is considered uninfested, and actions may be taken to eradicate any infestations that are found in those areas. Delimit surveys were carried out at all positive sites in front of the generally infested area.



Survey: Since the survey began in 1972; 345,608 moths have been caught in 90 of the 92 counties. Gypsy moth was not detected in Dubois and Sullivan Counties which are the two counties where gypsy moth has not been detected since surveys began in 1970. The results of the 2008 survey found that the majority of the moth catch was in the Evaluation Zone. The Evaluation Zone, which includes the quarantined counties of Steuben, LaGrange, Elkhart, Noble, Allen, and DeKalb, detected 82% of the moths (42,726 of 52,129). The northern third of the state falls in the Action Zone, which is below the Evaluation Zone under STS protocol. The Action Zone detected 17.9% of the moths (9,321of 52,129). The majority of the Action Zone moth catch occurs in the eastern part of the zone adjacent to the Evaluation Zone. The State Area detected 0.1% of the moths (82 of 52,129). The Delaware site, which caught 26 moths in 2007 and was treated in 2008, caught 0 moths in 16 delimit traps.

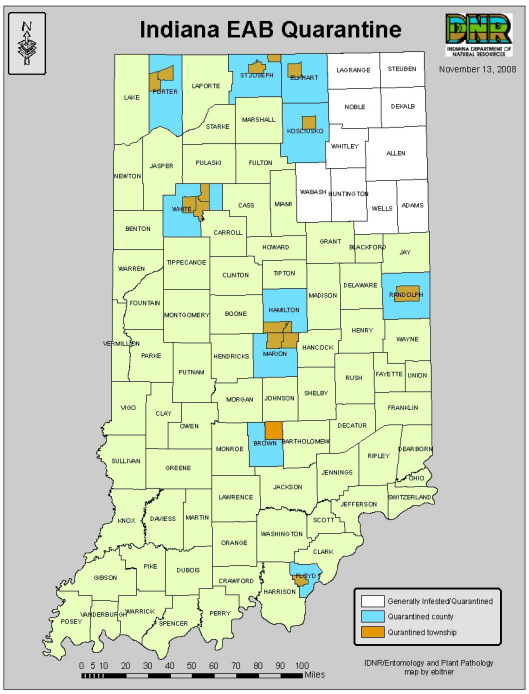
Treatment: Treatments to eradicate and slow-the-spread and development of gypsy moth were conducted on 17 sites totaling 13,418 acres in 8 counties. Thirteen sites totaling 4,103 acres in four counties were treated with Btk at 25 BIU/acre/application for slow-the-spread. Eleven of the thirteen sites were treated with two applications (3,867 acres). Two sites were treated with one application (236 acres). Two sites totaling 547 acres were treated with Btk at 30 BIU/acre/application (two applications each) for eradication. Two sites totaling 8,768 acres in 2 counties were treated with mating disruption. One site (1,861 acres) was treated with 15 grams and the other site (6,907 acres) was treated with 6 grams of pheromone flakes. Delimit surveys of Btk sites to monitor treatment success found treatment sites in the Fort Wayne area failed. Also all three life stages (egg masses, larvae, and adults) were found on the same day during monitoring of these sites. Aerial surveys detected 25 acres of defoliation in 7 sites in 3 counties (Allen (4 sites), Dekalb (2 sites), Noble (1 sites)).



Proposed treatments for 2008 include 3 Mating Disruption sites, 10 Btk sites and 1 Ground Treatment site.

2. Emerald Ash Borer

Emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, is an exotic beetle that was discovered in southeastern Michigan near Detroit in the summer of 2002. The adult beetles nibble on ash foliage but cause little damage. The larvae (the immature stage) feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Emerald ash borer probably arrived in the United States on solid wood packing material carried in cargo ships or airplanes originating in its native Asia.



Quarantine

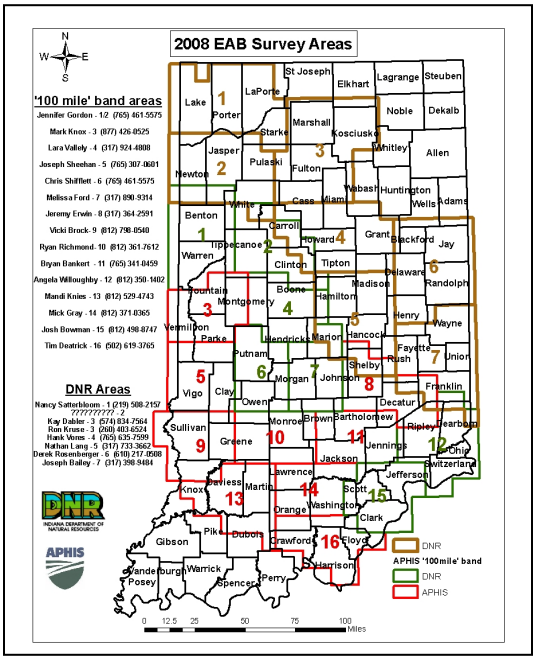
On November 10, 2008, Robert E. Carter Jr., director of the DNR, declared the following as "infested areas" and therefore under the Emerald Ash Borer quarantine: Hamblen Township in Brown County; Georgetown Township in Floyd

County; Plain Township in Kosciusko County; Jackson and Portage townships in Porter County; and Honey Creek Township in White County. The addition of these townships and counties came as a result of the Cooperative DNR and USDA survey using the purple panel traps placed during the summer and other survey methods. In addition to these new townships and counties, the survey has detected EAB throughout the 10 northeastern counties of Adams, Allen, DeKalb, Huntington, LaGrange, Noble, Steuben, Wabash, Wells and Whitley, which are now considered 'generally infested'. As such, regulated ash material may be moved through these counties but cannot be moved out of these counties, unless the material is moved under a compliance agreement, or has been mitigated so that it is not capable of spreading EAB. Although movement within these counties is allowed, the DNR recommends that movement occur during the non-flight season of September to April and under compliance agreements.

Further links and Information about where EAB is located in Indiana may be found at the IDNR Division of Entomology and Plant Pathology website: http://www.in.gov/dnr/entomolo/pestinfo/ashborer.htm . Purdue University also maintains an excellent website: http://www.entm.purdue.edu/EAB/

EAB Survey

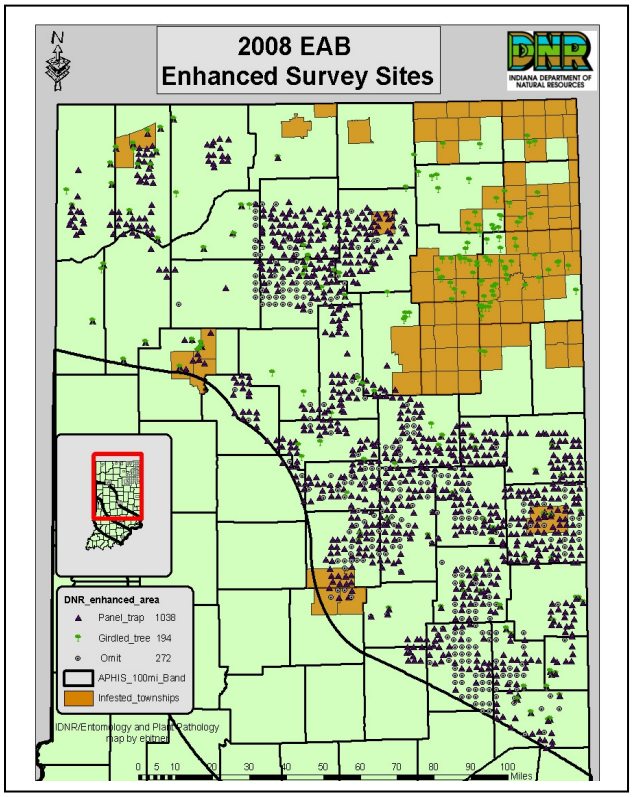
More than 23 field personnel from the Division of Forestry and USDA/APHIS were deployed to set 10,000 EAB panel traps and trap trees. The 2008 survey differed from that of 2007 in two significant ways. The first difference included the use of purple panel traps baited with manuka oil. The goal was to catch adult beetles instead of using girdled trees. The second change was that USDA/APHIS only funded a survey across a 100-mile band on a 1.5x1.5 mile grid. This resulted in the State of Indiana using funding from the US Forest Service to survey parts of Northern Indiana. Throughout the state the DNR continued to employ the use of girdled tress at high-risk sites (sawmills, campgrounds and composting sites). In addition to the panel traps and trap tree EAB survey, several complimentary survey methods were also employed: (1) DNR nursery inspectors conducted visual surveys of suspect ash showing woodpecker activity; (2) Delimitation within infested townships, especially outlier infestations, was conducted; and (4) aerial survey identified areas of declining ash for later examination from the ground.

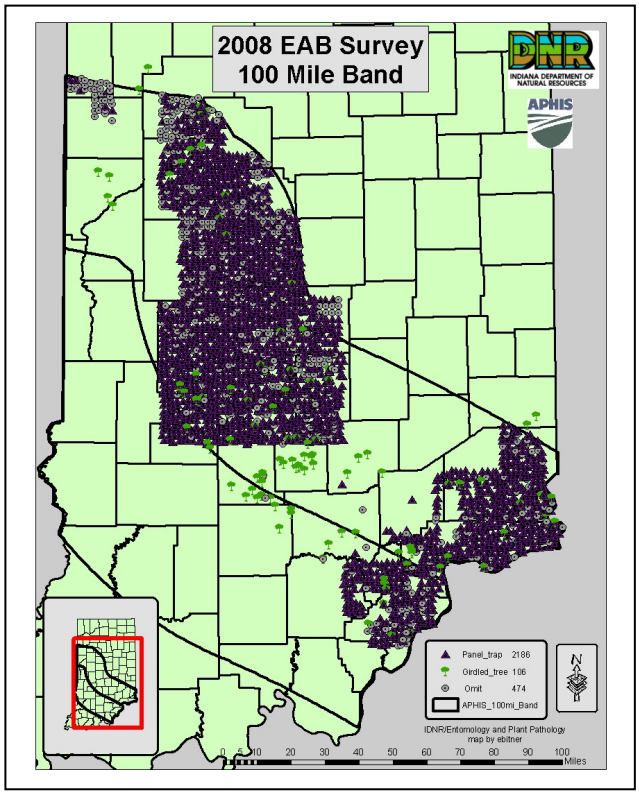


In the 100-mile band, the Survey goal was to visit 6,961 points placed on a 1.5x1.5 mile grid. To accomplish this, the area was divided into 16 survey units with between 420-450 sites per unit. APHIS personnel were responsible for 9 areas, while the Indiana DNR was responsible for 6 areas. In the DNR portion of the 100 Mile Band, the DNR was responsible to visit 3029 grid sites. During survey IDNT personnel visited 2768 total sites, placed 2186 purple panel traps, girdled 106 trees, and omitted 476 grid points due to no ash in vicinity.

DNR Enhanced Survey Area – The survey goal was to visit 2981 points placed on a 3km grid using both areas at high risk for EAB introduction (e.g. sawmills, nurseries, and campgrounds) and a random survey based on gypsy moth grid points. A total of 1448 total sites were visited,

with purple panel traps placed and 138 trap trees girdled. 272 grid points were omitted due to no ash in vicinity.

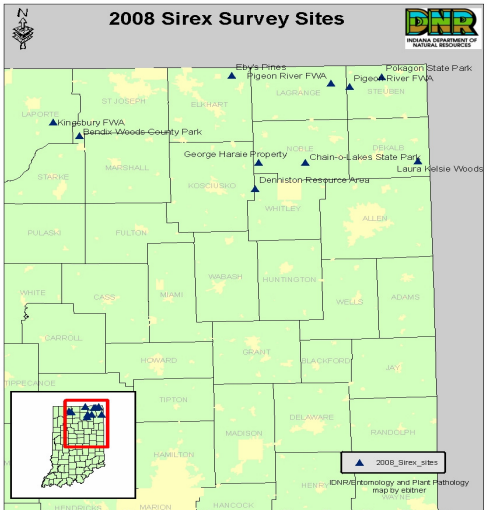




Aerial Survey: While it is difficult to distinguish between EAB damage to ash stands against other pathogens such as ash yellows, aerial surveys in Indiana have begun to delineate areas of ash in decline. Areas of declining ash suspected of to be caused by EAB encompass 166 acres of light and 218 acres of moderate decline in northeastern Indiana, in 2008. Near the Huntington area, inspection of heavy mortality in ash stands confirmed EAB responsible for 276 acres of heavy (>36 trees per acre) mortality,

For more information, please visit the website for EAB in Indiana:
http://www.entm.purdue.edu/EAB/

Indiana counties surveyed for Sirex Noctilio during 2008 *year (IDNR – Division of Entomology)*



3. Sirex Wood Wasp *Sirex noctilio*

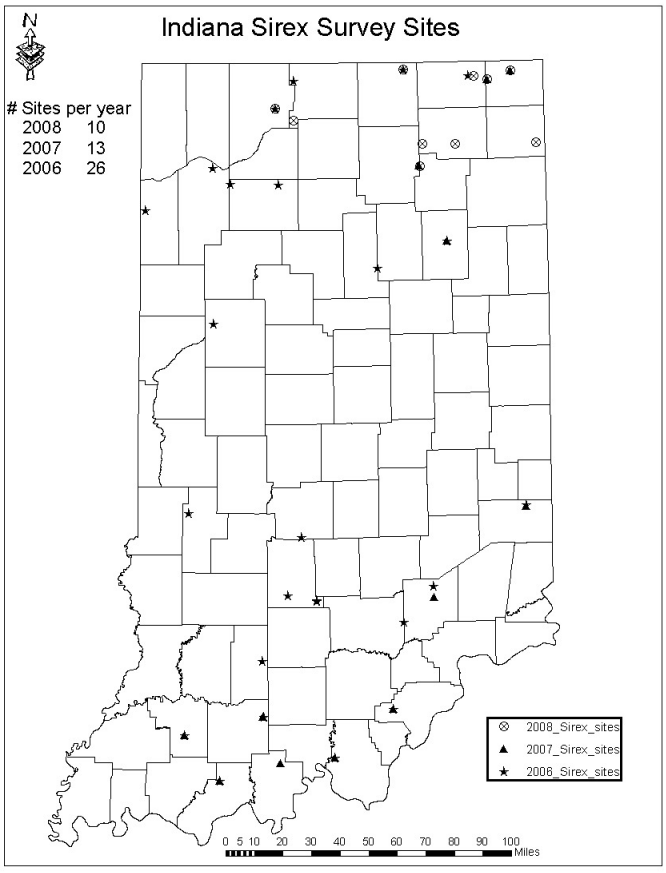
Since the interception of a single adult in Bloomington, IN during the summer of 2002, The Indiana DNR continues to survey for *Sirex noctilio*.

Survey

In 2008, Indiana DNR survey concentrated on areas where *Sirex noctilio* could be potentially become established. The survey concentrated on hard pine stands located in state parks, fish & wildlife areas and old Christmas tree plantations in northern Indiana in an effort to detect any spread to Indiana via established populations in Michigan. Ten locations with 3 Lindgren funnel traps per location were selected in Dekalb, Elkhart, Lagrange, LaPorte, Noble, St. Joseph, Stueben and Whitley counties. Lindgren funnel traps were placed by mid July and baited with the Sirex lure (alpha and beta pinene). Samples were collected every two weeks and lures were replaced every month. Samples were preserved with 70% ethanol and sent to the lab for sorting and identification. Siricids were separated for identification and a representative sample of all insects captured was sent to The Department of Entomology at Purdue University for additional identification and state record keeping.

Results and Discussion

All samples have been screened and no suspect specimens of *Sirex noctilio* were captured. 28 *Sirex edwardsii,* 47 *Sirex nigricornis,* 10 *Tremex columba* and 3 *Urocerus cressoni* were captured in 2008. Sircids were captured in all counties except Whitely County. These four species are the same species that have been captured over the last 5 years of surveying. Selected survey sites have varied over the last three years and each year there is an attempt to find new sites, especially if previously selected sites have shown low or negative Siricid captures. During 2006, 2007 and 2008 the average number of Siricids captured per trap was of 1.41, 0.76 and 2.93 respectively. *Tremex columba* were captured as early as July 31, 2008 and are usually the first species captured during the past survey years. Typically most of the Siricids are collected in late September and early October. *Sirex nigricornis* is the most abundant species that we have captured over the last five years.



Sirex noctilio, remain uncollected in Indiana following 5 years of survey. For further information, please visit the following informational website: http://na.fs.fed.us/spfo/pubs/pest_al/sirex_woodwasp/sirex_woodwasp.htm,

4. Secondary Exotic Insect Pests of Concern

a. Banded Elm Bark Beetle - *Scolytus schevyrewi*

Scolytus schevyrewi, the banded elm bark beetle, was first collected in insect traps set near Denver, CO and Ogden, UT, in April 2003. By March 2006 it had been collected in 21 states,

including Indiana. The coincident interception of *Scolytus schevyrewi* indicates that it has been established for some time.

Survey: As of 2008, the beetle is considered established in 5 northern Indiana counties. During 2008, a risk-based exotic bark beetle survey using172 traps in 54 locations across the state of Indiana found *S. schevyrewi* in Porter, LaPorte, and St. Joseph counties
For reference, note: http://pest.ceris.purdue.edu/searchmap.php?selectName=INBQSGA.

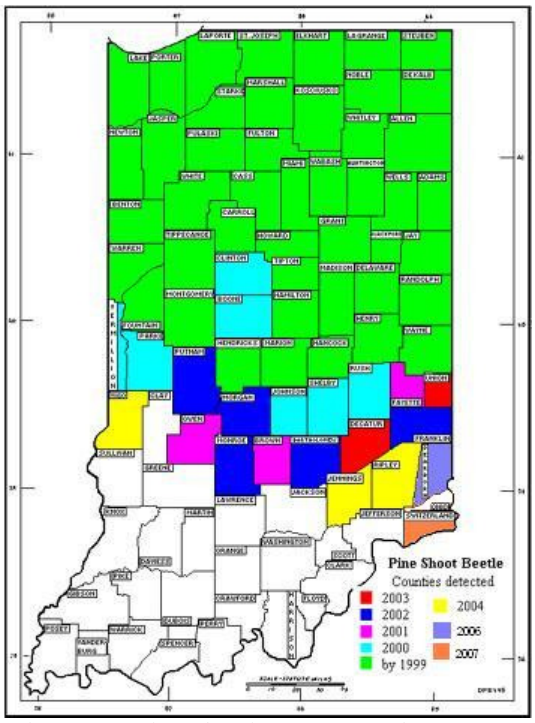
Risk: The banded elm bark beetle has a similar life cycle to that of S. multistriatus, the principal vector of Dutch elm disease. Furthermore it has been observed to be more aggressively colonizing dying elm trees, and poses an unknown risk to Indiana elms both due to its potential harm directly to elms as well as a vector for Dutch elm disease.

More information can be found at: www.na.fs.fed.us/pubs/palerts/banded_elm_beetle/beb.pdf

b. Pine Shoot Beetle - *Tomicus piniperda*

The pine shoot beetle (*Tomicus piniperda*) was first identified in pine plantations in the northern third of the state. The pine shoot beetle is an exotic species from Europe, and was first reported in Ohio 1992.

Yearly surveys for pine shoot beetle are conducted by USDA APHIS personnel using Lindgren funnel traps, in southern Indiana. Dearborn County was added to the list of quarantine counties in 2006, Switzerland County in 2007, and Greene County in 2008. *T. piniperda* is now is found in 66 of the state's 92 counties.



Indiana pine shoot beetle infestation, by county and year (IDNR – Division of Entomology)

c. Granulate (Asian) Ambrosia Beetle - *Xylosandrus crassiusculus*

Granulate ambrosia beetle has been identified as a forest pest in Indiana since 2005, when several yellow-poplar trees in Jackson County were killed by the pest. Granulate ambrosia beetle (GAB) or Asian ambrosia beetle was first found in the U.S. during 1974 on peach trees near Charleston, SC. In 1983, populations were found as far south as Florida and as far west as Alabama. In 1992, the USDA captured adults with Lindgren funnel traps placed in Johnson County on the southeast side of Indianapolis.

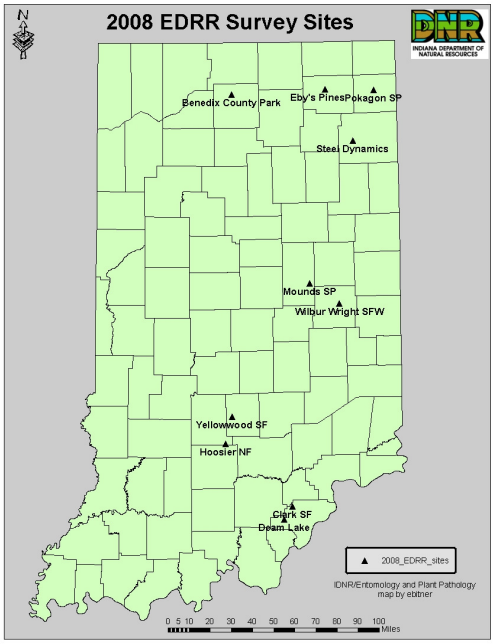
2008 Survey Data: Granulate ambrosia beetle is now found in over 30 Indiana counties and as far north as the Michigan border. In 2008 at least 2 surveys caught GAB in Indiana. In am exotic bark beetle survey conducted by APHIS, a total of 27 GAB were intercepted in traps located in Madison, LaPorte, St. Joseph, Allen, and Decatur counties as part of the risk-based exotic bark beetle survey. The APHIS survey placed 172 traps in 54 locations across the state of Indiana. Traps were placed based on the risk of introduction of pests at ports of entry and other high risk introduction sites. In a second survey, the IDNR Division of Entomology and Plant Pathology collected adult GAB in two new areas which included in Dekalb and Noble counties.

Granulate ambrosia beetle continues to be a sporadic but persistent problem in the state causing damage to nursery stock, urban landscapes and forests.

d. Exotic Bark Beetle: 2008 Early Detection Rapid Response (EDRR) Survey

Indiana participated in the Early Detection and Rapid Response (EDRR) program this year. The goal of the national EDRR project are to detect, delimit and monitor newly introduced exotic bark and ambrosia beetles at high-risk forest areas.

All non-native bark and ambrosia beetles (Scolytidae) are the targets of this survey. Three 12-unit Lindgren funnel traps were placed at 10 locations statewide. The EDRR survey traps were placed in wooded areas near high risk sites (those that import, store or recycle potentially infested solid wood packing material, dunnage, crating, or pallets) or fragmented or urban forests in the area. Traps were placed 25-30 m apart. Each of the traps had one of the following lures or lure combinations:



- Ultra-high release (UHR) ethanol lure only (general attractants for wood boring insects in deciduous hosts).
- UHR alpha-pinene and UHR ethanol lures together (general attractants for wood boring insects in coniferous hosts).
- Three-component exotic *Ips* lure. More specific for conifer-feeding exotic bark beetles e.g. *Ips typographus, Ips sexdentatus, Hylurgus ligniperda* and *Orthotomicus erosus*

Traps were monitored and samples were collected every two weeks from the middle of May to the end of September. Samples collected from the traps were sent to Cornell for species identification. Only one target species was found, *Tomicus piniperda.* However, it is already known to occur in the state.

e. Hemlock Wooley Adelgid: Hemlock is an uncommon tree species in Indiana forests, and is found in a few scattered relict populations where site conditions exist conducive to its growth and regeneration. Because of the beauty both of the tree and the sites in which it grows, most such locations in Indiana are usually either nature preserves or state parks.

The Hemlock Wooly Adelgid (HWA) is an invasive insect active in the United States since the 1950s. As it has spread over the Appalachians, it has begun to constitute a real danger to our state's hemlock populations.

HWA, for example, was found at three new sites in Ohio in 2006, and recently in sites in Michigan northeast of Traverse City. Concern in Indiana exists that HWA will enter the state on a landscape plant (as has happened in Michigan) and move into protected natural populations. Interstate nursery shipments are inspected, and it is believed that this will greatly reduce the risk of accidental introduction through planting stock. Nursery retailers, landowners and natural resource managers are encouraged to remain vigilant to the threat of HWA.

4. Non-Indigenous Plant Pathogens

1. Sudden Oak Death - *Phytophthora ramorum*

Indiana's 2008 SOD Survey

Indiana was surveyed again in 2008 for SOD, both by contractors for the USDA Forest Service, Forest Health Protection-Forest Health Monitoring Program and by Division of Entomology and Plant Pathology Nursery Inspectors. The purpose of these surveys was early detection of *Phytophthora ramorum* (Pr) in vegetation before infection centers become fully established and more difficult to eradicate.

In Indiana, 3 streams (Burns Ditch, Wildcat Creek, and Eagle Creek) were identified for testing based on SOD risk mapping. In each sample, 4 symptom-free rhododendron leaves in a mesh bag were tethered in the stream current. Two bait bags per site were deployed in nearby locations. These were exposed for 1 – 2 weeks per instance over 2 months during the growing season. Samples were sent to local labs to culture leaf bait pieces for *Phytophthora* spp. and *Pr*. Regional laboratories are asked to use nested or real-time PCR methods on the replicate sample of leaves to diagnose Pr yes/no. More details are at: http://fhm.fs.fed.us/sp/sod/sod.shtm. Additionally, IDNR Division of Entomology and Plant Pathology collected 414 symptomatic leaf samples from *Pr*. host species in several nurseries.

Results

USDA Forest Service: Of 48 possible samples from the stream samples, all tested negative for *Phytophthora ramorum*. The USDA Forest Service Forest Health Protection-Forest Health Monitoring Program has declared Indiana SOD-free. Due to higher priority concerns the Forest Service will probably not be sampling Indiana again next year.

IDNR - Division of Entomology and Plant Pathology Nursery: Of the 414 samples, 101 samples tested positive for *Phytophthora*, but all tested negative for *Pr*.

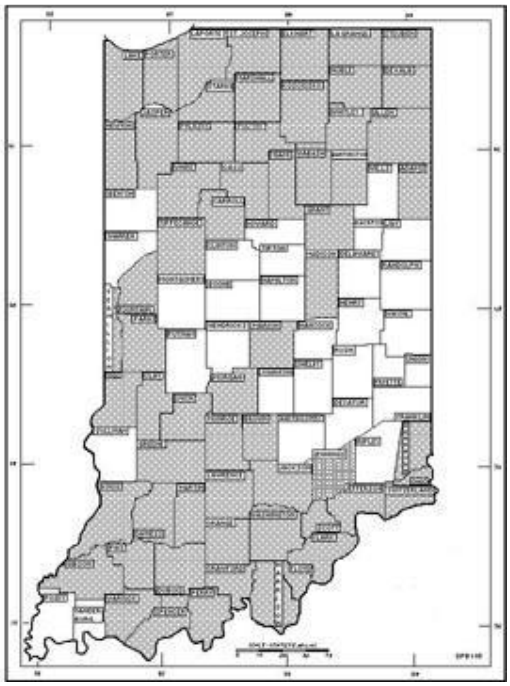
2. Dutch Elm Disease - *Ophiostoma ulmi (syn. Ceratocystis ulmi)*

Since its introduction into the US, Dutch Elm Disease (DED) has had a devastating effect on native elm populations. With the increasing age classes of Indiana's forests, similarly aging elms are beginning to show a marked increase of mortality through DED. Nearly 25% of U.S Forest Service Forest Health Monitoring (FHM) program plot mortality volume was due to elm mortality chiefly due to DED, on FHM plots 1998 -2002.

Anecdotal observation of Indiana forests by natural resource managers continue to show widespread mortality among pole- and sawtimber sized elm, especially American elms. As Indiana forests continue to age, the incidence of DED will probably increase. Forest managers should consider marking with prejudice sawtimber-sized elms, particularly in stands already expressing DED symptoms.

3. Oak Wilt - *Ceratocystis fagacearum*

Oak wilt was confirmed most recently in December 2007, in Jennings County at the Southeast Purdue Agricultural Center (SEPAC). This is the latest county with a confirmed identification, increasing the number of counties with oak wilt to 63. During the spring of 2008, the infested oak at SEPAC and an adjacent ring of trees were removed, and all material burned. To contain the possible spread of the pathogen through root grafts, a soil trenching was completed between the infestation and the remaining planting of oak.



Extent of oak wilt in Indiana in 2008

Oak wilt is predicted to continue as a minor and localized concern in Indiana, with the exception of the sand ridge areas of northwestern Indiana where it is commonly found on black oak stands.

Pockets of trees infected with the disease should be cut and properly treated. Injury to stems, especially in the red oak group, should be avoided to help prevent oak wilt from expanding. For more information, please view: http://www.na.fs.fed.us/spfo/pubs/howtos/ht_oakwilt/toc.htm

4. Butternut Canker - *Sirococcus clavigignenti-juglandacearum*

Butternut is being decimated throughout Indiana by *Sirococcus clavigignenti-juglandacearum*, a fungus most likely introduced from outside of North America. Butternut Canker was first observed in Wisconsin, in 1967, and has since been noted over nearly the entire range of this tree. The rapid decimation of butternut populations has been considered so severe that the U. S. Fish and Wildlife Service has listed the species as a "species of Federal concern."

:Butternut canker symptoms(USDA Forest Service).

Currently no butternut selections are available that have known canker resistance. A few healthy butternut trees have been found growing among diseased and dying trees and may be resistant to the disease, or they may be *buartnuts*, canker-resistant hybrids between butternut and Japanese walnut (*Juglans ailantifolia*) that were popularly planted after 1860. Reports of resistant butternut continue each year. Dr. Keith Woeste of Purdue University's Hardwood Tree Improvement and Regeneration Center (HTIRC) has been collecting butternut and creating breeding stock collections with the aim of reintroducing canker-resistant butternut.. Landowners are encouraged to locate and report healthy butternut to their District Forester, the State Forest Health Specialist or other directly to Dr. Woeste.

5. Beech Bark Disease – Disease complex of *Cryptococcus fagisuga* Lind and *Nectria coccinea* var. *faginata* Lohman

In areas to the north and east of Indiana, Beech Bark Disease (BBD) has caused significant mortality and defect in American beech. The non-native beech scale, *Cryptococcus fagisuga* Lind., first attacks beech stems. The wounds made by their feeding is in turn is invaded and trees are injured or killed by fungi, primarily *Nectria coccinea* var. *faginata* Lohman, Watson, and Ayers, and sometimes *N. galligena* Bres.

Indiana natural resource managers have been made aware of the disease complex and have been alert to landowner queries and evidence of BBD on public lands. According to Forest Service modeling, BBD will likely appear in northern Indiana within the next 10 years. To date, the nearest known infestations are in the western lower peninsula of Michigan.

In November 2008, a suspect interception of BBD was being investigated in SW Indiana near Vincennes. This pocket of dead and declining beech show no evidence of either perithecia (fungal fruiting bodies) or beech scale. This beech stand will continue to be monitored, and other reports will be investigated as they are received.

6. Red Bay Wilt – Risk to Indiana Sassafras and Spicebush

A new disease complex of redbay (*Persea borbonia*), a southern shrub / small tree has been recently described. The disease is caused by a fungus (*Raffaelea* sp.), and is spread by an Asian ambrosia beetle *Xyleborus glabratus,* which is reported the 12th introduced ambrosia beetle detected since 1990.

The disease was noted in redbay populations in 2002, in South Carolina and Georgia. The disease has also been discovered in individual plants of the federally endangered pondberry (*Lindera melissifolia*), the threatened pondspice (*Litsea aestivalis*), sassafras (*Sassafras albidum*) and avocado (*Persea americana*). In 2004, those states reported three counties with damage; by 2007 the disease has spread to 31 total counties. Officials estimate that natural spread is about 20 miles per year, but movement of infested firewood, wood chips and logs may be a major factor in spreading the disease into new locations not contiguous with main area of infestation. As of 2008, the disease complex has been found in an additional 6 counties in Florida, Georgia, and South Carolina.

Indiana has large populations of sassafras and related spicebush (*Lindera benzoin*). At this point, natural resource managers and landowners are encouraged to look for declining plants of these species associated with the toothpick-like frass projections caused by this ambrosia beetle, and report any suspected infestations.

5. Native Insect and Disease Concerns

1. Forest Tent Caterpillar

The **Forest Tent Caterpillar** (FTC) epidemic in Southeast Indiana collapsed in 2007, resulting in greatly reduced defoliation of low levels in four Indiana counties. Defoliation during 2006 had been at an all-time high of 74,199 acres affected. No new defoliation was observed in 2008.

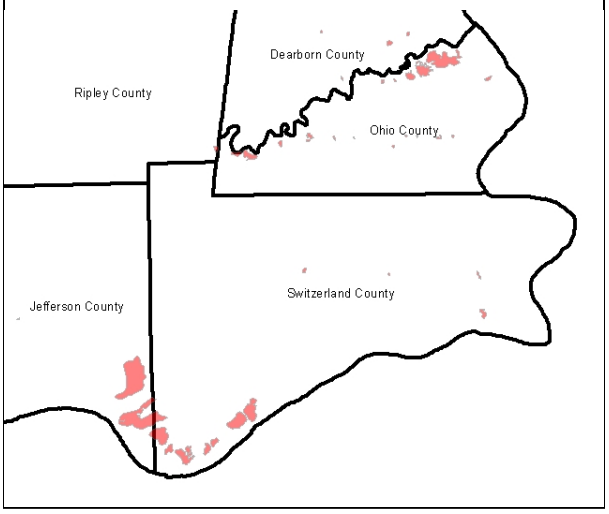
2008 Indiana Forest Tent Caterpillar Mortality – new acres mortality, by county

County		Mortality
Clark		0
Dearborn		74
Jefferson		2,210
Ohio		1,386
Ripley		31
Switzerland		1871
TOTAL		**231**
TOTAL ACRES MORTALITY		**5,572**

Mortality from the observed four years of defoliation was apparent from aerial survey FTC primarily defoliates oaks and sugar maple, black cherry and hickory. Mortality to oaks, especially black oak, and sugar maple had started to occur in 2006, but was only observed in scattered individual trees. By 2008 additional stands of trees were seen to be dead from those observed in 2007. When combined with recent droughts, it is expected that mortality will continue to appear over the next 5 – 8 years from the result of FTC defoliation.

Cause of FTC Infestation Collapse: Perhaps the most surprising development has been the effect of late-spring freezes on FTC. While reports of 'Friendly Fly', *Sarcophaga aldrichi*, a native parasite of FTC were noted, it was largely reported that the late April freeze after leaf emergence had devastating effect on FTC populations.

Forest Tent Caterpillar (FTC) related mortality in southeastern Indiana, in 2008.



Management Response: It is recommended that management activities (salvage harvests) be conducted within one year and no longer than three years after trees die to optimize recovery of timber value and to return the forest to a healthy state. Thus, management should begin in 2008 and continue through 2010. Much of the management effort will be directed at private landowners. It is also recommended that management activities be conducted in a manner to prepare the future stand for gypsy moth by using the Gottschalk's Silvicultural Guidelines for Forest Stands Threatened by Gypsy Moth.

2. Ash Yellows

Ash yellows (also known as ash decline) continues to be found across the state primarily on white and green ash. The disease is caused by a microbe that resembles bacteria which lack cell walls, but have many differences and are grouped differently. These microbes are called mycoplasma-like organisms (MLO), and are possibly transmitted by leafhoppers. Ash Yellows continues to be observed by forest health surveyors, especially in areas where EAB is encroaching, because the symptoms are similar

3. White Pine Root Decline - *Verticicladiella procera*

Procera Root Rot (White Pine Root Decline) has been noticeably killing white pine across the state for more than 10 years. Again in 2008, mortality from this disease continued its role as the most common request for assistance. It continues to kill windbreak, yard and plantation trees. This disease is the most common forest pest that landowners request assistance, and as such has the status of the number one disease in Indiana.

Trees from 4 to 30 feet tall and 3 to 6 inches in diameter are commonly killed. Trees can turn brown in color at any time of the year, but do so more commonly in the spring and fall (Figure 14). Infected trees appear light green and sparse or thin at first. Then the trees turn brown in a short period of time. Most landowners do not recognize the early symptoms of the disease. They usually see the dead brown tree and sawdust from woodborers that attack the dead tree. Management of the disease is done by using sanitation measures. There is no cure or preventative treatment, other than the avoidance of planting white pine in wet sites, for the disease.

USDA, Forest Service, S&PF

Figure 14: *Procera Root Rot tends to affect single trees in windbreaks*

4. Anthracnose

The cool month of May 2008, and wet spring including heavy rains produced numerous reports of anthracnose defoliation compared to last year. Anthracnose was reported by DNR nursery inspectors, for example, on pockets of sycamore and other hardwoods throughout Indiana. Anthracnose in walnuts, which occurs later in the summer, was not noted in 2008.

Anthracnoses affect most genera of hardwood tree species in Indiana. In wet years such as 2008, it can be possible to see widespread effects on many species. Sycamore is the most susceptible species, and is the gauge that is used to determine the severity of anthracnose each year.

It is impractical and impossible to control anthracnose in forest stands. For urban forests and nursery stock, anthracnose may be regulated by raking leaves and pruning infected twigs and branches. This reduces the amount of overwintering fungi in plant materials that is available to cause infection during the next growing season.

5. White Oak Mortality

Reports of white oak and chestnut oak groups dying have been received from 2004 until the present. Normally the white oak group is more resistant to death from various stress factors compared to the red oak group. Examination of two sites during 2008 in Jennings and Scott counties found that Two-Lined Chestnut Borer *(Agrilus bilineatus)* and *Armillaria* Root Rot appeared to be involved in the decline and death of the white oak. The particular cause in the Jennings County situation was a timber sale that opened up the stand and exposed the white oak to expanded growth. The complicating factor in this instance the opening of the stand increased airflow and transpiration. A soil hardpan in the site prevented root access to subsoil moisture

during the drought of 2007, fatally stressing what would have been a remaining high-quality stand. Adjacent stands not affected by harvest remained unaffected.

A. bilineatus attacks primarily oaks trees, weakened by various stress factors including drought and defoliation. The larvae bore into the inner bark, begin feeding and form meandering galleries in the inner bark and outer wood. The feeding galleries of many larvae in a heavy infestation effectively girdle the tree by blocking the movement of food to the roots and water to the shoots. These borers first infest the upper crown; later infestations are lower and often reach the base of the tree. The combined actions of the borer in the stem and the fungus in the roots can bring about rapid decline and death. In areas were groups of white oak trees are dying, salvage harvest operations should be implemented to preserve the timber value and contain further spread of two-lined chestnut borers.

6. Decline in Hickory

Mortality of hickory has been linked to outbreaks of the hickory bark beetle (*Scolytus quadrispinosus*), Phomopsis galls, *Armillaria* root rot and the activities of a flatheaded woodborer (*A. otiosus*). With bitternut and pignut hickory, however, certain trees have been observed to decline and suddenly die without the presence of the above agents. Moreover, shagbark and shellbark hickory, even when associated with pignuts and bitternut hickory in the same forest, do not appear to be affected with the same frequency. It has been postulated that a disease complex between hickory bark beetle and fungi (*Ceratocystis smalleyi* and *C. caryae*) may be responsible for the decline in smoothbarked hickory stands, especially following drought.

Two Indiana forest stands were examined by the USDA Forest Service in 2008, as part of a larger national study of hickory decline. While hickory bark beetle and *Ceratocystis* were isolated from declining smoothbark hickory, the observations were confounded by widespread ice storm damage that broke the tops out of many trees in both sites. Both apparently healthy trees with top damage, and declining trees were observed in about 50% of the smoothbark (principally bitternut) hickory.

7. Looper Complex – Linden Looper *Erannis tiliaria* and Half Winged Geometer *Phigalia titea*

Dramatic, cyclical defoliation events have been noted in southern Indiana, caused by the native half-wing geometer and linden looper – hence the name “Looper Complex”, for over 30 years. Hosts of these insects include most hardwood trees, including various oaks, hickories, and red maple. Their populations exist at low to moderate levels, and then expand dramatically every 10 to 20 years.

The last epidemic, running from began in 2001 – 2005, collapsed by the spring of 2005. Aerial and field surveys to date have not detected noticeable defoliation or significant insect levels.

9. Bacterial Leaf Scorch

In Bacterial Leaf Scorch (BLS), plants are damaged by a native bacterium (*Xylella fastidiosa*) that multiplies rapidly within active plant xylem, clogging it. Deprived of water, scorch-like leaf symptoms on the leaves lead to twig and branch death, and in some cases plant decline and death. Affected tree species include sycamore, mulberry, red maple, sugar maple, sweetgum, American elm, and a number of oaks such as bur, pin, scarlet, red, and shingle oaks. Control

measures focus on sanitation, with more intensive measures available for high-value specimen trees.

IDNR Division of Entomology and Plant Pathology personnel conducted field observations looking for trees exhibiting BLS symptoms, as part of a national survey. A total of 27 leaf samples were taken and sent to the diagnostic lab at Michigan State University. A total of 4 samples came back positive, in Clay, St. Joseph, Tippecanoe, and Vigo counties.

An excellent website that describes the disease including many clear photographs of symptomatic foliage can be found at: http://www.apsnet.org/online/feature/bls/

10. Miscellaneous Forest Insect and Disease Concerns in 2008

The following miscellaneous insect and disease pests were reported by landowners and natural resource professionals for 2007. Their appearance was reported in some instances to be locally destructive, but overall they were not a widespread concern to the forest base. Hypertext links to forest pest factsheets may be linked to by following the imbedded links in the common names of each pest:

Insects:
Aphids: The number of aphids was noted by IDNR Nursery Inspectors on woody plants declined in 2008 compared to 2007. Specific species noted this year included the Wooly Apple Aphid, and Wooly Beech Aphid, though there were certainly other species at work. Host plants observed in 2008 included: birch, ash, maple, burning bush, spruce, hawthorn, *Spirea*, oaks, crabapples, *Amelanchier*, walnut, fir, yellow-poplar, and *Rhododendron*. Along with scale insects, aphids create places for sooty mold through the excess nutrients from plant sap ("honeydew") that they excrete.

Bagworms (*Thyridopteryx ephemeraeformis*) – With increasingly warmer winters and recently dry summers, bagworms have become more pronounced and range further north than in the past. IDNR Nursery Inspectors reported bagworms statewide in 2008, from June through September. The fed on a wide variety of hosts, including: Pine species, Norway and Colorado blue spruce, sweet gum, red maple, arborvitae, junipers, honey locust, cherry, pin oak, bald cypress, Douglas-fir and white fir. Damage was reported to be widespread but light to moderate in severity. Bagworms are most noticeable in late summer and fall when they have reached the largest size and done the most damage.

Spider Mites (various species) – The wet commencement of summer weather increased plants abilities to deal with attacks from various pests, including mites Even so, observations of Spruce Spider Mites, European Red Mites (serviceberry and crabapple), Honeylocust Mites (Honeylocust), and Two-spotted Spider Mites (various tree species) were made.

Tuliptree scale (*Toumeyella liriodendri*) and other scale insects - The tuliptree scale is one of the largest soft scale insects in the United States. In 2008, tuliptree scale was noted especially in southwestern and central Indiana. Scale insects, like many others pests, have decreased when compared to their effect in the 2007 drought. Other scales observed include Cottony Maple Scale, Cotton Cushion Scale, Oystershell Scale, Pine Needle Scale, Lecanium Scale, and Euonymus Scale.

Fall Webworm (*Hyphantria cunea*): Numerous instances of large Fall Webworm were reported in 2008, especially in southwestern Indiana. It was reported in Hancock County (central Indiana) on June 5th by an IDNR Nursery Inspector, which is remarkably early for the species.

In the eastern U.S., pecan, walnut, American elm, hickory, fruit trees, and some maples are preferred hosts; in some areas persimmon and sweetgum are also readily eaten.

Eastern Tent Caterpillar (*Malacosoma americanum)* Eastern Tent Caterpillar (ETC) continued to be reported at much as an occasional pest. It is likely that this insect will again increase in importance and landowners should monitor their cherry trees for ETC activity.

Locust Leaf Miner: (*Odontata dorsalis*): Following outbreaks in southern Indiana during the early 2000's, Locust Leaf Miner has receded in intensity. Compared to reports from past years, IDNR Forest Health Program did not receive calls concerning this pest, nor did IDNR Nursery Inspectors note damage. It is likely that this native insect is a trough of its population cycle, and Indiana landowners should look for its inevitable return.

Zimmerman Moth (*Dioryctria zimmermani*): Zimmerman moth were encountered in nurseries and Christmas tree plantations in southwest, west-central, and central Indiana during 2008.

Summer Caterpillars: Mimosa Webworm, Yellownecked caterpillar, Tussock Moth Caterpillars, Poplar Tentmaker caterpillar were observed this year in Indiana. Some damage was noted, especially with yellownecked caterpillars.

Periodical Cicada: Brood XIV arrived in spots of south-central Indiana in May of 2007. Damage to twigs and branches from ovipositing was evident at Harrison Crawford State Forest with 6 – 8 weeks as weakened branches broke, turned brown, and created "flagging" across forest and ornamental trees. Brood XIX, a 13 year brood will visit southwest and western Indiana in May 2011.

Diseases:

Verticillium Wilt: Verticillium wilt in maples is caused by the soil-borne fungi, *Verticillium dahliae*. Because of its ability to spread internally or systemically within the plant and to kill the plant, Verticillium wilt is considered a serious disease. Herbicide damage, adverse environmental conditions and mechanical damage may cause the same or similar symptoms. In 2008, IDNR nursery inspectors reported several cases of Verticillium wilt in central and south central Indiana, in maples, redbud and smoketree.

Oak Tatters: The tattered foliage of oak has been reported in Indiana since 1983. The tattered foliage of primarily white oak, and other oaks was not reported in 2008 as in prior years.

Fire Blight: Fire blight is a common and very destructive bacterial disease of apples, pears, and crabapples. While native apples and crabapples are very minor components of Indiana's forest resource, both they and domesticated trees constitute important food sources for wildlife. IDNR Nursery Inspectors have noted that 2008 showed occasional observations of fireblight. This follows 2007, which was an especially severe year for fireblight.

6. Weather-Related Issues in Indiana Forests

Ozone Damage: Indiana again participated in the national ozone biomonitoring survey for vegetative damage. A nationwide network of over 1130 ozone biomonitoring sites has been established in forested areas in 45 states. Each year these sites are evaluated for the amount and severity of ozone injury on sensitive plants. The foliar injury data is used to quantify regional trends in ozone stress in terms of significant changes in the number and distribution of biomonitoring sites with ozone injury, and increases or decreases in injury severity.

In Indiana, 24 biosites were surveyed during late July and early August, 2008. Ozone damages were most pronounced in the south-central and southwestern portions of the state.

June Floods – Tornados, flooding, and drought are events that commonly stress and damage Indiana forests. The last major growing season floods to seriously impact forests occurred in this year along the upper forks of both the west and east forks of the White River. Floods are re-current events, yet affect floodplain areas where many tree species have evolved to withstand a certain amount of growing season inundation. The floodwaters of 2008 reached 500-year levels in many instances, and will continue to affect river corridor forests for several years as a result.

Hurricane Ike: Tornados and windstorms, lightning strikes, etc, are acute, dramatic events that cataclysmically affect forests. They remain random, localized, and difficult to predict. This past summer there were several straight-line wind incidents associated with frontal activities. Windfall and broken tops of trees occurred throughout the state.

On September 14th, 2008, a highly unusual weather event afflicted Indiana, the inland advance of Hurricane Ike. The effects of Hurricane Ike in inland North America were unusually intense and included widespread damage across all or parts of eleven states. The severe winds reported across the Midwest to the east of the center (although little or no rain fell in many of those areas) were as a result of a combination of factors, including the strength of Ike itself allowing for a strong pressure gradient and a well-defined structure, the location on the east side of the storm where the winds are usually stronger in a northward-moving system due to its forward motion, its fast forward motion of about 40 miles per hour and the warm air ahead of the storm allowed the high winds aloft to reach the surface easier. Many areas reported wind gusts to hurricane force. The northwestern part of Indiana was hard hit by flooding, which was partially related to the frontal boundary and partially related to Ike. Straight line winds in southern Indiana and massive floods in the northwestern side of the state each affected forest stands significantly

2008 Late Season Drought: Contrastingly, droughts affect widespread areas and may, along with freezes, frosts, and ice storms, be among the most pervasive abiotic factors in the long-term health of Indiana forests. Droughts frequency and intensity appear to be increasing as atmospheric carbon levels elevate, leading to altered rainfall and temperature patterns and increased soil moisture desiccation. Consequently, drought can lead to forest declines.

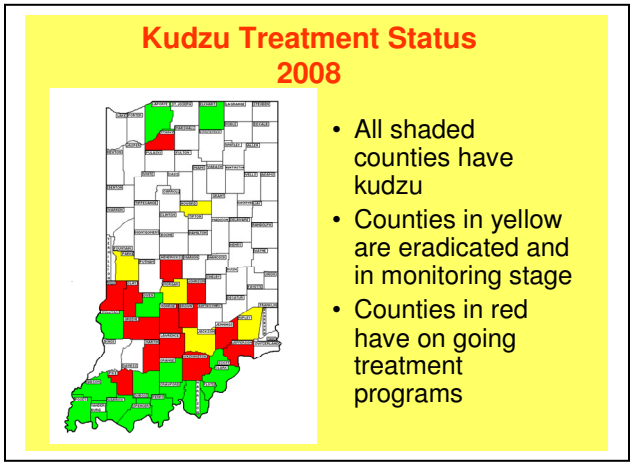
2008 saw drought affect southern Indiana from August through October. Because of the cool, wet spring, the effects of the late season drought were mainly mitigated, except for shallow-rooted species.

2008 May – Cool Wet Spring: May 2008 saw below-average temperatures. This delayed leaf expansion and somewhat reduced the growing season available to tree species. Despite this slow

start, the excessively wet spring produced remarkable tree growth and fruiting. The only drawbacks to the wet June was increased anthracnoses, individual tree death caused by *Phytophthora,* flood damages in tree lodging, death, and long-term decline, and occasional reports of nutrient deficiencies in saturated soils

7. Invasive Plant Species

Invasive exotic plant species are non-native plants that form self-sustaining and expanding populations within a natural plant community with which it had not previously been associated. Invasive exotic plants constitute a threat to natural areas in Indiana. They displace native plants, eliminate food and cover for wildlife, and threaten rare plant and animal species. However, among natural resource professionals there exists difference in opinions over which species constitute the greatest threat to natural areas. Consequently, species that are considered a grave threat by some resource professionals are still recommended by other resource professionals and sold by nurseries. Many species of invasive exotic plants are generally regarded as economically disruptive to agriculture and thus regulated by state law as noxious weeds. This law requires property owners to control noxious weeds, including listed invasive plant species. Among those plant regulated is Kudzu (*Pueraria lobata*), an Asian native normally associated as an engulfing invasive vine in the Southern U.S.



As of May 2008 there were 109 kudzu sites totaling 109.41 acres in the state of Indiana. During 2008, six new kudzu sites totaling 8.48 acres were confirmed in 4 counties. We are still receiving new reports of kudzu and there are likely to be more confirmed sites this fall, adding to the total acreage.

During 2008, 30 sites were treated in 14 counties. 27.09 acres were treated in Brown, Clay, Greene, Hendricks, Jefferson, Jennings, Johnson, Lawrence, Martin, Monroe, Pike, Starke, Vigo and Washington Counties. Clopyralid and glyphosate have been the primary herbicides used for control and many sites are responding well. However, there are a few sites that are persistent and problematic. Some sites are on their fourth year of treatment and may need a fifth year follow up treatment to treat young resprouts Without follow up treatments the kudzu will grow again and quickly take over an area. Kudzu eradication is a matter of persistence and at this time it appears it will take up to 5 years to eradicate problematic sites.

Treatment costs have ranged anywhere from 800- 1,600 dollars per acre per application. Much of this cost is associated with labor, travel and equipment movement. Typically, less herbicide is used at sites in consecutive years, but more labor is spent trying to find resprouts as sites become thin. The Indiana DNR, Division of Entomology and Plant Pathology intends to continue eradication efforts as long as funding is available and additional sites are to be schedule for treatment in 2009.