



Indiana Department of
Natural Resources DNR

2016 Indiana Department of Natural Resources Division of Entomology and Plant Pathology Report



Annual Report

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Section I. Nursery Data

A. Certified Nurseries

In 2016, the Indiana Department of Natural Resources (IDNR) - Division of Entomology and Plant Pathology (DEPP) certified 347 nurseries for a total of 3,713 acres, with the average acreage per facility being 10.7 acres, a slight increase in acreage from 2015 (Figures 1 and 2). Over 60 percent of certified nursery growers in Indiana is less than five acres with only 13 growers having 50 or more acres (Figure 3).

Indiana Code 14-24-6-3 defines nursery stock as: “botanically classified hardy perennial or biennial trees, shrubs, vines, and plants, evergreens, fruit pits, and other plants or plant parts capable of propagation. The term does not include corms, tubers, field vegetables, or flower seeds.”

A Nursery Grower license in Indiana may be landscapers growing some of their own material for planting; small businesses growing stock for sale at local farmers markets or internet sales; still other growers are specialists growing orchids, hostas or daylilies for intrastate movement. Indiana has a few large-scale greenhouses growing annual material that will be sold all over the country and in a few cases internationally that are issued a Nursery Voluntary License. These facilities are inspected in the same manner as all Nursery Growers.

Large growers who sell wholesale material only require the buyer to have a dealer’s license and includes nursery centers from the small, locally-owned retailer to the large nation-wide chain and the local landscaper.

The health of the economy has an effect on the nursery industry, directly and indirectly. New construction relies on large-scale landscaping. If the number of new construction decreases, so does the need for landscaping material.

Decline in the overall number of Nursery Grower licenses in Indiana can also be attributed to an aging population. In many instances, these are family-owned businesses and as one generation ages, their children are not always interested in this type of employment.

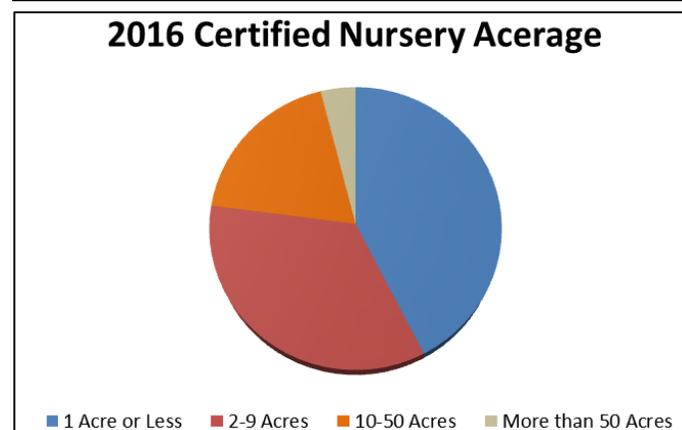
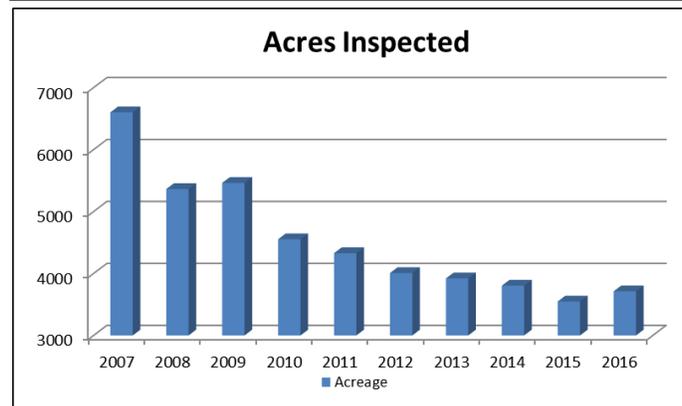
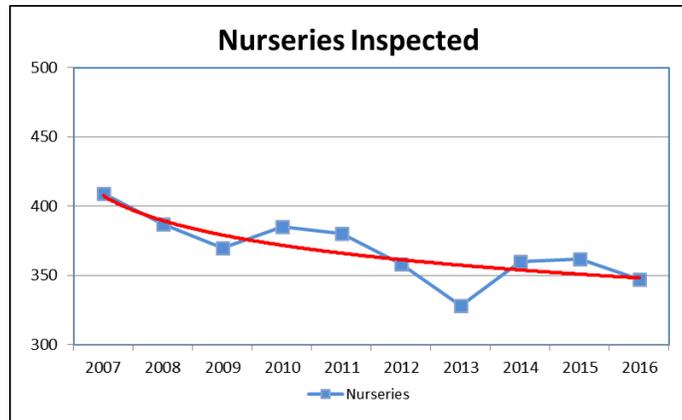


Figure 1 (top): total number of nurseries inspected by year beginning in 2005 with a red trend line showing steady decline in total licenses since 2006. Figure 2 (middle): total number of certified nursery acres inspected beginning in 2005. Figure 3 (bottom): percentage of certified nurseries with acreage reported in each category.

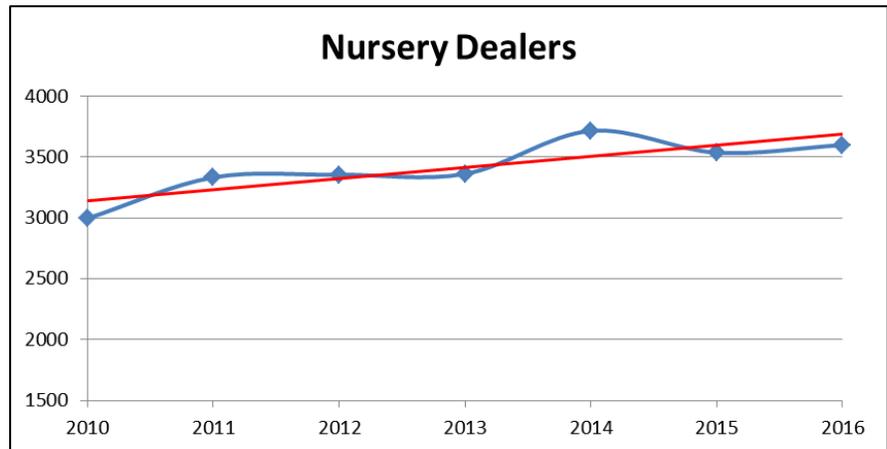
B. Dealers

While the number of certified growers has been on a steady decline for the last 10 years, the number of nursery dealer licenses has remained relatively steady indicating a shift in the source of material. In some cases, rather than grow material themselves, landscapers have found it more economical to buy their stock. In others, pressure from large-scale out-of-state wholesale growers has made it difficult for some Indiana businesses to be competitive. Still other of the smaller businesses was growing more as a hobby or second income and has either lost interest or the need to continue.

In 2016, there were 3,600 active Nursery Dealers in Indiana. This number has been on a slight increase since 2010 (Figure 4). Nursery Dealers are defined as any business that sells nursery stock (see above for definition). Facilities that strictly sell annuals may voluntarily request a license. Due to staff limitations, Nursery Dealers are randomly inspected each year with a focus on dealers who import nursery stock from other states and sell a large volume of stock.

Certified Nursery Growers and Nursery Dealers are able to renew licenses online at <https://mylicense.in.gov>. This assists in streamlining the renewal process and ensures growers and dealers are licensed properly and in a timely manner. This database also allows staff to quickly access facilities that are not licensed to ensure compliance. The Online Licensing Database (<https://mylicense.in.gov/EVerification/Search.aspx>) allows potential customers or state officials to verify certification quickly and efficiently.

Figure 4 (right): total number of Nursery Dealer's licenses issued by DEPP since 2010 with a red trend line showing the steady increase in overall number of licensed dealers.



C. Outreach and Education

The Entomology Weekly Review is written by Division staff to inform stakeholders and other interested parties of current news, issues, and pest pressures occurring in Indiana. The Review is published once a week from the beginning of May through the end of August and as needed through the rest of the year. It is distributed by an email list serve managed by DNR Communications. In 2016, there were 2183 subscribers, up almost 32% from 2015. This popular feature has continued to add subscribers since 2012 (Figure 5). A subscription link can be found at the bottom of the Division main page:

<http://www.in.gov/dnr/entomolo>.



Figure 5: number of individual subscribers to the Weekly Review which is written by DEPP staff.

In addition to publishing the weekly review, Outreach, extension and education of the public is important to the Division, to that end, DEPP staff assists with the Invasive Species Booth at the state fair, staff a booth at the Indiana Flower and Patio Show, provide outreach at the Indiana Landscapers Association’s Green Expo (INLA) as well as the Indiana Arborists Association (IAA) annual conference. Individual staff members also get many requests for speaking engagements from local Master Gardener groups, schools, scout troops and others. Talks are on a variety of topics covering invasive species in Indiana.

Staff members also regularly reply to homeowner initiated calls to the 866-No-Exotic hotline. This number is used for reports of possible invasive pests like Emerald Ash Borer (EAB), Asian Long-Horned Beetle (ALB), Gypsy Moth and Giant Hog Weed. Even though DEPP has not confirmed ALB or Giant Hog Weed in Indiana, calls o the hotline promote an excellent opportunity to communicate with the public one-on-one and provide further educational materials.

Staff also assisted in several DNR State Fair clean-up days in which trees were trimmed, weeds pulled, trash picked up and general maintenance of the grounds was completed. DEPP set up and maintained the Butterfly Garden at the DNR Building at the State Fairgrounds, a very popular attraction.

In 2016, DEPP also hosted the 46th annual meeting of the Central Chapter of the Horticultural Inspection Society (HIS). This annual event is an opportunity from members of all 12 states in the Central Chapter to meet and discuss current topics of interest including movement of regulated nursery stock. This year’s meeting in Lafayette, Indiana, had over 30 attendees including members from 10 Central Chapter states and a member from the Western Chapter. This group is designed to promote high standards of plant inspection work, to provide cooperative effort and cooperation with efforts of others toward stimulating interest in professionalizing plant inspection work and to provide a means of disseminating information. There are four HIS chapters; Central, Eastern, Southern and Western. Each works closely with their respective regional plant boards.

DEPP personnel gave a presentation at the National Walnut Council meeting in southern Indiana about trapping for Thousand Canker Disease (TCD). There were over 60 individuals from several states in attendance.

D. Most Frequently Reported Pests

This list is compiled by DEPP staff using Nursery Inspection Reports. Pests are ranked based on the number of incidents as well as the severity of any infestation. The list is divided into northern and southern regions due to the differentiation of weather patterns between those two parts of the state. This division is based on inspectors territories with five inspectors’ regions considered northern and four considered southern.

Northern Region		Southern Region	
Insects	Diseases/Abiotic	Insects	Diseases/Abiotic
Mites	Needle Cast	Aphids	Mildew
Aphids	Leafspots	Mites	Leafspots
Japanese Beetle	Mildew	Bagworm	Rusts
Leafhopper	Apple Scab	Japanese Beetle	Apple Scab
Flea Beetle	Tar Spot	Leafhopper	Botrytis
Thrips	Rusts	Leaf Miner	Needle Cast
Scale	Nutrient Deficiencies	Whitefly	Nutrient Deficiencies
Bagworm	Fire Blight	Thrips	Cankers
White Pine Weevil	Anthraxnose	White Pine Weevil	Root Rot
Insect Feeding	Abiotic Damage	Scale	Shot Hole Fungus

Section II. Phytosanitary Data

A. Phytosanitary Certificates

From January 1, 2016 through December 31, 2016, there has been a total of 2,763 federal and 227 state phytosanitary certificates issued (Figures 6 and 7) for 68 different species of plant products to 90 different countries. This includes 577s (Phytosanitary Certificates), 578s (Processed Plant Products) and 579s (Re-export of Products) and includes both original and reissued certificates.

Due to the different ways countries require quantities to be reported in official documentation, it's difficult to determine what commodity is shipped internationally the most by weight, however, DEPP issued 803 phytos for grain (772 of which were for popcorn); 458 phytos for seeds (228 of which were for corn); 961 phytos for lumber (mostly for oak, ash and walnut) and 304 phytos for logs (144 of which were for walnut). Indiana commodities are most often sent to China (647 issued phytos), Mexico (324 issued phytos), Vietnam (204 issued phytos) and Hong Kong (181 issued phytos) (Figure 8).

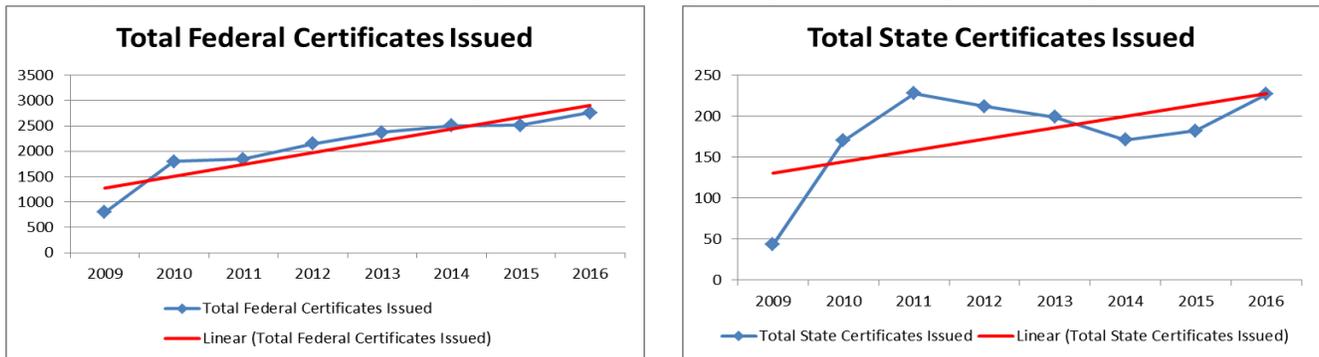
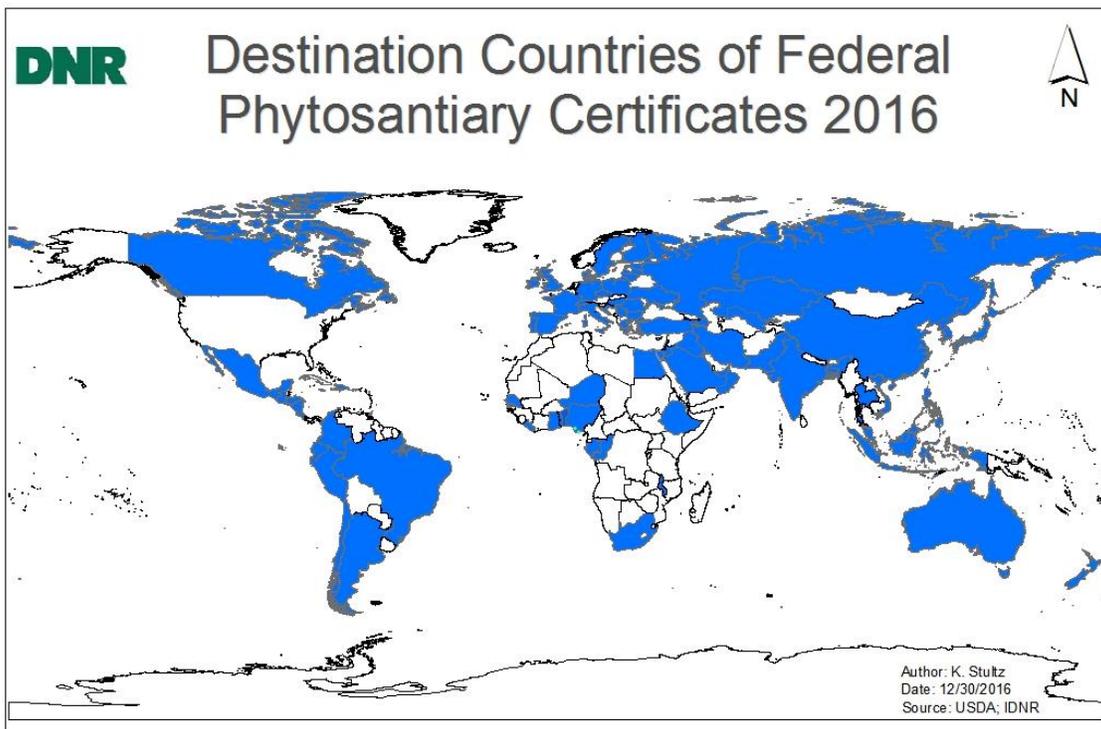


Figure 6 (left): total number of Federal phytosanitary certificates issued (both original and reissued). Figure 7 (right): total number of state phytosanitary certificates (original and reissued). Both graphs include a general trend line indicating the number of certificates for export continues to rise. Figure 8 (below): shows the destinations of Indiana plant products being exported.



B. Commodity Fumigation

Changing requirements in the logging industry and an overwhelming demand for fumigation services in coastal ports increases the need for inland fumigation sites. Fumigation Service and Supply, Inc. established the first export fumigation treatment facility in Indiana in 2007.

Responsibility for monitoring fumigations to ensure they are compliant with United States Department of Agriculture (USDA) Treatment Manual guidelines has been given to the DEPP with oversight provided by USDA Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ). Since the program began

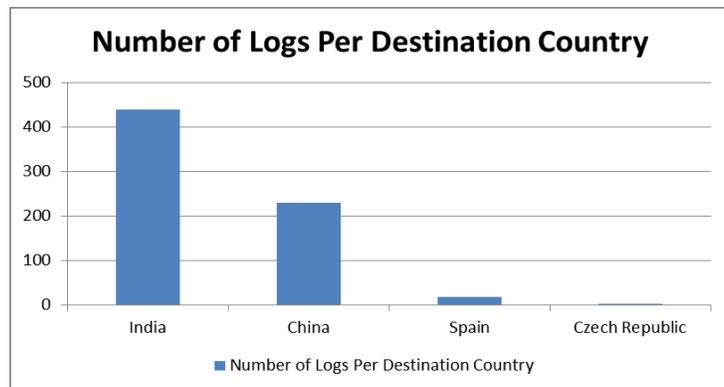
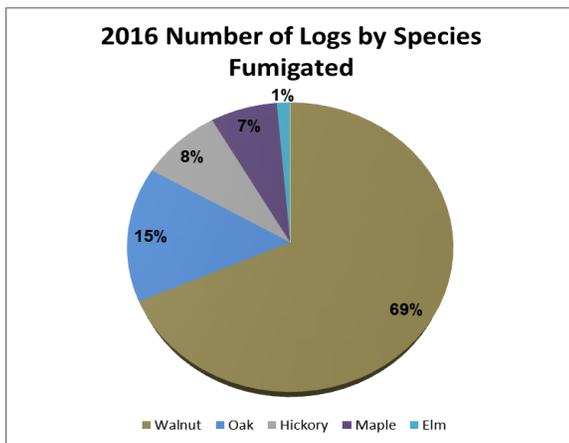
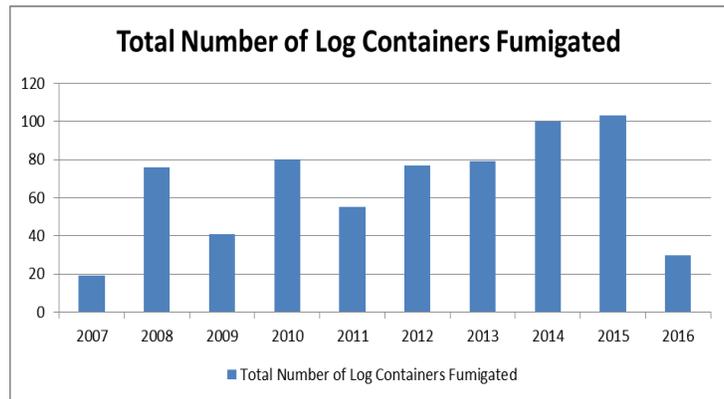


Figure 9 (top right): total number logs fumigated since the program began in 2007. Figure 10 (bottom left): shows that walnut is the most often fumigated log species. Figure 11 (bottom right): shows the destination for most of Indiana's fumigated logs.

in 2007, over 600 containers of logs (Figure 9) from two dozen different exporters have been fumigated for shipment to Asia and the European Union. These containers consisted of millions of board feet of logs and lumber able to move through the coastal ports without further treatment, and reached consumers overseas without delays at ports. There have been 31 containers consisting of 674 logs fumigated in 2016. Most of the logs fumigated were walnut (*Juglans spp.*) (Figure 10) and the majority of these were destined for India (Figure 11).

The facility has also been able to certify various other commodities such as seed, grain and erosion control mats. Fumigation personnel also monitors fumigations of 44 grain bins and two railcars of popcorn at one popcorn producer in the state. All fumigations are performed via USDA standards or requirements on Import Permits for shipment abroad as well as within the continental United States, thereby assisting other customers and industries within the state of Indiana with their export needs.

Section III. Surveys and Exotic Species

A. Repealed Rules

On October 7, 2016, the Division finalized the repeal of both the larger pine shoot beetle and emerald ash borer quarantine rules. Indiana has only has four of 92 counties in which EAB remains to be

found. Those are Benton, Fountain, Vermillion and Warren though it is suspected that EAB has found its way into those areas as well but the populations have yet to be discovered and reported.

B. Gypsy Moth

Lymantria dispar, more commonly known as the Gypsy Moth, is a native of Europe and has been a major pest for the eastern United States since its accidental introduction in the 1800s. While its preferred host is oak (*Quercus* spp.), Gypsy Moth will feed on several hundred species of hardwood and coniferous species of trees and shrubs making it a major threat.

The 2016 Cooperative Gypsy Moth Survey completed its 28th year of the statewide survey. The survey is part of the Slow-the-Spread (STS) Program and uses the STS protocol for its design and operation dividing the state into three zones: the STS Evaluation Zone, the STS Action Zone, and the State Area (Figure 12). The survey design used fixed 5K, fixed 3K, and fixed 2K grid survey points for the three zones. Across all zones, the survey used 11,055 trap sites all referenced by GPS (Figure 13). Six counties in the state area were not trapped in 2016 compared to four counties not trapped in 2015. Areas are not trapped mostly for economic reasons, but also because of negative trap catches in previous years. There are plans to survey most of these counties in 2017.

The survey detected 32,431 moths from 59 counties ranging from 1 to 5,358 moths per county (Figure 14). This year's moth catch is 17,101 more than last year's number of 15,330 (Figure 15). Positive traps occurred in 58 counties; 32 in the STS zones and 27 in the State Area.

The results of the 2016 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, St. Joseph, Porter, Allen, LaPorte and DeKalb (Figure 16), detected 72% of the moths (23,351 of 32,431). The northern third of the state falls in the Action Zone, which is below the Evaluation Zone under STS protocol. The Action Zone detected 27.6% of the moths (8,941 of 32,431). The majority of the Action Zone moth catch occurred in the northern and eastern parts which are adjacent to the Evaluation Zone. The State Area detected 0.4% of the moths (139 of 32,431).

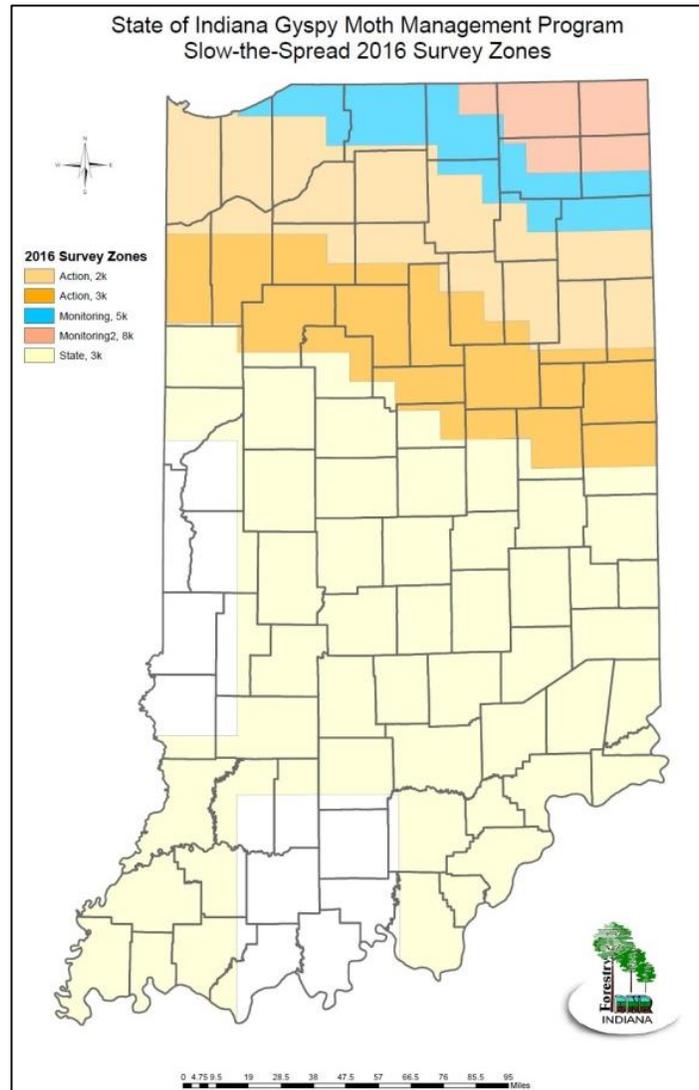


Figure 12 (above): shows survey zones for the Gypsy Moth Survey. Areas in white were not trapped for budgeting reasons and due to negative catches in past years.

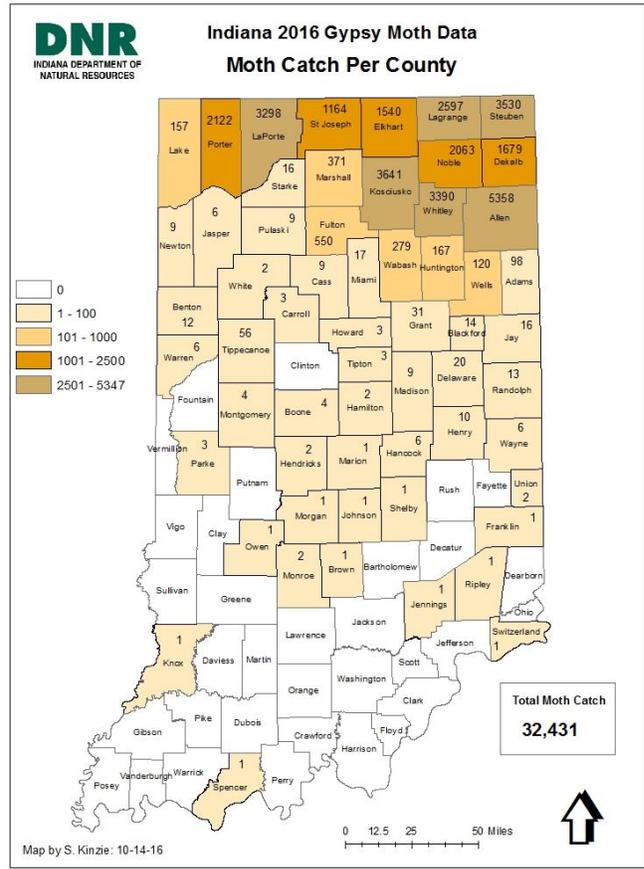
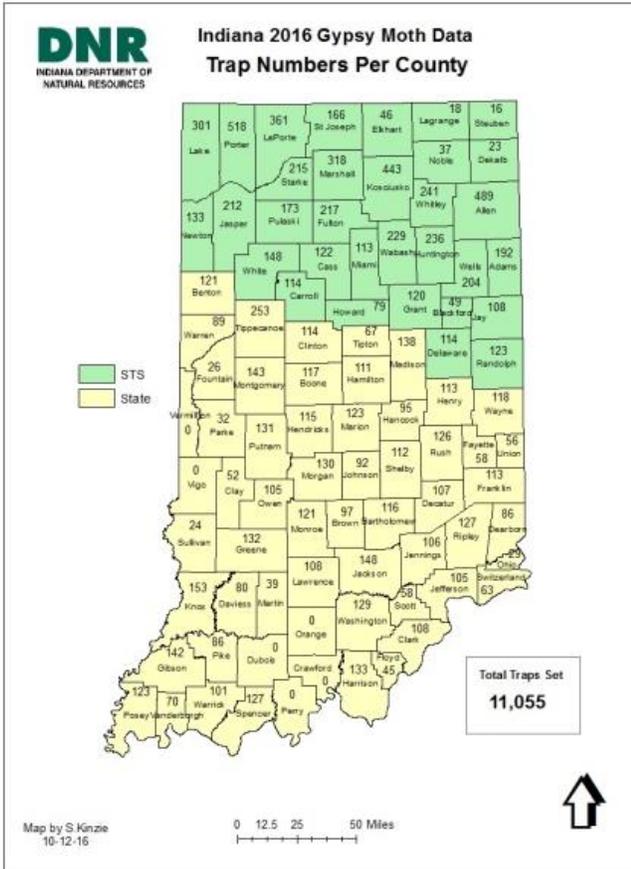
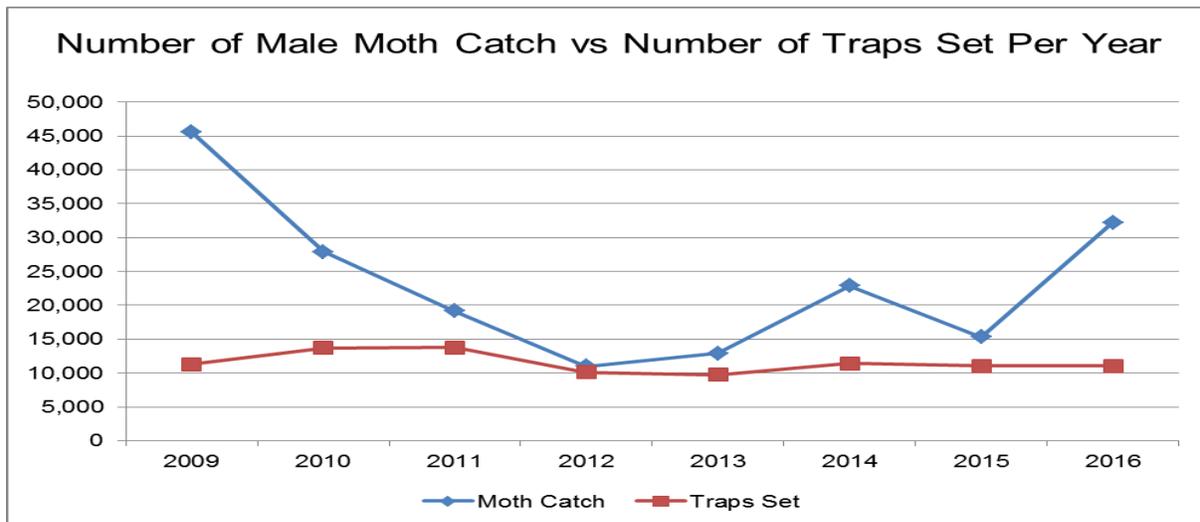


Figure 13 (above right): Shows the total number of traps placed in each county. Figure 14 (above left): Shows the total number of male moth catch per county. Figure 15 (below): Shows the total number of male moth catch since 2009 and includes the number of traps set each year.



Since the survey began in 1972, a total of 512,809 moths have been caught in 90 of the 92 counties. Gypsy moth has not been detected in Dubois or Sullivan County since surveys began in 1972.

Aerial surveys detected two areas of noticeable defoliation (96 acres) in Porter County. Other reports of defoliation in LaPorte, Porter and Allen counties were not detectable by aerial survey. They were very light and only visible from the ground.

The last time aerial surveys detected defoliation from Gypsy Moth was in 2009 when 70 acres of defoliation occurred DeKalb and Allen counties.

The 2014 eradication treatment at Purdue University has not achieved its goal. The 2016 delimit survey detected 46 moths in and around the 2014 treatment site compared to only five moths in 2015. Treatments will be done in the spring of 2017 in Tippecanoe County on the Purdue University campus.

Treatments:

Btk (*Bacillus thuringiensis kurstaki*): Treatments to slow-the-spread and development of gypsy moth were conducted on four sites totaling 1,089 acres in four counties (Figures 17 and 18). The sites were treated with Btk at 25 BIU with two applications for a total of 2,178 treated acres.

Mating Disruption: Four sites totaling 4,573 acres were treated with pheromone flakes (Disrupt II, Hercon). All four sites were at 6 grams. (Figures 17 and 18).

Treatments for 2017 are being evaluated and will be finalized early in 2017.

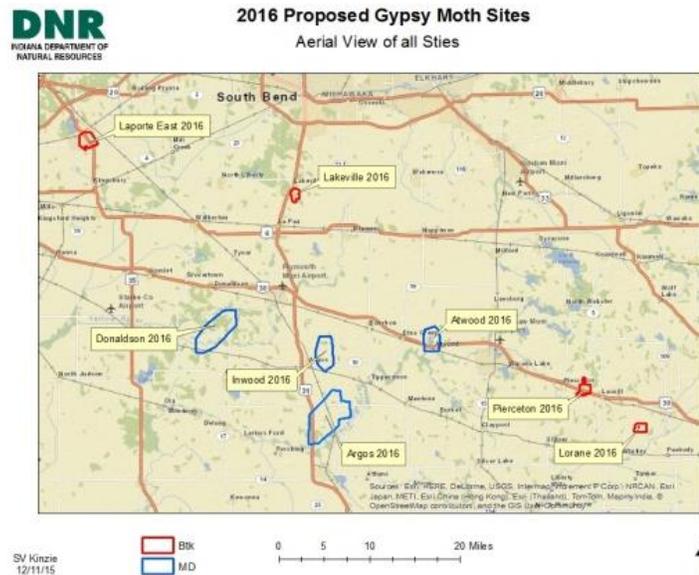
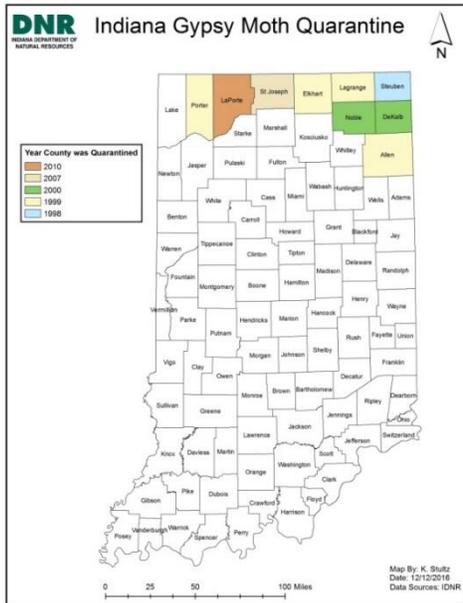


Figure 16 (above): shows the current Indiana Gypsy Moth Quarantine. Figure 17 (right): is an aerial view of treatment sites. Figure 18 (below): is a table of treatment sites and acreage

County	Site Name	Treatment			EA Acres	Treat Acres	Total Acres treated all applications
		Material	No. of Applications	Method			
Kosciusko	Pierceoton 2016	Btk 25 BIU	2	Aerial	1,054	571	1142
Laporte	Laporte_East 2016	Btk 25 BIU	2	Aerial	1,716	310	620
St. Joseph	Lakeville 2016	Btk 25 BIU	2	Aerial	670	124	248
Whitley	Lorane 2016	Btk 25 BIU	2	Aerial	799	84	168
	Total STS				4,239	1089	2178

Mating Disruption	Site Name	Rate	EA Acres	Polygon Acres	Planned Acres	Acres Actually Treated	
County							
	Kosciusko	Atwood 2016	6 grams	2,745	1,828	1200	1042
	Fulton/Marshall	Argos 2016	6 grams	10,262	867	550	658
	Marshall	Inwood 2016	6 grams	3765	584	400	358
	Marshall	Inwood 2016 East	6 grams	xxxxx	108	100	112
	Marshall/Starke	Donaldson 2016	6 grams	7656	1,502	1400	1423
	Marshall/Starke	Donaldson 2016 Center	6 grams	xxxxx	920	750	781
	Marshall/Starke	Donaldson 2016 South	6 grams	xxxxx	226	225	199
	Total			24,428	6,035	4625	4573

C. Thousand Canker Disease of Black Walnut

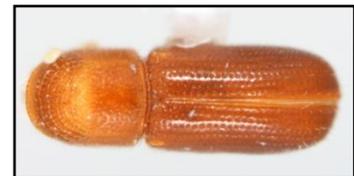
Thousand Canker Disease (TCD) is a disease complex consisting of a fungus (*Geosmitha morbida*) that has to be introduced into walnut trees (*Juglans spp.*) via a vector. In this case, the vector is a beetle known as *Pityophthorus juglandis*, or walnut twig beetle. This disease complex is native to the Southwestern United States where its original host was western walnut species including *J. californica*, *J. hindsii* and *J. major*. Eastern black walnut (*J. nigra*) is widely planted in the western United States and became a new host for this disease complex. It was first reported outside of its natural range in 2010 when it was discovered in Tennessee. Since then, North Carolina, Virginia, Maryland, Pennsylvania, Ohio and Indiana have found either walnut twig beetle, the fungus or both. Although walnut twig beetle was captured at two separate mills and the fungus was cultured out of material from Brown County, Indiana has not found walnut twig beetle in conjunction with the fungus in a living tree.

In 2015, the Division conducted two TCD trapping surveys in the state with a total of 2,889 samples collected and 1,010 insects submitted for identification. The first survey was funded by a grant from the Farm Bill which consisted of 148 traps set near high risk sites. Two walnut twig beetles (*Pityophthorus juglandis*) were collected as part of this survey in a trap at a veneer mill in Edinburgh, Indiana in September, 2015. In response to this, the mills records were reviewed to determine the origin of walnut material around the time the insects were collected. Logs that came in during that time originated in Indiana, Ohio, Kentucky and Tennessee. Although an exact location of origin has not been determined, it's likely that the insects came from either the Tennessee or Kentucky material. The Tennessee material originated in the western part of the state, however, the Kentucky records indicated the mill received material from several counties, three of which are adjacent to buffer counties in Tennessee. As part of this investigation, the mill's compliance agreement was modified so the inspector must be notified when material from Kentucky or any currently infested state will be arriving.

The second survey was funded by a Forest Service grant and was a delimit survey conducted within a 169 square mile area around a mill in southern Franklin County, Indiana, where walnut twig beetle was captured in 2014. This survey contained 217 grid points made up of a 500 meter, a 1-kilometer, and a 3-kilometer grid. Out of the 217 potential survey locations, 126 traps were deployed. Four walnut twig beetles were captured at the mill location in 2015, one of which was collected at a trap near a small walnut tree across the road from the mill.

In 2016, these two TCD trapping surveys were conducted again (Figure 19). The Farm Bill survey consisted of 129 traps set at high-risks sites throughout the state. The second survey was the Wilhelm Delimit survey consisting of 55 traps, five of which were dry cup collection. Four of the Wilhelm traps were on the mill property; the other 52 traps were set near walnut trees in a woodlot directly across the road from the mill. The dry collection cups were utilized so that fungi could be cultured from the bodies of certain species of bark and ambrosia beetles that were collected. It is estimated that 2,354 samples have been collected from both surveys. By December 1, 2016, 1,194 samples were screened with no walnut twig beetle having been identified.

In addition to the trapping surveys, the walnut tree where a walnut twig beetle was collected in the 2015 Forest Service survey was cut down and examined for evidence of cankers and bark beetle activity. It was then cut up into one inch bolts and selected bolts were taken to Purdue for placement into rearing buckets. As of August 2016, very few insects had emerged from the bolts and none of those were walnut twig beetle.



Above: Walnut twig beetle collected during the 2014 TCD survey. Photos by Bobby Brown, USDA APHIS PPQ.

A Windshield Survey was also conducted in 11 new locations in 2016 (Figure 19). This is a visual survey of walnut trees in urban areas. The purpose is to locate walnut trees in urban areas and evaluate them for symptoms consistent with TCD. New for 2016 was the use of Arc Collector on mobile devices to collect the data instead of using GeoLink on a laptop computer. Using Arc Collector made the survey more efficient by allowing the data to go directly into the state's GIO library where it could be accessed by all of the inspectors. This change allows the Division to stop using paper maps which were time consuming to create. Arc Collector also allows the Division to take photographs of suspect trees. The pictures are linked to a specific data point making it easier to evaluate a suspect tree over time. This year's visual survey was conducted in the following areas: Brookville Heights/New Palestine, Frankfort, Huntington, Liberty, Milan, Mitchell, New London/Russiaville, North Judson, Petersburg, Seymour and the northern half of Warsaw. A total of 1,423 trees were surveyed. Out of the 1,423 trees visually inspected, 44 were listed as suspect and will be reevaluated over time. Since this survey began in 2012, 5,054 trees have been evaluated in 49 municipalities.

The Division also utilizes Gypsy Moth trap tenders who collected data on the location and condition of walnut trees near gypsy moth traps (Figure 20). In 2015, data was collected on 722 trees and trap tenders recorded 17 trees as being suspicious. After evaluation by DEPP inspectors none of the trees were determined to have TCD. In 2016, Gypsy Moth trap tenders collected information on 808 trees. Of those, information about the location and condition of 37 were forwarded to inspectors for further investigation. Since the trap tender survey began in 2011 data has been collected on over 6,000 walnut trees.

DEPP has been awarded \$25,000 in Farm Bill grant money to continue surveying for TCD in 2017.

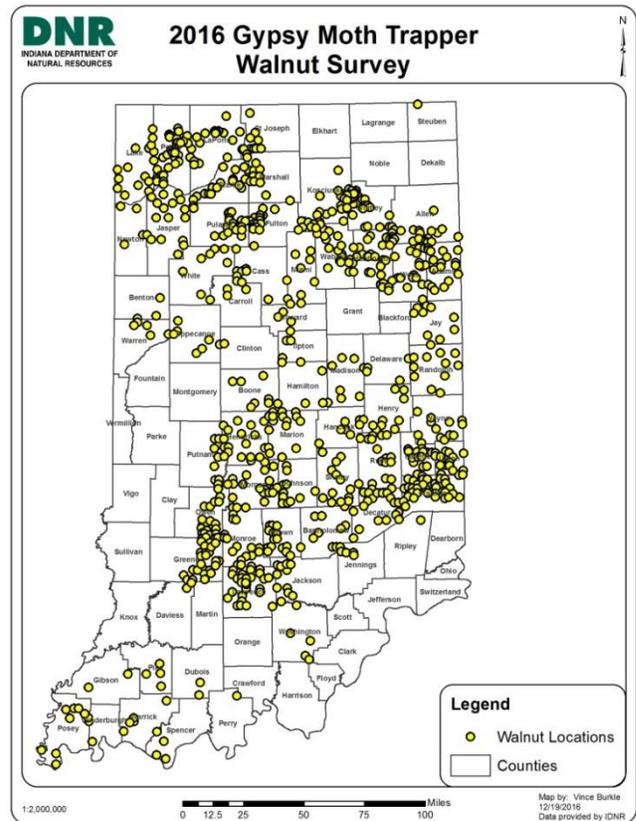
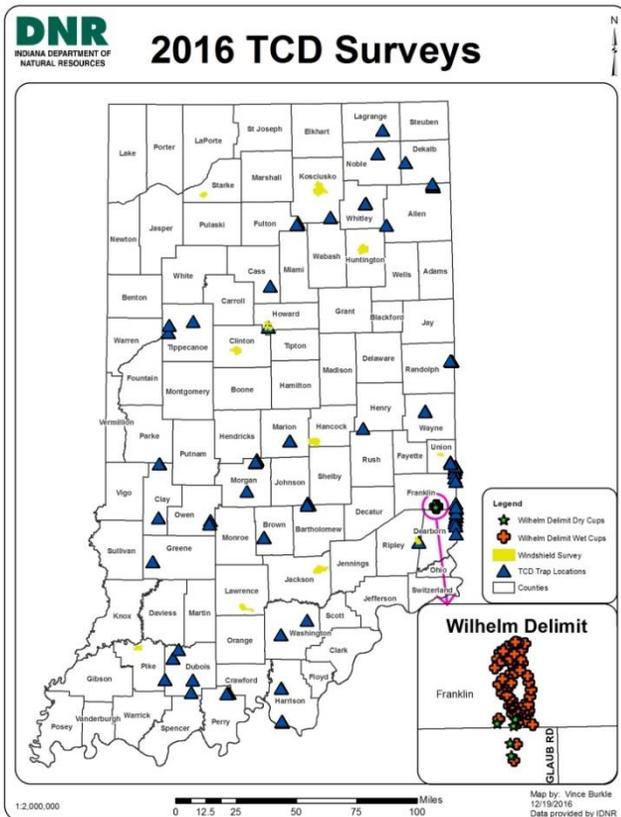


Figure 19 (above): shows the three separate TCD surveys conducted. Figure 20 (right): shows where Gypsy Moth trap tenders noted walnut trees in possible distress.

D. Sudden Oak Death (SOD)

Pythophthora ramorum is a fungal infection often referred to as Sudden Oak Death (SOD), ramorum leaf blight or ramorum dieback. While in some species it only causes foliar lesions, in several oak (*Quercus* spp.) species, it can cause trunk or bole lesions which lead to the eventual death of the plant. Only members of the red oak group have been found to be susceptible to this pathogen.

The origin of *P. ramorum* is unknown, but it was first reported on tanoak in California in 1995. Since that time, the pathogen has been found in a number of areas on the west coast. California, Oregon and Washington states are currently federally regulated areas due to the presence of *P. ramorum* in either forest areas or plant nurseries.

In an attempt to limit the artificial and accidental spread of SOD, DEPP conducts an annual survey in which leaf samples are collected and sent to Purdue’s Plant and Pest Diagnostic Lab for testing. The samples are taken from material that originates from western states.

As part of DEPP’s annual SOD survey, 20 separate locations were surveyed in 18 counties (Figure 21) in 2016. A total of 394 SOD survey samples along with seven trace forward samples were collected. The trace forward samples came from a single location. Of the 394 total samples collected, 81 of those tested positive for *Phytophthora* spp. None of those tested positive for *P. ramorum*.

E. Old World Bollworm

The old world bollworm, *Helicoverpa amigera*, a high priority pest of grains, fruits, vegetables, and flowers was not detected in the 2016 Indiana Nursery and Retail Plants Survey. Universal moth traps with pheromone lure were placed at 47 high-risk sites representing 19 counties. Trapping period ranged from May 4 to August 25 statewide and resulted in 285 negative records. Counties with trap sites included Allen, Boone, Clark, Dearborn, Dubois, Floyd, Hamilton, Harrison, Hendricks, Kosciusko, LaPorte, Lawrence, Marion, Porter, Ripley, Tippecanoe, Vanderburgh, Warrick, and Whitley. The results of this survey suggest that the old world bollworm has a very low probability of being present in the state.

F. Boxwood Blight Survey

Boxwood (*Buxus* spp.) has been called, “Man’s Oldest Garden Ornamental,” and was introduced to North American from Europe in the 1600s. In recent years, it has once-again become a corner-stone of

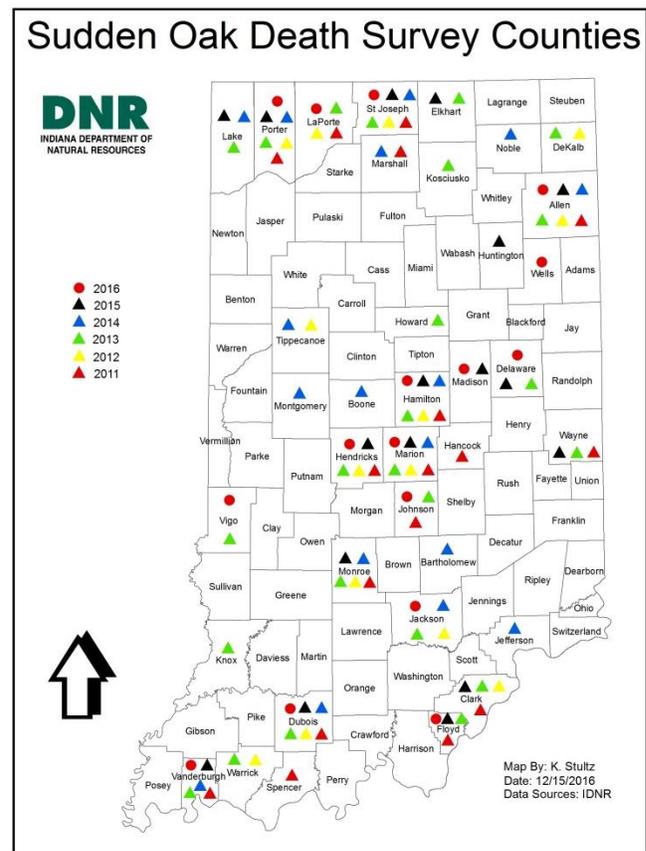
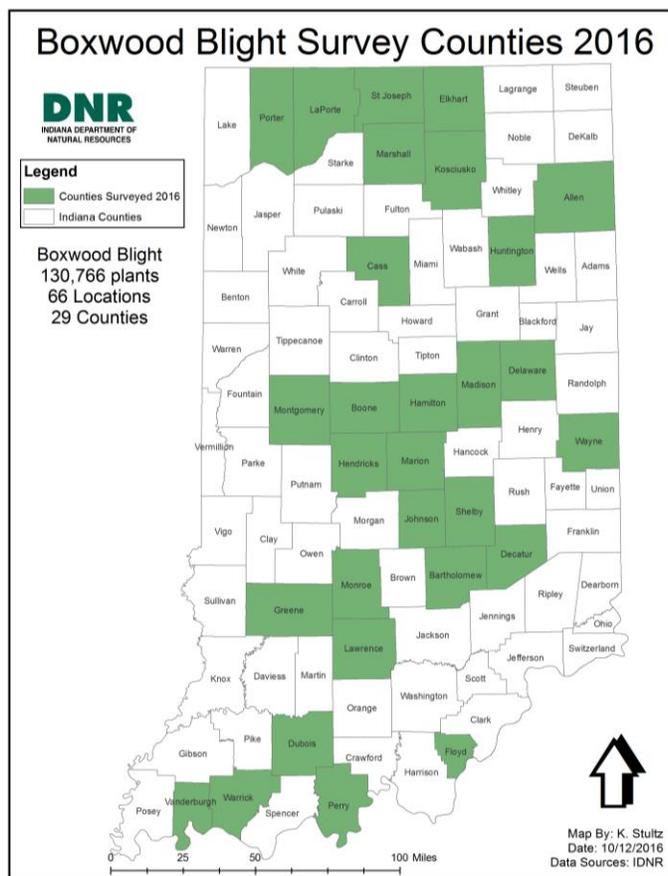


Figure 21: counties surveyed for *Phytophthora ramorum* for the last six years.

the horticultural industry. Known for being low maintenance, its evergreen form is suitable in a variety of situations. In the 1990s a new fungal pathogen of *Buxus* spp. was described in the United Kingdom and in 2002 it was described in New Zealand.

Cylindrocladium buxicola (syn. *C. pseudonaviculatum* or Boxwood Blight as it is more commonly known) is a devastating fungal infection that affects all above ground parts of boxwoods. It spreads rapidly in warm, humid conditions and causes severe leaf drop and eventual death of the plant. Boxwood blight has been confirmed in 19 states (Ohio, Pennsylvania, New York, New Jersey, Delaware, Connecticut, Massachusetts, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Alabama, Florida, Kansas and Oregon). DEPP began a visual survey for boxwood blight in 2012.

During the 2016 inspection season, DEPP inspectors visually inspected 130,766 individual plants at 66 locations in 29 counties (Figure 22). Of the 66 locations, 42 were nursery dealers, 22 locations were certified nursery growers and two locations were landscape environments. The goal of the survey was to obtain negative data in order to provide evidence that supports the absence of the boxwood blight pathogen in the state of Indiana, and allow for possible early detection and rapid response to introductions of the pathogen. Boxwoods were visually inspected for the presence of leaf drop and dieback throughout the growing season.



Results:

This survey and routine nursery inspections did not confirm the presence of boxwood blight. Inspectors reported *Volutella* blight and *Macrophoma* leafspot at some locations. Other reported problems included frost injury, boxwood psyllids, boxwood mites and boxwood leaf miner. Boxwood mite infestations were more common this year compared to 2015

Boxwoods were shipped to Indiana from numerous out-of-state sources including states with known boxwood blight locations, but this year there were no Canadian

sourced shipments. Thirty-four different cultivars were inspected during the survey. Cultivars Winter Gem, Winter Green, Green Velvet, Green Gem and Green Mountain were the dominate cultivars

Figure 22 (above): counties surveyed for boxwood blight symptoms. Figure 23 (below): cultivars of boxwood noted during the survey.

Cultivars Reported 2016 Boxwood Blight Survey		
B. sempervirens	Green Beauty	North Star
B. microphylla	Green Gem	Roboxupt
Baby gem	Green Mound	Shadow Century
Chicagoland Green	Green Mountain	Sprinter
Common	Green Velvet	Variiegated English
Cranberry Creek	Green Tower	Vay Day
Dwarf English	Highlander	Wee Willie
Friendship	Justin Bowers	Winer Beauty
Golden Dream	Korean	Winter Gem
Golden Sunburst	Little Gilbert	Winter Green
Golden Triumph	Northern Charm	Woodburn Select
Graham Blandy		

inspected making up 64% of the total plants surveyed. Boxwoods originated in 11 states including California, Indiana, Kentucky, Maryland, Michigan, North Carolina, Ohio, Oklahoma, Oregon, Tennessee and Wisconsin.

Discussion:

Although boxwood blight was not detected in the 2016 survey, it still could be present somewhere in Indiana and DEPP must continue to survey for the presence and potential introduction of this disease. Survey results provided evidence that boxwoods are shipped to Indiana from states (Kentucky, Maryland, North Carolina, Ohio, Oregon and Tennessee) that have had previous confirmation of the disease, therefore, there is a significant risk for introduction of the boxwood blight pathogen. Excessive rainfall occurred this summer over the southern two thirds of the state, while extreme northern Indiana had some dry periods. However, the large rainfall totals were accompanied by temperatures that were consistently in the upper 80s to low 90s which is somewhat above the optimum temperature for boxwood blight. This is the fifth year of negative data for the presence of boxwood blight. Future surveys will continue in an effort to provide early detection and rapid response of boxwood blight.

G. Kudzu Eradication Project

Pueraria lobata (syn. *P. montana* var. *lobata*), better known as kudzu, was first introduced into the United States from Asia at the 1876 Philadelphia Centennial Exposition. In the 1930s through the 1950s, it was widely planted as erosion control mats due to its rapid growth rate. Since that time, it has found its way onto many state noxious weed lists and is considered very invasive. It can quickly out compete native vegetation. This change in plant habitat can cause the loss of habitat and food for existing wildlife, alter soil chemistry and structure, replace and possibly lead to the local extinction of native sensitive, threatened or endangered species, increase ozone levels, and harbor pathogenic plant diseases or invasive insect species which may spread to other plant species.

Kudzu is a member of the Fabaceae family and closely related to soybeans (*Glycine max*), an important commodity in Indiana. It is a host plant for Asian soybean rust (*Phakopsora pachyrhizi*) which has been shown to reduce soybean yields from 10 to 80% (CRS 2005). It is also a host for the non-native bean plataspid (*Megacoptera cribraria*) which has caused crop loss of up to 50% in soybeans and other legumes in its native region (USDA 2010).

Currently there are 167 confirmed kudzu sites in 41 counties totaling 180.85 acres. Four new sites were confirmed in 2015 totaling 0.66 additional acres. In 2016, 10 new sites have been confirmed totaling an additional 3.58 acres (Figure 24).

Treatment of kudzu by DEPP began in the late summer of 2006 and has been ongoing annually for the last 11 years. During this time, 109 sites in 35 counties totaling 89.49 acres have been treated by the Division. There are a total of 125 kudzu sites that have received treatment. Six of these sites are being treated by homeowners with an additional 10 sites being treated by other DNR divisions. The total number of acres in the treatment program is 103.45 which is approximately 57 percent of the documented kudzu acreage.

The success of the project has been measured through post-treatment site monitoring and calculation of yearly metrics. 78.38 acres or approximately 43 percent of documented acres in the state are at a level in which only spot treatments are necessary. However, there are 93.19 acres of kudzu sites that have a moderate to heavy population level and are in need of contractor or chemical treatment by the Division.

Of the 109 sites treated by DEPP, 76 percent of those have at least 90 percent suppression of kudzu and 68 percent of those sites are in monitoring stage in which kudzu growth is not readily visible and is nearly eradicated with only a need for spot treatments. Kudzu has been eradicated from four counties including Jackson, Howard, Hendricks and Johnson Counties. A total of 12 sites are likely to be

eradicated including specific sites in Brown, Jennings, Monroe, Morgan, Pike and Lawrence counties. These percentages are down slightly from last year since additional sites were discovered and sites that were previously adequately suppressed have had growth resurgence.

The Indiana DNR has spent approximately \$513,777 for kudzu treatments over the last 11 years. This cost is based on contracts for treatment and erosion work and does not include hours and mileage spent by DNR staff. The average treatment cost has been \$1,114.79 per acre per application.

During 2016, DEPP treated 76 sites in 27 counties totaling 72.65 acres. This is the most acreage ever treated in one year by the division. The contract work of 61 sites was completed by September 15, 2016. Fifteen additional sites totaling 7.59 acres were treated by Indiana DNR, DEPP personnel by September 30, 2016. This saved the division approximately \$8,461.26 in project costs. The Brown County Native Woodland Project is assisting the project by conducting spot treatments at 0.72 acres in Brown County, Indiana.

The Division is continuing to develop a working relationship with The Southern Indiana Cooperative Invasives Management (SICIM) organization to build relationships with local invasive species organizations that can implement spot treatment programs of kudzu sites that have been suppressed in their counties. DEPP received federal funding in the amount of \$70,000 for the 2017-18 kudzu project which will be used to expand the program to other sites not previously treated.

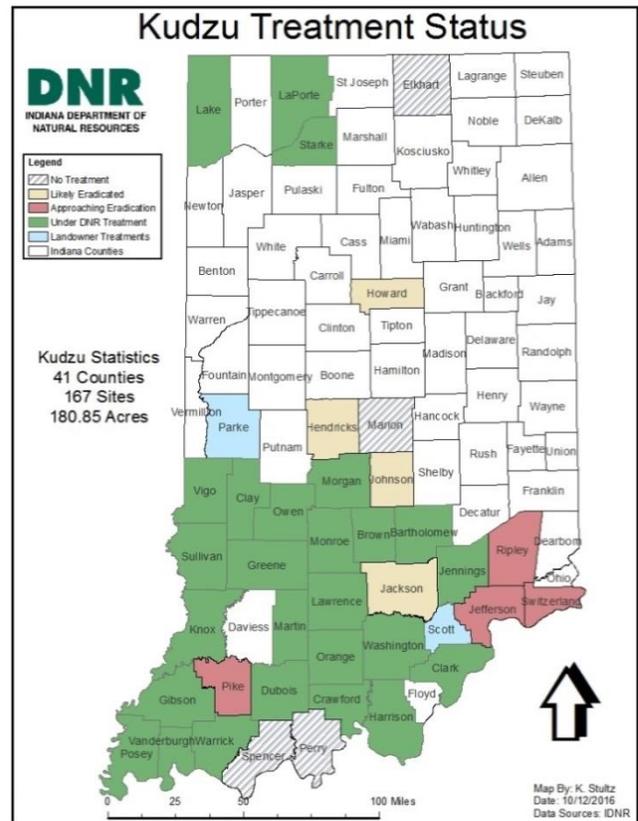


Figure 24: are the counties with confirmed kudzu sites and the treatment status of those sites.

H. Emerald Ash Borer Parasitoid Release Program

Emerald Ash Borer (EAB) was first detected in 2003 in South East Michigan. Its introduction probably preceded its discovery by at least a decade. Since then, it has spread to 30 states and two Canadian provinces. Currently within Indiana there are only two counties in South West Indiana in which EAB has not yet been found. Although chemical control of EAB is possible with landscape trees there is no feasible way to control EAB in a forested setting. The only means of management to date has been through the use of quarantines which slow the human assisted spread of EAB. There have been two main approaches taken to try and control EAB on an environment wide scale. The first avenue is by trying to find, breed or engineer a tree that has a resistance mechanism to EAB and is able to survive EAB attacks. The second approach has been Biological Control. Many, who are reading this, may not be well versed with the concept of Bio-control. Bio-control is defined by Webster’s dictionary as the reduction in numbers or elimination of pest organisms by interference with their ecology as by the introduction of parasites or diseases, or an agent used in biological control.

Currently in a United States Department of Agriculture Lab in Brighton Michigan there four bio-control agents being reared for control and management of the Emerald Ash Borer. To ensure that the potential Emerald Ash Borer bio-controls would not attack native insects the United States Department of Agriculture started collecting insects from the wild in the native range of the parasitoids. Thousands of wood boring insects from a dozen insect families were collected. If a parasitoid was observed attacking a wide host range, it was eliminated from consideration for release in the United States. After the initial field data was collected, the parasitoids were studied in the lab with “no choice” lab studies in which the parasitoids are given what’s believed to be a non-host insect and observing if they will attack it. Some species of



Figure 25: EAB parasitoids *Oobius agrili* (top right photo by Houping Lui of Michigan State) next to an EAB egg, *Spathius* spp. (bottom left) and *Tertrastichus planipennis* (bottom right photos by David Cappaert (ESM Mary Hooker).

the *Agilus* genus, other than EAB like two lined chestnut borer and bronze birch borer, were documented being attacked but all parasitoids were observed to show a very strong or absolute host preference for EAB. Three of the species are larval parasitoids, and one is an egg parasitoid. A parasitoid is an organism that feeds on its host like a parasite but eventually kills the host. The four insects are *Oobius agrili* (the egg parasitoid), *Tertrastichus planipennis*, *Spathius agrili*, and *Spathius galinae*.

In 2016, IDNR-DEPP initiated the release of the four parasitoid insects to help manage the damage caused by EAB. *Oobius agrili* is a minute egg parasitoid about the same size as an EAB egg. *Tertrastichus planipennis* is a small wasp which can locate EAB larvae under the surface of the bark of ash trees. *Spathius galinae* and *S. agrili* are somewhat larger than *Tertrastichus* and biologically they are similar in the way that they find and kill EAB larvae.

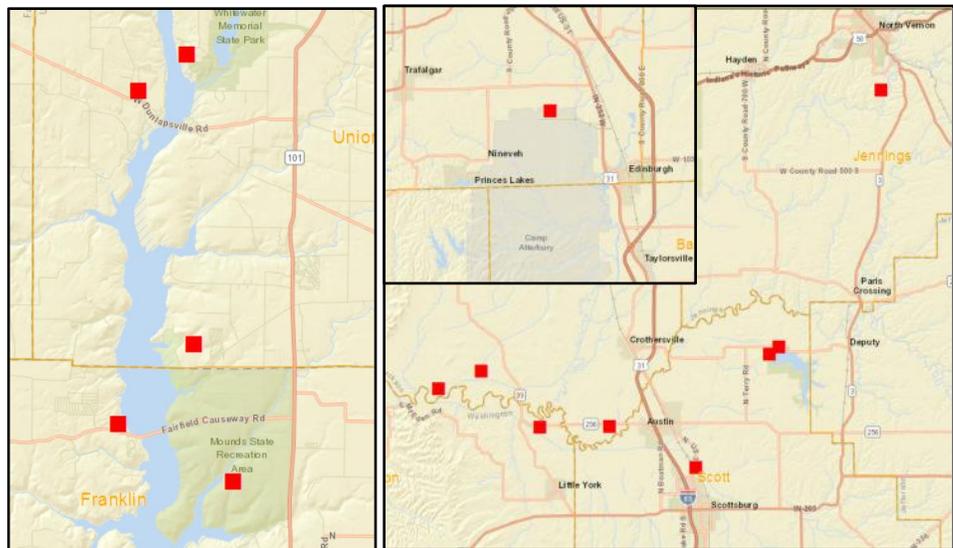


Figure 26: maps indicating the locations of EAB parasitoid releases.

The insects are shipped overnight from the USDA rearing facility in Brighton, Michigan and are released by DEPP staff the same day they arrive. There are five sites around Brookville Lake, one site at Crosby Fish and Wildlife Area, two sites at Hardy Lake, four sites at Austin Bottoms, and one site at Atterbury Fish and Wildlife Area (Figure 26).

Release began in late April and continued for 22 weeks through the end of September. Between 2,500 and 13,500 insects were released weekly. Over 77,000 *Tertastichus*, over 52,000 *Oobius* and almost 5,000 *Spathius* were released during the course of the summer.

Releases will continue in 2017 and then in 2019 after the insect population has had time to grow, DEPP will be in the process of trying to re-capture the insects to assess the establishment level. *Spathius* species have longer ovipositors which help to penetrate deeper into ash trees reaching more EAB larvae.

I. First/Unusual finds in Indiana

Tar Spot (*Rhytisma* spp.) was confirmed on *Ilex decidua* (commonly known as Possumhaw) for the first time in Indiana during the 2016 growing season. It was discovered in Knox County at a licensed certified nursery grower's location. Tar Spot symptoms were found on six varieties of *I. decidua* including Red Escort, Sentry, Pocahontas, Warrens Red, Red Cascade and Finch's Gold (Figure 27).



Figure 27: Confirmed Tar Spot on two varieties of *Ilex decidua*. Photos by Angela Rust.

During an inspection at Lowe's Home Improvement in Bedford, Indiana peonies that had viral symptoms were encountered. A whole plant sample was sent to the Purdue Diagnostic Lab and subsequent samples tested PCR positive for Tobacco rattle virus (TRV) at the University of Wisconsin laboratory. Cultivars with symptoms include Sarah Bernhardt, Vogue, Shirley Temple and Karl Rosenfield. All plants were destroyed. This is an unusual virus to find on peonies, but viruses have previously reported on this species (Figure 28).



Figure 28 (right): Confirmed Tobacco Rattle Virus on Peony. Photo by Ken Cote.

J. Apiary Report

Indiana had an estimated 3,000 beekeepers in 2016. The majority of Indiana's Beekeepers are hobby beekeepers. There is an estimated 25 sideline beekeepers, and seven commercial beekeepers. Hobby beekeepers usually have less than 50 hives and produce honey for gifts and income to support their beekeeping hobby. Sideline beekeepers have 500 hives or less, but keep bees as a part time job to supplement income. Commercial beekeepers typically have at least 1,000 or more hives and make a

living from keeping honey bees. There has been an increase in the number of beekeepers each year. Others have given up beekeeping due to losing bees each year and the increasing cost of replacement bees.

In 2016 the Chief Apiary Inspector spoke at the 3 Indiana Beekeepers Association meetings and 23 local beekeepers association meetings. The inspector spoke about honey bees and pollinators to three agriculture groups, two garden groups, and seven school groups. The Inspector also did two presentations at the flower and patio show on “Gardening for Butterflies”. The Inspector with assistance from the Indy South Beekeepers Club talked about honey bees and beekeeping, demonstrating extracting honey and gave honey samples at the Southeastway Indy Park’s annual Bugfest that over 2000 children attended.

In 2016, the Chief Apiary Inspector inspected 138 Apiaries, opening 1,208 hives certifying 4,600 hives. Of the certified hives, an estimated 1,500 are going to Florida, Mississippi and Texas for the winter. Another 6,000 hives will be moved to California for almond pollination. From August through October 2016, 12 samples were collected for the 2016 USDA Honey Bee Health Survey. The other 12 samples to meet the survey guidelines will be completed in the spring of 2017, before the deadline of June 1, 2017.

Inspections of apiaries were completed through the entire year. Colder months of January, February, March and December consisted of looking at dead hives for possible disease problem. Sample of dead bees were sent into the USDA Beltsville Bee lab for identification of Varroa mites, tracheal mites and Nosema disease. April through November inspections of live hives were possible. A warm October and November allowed for late inspection of live hives. Chalk brood (*Ascophæra apis*) and sac brood virus was identified in six hives in five apiaries. Nosema disease (*Nosema Apis* & *Nosema ceranae*) was identified in five hives in three apiaries. American foulbrood (*Bacillus larvae*) was identified in only one hive in one apiary. European foulbrood (*Melissococcus plutius*) was identified in three hives in two apiaries. In 15 hives in six apiaries there were symptoms of what some are calling “Snotty Brood” (figure 29) or Parasitic Mite Syndrome. This is not American foulbrood or European foulbrood. The larva dies fairly early and just melts in the cell. It is associated with Varroa mites and any of the bee viruses that the Varroa mites can pass onto the bees when they feed on the larvae. Treating with Antibiotics, treating for Varroa mites, requeening and feeding hives with sugar water helped cleaned up the problem.

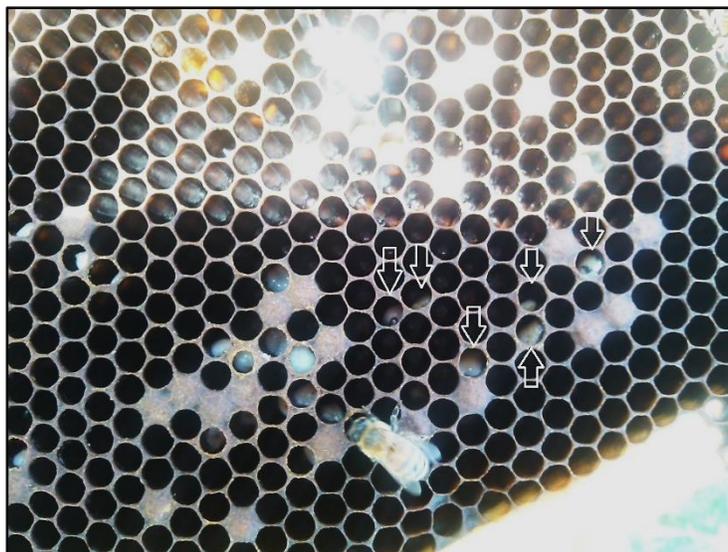


Figure 29 (above): Snotty brood in open cells marked with arrows. Figure 30 (below): Virus symptoms observed in weak hive. The dead pupa have deformed wings and the bees die in the cell because they are too weak to pull themselves out of the cells. Photos by Kathleen Prough.



Varroa mite counts were low from spring into August. By the end of September the varroa mite counts were at the economic treatment threshold (3-10 mites per 100 bees). Some beekeepers had to repeat a treatment for mites or use a new mite treatment in late fall. Beekeepers used several varroa mite treatments, with Apivar strips and Oxalic acid fumigation as the two main matricides used.

Colony Collapsed Disorder (CCD) was reported and observed in October and November. Instead of calling it colony collapse disorder some are calling it Parasitic Mite Syndrome. Both are associated with Varroa mites, viruses, poor nutrition and pesticide exposure. Within days the bees were dead or left the hive. The number of hives reported with Parasitic Mite Syndrome was lower in 2016 compared to 2015. Observation of the dead hives found dead capped brood or bees that died trying to get out of cells. The hives did not have American foulbrood or European foulbrood. Deformed wing virus was observed on some of the dead pupa that were pulled out of the cells. Varroa mites are the major pest beekeepers need to monitor and treat for to help prevent this problem.

Small hive beetles (*Aethina tumida*) were found in apiaries throughout Indiana. Only four hives were reported damaged by small hive beetle larvae. Greater wax moths (*Galleria mellonella*) did more damage to weak and dead hives than small hive beetles. In several inspections, the adult wax moths were observed hiding between the top cover and inner cover. In seven hives in five apiaries wax moth larvae were observed tunneling through the wax foundation. Several dead hives were fully infested with webbing from the larvae and pupal chrysalises. Some hives had to be reduced down in size and infested frames pulled so the bees could protect their comb from wax moths as well as small hive beetles.

Beekeepers reported 27% Winter Loss for the winter of 2015-2016. Reported losses in September and October of 2016 were 20%. The 2016 fall losses were more likely due to varroa mites and bee viruses. Several hives that died in late February and March had queen problems since there was no evidence of the queen starting to lay eggs or brood found. If there is no new brood started by March the hives will dwindle down in population until they are all dead. Commercial Beekeepers that took hives to California had low winter losses and brought back strong hives again this year.

Pesticide kills were reported by beekeepers throughout the state during corn planting. At least five beekeepers reported aerial applications killing their foraging bees. In one incident the aerial applicator flew over the beekeepers hives and house. Most bee kills were not reported to Indiana State Chemist office or their office was not able to do an investigation. Some of these beekeepers had registered their apiaries in the Drift Watch website, but were not contacted by the applicators.

Honey bee queen problems were reported throughout the state. Many hives replaced introduced queens or did not replace a failing queen. Some new hives built up fast with a great brood pattern, but collapsed in September. Many queens with packaged bees were either replaced by the bees or the beekeeper. Poor quality queens need to be replaced as soon as possible. The increase in the number of Indiana queen breeders is helping Indiana beekeepers find local queens. With the temperature fluctuations in May, Indiana queen breeders had some problem with raising queens and getting them mated.

Honey production was reported above average for Northern Indiana and below average for most of central and southern Indiana. The Reported bulk price of honey in November was \$1.65 to \$1.85 per pound for amber honey, \$2.00 to \$2.15 per pound for light honey.

Indiana's main nectar flow for the southern part of the state was in May. Beekeepers in the southern half of the state were able to take honey off at the end of May, but not much after that. The southern half of Indiana received above average rainfall from June through August. Rain can knock nectar out of flowers and discourage the bees from leaving the hive. Nashville, Bloomington and Bedford area received so much rain that the beekeepers had to supplement feed sugar water June through August. At least two hives inspected in Nashville, Indiana died due to lack of nectar in the hives. The dearth period (nectar flow is at a minimum) in the southern part of the state lasted from late June to September. In September and October aster and goldenrod produced some nectar.

Northern Indiana reported above average in honey production. Northern beekeepers reported averaging over 60 lbs. per hive. First honey was taken off in June. Northern Indiana received less rain and the plants produced nectar longer. Northern Indiana dearth period was July to early August. They had an excellent goldenrod and aster flow in August and September.

Beekeepers were able to feed sugar water or corn syrup into November to help the bees store enough food for winter supplies. Many added candy board on top of wintering hives for emergency food supply. More beekeepers are wrapping hives for the winter (figure 31). A few are putting hives in a 3 sided lean-to or in sheds. The important thing in Indiana is to have a good wind break from the cold northwestern winter winds.



Figure 31: Hive wrapped in tar paper with candy board on top.
Photo by Kathleen Prough.

Section IV. Division of Entomology & Plant Pathology Staff

In June, 2016, the Division welcomed Megan Abraham as the State Entomologist and Division Director. Former Director, Phillip Marshal resumed his duties as the Division of Forestry's Insect and Disease Specialist. The Division website is <http://www.in.gov/dnr/entomolo/>. Staff contact information can also be found there.

