2021 Indiana
Forest Health Highlights

1. Indiana's Forest Resources

Figure 1. Distribution of Indiana's Forests

1.1 Forest Area, Types, Species

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 (figure 1)

Currently, Indiana houses 4,792,800 acres of forest land. Forested area has decreased by about 83,200 acres (1.7 percent) since 2015.

Timberland accounts for 4,623,000 acres (96.4 percent) of forest land, while 169,900 acres (3.5 percent) of forest land is reserved or unproductive.

Eighty-three (83.2) percent, or 3,987,600 acres of forest land, is privately owned. The state and local government own 6.0 percent or 288,000 acres while the federal government owns roughly 7.2 percent or 347,400 acres. A little over 3.5 percent or 169,900 acres of forest land is considered reserved.

Indiana has surprisingly diverse forests, encompassing northern maple / beech / birch types to southern bald cypress swamps. The land is dominated by the oak-hickory type in south-central Indiana. The 2020 FIA survey period identified 90 different tree species growing in Indiana forests. Hardwoods are the dominant species in Indiana. The oak/hickory group alone occupies 60 percent or 2,890,100 acres of forest land, the bulk of which resides in the white oak/red oak/hickory forest type.

Forest land consists mainly of sawtimber stands at 3,934,700 acres or 82.1 percent, pole timber stands at 574,900 acres or 12.0 percent, seedling-sapling stands at 255,600 acres or 5.3 percent, and nonstocked at 27,600 or less than 10.01 percent. Indicative of a maturing (aging) forest, white and red oak/hickory is found primarily in the sawtimber stand-size class.

The sugar maple (*Acer saccharum*) is the most numerous tree in Indiana with an estimated 342 million individuals; followed by American beech, sassafras, American elm, and red maple for number of trees >1 inch at root collar on forest land. Interestingly, sugar maple is not the most voluminous species in the state that distinction belongs to the state tree, yellow poplar, a.k.a. the tulip tree (*Liriodendron tulipifera)* with a net volume of nearly 1.41 billion cubic feet. These yellow poplars also store approximately 26.34 million tons of woody biomass in their tissues.

Ash species group followed by yellow-poplar show the highest mortality (by number of trees) in Indiana for the 2020 forest inventory, and by volume white ash, green ash, yellow-poplar are the top three followed by black oak, sugar maple, white oak, black cherry, slippery elm, American elm, and red maple. Annual mortality is 14,030,861 trees and 173.9 million cubic feet.
Source: Forest Inventory EVALIDator web-application Version 1.8.0.01. https://apps.fs.usda.gov/Evalidator/evalidator.jsp
Source https://public.tableau.com/views/FIA_OneClick_V1_2/Factsheet?%3AshowVizHome=no

1.2 Volume – Growth & Mortality

Net volume (10.5 billion cubic feet) experienced an increase of about 3.0 percent since 2015. Yellow poplar and sugar maple were the top two individual tree species by volume estimates, with over 1.3 and 0.98 billion cubic feet, respectively. White oak, black oak, and American sycamore rounded out the top five each with over 0.44 billion cubic feet. Annual net volume growth (173.3 million ft^3) was led by yellow-poplar and sugar maple (33.7, 23.7 million cubic feet). White ash continues to be number one in annual mortality – 43.9 million cubic feet. Green ash, yellow poplar, black oak, and sugar maple, respectively, round out the top five in annual mortality (18.3, 13.2, 8.3, 7.0 million cubic feet). Total annual mortality of sound bole volume is 173.9 million cubic feet.

Source: Forest Inventory EVALIDator web-application Version 1.8.0.01. https://apps.fs.usda.gov/Evalidator/evalidator.jsp

1.3 Forest Product Industry

The Indiana forest products industry is the sixth-largest manufacturing industry in the state. Indiana ranks ninth nationally in total lumber production and third in hardwood lumber production. Indiana forests contribute over $10 billion annually (2018) to Indiana's economy. In 2013, Indiana's primary wood-using industry included 130 sawmills, five veneer mills and two mill

producing other products. Direct employment within the industry accounted for over 70,000 (2016) people and by indirect and induced effect, the industry supports around 60,000 jobs. Forest-based manufacturing provided $5.5 billion (directly and indirectly) in value-added, $8.7 billion in value of shipments, and a payroll of $2.6 billion to Indiana's economy in 2016. Between 2008 and 2013, industrial round wood production increased by 8.3 percent to 69.1 million cubic feet. Saw logs accounted for 92 percent of the total harvest, with other minor products primarily veneer logs, pulpwood, handles, and cooperage making up the rest.

More information on Indiana Timber Industry:

1. 2013, Resource Update FS-116 https://www.fs.fed.us/nrs/pubs/ru/ru_fs116.pdf
2. Indiana Hardwood Assessment https://www.in.gov/isda/files/IN%20Hardwood%20Assessment%20Final.pdf
3. Forests of Indiana 2015 https://www.in.gov/dnr/forestry/files/fo-2015_FIA_Annual_Report.pdf

1.4 Maple Syrup – maple syrup report 2021 not produced.

Maple syrup is a product of Indiana's forests. In 2020, there were 200 maple syrup producers with 29 counties having at least one producer. Most are found in northern half of the state. Of those, 78 responded to a survey with 53 indicating a total production of 24,139 gallons of maple syrup. This was up from 19,168 gallons in 2019. A total of 53,152 taps produced an estimated 1,079,013 gallons of sugar water with an average 44.7 gallons to get one gallon of maple syrup. The 2020 retail prices for gallon, quart and pint are $43.72, $13.46 and $8.39, respectively. Average dollar return per tap is $24.45 compared to $14.42 in 2019. The estimated statewide income is $1,055,313 and can approach $1.3M accounting for producer consumption, product given away and product not reported.

Source: Maple syrup report 2020

2. State Forest Health Issues – An Overview

The **2021 growing season's forest health problems and concerns** began with concern for Brood X Periodical Cicada. Many landowner concerns were addressed especially for planting seedlings and 1 to 5 year old plantings. Damage was reported across southern Indiana, mostly south central forested area. Flagging damaging to large trees occurred but was not heavy except for few local areas.

Again, this year like the prior two years with a wet late April and May to June brought on leaf disease such as anthracnose. However, the gyspy moth, now called spongy moth, *Lymantria dispar*, population across northern Indiana was not impacted by *Entomophaga maimaiga* and NPV virus until defoliation had occurred.

Emerald ash borer (EAB) continued to increase ash mortality in southwestern toe of the state. The peak of mortality in this area is expected in 2022.

Oak shot hole leaf miner did not occur in 2021 although anthracnose damage occurred in the area it damaged in 2020.

Sudden oak death, *Phytophthora ramorum*, was not detected in nursery surveys in 2021. The detection in 2019 on rhododendrons distributed to garden centers across the state is still a concern. This disease is not present in Indiana.

Surveys for thousand cankers disease of black walnut did not detect walnut twig beetle or an infected tree in 2021. Walnut twig beetle trapped at two sawmills and two plantations prior to 2019 was not detected. This disease is not present in Indiana.

The first occurrence of Spotted lantern fly, *Lycorma delicatula,* was reported and confirmed in Switzerland county in July. Surveys determined it was an infestation and was introduced by a household move from Pennsylvania and by visiting relatives and friends from Pennsylvania. The Division of Entomology and Plant Pathology surveyed to define the infestation and conducted treatments to kill the adults and remove/kill tree of heaven. The initial infestation is 90 acres, but management work has expanded to 1,000 acre area.

Future forest pests of concern are the exotic pests, Asian longhorned beetle, hemlock woolly adelgid, beech bark disease, beech leaf disease, gold spotted oak borer, other *Agrilus* spp., and laurel (red bay) wilt.

Asian longhorned beetle (ALB) adult was captured inside a factory in Porter county in 2020. The 2020 and 2021 surveys did not detect ALB or a tree with symptoms of attack. This supports the belief it was an interception from shipping material and not from a local infestation.

Laurel wilt is believed to be present based on reports of wilting sassafras trees. However, samples from wilted sassafras saplings tested negative for the wilt fungus.

Survey for beech leaf disease was limited in 2021 and was not detected or reported.

Invasive plants affecting Indiana forest regeneration and biodiversity are kudzu, *Pueraria montana*, tree of heaven, *Ailanthus altissima*, bush honeysuckle, *Lonicera spp.*, Japanese stilt grass, *Microstegium vimineum*, garlic mustard, *Alliaria petiolate*, and others.

The kudzu eradication program continues its efforts and to date 212 sites in 43 counties totaling 239.34 acres are confirmed. This is an increase of 4 sites and 11.66 acres. The goal is to move kudzu to the Ohio River and eventually out of Indiana.

The Division of Entomology and Plant Pathology implemented the Terrestrial Plant Rule (312-IAC-18-3-25) in 2020 prohibiting and restricting 44 terrestrial invasive plants. With the Aquatic Plant Rule (312-IAC-18-3-23), 74 invasive plants are prohibited or restricted from sale or position.

3. First time occurrence impacting Indiana Forests

3.1 Oak Shot Hole Leaf Miner – *Japanagromyza viridula* syn *Agromyza viridula*

Figure 1: Shot hole leaf miner damage on black oak leaves.

2020 was the first occurrence of oak shot hole leaf miner. The female punctures the opening buds with her ovipositor and feeds on the fluids that emerge from the wound. As the leaf continues to grow, the wound becomes a circular hole creating a shot hole appearance to the leaf (figure 2).

Later the female lays an egg in the edge of the leaf. A maggot hatches and feeds (mine) between the upper and lower leaf surface. Eventually, the mined leaf area turns black in color and is similar in appearance to anthracnose infected leaf tissue. This damage results in defoliation to the tree as leaves do not develop to normal shape and size.

The 2020 aerial survey mapped 76,992 acres of defoliation through south central Indiana (Figure 3). Its noticeable damage to black oak and other oaks in conjunction with weather and anthracnose over a large area in south central in 2020 did not repeat in 2021, although some shot hole damage occurred at a low level to oaks.

Figure 2: Areas of shot hole leaf miner defoliation mapped during 2020 aerial survey in south central Indiana.

4. Exotic Insect Pests of Indiana Forests

Gypsy moth, thousand cankers disease of black walnut, chestnut oak mortality and oak wilt dominated the monitoring and management activities. Monitoring activities are adding sudden oak death, laurel wilt (sassafras mortality), beech leaf disease, hemlock woolly adelgid and spotted lantern fly to forest health survey activity in 2022.

4.1 Gypsy Moth, now known as Spongy Moth – *Lymantria dispar dispar*

Entomological Society of America is changing common name Gypsy Moth to Spongy Moth in 2022. This report drafted before and during the common name change process continues to use gypsy moth with no intent to demean anyone and to prevent confusion while implementing the name change.

The 2021 Cooperative Gypsy Moth Survey completed its 34th 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 (figure 4): the STS Evaluation Zone, the STS Action Zone, and the State Area. The survey design used fixed 8K & 5K, fixed 3K & 2K and fixed 3k survey grid points for the three zones, respectively. In the state area, 13 counties were surveyed partially or not at all for economic reasons and no trap catches in prior years. Across all zones, the survey deployed 10,293 traps all referenced by GPS.

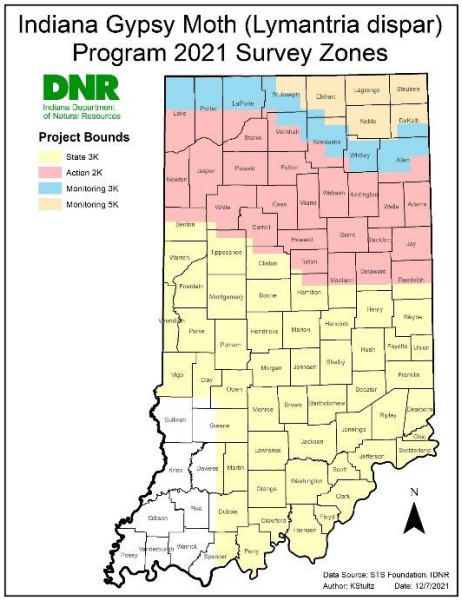

Figure 3: Gypsy moth survey zones - yellow state zone, pink slow the spread action zone, blue slow the spread monitoring zone 5k, tan slow the spread monitoring zone 8k

The survey detected 41,770 moths from 58 of counties (29 in the STS, 9 in STS and State and 20 in the state Zone) ranging from 1 to 7,701 moths per county. Total moths is 15% higher than 2020 catch of 35,075 moths and more than double 2019. (figure 5). There was low catch positive traps through the STS action zone from a larval blow-in event from the epidemic in Michigan. A larval and moth blow event has occurred 2 or 3 times in the past with trap catch decreased the following year.

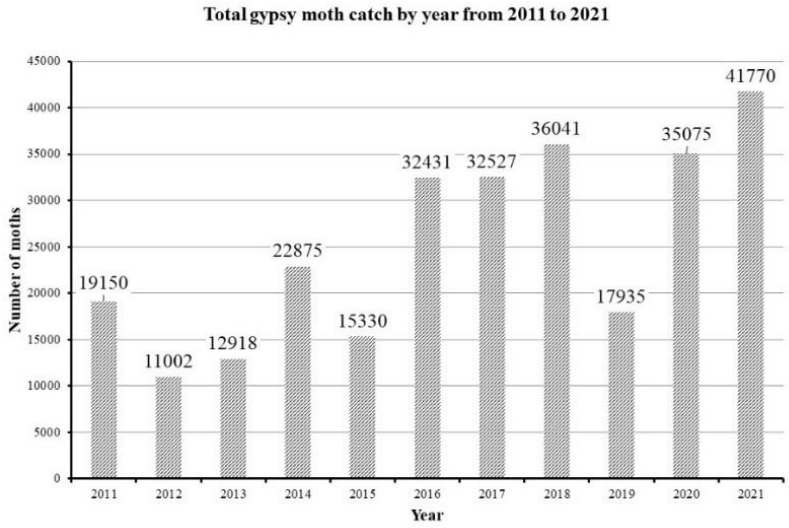

Figure 4: Graph showing number of male gypsy moths caught by year from 2011 to 2021

The 2021 survey found that most of the moth catch, 83.69% of the moths (34,804 of 41,770, in the Evaluation Zone, which is Monitor 1 &2 zones. It includes the quarantined counties of Steuben, LaGrange, Elkhart, Noble, St. Joseph, Porter, Allen, LaPorte and DeKalb. detected The Action Zone detected 16.3% of the moths (6,775 of 41,770). The State Area detected 0.44% of the moths (183 of 41,770).

Most of the Action Zone moth catch occurred in the central and eastern parts. There was low catch positive traps spread in this area from a larval blow-in event from the epidemic in Michigan. This moved the 1 moth line south into Grant, Huntington, and Wabash county. A larval and moth blow event has occurred 2 or 3 times in the past with trap catch decreased the following year.

Since the survey began in 1972, a total of 676,194 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.

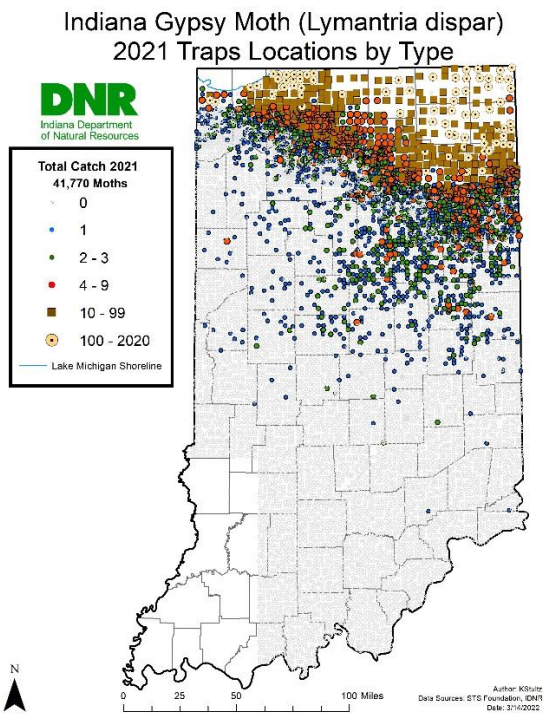

Figure 5: Map showing 2021 Gypsy Moth trap locations range of catch from 0 to 100+ in each trap.

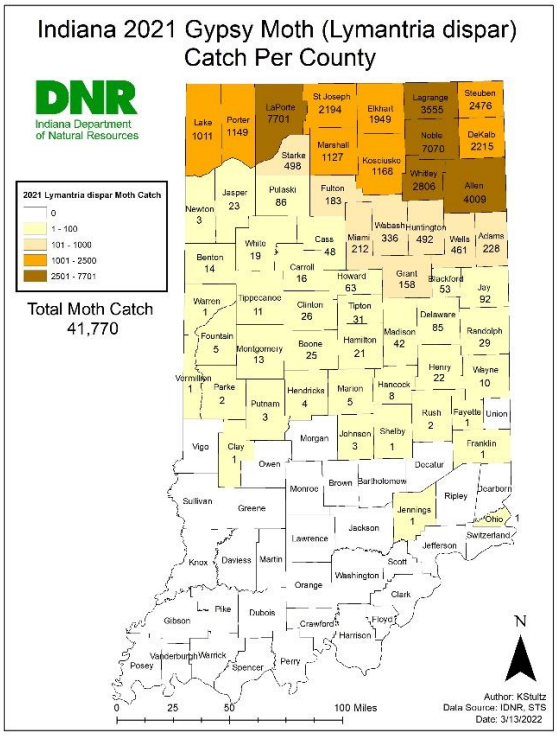

*Figure **6**: 2021 total moth catch in each county. Total state catch is 41,770.*

Defoliation 2021

Aerial survey recorded 1,063 acres of noticeable defoliation in Allen, DeKalb, LaPorte, and Noble counties. North central LaPorte county had the most followed by Noble and DeKalb. Defoliation not noticeable to map by aerial survey was reported in Elkhart, LaGrange, and Porter counties. Light and localized defoliation likely occurred in St. Joseph, Steuben and Whitley but was not reported. This year was the most noticeable defoliation acres and locations in one year. This total exceeded the total defoliation acres reported for all prior years which totaled <320 acres (2008 to 2020).

Table 1; 2021 Gypsy moth defoliation acres by county

County	Allen	DeKalb	LaPorte	Noble	Total
Acres	8	32	709	314	1063

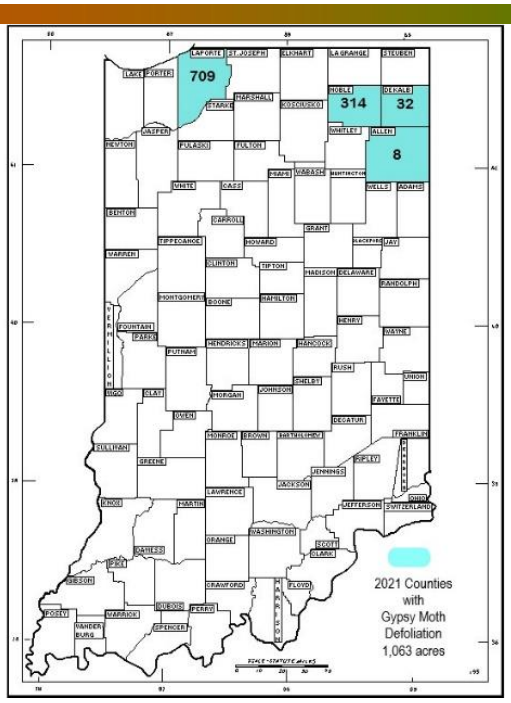

Figure 7: 2021 counties and acres of Gypsy Moth Defoliation.

Treatments 2021:

Btk (*Bacillus thuringenisis kurstaki*):

Treatments to slow-the-spread and development of Gypsy moth were conducted on 3 sites in 2021 with 1,031 acres treated (table 2 and figure 9). All sites were treated twice bringing total to 2,062 acres treated for all applications. Application cost was $39.60 per acre per application and total cost was $81,655.20.

Table 2; 2021 sites by county, acres treated by Btk

COUNTY	SITE NAME	Acres	Total Acres Treated
Allen	Maples Btk 2021	350	700
Miami	Deedsville Btk 2021	669	1,338
Wells	Preble Btk 2021	12	24
			2062

Mating Disruption:

Three sites totaling 4,544 treated acres were treated once with Splat GM Organic. Two sites totaling 4,219 acres were treated at 6 gram/acre and one site of 325 acres at 15 gram/acre (table 3 and figure 9). Mating disruption application cost was $7.00 per acre for 6 gram and $12.53 per acre for 15 gram. Total cost was $33,605.25.

Table 3: 2021sites by county, rate, acres treated with mating disruption

COUNTY	SITE NAME	Acres	Total Acres Treated
Adams	Decatur MD6 2021	1,549	1,549
Wabash	Lagro MD6 2021	2,670	2,670
Wabash	Lagro MD15 2021	325	325
			4,544

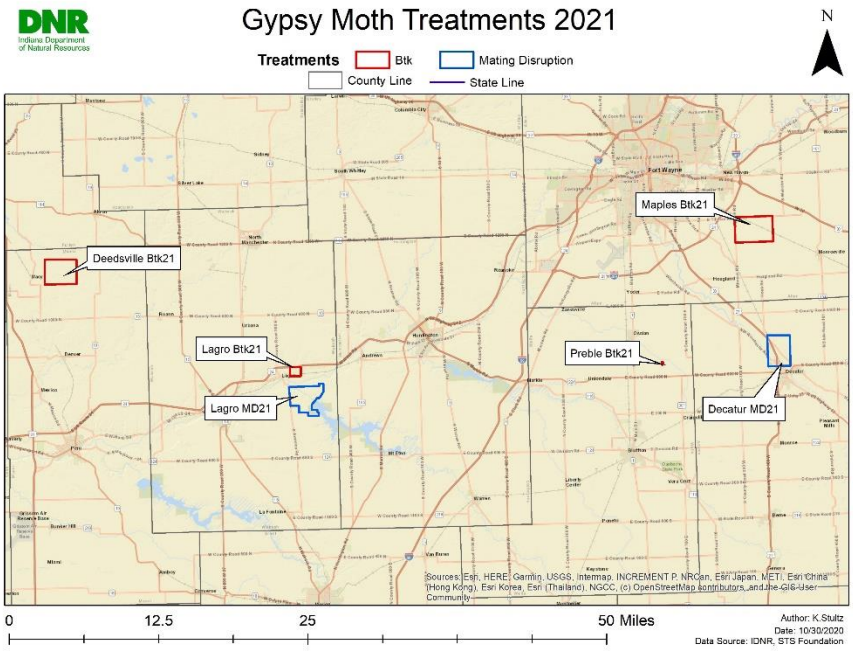

Figure 8: Map: 2020 Gypsy Moth Treatment Sites. Blue outline is Mating Disruption. Red outline is Btk.

Eradication: - Richmond:

The site was detected in 2016, delimited in 2017 and 2018, treated in 2019 with 2 applications of Btk. Following treatment, the 2019 post treat delimit detected 1 moth. The 2020 post treat delimit caught seven moths in six traps in and adjacent to the treatment site and no detection of eggmasses. The 2021 post treat delimit detected 2 single moth traps on western side of the delimit and no moths caught in the core treatment area. The site will be delimited in 2022 to determine if gypsy moth has moved from original core area. If no moths detected in 2022 in the western side, the delimit will be repeated in 2023 and eradication declared if no moths detected.

Eradication: - Purdue:

In 2014, an eradication began with treatment on the campus of Purdue University. In 2015, five moths were caught in the 2014 treatment area, but in 2016 that number jumped to forty six prompting treatment again in 2017. In 2017, twenty four moths were caught in eleven traps in the 2014 treatment area. In 2018, nine moths were caught in two traps at the core of the treatment area. In 2019, 5 moths were caught in one trap in the treatment area and traps placed on the center core trees of the infestation did not capture moths. That one trap was near construction trailers for a new residence hall in the treatment area. Thus, the five moths are believed to have originated from contractors bringing life stages to the treatment area. No moths were trapped in the area in 2020 and 2021. If the 2022 delimit detects no moths, eradication will be declared.

Quarantine:

The 10-moth line is used to consider a county for quarantine. The ten moth line map below (figure 10) shows the historic 10-moth line for the last five years. It continues to remain fairly stationary. However, it has moved more than halfway through Whitley County which is a criterion used to quarantine a county. Adding Lake County will close a ‘gap’ in the quarantine area with Illinois.

The process is underway to quarantine Lake and Whitley counties (figure 11). Initial adoption is expected in early 2022. Final adoption is expected in late 2022.

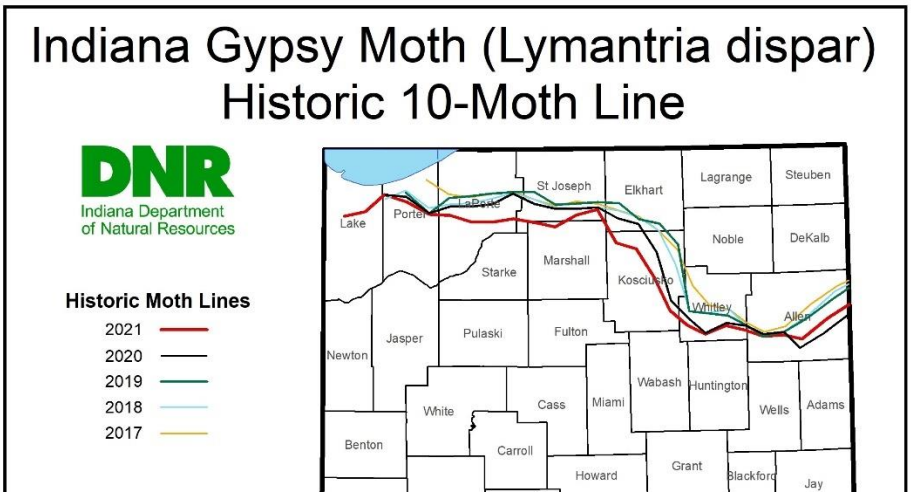

Figure 9: Map: Ten moth line from 2016 to 2020. Line means an average of ten moths caught per trap around the line.

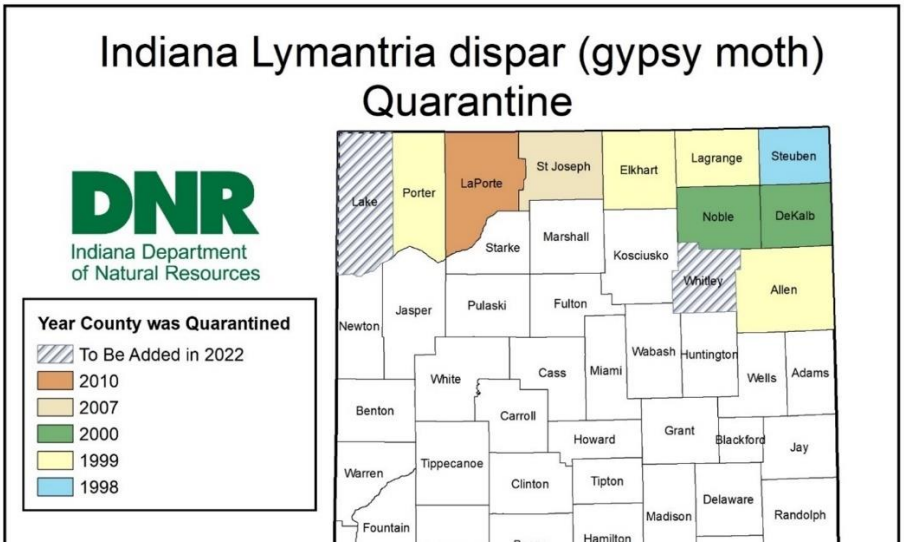

Figure 10:Counties quarantined and proposed for quarantine 1996 to 2022.

Spread Rate:

For 2021, the annual spread rate is 6.62 miles per year. The annual spread rate is slightly above Indiana's goal of 6.00 mile per year. It is 1.00 mile more than 2020 rate. This is due to larval and moth blow mentioned above. Using a 3 year average, spread rate is 2.56 miles per year well below the goal.

Table 4: Gypsy moth annual and 3 year average spread rate in kilometers and miles

Unit	2021	3 year average
Kilometer	10.37	4.03
Mile	6.62	2.56

4.2 Emerald Ash Borer - *Agrilus planipennis* Fairmaire

Emerald Ash Borer (EAB) was detected in all 92 counties by 2017. EAB took from 2004 to 2017 to travel across Indiana. Indiana EAB quarantine was repealed October 2016.

Based on prior aerial surveys, the peak of the "killing wave" in southwest Indiana may have occurred in 2021, but aerial survey was not conducted to verify this. However, received reports of extensive ash mortality in southwest 'toe' of the state.

Through 2020 aerial survey EAB mortality totaled 169,745 since 2009. This total is only through aerial survey mapping the advancing front of mortality and acres with ash mortality. EAB is considered to be in all forests with ash.

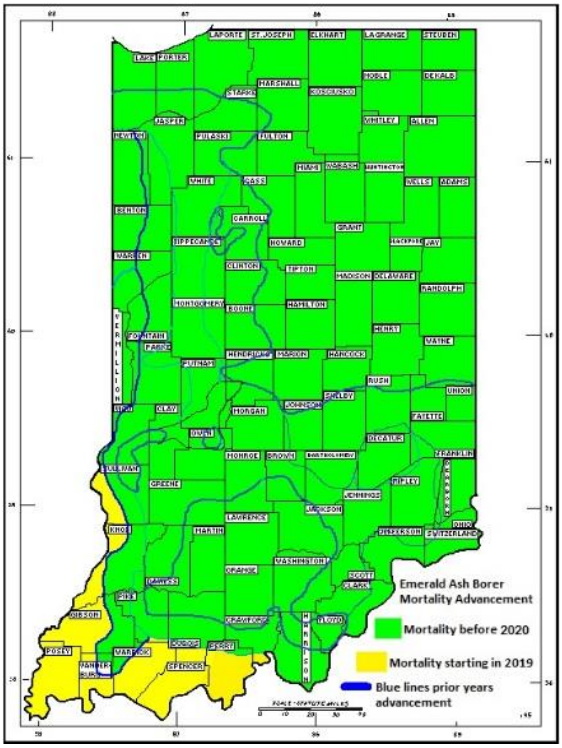

Figure 11:Emerald ash borer mortality progression by aerial survey through 2020 - past mortality in green and progressing mortality in yellow.

4.3 Thousand Canker Disease – *Pityophthorus juglandis & Geosmithia morbida*

The 2021 walnut twig beetle (WTB) (photo) survey consisted of 92 Lindgren funnel traps at 33 high risk sites (sawmills and veneer mills) and 36 plantations or woods (figure 13 & 14). Traps were deployed mid to late April and were removed in early October. Over 900 samples collected and no WTB was detected 2021

Photo: Walnut Twig Beetle collected during 2014 survey. Photo by Bobby Brown USDA

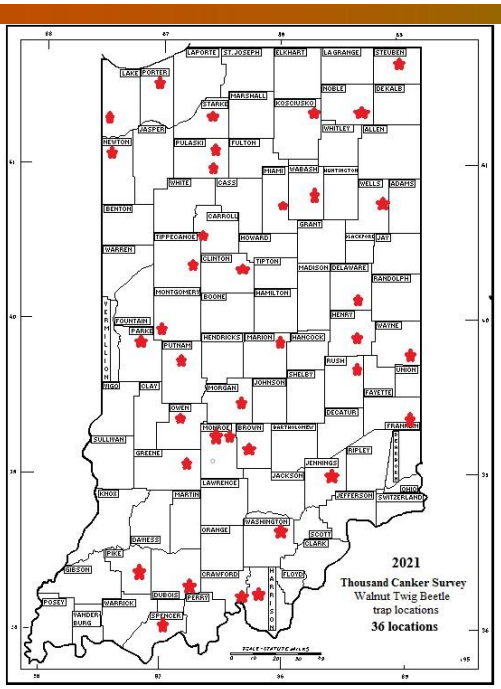

Figure 12: Map of 2021 location of walnut twig beetle traps in woods or plantations.

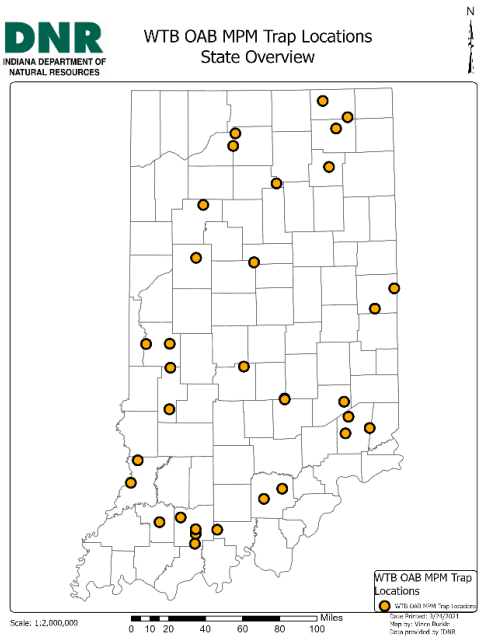

Figure 13: Map of 2021 location of walnut twig beetle traps at high risk sites

The Windshield Survey for black walnut trees was conducted in 10 cities in 2021. Surveyed were Akron, Bargersville, Boonville, Sullivan, Henryville, Jamestown, Medaryville, Roanoke, Spiceland, Indianapolis (Perry Township, NW 1/3 of township). 842 trees were surveyed with 9 listed as suspect for future evaluation. Suspect trees from prior year survey are not showing progressive symptoms. Since this survey began in 2012, 12,042 trees have been evaluated with 152 suspect trees and no positive trees in 121 municipalities

Gypsy moth trap tenders also collected data on the location and condition of walnut trees near gypsy moth traps. They identified 250 trees and identified 5 trees that had symptoms which were given to nursery inspectors to check and monitor in the future. Since 2011, trap tenders have monitored over 9,558 walnut trees

From two beetles in 2014, four beetles in 2015 and one beetle in 2016 at the sawmill in Franklin County, the sawmill has been free of walnut twig beetle for 4 years, 2017-2020; and possibly 2021 for a fifth year once sample screening is complete.

The veneer mill in Johnson county was free of Walnut Twig Beetle for 3 years - 2016-2018. One beetle was collected 7/31/2019 and again 6/29/2020 from a funnel trap at its south log yard site which is in Bartholomew county immediately across the county line with Johnson county. WTB has not been detected at the veneer mill or south log yard in 2021.

The Black Walnut Plantation on Yellowwood State Forest where *Geosmithia morbida* was detected on the weevil *Stenomimus pallida* and served as a research site continues to show NO symptomatic trees and no walnut twig beetle detected by traps or trap trees.

The 2018 trap tree survey locations in Crawford and Jennings detected WTB at each location. Delimit survey of each location 2019-2020 did not detect WTB. The 2021 delimit survey has not

detected WTB however sample screening in ongoing. Trees in these plantations do not show symptoms of TCD.

To date, Thousand Cankers Disease of Black Walnut (TCD) has NOT BEEN DETECTED AND CONFIRMED from a walnut tree in Indiana. There is NO mortality of black walnut trees from TCD occurring in Indiana.

5. Other Exotic Insect Pests of Concern

5.1 Asian Long-horned Beetle (ALB) - *Anoplophora glabripennis*

Asian long-horned beetle was collected in 2020 inside one industrial building in Porter county and confirmed by USDA. Survey around the facility and 5 traps placed at and in the area around the site in 2021 did not detected a beetle or evidence of attack on any trees. This continues to be considered an interception and not an infestation. Surveys will continue in the future.

ALB does not occur in Indiana and concern continues for introduction into southeastern Indiana from the Bethel, Ohio infestation

With that concern, one homeowner in Ohio County reported seeing a possible adult at their home; A visit did not find evidence of ALB on trees or able to confirm if it was ALB observed by the homeowner.

5.2 Hemlock Woolley Adelgid - *Adelges tsugae*

Hemlock Woolly Adelgid (HWA) was detected in one site in LaPorte County in 2012. Survey of that site and surrounding area since 2012 has not detect HWA. Survey of native eastern hemlock forest locations scattered across Indiana continues and through 2021 HWA has not been detected and has not been detected in any landscape, nursery, and retail locations.

5.3 Spotted Lanternfly – *Lycorma delicatula*

Figure 14(Left) Spotted Lanternfly 4th instar nymphs. Photo by Stephen Ausmus

Figure 15 (Right) Spotted lanternfly adult. Photo by Lawrence Barringer, Pennsylvania Department of Agriculture

Spotted lanternfly (SLF) in an invasive species native to China, Bangladesh and Vietnam and was detected in Berks county Pennsylvania in 2014. It is a colorful planthopper that sucks sap from plants excreting a honey dew that is sticky and turns black with the growth of sooty mold. Besides the nuisance of insect and the honey dew dropping from infest trees, this sap feeding stresses the plant and can lead to dieback.

It feeds on more than 70 plant species and has a strong preference for grapevines, maples, black walnut, birch and willow. Tree of Heaven, an invasive tree, plays a role in the life cycle of spotted lanternfly.

Spotted lantern fly (figure 15 & 16) was reported July 9th by a landowner in Switzerland County. Survey of the reported location found an infestation. Tree of Heaven was the primary tree with SLF. Origin of the infestation is Pennsylvania carried on vehicles by the landowner's neighbor moving to the area, the neighbor's family members visiting and visitors attending dog competitions the neighbor hosted.

The Division of Entomology and Plant Pathology conducted surveys in and around the landowner property to determine extent of the infested area. Following detection of infested trees on adjoining properties to the landowner, a 90 acre infested area was defined, 3 landowner permission obtained, approval of 24c label to apply dinotefuran insecticide, DNR Environmental Coordination obtained, and in August Division personnel treated tree of heaven with Transtect insecticide. In September, Pennsylvania Department of Agriculture sent 2 staff to train and assist Division staff in foliar application of dinotefuran to tree of heaven in the infested area to kill adults.

In addition to insecticide application, Triclopyr 4 herbicide was applied to small tree of heaven. Additional survey work expanded the initial treatment area to 1,000 acres with plans to resume management efforts to reduce establishment and prevent spread in 2022. Purdue University Department of Entomology began Information and education effort receiving assistance from Ohio and Pennsylvania Extension Service and Pennsylvania Department of Agriculture.

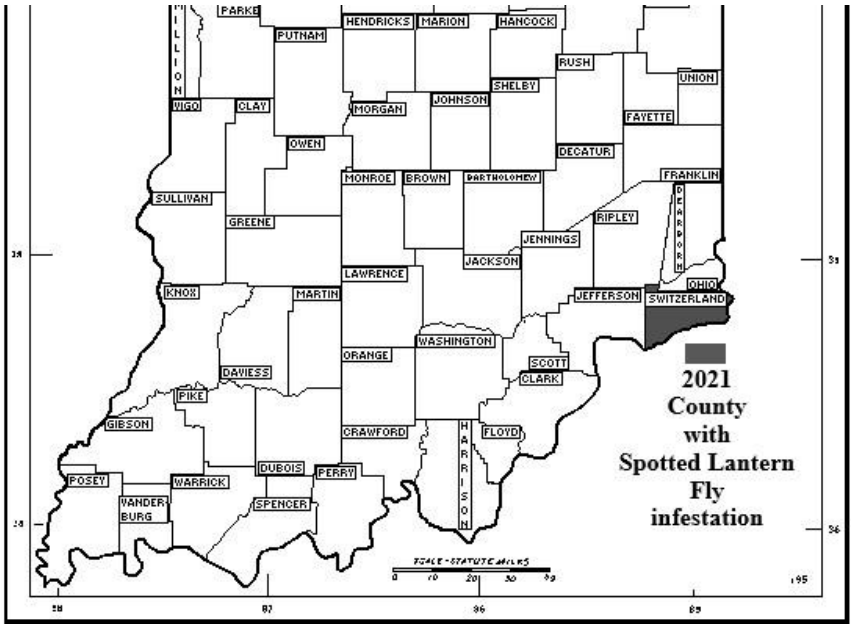

Figure 16: 2021 spotted lantern fly infested county,

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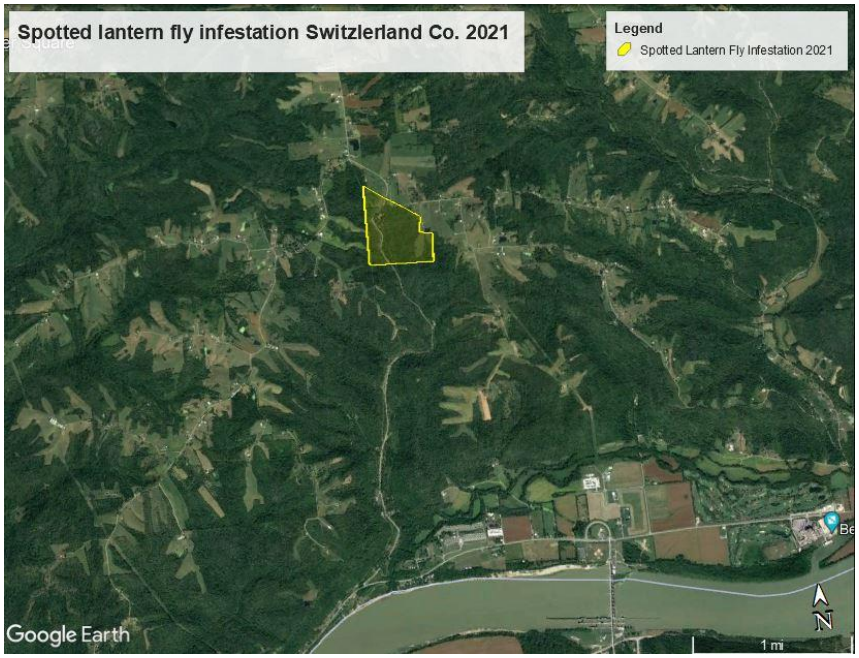

Figure 17: 2021 spotted lantern fly infested area (yellow outline) in Switzerland county.

6. Plant Pathogens of Concern

6.1 Chestnut Oak Mortality – disease complex cause under study

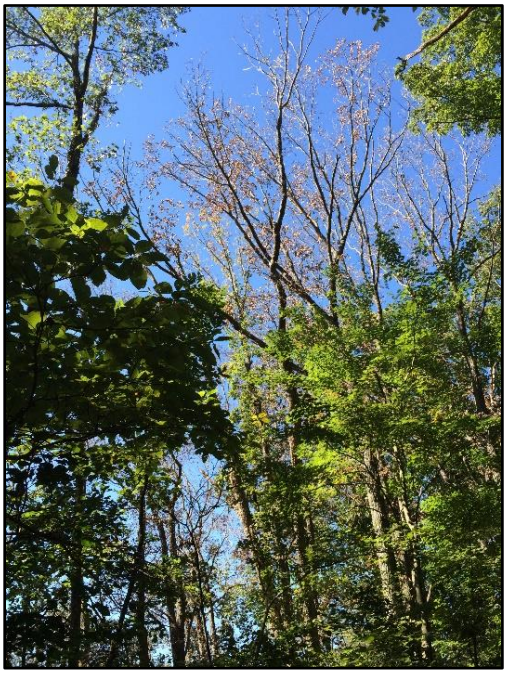

Figure 19: Chestnut oak mortality Patoka Reservoir September 2016

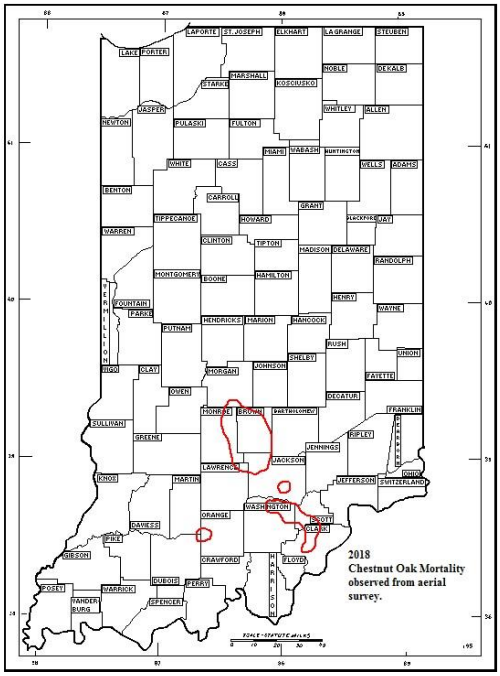

Figure 19: Areas in southern Indiana with chestnut oak mortality in 2018

The forest health management plan to address chestnut oak mortality (figure 19) at Patoka Reservoir (Dubois county) received the decision notice from the Army Corps of Engineers to proceed and a harvest was advertised and awarded in late 2021. The harvest is expected to occur

and be completed during winter 2021-2022. The plan proposes to salvage morality, suppress further mortality, regenerate the forest, and implement wildlife management in the area.

Chestnut oak mortality is present across the forests of south central Indiana starting in 2016 and continuing through 2021. As in prior years, the declining and dying trees occurred in and around areas detected in prior year surveys (Figure 20).

2021 aerial survey recorded 22,009 acres with chestnut oak mortality which is like prior survey acres. Many of the 2021 locations were detected in prior surveys. The 2021 survey area included Brown County State Park, Morgan-Monroe and Yellowwood State Forests, Hoosier National Forest, and Camp Atterbury.

The 2016-2021 Continuous Forest Inventory for state forests and classified forests has not been completed. The latest inventory covers 2015-2019 and it has shown that chestnut oak average annual volume mortality from 2015-2019 is leading other species at 15%. Following it is white ash – 13.7%, yellow poplar – 9.2%, black oak – 8.7%, and white oak 8.4%. During this time-period all oaks accounted for 41% of average annual volume mortality.

Observations of this disease initially indicated it only involves chestnut oak with *Armillaria mellea*, hypoxylon canker *Biscogniauxia atropunctata, Agrilus bilineatus,* possibly *Phytophthora cinnamomi* as agents. However with white oak showing 8.4% mortality, there is additional concern that the disease may be moving from chestnut oak into white oak and possibly other white oak group species.

Chestnut Oak Mortality Project - The USDA Forest Service Emerging Pest Fund provided funding to Purdue University Department of Forestry and Natural Resources and IDNR to conduct field study of the mortality. In 2021, the Purdue graduate student examined 1,505 trees of them 683 are chestnut oak collecting data on the conduction of the tree and other site characteristics.

The project found survey plots in the southern area of Yellowwood State Forest and its junction to Hoosier National Forest contained the most declining and dead chestnut oak. Unhealthy and dead chestnut oak were codominant trees and occurred across all slope positions.

Root sampling conducted on 5 sites in 2021 to define sampling methods found one occurrence each of *Phytophthora cinnamomi* and *Phytopythium vexans*.

Increment cores were collected from 198 trees for analysis in 2022. Root sampling will continue at 25 plots in 2022.

6.2 Oak Wilt - *Bretziella fagacearum* (formerly - *Ceratocystis fagacearum*)

Oak wilt confirmed for first time in black oak in one forest in Franklin County in 2021.

Oak wilt was reconfirmed from red and black oak in seven counties –Allen, Brown, Grant, Noble, Orange, Porter and Washington. The last time Allen, Noble, Orange, and Washington county confirmed for oak wilt was prior to 1979. Grant county was first confirmed in 2001, reconfirmed in 2011 and again in 2021. Thus, likely to be reconfirmed in 2031. Porter county last confirmed in 2004. (figure 21).

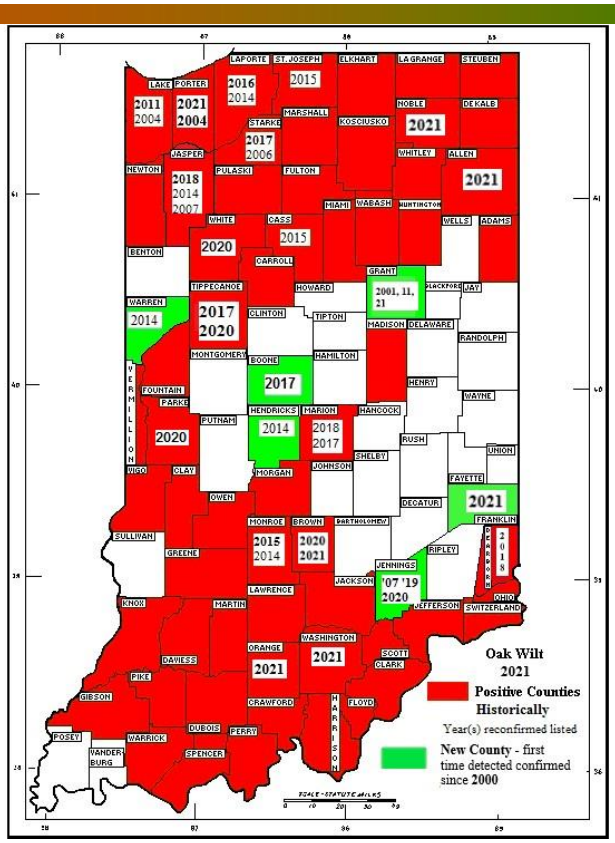

Figure 20:Counties confirmed with oak wilt. Counties in red were confirmed with oak wilt from original surveys through 1979. Green shaded counties were first time confirmation after 2000, Years in county indicate year of confirmation or reconfirmation.

Blackford, Bartholomew, Johnson, Posey, and Vanderburgh counties are possible first time detection of oak wilt. The Grant county 2021 reconfirmation is less than one mile west of Blackford county. The 2020 and 2021 reconfirmations in Brown county are less than 1 and 2 miles, respectively of Bartholomew and Johnson county. Based on symptom reports oak wilt is possible in Posey and Vanderburgh county. It is likely that these counties will be confirmed in 2022

Oak wilt has been detected in 66 counties and reconfirmed or first time confirmed in 23 counties since 2000 (figure 20). It is common in the woodlots of northwestern Indiana in the Kankakee River basin. Mortality occurs to red and black oak in small spots, less than one acre, consisting of sapling to saw timber size trees totaling less than 10 trees per spot, usually one to five trees.

In southern Indiana forests, oak mortality may be Oak Decline and not Oak wilt. Symptoms of the two diseases are similar and testing is needed for oak wilt confirmation versus oak decline. Oak wilt has not been detected in white oak or other white oak group trees in Indiana.

6.3 Sudden Oak Death - *Phytophthora ramorum*

The Division of Entomology & Plant Pathology continued the annual Sudden Oak Death (SOD) survey in nurseries and garden centers in seventeen counties. Nursery inspectors submitted 204 samples of which 23 were trace forward samples from regulated nurseries and all were negative

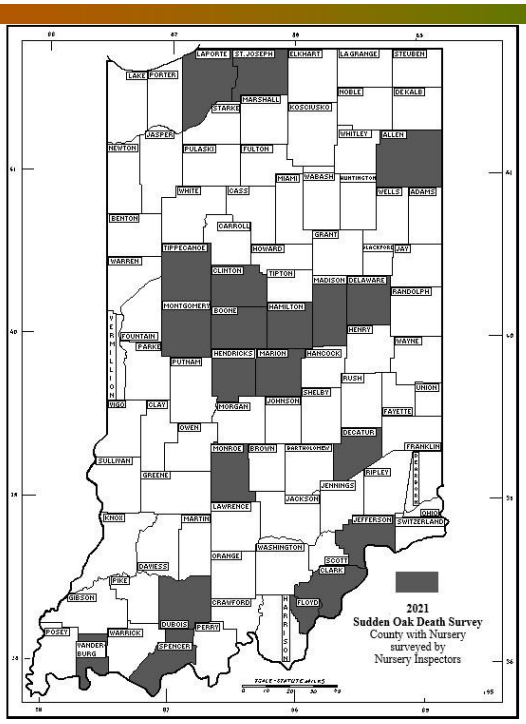

Figure 21: Counties with garden centers surveyed in 2021 for sudden oak death

for *Phytophthora ramorum*. There were no reports of suspect oak trees with SOD symptoms because of the 2019 SOD interceptions on Rhododendrons in garden centers.

The only time SOD has been detected in Indiana is through the nursery trade in 2006, 2012 and 2019. And the disease has not been detected in the rural or urban forest.

6.4 Red Bay (Laurel) Wilt – *Raffaelea lauricola*, red bay ambrosia beetle, *Xyleborus glabratus*

Sassafras and spicebush are host of this disease and are present in Indiana forests. In 2020 the disease was detected in two Kentucky counties that border Clark, Floyd, and Harrison county. Those detections and reports of wilting sassafras from foresters make it likely the disease is in Indiana.

Wilted sassafras in Brown County State Park in 2019 had sapwood stain and ambrosia beetle attack typical of Laurel Wilt. However, samples were not tested than and testing in 2021 of adjacent wilted trees did not confirm the fungus. 2020 ambrosia beetle traps did not detect red bay ambrosia beetle and no traps were placed in 2021.

Besides the Brown county samples, samples from trees in Lawrence, and Monroe counties were tested in 2021. All were sent to Purdue Plant Diagnostic Lab, University of Florida Plant Diagnostic Center in Gainesville, and USDA Forest Service Pineville, Louisiana. The Florida and Forest Service locations are familiar with testing for Raffaelea lauricola. Purdue lab is developing the testing for Raffaelea lauricola. Tests from each lab did not confirm Raffaelea lauricola. There were faint indications in gels from Florida lab but not good enough to confirm the fungus.

Several reports of dying sassafras were reported and examined in 2019. At three locations, reported trees were actively wilting when examined in July 2019. Samples from the wilting trees

were not able to be tested for the fungus in 2019. Using two of the locations with wilting trees and one location reported in 2019 in Brown, Jefferson and Monroe county were trapped for red bay ambrosia beetle in 2020. The traps did not detect the beetle. Survey for wilting sassafras and trapping will continue in 2021.

6.5 Beech Leaf Disease - *Litylenchus crenatae mccannii*

This disease was detected in northeast Ohio in 2012 and other eastern states and Ontario, Canada.

A nematode *Litylenchus crenatae mccannii* was found to be the cause of this disease. This is a subspecies of *Litylenchus crenatae* which is native to Japan found on *Fagus crenata*. In the U.S. there is morphological and host range differences that resulted in the subspecies designation.

An organized survey was not conducted in 2021 by district foresters and no reports of symptomatic trees was received. The district foresters conducted the survey in 2020 and did not detect the disease. One nature preserve in northeast Indiana was surveyed with no detection of the disease. Through 2021, this disease is not present in Indiana.

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6.6 Beech Bark Disease - *Cryptococcus fagisuga, Nectria coccinea* var. *faginata*

No survey was conducted in 2021 for this disease. Foresters and arborists did not report a beech that may have this disease. Thus, this disease is not present in Indiana and is expected to first occur in northern Indiana because of its presence along Lake Michigan in the Lower Peninsula of Michigan. The concern is the possibility that infected/infested material (firewood) is brought into Indiana.

6.7 Bur Oak Blight - *Tubakia iowensis*

Bur oak blight was first detected in 2017 in Lake county. In 2018, the fungus was confirmed on swamp white oak in Allen county. No reports of the disease were received in 2019 and 2020. However, in 2020, I observed one symptomatic tree in Lake county in September and other trees in Lake county observed with symptoms in 2017 did not show symptoms in 2020. No reports of this disease in 2021.

6.8 White Pine Needle Cast – *Dothistroma pini*

Yellow and tan color needles were observed on large white pine in September 2018 in Monroe county along highway 446 on the Hoosier National Forest. Purdue Plant Diagnostic lab confirmed *Dothistroma pini* present in symptomatic needles. Symptoms have been observed in Brown, Monroe, and Orange counties since 2018 and were observed in 2021. To date, no mortality from the thinning trees has been observed or reported.

7. Native Insect and Disease Concerns

7.1 Jumping Oak Gall - *Neuroterus spp.*

Figure 22: Jumping oak galls on underside of white oak leaf.

No reports were received in 2021. It was reported in 2019 on white oak in Martin, Lawrence and Orange counties in 2019 (figure 23). Prior to that, noticeable damage occurred in 2016. Other years of damage are 2012 and 1999.

7.2 Forest Tent Caterpillar – *Malacosoma disstria*

There was no report of forest tent caterpillar in 2021. The last epidemic occurred in southeastern Indiana 2002 -2006 (Dearborn, Jefferson, Ohio, and Switzerland counties). Prior to that, the only other recorded epidemic was in the mid-late 1970s in south-central Indiana (Greene, Lawrence, Martin, and Monroe counties).

7.3 Looper Complex – Linden looper, *Erannis tiliaria,* half winged geometer, *Phigalia titea*

Defoliation by this looper complex did not occur in 2021. The last occurrence was 2013 with very light defoliation in Washington County in Jackson-Washington State Forest.

The first looper defoliation occurred 1978-1982 across south-central Indiana. The second defoliation occurred from 2003-2004, defoliating 89,252 acres in 2003 and 131,943 in 2004 over seven south-central counties each year.

7.4 Anthracnose – *Apiognomonia* spp.

With the cool wet spring weather in late April and early May, anthracnose occurred again in 2021 to sycamore, oaks, and other species. Although oak anthracnose damage was reduced compared to 2020. Sycamore damage was similar to 2020 with defoliation heavy in selected areas across the state.

7.5 Tulip Tree Scale - *Toumeyella liriodendra*

Tulip tree scale damage occurred 2011 to 2012 in south central Indiana. Combined with the 2012 drought, yellow poplar mortality was widespread in 2012 and 2013. In 2020, I received a few reports of black sooty mold and trees dripping sap from tulip trees in plantations, and only one report of noticeable scale damage.

8. Weather-Related Issues in Indiana Forests

Although tornadoes, high windstorms, and flooding occur each year, during aerial survey for Chestnut Oak Mortality 3 areas of wind damage occurred on the Hoosier National Forest on the south shore of Monroe Reservoir and included areas in the Deam Wilderness.

9. Invasive Plant Species

9.1 Kudzu - *Pueraria lobata*

Kudzu, an Asian native invasive vine, is located throughout Indiana but is predominately in southern Indiana. Currently there are 212 known sites totaling 239.34 acres in 43 counties (figure 24). Many of the sites are less than one acre. Four new sites totaling 11.66 acres were confirmed in 2021

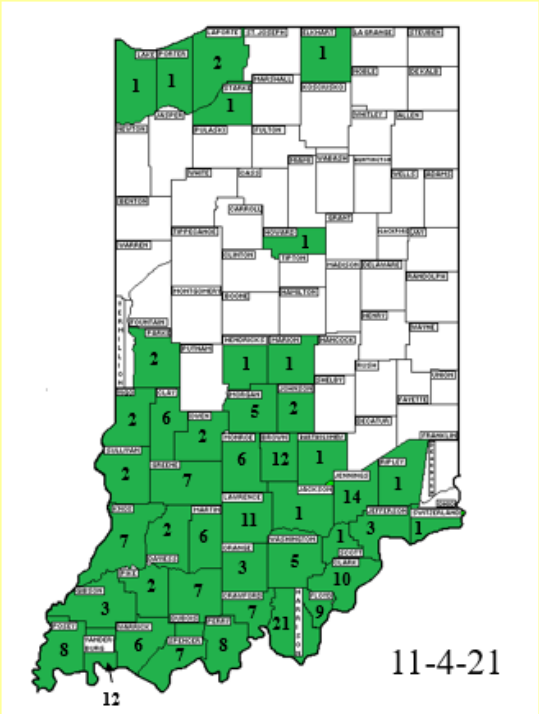

Figure 23: Counties with Kudzu and number of kudzu sites in each county

Treatment of kudzu by IDNR-DEPP began in 2006 and has continued annually to remove kudzu from Indiana. In 2021, herbicide applications were conducted at 47 kudzu sites in 19 counties. A total of 59.4 acres were treated by IDNR-DEPP staff and by contract in 2021.

For all DNR DEPP treated sites, 94.0 percent have at least 90 percent suppression or greater. This is up from 88.0 and 91.2 percent in 2019 and 2020, respectively.

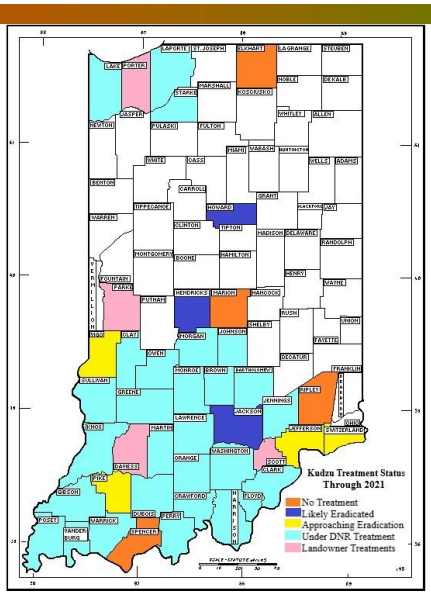

Figure 24:Kudzu treatment status by county - no treatment, likely eradicated, approaching eradication, under DNR treatment, landowner treatment

A total of 37 sites appear to be eradicated including those treated by private landowners, commercial owners and DNR. Specific sites are in Brown, Clark, Harrison, Howard, Jackson, Johnson, Jennings, Knox, Lawrence, Monroe, Morgan, Owen, Pike, Starke, and Warrick counties. Figure 25 map indicates status of treatment in each county with kudzu.

(Ken Cote, Division of Entomology & Plant Pathology Personnel Communication)

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