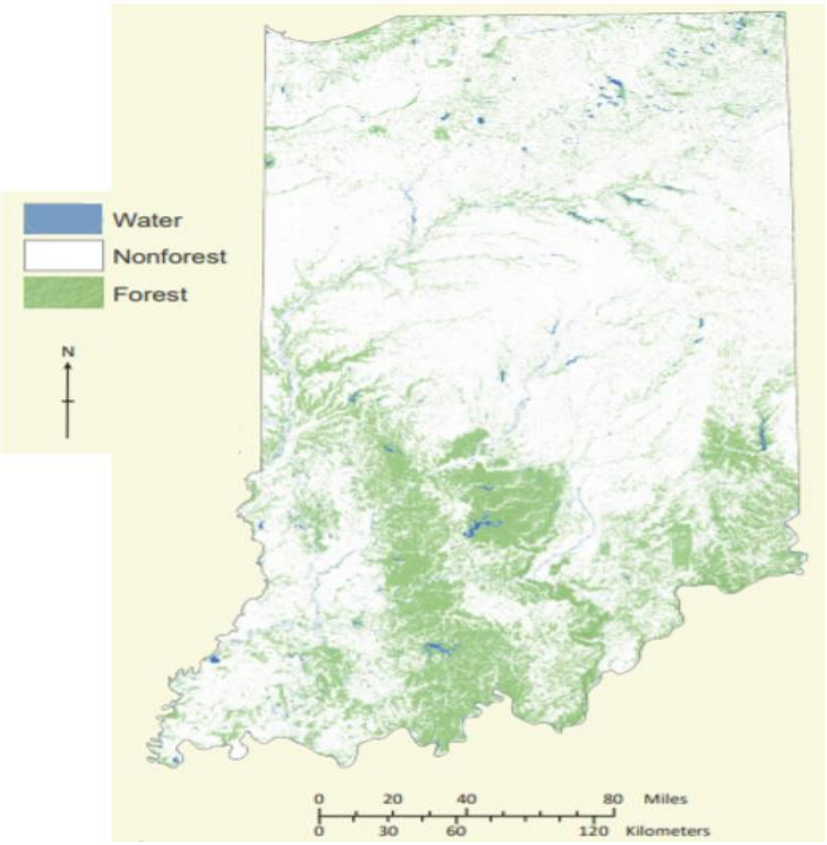
2023 Indiana
Forest Health Highlights

1. Indiana Forests & Industry

1.1 Forest Trends

At the turn of the 19th century, Indiana's forests were being rapidly cut, cleared, and burned with little thought to providing a heritage for the future. By 1900 Indiana forests only comprised approximately 1.5 million acres. The forestry profession in general arose to protect, plant, and nurture our forests…to ensure a continuity of growth for future generations. Now, largely due to the management guidance and example of the forestry profession, Indiana is home to approximately 4.8 million acres of forestland. Indiana is internationally renowned for producing high quality hardwood timber from its substantial and sustainable forest base, as well as providing recreation, wildlife habitat, environmental services, and quality-of-life benefits. Most forests are in the southern half of the state. Map 1 shows the current distribution of forest and non-forested.



Map 1: Distribution of forest in Indiana.

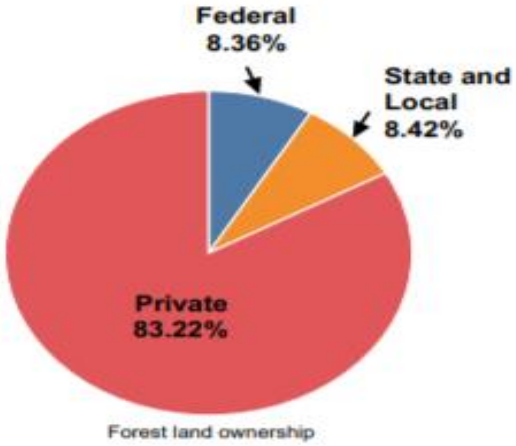


Figure 1:Forest land ownership.

Figure 1 depicts how this forestland is distributed among ownership classes. Private landowners own 83 percent of the forestland, with federal and state/local governments comprising nearly equal amounts of the remainder. Interestingly, in 1978 there were only about 50,000 private forest landowners. Today, there are an estimated 85,000 private forest landowners, the vast majority of which own less than 50 forested acres. Each private landowner owns forests for a unique reason. This makes it difficult to explain and predict how landowners will manage their forest resources. As owners age and pass their land on to the next generation, many times these forested parcels are divided into smaller parcels, thus increasing the number of owners while reducing parcel size, and additionally adding complexity to managing these forestlands.

Indiana forests are dominated by the oak-hickory forest type (Figure 2),

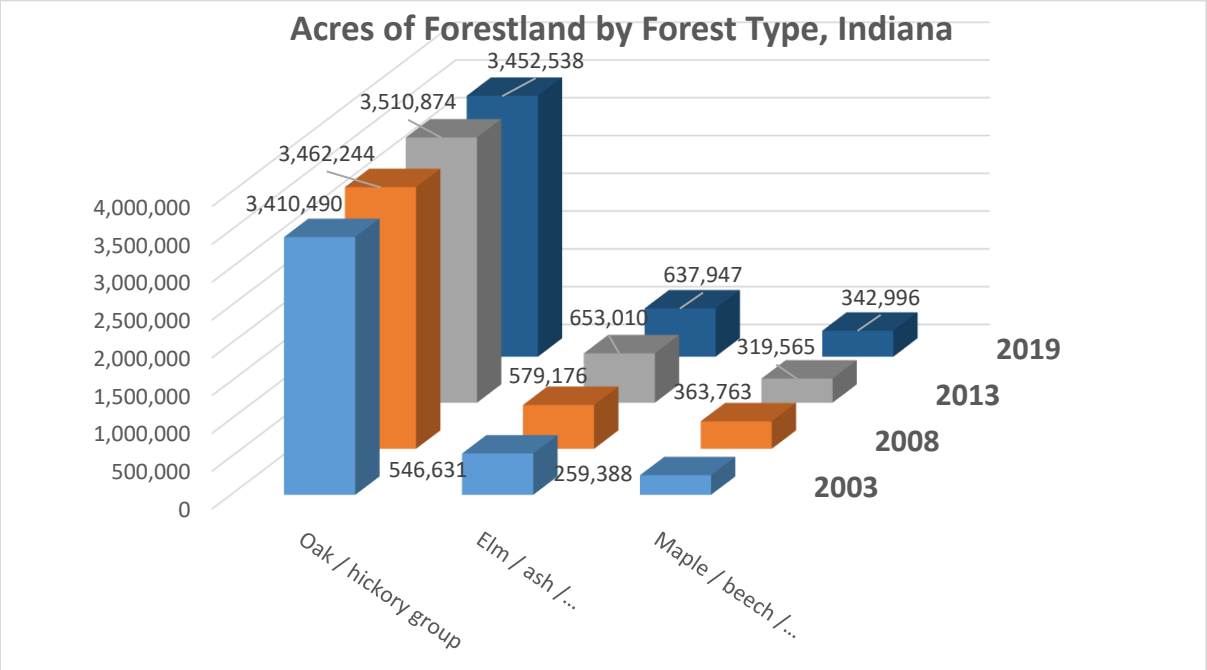


Figure 2: Acres of forestland by forest type

brought about through the history of forest management referenced above. Indiana forests are maturing and continue to shift to larger-sized individual trees and older-aged stands as shown in Figure 3.

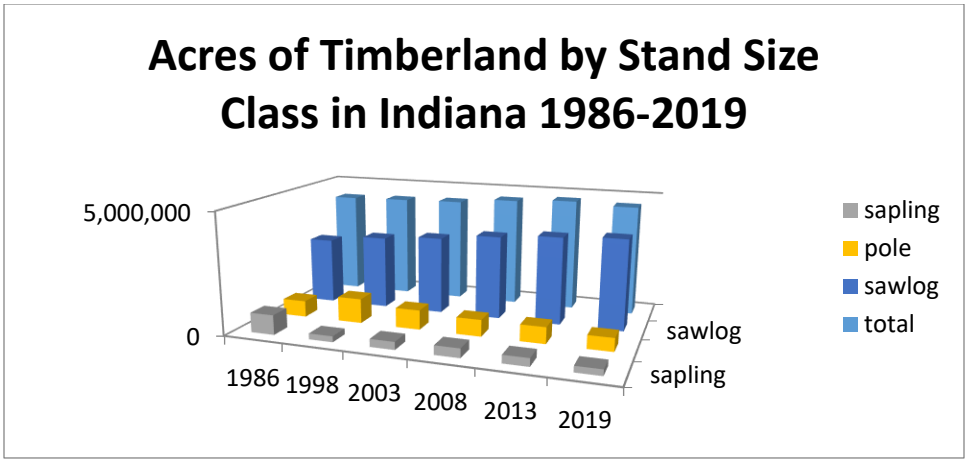


Figure 3: Acres of timberland by stand size class from 1986 to 2019.

As trees and stands mature, ecological processes change. Growth rates diminish. Stands become more susceptible to insect and disease infestation. Carbon sequestration slows. Managing these stands can keep them growing optimally.

Many stands are at a key turning point in time. Without manipulative intervention through forest management practices or major natural disturbances, these forests are primed to turn from our traditional oak-hickory forest types into the shade-tolerant beech-maple species mix. Forests are maturing, and through the process of forest succession, shifting to different forest types in many places throughout Indiana and the entire Central Hardwood region (Abrams 2003, Aldrich et al. 2005, Schmidt et al. 2000, Woodall et al. 2005). As maturing oaks and hickories die, they often are replaced by other competing species, such as sugar maple and yellow poplar, rather than young oaks or hickories. Driving these shifts are significant reductions or even failures in oak/hickory regeneration (Aldrich et al. 2005, Gormanson et al. 2016, IN DNR 2008, Lorimer 1993, Woodall et al. 2005).

Figures 4 and 5 depict changes in recent years of the number of oak and maple trees in the pole. size class (5–11-inch diameter range). Notice the difference in scale of the Y-axis, but also how the oaks are diminishing over time while the maples are increasing in numbers. This shows that the shade tolerant maples are poised to dominate the overstory in future years. If the perpetuation of the oak/hickory forest type is a primary goal for the forests of Indiana, natural resource managers will need new management strategies and practices to change the current trends, which could take decades to alter.

Source: DNR Division of Forestry 2023-2027 Strategic Direction. https://www.in.gov/dnr/forestry/files/fo-2023-2027-Strategic-Direction-Document.pdf

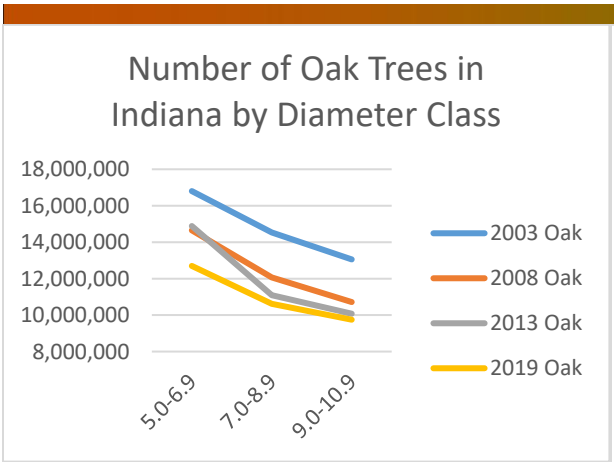


Figure 4:

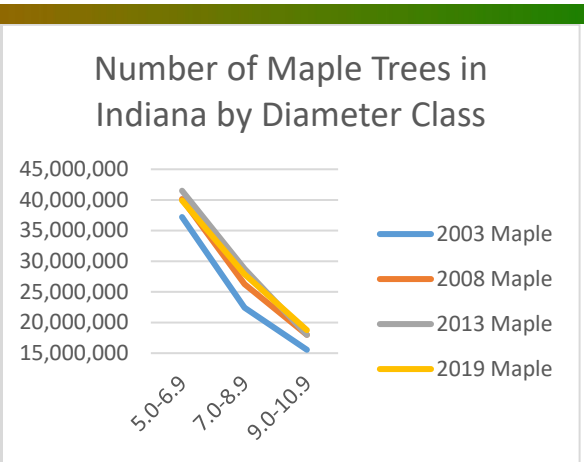


Figure 5:

1.2 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. Indiana Hardwood Assessment https://www.in.gov/isda/files/IN%20Hardwood%20Assessment%20Final.pdf
2. Forests of Indiana 2015 https://www.in.gov/dnr/forestry/files/fo-2015_FIA_Annual_Report.pdf

1.3 Maple Syrup – maple syrup report 2021 -2022 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 dollars 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

For information on maple syrup production in Indiana visit Indiana Maple Syrup Association.
https://www.indianamaplesyrup.org/

2. State Forest Health Issues – An Overview

The **2023 growing season's forest health problems and concerns** begin with **frost, freeze and rain** last week of April and first week of May. Temperatures and rain during that time averaged in the high 40's and low 50's. Rain average per week exceeded 1.0 inch. From prior years' experience with similar temperature and rain averages, anthracnose disease develops on several tree species, especially sycamore. **Sycamore anthracnose** occurrence and severity is an alert that foliage disease can occur on other trees. Sycamore anthracnose was severe across the state defoliating sycamore heavily. When this occurs, sycamore does produce full size leaves and tree canopy until July 4 or after.

As in prior years forest landowners and foresters questioned and reported the mis-shaped white oak and other oaks leaves from spring to late summer. Landowners see the mis-shaped leaves and asked what caused it and will it impact or kill the tree. The mis-shaped leaves are curled, twisted downward which is symptoms of **growth regulator herbicide** such as 2,4D or Dicamba.

Spongy moth traps captured more moths in 2023 than 2022 (39,525 to 23,457) but slightly less than 2021 (41,770). Trap capture location increased across central and southeastern Indiana and indicates a moth or larval blow in event occurred. This has occurred in prior years with decreased moth capture location the following year.

Spongy moth made its first ever appearance in Dubois County with one positive one moth trap. Since survey began in 1972, Sullivan County now remains the only county with no detection of spongy moth.

Spongy moth treatment to slow the spread occurred in 4 locations totaling 51,163 acres. One location, Kingsbury Fish & Wildlife Area in LaPorte County, was treated with Btk for second consecutive year. Three locations occurring in Fulton, Kosciusko, Marshall, and Starke Counties were treated were treated with mating disruption.

Spongy moth defoliation repeated in LaPorte and Porter Counties occurring in the same areas defoliated from 2 prior years.

And Lake and Whitley Counties were added to Indiana's and USDA's spongy moth quarantine.

Spotted lantern fly, arriving 2021 in Switzerland County and 2022 in Huntington County was detected in Allen, Elkhart, Porter, and St. Joseph Counties. The new locations are all associated with rail lines and rail yards as spotted lantern fly has shown it hitches a ride on trains. The rail areas are likely to have tree of heaven which it needs for its life cycle.

Another new pest – **beech leaf disease** – was found in northwest Ohio in 2022 and in southeast Michigan. A survey late in 2022 in northeast Indiana did not detect the disease. The disease symptom was not reported by foresters this year and ongoing survey late in 2023 has not detected the disease, however testing of bud samples is in process.

Walnut twig beetle, vector of *Geosmithia morbida* that combine to create thousand cankers disease, trapping and visual survey did not detect the beetle or an infected tree. The last trapped

beetle occurred in 2020 at a log yard and has not been detected since at the log yard. This disease is not present in Indiana.

Emerald ash borer (EAB) is finishing its killing of ash trees in the southwest toe of the state. Across the state efforts continue to locate amongst dead ash surviving ash that may have resistance or tolerance.

A **Chestnut oak mortality** research study by Purdue grad student found the mortality was not caused by a pathogen as concern was the mortality was like sudden oak death in California. The study found the mortality to follow the classic oak decline process and is associated with the 2012 severe drought and possibly smaller droughts before 2012. And that early fast growth in tree's life put growth in the tree top and not the roots. Early slow growing trees put growth in the roots. Putting growth in roots helped those trees survive compared to fast growing trees. The mortality effects are still evident in the forest.

Oak wilt was reconfirmed in Franklin, Huntington, and Morgan counties. No first-time occurrence was found in counties that have never confirmed oak wilt.

No other defoliation, mortality, or new pest occurred in 2023. Overall, the main concerns are herbicide damage, spongy moth defoliation, oak wilt, and oak decline.

Future forest pests of concern are the exotic pests, Asian longhorned beetle, hemlock woolly adelgid, beech bark disease, sudden oak death, gold spotted oak borer, other *Agrilus* spp., ZigZag Sawfly of Elm, and laurel (red bay) wilt. They were not detected in 2023.

Asian longhorned beetle (ALB) adult was captured inside a factory in Porter County in 2020. Surveys through 2023 have not detected infested trees. Still a concern for southeast Indiana due to the infestation east of Cincinnati Ohio.

Laurel wilt is believed to be present based on reports of wilting sassafras trees. However, samples have not confirmed presence of the wilt fungus nor red bay ambrosia beetle.

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 through 2022 216 sites in 43 counties totaling 241.20 acres are confirmed. 3 new sites of 1.81acres confirmed in 2022. 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.
https://www.in.gov/dnr/rules-and-regulations/invasive-species/terrestrial-invasive-species-plants/

3. First time occurrence impacting Indiana Forests

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

Figure 4: Shot hole leaf miner damage on black oak leaves.

Shot Hole Leafminer damage (figure 5) that occurred in 2020 to 79,992 acres through south central Indiana (Figure 6) to black oak and other oaks did not occur in 2023. That event also had spring frost/freeze events. There was spring frost/freeze this year but the leafminer did not join to damage the forest.

Figure 5: Areas of shot hole leaf miner defoliation mapped during 2020 aerial survey in south central Indiana.

4. Exotic Insect Pests of Indiana Forests

Spongy moth, thousand cankers disease of black walnut, oak wilt, and beech leaf disease dominated the monitoring and management activities. Monitoring activities included herbicide damage to white oak, sycamore anthracnose, laurel wilt (sassafras mortality), hemlock woolly adelgid and spotted lantern fly to forest health survey activity.

4.1 Spongy Moth – *Lymantria dispar dispar*

The Cooperative Spongy Moth Survey completed 36th year I 2023. 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 7): 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, eight counties were surveyed partially or not at all for economic reasons and no trap catches in prior years. Across all zones, the survey deployed 9,528 traps all referenced by GPS.

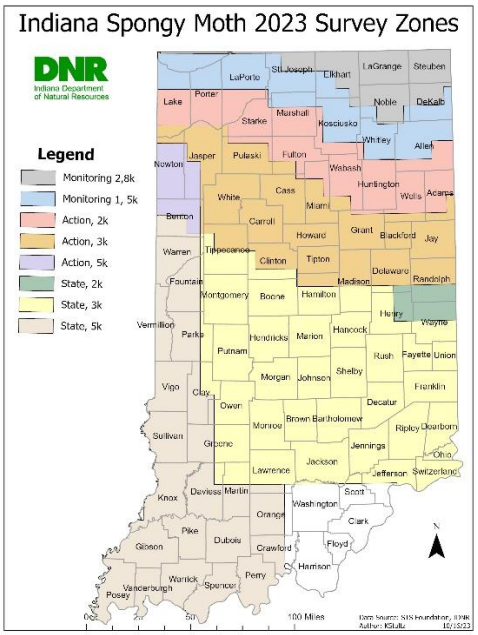


Figure 6: Gypsy moth survey zones - yellow state zone, pink slow the spread action zone, blue slow the spread monitoring zone 5k, tan slow the spread monitoring zone 8k.

The survey detected 35,535 moths from 65 counties (38 in STS, 27 in State) ranging from 1 to 5,791 moths per county. LaPorte county had the highest moth catch – 5,791, followed by LaGrange, Allen, Elkhart and Noble.

Total moths are 0.05% lower than 2021 catch (41,770) and 68% higher than 2022 catch (23,457). (figure 8).

The positive trap pattern in action zone and southeast Indiana indicates a “moth blow” event occurred. This is also indicated by the scattered increase of 1,2 or 3 moth traps in agricultural areas.

Examination of moths in traps found moths were slightly smaller than normal. The condition of these moths was good, that is no torn or tattered wings and missing scales on wings. With this condition, it could indicate larval blow into the state. If moths blew in during moth flight and mating time, torn and tattered moths could be expected but was not found.

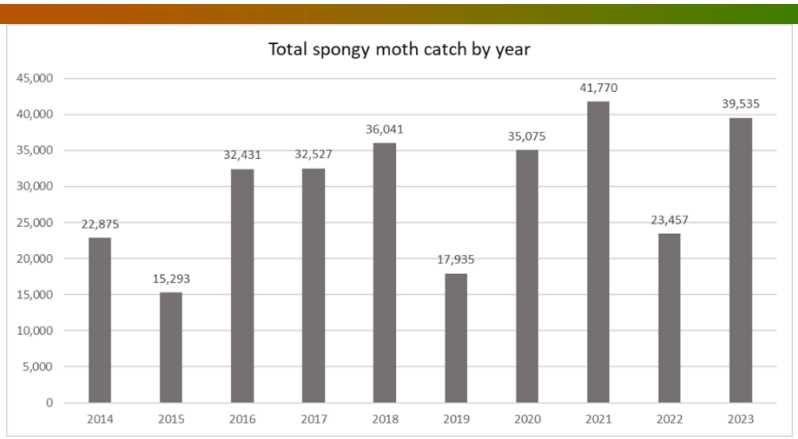
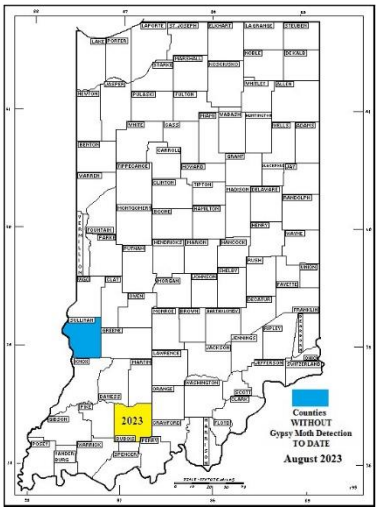


Figure 7: Graph showing number of male spongy moths caught by year from 2011 to 2023.

As in prior years, most of the moth catch was in the Evaluation Zone. The Evaluation Zone is Monitor 1 & 2 zones, is the quarantined counties of Allen, DeKalb, Elkhart, LaGrange, Lake, LaPorte, Noble, Porter, St. Joseph, Steuben, and Whitley, and detected 75.45% of the moths (29,828 of 39,535).

The Action Zone detected 23.7% of the moths (9,371 of 39,535) with most detected in northern part of the action zone which had the delimit trapping. On the eastern side, most of the positive traps caught 1 to 2 moths. Positive traps extended farther down the state which also occurred in 2020 and 2021.

The State Area detected 0.85% of the moths (336 of 39,535). The southeast corner of the state from I-70 south to Ohio River had more positive traps scattered across the counties than in prior years.



Since the survey began in 1972, a total of 739,057 moths have been caught in 91 of the 92 counties.

Spongy moth made its first ever appearance in Dubois County with one positive one moth trap. Since survey began in 1972, Sullivan County now remains the only county with no detection of spongy moth.

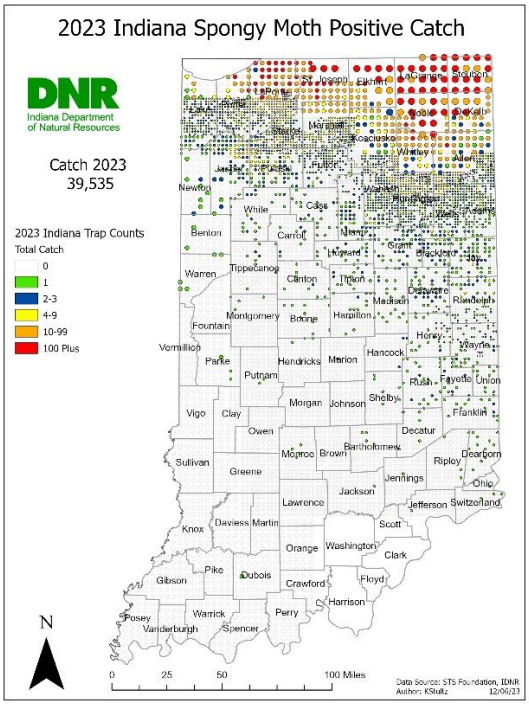


Figure 8: Map showing 2023 Gypsy Moth trap locations Total range of catch from 0 to 100+ in each trap.

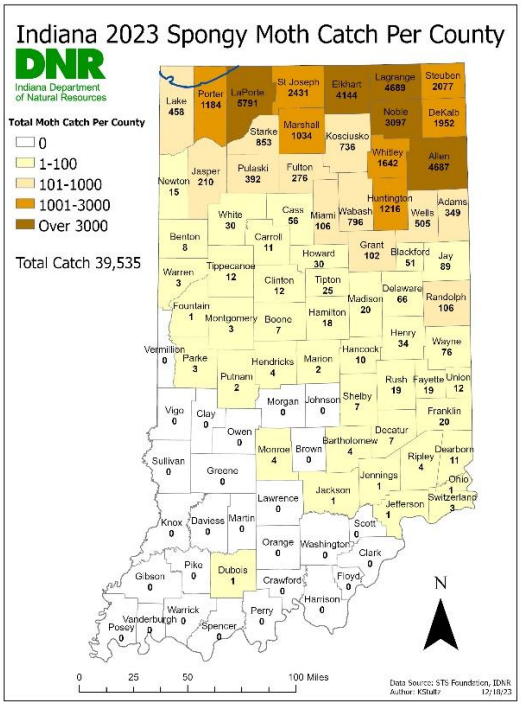


*Figure **9**: 2023 total moth catch in each county. state catch is 39,535.*

Defoliation 2022

Aerial survey recorded noticeable defoliation in LaPorte (3,217) and Porter (549) counties totally 3,766 acres. (Figure 10).

This was the third year of noticeable defoliation in LaPorte county. More locations were mapped due to better weather and care in sketch mapping, however intensity of defoliation appeared to be less than 2022. The 2021 large, defoliated area had decreased area of defoliation in 2022 but returned in 2023 to similar 2021 area of defoliation.

2023 was second year of noticeable defoliation in Porter County and occurred in same area as 2022 with similar intensity. Observed oak mortality in one of two defoliated areas in 2023.

The two areas occurred in the Dunes National Lake Shore area south of Indiana Dunes State Park between U.S. Hwy 20 and 12 east of IN 49.

The 2021 noticeable defoliation in Noble County occurred in Chain O Lakes State Park in the campground area and a Nature Preserve inside the park. The 2022 Btk treatment prevented defoliation in the campground, but there was defoliation in the Nature Preserve in 2022, but less than 2021. There was no defoliation in 2023 in the treated area or elsewhere in the park.

Total defoliated acres in 2023 is 3,766.

2023 completed the first recorded occurrence of defoliation for three consecutive years on the same area in Indiana. 2022 and 2023 each exceeded the 1,184 total acres of defoliation recorded in Indiana from 2008 to 2021.

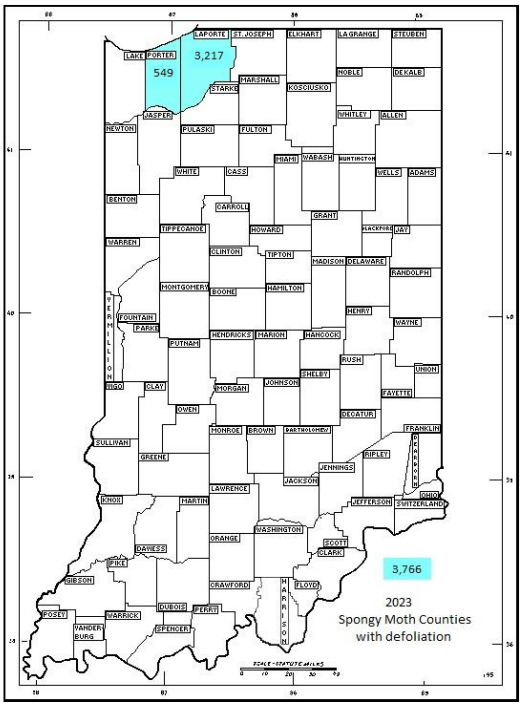


Figure 10: 2023 counties with Spongy Moth Defoliation.

Treatments 2023 to Slow The Spread:

Btk (*Bacillus thuringenisis kurstaki*):

Treatment using Btk to slow-the-spread and development of Spongy moth occurred on one site totaling 3,132 acres (Table 1). This was a re-treatment of Kingsbury Btk22 site and enlarged area from 625 acres in 2022. It was applied at 38CLU/acre. Application cost was $49.80 per acre and total cost was $155,973.60.

Table 1: 2023 site and acres treated by Btk.

County	Site Name	Program	Treatment Type	Treatment Material			EA Acres	Estimated Treatment Acres	Acres Treated
				Rate	Application #	Method			
LaPorte	Kingbury Btk 23	STS	Btk	38 CLU	1	Aerial	5,791	3132	**3132**
		Total Acres STS					5,791	3132	**3132**

Mating Disruption:

Three sites totaling 48,131 acres were treated once with 6gm/acre Splat GM Organic (table 3 and figure 12). Mating disruption application cost was $7.26 per acre totaling $349,431.06.

Table 1: 2023 sites by county, rate, acres treated with mating disruption.

County	Site Name	Program	Treatment Type	Treatment Material			EA Acres	Estimated Treatment Acres	Acres Treated
				Rate	Application #	Method			
Starke/Marshall	Plymouth MD 23	STS	Splat GM O	6 g	1	Aerial	60,243	31034	**40492**
Marshall/Koscuisko	Etna Green MD 23	STS	Splat GM O	6 g	1	Aerial	2,781	897	**1100**
Koscuisko/Fulton	Beaver Dam MD 23	STS	Splat GM O	6 g	1	Aerial	22,424	4610	**6539**
		Total 6 g					85,448	36541	**48131**
		Total Acres STS					85,448	36541	**48131**

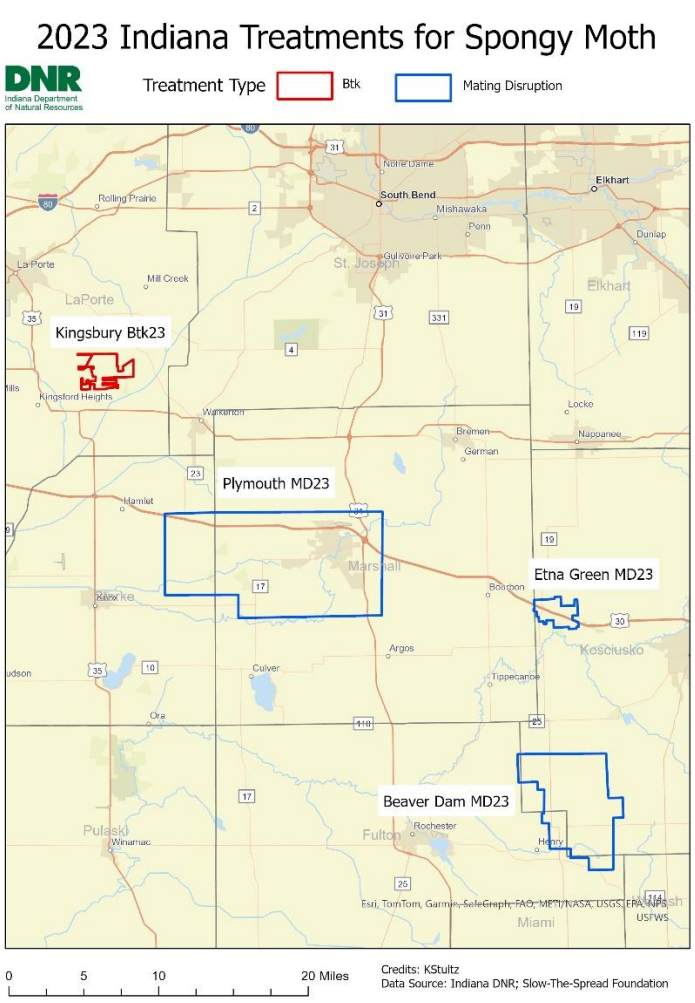


Figure 11: Map: 2023 Spongy Moth Treatment Sites.
Site label has name and treatment material.

<u>Treatment Analysis of Btk and 2022 Mating Disruption sites (Figure 12)</u>
Slow-the-Spread analysis found the 2023 Kingsbury treatment successful versus partially successful in 2022.

Analysis of the eleven 2022 mating disruption sites found 7 sites successful and 4 sites partially successful.

Successful sites - IN_MACY_MD_22, IN_Argos_MD_22, IN_Beardstown_MD_22, IN_Bluffton_MD_22, IN_Hoagland_MD_22, IN_VALPARAISO MD 22, IN_Warren_MD_22.

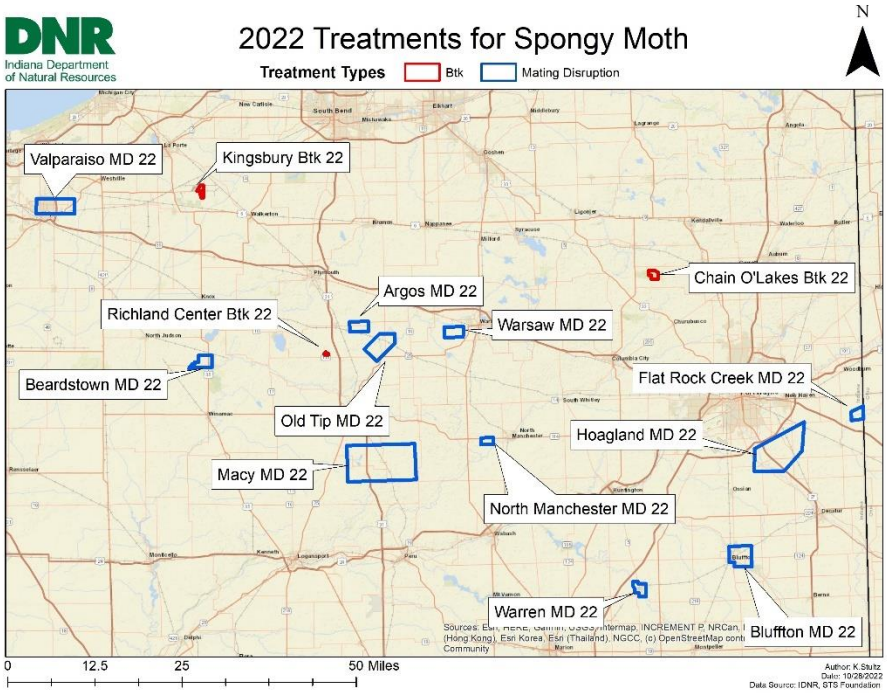


Figure 12: Map 2022 Spongy Moth Treatment Sites. Site label has name and treatment material.

Eradication: Richmond

The 2021 delimit detected 2 single moth traps on the western side of the delimit of the eradication area. The 2022 delimit detected 2 single moth traps again on western side of the eradication area. In 2023, a 17 trap delimit was placed and 10 of those traps captured 14 spongy moths. Since there is still a lingering moth catch in the eradication area, treatment is planned for 2024.

Quarantine:

Lake and Whitley counties were quarantined initially in November 2022 with implementation in April 2023.

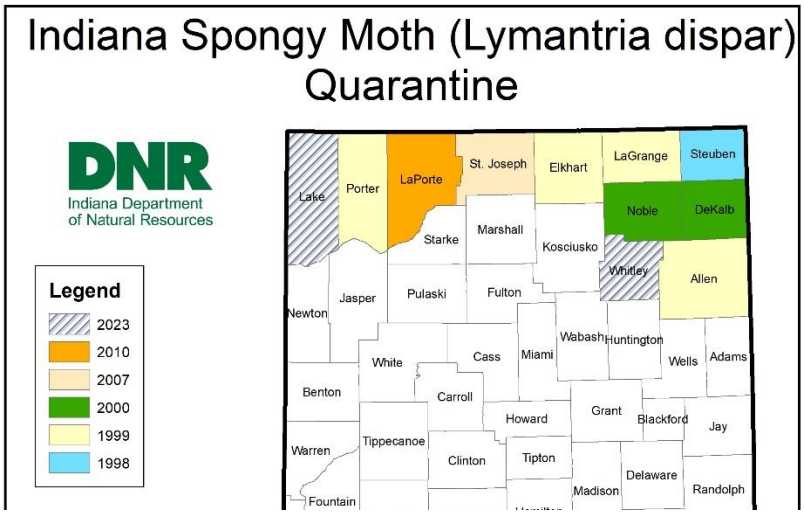


Figure13: Counties quarantined 1998 to 2023.

Spread Rate:

For 2023, the annual spread rate is 10.8 miles per year, and the three-year average spread rate is 3.4 miles per year. The annual rate is 70% above Indiana's goal of 6.00 mile per year. However, the 3-year average is 45% below the goal.

Table 2: Gypsy moth annual and 3-year average spread rate in kilometers and miles.

Unit	2023	3-year average
Kilometer	17.42	5.09
Mile	10.8	3.4

Moth Lines:

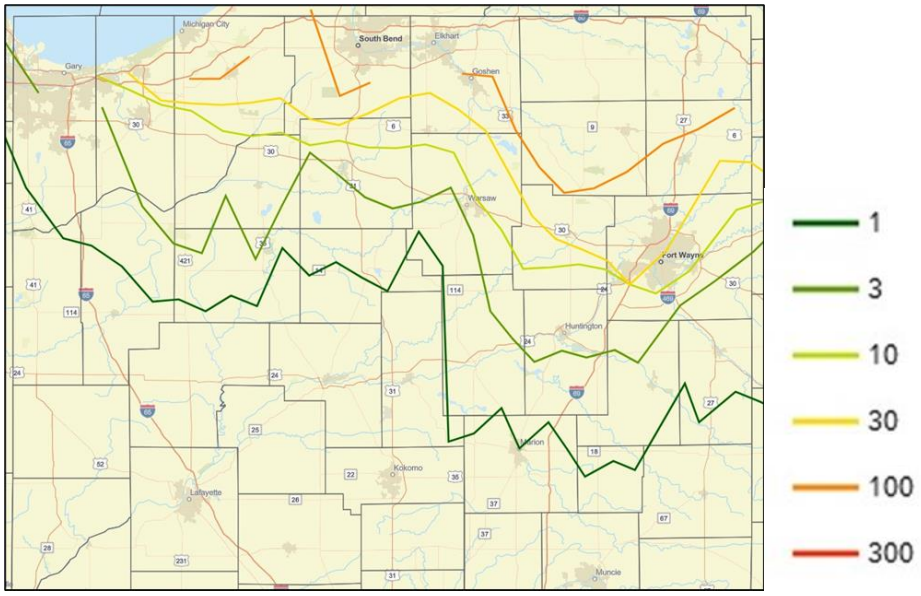


Figure 14:2023 moth lines, from south to north the 1, 3, 10, 30, 100 moth line and 300 moth line if it is present.

The increased total moth catches and occurrence of 1 to 3 moth traps in the lower area of the action zone and extending south into southeast Indiana moved the moth lines south for 2023 especially the 1 and 3 moth line. These lines are at similar location on the eastern side of the action zone as the 2021 moth lines. Based on prior years, the moth lines have extended south, and the following year returned north to prior area. They are expected to return north after 2024 survey.

The 10-moth line begins to follow U.S. Hwy 30 across the state from Allen to Lake County compared to prior years when it followed U.S. Hwy 30 in just the eastern half of the state.

The 10-moth line remained stable for the prior six years and has moved south in 2023.

The 10-moth line has remained relatively unchanged for the last 3 years across the state. It has stayed in the same area of Allen County from 2015 to 2023, advancing and receding from 2021 to 2023 It is used in the decision to quarantine a county. When it is half-way through a county, the process to quarantine the county begins. Whitley county was quarantined in 2023 following this guide. Lake County was quarantined in 2023 but the moth line was not the decision guide. The decision was based on the need to close a gap in the federal quarantine with Illinois Lake County making it easier for business to manage movement of regulated items.

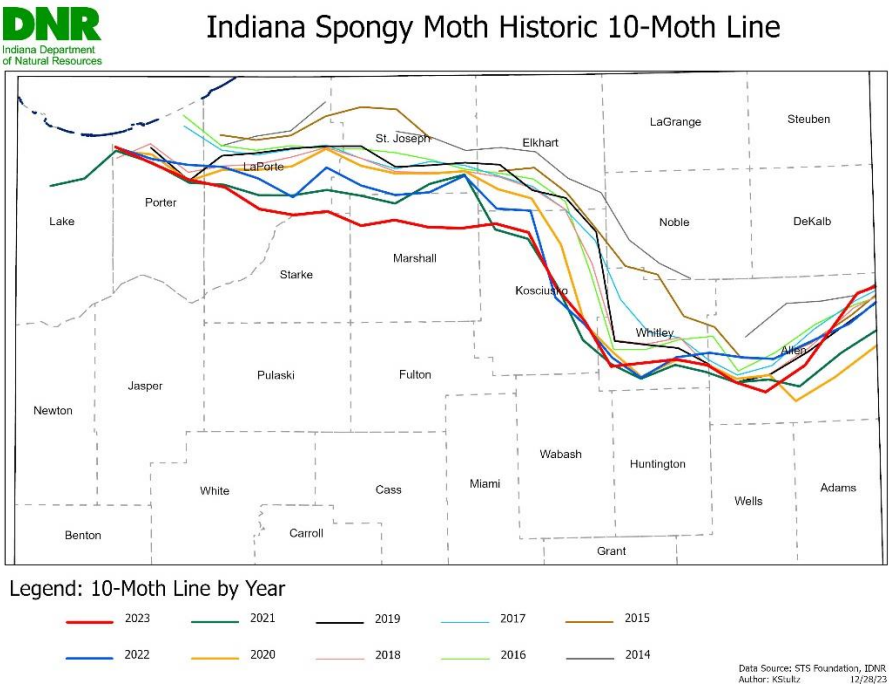


Figure 15: Map: Ten moth line from 2014 to 2023. Line means an average of ten moths caught per trap around the line for the specific year.

The 10-moth line begins to follow U.S. Hwy 30 across the state (Allen to Lake County) compared to prior years when it followed U.S. Hwy 30 in just the eastern side of the state.

The 10-moth line remained stable for the prior six years and has moved south in 2023.

After 36 years, DNR Slow The Spread Program 1988-2000 and USFS Slow The Spread Program 2001-2023, spongy moth may start to spread south of US Highway 30 (Lincoln Highway) that runs from Fort Wayne to Chicago.

4.2 Emerald Ash Borer - *Agrilus planipennis* Fairmaire

EAB was confirmed in all 92 counties in March 2017. EAB took from 2004 to 2017 to travel from northeast to southwest Indiana. From 2009 to 2020, 169,745 acres of EAB mortality was recorded by aerial survey mapping the advancing front of mortality. Its mortality has completed its move through the state. All forest acres containing ash have or have had mortality caused by EAB. This also includes all urban forests and street trees.

No survey was conducted in 2023. Foresters reported ash mortality common in extreme southwestern counties in 2022 and again in 2023. Across the state efforts continue to locate live ash trees amongst dead ash that may have resistance or tolerance.

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

The Walnut Twig Beetle trapping survey consisted of 29 locations – plantations or forest – placing 30 lindgren funnel traps baited with the walnut twig beetle lure. One trap was placed in the black walnut plantation in Yellowwood State Forest where *Stenomimus pallidus* with *Geosmithia morbida* was originally collected by USFS survey.

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

Traps were placed at 28 high-risk sites - sawmills and veneer mills - throughout the state in 2023. For the 2 locations with previous trapping of WTB, traps were not placed at the Franklin County sawmill, but 4 traps were placed at the veneer mill in Edinburgh.

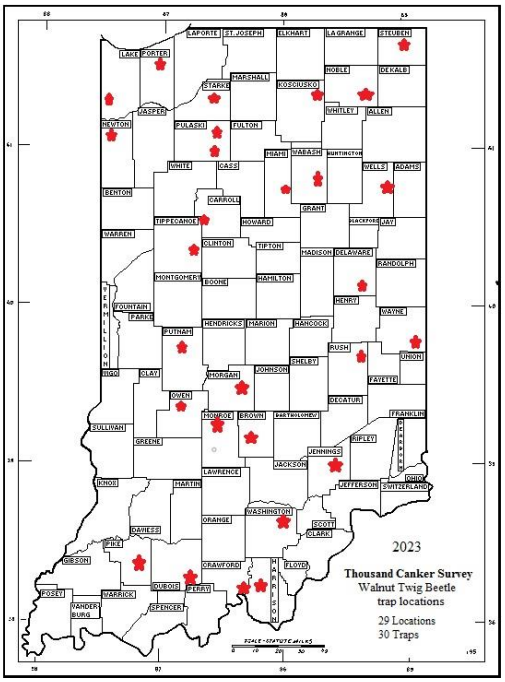


Figure 16: Map of 2023 location of walnut twig twig beetle traps in woods or plantations.

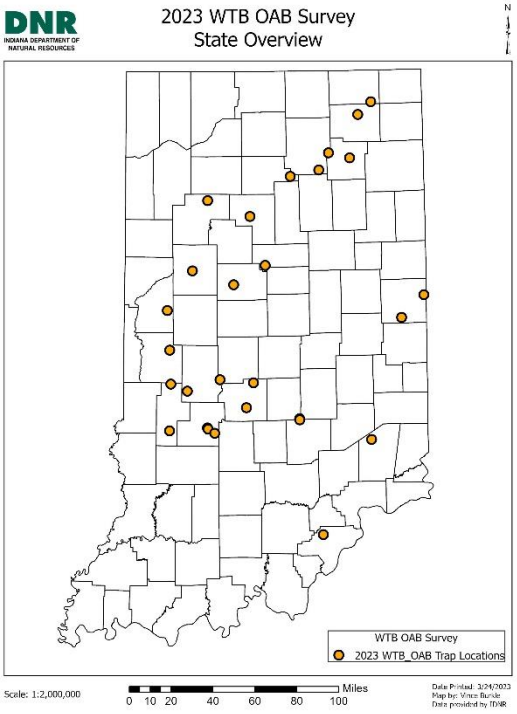


Figure 137: Map of 2023 location of walnut beetle traps at high-risk sites

From two beetles in 2014, four beetles in 2015 and one beetle in 2016, the sawmill in Franklin County has not detected the beetle through 2022. With no detection for six years, no traps were place at the mill in 2023.

The veneer mill in Johnson County was free of walnut twig beetle from 2016 to 2022. Its south log yard just across county line in Bartholomew County had one beetle trapped 7/31/2019 and again 6/29/2020 from a funnel trap. WTB was not detected at the south log yard in 2021 and 2022. Screening of 2023 traps samples to date has not detected WTB.

The 2018 trap tree survey in Crawford and Jennings detected walnut twig beetle at each location from the trap tree, but not traps. *Geosmithia morbida* was found on walnut twig beetles – one each from sample above girdle and branch – by culture and DNA test.

Delimit survey using 9 traps at each location in 2019 to 2021 did not detect WTB. The 2022 and 2023 survey used one trap at the girdled tree location. WTB was not detected in 2022. Sample screening for 2023 in process. Trees in these plantations do not show symptoms of TCD.

The Black Walnut Plantation on Yellowwood State Forest where *Geosmithia morbida* was first 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 in 2023.

The windshield survey was conducted in 13 cities - Alexandria, Cicero, Covington, Crown Point, Flora, Lafayette, Ligonier, Rising Sun, Rockport, Santa Claus, Terre Haute, Versailles, and Vevay. 469 survey points and total of 892 trees surveyed. 14 suspect trees detected. Since this survey began in 2012, 13,506 trees have been evaluated with 167 suspect trees and no positive trees in 148 municipalities.

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.

4.4 Spotted Lanternfly – *Lycorma delicatula*

Figure 148 (Left) Spotted Lanternfly 4th instar nymphs. Photo by Stephen Ausmus

Figure 159 (Right) Spotted lanternfly adult. Photo by Lawrence Barringer, Pennsylvania Department of Agriculture

Spotted lanternfly (SLF) (figure 18 & 19) is an invasive species detected in Berks County Pennsylvania in 2014. This colorful planthopper sucks sap from plants excreting a honey dew that is sticky and turns black with the growth of sooty mold after raining down in the forest.
It feeds on more than 70 plant species and has a strong preference for Tree of Heaven also an invasive species, grapevines, red maples, black walnut, birch, and willow.

It was detected in Allen, Elkhart, Porter, St. Joseph Counties during summer 2023. All detections are associated with railyards and rail lines. Elkhart/St. Joseph County locations are linked by rail line going from Midway (Northwest of Goshen) to Elkhart and west to Mishawaka. Heaviest infestations are downtown Elkhart, east end of Norfolk Southern Elkhart railyard and Byrkit Ave rail crossing in Mishawaka. Porter County also detected it at the 8th street rail crossing in Chesterton. Allen County location is southwest of downtown Fort Wayne along the rail line near its crossing of St. Mary's River.

The Huntington infestation in 2023 covers an estimated 2,000-acre area based on the detection in Huntington City.

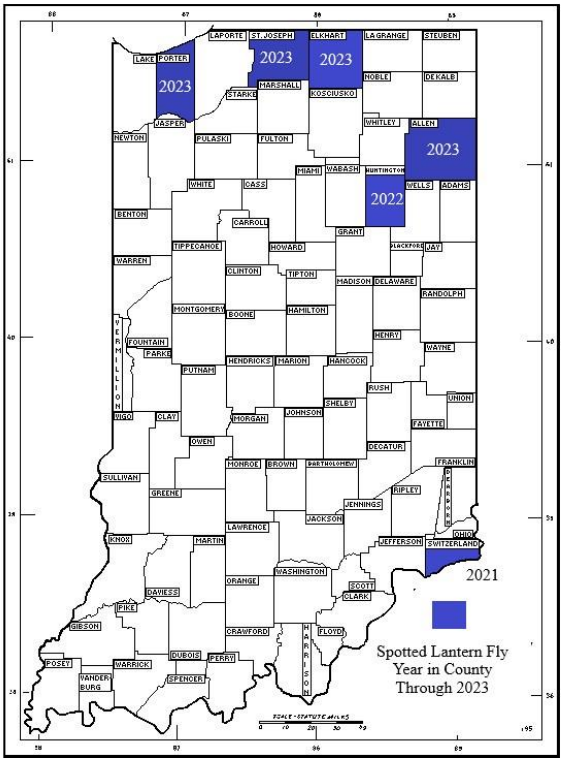


Figure 16: Spotted lantern fly infested counties through 2023.

5. Other Exotic Insect Pests of Concern

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

Survey around the industrial building where ALB was collected in 2020 has not detected the beetle or infested trees from 2021 to 2023.

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

There were no reports of possible ALB infested trees or the beetle in 2022.

5.2 Hemlock Woolley Adelgid - *Adelges tsugae*

In 2012, Hemlock Woolly Adelgid (HWA) was detected in one site in Michiana Shores in LaPorte County. The site is ½ mile south of Michigan line and 8 miles south of an infestation in New Buffalo, Michigan. Survey of that site and surrounding area since 2012 has not detect HWA.

Survey of native eastern hemlock forest locations scattered across Indiana through 2023 has not detected HWA. It has not been introduced through nursery stock and detected in any landscape, nursery, and retail locations.

6. Plant Pathogens of Concern

6.1 Chestnut Oak Mortality – not Pathogenic, Drought induced decline.

Figure 20: Chestnut oak mortality Patoka Reservoir September 2016

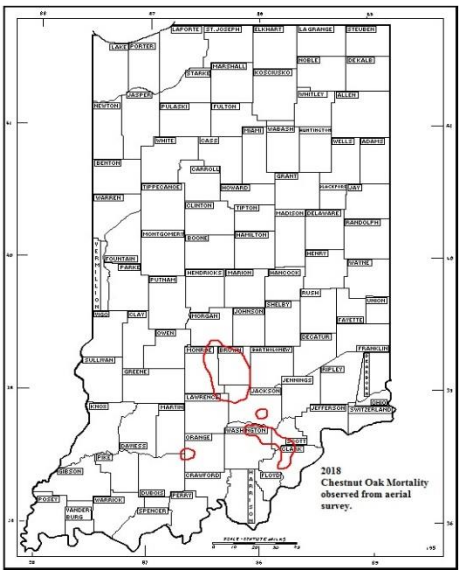


Figure 17: Areas in southern Indiana with chestnut oak mortality in 2018

The forest health management plan to address chestnut oak mortality (figure 20) 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 occurred winter of 2022-2023.

Chestnut oak mortality is still present in south central Indiana in the areas reported in prior years. No aerial survey was conducted to record new or prior mortality.

The chestnut oak mortality project conducted by Purdue grad student completed analysis of increment cores and review of FIA data of oak mortality to understand the mortality.

The student collected data on 130 plots over Morgan Monroe State Forest, Yellowwood State Forest, and Hoosier National Forest. Data for plots in Yellowwood State Forest south of highway 46 and northern portion of Hoosier National Forest had the highest mortality and unhealthy trees. Data indicates north, and northeast aspects had a higher proportion of dead trees and higher slope position had the higher proportion of mortality followed by mid slope position. And indicates high stand density had higher mortality.

The student completed the dendrochronological study of declining chestnut oak and surviving chestnut oak. A paper of the study results has been submitted to journal of Forest Ecology and Management.

Dendrochronology analysis of annual rings found that smaller drought events before 2012 placed the trees in a position leading to decline and death when the strong 2012 drought occurred. The analysis found that trees growing fast in their early years were more likely to decline and die. The slower growing trees in the early years tolerated the drought as they put more resources into roots than above ground tree parts. Fast growing trees put resources in the above ground part of the tree.

That study and other study results found the mortality is not associated with any pathogen, as *Phytophthora cinnamoni* was considered a possible cause as its occurrence was very limited. The mortality followed typical drought induced oak decline series.

Declining trees are still present and occurring but at a lesser rate from reports of foresters.

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

Oak wilt was not confirmed from a new county in 2023.

It was reconfirmed in three counties – Franklin, Huntington, and Morgan - previously confirmed. Franklin County first confirmation was 2021 and second confirmation in 2023.

Huntington and Morgan counties were reconfirmed for the first time since 1979. In Morgan County it was confirmed in a 5-acre pin oak plantation with active oak wilt in one acre. Pin oak trees had exposed fungal mats. It was confirmed in one acre area of 80-acre forest in Huntington County.

Oak wilt was reported on Ball State University land in Delaware County in 2022, but the trees were not sampled and confirmed by lab analysis. The location was not visited in 2023. If confirmed this would be confirmed occurrence in the county.

The number of oak wilt counties remains at 66 (figure 22).

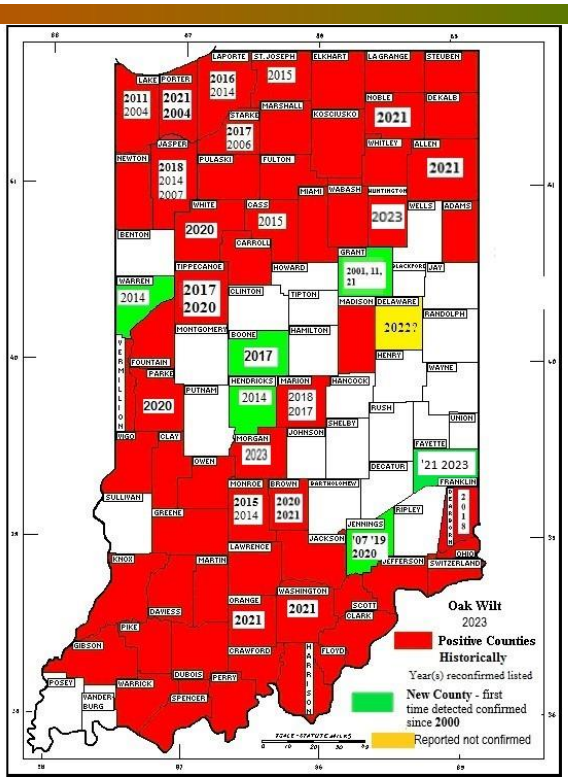


Figure 182: Counties confirmed with oak wilt. Counties in red were confirmed with oak wilt from original surveys through 1979. Green shaded counties were first time confirmation after 2000, Years in county indicate year of confirmation or reconfirmation.

Besides Delaware, 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. The reconfirmation in Franklin is in the northeast corner a few miles west of Decatur and Rush Counites.

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. Nursery inspectors submit 200 or more samples each year from any of 5 vector species they encounter in nursery inspections.

The 2023 samples have not detected *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 vector species in nursery trade in 2006, 2012 and 2019. 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 sassafras in two Kentucky counties that border Clark, Floyd, and Harrison County. Kentucky forest health has not reported additional location of sassafras with laurel wilt in their border counties to those Indiana counties.

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 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 since 2020.

Besides the 2021 Brown County samples, samples from trees in Lawrence, and Monroe counties were tested in 2021. Lab tests did not confirm laurel wilt fungus.

No report received of wilting sassafras in 2022.

A few reports of wilting sassafras in 2023. One from Lawrence County. And one from Monroe County. The report in Monroe County tested at Purdue Plant Diagnostic Lab was negative. Received one report of wilting spice bush from Gibson County and it was examined and tested. No trapping survey for red bay ambrosia beetle in 2023.

This disease is suspected to be in Indiana, but through 2023 it has not been detected and confirmed.

6.5 Beech Leaf Disease - *Litylenchus crenatae mccannii*

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.

Survey by district foresters in 2020 did not detect the disease. Survey was not repeated in 2021.

Ohio reported beech leaf disease in a nature preserve in northwest Ohio 30 miles east of Steuben County in mid-summer 2022.

Late summer after Ohio's report, Michigan reported it in 3 southeastern counties adjacent to and north of Detroit.

Late summer visual surveys in 14 locations total in DeKalb (2), LaGrange (3), Noble (3), and Steuben (6) Counties with a total of 19 sample points and did not detect the disease.

Foresters did not specifically survey for this disease in 2023. They were informed of disease symptoms and asked to report possible infected trees when they inspected classified forests and state forests. Foresters did not report American Beech with symptoms of this disease.

The 2023 survey for buds is a Bipartisan Infrastructure Law invasive species survey grant between Indiana, Michigan, and Wisconsin Departments of Natural Resources. Each state collects buds and submits them to Purdue Plant Diagnostic Lab to test for DNA of the nematode.

In November and December, 31 locations in 13 counties were surveyed - Allen, DeKalb, Greene, Huntington, LaGrange, Monroe, Noble, Owen, Pike, Spencer, Steuben, Wabash, and Wells. Survey in these counties involved collecting buds submitted to Purdue Plant Diagnostic Lab tested for the DNA of the nematode. At preparation of this report, field survey is finishing, and samples sent for testing. No detection of the nematode to date. This survey will continue through the winter and through 2025.

Through 2023, this disease is not present in Indiana.

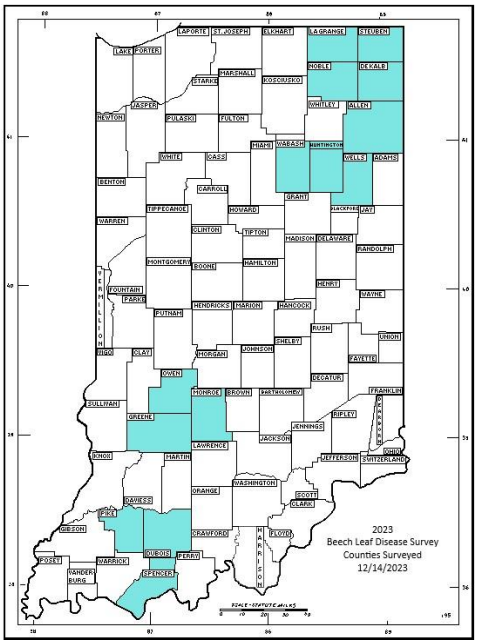


Figure 19:Beech leaf disease survey counties

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

No survey was conducted in 2023 for this disease. Foresters and arborists did not report a beech tree with the beech scale or cankers of the *Neonectria* fungus. Thus, this disease is not present in Indiana.

Its first occur is likely in northern Indiana, possibly LaPorte County, 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. In 2020, one symptomatic tree was observed 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 to 2023.

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. Through 2023, those trees still have some symptoms of the disease but have not progressed toward death.

Symptoms have been observed in Brown, Monroe, and Orange counties since 2018 and were observed in 2021. Symptoms were observed in Pike County on Pike State Forest in 2022. The trees have had the disease for several years.

7. Native Insect and Disease Concerns

7.1 Jumping Oak Gall - *Neuroterus spp.*

Figure 203: Jumping oak galls on underside of white oak leaf.

Received one report from Lake County. This was first report in northern half of Indiana. It was found on heavily infested bur oak leaves on the forest floor in a 20-acre forest in December 2023.

No other reports were received in 2023. The last report was 2019 on white oak in Martin, Lawrence, and Orange counties. 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 or its defoliation in 2023. 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 2023. 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.

Using the timeline of the two epidemics occurring about every 20 years, loopers and their defoliation could occur in 2024.

7.4 Anthracnose – *Apiognomonia* spp.

Sycamore anthracnose caused significant defoliation across Indiana in 2023. Most trees returned to full leaf in early July. No estimate of acres of defoliation.

2020 was last year of significant anthracnose damage. In 2021, it occurred to sycamore in selected areas across the state at a similar level of damage as 2020. On oak and other species, it was less than 2020 damage.

7.5 Tulip Tree Scale - *Toumeyella liriodendra*

There were no reports of the scale in 2023. The last report was 2020, with a few reports of black sooty mold and trees dripping sap from tulip trees in plantations, and one report of noticeable scale damage. The most damage occurred 2011 to 2012 in south central Indiana combined with the 2012 drought, yellow poplar mortality was widespread in 2012 and 2013.

8. Invasive Plant Species

8.1 Kudzu - *Pueraria lobata*

No update for 2023 from the Division of Entomology and Plant Pathology eradication effort. Following is 2022 status report.

Kudzu, an Asian native invasive vine, is located throughout Indiana but is predominately in southern Indiana. Currently there are 216 known sites totaling 241.20 acres in 43 counties (figure 24). Many of the sites are less than one acre. Three new sites totaling 1.81 acres were confirmed in 2022.

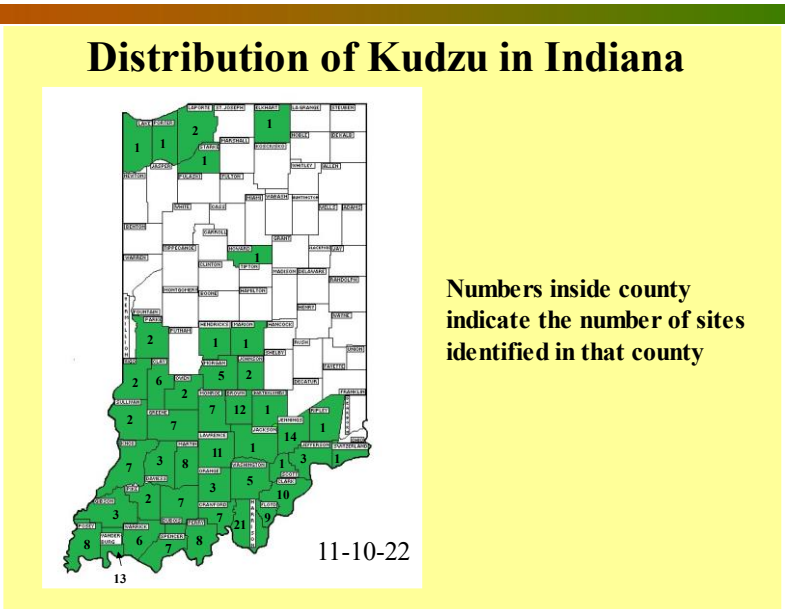


Figure 21: Counties with Kudzu and number of kudzu sites in each county

Treatment of kudzu by IDNR-DEPP began in 2006 and has continued annually to remove kudzu from Indiana. In 2022, herbicide applications were conducted at 38 kudzu sites in 20counties. A total of 63.21 acres were treated by contract in 2022. No staff treatments in 2022.

For all DNR DEPP treated sites, 96.0 percent have at least 90 percent suppression or greater in 2022. This is up from 88.0, 91.2, 94.0 percent in 2019 to 2021, respectively.

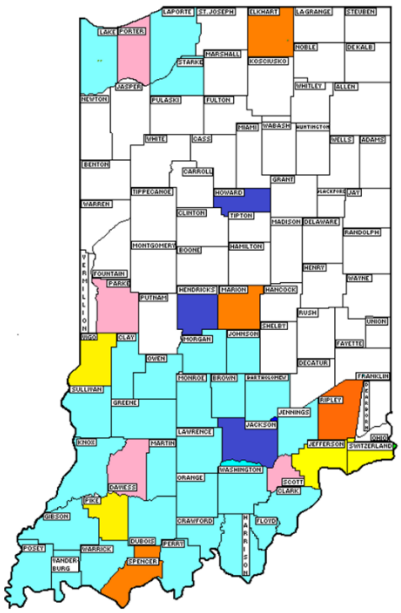


Figure 225: Kudzu treatment status by county - no treatment Orange, likely eradicated dark blue, approaching eradication yellow, under DNR treatment light blue, landowner treatment pink.

A total of 39 sites appears 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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