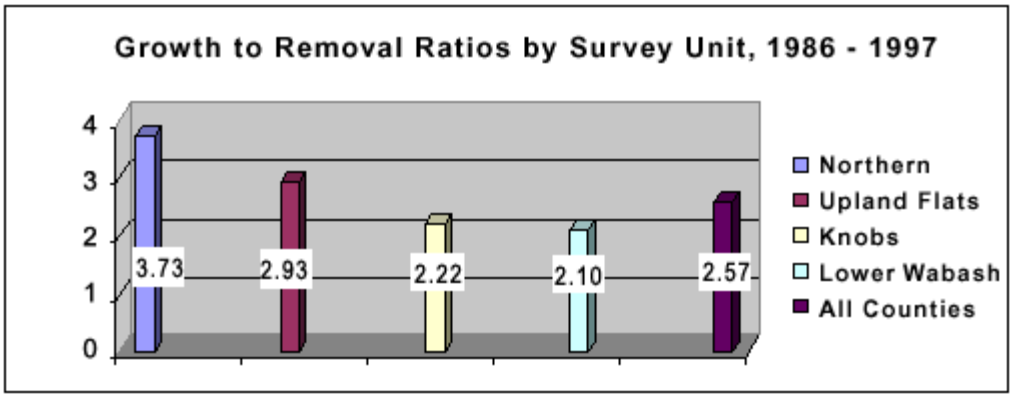
# 2000 Forest Health Highlights
# Indiana

## The Forest Resources

Indiana ranks third nationally in hardwood lumber production adding over $4 billion to the state's economy. The forest products industry is the fifth largest manufacturing industry in the state. Of the over 1000 business and manufacturers in the forest products industry, 59,000 people are employed with a total payroll over $1 billion annually. For the second quarter of 1997, lumber/wood product exports totaled $57 million an increase of 22% from the first quarter.

To support the industry, Indiana forest resources continue to grow 2 ½ times the volume being removed. For the most recent year with available statistics, an estimated 500 million board feet were harvested to produce sawtimber, veneer, handles, pulp and cooperage.

Forests of Indiana: A 1998 Overview PDF

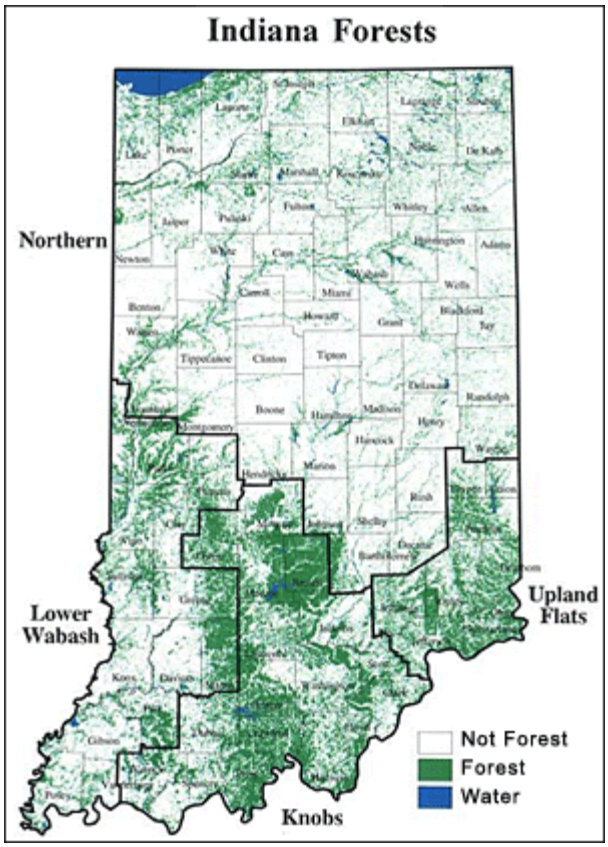



Source: Forests of Indiana: A 1998 Overview, USDA, NA-TP-03-00, September, 2000

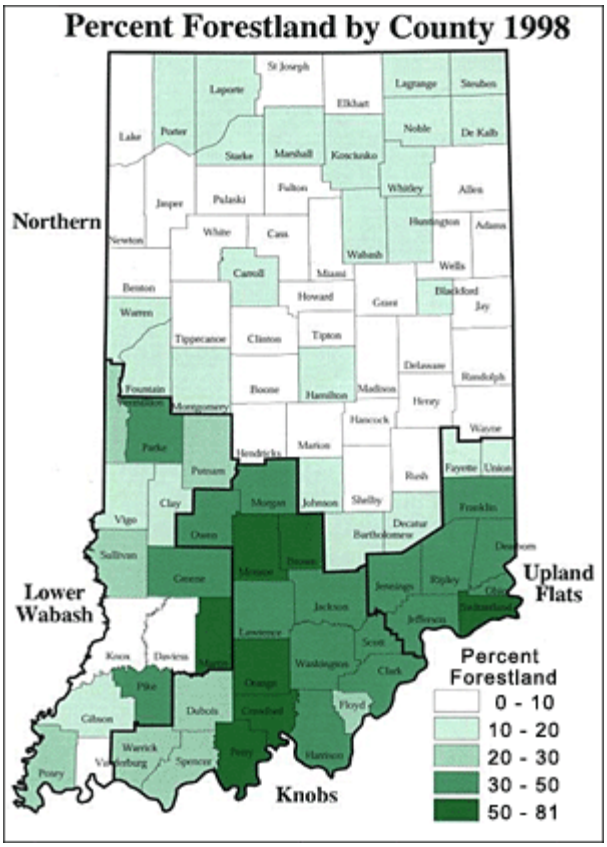
Since 1907, forestland increased approximately 430,000 acres, and from 1967 to 1998, the volume of timber increased from 3,800 to 6,900 million cubic feet. More than 85 different trees grow in Indiana forests.

| Indiana Forest Statistics | |
|---|---|
| Total acres | 22,957,400 |
| Forested acres | 4,501,300 |
| Percent forested - all land | 20% |
| Percent timberland - all land | 19% |
| Percent timberland - forest land | 96% |
| Reserved acres 159,100 or 3.5% of forest land | |

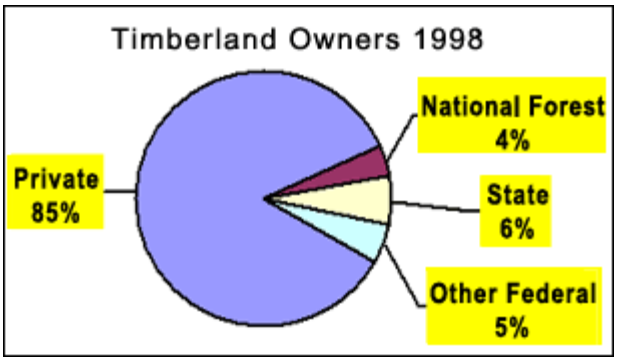
Hardwoods account for 95% of the forest that is identified into 13 forest types. Good sites (ability to produce >85 $ft^3$/yr) represent 63% of the forest, which is privately owned (85%).

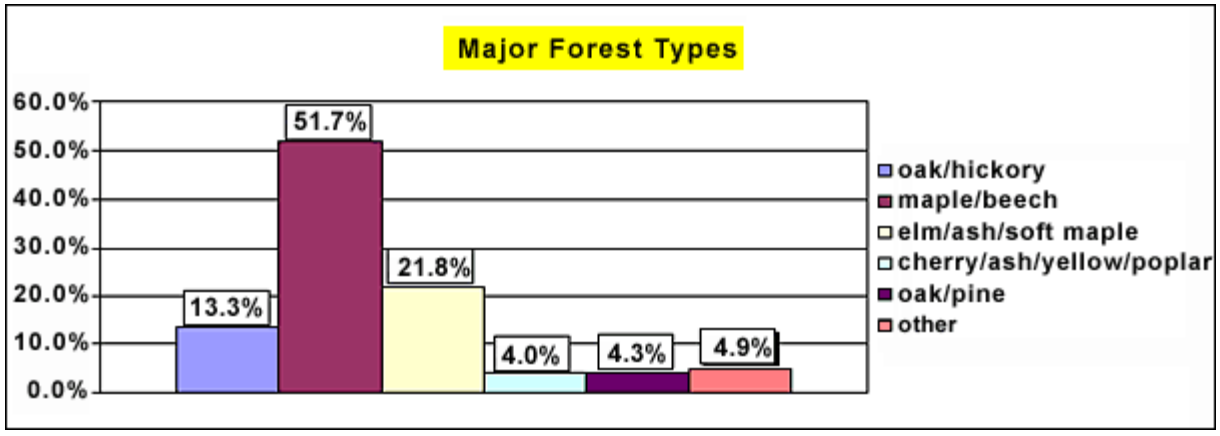



Source: Indiana land cover produced by cooperative project between the U.S. Geological Survey and the U.S. Environmental Protection Agency based on Landsat TM5 Imagery acquired by the Multi-resolution Land Characterization (MRLC) Consortium. The images date from 1989 to 1993. Classes 41-43 and 91 were used to represent Indiana forests.




Source: NC-FIA Indiana 1998.




## Special Issues

### Gypsy Moth Recedes Again

Gypsy moth again decreased in 2000. Using male moth captures to gage the ebb and flow of gypsy moth, the 2000 **Cooperative Statewide Gypsy Moth (GM) Survey** detected 5,744 moths which equaled the 5,798 caught in 1996. We questioned where all the gypsy moth came from after the 1997 survey; decided they came from a larval blow in after the 1998 survey; asked where they went following the 1999 survey; and now realize that this was the "ebb and flow" nature of the expanding front of the gypsy moth invasion.

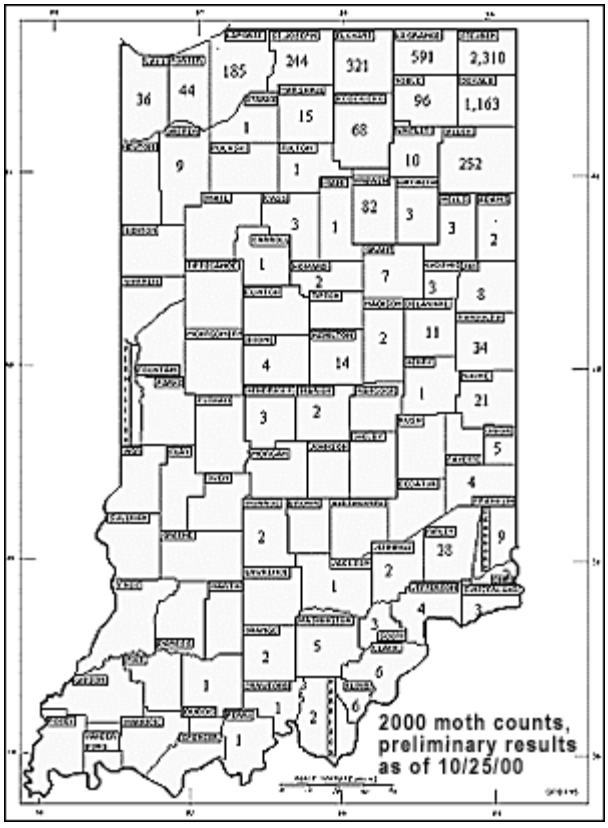
The 5,744 male moths is 1/2 of the 13,498 moths caught in 1999, less than 10% of the moths caught in 1998 or 1997 and equal to 1996. The maps below show the progression/regression of GM from 1996 to 1999 (note: 1996 & 1997 maps based on average moth/trap/county. The 1998, 1999 & 2000 maps based on STS analysis from GPS referenced traps).

The 2000 Cooperative Gypsy Moth Survey completed its thirteenth year of the statewide survey. Trap locations were geographically referenced for the third straight year using Global Positioning Satellite (GPS) units and submitted to the GM Slow-The-Spread (STS) web site **www.gypsymoth.ento.vt.edu/STS**. The 2000 survey switched from mile based grids to kilometer based grids, and set 2,000+ intensive and 13,800+ detection traps. Moths were detected in 39 counties ranging from 1 to 2,310+ moths. The map below shows the moth catch for each county.

Management efforts to eradicate and slow the spread of GM applied Btk to 917 acres on 3 sites and pheromone flakes for mating disruption to 9,325 acres on 11 sites. A total of 10,242 acres were treated.

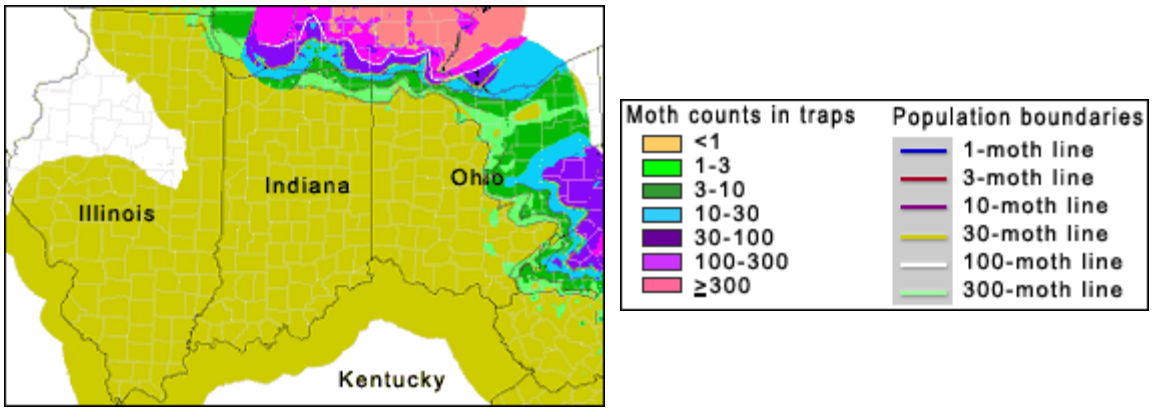
Analysis of the survey data in the 3 Btk sites found that treatments were successful in eradicating and slowing-the-spread of gypsy moth.

The 11 pheromone flake treatment sites will be surveyed in 2001 to determine success. From 2000 survey data around and outside the sites, treatments appear to be successful from the lack of moth capture near the sites.

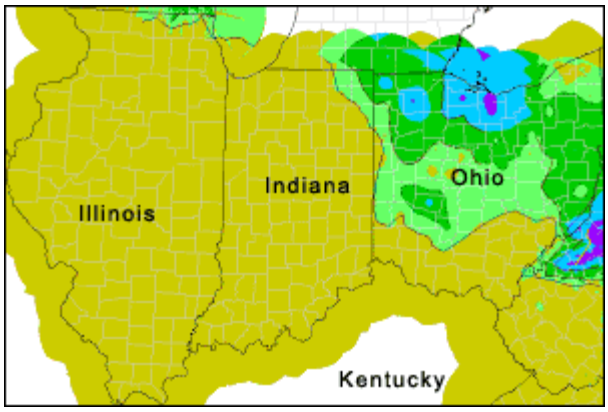



**Click here to view full-scale map.**

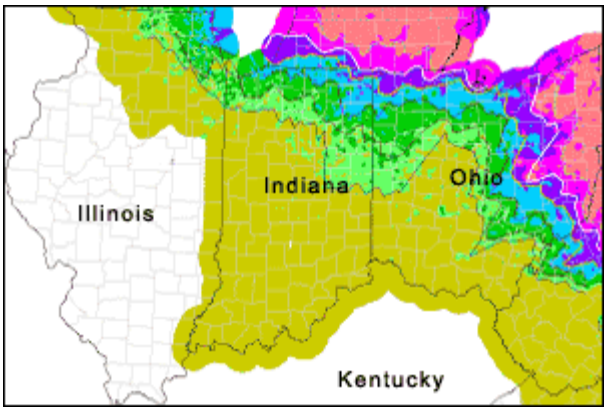
**The Ebb & Flow of Gypsy Moth from 1996 to 2000**



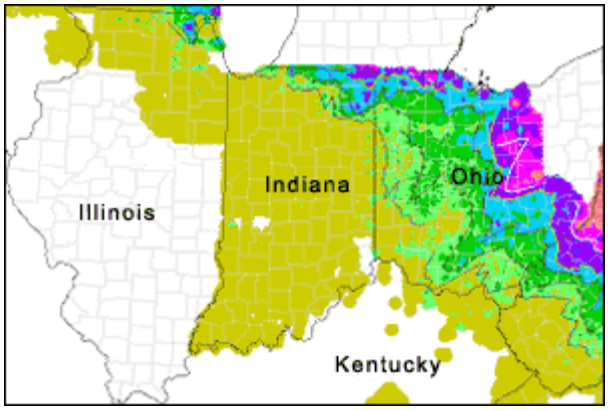

Map 1. The location of GM advance in 1996



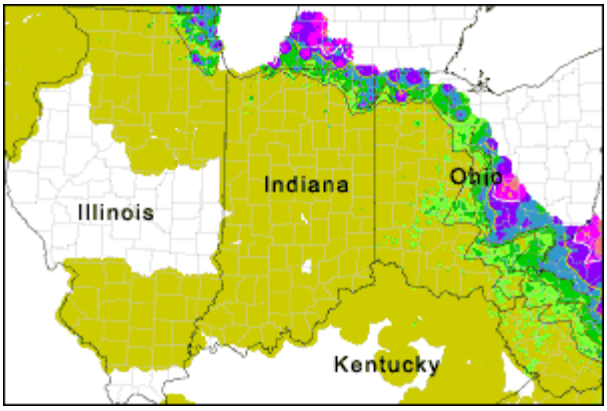

Map 2. The location of GM advance in 1997




Map 3. The location of GM advance in 1998.




Map 4. The location of GM advance (recession) in 1999.

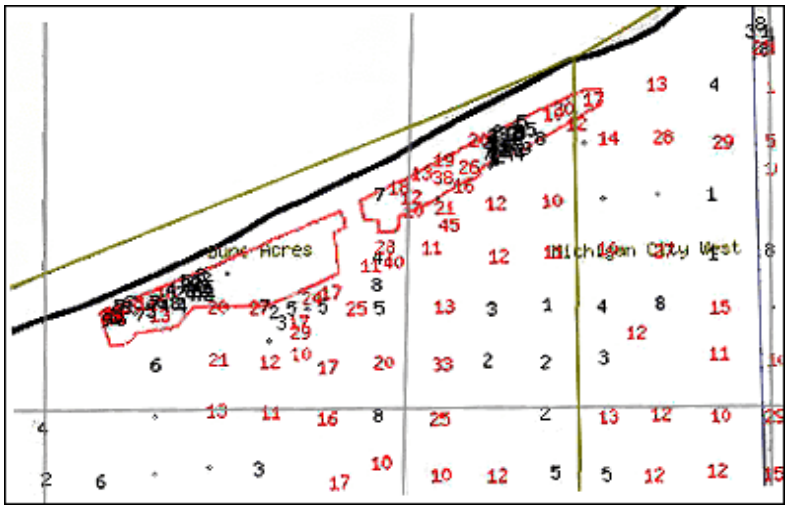



Map 5. The location of GM advance (recession) in 2000.

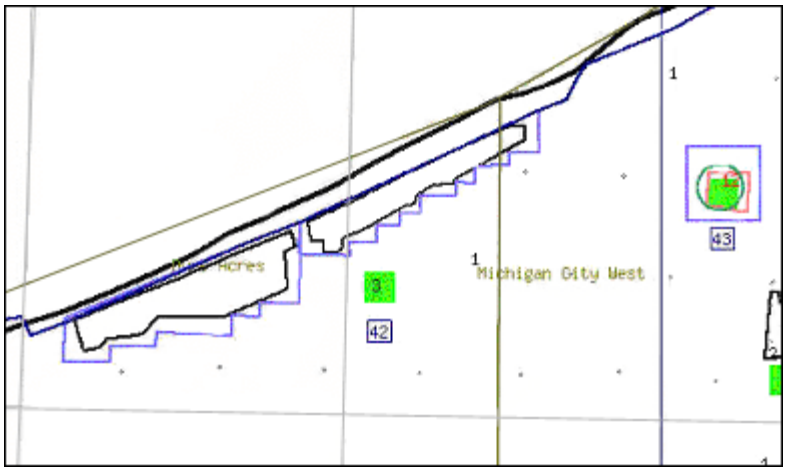
| Year | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|
| Number of Male Moths Caught | 5,798 | 61,994 | 81,995 | 13,498 | 6,000 |

Pheromone flakes were applied in 1999 on 3,934 acres in Porter County. The 2000 gypsy moth survey placed traps throughout the treatment area to determine success of the treatment. The maps below show the treatment

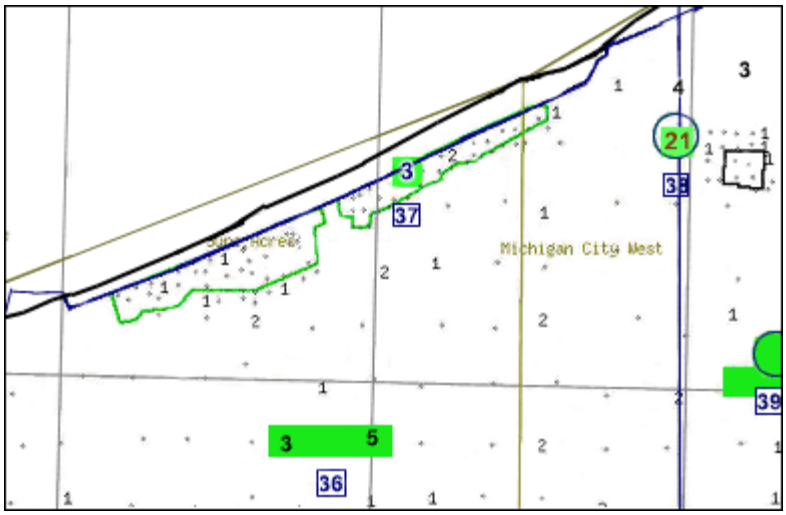
areas and moth capture in 1998, 1999 and 2000. No traps are placed inside the treatment blocks during the year of application - 1999. The treatment was successful comparing 1998 to 2000 moth capture. There is one site in the east treatment area that detected moths. This site will be resurveyed in 2001 to confirm success and provide further management effort to slow the spread of GM. Overall, the goal of Slowing-The-Spread of gypsy moth was met in this area. (Note: STS analysis determine Treatment success values of T=0.20 and C=0.22 for the west area; and T=0.19 and C=0.23)



Moth capture in 1998 in and around the pheromone flake treatment areas in Porter County.



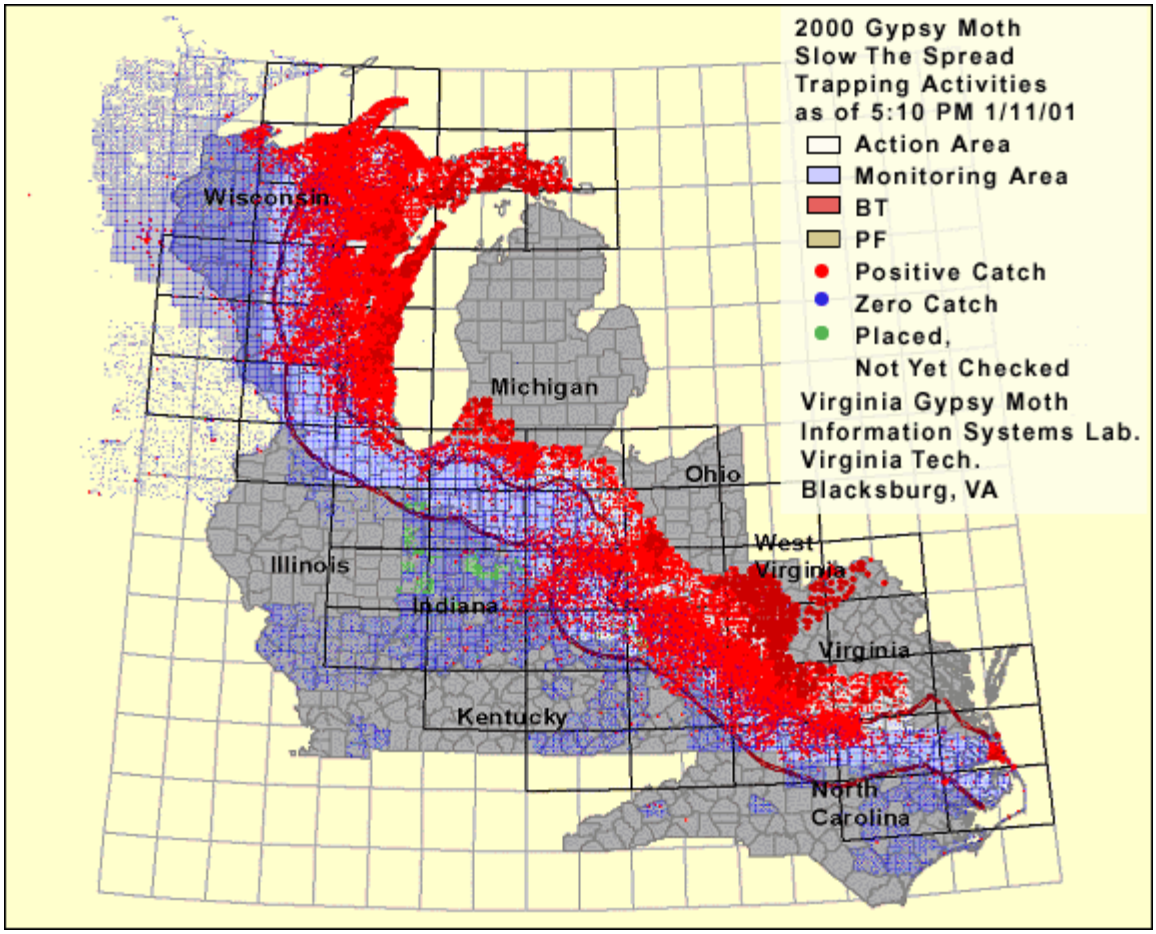
Moth capture in 1999 around the pheromone flake treatment areas in Porter County. No traps set in areas during year of treatment.



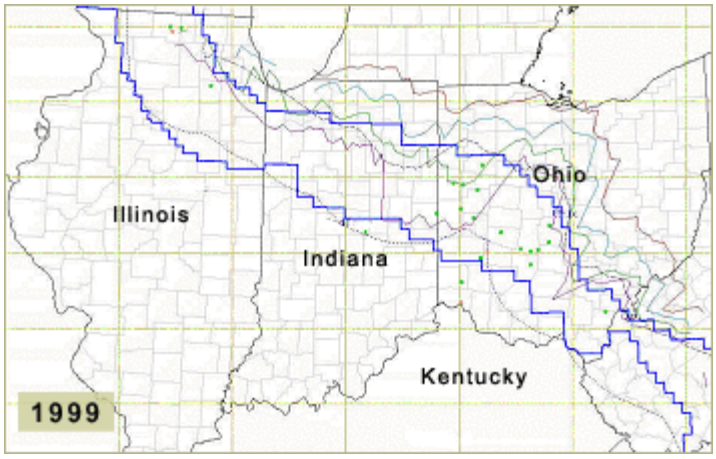
Moth capture in 2000 in and around the pheromone flake treatment areas in Porter County.

Since 1980, male gypsy moths have been detected in the state every year. This indicated that GM could be establishing itself in the state. With the Cooperative Statewide Survey identifying introductions and eradication projects eliminating those introductions, the spread of GM into and within Indiana has been delayed by 10 or more years.

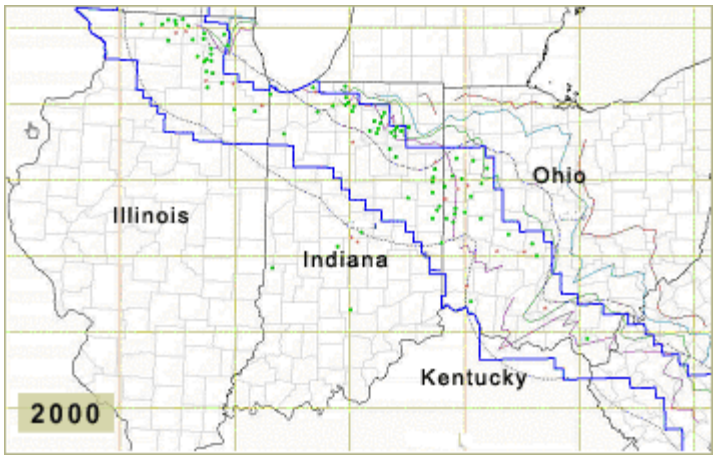
To date, noticeable widespread defoliation by gypsy moth has not been detected in Indiana. The only reported tree defoliation occurred in Steuben and DeKalb Counties to individual yard trees at three sites. These three sites also recorded the first confirmed occurrence in Indiana of the fungus, *Entomophaga maimaiga*, and Neucleopolyhydroysis Virus (NPV). The fungus and virus kill gypsy moth larvae, are specific to gypsy moth only and help to provide control of gypsy moth populations. To find these gypsy moth parasites in the early stages of a gypsy moth invasion is unusual and very positive for Indiana's gypsy moth management effort. The fungus and NPV are usually active in higher level populations than occur in Indiana. These two parasites, especially *E. maimaiga*, have been a controlling factor in the gypsy moth populations of the generally infected northeastern states and Michigan.




The spread continues to be slowed with the addition of STS technology to the Cooperative Statewide Survey. The maps below show the moth lines for 1999 to 2001 and demonstrate a reduction in moth spread. Without these efforts, GM would have been a resident of Indiana by 1988, widespread forest defoliation would be a reality, and mortality within the forest would be occurring.




Click here to view full-scale map.



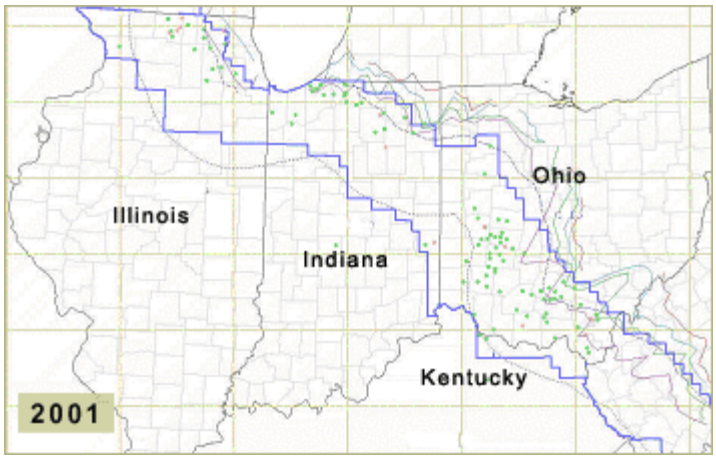

Click here to view full-scale map.

STS moth lines and Action zone for 1999 to 2001.

Top Line= 30 moth line
2nd Line from top = 10 moth line
3rd Line from top = 3 moth line
4th Line from top = 1 moth line

Solid Blue Lines= Action Zone Boundary adjusted for fieldwork

Dashed Line= Action Zone Boundary defined by STS analysis.



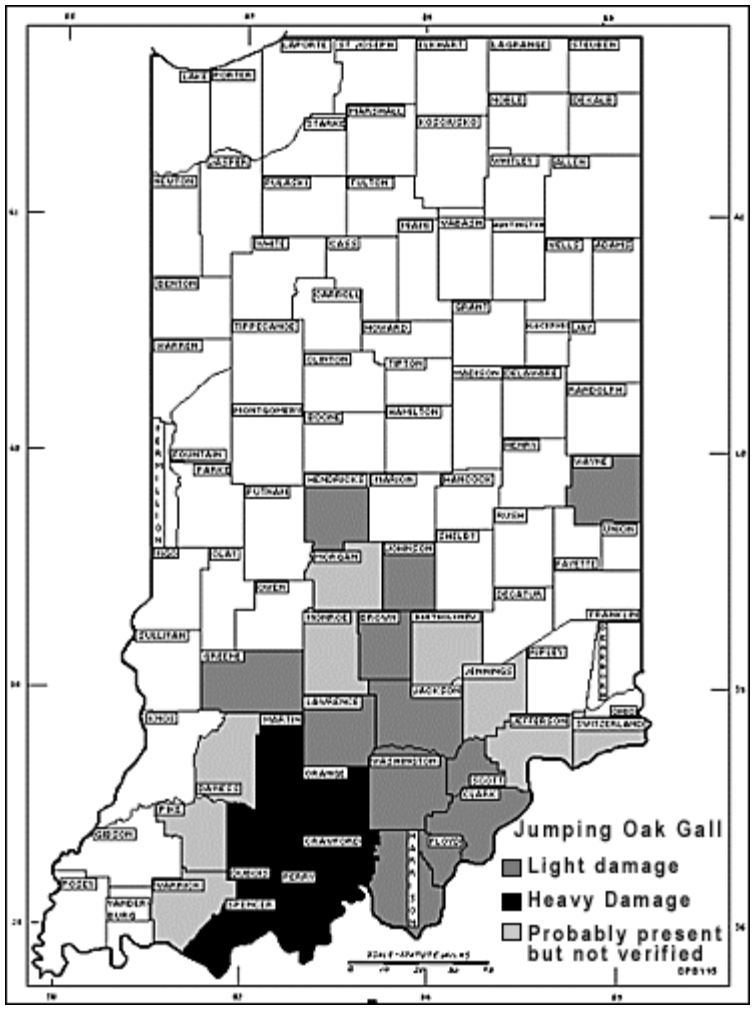

Click here to view full-scale map.

## White Oak Foliage Stays Green, Jumping Oak Gall Disappears

The white oak in the forest of south central Indiana turned brown in color in May and June of 1999 from an epidemic of this gall. As this was the first occurrence of this gall in Indiana's forests, what would happen to white oak in 2000 was unknown. But, it was expected that the wide spread discoloration of foliage would occur again.

In 1999 everyone wanted to know what made the white oak turn brown. In 2000, the question is, why did the gall not attack the white oak again? Only one report of individual trees turning a light brown was received.

The question changes each year. For 2001, what will happen? Will they be back again?




Click here to view full-scale map.

Jumping oak gall forms its gall in late May and early June on the underside of the foliage. One or more species of a Cynipid wasp *(Neuroterus spp.)* form the gall that causes the leaves to yellow than turn brown.

The damage in 1999 started along the Ohio River and went north through Perry County extending to Martin and Lawrence counties and east to Washington County. Additional reports of the gall occurred in the middle part of the state - Johnson, Hendricks and Wayne counties. An aerial survey estimated that discoloration occurred to white oak on 1,000,000 acres of forestland (see map).

The wasp creates a round gall on the underside of the leaf, which results in a small yellow spot that turns brown. With several hundred spots per leaf, eventually the leaf turns totally brown. This is equal to defoliation like the feeding of caterpillars on leaves. The leaf is not able to produce food for the tree and the tree is weakened. With the summer drought adding stress to the tree, the question is what will happen to white oak in 2000. They are expected to survive in a weaker state than normal, and the jumping oak gall is expected to return in 2000 to do damage again.


Galls on leaf caused by jumping oak gall wasp.

## Oak Tatters still present

The tattered foliage of oak has been reported in Indiana since 1983. The tattered foliage of primarily white oak, and other oaks (burr, swamp white, red,

black and shingle), was noticeable again in 2000 to scattered trees. Overall, damage was light to the white oak population.


Tattered leaves with veins remaining.

Tattered foliage loses the tissue between the leaf veins, which gives the leaf a "tattered appearance". Heavily tattered trees appear defoliated or with sparse foliage. Commonly found on white oak, tatters occurs on other oaks and occasionally on other hardwoods. Although defoliation to the tree, damage such as mortality has not been widespread.

Tatters occur to the first flush of foliage in the spring. To date, the cause of tatters has not been verified, however temperature injury, insect feeding or oviposition, and herbicide have been suggested as causes. Tatters is not limited to Indiana, damage has occurred from Ohio west to Iowa.

## Eastern Tent Caterpillar Strips Black Cherry

Black cherry trees in southern Indiana were stripped of their leaves in May. For the first time since forest pest conditions have been recorded, eastern tent caterpillar was at epidemic levels causing moderate to severe (100%) defoliation to black cherry in southern and south central Indiana. Defoliation occurred to trees primarily along the roads and in fence rows, but also occurred on yard and forest trees. No acres of defoliation were estimated as black cherry is a small component of the forest. However, every acre where black cherry resided had moderate to severe defoliation to all age of trees from saplings to timber size trees. occurred on yard and forest trees. No acres of defoliation were estimated as black cherry is a small component of the forest. However, every acre where black cherry resided had moderate to severe defoliation to all age of trees from saplings to timber size trees.


Eastern tent caterpillar and nest.

## White Pine Randomly Die

Procera Root Rot (White Pine Root Decline) has been noticeably killing white pine across the state for the past 10 years. In 2000, it continued to kill wind break, yard and plantation trees. This disease is the most common forest pest that landowners request assistance. Thus from this 10 year history, the disease has the status of the number one disease in Indiana, as it is killing more trees than any other forest pest.

Trees from 4 to 30 feet tall and 3 to 6 inches in diameter are commonly killed. Trees can turn brown in color at any time of the year, but do so more commonly in the spring and fall. Infected trees appear light green and sparse or thin at first. Then the trees

Declining sapling caused by Leptographium procerum.

turn brown in a short period of time. Most landowners do not recognize the early symptoms of the disease. They usually see the dead brown tree and sawdust from woodborers that attack the dead tree.

## Regional Issues

**The distribution of Pine Shoot Beetle**, *Tomicus pineperda*, continues to move through the state with 8 new counties added to the quarantine area. This is still a regulatory pest and not considered a serious threat to the health of the pine forests of the state.

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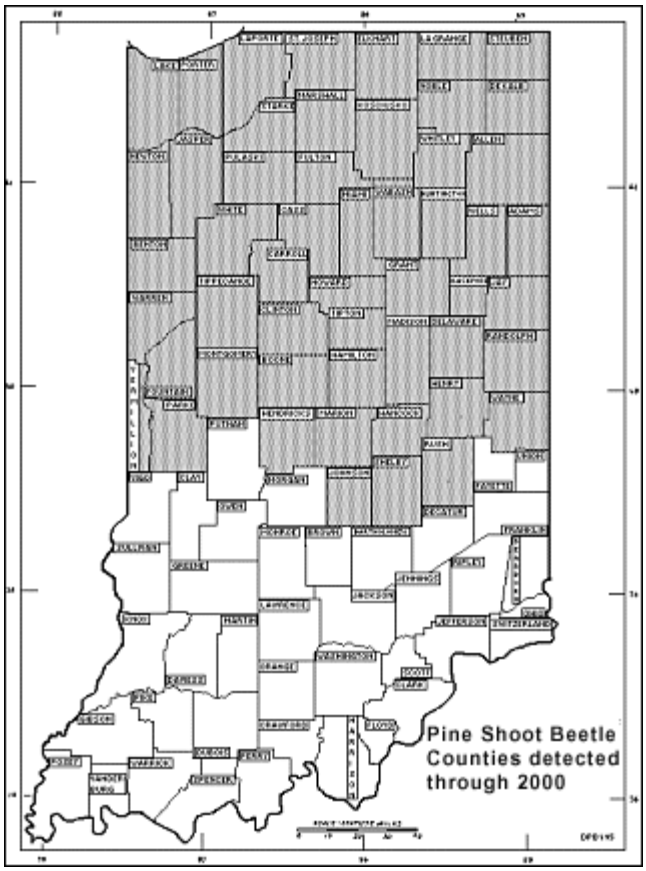
Pine shoot beetle mining the pith.




Click here to view full-scale map.

**Butternut canker** affects trees throughout the state. During the past five years, landowners have reported butternut trees that may be tolerant or resistant to the disease. From these reports, nine butternut were

located that may have possible resistance/tolerance to this disease Scionwood was collected from these trees and grafted onto black walnut. Reports of butternut continue each year; however work limitation have slowed the screening of the reported trees. Landowners are still encouraged to locate and report healthy butternut.


Wedge-shaped butternut canker.

## Forest Health Monitoring Survey

In 1996, Forest Health Monitoring (FHM) established 144 plots across the state. Of these, 38 plots had a forest condition. The FHM plot consists of 4 subplots with each subplot a fixed radius of 24 feet. FHM plots are located according to a national survey grid and are approximately 16 miles apart.

The information collected in the FHM survey is part of a national design. Thus, results of the survey are used to make comparisons and analysis on a national or forest type basis. Using the data to make analysis within state boundaries is not statistically sound as this time. However, the baseline data can give a "snapshot" of the trees and forests in Indiana at the start of the annual FHM survey.

On each subplot, information is taken on all trees 5.0+" DBH. A microplot is used to collect information on seedlings (<1.0") and saplings (1.0-4.9"). The tree information collected consists of crown and damage measures. Crown measures are live crown ratio, crown density, foliage transparency, dieback, crown position, crown exposure and crown diameter.

The **crown measures** of foliage transparency, crown density, dieback and live crown ratio can be used to access the tree's "health". Trees with **low** foliage transparency and dieback values and **high** crown density and live crown ratio have increased potential for carbon fixation, nutrient storage, survival and reproduction.

Using these measures and making comparisons between years, the FHM survey should identify a problem with a tree species or forest type. Once identified, a problem can be evaluated on a more localized basis to understand the problem and define management measures. The information below summarizes the survey findings.

For **foliage transparency,** which is used to indicate defoliation, the survey found 97% of the hardwoods and 92% of the softwoods had normal transparency (<30%). Only maple, oak, elm and ash had any trees with moderate to severe transparency (30-50% & >50%).

| Foliage Transparency | | |
|---|---|---|
| | % Normal: <30% | % Moderate/ Severe: >30% |
| Hardwoods | 97 | |
| Softwoods | 92 | |
| Maple | | 0.9 |
| Elm | | 2.0 |
| Oak | | 2.5 |
| Ash | | 6.5 |

**Dieback** is the amount of

| | Hardwoods (%) |
|---|---|
| No Dieback | 84 |
| Light Dieback (6-20%) | 13.7 |
| Moderate/Severe (21-50% & >50%) | 1.6 |

current years twigs that have died in the outer tree crown. No dieback was found on 84% of the hardwoods and 96% of the softwoods. Light dieback (6-20%) was observed on 13.7% of the hardwoods. Moderate to severe dieback (21-50% & >50%) was recorded on 1.6% of the hardwoods. By genus/species, Oak, elm, maple, ash and yellow poplar had the most dieback recorded.

**Crown density** is the amount of foliage, twigs, branches, and seeds in the crown. The survey found 98.7% of all trees had average to good density (21-50% & >50%). Only hardwoods - elm, yellow poplar and black walnut - recorded trees with poor density (<20%). By genus/species, ash, aspen, and beech had more trees with average density than a good density. Maples had the highest percent of trees with good density for the hardwoods.

| Genus/species | Average (21-50%) | Good (>50%) | Genus/ species | Average (21-50%) | Good (>50%) |
|---|---|---|---|---|---|
| Sweetgum | 16.7 | 83.3 | Elm | 38.8 | 57.1 |
| Maple | 22.5 | 77.5 | Oak | 48.2 | 51.8 |
| Yellow poplar | 22.7 | 75.0 | Beech | 53.8 | 46.2 |
| Walnut | 25.0 | 68.8 | Ash | 57.6 | 42.4 |
| Basswood | 33.3 | 66.7 | Aspen | 62.5 | 37.5 |
| Hickory | 37.7 | 62.3 | Other | 46.1 | 50.8 |

For hardwoods, 64% of the trees had **Live Crown Ratios** greater than 40%; whereas the softwoods had 87% of the trees greater than 40%. Examining individual genus/species, there may be concern with ash, yellow poplar, black walnut and elm that had 40%, 58%, 57% and 66%, respectively, of the trees sampled with LCR >40%. This may indicate a problem in the "health" of this genus/species.

| Live Crown Ration (Percent of Trees) | |
|---|---|
| | LCR >40% (%) |
| Hardwoods | 64 |
| Softwoods | 87 |
| Ash | 40 |
| Yellow poplar | 58 |
| Black Walnut | 57 |
| Elm | 66 |

**Damage indicators** are cankers, open woods, decay conks, broken bole, brooms, dead terminals, discolored foliage and more. Decay indicators represented 70% of the damages recorded. The survey found no damage on 70% of the hardwoods and 91% of the softwoods. By genus/species, of all trees sampled, maple, ash, oak, hickory, elm, yellow poplar and beech had damage recorded more than other species. Within a genus/species, beech, maple and ash had the highest percentage of trees with damage. In the hardwoods, 8% of the trees sample had more than one damage.

From the initial data, the "health" of ash, yellow poplar, elm and perhaps maple and oak in Indiana needs to be monitored for future change. The live crown ratio, crown density, crown transparency and crown dieback data for these genus/species indicate they may have a greater

"health" concern than other genus/species

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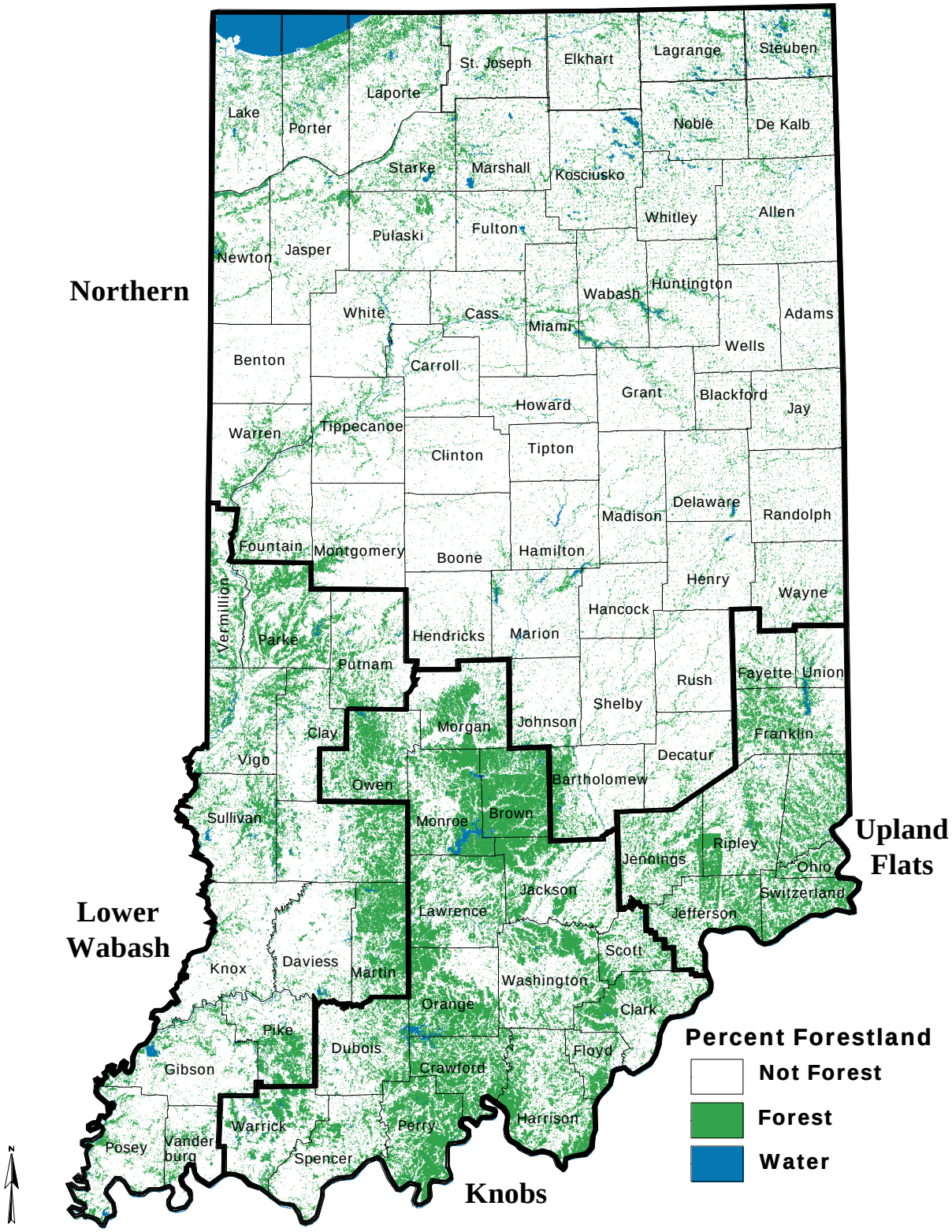
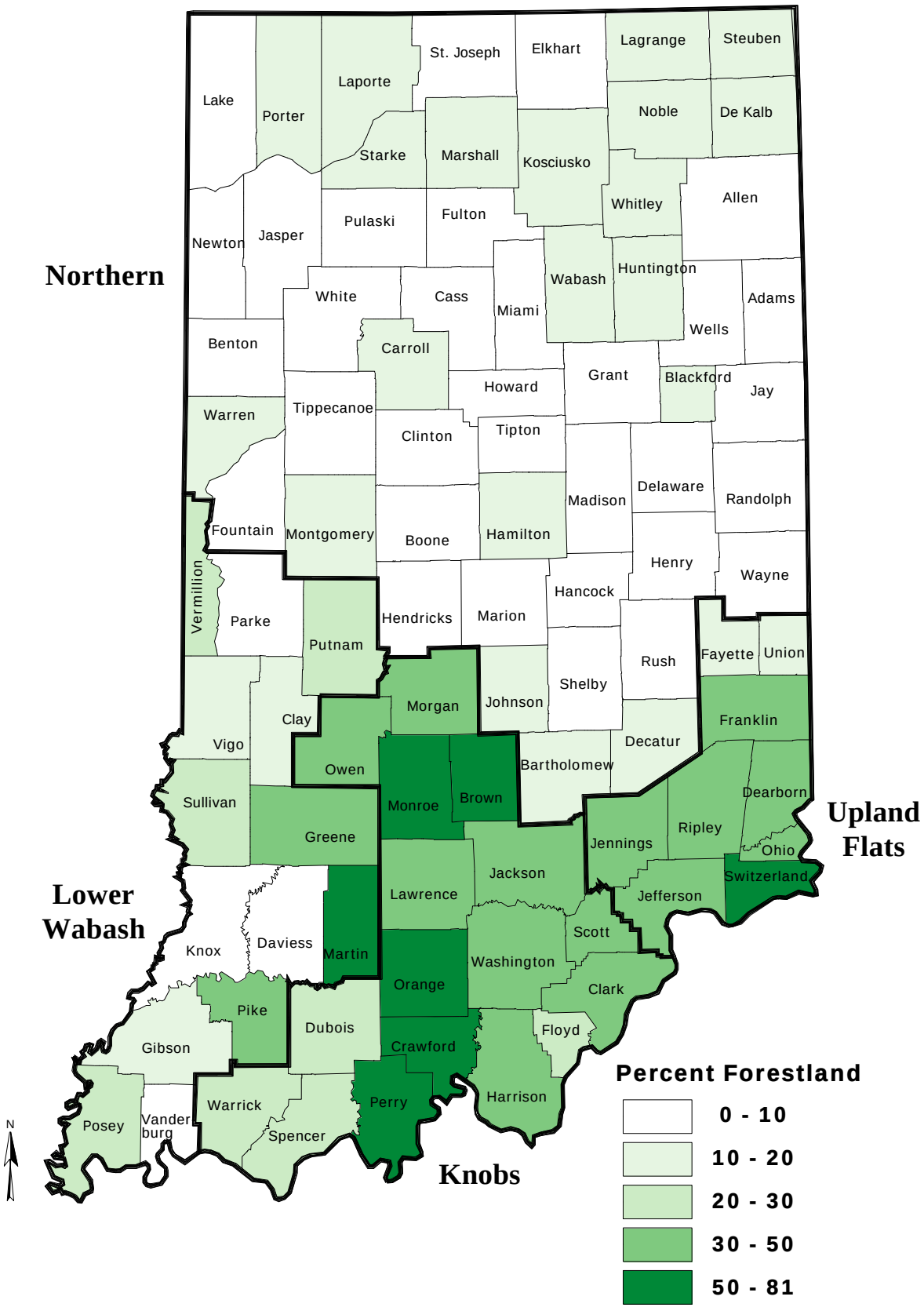
# Indiana Forests




Source:
Indiana Land Cover produced by a cooperative project between the U.S. Geological Survey and the U.S. Environmental Protection Agency based on Landsat TM5 Imagery acquired by the Multi-resolution Land Characterization (MRLC) Consortium. The images date from 1989 to 1993. Classes, 41 - 43 and 91 were used to represent Indiana's forests.

# Percent Forestland by County 1998




**Source: NC-FIA Indiana 1998**