Invasive Insects Threatening Our Forests in Pennsylvania

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Oak Foliage Pest

- Is this “shot-hole” feeding injury caused by a leaf-eating caterpillar?
- If it’s not, what is the causal organism of this damage?

Oak Foliage Pest

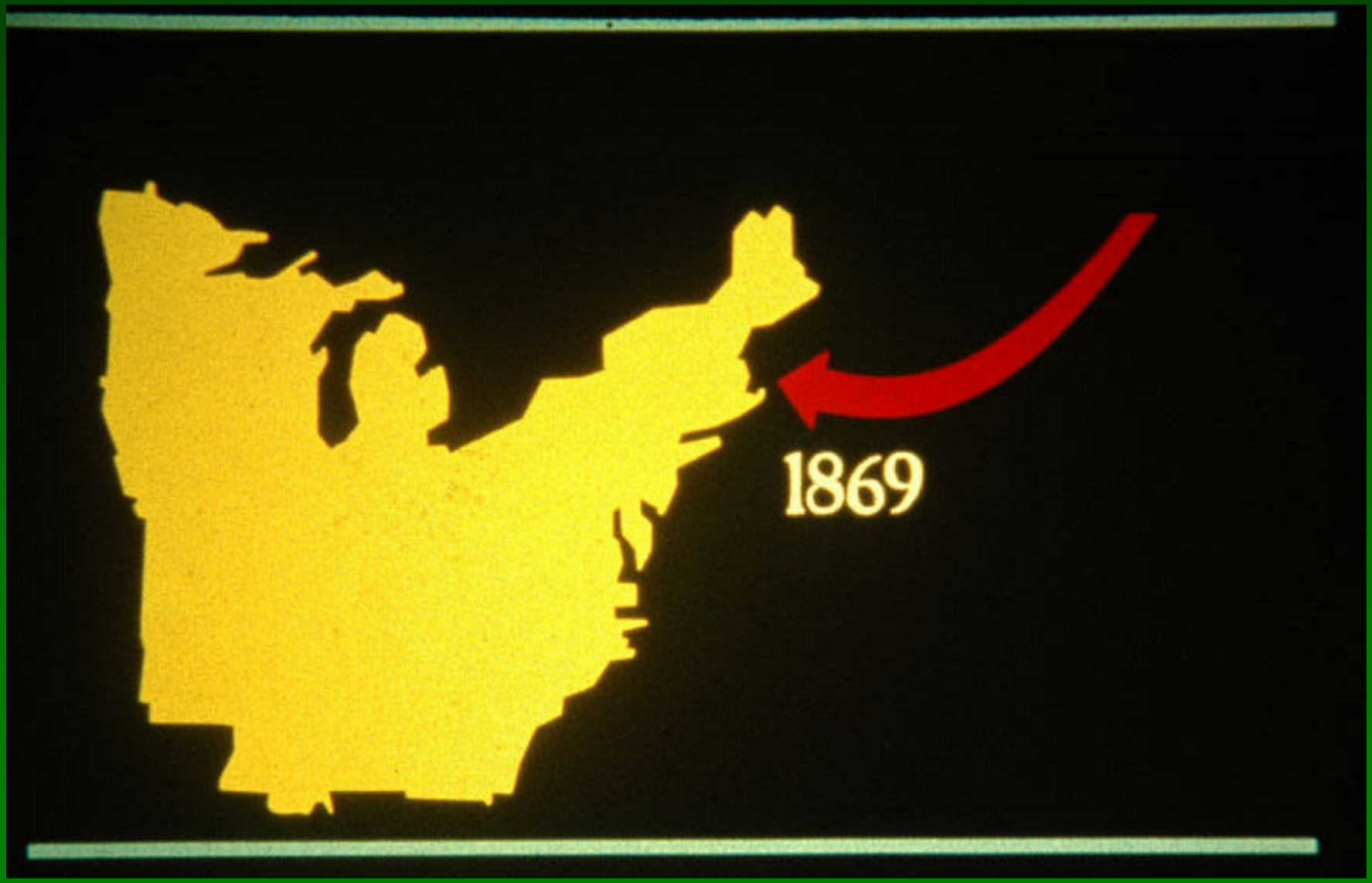
- This “shot-hole” injury is caused by the leafmining fly, *Agromyza viridula*
- The adults are active very early in the growing season when the foliage is quite small

Gypsy Moth

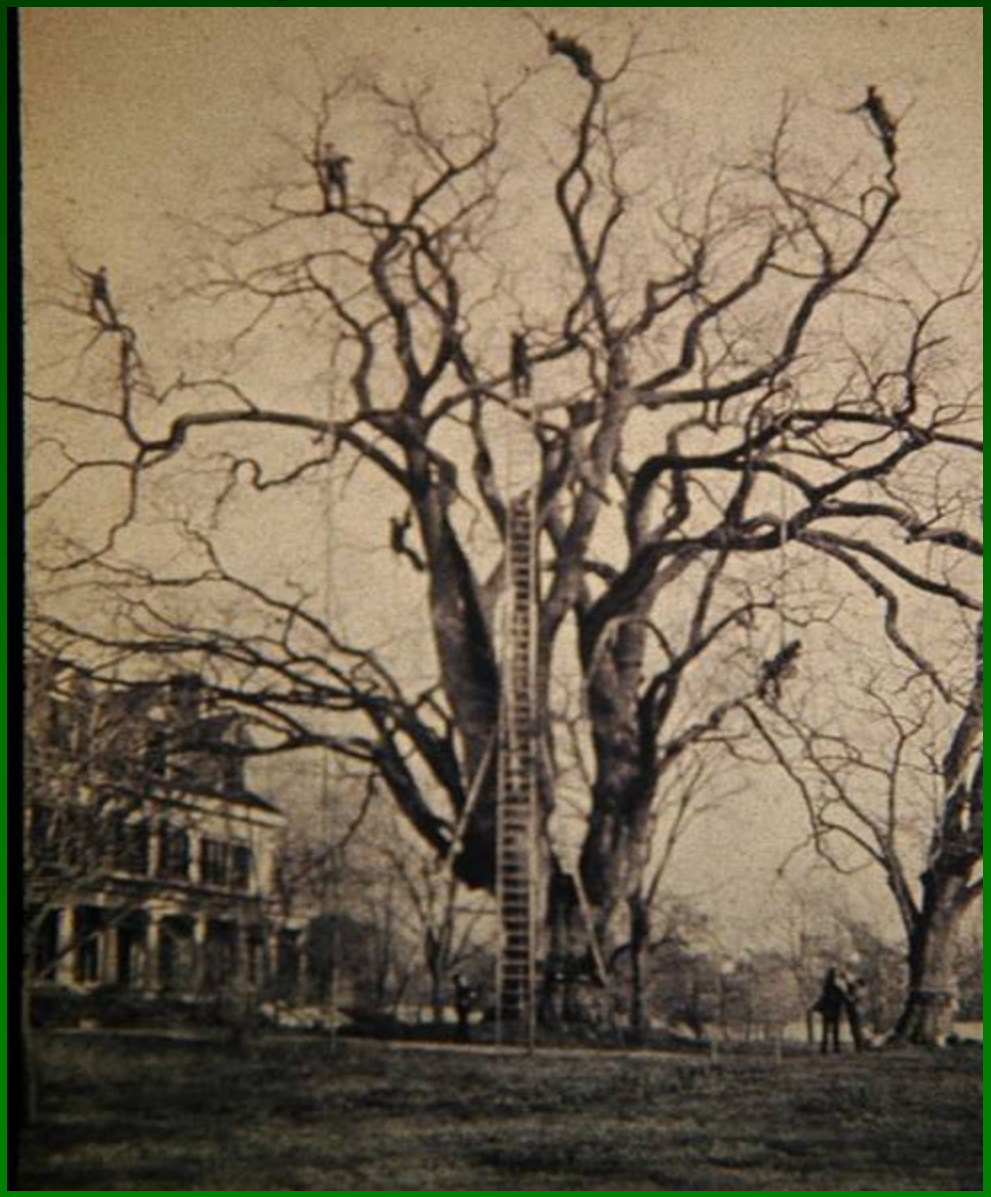
Gypsy Moth

females laying eggs

Gypsy Moth



Gypsy Moth

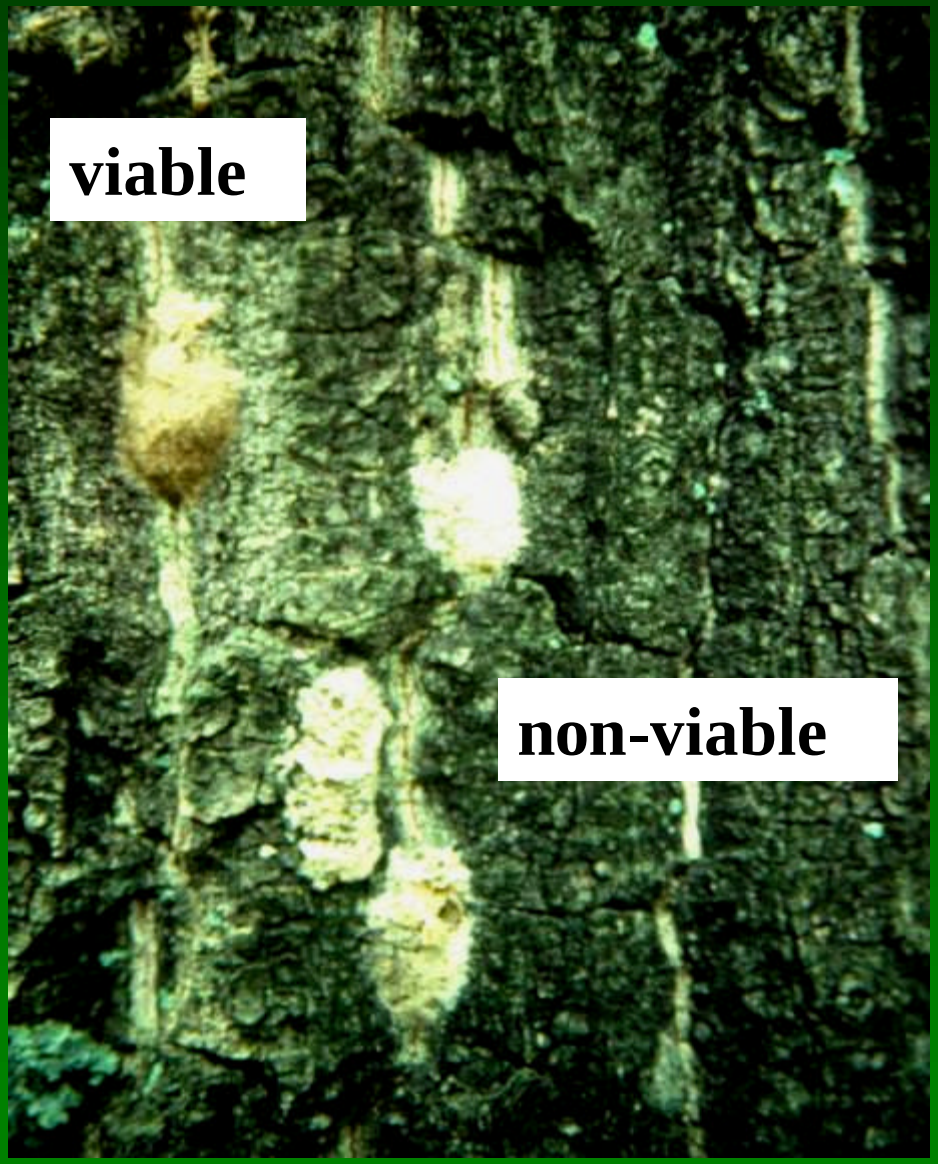


Gypsy Moth

Gypsy Moth

How many viable egg masses do you see?

Gypsy Moth



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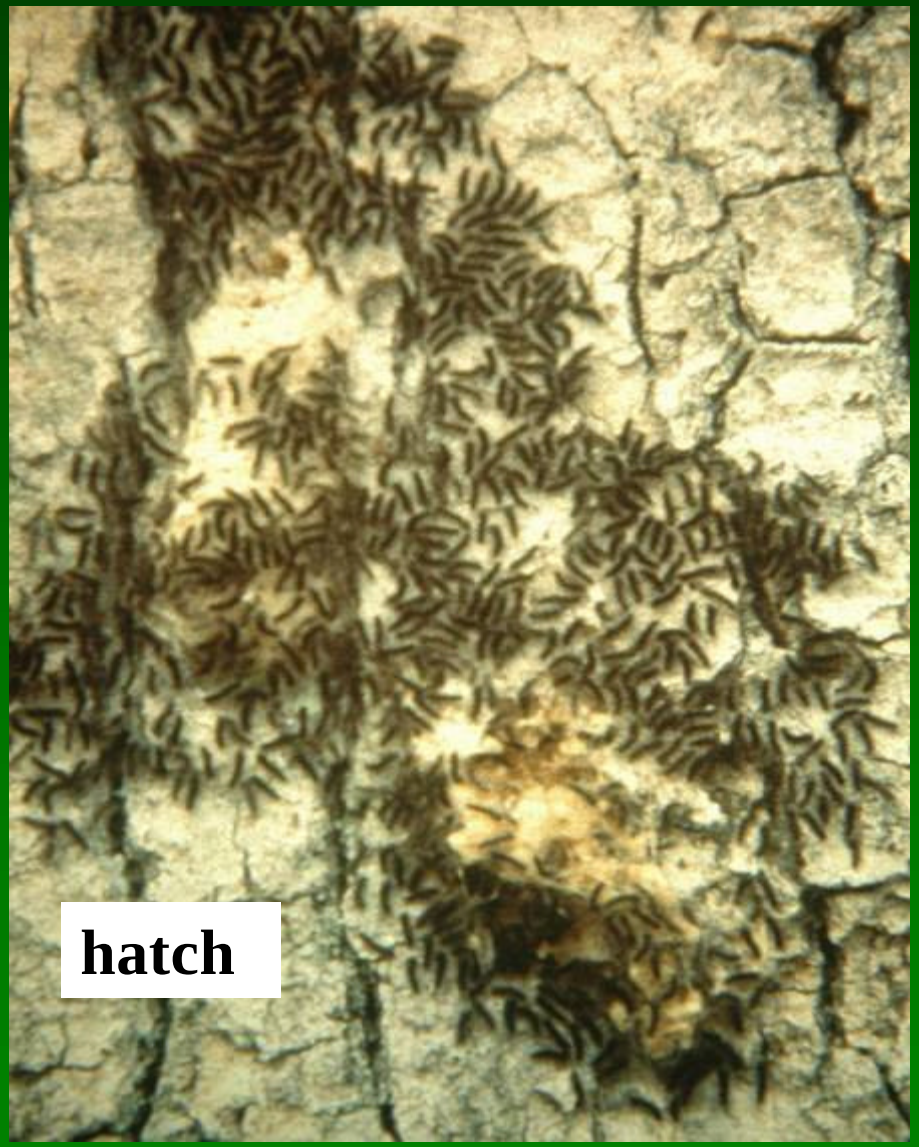

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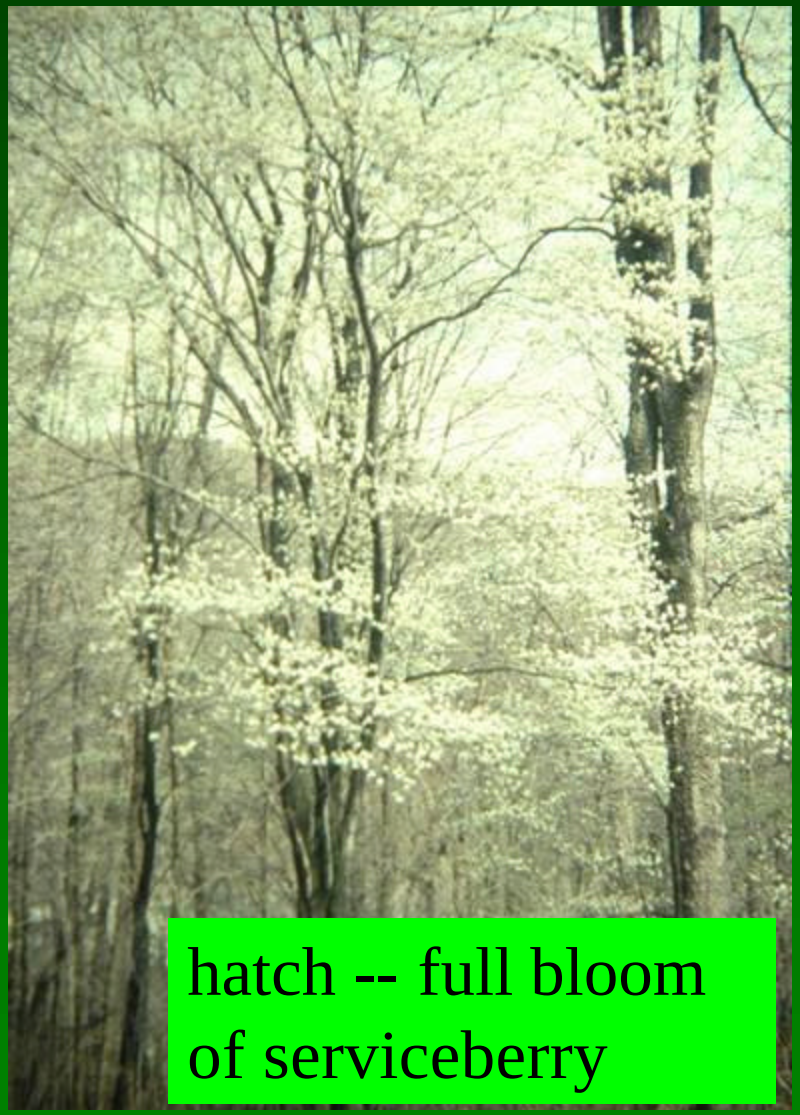

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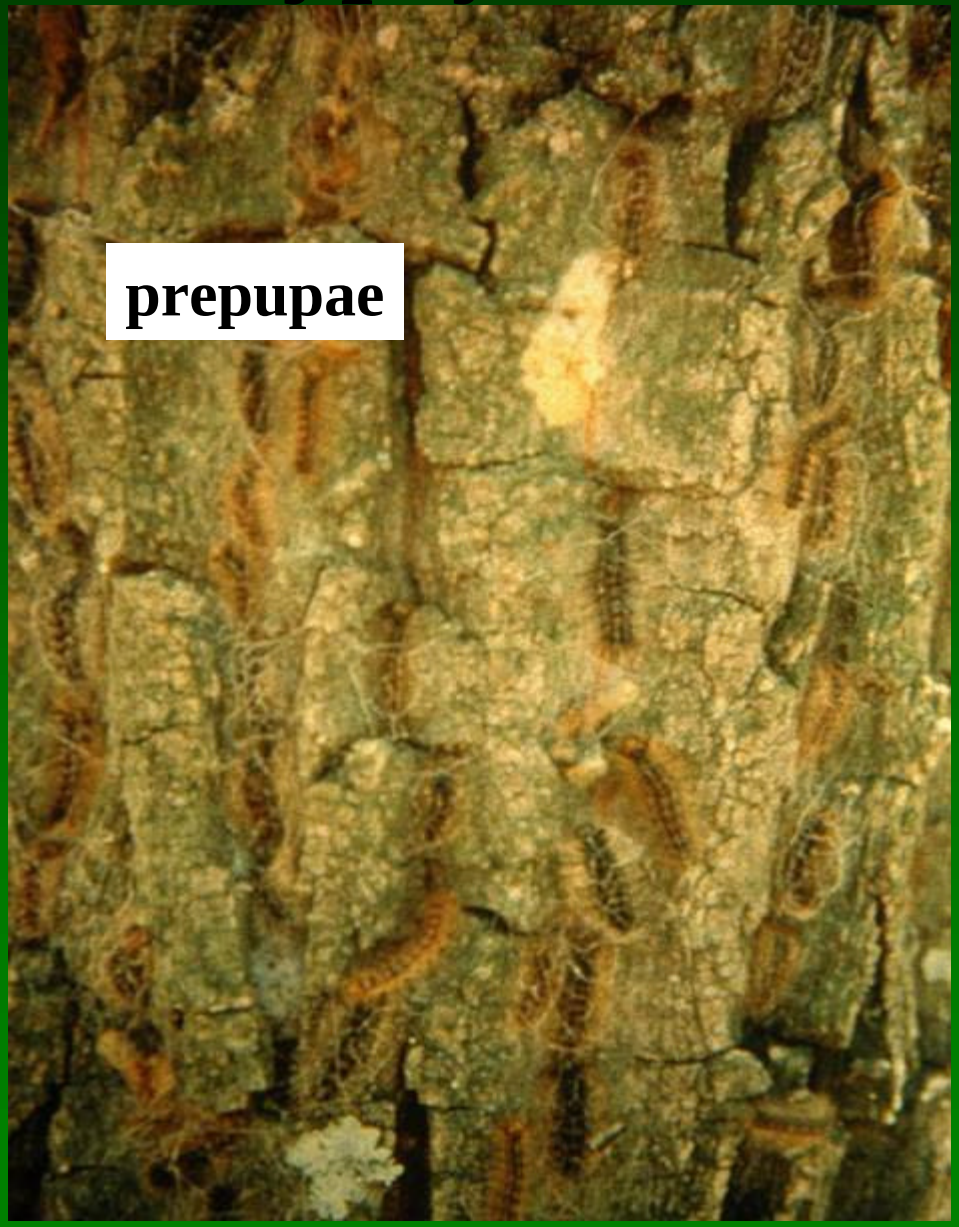

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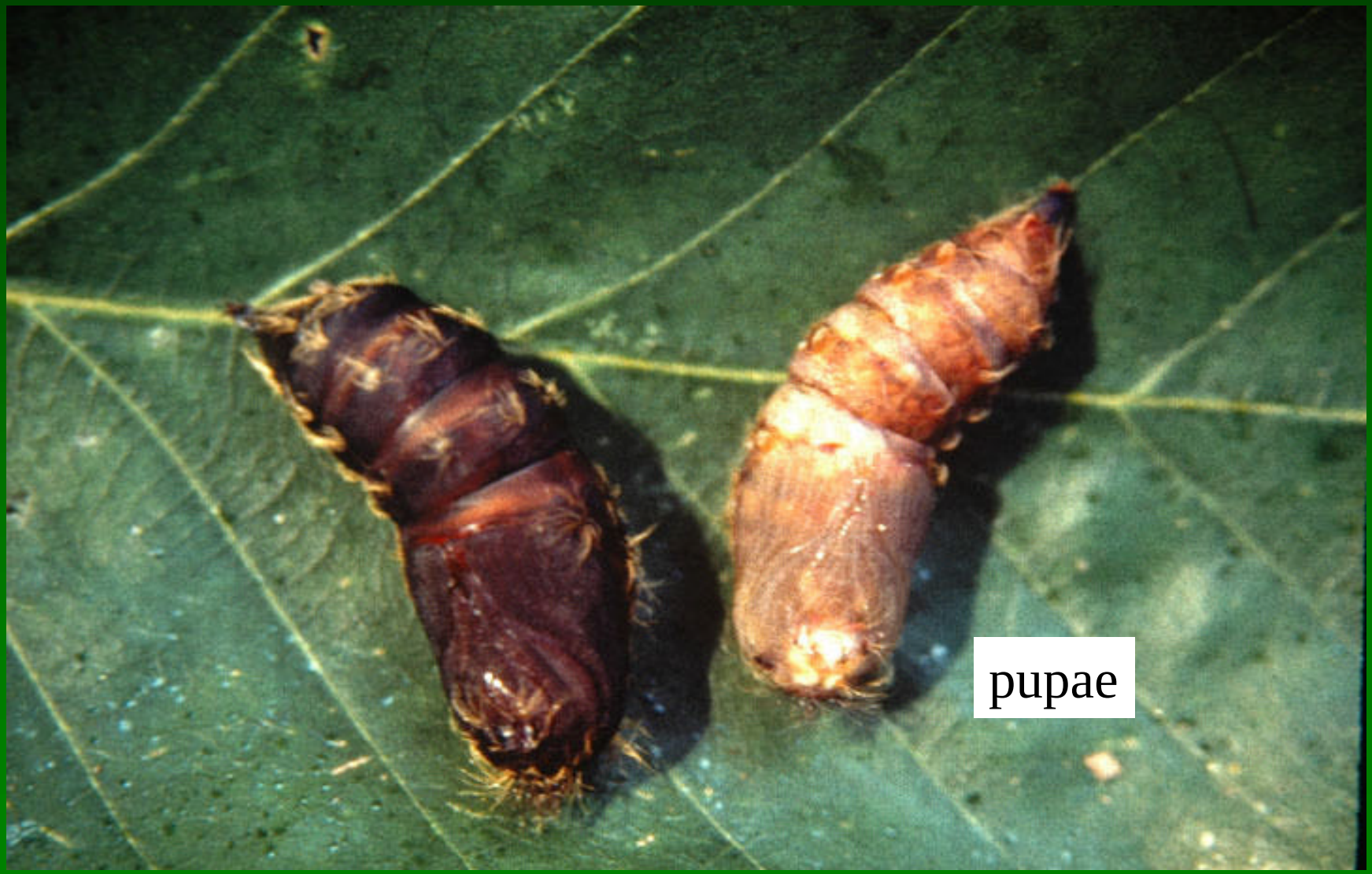

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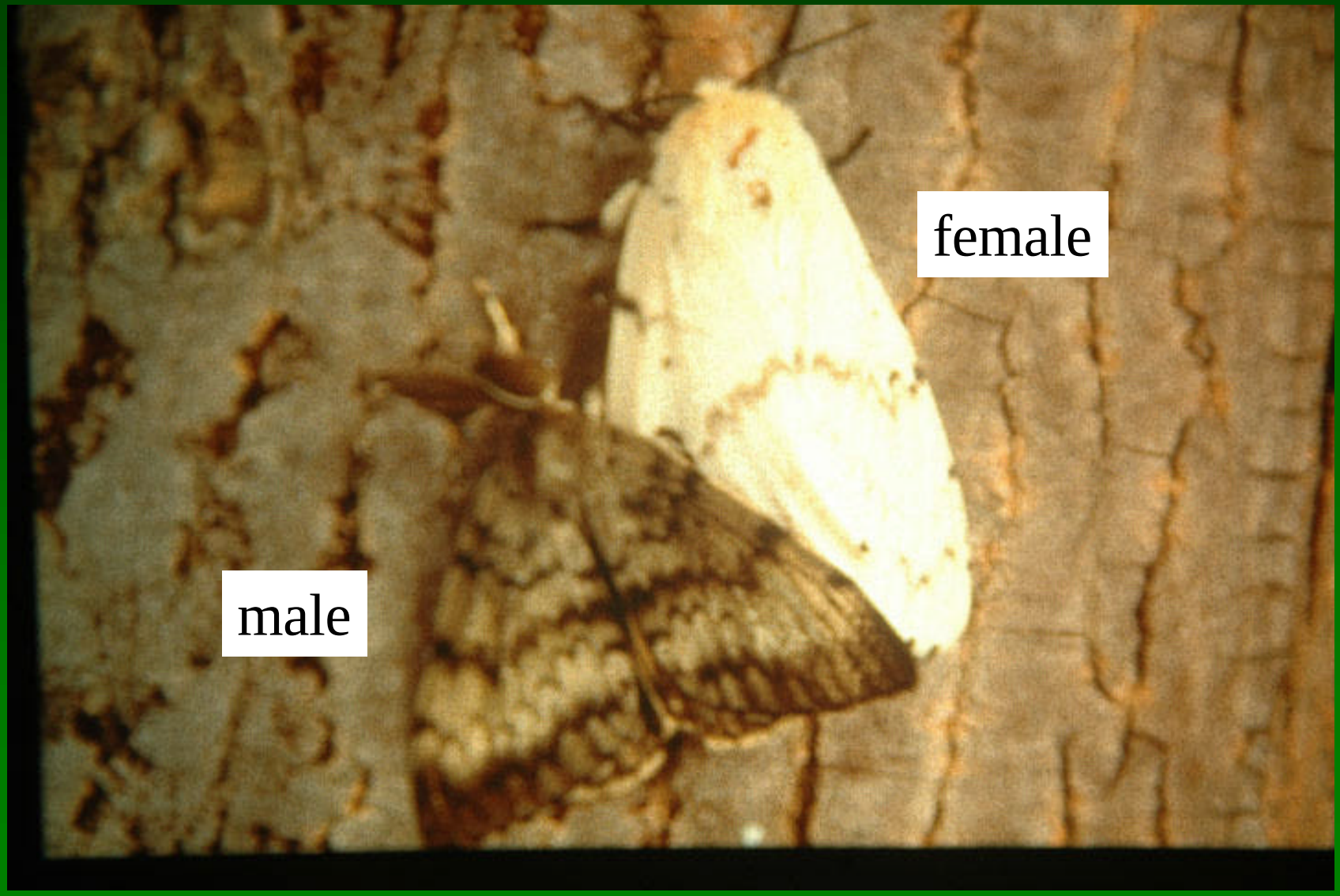

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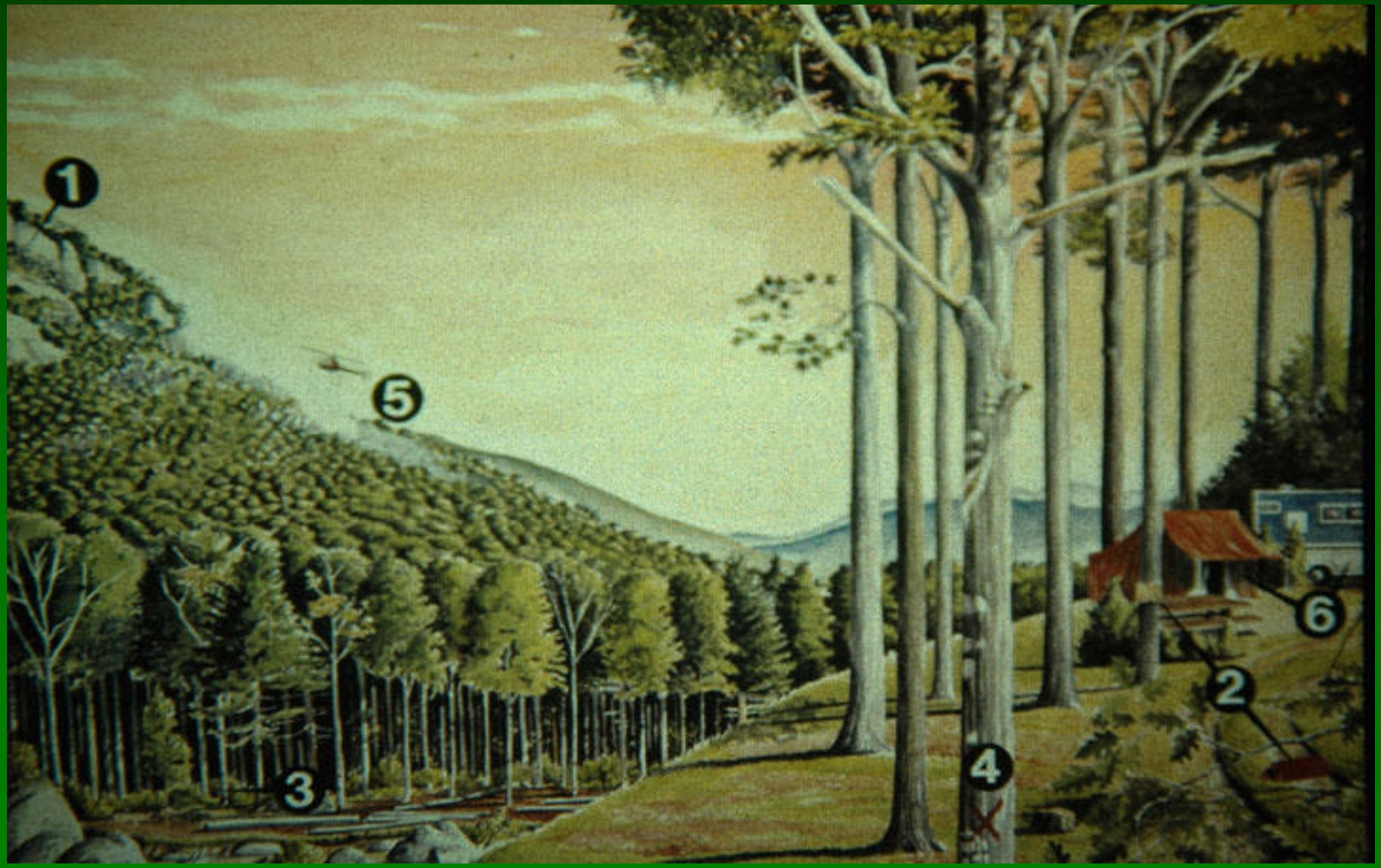


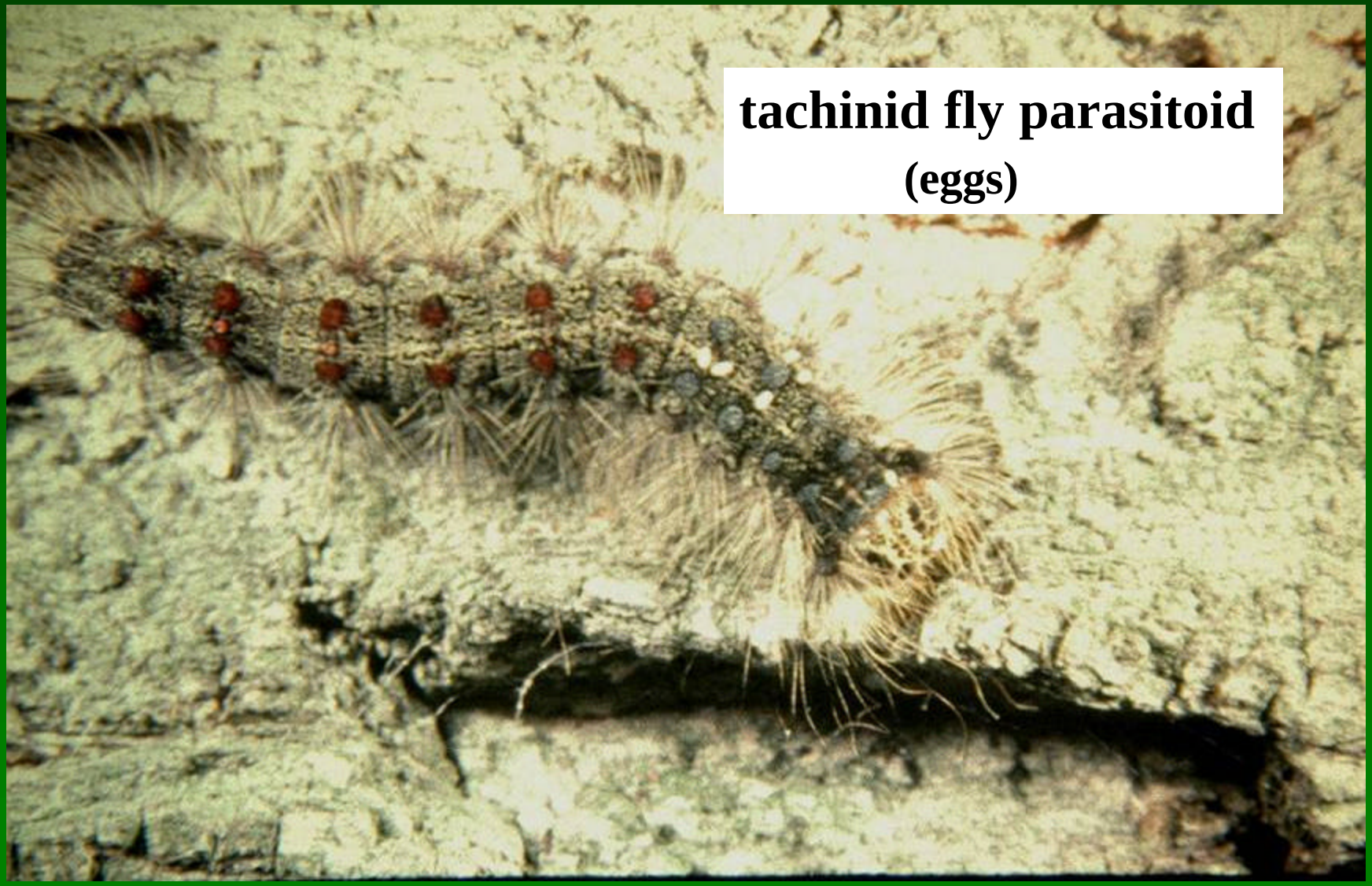
Gypsy Moth

“Biocontrol Agents”

An introduced wasp parasitoid, *Ooencrytus kuvanae*, that lays its eggs in the eggs of the gypsy moth (30-40% parasitism)

Adults are active when air temperatures are around 50° F

Gypsy Moth



Gypsy Moth

"Biocontrol Agents"

The wheel bug, *Arilus cristatus*; feeds on leaf-eating caterpillars

Gypsy Moth

“Biocontrol Agents”

An insect pathogen causing mortality of the gypsy moth in the larval stage

What Species of Scale Insect is Pictured Below?

- The host plant is oak
- You'll observe these on the host in early spring before new growth occurs

What Species of Scale Insect is Pictured Below?

The correct diagnosis is …

“katydid eggs”

Emerald Ash Borer (EAB) -

History of the EAB

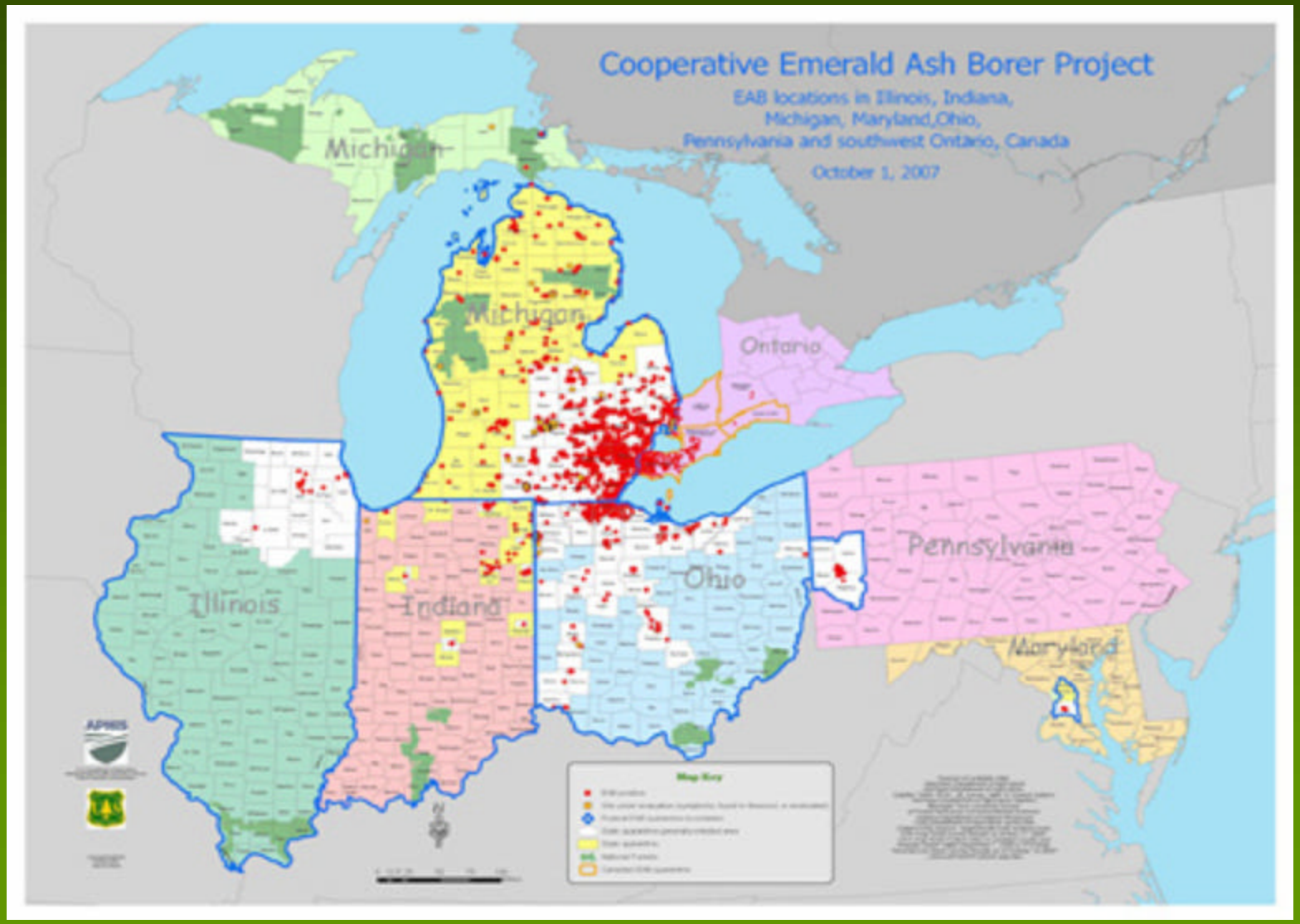
- First identified in southeastern Michigan in July 2002
- Evidence suggests that EAB had been established in Michigan for at least six to ten years
- Early on more than 3,000 mi^2 were infested with EAB in southeastern Michigan
- As of 2007, the total EAB-infested area in the US exceeds 40,000 mi^2

Emerald Ash Borer (EAB) -

History of the EAB

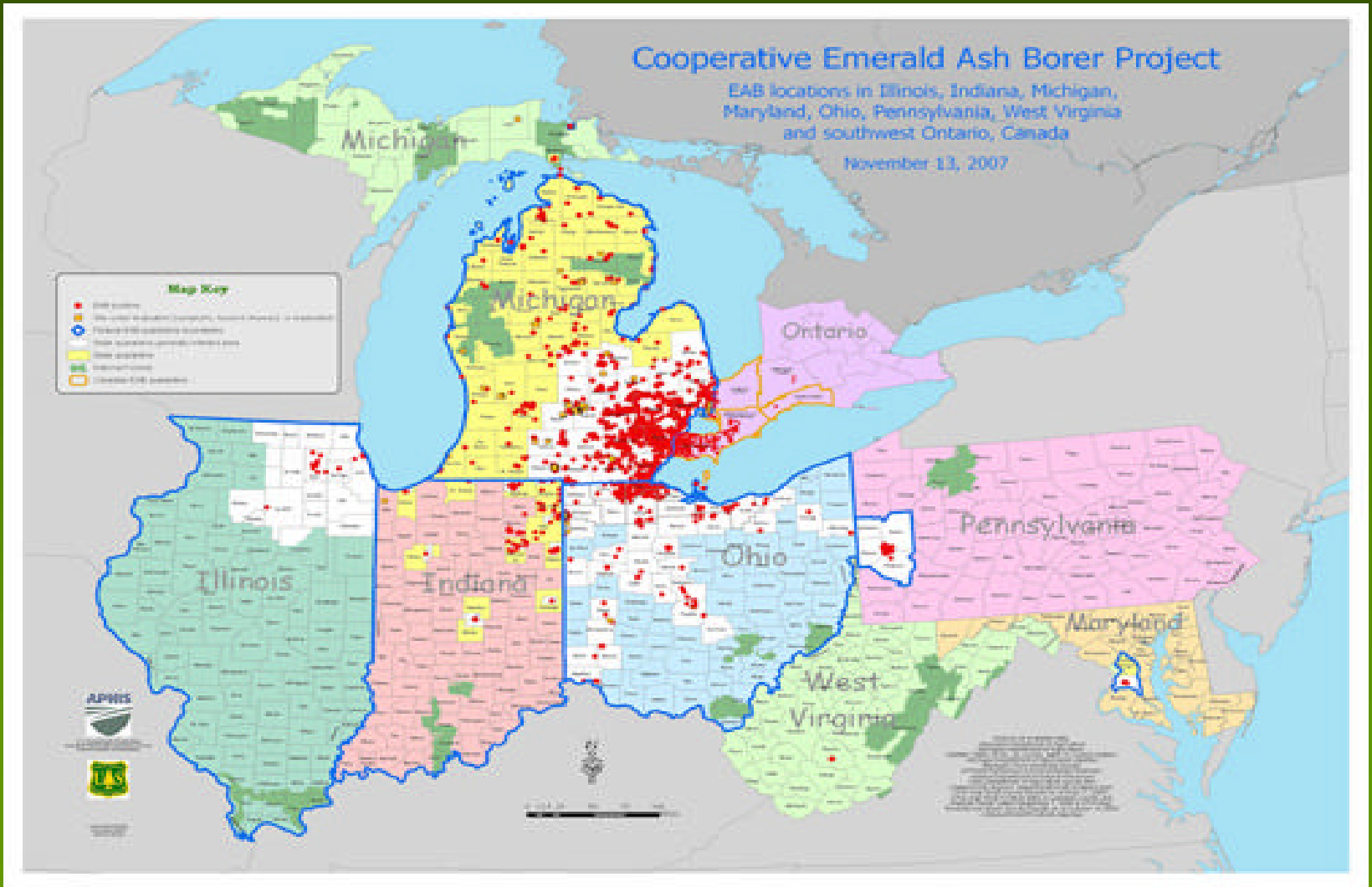
- Prior to 2006, EAB was known to be established in Michigan, Indiana, Ohio, and Ontario, Canada
- In August 2006 it was detected for the first time in Illinois
- In 2006 EAB was detected again in MD where it had entered the state in 2003 on infested nursery stock which was quarantined and destroyed
- Since 2002 more than 40 million ash trees are dead or dying from attack by the EAB

Emerald Ash Borer (EAB)



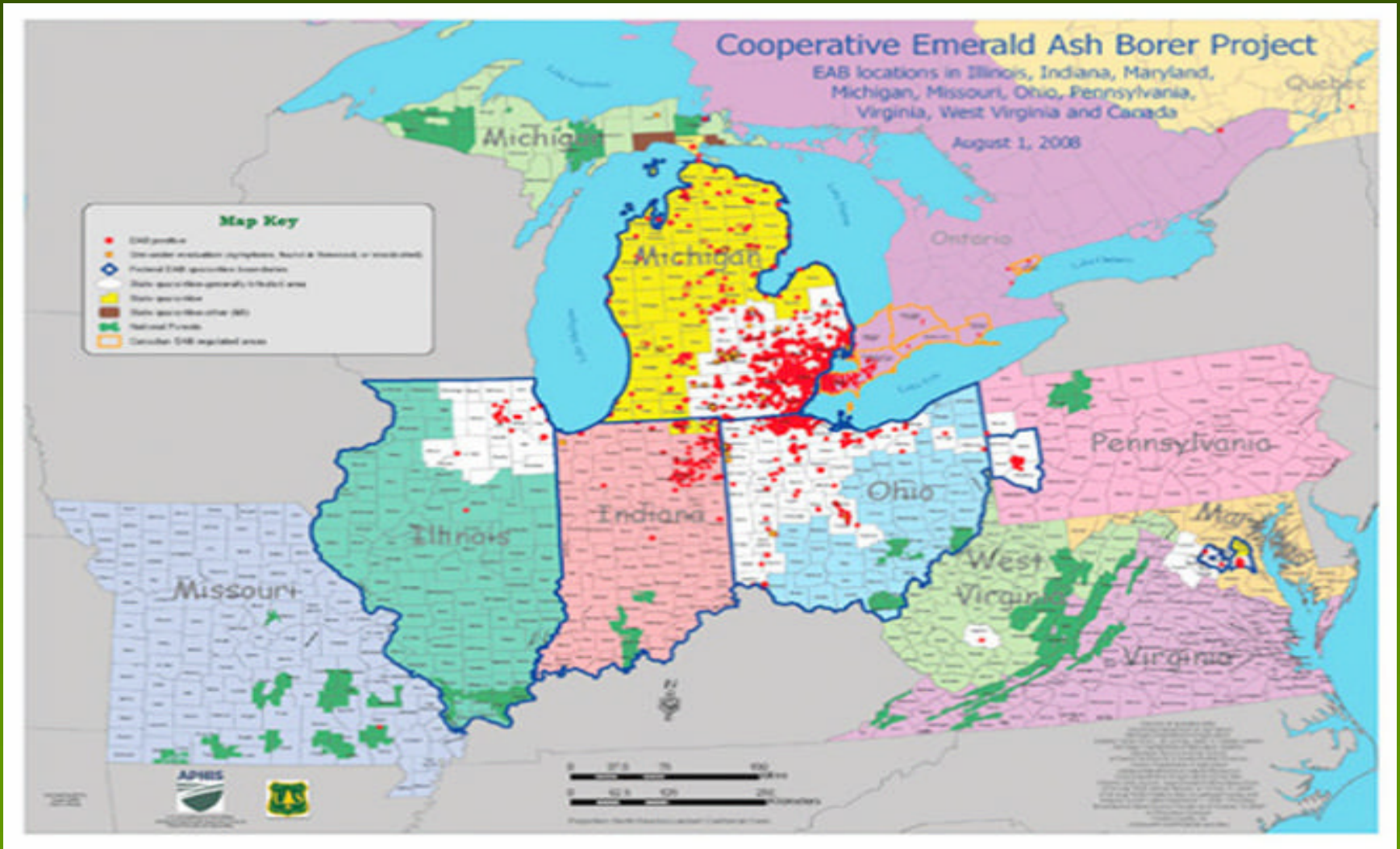
Emerald Ash Borer (EAB)

EAB found in southern West Virginia in October 2007



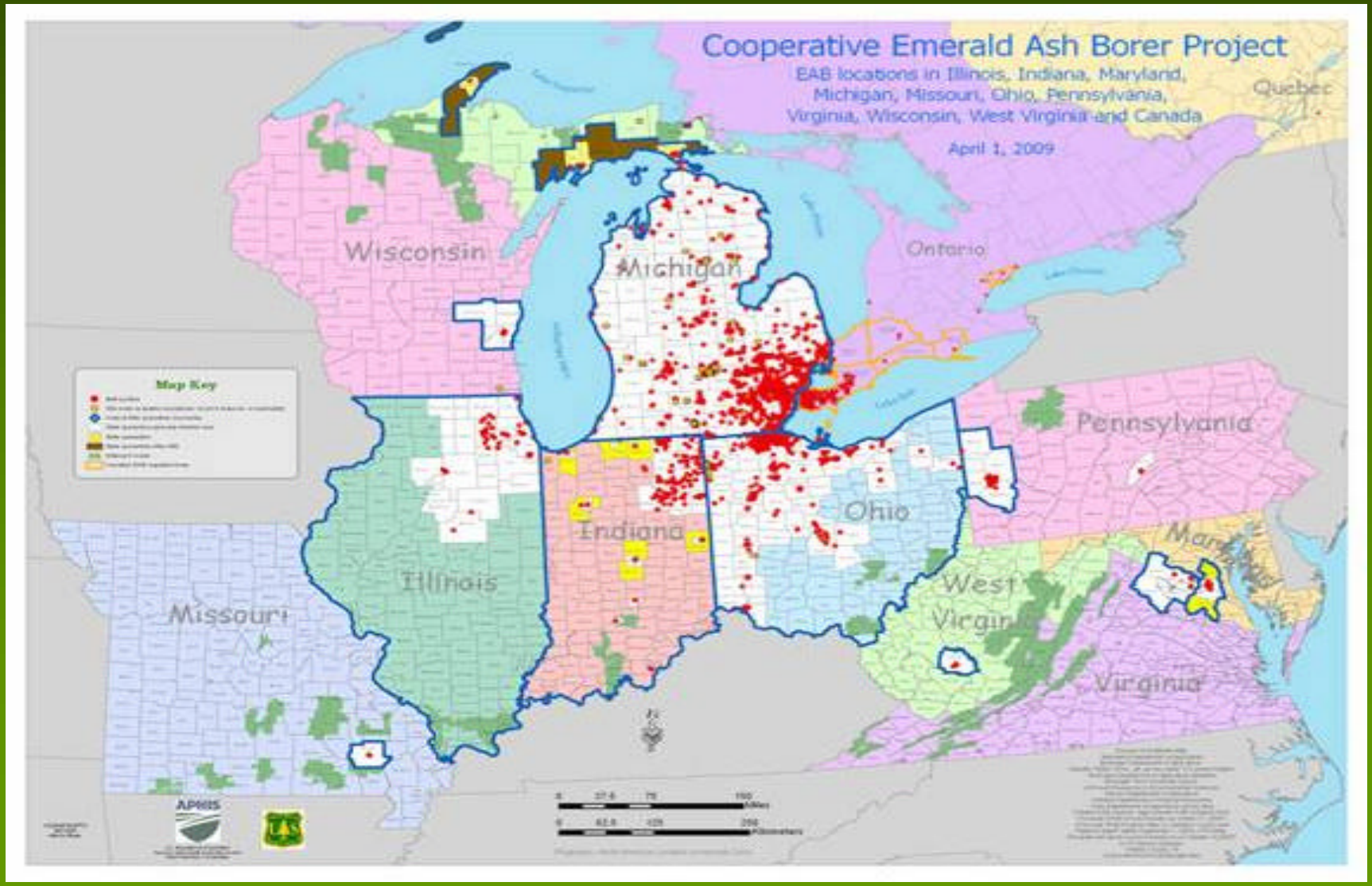
Emerald Ash Borer (EAB)

Mercer Co., PA 2008



Emerald Ash Borer (EAB)

Mifflin Co., PA -- February 2009



Emerald Ash Borer (EAB) -

- History of the EAB in the US
- Economic impact of EAB in the US

Emerald Ash Borer (EAB) -

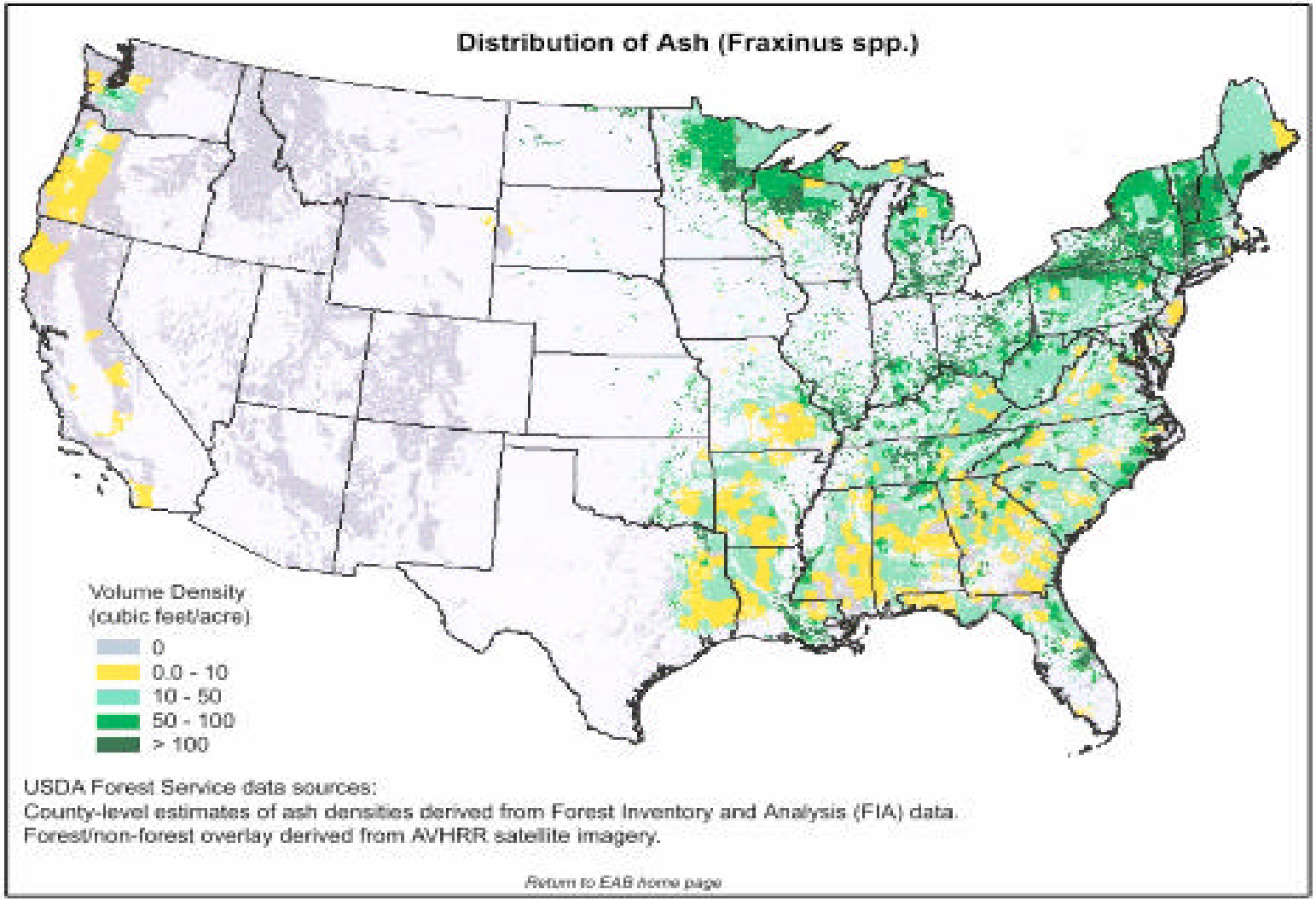
Economic impact

- EAB poses a significant threat to North America's ash resources
- EAB arrived with no known natural enemies in North America
- Control tactics are limited with tree removal being a principal control option
- EAB infests and destroys native and landscape ash trees, resulting in the loss of millions of dollars to the forest products and nursery industries
- EAB will cause damage to forest ecosystems due to the loss of ash species, impacting biodiversity and wildlife

Emerald Ash Borer (EAB) -

Economic Impact

Emerald Ash Borer (EAB)



Emerald Ash Borer (EAB) -

Economic impact

- Nearly 114 million board feet of ash sawtimber with a value of $25.1 billion is grown in the eastern United States
- In Pennsylvania ash accounts for 5% of timber production
- White, black, and green ash are widespread in the forests of the eastern United States and Canada, comprising over 7% of hardwood species and 5.5% of all species
- The wood is used for a variety of applications including tool handles, baseball bats, furniture, cabinetry, solid wood products, packing materials, pulp, and paper

Emerald Ash Borer (EAB) -

Economic impact

- Ash is an extremely popular landscape tree because of its tolerance to poor planting conditions -- it was planted widely in many states to replace elms lost to Dutch elm disease
- The spread of EAB could have an enormous impact on the U.S. nursery industry, municipal governments, and individual homeowners
- With median approximate values ranging from $50 to $70/tree, the ash nursery stock crop is worth between $100 and $140 million annually
- The USDA estimates the EAB's potential impact to the national urban landscape would be a loss of 0.5-2% of the total leaf area (30-90 million trees) with a value of $20-$60 billion

Emerald Ash Borer (EAB)

Early Detection Efforts -- in PA

- In 2003 the PA Emerald Ash Borer Task Force is established
- Task force is comprised of individuals from federal and state agencies
- Discusses and implements monitoring and trapping protocols for the EAB at sites in PA
- Develops the EAB Action Plan for PA

Emerald Ash Borer (EAB)

Early Detection Efforts -- in PA

- In 2006 the PA Dept. of Agriculture and the USDA-APHIS-PPQ established ash trap trees
- Trap trees are ash trees that are intentionally injured to attract any EAB adults that might be in the area
- Trap trees were established along the western inbound lanes of Interstates 90, 80, and the Pennsylvania Turnpike
- The PA Bureau of Forestry also established trap trees in state forest land, state game lands, and along I-79, furthering our coverage of susceptible ash resources

Emerald Ash Borer (EAB)

Early Detection Efforts -- in PA

- The PA Dept. of Agriculture's (PDA) statewide force of plant inspectors targets ash trees for close examination during their regular nursery inspection rounds
- The PDA hires summer interns to conduct visual inspections of ash trees in urban forests and landscapes in areas where we feel that EAB may first appear in the state
- The PA DCNR, Bureaus of Forestry and State Parks conduct the same types of monitoring activities in state parks and state forest lands, and state game lands
- The USDA, Forest Service monitors ash trees on federal land

Emerald Ash Borer (EAB)

"First Detection in Pennsylvania"

- An adult emerald ash borer was collected on June 22, 2007 from a green ash tree in a non-residential landscape in Butler County, Cranberry Township, Pennsylvania
- On June 27, 2007 the Pennsylvania Department of Agriculture issued a quarantine for Allegheny, Beaver, Butler, and Lawrence Counties in western Pennsylvania

Emerald Ash Borer (EAB)

Emerald Ash Borer (EAB)

Local News
COVERAGE CLOSE TO HOME • EDITORIALS • Pittsburgh Post-Gazette • THURSDAY, JUNE 28, 2007

Little bug, big worries in Cranberry

State acting quickly to squash any threat from emerald ash borer

An adult emerald ash borer. The bug is shown at five to seven times its actual size, which is about that of a penny.

By Dan Majors
Pittsburgh Post-Gazette

State officials yesterday banned the transportation of ash trees and firewood into or out of Allegheny, Butler, Beaver and Lawrence counties after an emerald ash borer — a tiny green beetle from Asia — was discovered in a tree in Cranberry.

The Pennsylvania Department of Agriculture entered the quarantine in an attempt to protect the state's ash trees, which are commonly used in roadside landscaping because of their ability to tolerate road salt. The wood, which is pliant yet tough, is used to make baseball bats.

The discovery of the emerald ash borer in a young ash tree along Route 19 near the Interstate 79/Pennsylvania Turnpike Connector is alarming, officials said, because the wood-boring beetles have been responsible for the destruction of more than 30 million ash trees in Michigan, Ohio and Indiana since they were first reported near Detroit in the July 2002.

In response to the discovery, swarms of inspectors from the state Forestry Service and the state and U.S. agriculture departments will descend upon Cranberry today for a two-day survey, examining ash trees

SEE BUG, PAGE B-5

Emerald Ash Borer (EAB)

First Detection in Pennsylvania

- Ground surveys were and are being conducted by the Pennsylvania Department of Agriculture; USDA, Animal and Plant Health Inspection Service, Plant Protection and Quarantine; PA DCNR, Bureau of Forestry, Division of Forest Pest Management; Pennsylvania State University, Cooperative Extension, Department of Entomology; and certified arborists to further delineate the extent of the infestation

Emerald Ash Borer (EAB)

Image by Greg Hoover

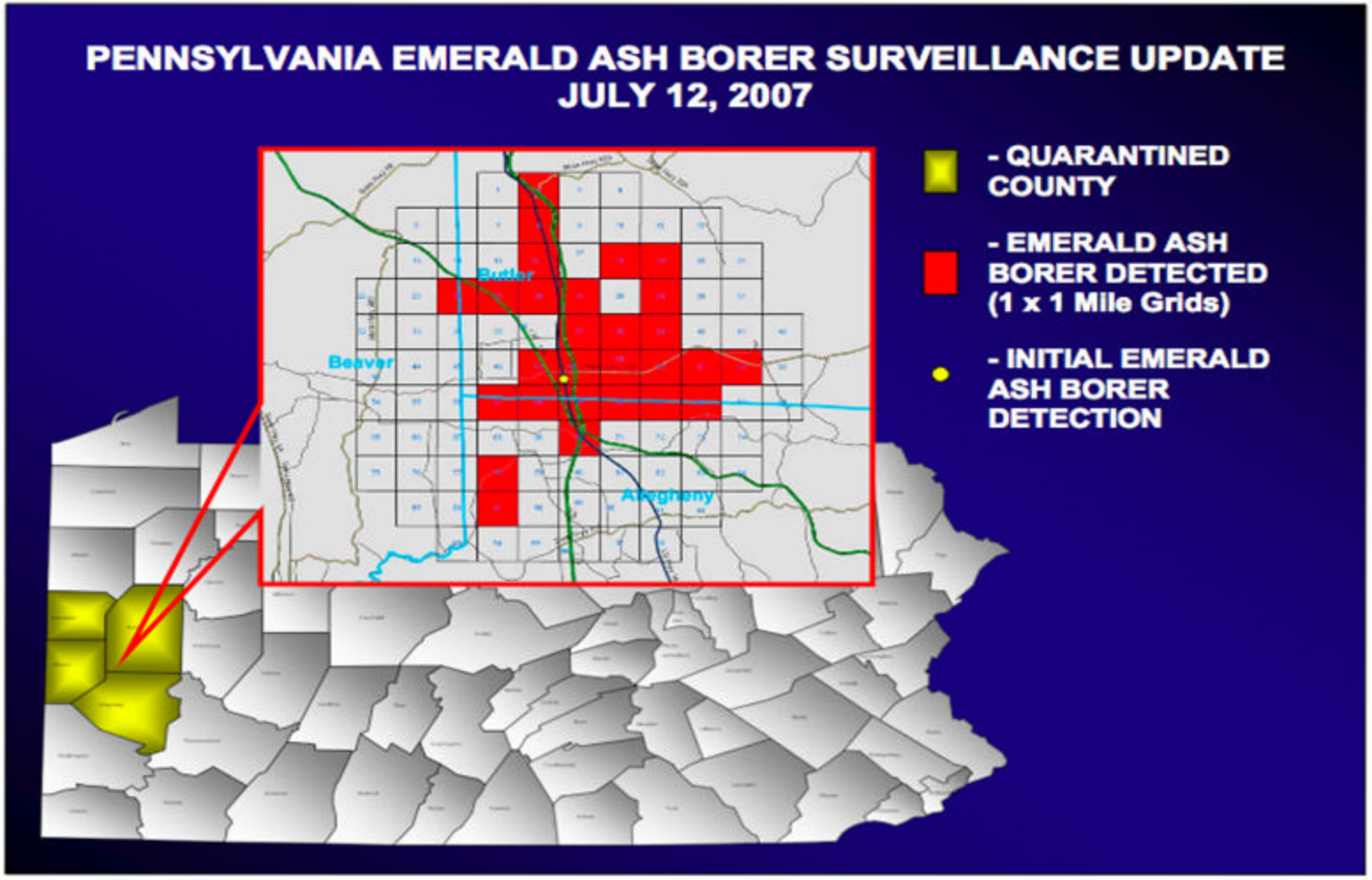
Emerald Ash Borer (EAB)

Emerald Ash Borer (EAB)

First Detection in Pennsylvania

- On Friday, June 29, 2007 the emerald ash borer was confirmed in Marshall Township, Allegheny County, PA
- On July 2, 2007 an order of quarantine was established by the PA Dept. of Agriculture on the movement of firewood of all types into the Commonwealth

Emerald Ash Borer (EAB)



Emerald Ash Borer (EAB) -

- History of the EAB in the US
- Economic impact of EAB in the US
- Taxonomy, biology, and life history

Emerald Ash Borer (EAB) -

Taxonomy

- **Insect order:** Coleoptera (beetles and weevils)
- **Insect family:** Buprestidae (adults are called metallic wood-boring beetles; larvae are known as flatheaded borers)
- **Scientific name:** *Agrilus planipennis*
- **Host Plants:** *Fraxinus* spp.; black, green, pumpkin, and white ash and their cultivars
- **Description:** adults are 7.5-13.5 mm (1/3 to 1/2 inch) long with a slender, elongate body and dark emerald green front wings

Emerald Ash Borer (EAB) -
Life History

Emerald Ash Borer (EAB) -

Life History

- Adults feed on ash foliage; creates small irregular-shaped notches along the leaf margins
- Larvae feed on phloem and outer sapwood for several weeks
- Larvae construct galleries (tunnels) that may be 20-30 cm (8-12 inches) long
- Pupation occurs in late April or May
- Adult emergence begins in May; peaks in late June to mid-July

Emerald Ash Borer (EAB) -
Life History

- Adult emergence holes are “D-shaped” and about 3-4 mm (1/8-1/6 inch) in diameter
- Males live an average of 13 days; females live 21-22 days
- Females lay 60-90 eggs during their lifetime
- EAB will develop in trees and branches ranging from 2.5 cm (1 inch) to 140 cm (55 inches) in diameter
- One generation is usually produced each year; research has indicated the EAB may also have a two-year life cycle

Emerald Ash Borer (EAB) -

Life History

Emerald Ash Borer (EAB) -

Life History

- **Description:** mature larvae are 25-32 mm (1-1 1/4 inches) long, cream and dorsal ventrally flattened
- **Overwintering life stage:** larva
- **Vulnerable life stage:** larva or adult
- **Treatment timing:** none suggested; quarantines in place; EAB is native to Asia (China, Korea, Japan, Mongolia, Taiwan, and the Russian Far East)

Emerald Ash Borer (EAB) -

Emerald Ash Borer (EAB) -

- History of the EAB in the US
- Economic impact of the EAB in the US
- Taxonomy, biology, and life history
- Symptoms and signs of the EAB

Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack

- Difficult to detect EAB on newly infested trees
- Marginal notching of leaflets by adults
- Jagged holes excavated by woodpeckers that feed on mature EAB larvae
- D-shaped emergence holes in bark
- Vertical splits in the bark above larval galleries
- Wilted foliage and crown dieback
- Epicormic shoots (“water sprouts”) on trunk

Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack

Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack

woodpecker damage

overwintering larva

Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack

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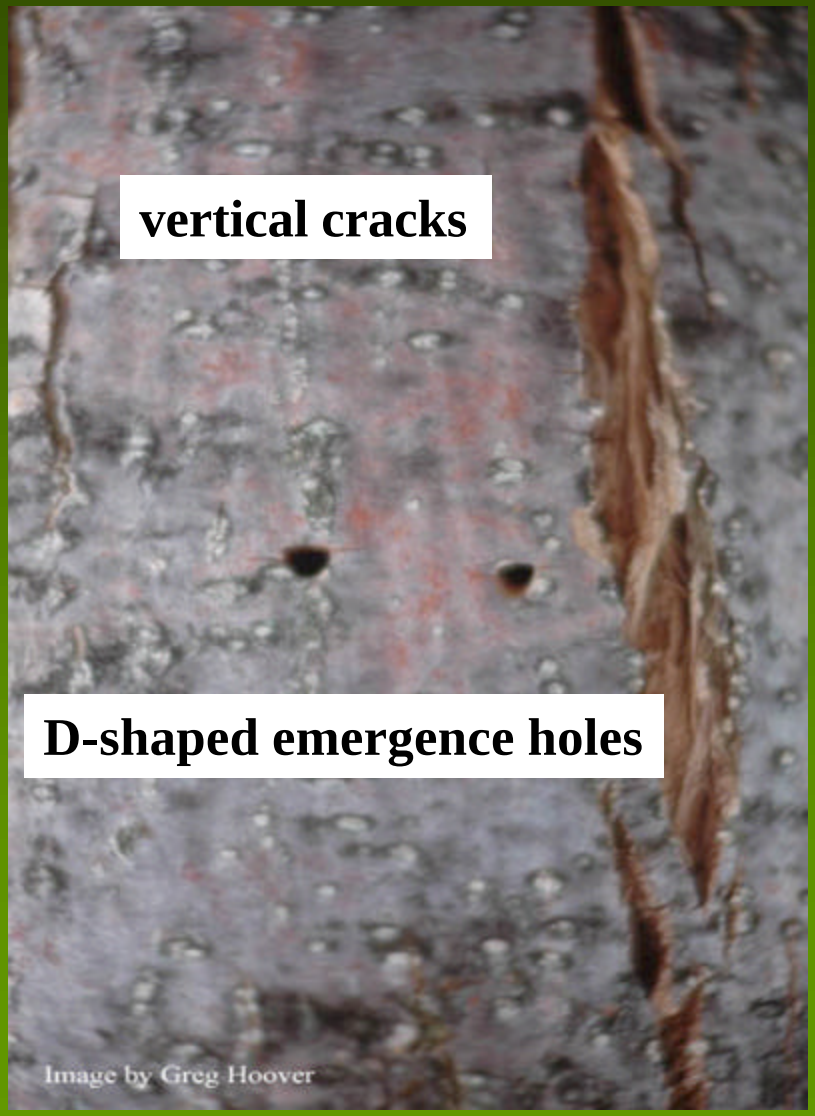
Symptoms and Signs of Attack

Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack



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Symptoms and Signs of Attack

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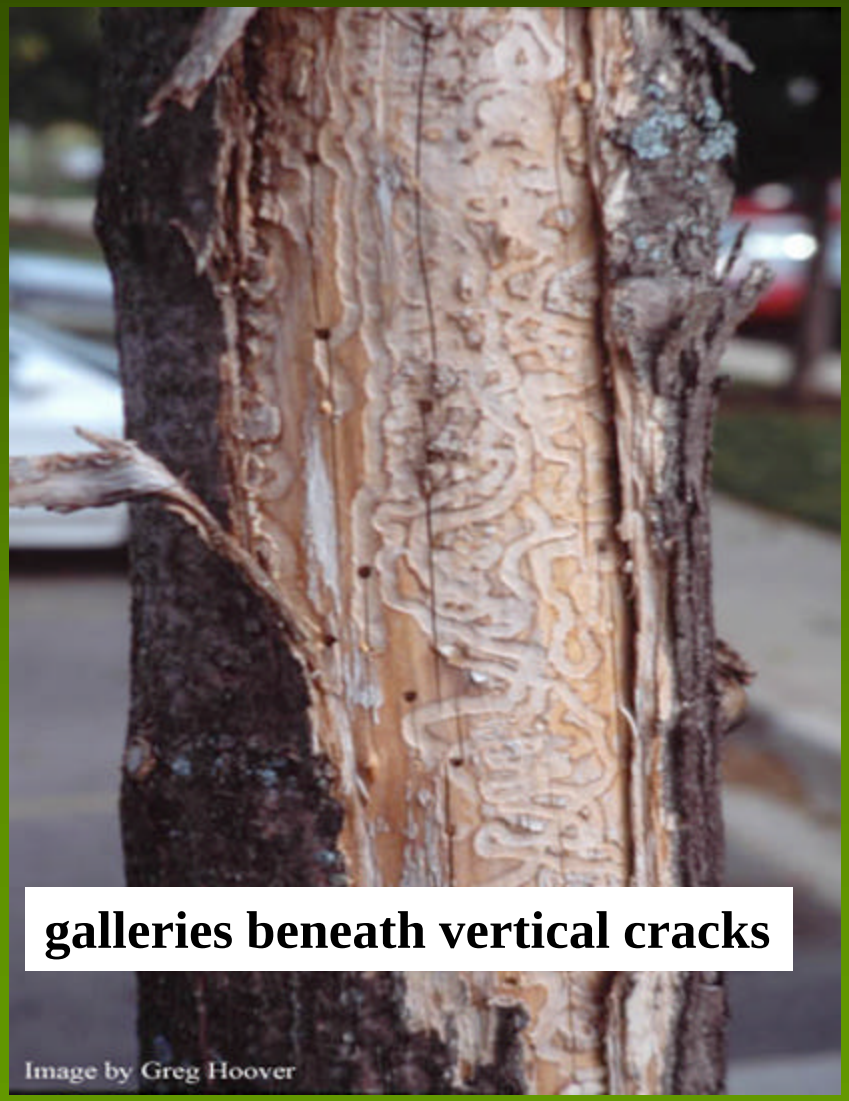
Symptoms and Signs of Attack



Emerald Ash Borer (EAB) -

Symptoms and Signs of Attack

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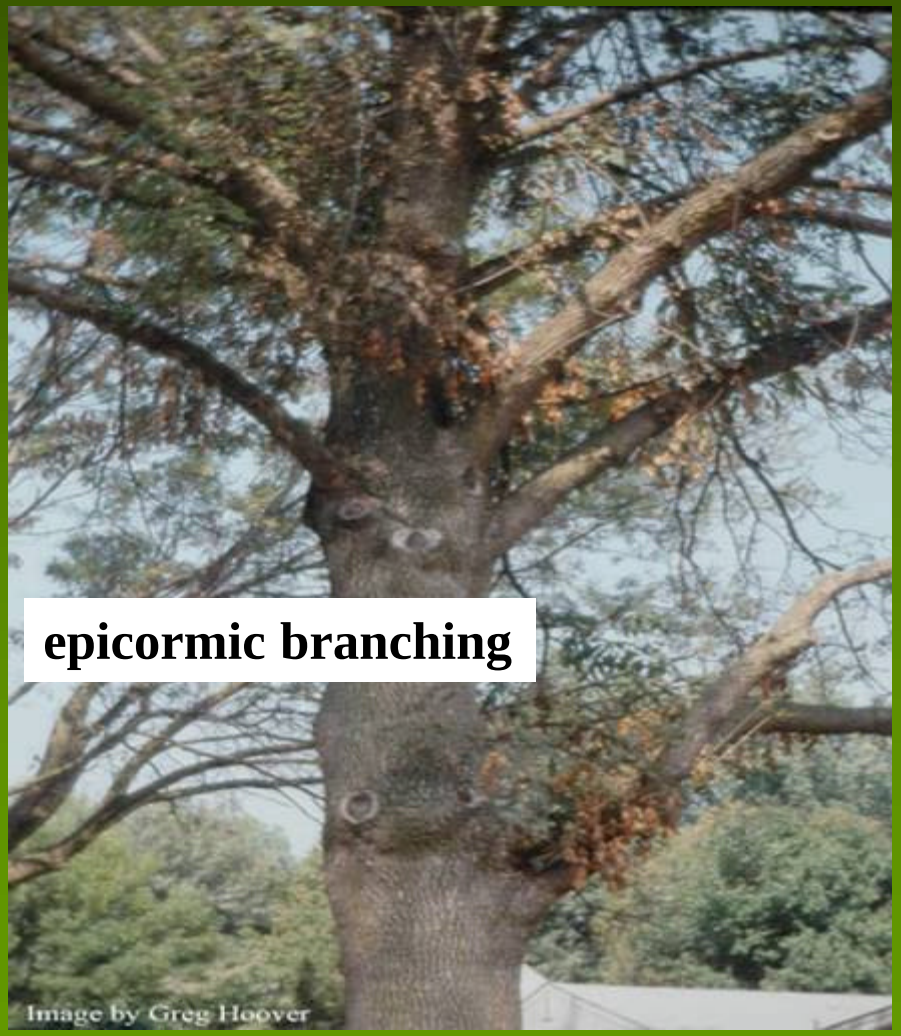
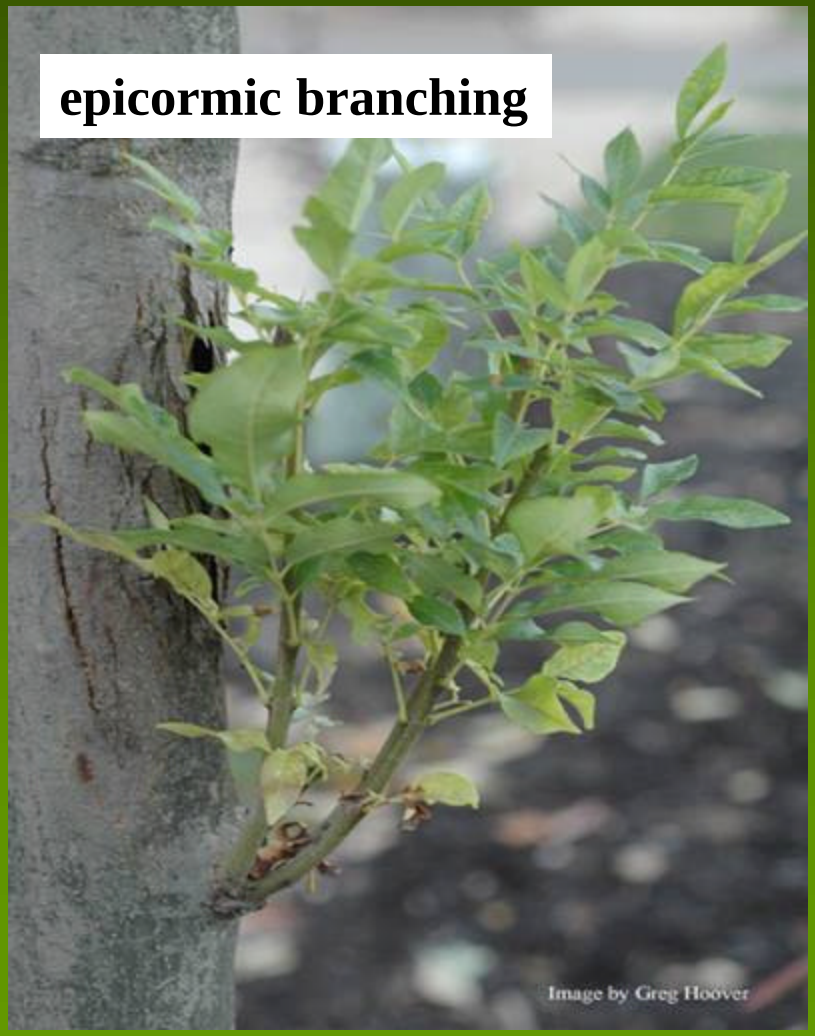




Emerald Ash Borer (EAB) -

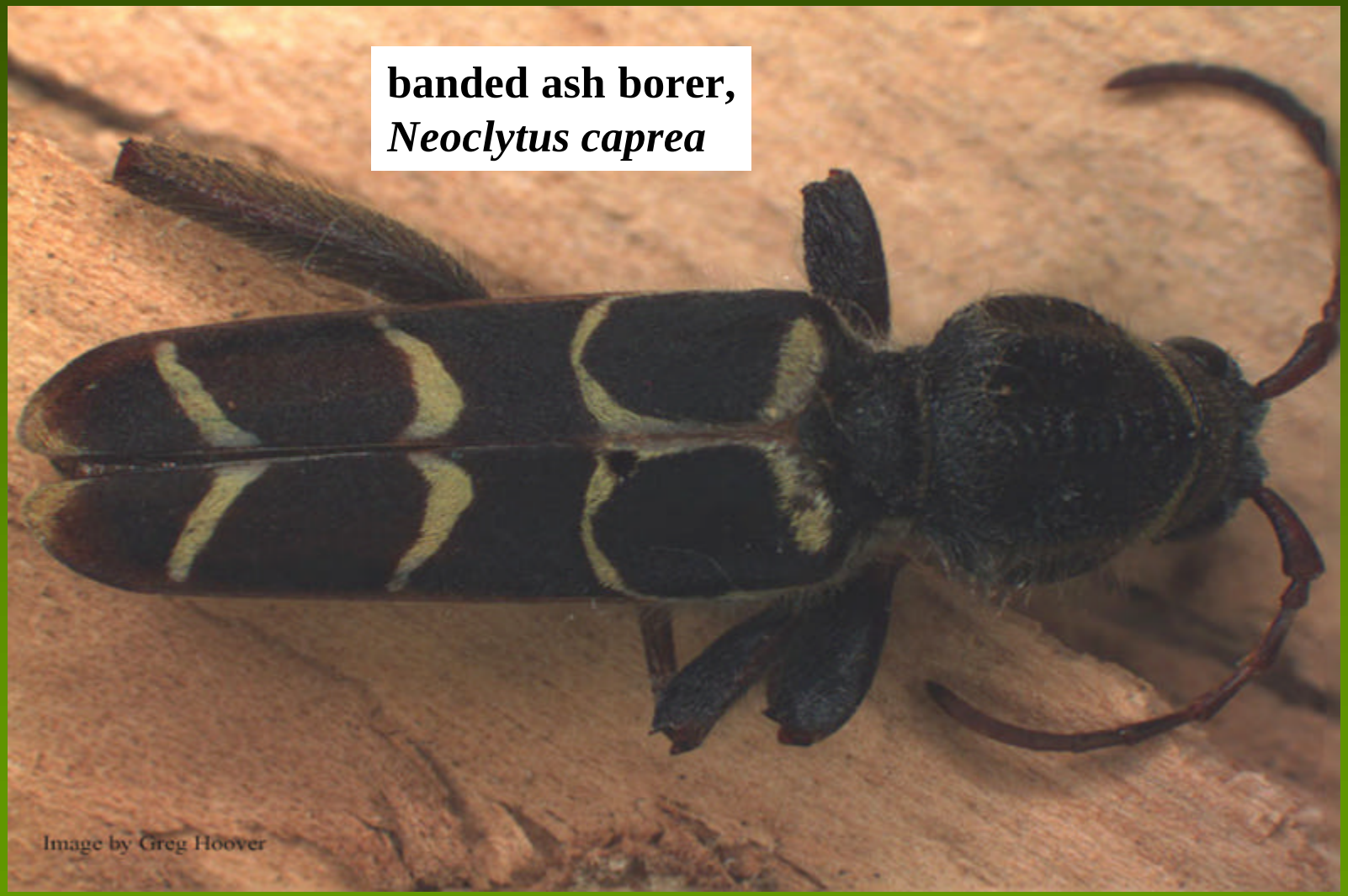
- History of the EAB in the US
- Economic impact of EAB in the US
- Biology and life history
- Symptoms and signs of EAB
- **Other native wood-boring insects on ash**

Emerald Ash Borer (EAB) -

Other Wood-Boring Insects on Ash

Emerald Ash Borer (EAB) -

Other Wood-Boring Insects on Ash



Emerald Ash Borer (EAB) -

Other Wood-Boring Insects on Ash

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Other Wood-Boring Insects on Ash

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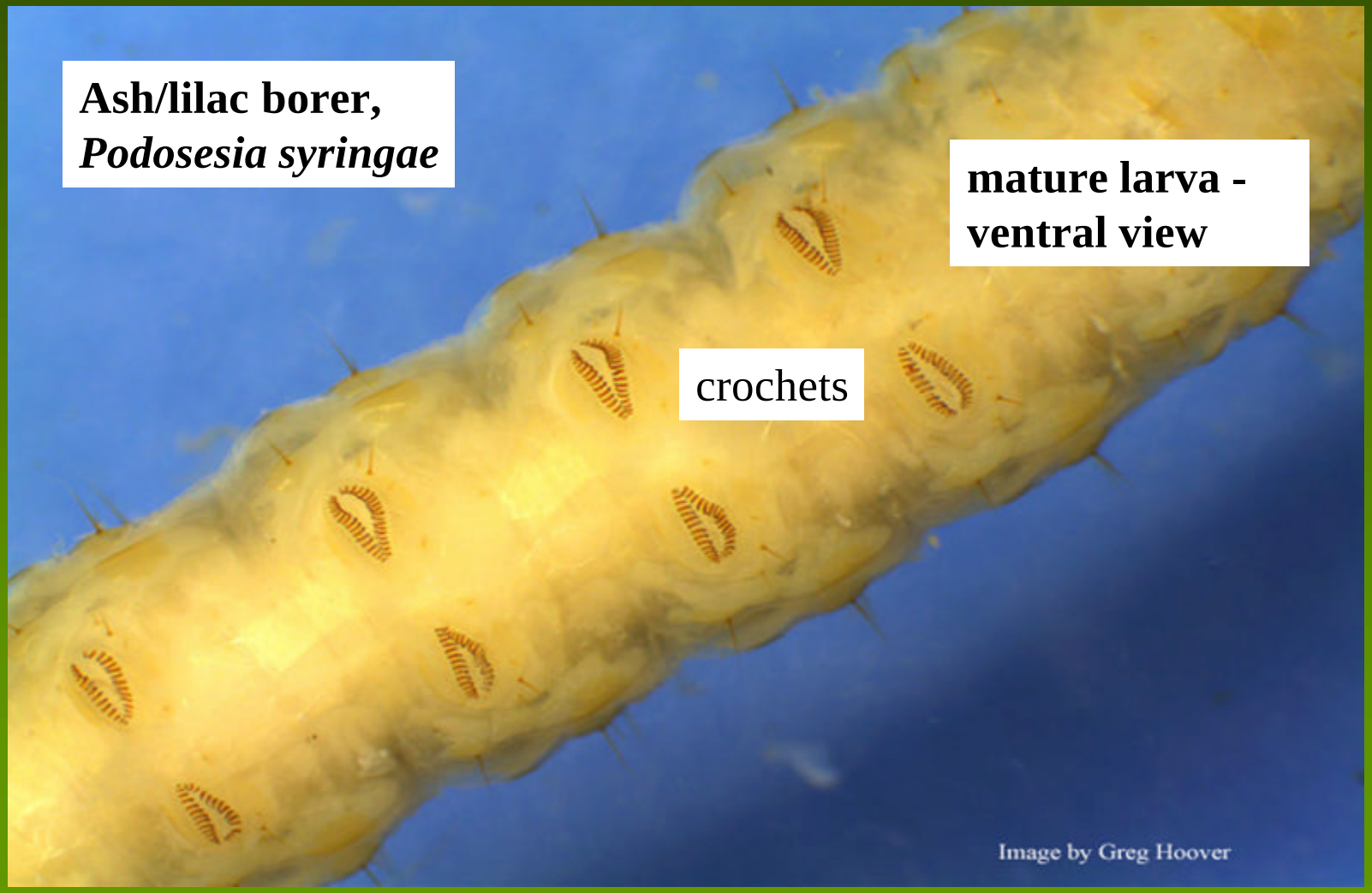
Other Wood-Boring Insects on Ash



Emerald Ash Borer (EAB) -

Other Wood-Boring Insects on Ash

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Other Wood-Boring Insects on Ash

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- EAB look-alikes

Emerald Ash Borer (EAB) -

"Look-Alikes"

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"Look-Alikes"

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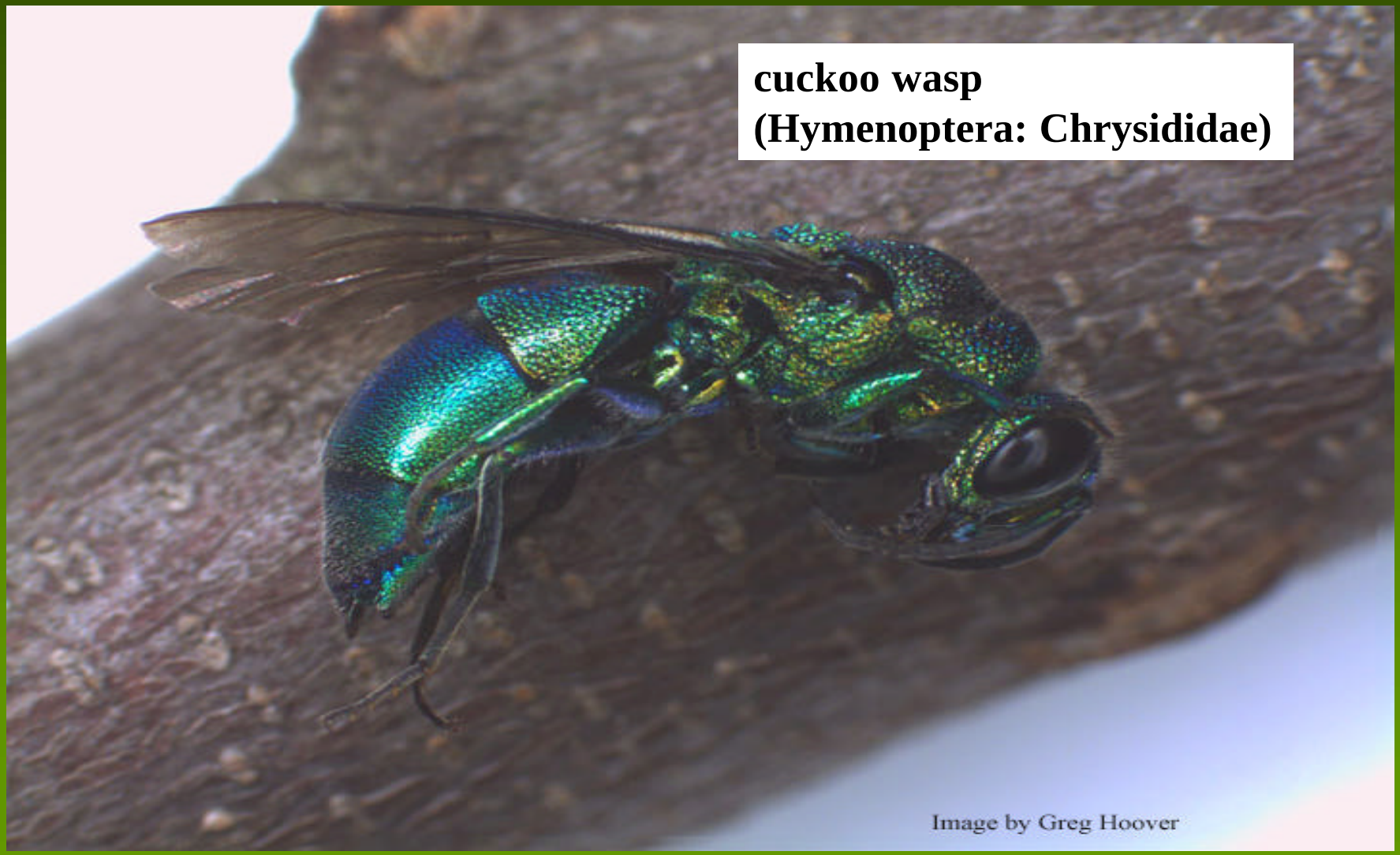
"Look-Alikes"



Emerald Ash Borer (EAB) -

"Look-Alikes"

Emerald Ash Borer (EAB) -

"Look-Alikes"

Emerald Ash Borer (EAB) -

"Look-Alikes"

a dog-day cicada, *Tibicen* spp.

Emerald Ash Borer (EAB) -

- History of the EAB in the US
- Economic impact of EAB in the US
- Biology and life history
- Symptoms and signs of EAB
- Other native wood-boring insects on ash
- EAB look-alikes
- **Management strategies for EAB in Pennsylvania**

Some Solutions for Management of the Emerald Ash Borer

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Some Sources of Information on the Emerald Ash Borer

"What's currently being done by the federal and state regulatory agencies in the EAB quarantine area in western Pennsylvania?"

- **The Pennsylvania Department of Agriculture (PDA) and the USDA-APHIS-PPQ are writing compliance agreements for the chipping of ash wood inside the quarantined counties**
- **In 2008 field surveys were conducted in 35 counties mostly in western and some eastern Pennsylvania with purple panel sticky traps**
- **Sampling in 2009 for EAB adults with purple panel sticky traps and lures will occur in 15 western PA counties**

Some Sources of Information on the Emerald Ash Borer

Purple Panel Sticky Trap

Each of the three panels are 15” X 24”; coated with sticky material

Placed approx. middle of the crown of an open grown ash

Some Sources of Information on the Emerald Ash Borer

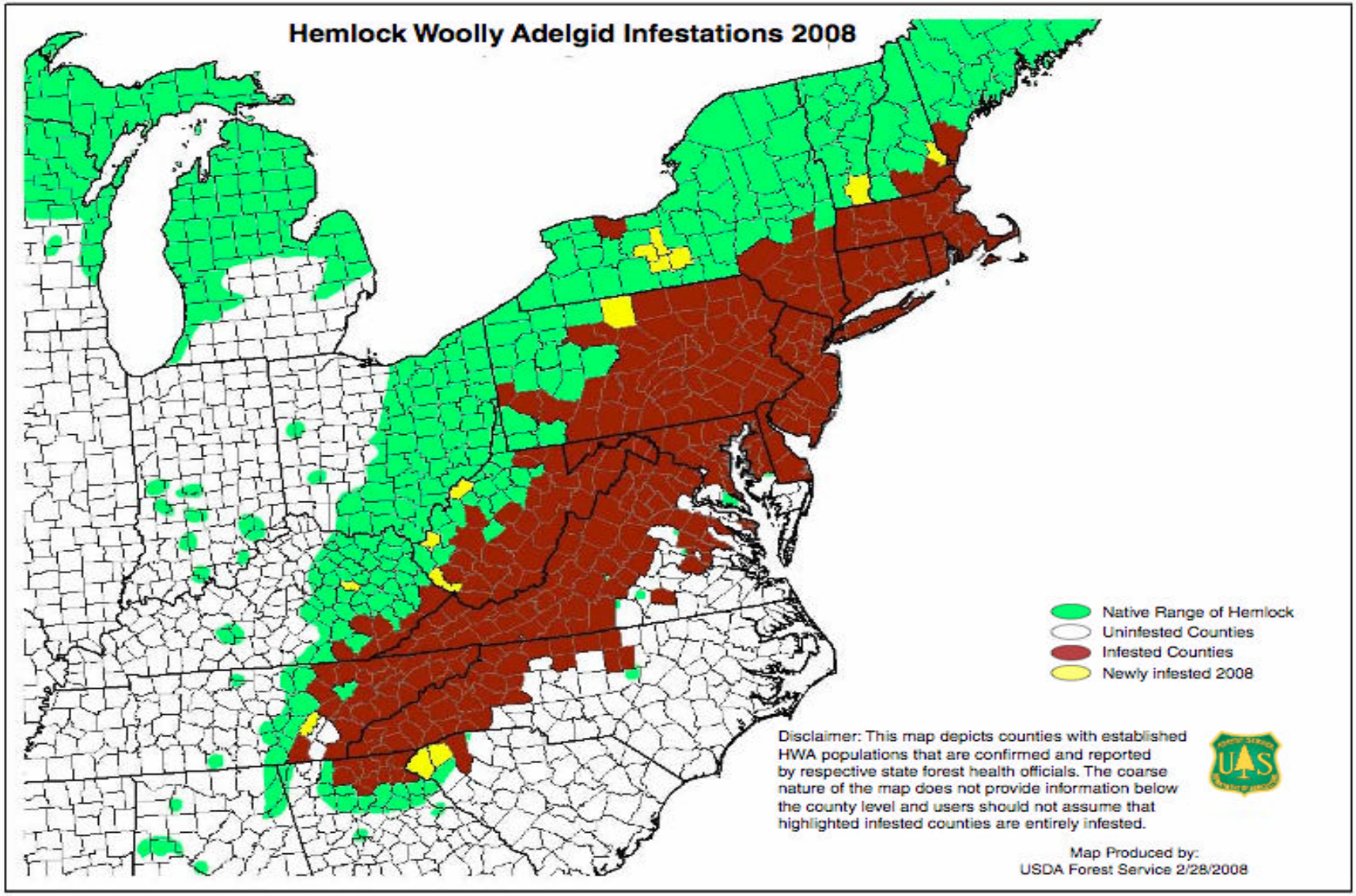
"Who do I contact to get more information on the EAB in Pennsylvania, get an EAB suspect specimen accurately identified, or to report a potentially EAB-infested ash tree?"

- **Contact your local county's Penn State Cooperative Extension Office,**
- **Contact the nearest PA Department of Agriculture regional office,**
- **Contact the PA DCNR, Bureau of Forestry's Division of Forest Pest Management office,**
- **Call the Pennsylvania EAB hotline at 1-866-253-7189**

Hemlock Woolly Adelgid

thinning of tree crown

Hemlock Woolly Adelgid



Hemlock Woolly Adelgid

Hemlock Woolly Adelgid

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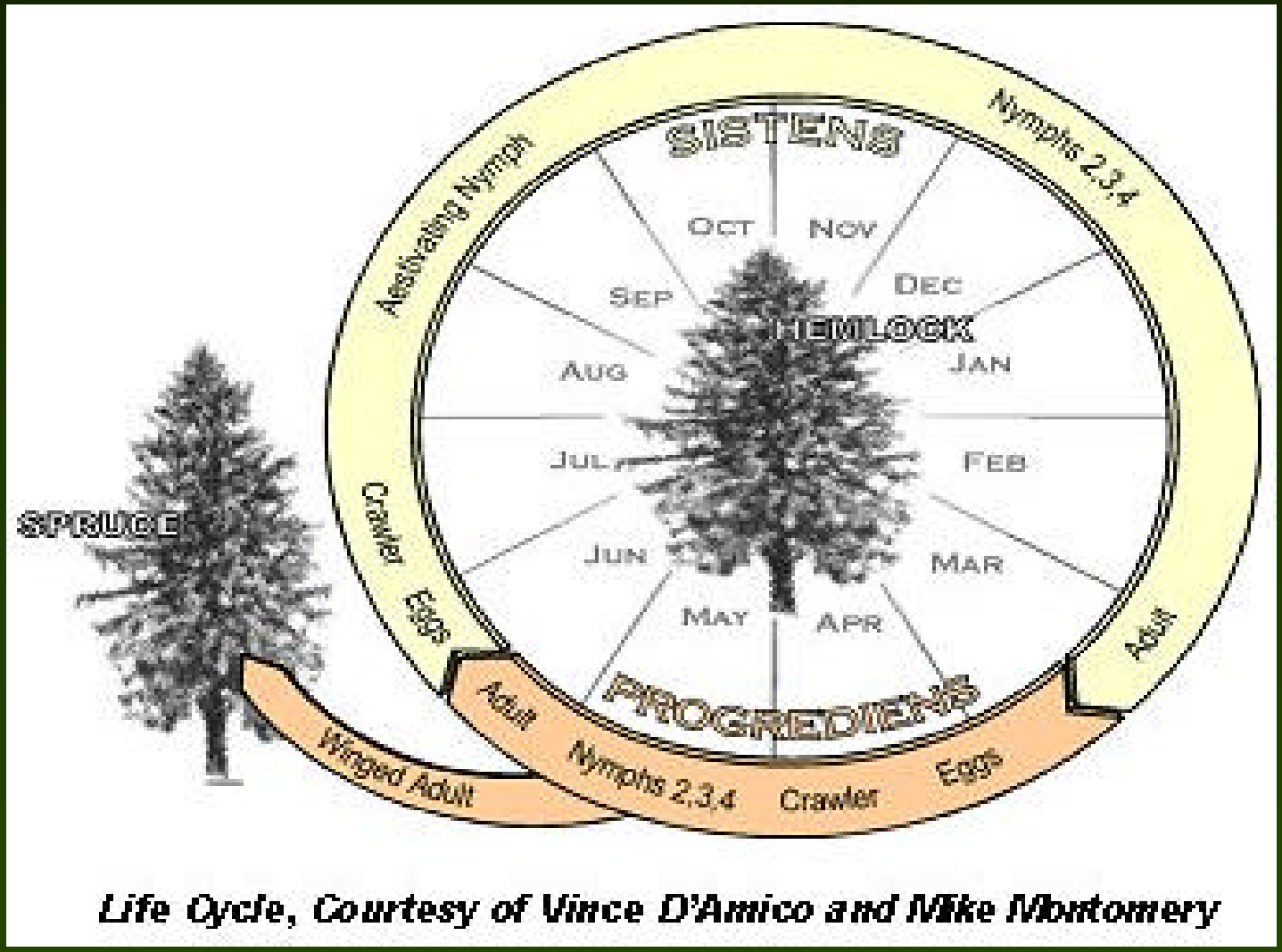
Hemlock Woolly Adelgid

Life Cycle

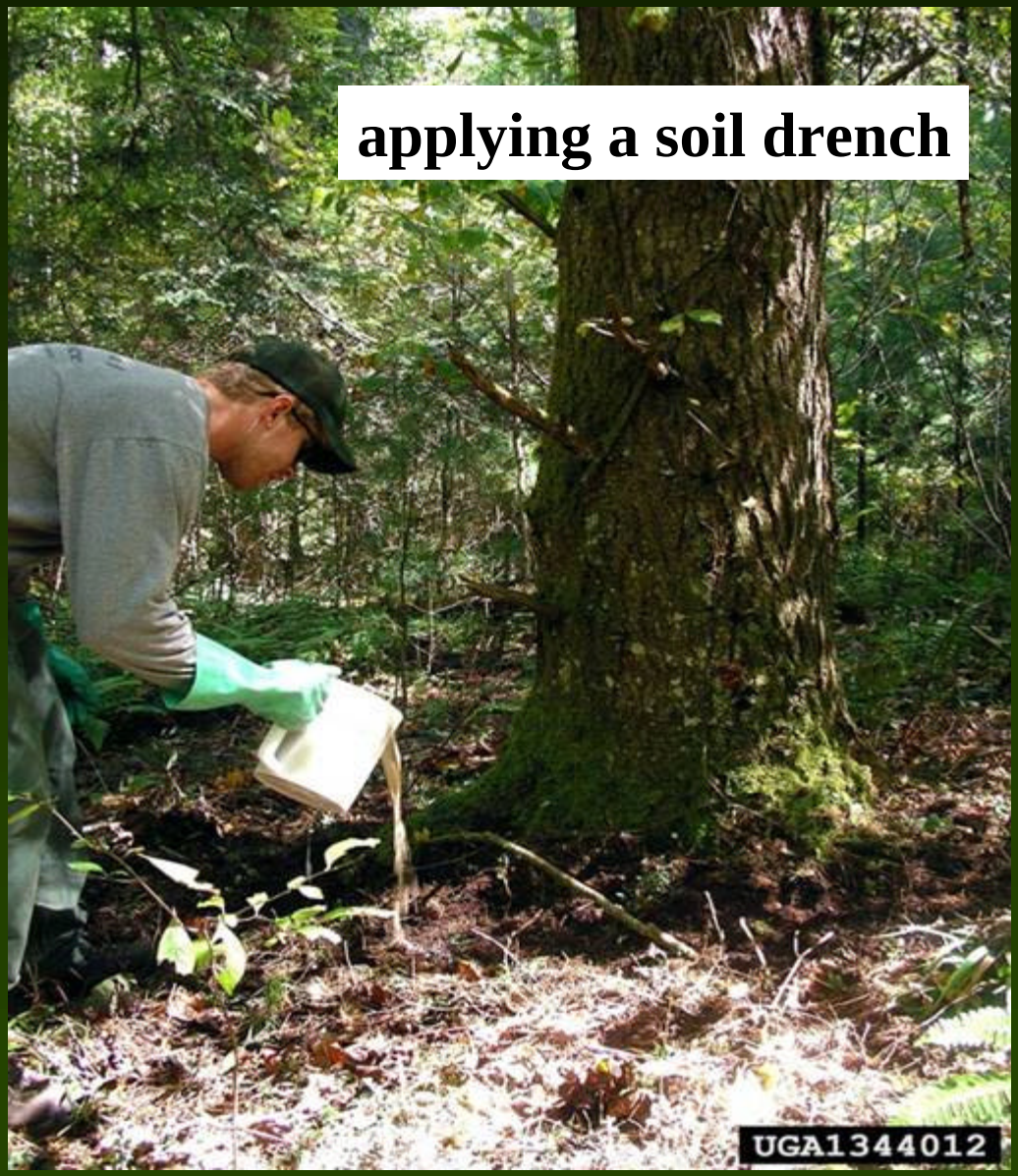


Life Cycle, Courtesy of Vince D'Amico and Mike Montomery

Hemlock Woolly Adelgid

spraying with insecticidal soap

Hemlock Woolly Adelgid



Hemlock Woolly Adelgid

Hemlock Woolly Adelgid

Biological Control

the lady beetle, *Sasajiscymnus tsugae*

Hemlock Woolly Adelgid

Biological Control

Hemlock Woolly Adelgid

- Hemlock woolly adelgid (HWA) sucks fluid from the base of hemlock needles.
- It may also inject toxins into the tree as it feeds, accelerating needle drop and branch dieback.
- Although some trees die within four years, trees often persist in a weakened state for many years.
- Hemlocks that have been affected by HWA often have a grayish-green appearance (healthy hemlock needles normally have a shiny, dark green color).

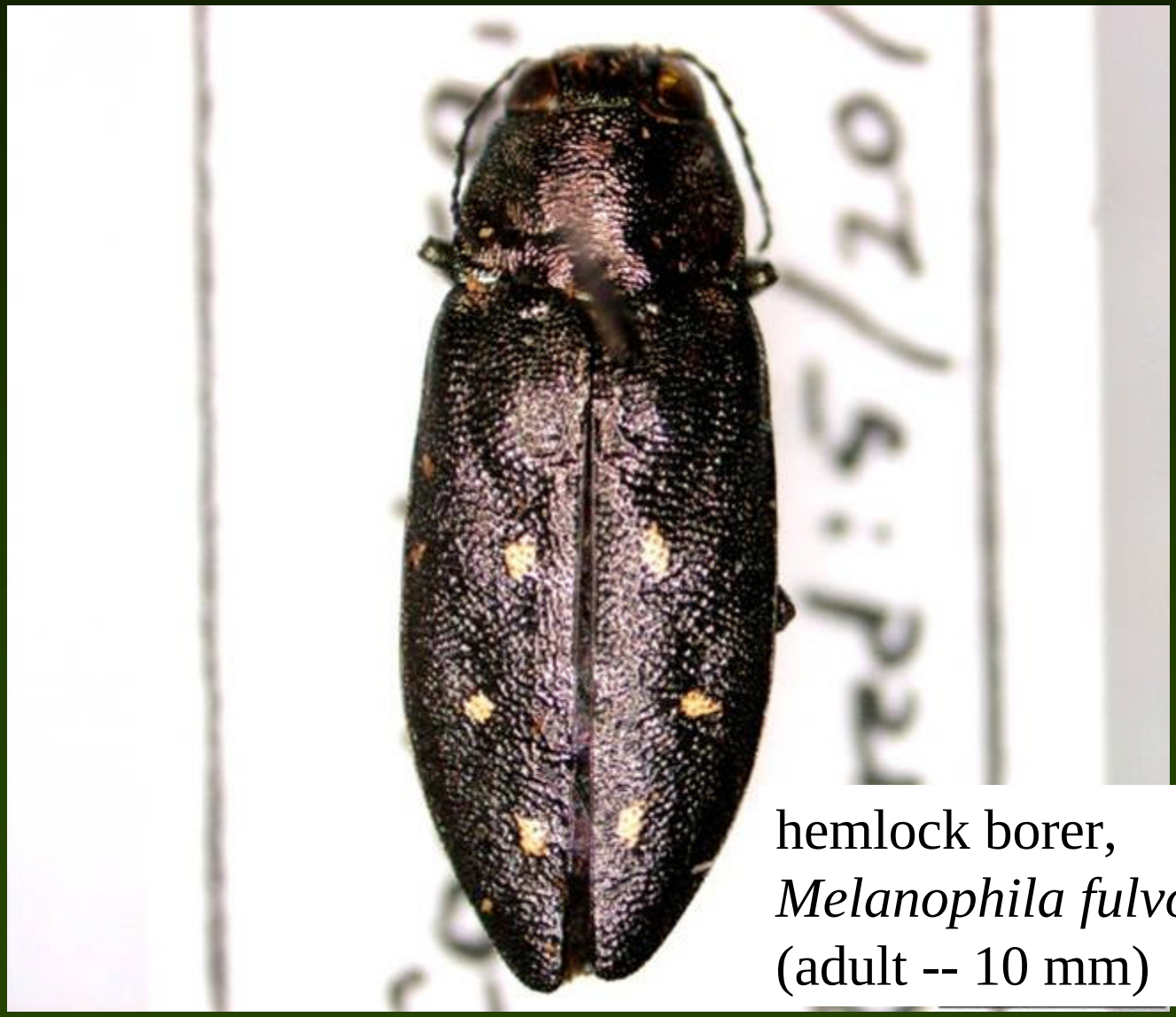
Hemlock Woolly Adelgid

- Other factors can influence the impact of the hemlock woolly adelgid. Other insects, such as elongate hemlock scale, hemlock borer, and spittlebugs, which are also found on hemlock, can compound the impact of HWA.
- Drought and fungi, such as *Fabrella* or *Korfia tsugae*, can weaken hemlock and cause it to become more susceptible to insect damage.
- Low winter temperatures, cold snaps (episodes of freezing and thawing), and heavy thunderstorms can reduce populations of the HWA.

Hemlock Woolly Adelgid

with Elongate Hemlock Scale

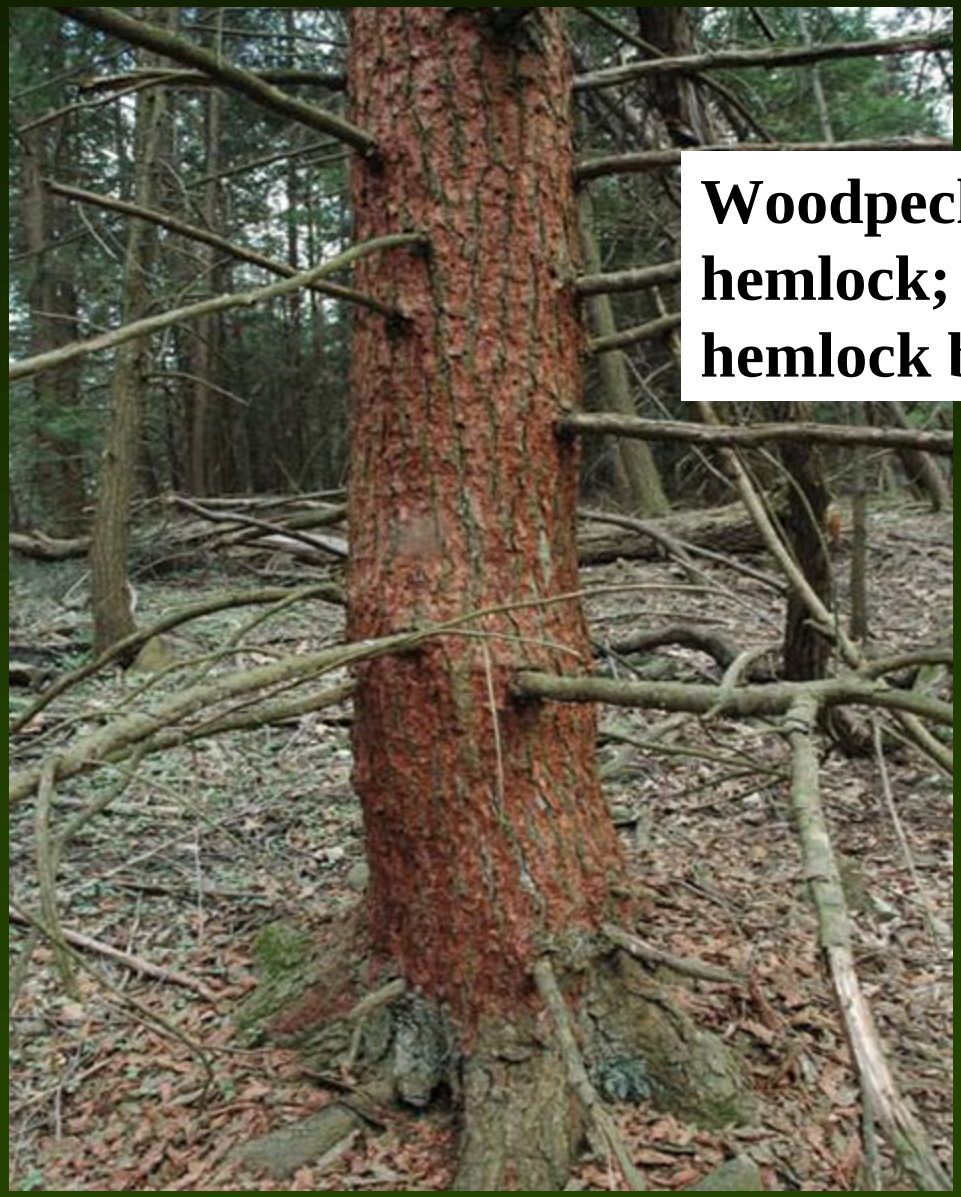
Hemlock Woolly Adelgid



hemlock borer,
Melanophila fulvoguttata
(adult -- 10 mm)

Hemlock Woolly Adelgid

Hemlock Woolly Adelgid



Woodpecker damage to hemlock; feeding on hemlock borer larvae

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- Particularly in the mountains, it is not uncommon to find hemlocks where the insect has been killed on the top third of the trees, where it's colder and windier, but survive on the bottom two-thirds.
- On the other hand, mild winters can result in sharp increases in HWA populations.

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- Hemlocks growing on sites of marginal quality (very steep slopes, dark ravines, bedrock ridge tops) declined more rapidly than hemlocks growing on sites with better quality (flat to shallow slopes, slightly concave (valley) or convex (ridge). Hemlocks on the better quality sites often showed improvement some years.

- Hemlock trees growing on ridge tops, on exposed drier sites, or infested with any other secondary pests like scale insects often succumb more quickly to HWA infestation.

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- In addition, extreme cold winter temperatures (below – 5^{o}F) for even a few hours can cause severe HWA population reductions, which may temporarily slow the spread and impact of HWA across a forest or landscape.

- Research has also shown that hemlock trees are just as likely to be infested with HWA whether they occur in a hemlock-dominated system or in mixtures with hardwoods or other conifer species.

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Silvicultural Options

- There is often a desire to manage a forest in a way that is most “natural.”
- The current widespread outbreak of the invasive HWA is novel and not like any other form of natural disturbance known to affect hemlock trees or forests.
- Therefore, harvesting options and related costs will differ depending on the size structure of hemlock in a particular forest and whether the management goal is aesthetics, wildlife habitat, water quality protection, public safety, future successional dynamics, timber revenue, or a combination of these goals.

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Silvicultural Options (cont.)

- Unless timber revenue is the main objective, pre-emptive cutting or pre-salvage of uninfested forests is not recommended, as the future interactions between hemlock and HWA are uncertain and cutting could remove potentially resistant hemlock.

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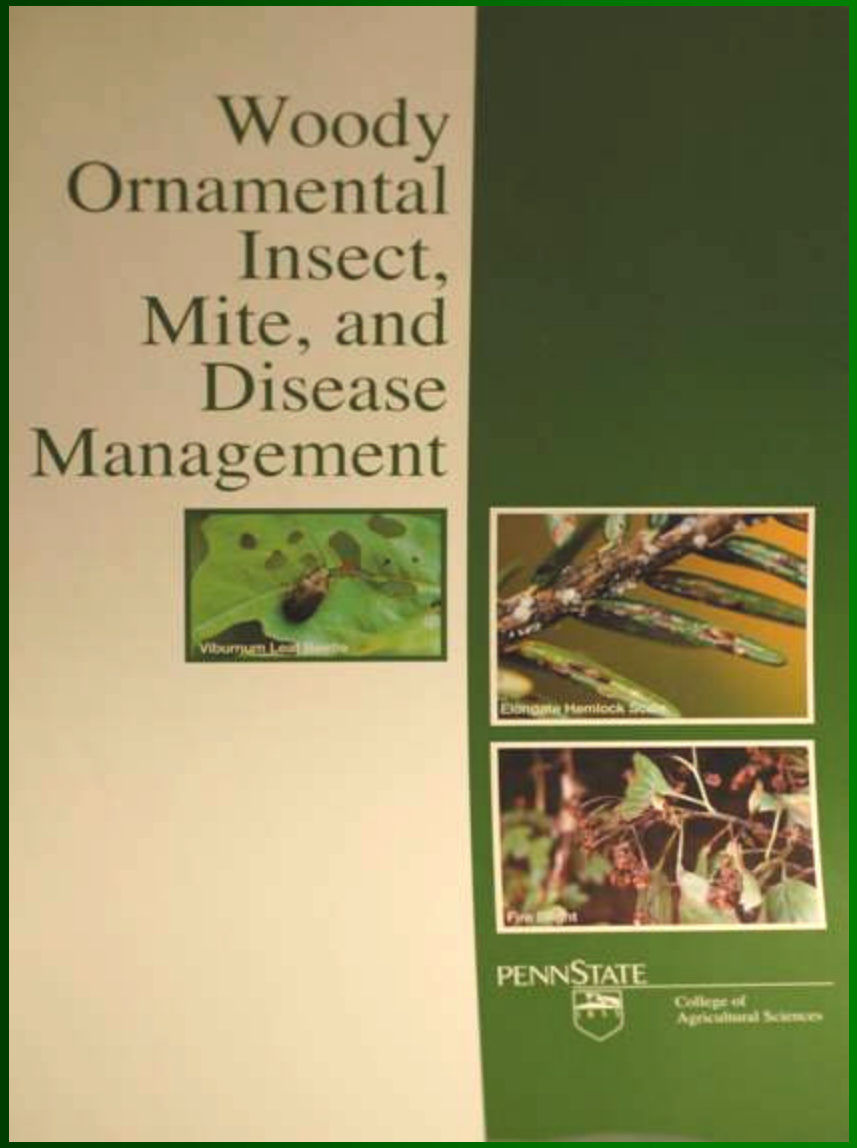
Every woodland owner/manager should consider these factors to make an informed decision about the future of their hemlock.

- Financial: What value might be lost? ex. $25-$40/Mbf
- Aesthetics: What will my forest look like?
- Ecological: What will happen in the forest? Will it be healthy?
- Habitat: What wildlife will occupy the forest?
- Liability: What is the risk of people being injured by falling trees and branches?
- Risk or probability of infestation: How close is HWA to the property? Based on estimates of how it spreads, when might it arrive?
- Future: What are the alternatives?

Woody Ornamental Pest Management Guide



- Woody Ornamental Pest Management Guide
- Page numbers linked the book, “Insects That Feed on Trees and Shrubs”
- Penn State Cooperative Extension, County Offices
- 814.865.6713 -- @ PSU
- Electronic version -- http://woodypestguide.cas.psu.edu


QUESTIONS?

Thank You !