Swiss Federal Institute for Forest, Snow and Landscape Research (**WSL**)

www.forestinvasion.cz

Outcomes of attempts to eradicate *Agrilus planipennis* in North America and potential lessons for incursion responses in Europe

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Andrew Liebhold (Czech Univ. Life Sci.),
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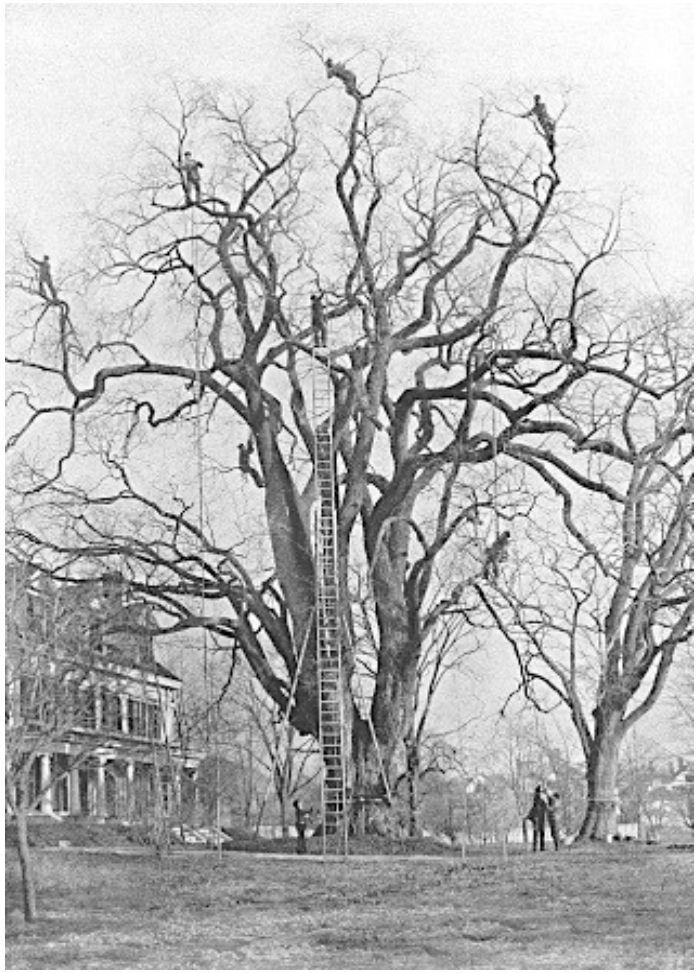
EPPO – FAO-REUFIS – BFW Conference: ... Emerging Risks of Agrilus Wood Borers
Vienna, 21 April 2026

Background and outline

1. Is eradication of non-native forest insects possible?
2. Examples of successful eradications (in general)
3. Eradication methods and ‘tools’
4. When eradication *likely* is or isn’t possible
5. *Agrilus planipennis* (emerald ash borer, “EAB”) invasion in North America
6. Attempts to eradicate EAB in North America
7. Prospects for EAB eradications in Europe

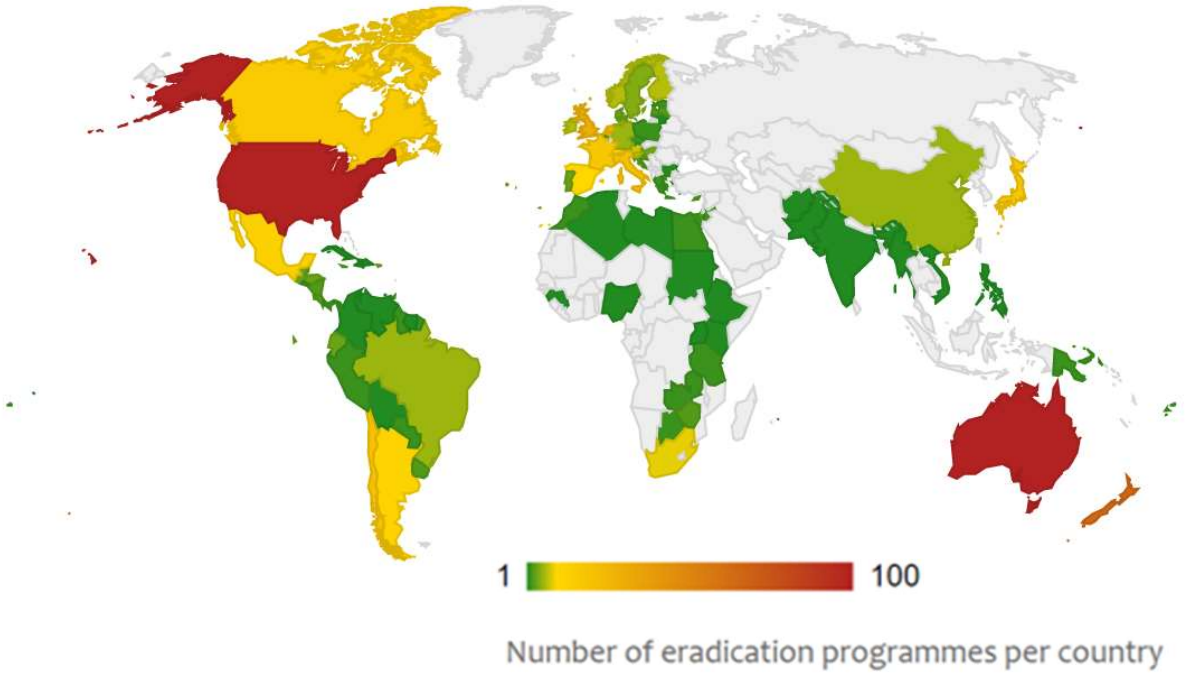


Spongy moth (*Lymantria dispar)* eradication attempt, Boston 1903

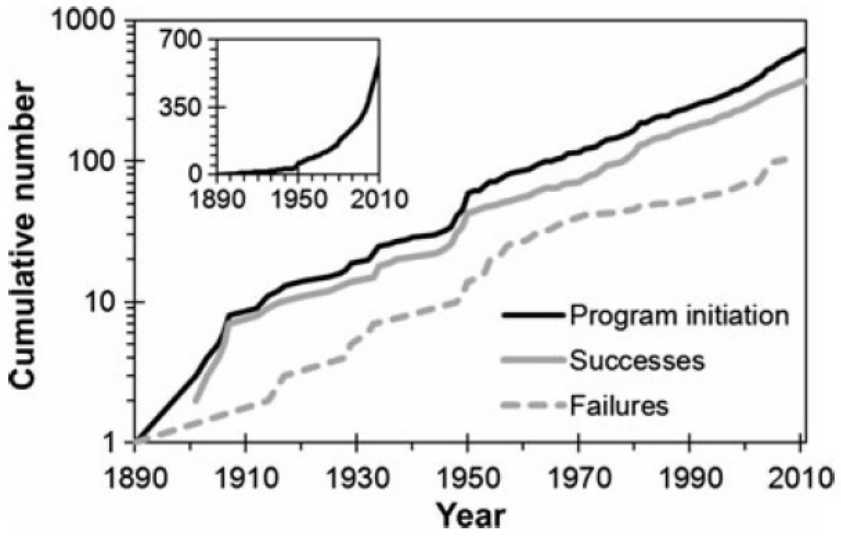
1. Is eradication of forest insects possible?

gerda
global eradication and response database

Gerda · global eradication and response database

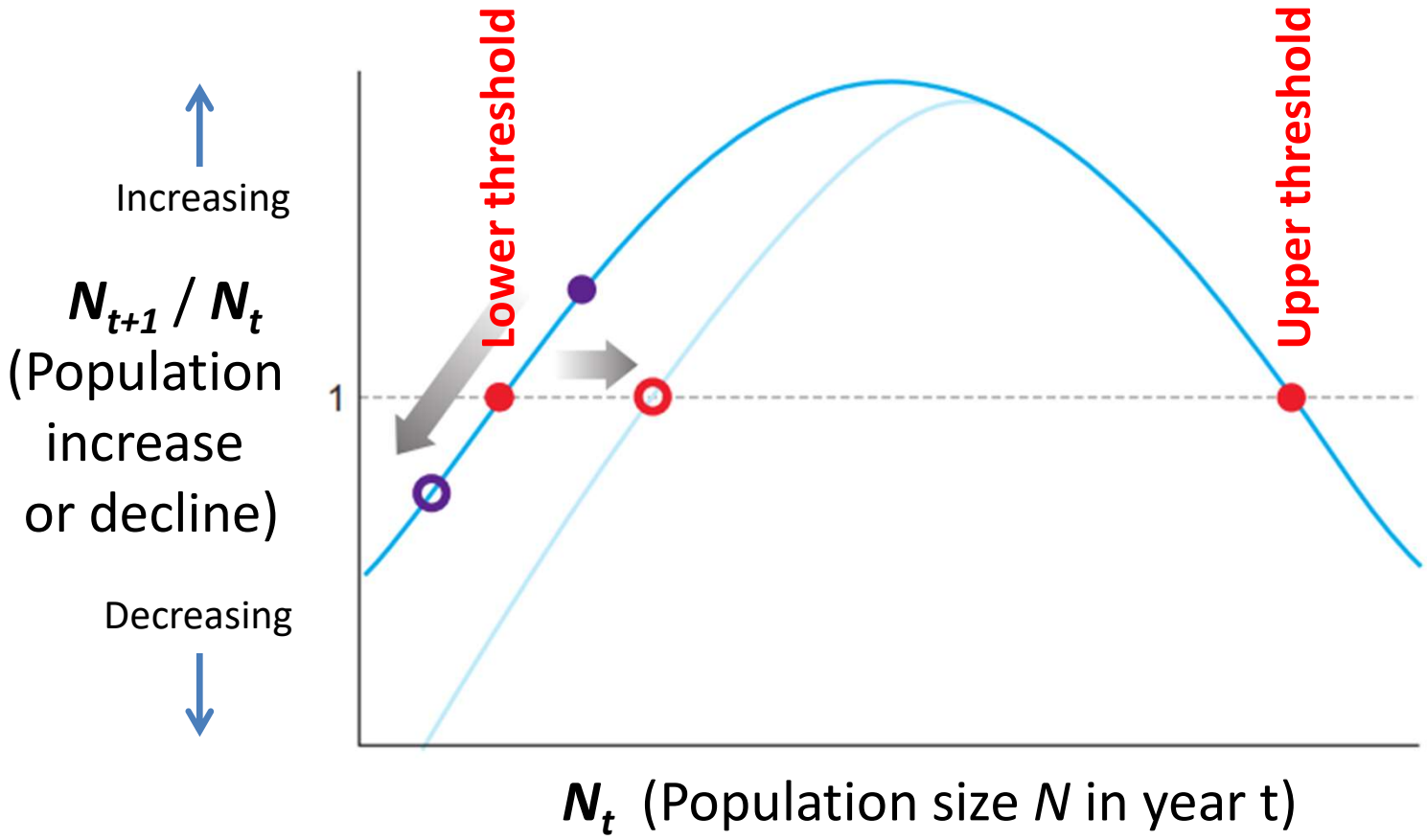


Number of eradication programmes per country



Tobin et al. (2014) Biological Invasions

Role of Allee effects in eradications



Liebhold & Tobin (2008) Annual Review of Entomology

2. Examples and analyses of previous eradications

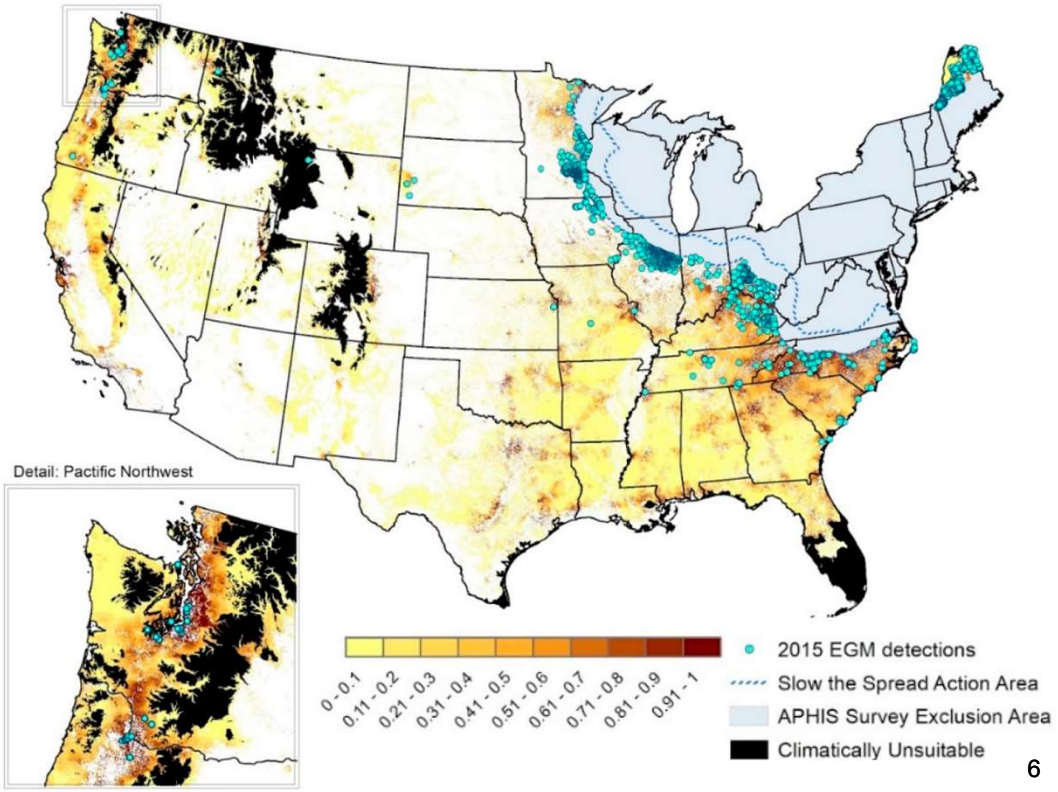
Spongy moth (*Lymantria dispar)*
"**Slow the spread" programme**

Established

Spread front & STS Action Area

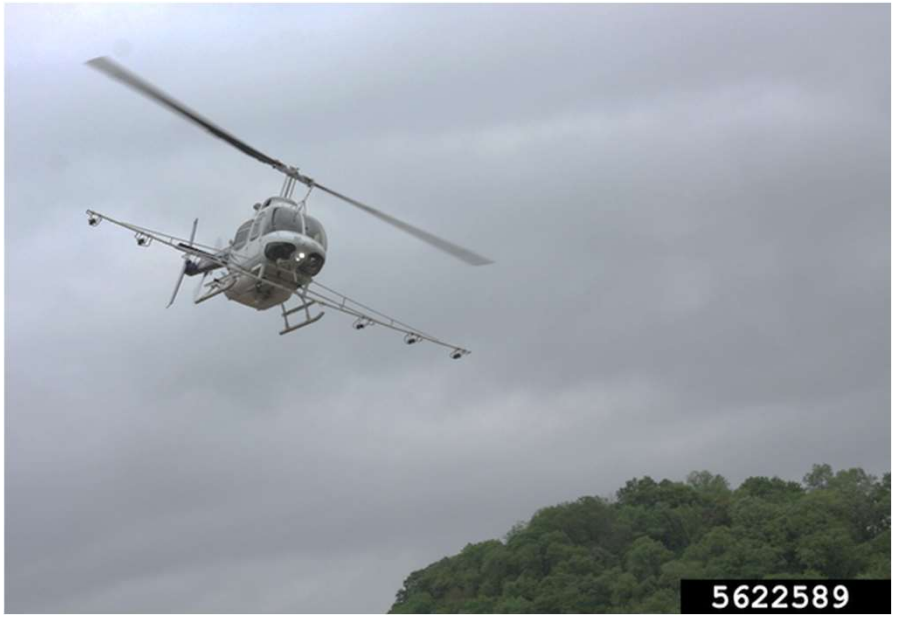
Cook et al. (2019) Forests

- *L. dispar* detections & eradications (2015)
  (Gradient: Risk of arrival & establishment)



Successful eradications of *Lymantria dispar* in the USA

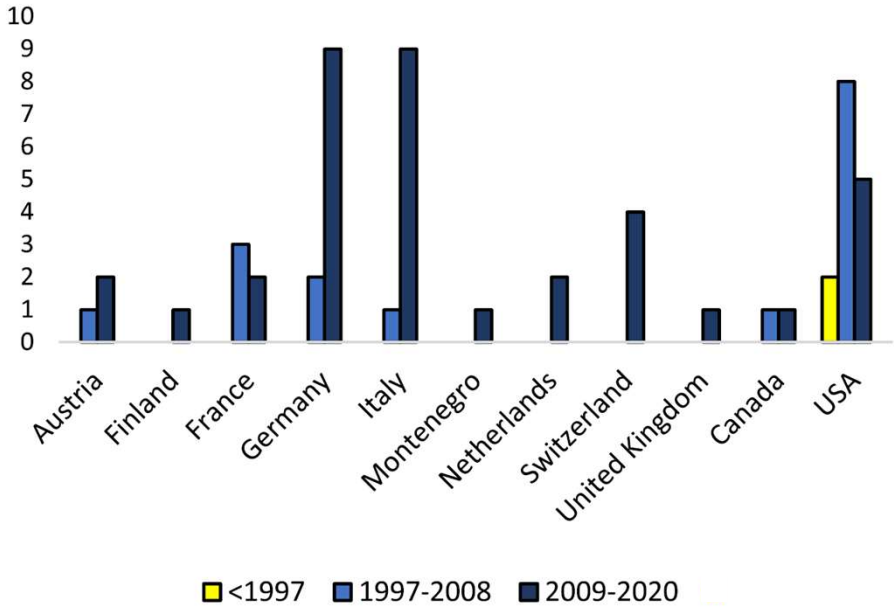
- Very effective **pheromone traps** for **detection** and **delimitation**
- **100 000 - 200 000 of traps** placed across survey area in the USA



- **Effective eradication treatments** including **pesticides** (*Btk*) and **mating disruption** using pheromone applications

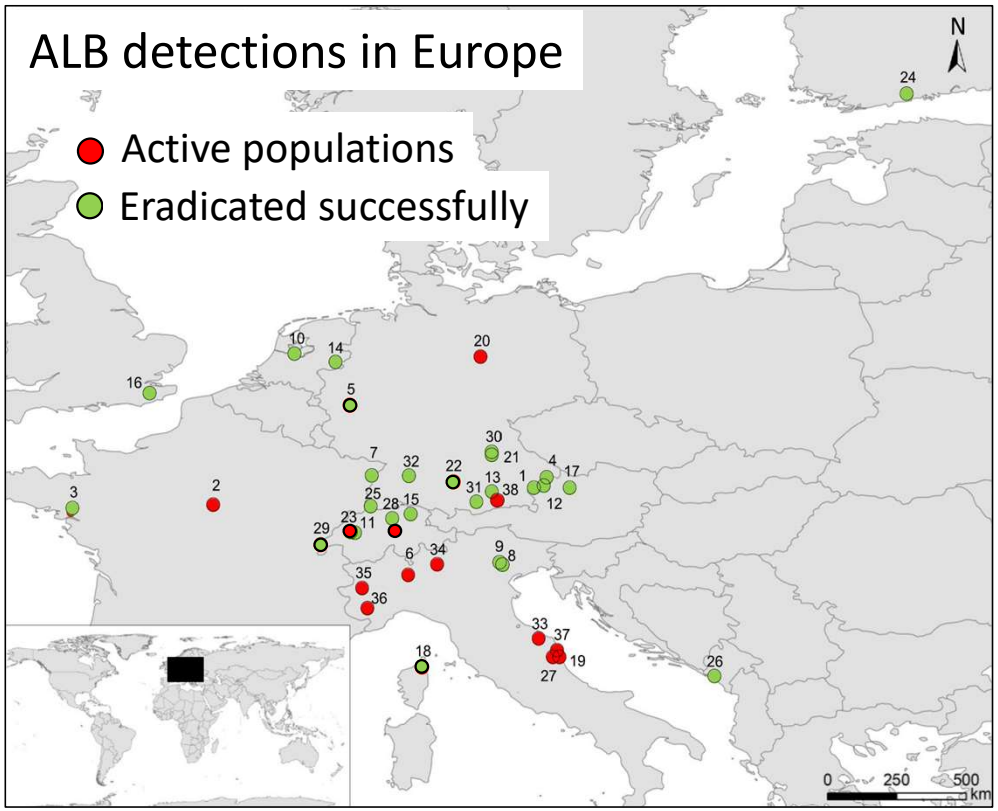
“Asian longhorn beetle” (*Anoplophora glabripennis*) eradications

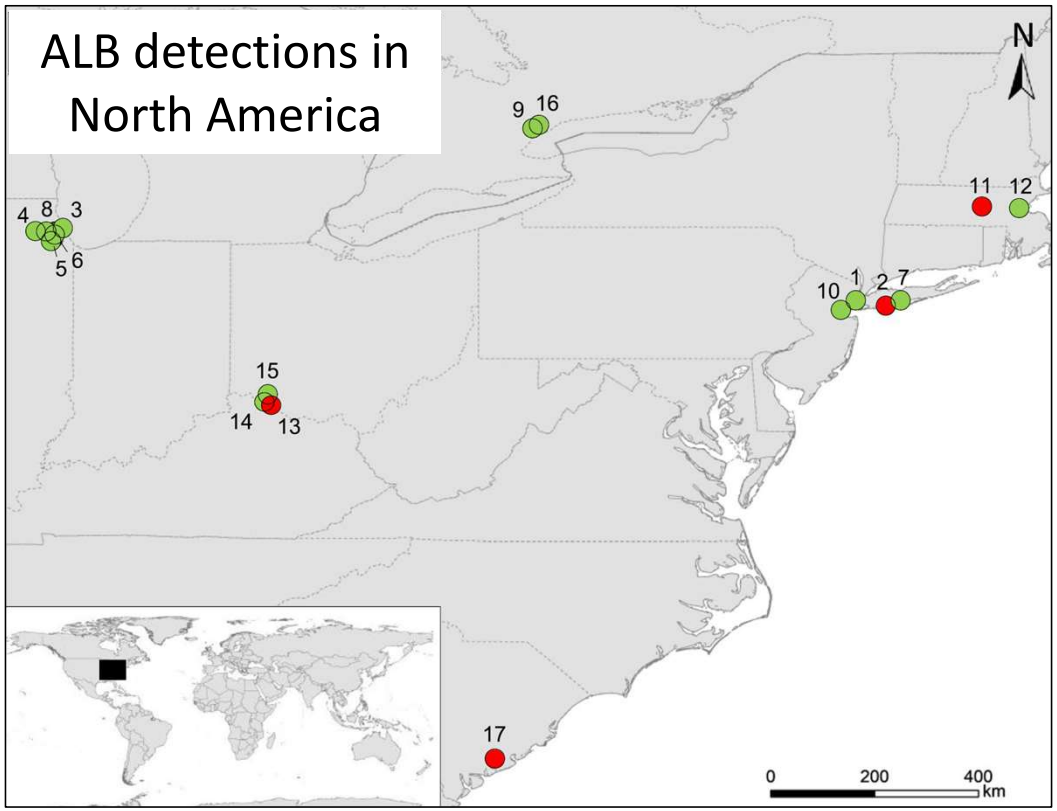
Number of ALB detections 1996-2020



Branco, Branco et al. (2014) J. Pest Science

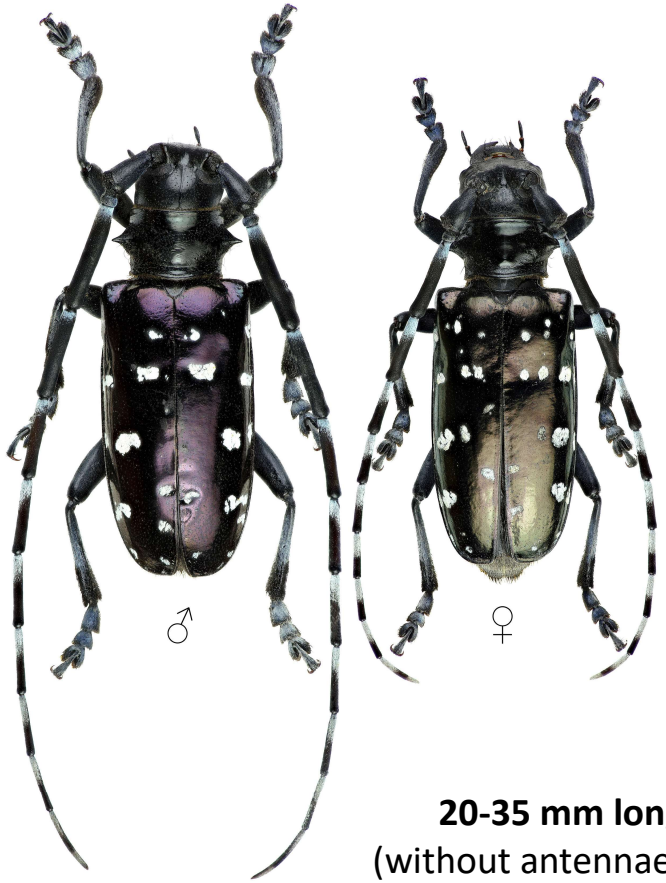
Status of ALB detections and eradications (as of 2020)





Branco, Branco et al. (2014) J. Pest Science (updated from EPPO Global Database: https://gd.eppo.int/taxon/ANOLGL/distribution)

Why are ALB eradications successful, in most cases?



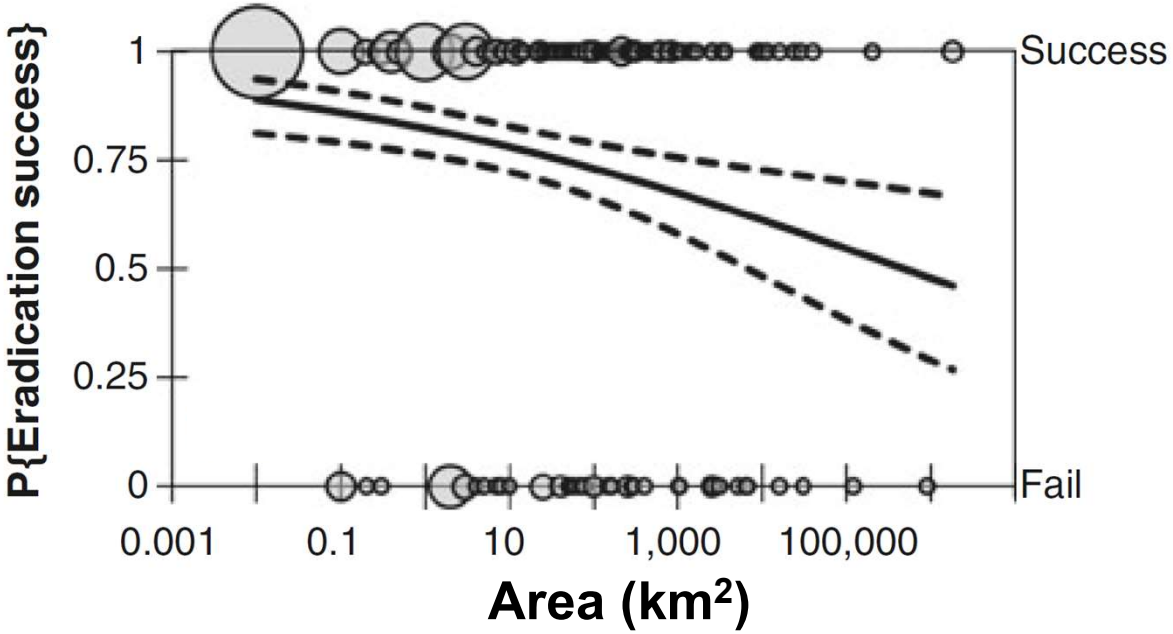
20-35 mm long
(without antennae)

Photo © Sergei O. Kakunin, https://cerambyx.uochb.cz

- **No great detection tools** (no long-range pheromone), but …
- **ALB are very conspicuous** (many detections by members of the public (citizen scientists) and officials
- **Beetles disperse slowly** (time for incursion responses)
- … and **do not disperse far** (by flight)
- **Host (tree) removal is effective for eradication**

Eradication can be highly successful

- 672 arthropod eradication programmes, 91 countries, 1890 to 2010 (**GERDA database**)



Tobin et al. (2014) Biological Invasions

→ Success rate depends on **size of infested area** (the smaller, the better)

→ **Surveillance** is critical to enable **early detection** (before an invader is widespread)

3. Eradication methods

Manual removal of egg masses
(*Lymantria dispar* in Massachusetts, late 1800s)

- not successful on this occasion
- not recommended

from Myers et al. (2000) Trends in Ecol. and Evol.

Most common methods

- Host removal and destruction
- Pesticide application
- Mating disruption (with pheromones)
- Sterile insect technique
- Qurantine and movement control
- Public awareness …

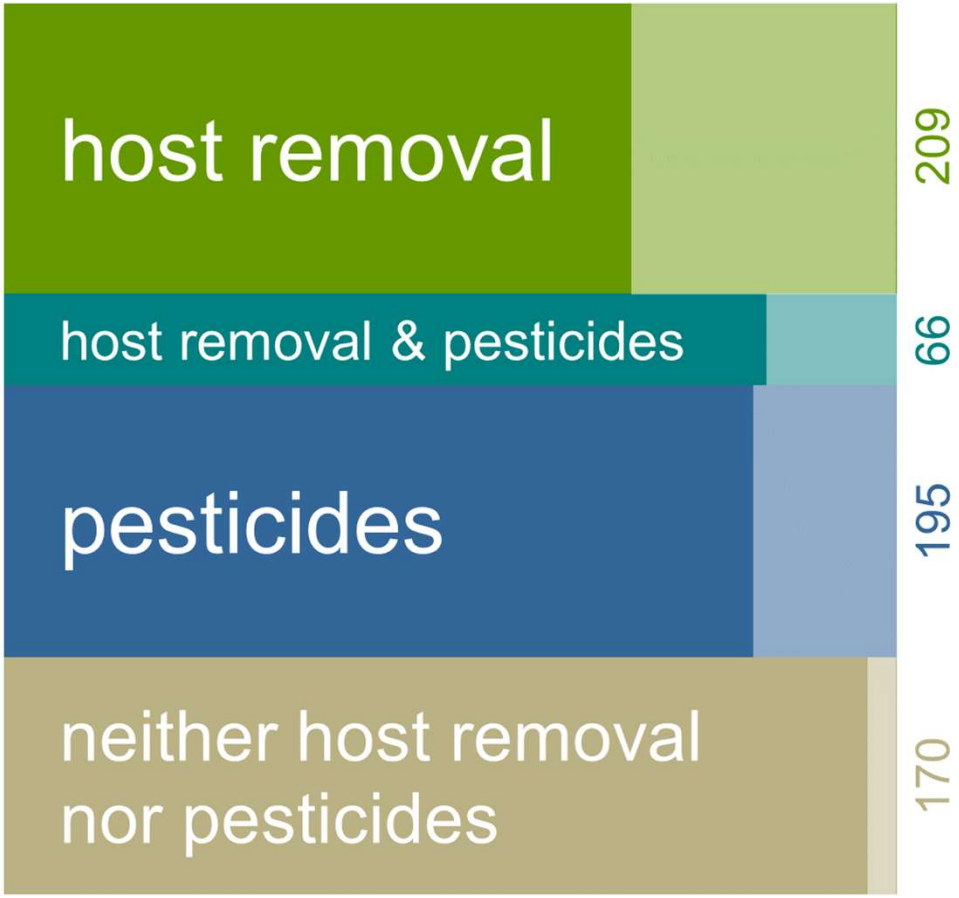
DONTMOVEFIREWOOD.org

Protect the Trees You Love
From Tree-killing Bugs

Most common methods & their success rates

- **640 cases** (mostly insects, some pathogens) where outcome known
- Darker shades – successful
- Lighter shades – unsuccessful
- from 'GERDA' (the Global Eradication and Response Database)

  http://b3.net.nz/gerda/



Barron, Liebhold, Kean, Richardson & Brockerhoff (2019) J. Appl. Ecol.

4. When eradication *likely* is or isn't possible

Eradication possible when …

+ **Effective detection tools** (and delimitation tools) available
+ **Early detection** possible (effective surveillance, slow dispersal)
+ **Eradication tools & treatments available** (and ready to use)
+ **Incursion response plans, financial resources & staff**
+ **Communication with stakeholders and the public** (participatory)

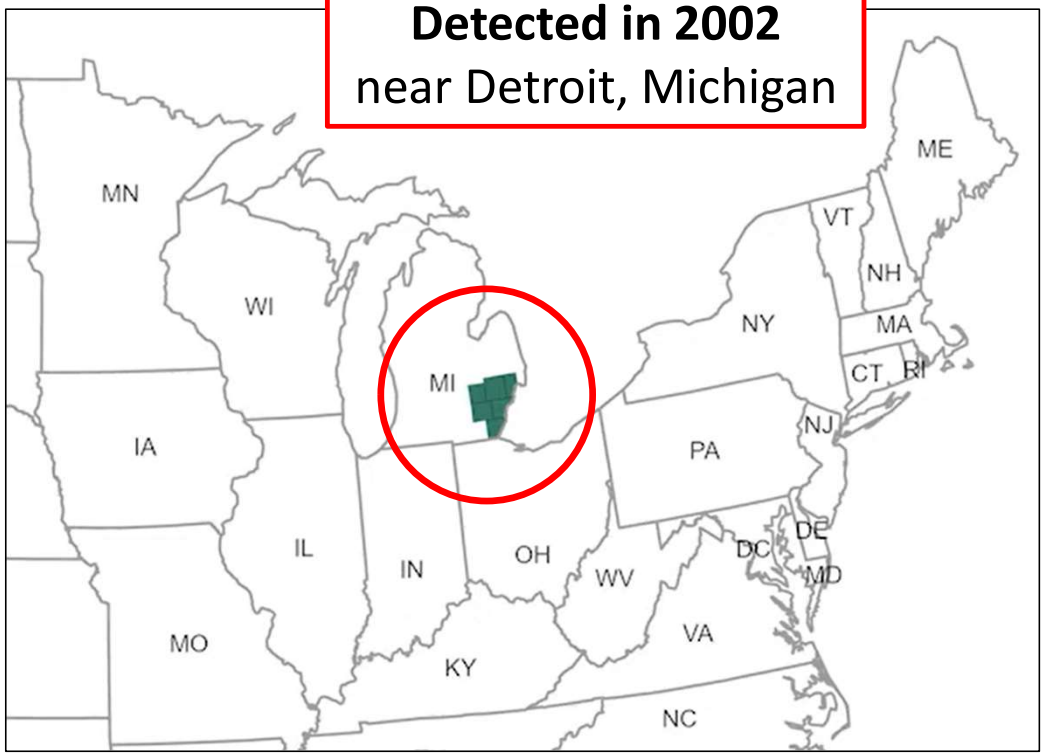
Eradication difficult or impossible when …

- **No effective detection tool** (e.g., no long-range pheromones)
- **Early detection unlikely** (e.g., damage symptoms appear after pest dispersal)
- **No treatment methods** (or **methods that are controversial**, e.g., pesticide use)

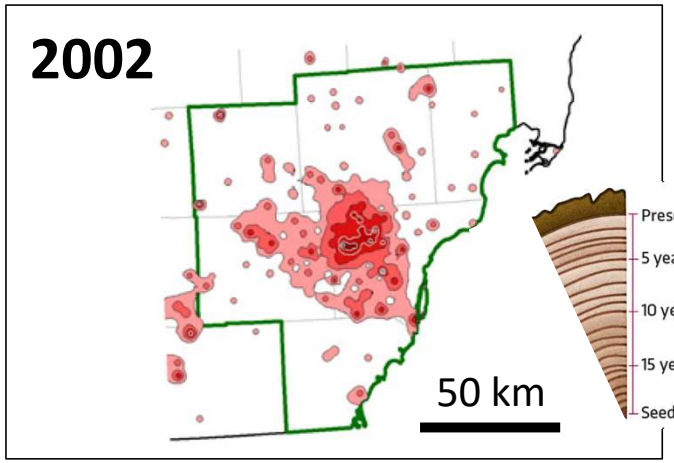
Brockerhoff et al. (2010) New Zealand Journal of Forestry Science; Liebhold et al. (2016) Annual Review Entomology

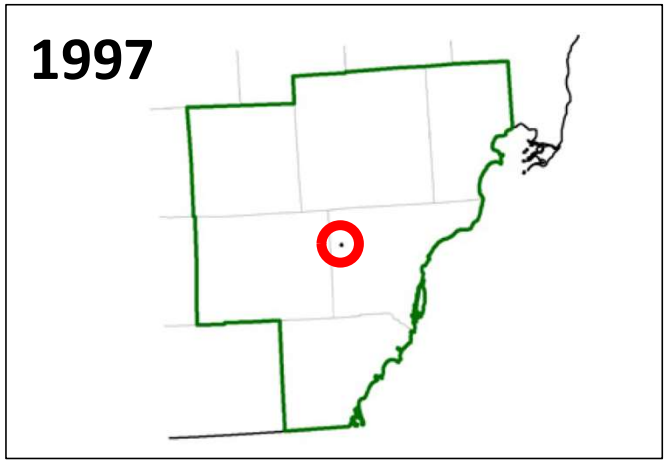
5. EAB (*Agrilus planipennis*) invasion in North America

Detected in 2002
near Detroit, Michigan



USDA APHIS EAB Infestation Time Series Spread Map
www.youtube.com/watch?v=D3Rte2zVRqU

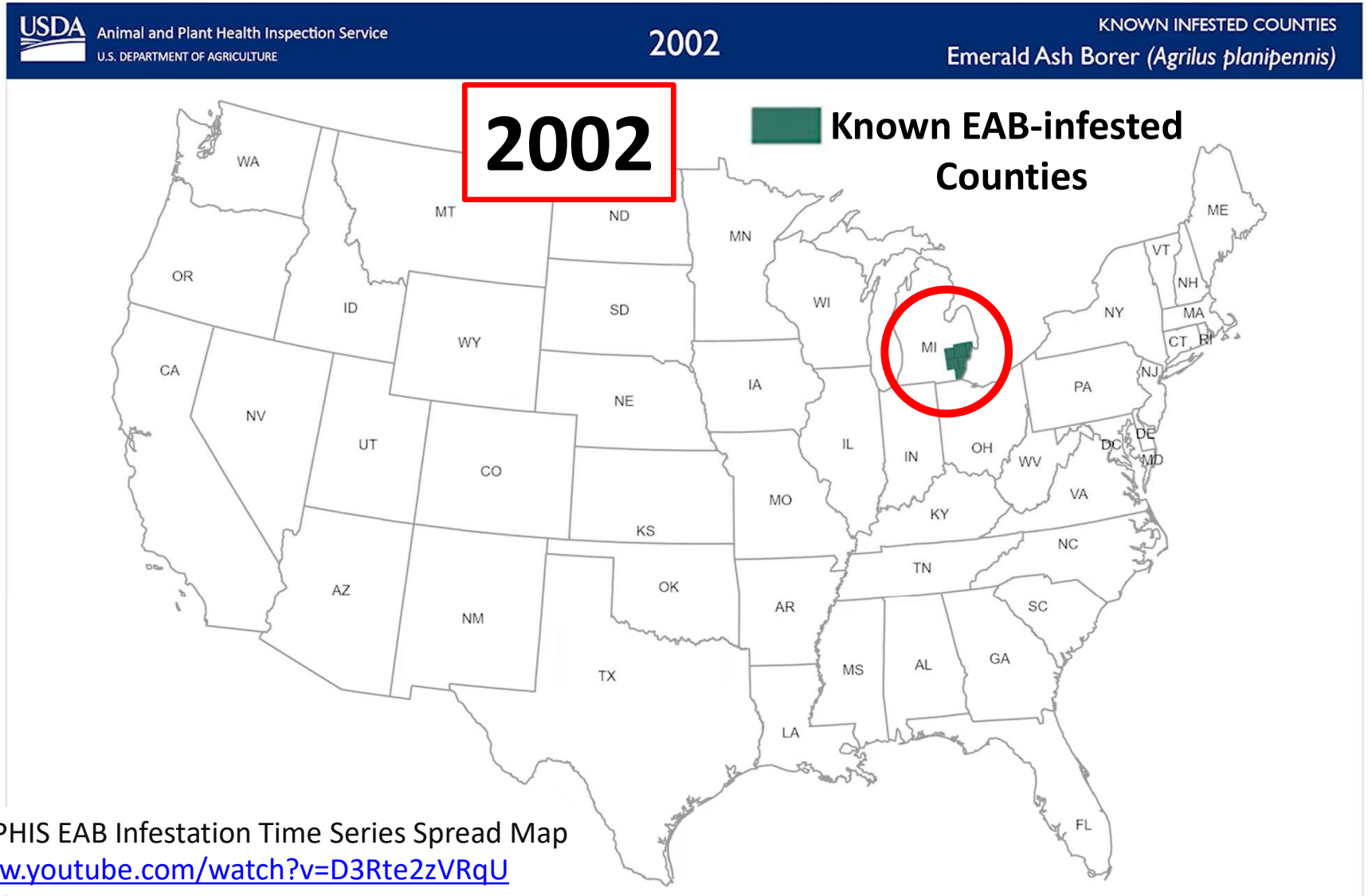




Actual establishment earlier, probably early 1990s

Siegert et al. (2014) Diversity Distrib.

www.sciencefocus.com/nature/climate-csi-how-counting-tree-rings-can-unlock-environmental-mysteries



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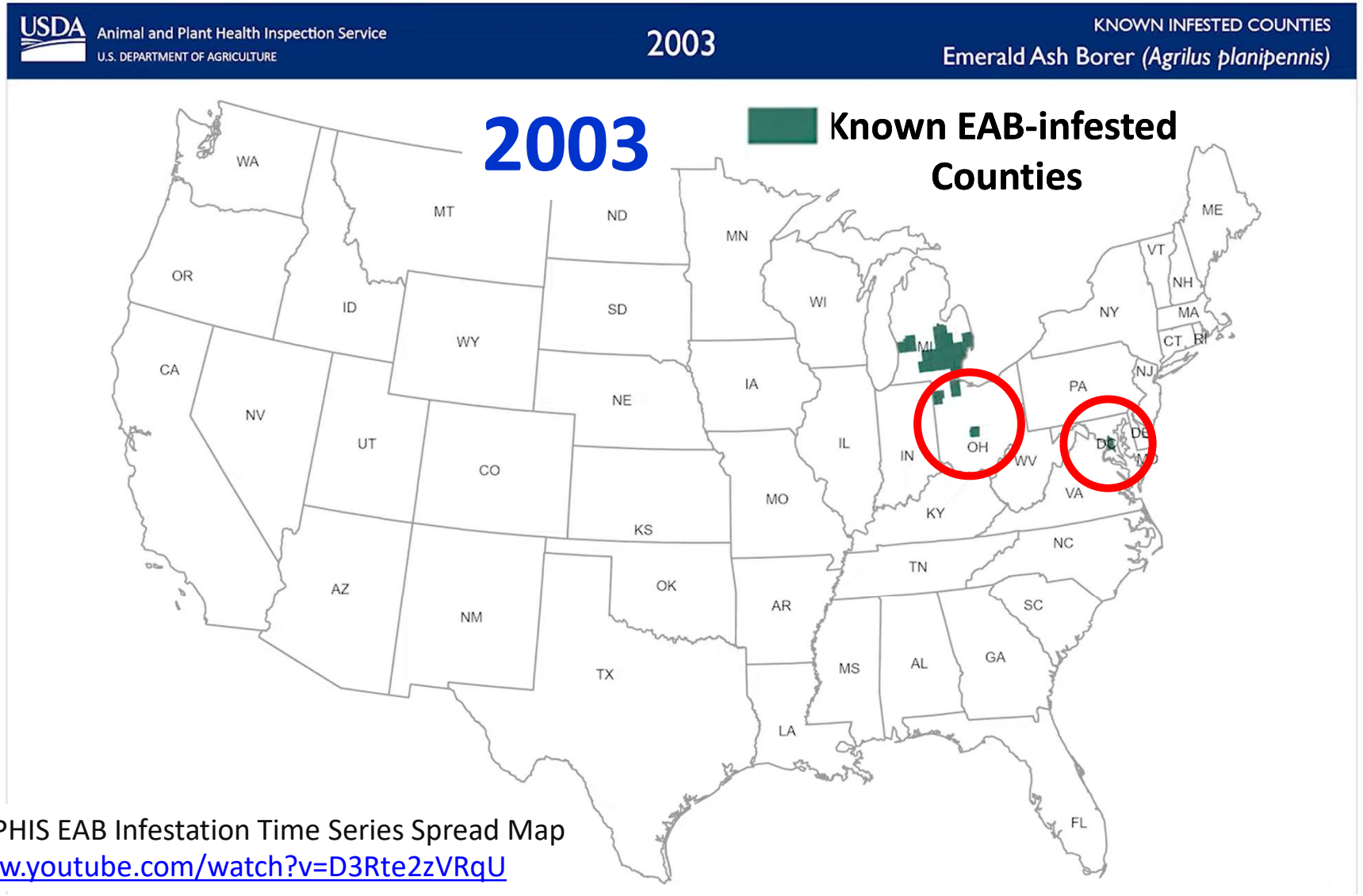

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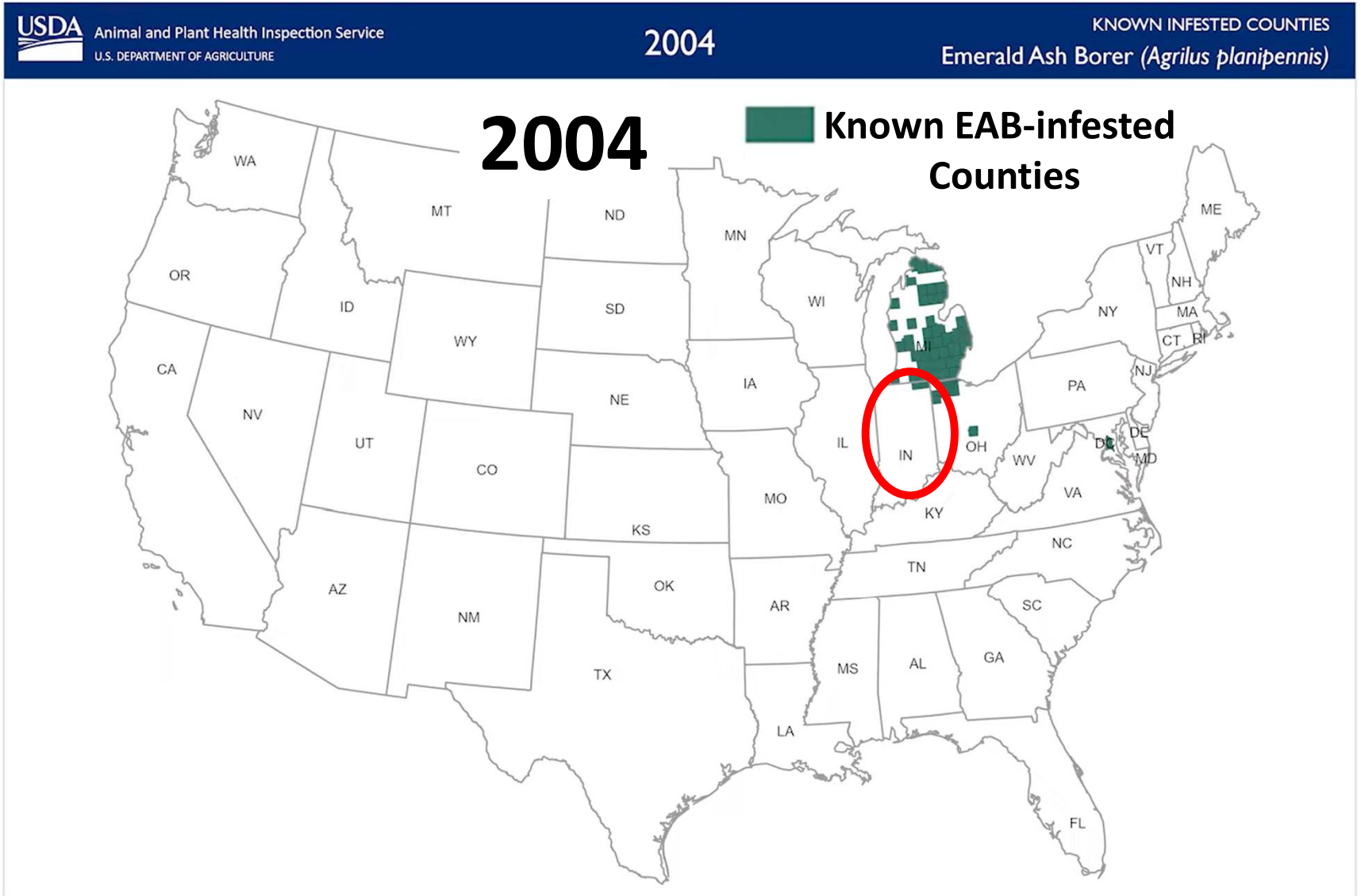
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Animal and Plant Health Inspection Service
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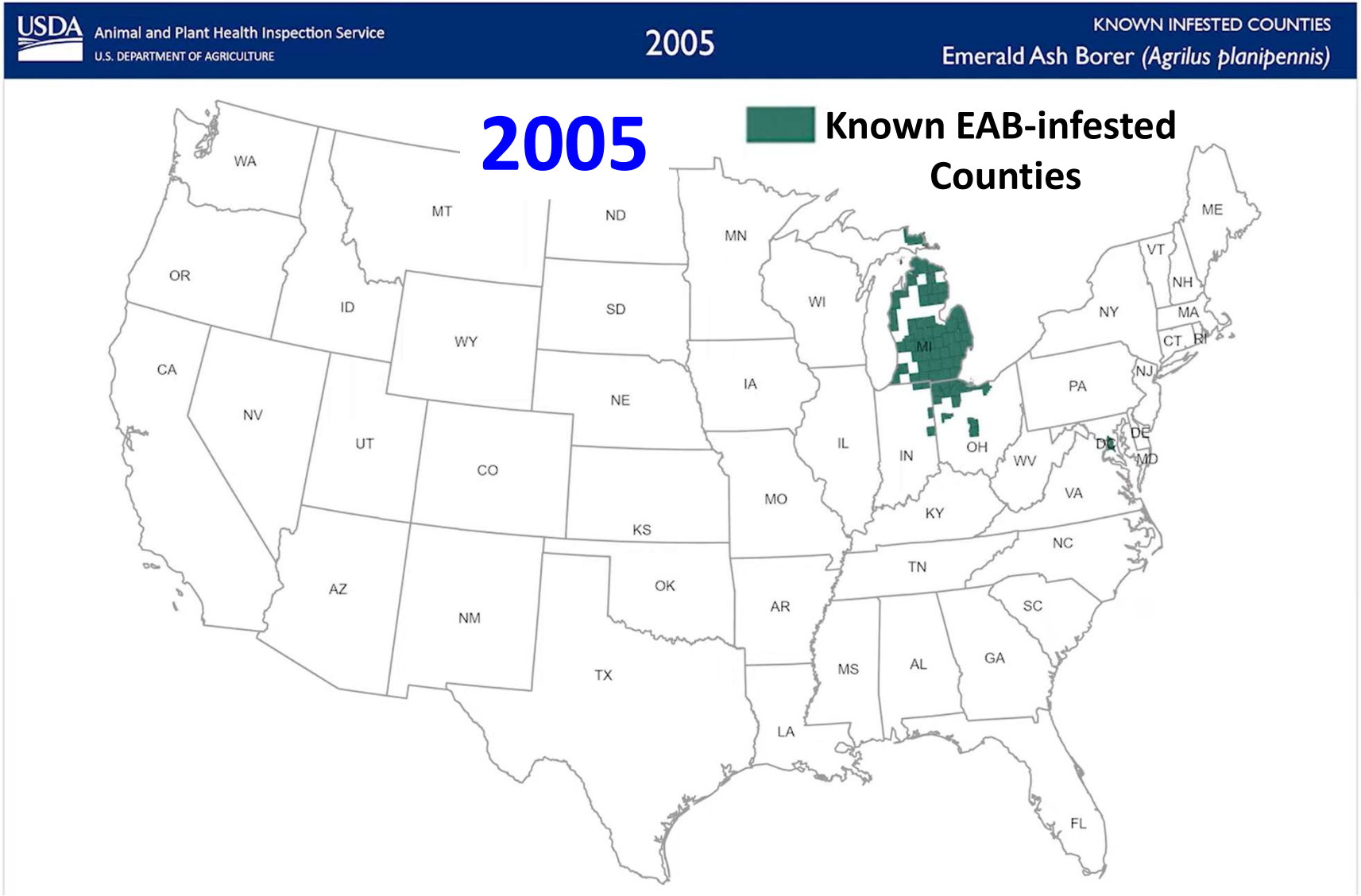
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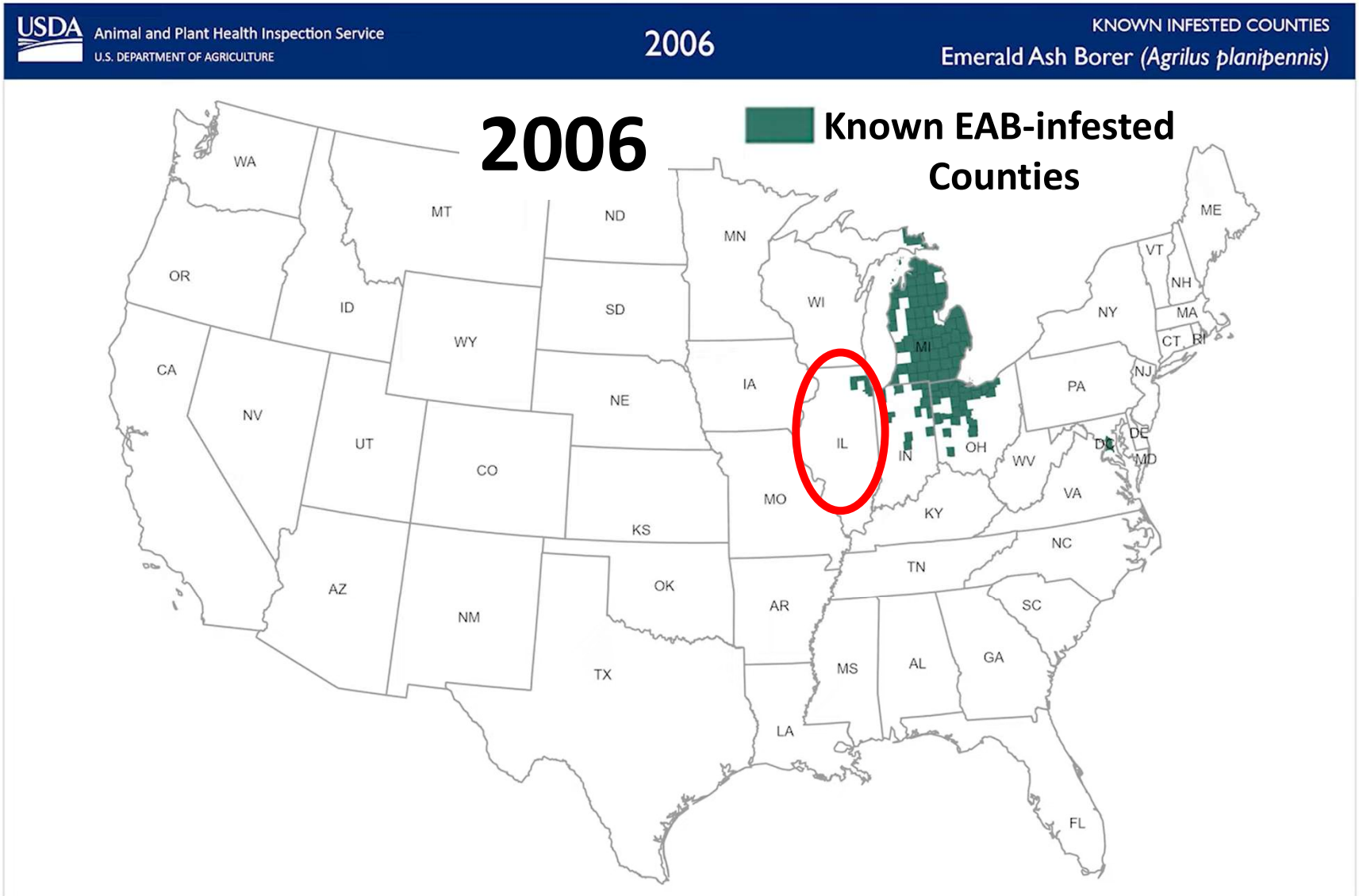
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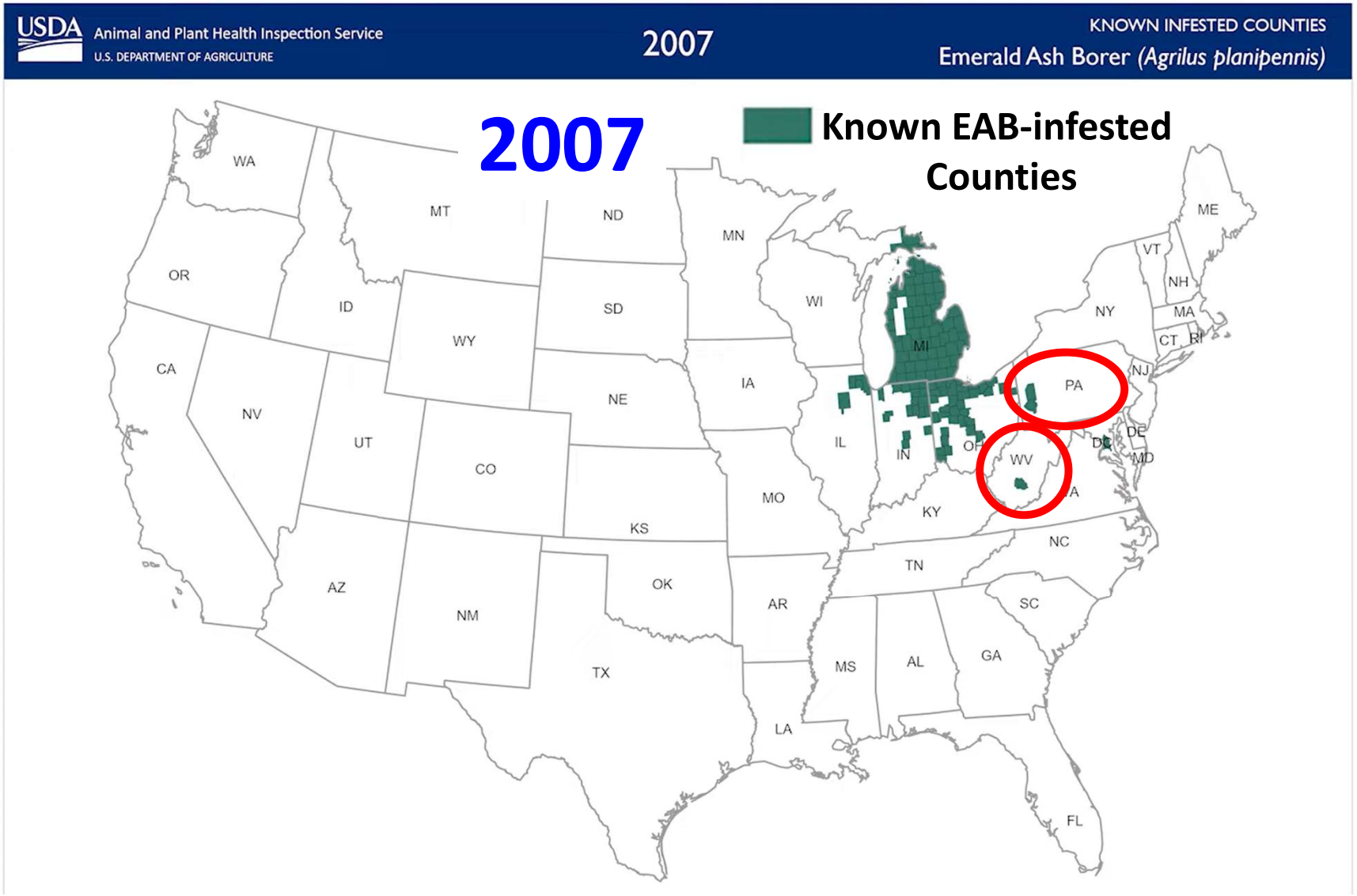
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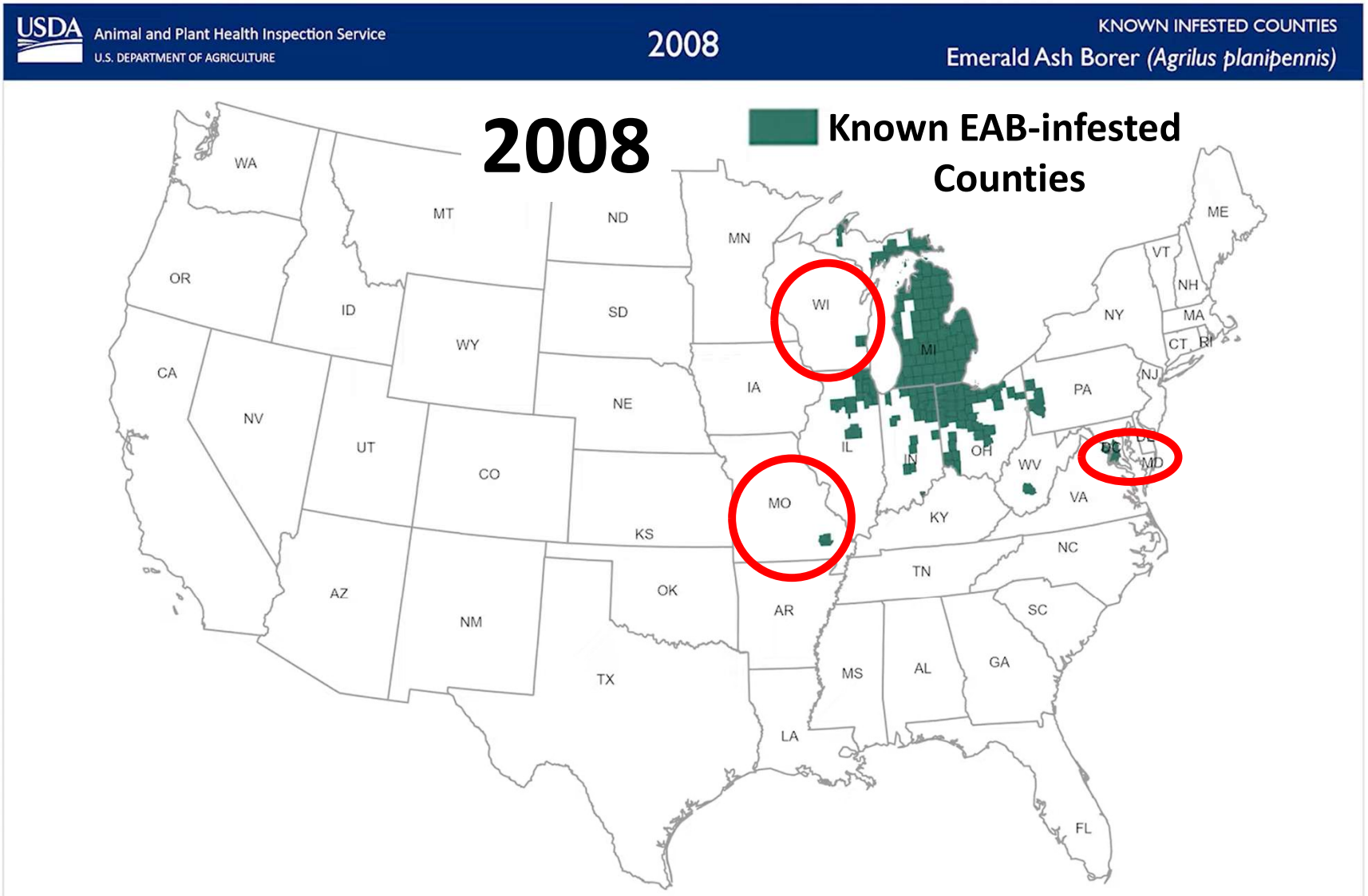
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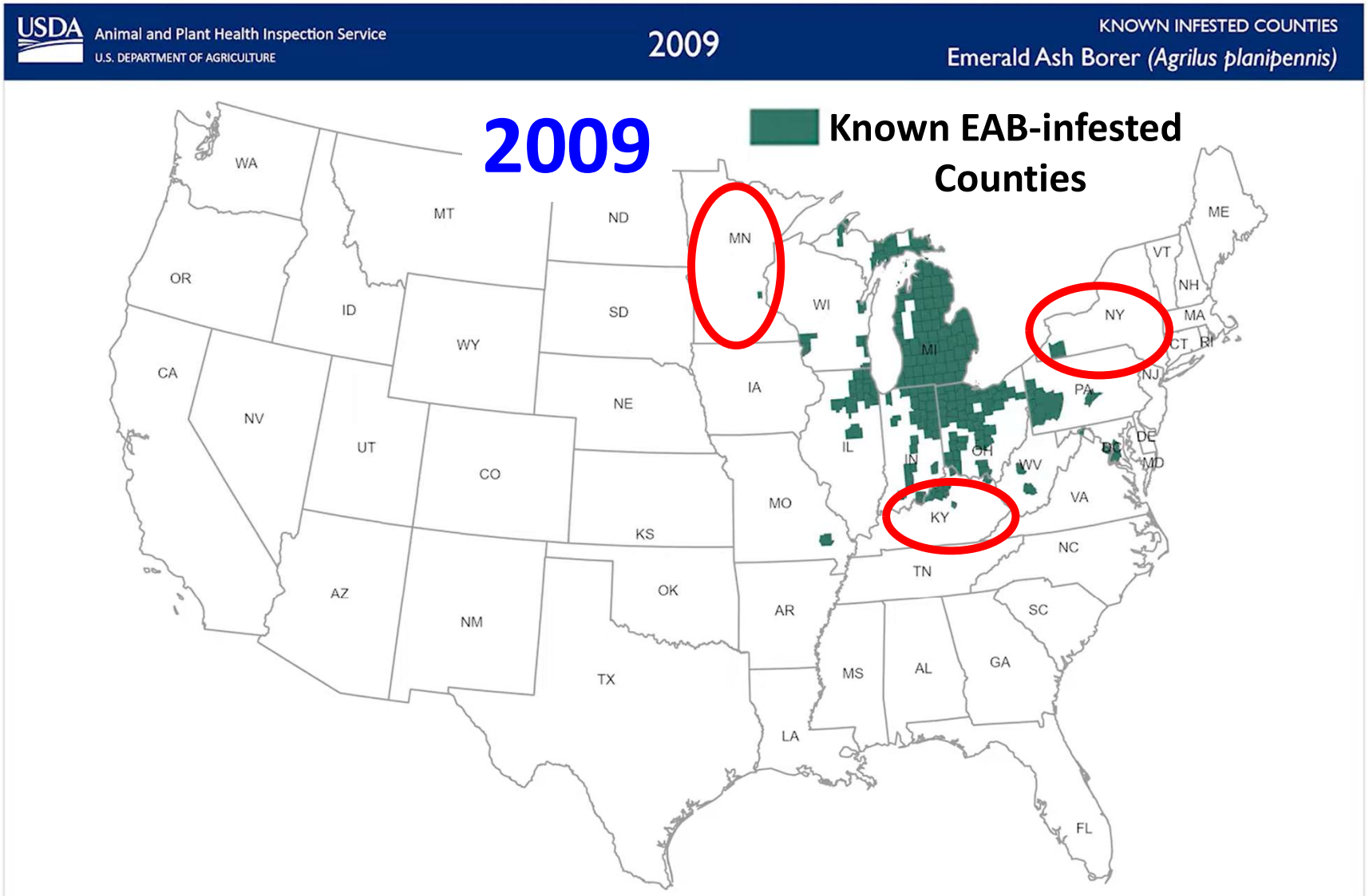
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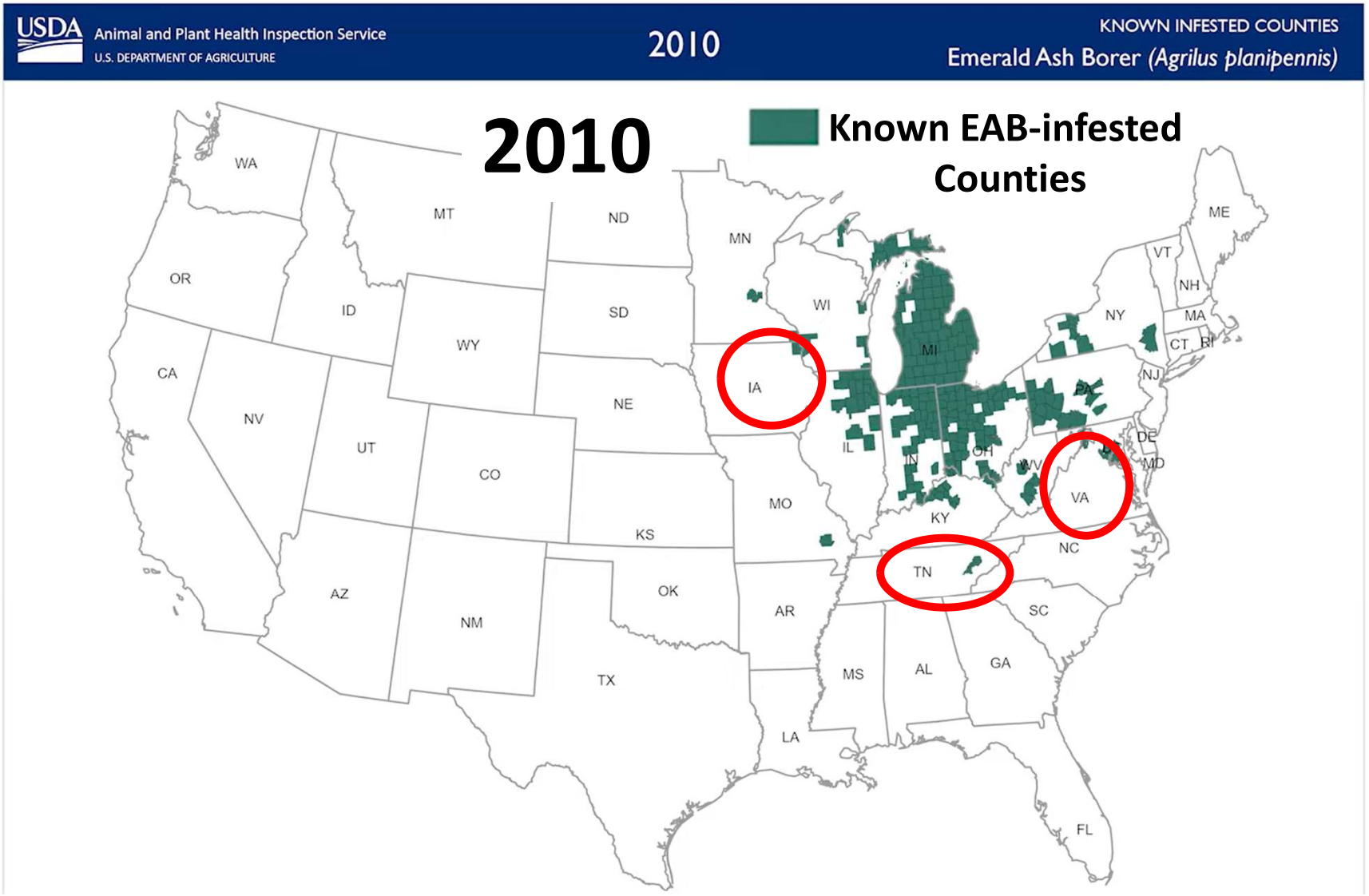
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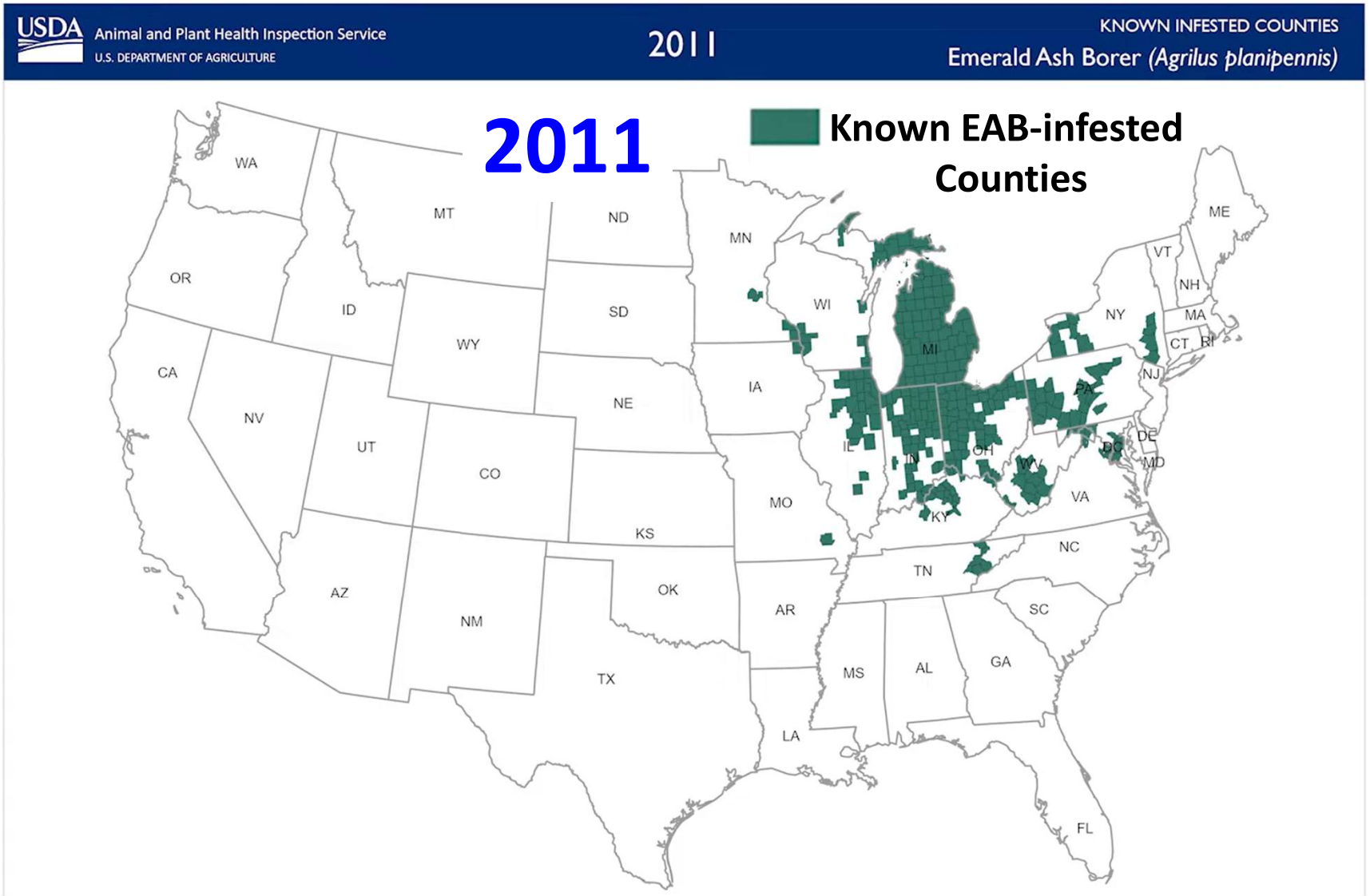
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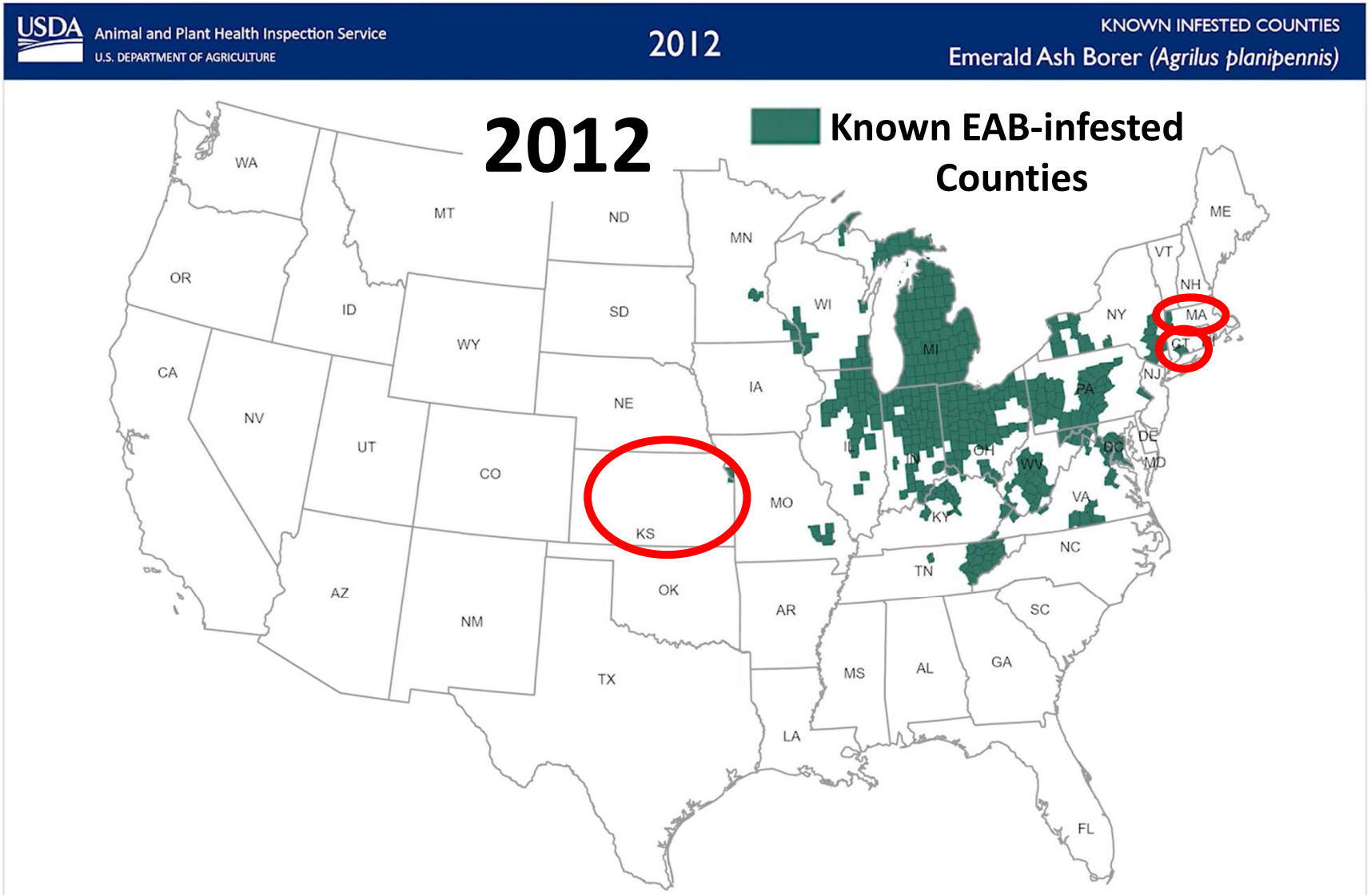
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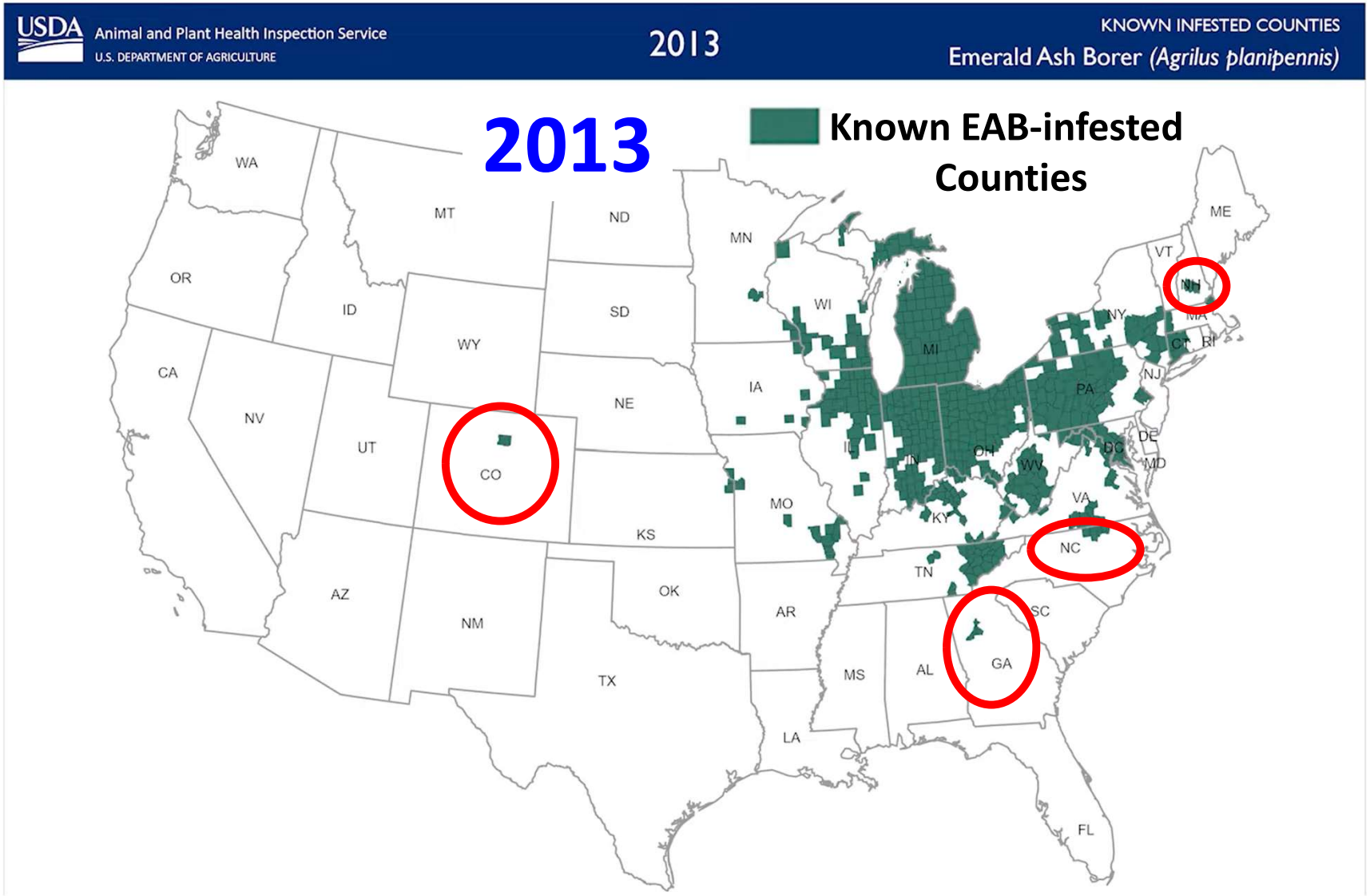
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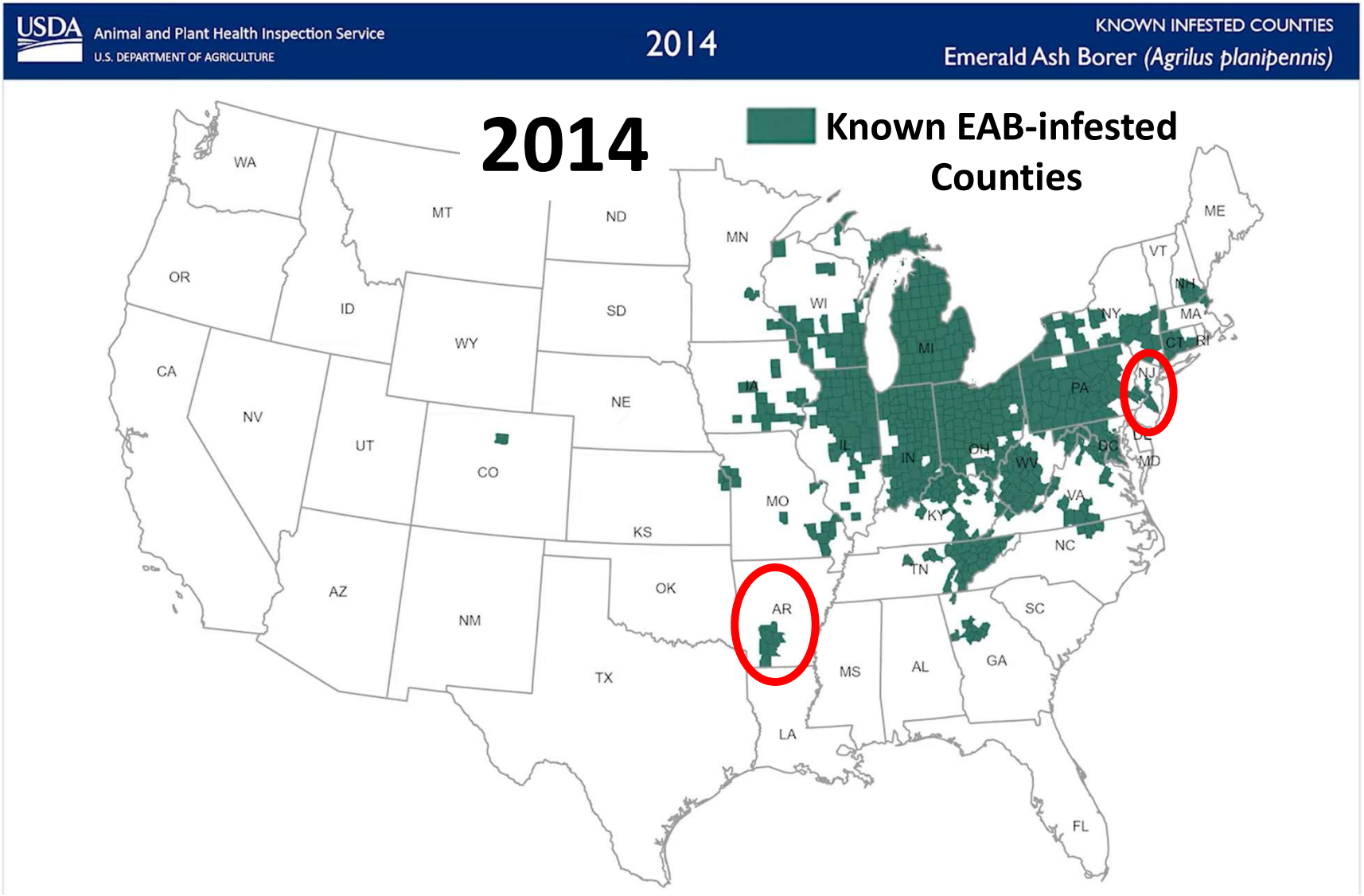
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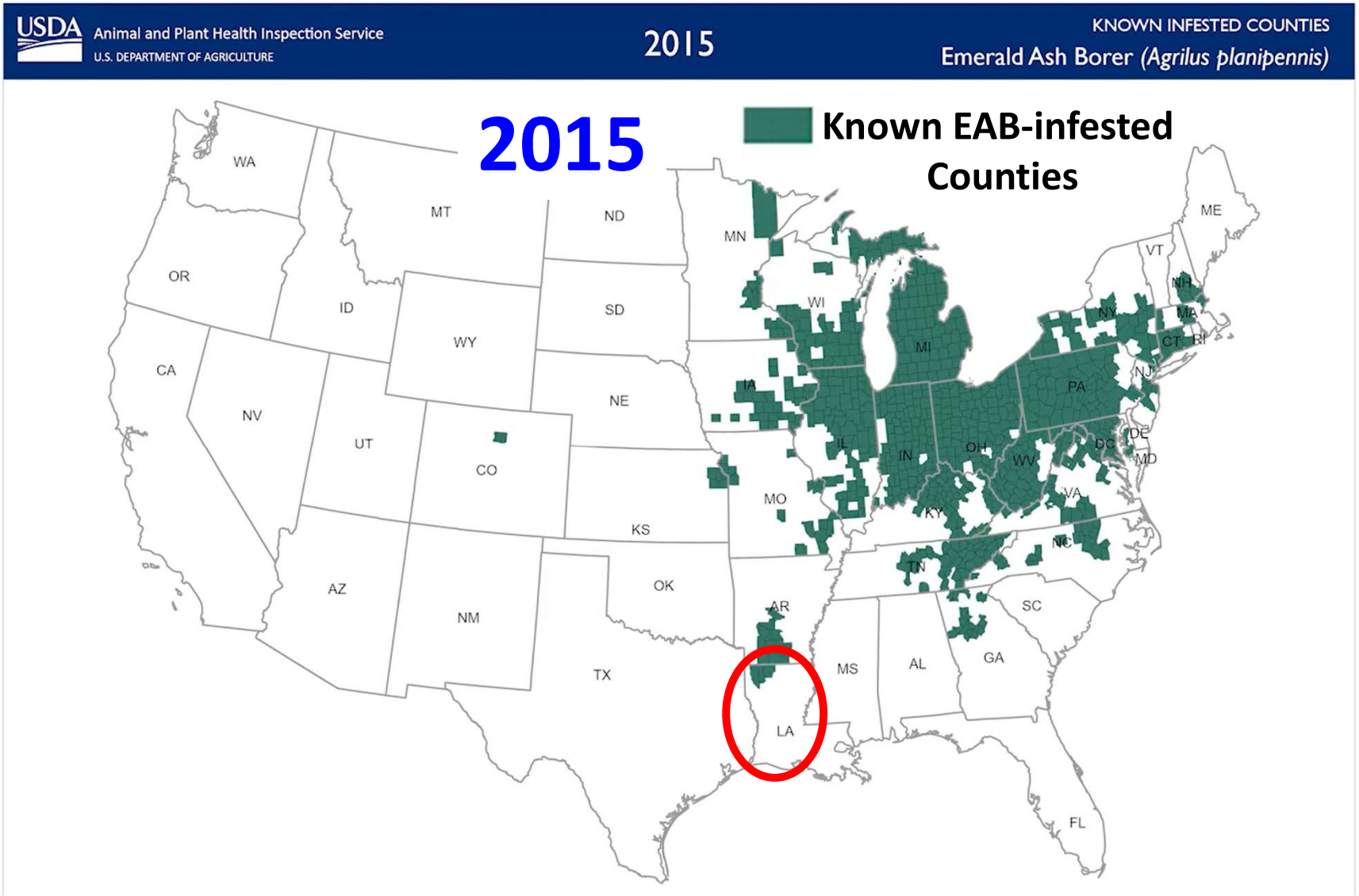
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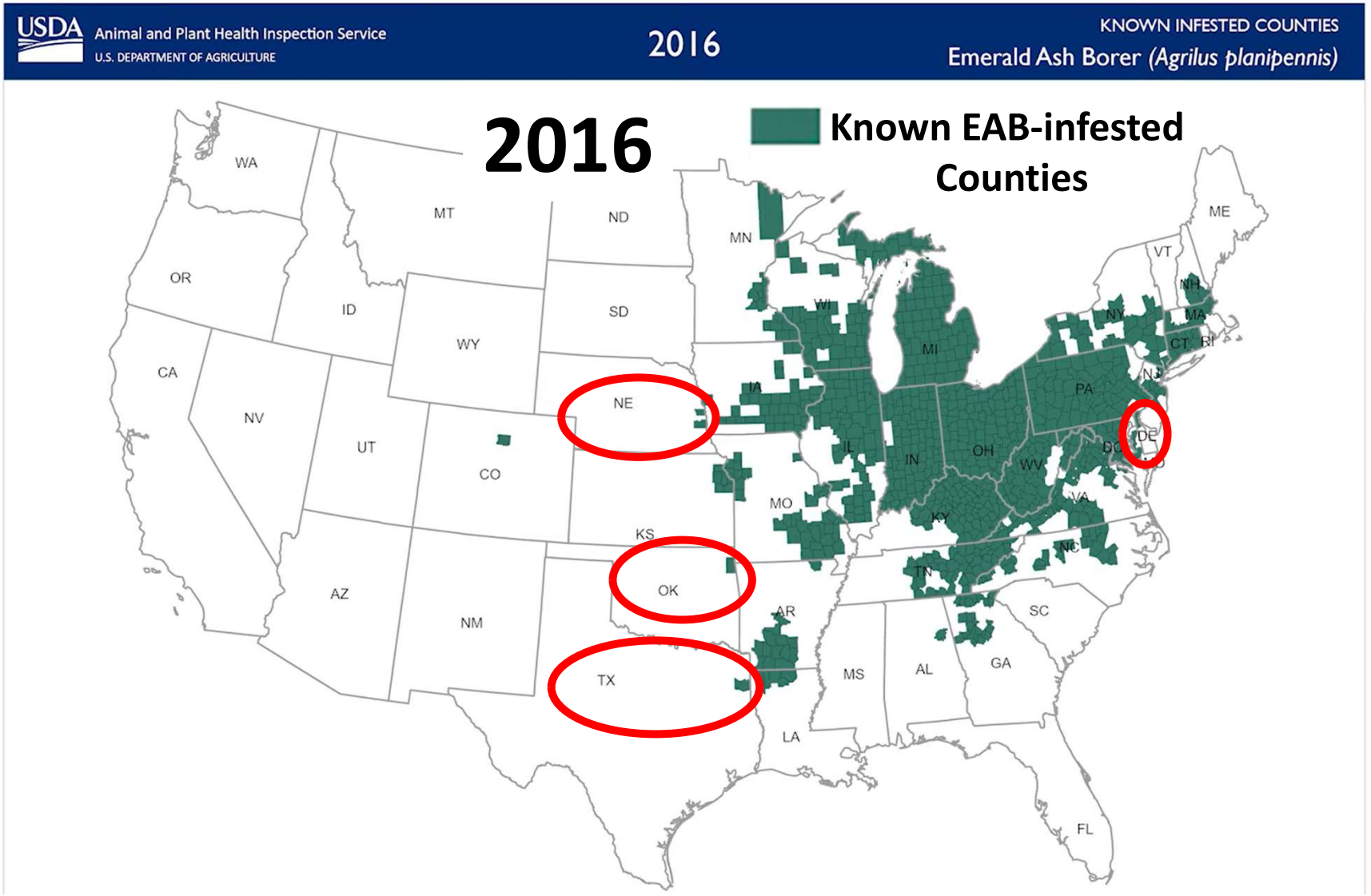
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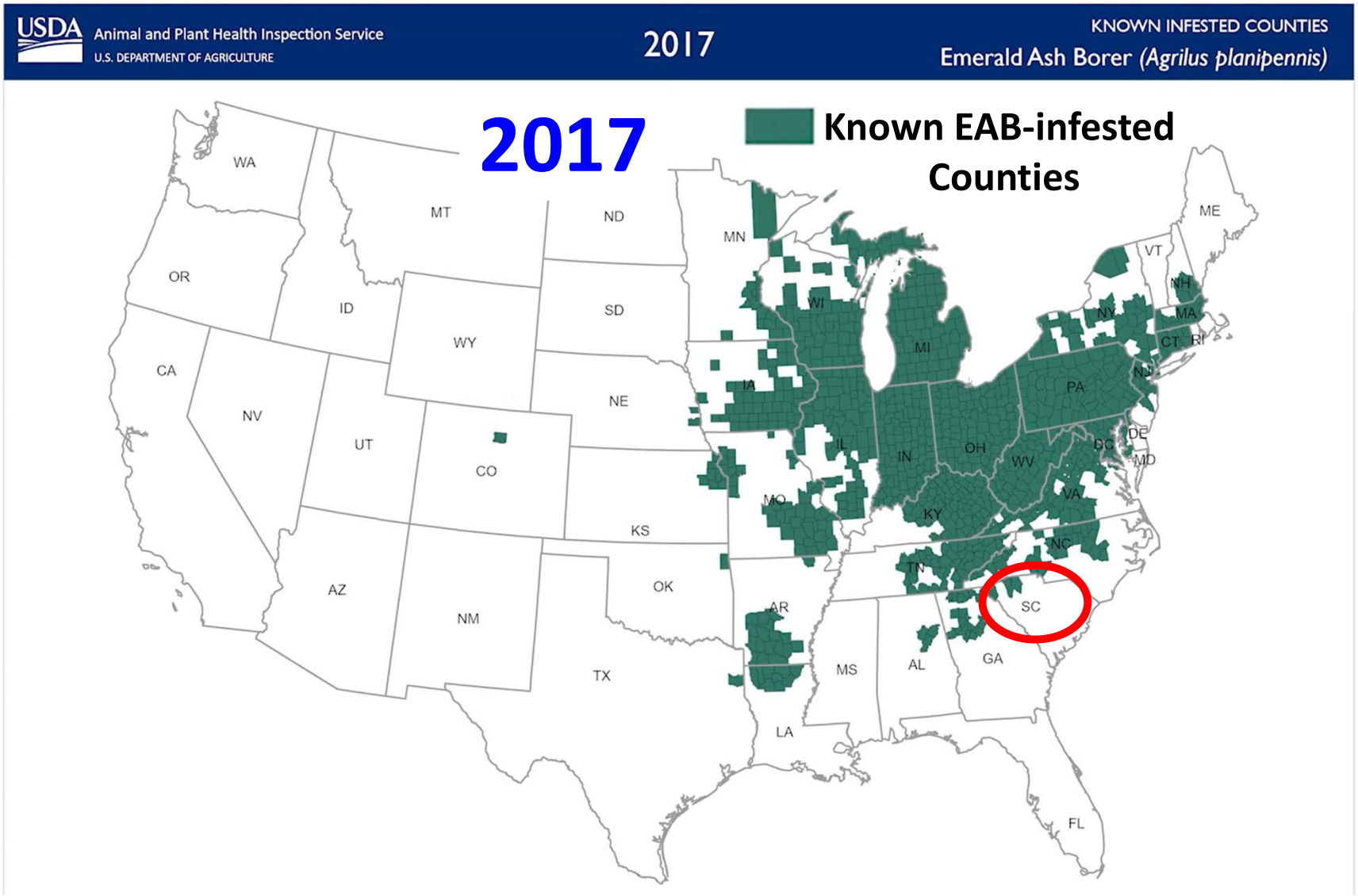
USDA
Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE
2017
KNOWN INFESTED COUNTIES
Emerald Ash Borer (Agrilus planipennis)
2017
Known EAB-infested Counties
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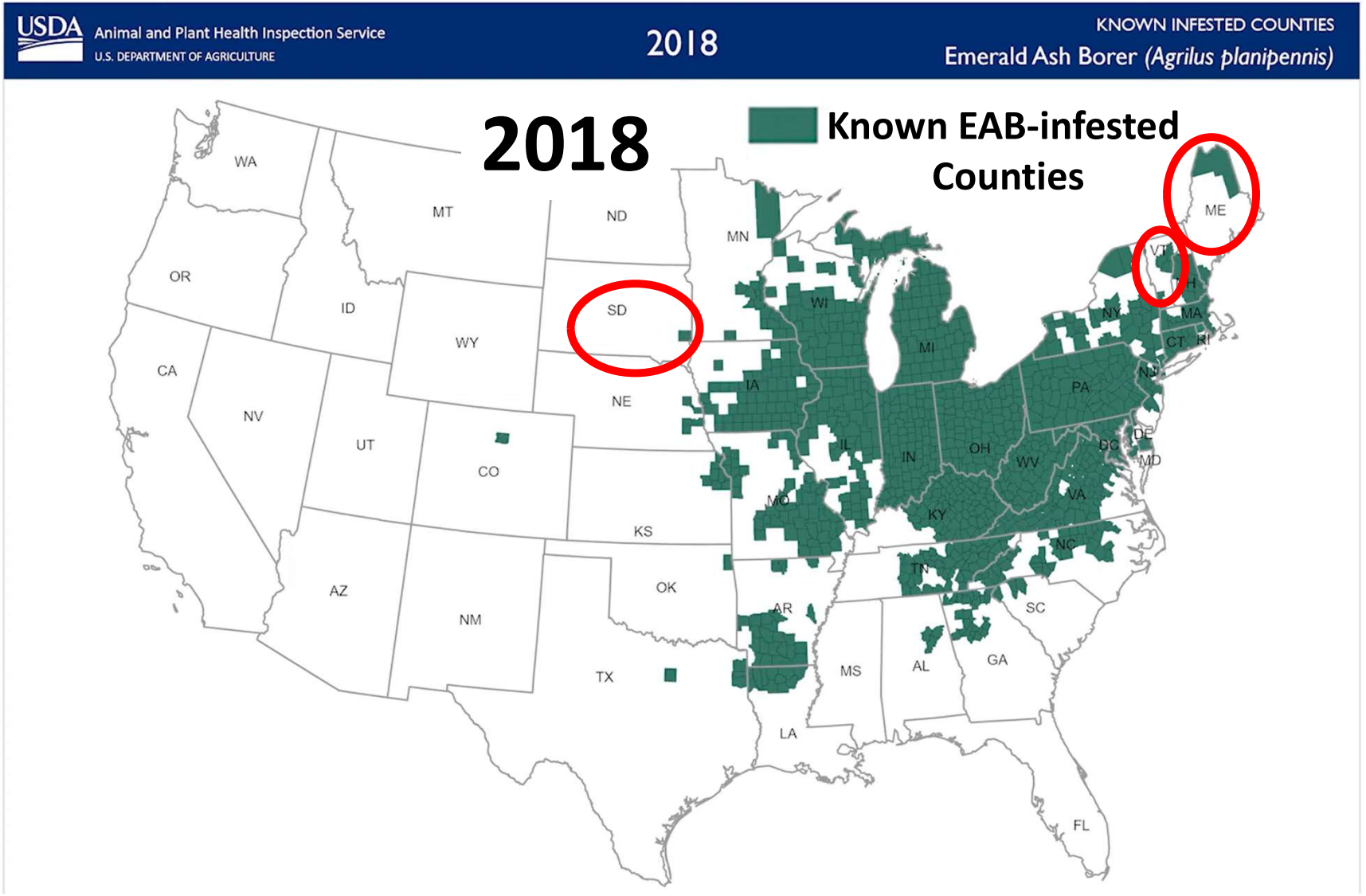
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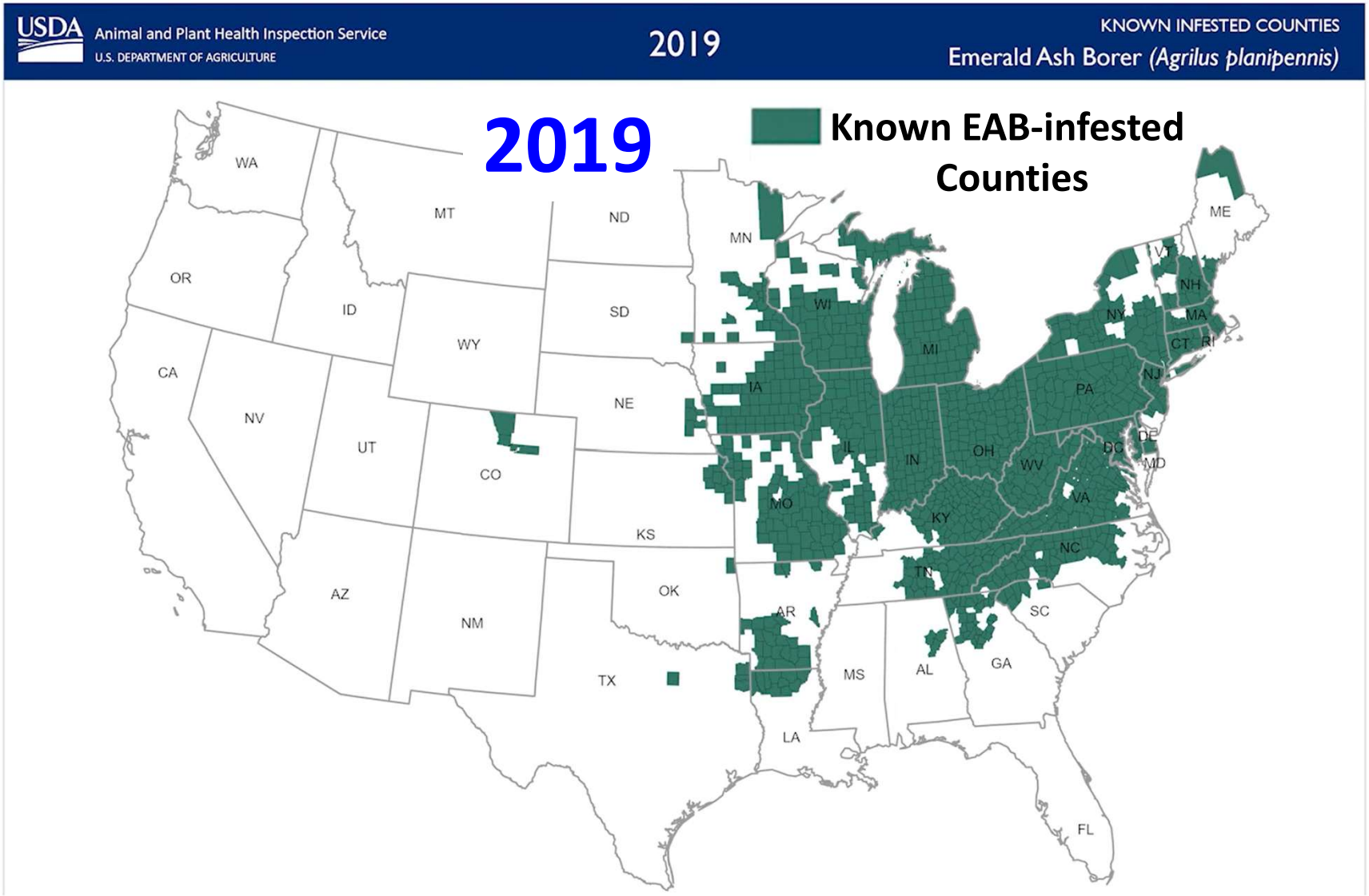
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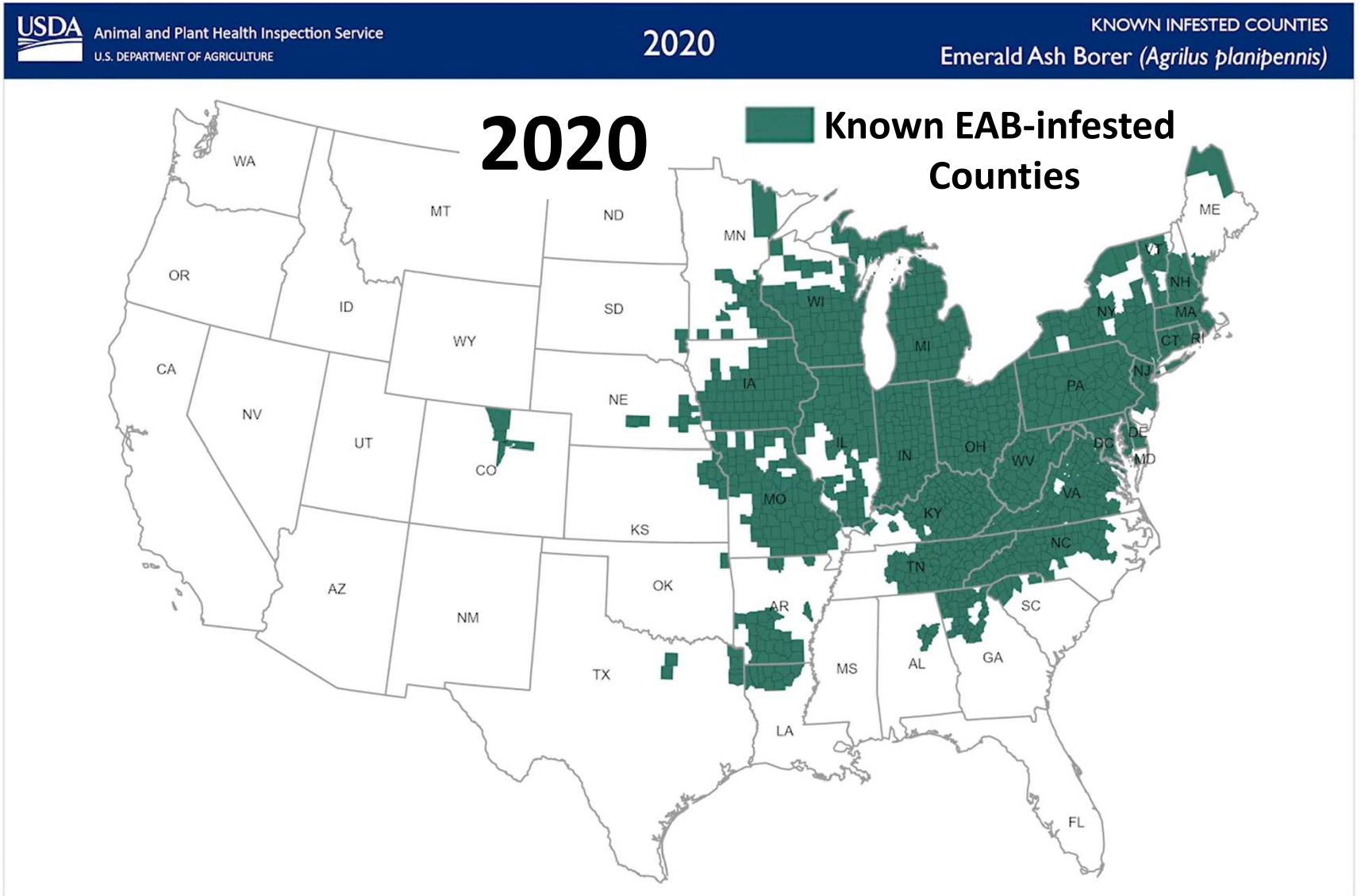
USDA
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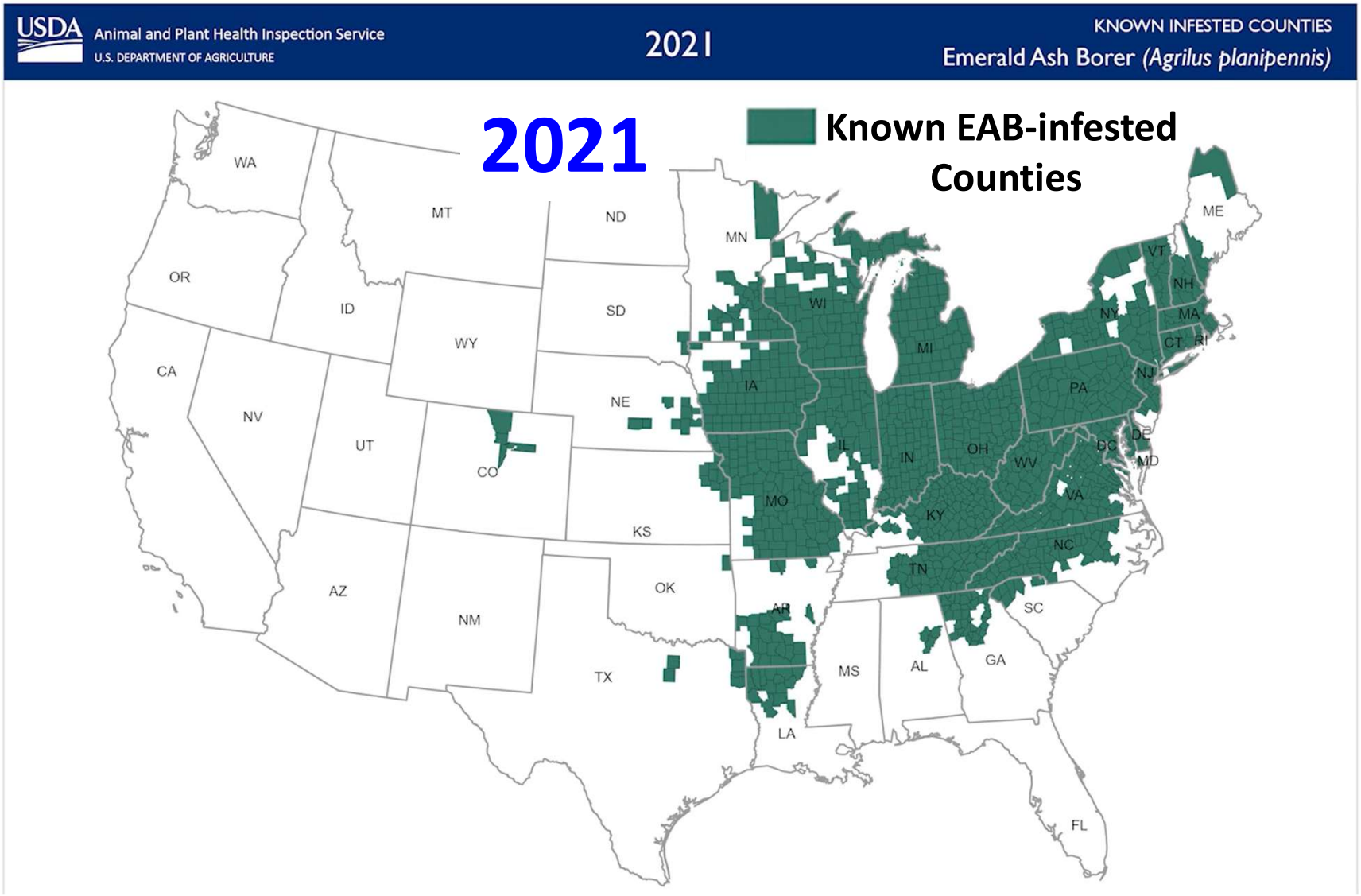
USDA
Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE
2021
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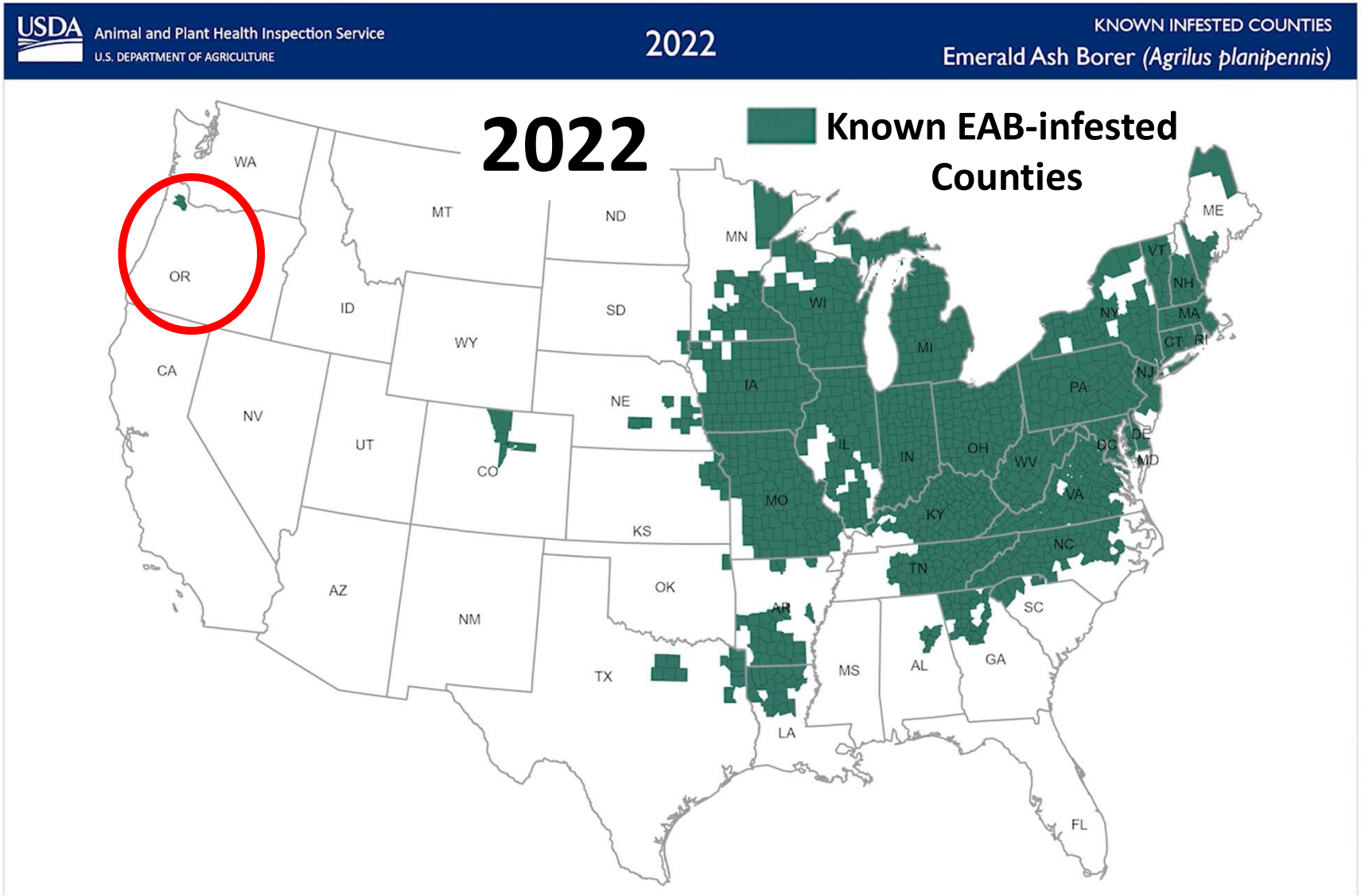
USDA
Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE
2022
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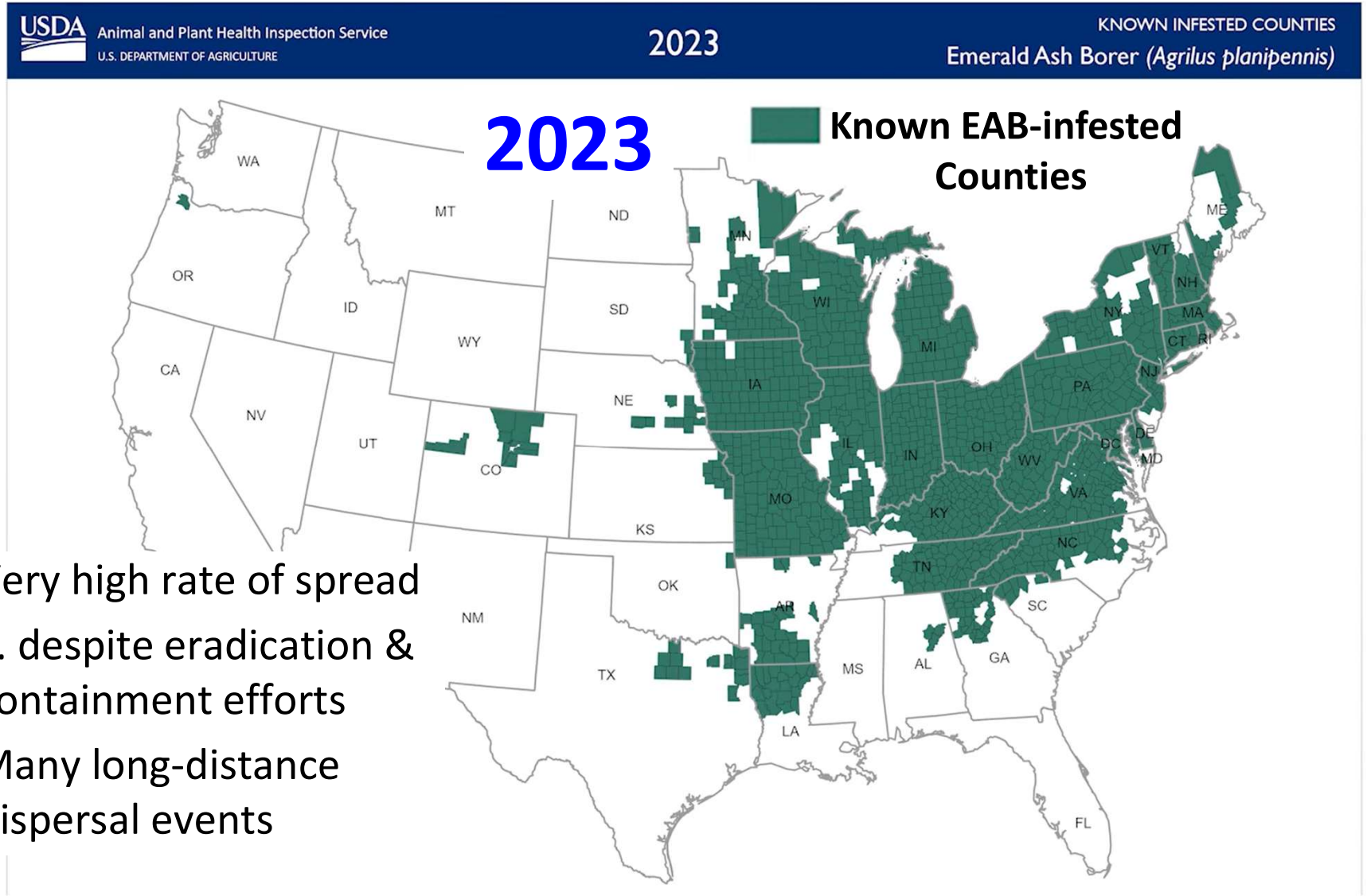
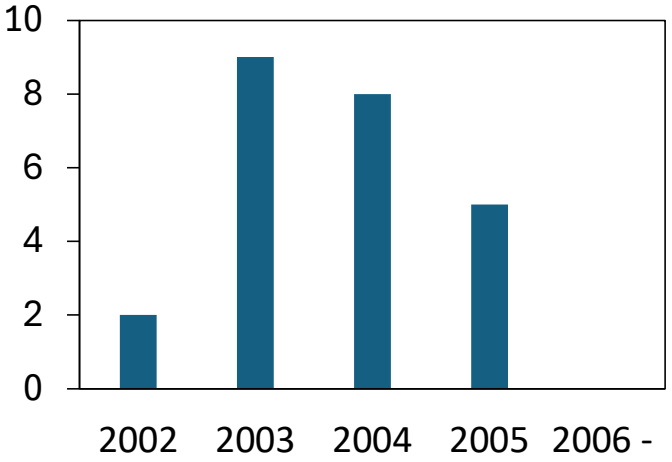


- Very high rate of spread
- … despite eradication & containment efforts
- Many long-distance dispersal events

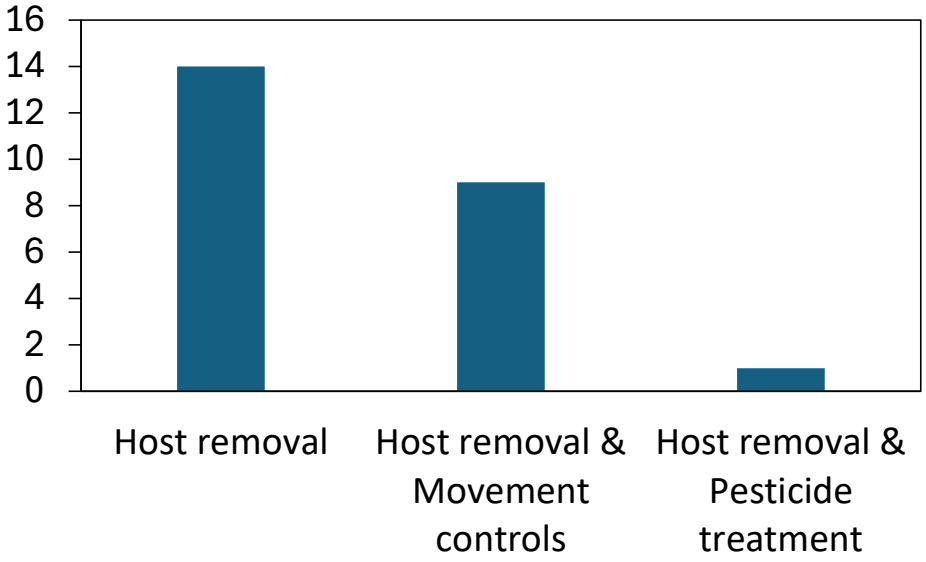
6. Attempts to eradicate EAB in North America

- **24 EAB eradication attempts** in Gerda
- 11 OH, 8 MI, 2 IN, 1 MD, 1 VA, 1 ON
- **All unsuccessful**

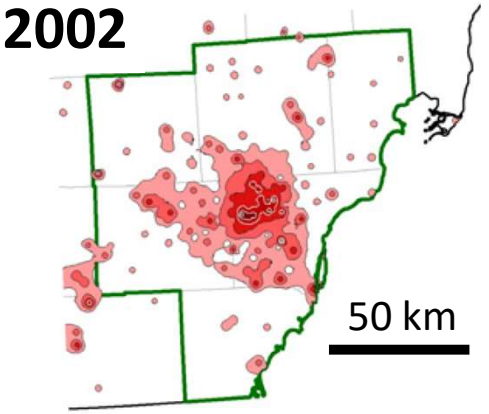
Number of eradication attempts by year of detection



Number of eradication attempts by eradication method used



Reasons for lack of EAB eradication success



- Initial incursion detected very late, already very widespread
- Containment of infestation unsuccessful (human-assisted spread)
- Detection was, and remains, difficult because:
  - External signs of infestation (EAB exit holes, woodpecker holes) usually begin in upper canopy; difficult to see
  - External symptoms only noticeable about 4 years after infestations began
  - By then, many adults already dispersed

Woodpecker holes

Adult EAB exit hole

Canopy dieback

Early detection by surveillance trapping?

Trap designs compared in Michigan & Ontario, sites with low EAB densities

Canopy traps

APHIS green funnel

Green panel

APHIS dark purple panel

Double-Deckers

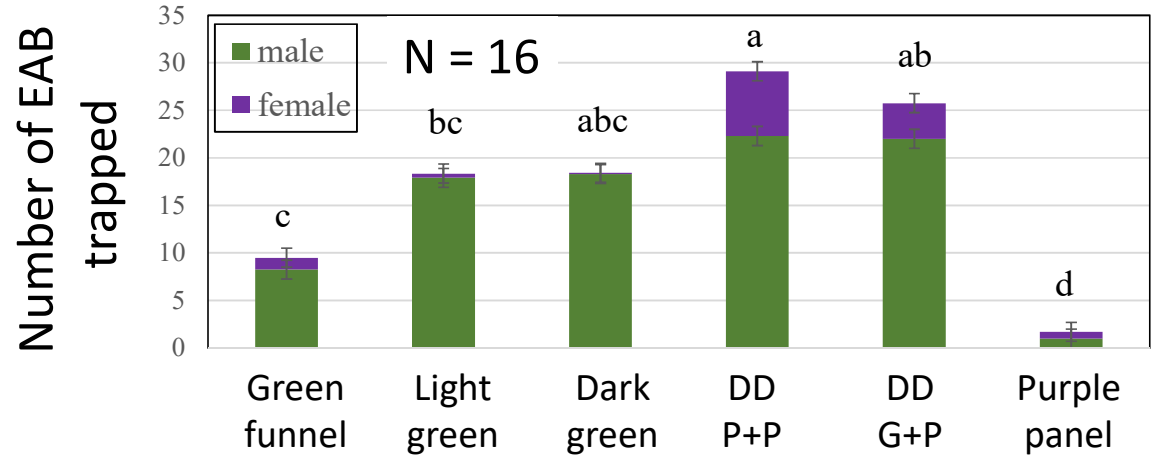
Light green Light purple

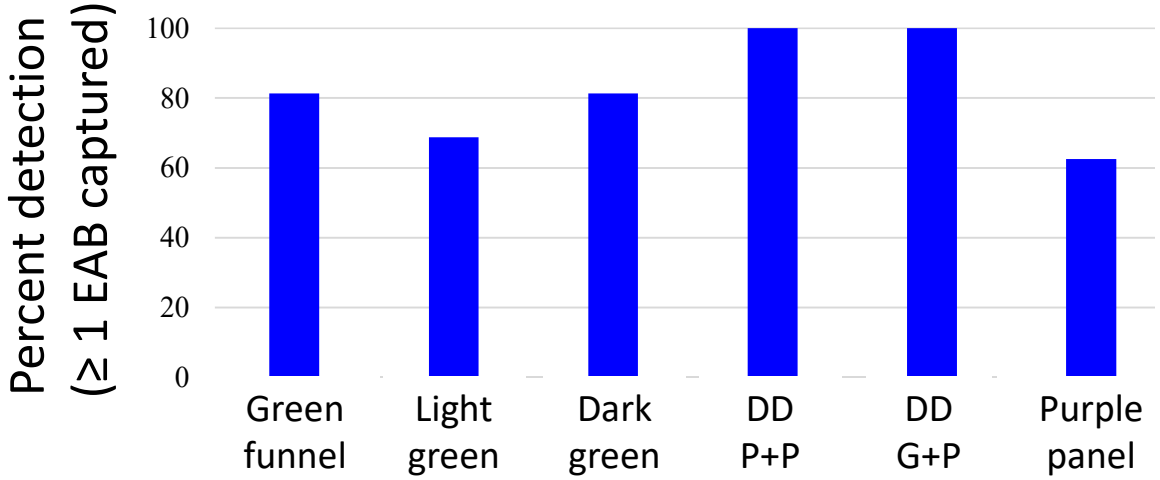
Dark purple Dark purple

- All traps baited with cis-3-hexanol lures
- EAB contact pheromone (close range) added to green panels
- Ethanol lure added to DD-PP

Tobin et al. (20121) J. Econ. Entomol.

Trapping study in Michigan & Ontario (low densities) (Tobin et al. (2021) J. Econ. Entomol.)





Number trapped:

- Males dominated captures
- Males preferred green panels
- Females preferred purple panels, … but low capture rates

Detection per se (≥ 1 captured)

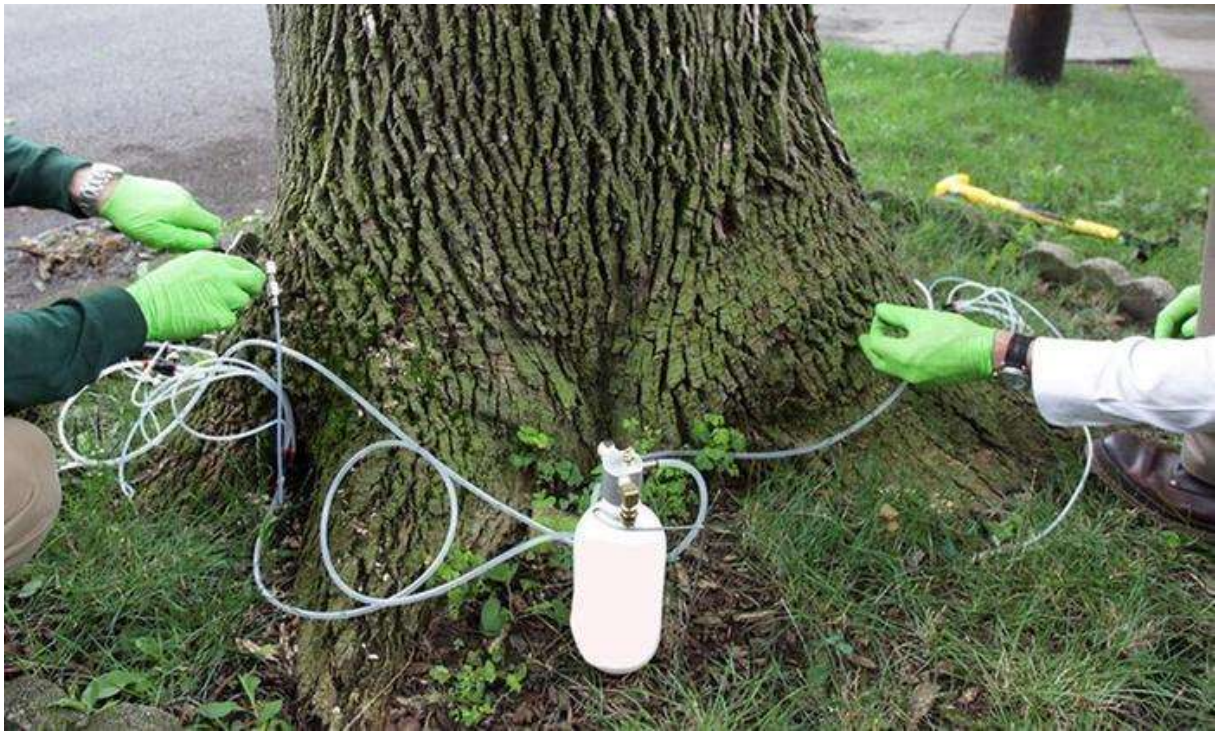
- Double-deckers (DD) had highest detection rates
- DDs had highest number of EAB per m^2 of surface area
- Purple panels in canopies (USDA APHIS trap) least effective

Early EAB detection by surveillance trapping? Eradication?

- Traps not very effective; lack of long-range attractant: Early detection unlikely
- In North America, **eradication no longer a goal** for new infestations

In North America today:

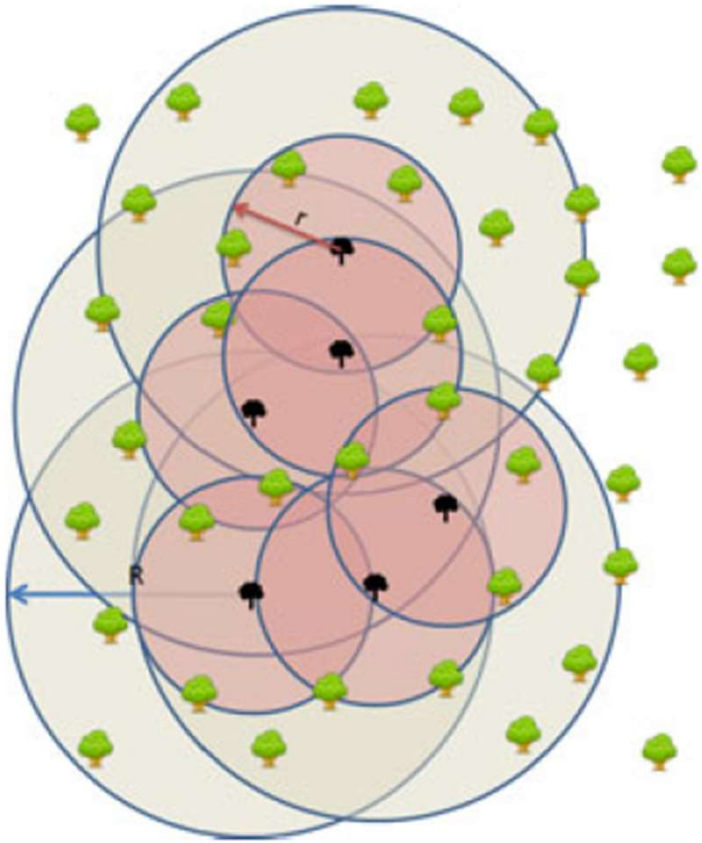
- Instead of host removal (*including healthy trees*), urban trees protected with systemic insecticide (Emamectin benzoate)
- Protects urban trees, staggers ash replacement, more cost-effective



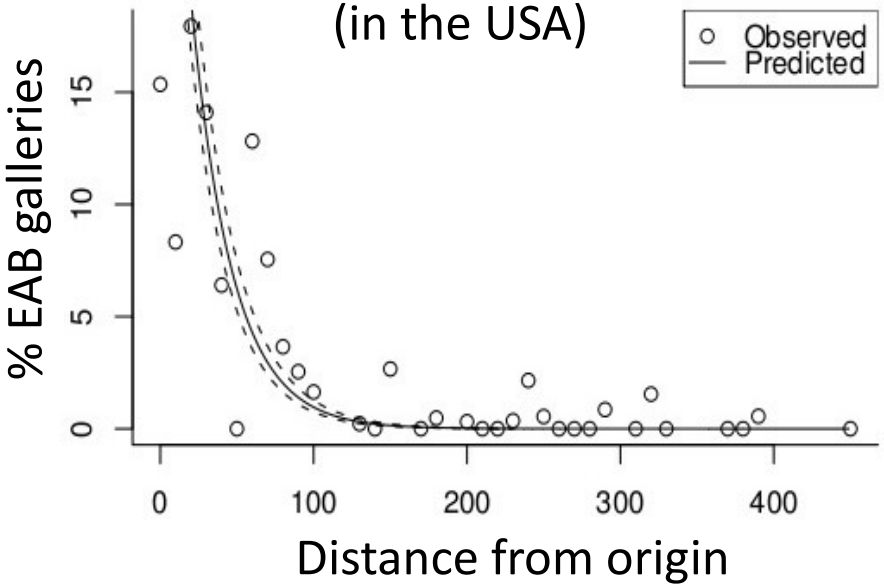
https://eastprovidenceri.gov/sites/default/files/styles/pop_up_render_1060x795/public/field/image/node-related-images/trunkinjection.jpg?itok=eN6ohTQl

7. Prospects for EAB eradications in Europe

Radius Delimiting survey: 1 km
Radius Clearcut area: 100 m



Percent EAB galleries by distance from origin
(in the USA)



- Most EAB females laid their eggs within 100 m
- Some dispersed up to 400 m, few maybe to 5 km?

Mercader et al. (2009, 2011, 2012, 2016);
McCullough et al. (2011, 2015); Siegert et al. (2010, 2015)

… Prospects for EAB eradications in Europe

- Early detection even less likely in Europe
- Ash trees are already sick from ADB,
- and EAB symptoms less conspicuous
- Lots of ash trees in urban areas,
  … no shortage of hosts
- Eventual establishment highly likely
- **Prospects for eradication?** Not good

Photo: Eckehard Brockerhoff, WSL

Conclusions

- Eradication of invading forest insects often successful (in general)
- Eradication of EAB unlikely
- … unless it was detected very early (before adult dispersal)
- Large scale host removal may not be effective, but very costly
- Management (instead of eradication) of established populations with systemic insecticides may be a better strategy
- Emamectin benzoate is registered in EU (e.g., for use on fruit trees)
- Planting ash trees in urban areas is no longer a good idea

Thank you!

For your attention

- Funding from …

ETH Domain

Swiss Federal Government