USDA Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Current status, successes, and limitations of the USDA APHIS PPQ emerald ash borer biological control program

Chrissy Dodge

USDA - United States Department of Agriculture
APHIS - Animal and Plant Health Inspection Service
PPQ - Plant Protection and Quarantine
S&T - Science and Technology
Forest Pest Methods Laboratory, Buzzards Bay, Massachusetts, USA

EPPO FAO-REUFIS BFW Conference

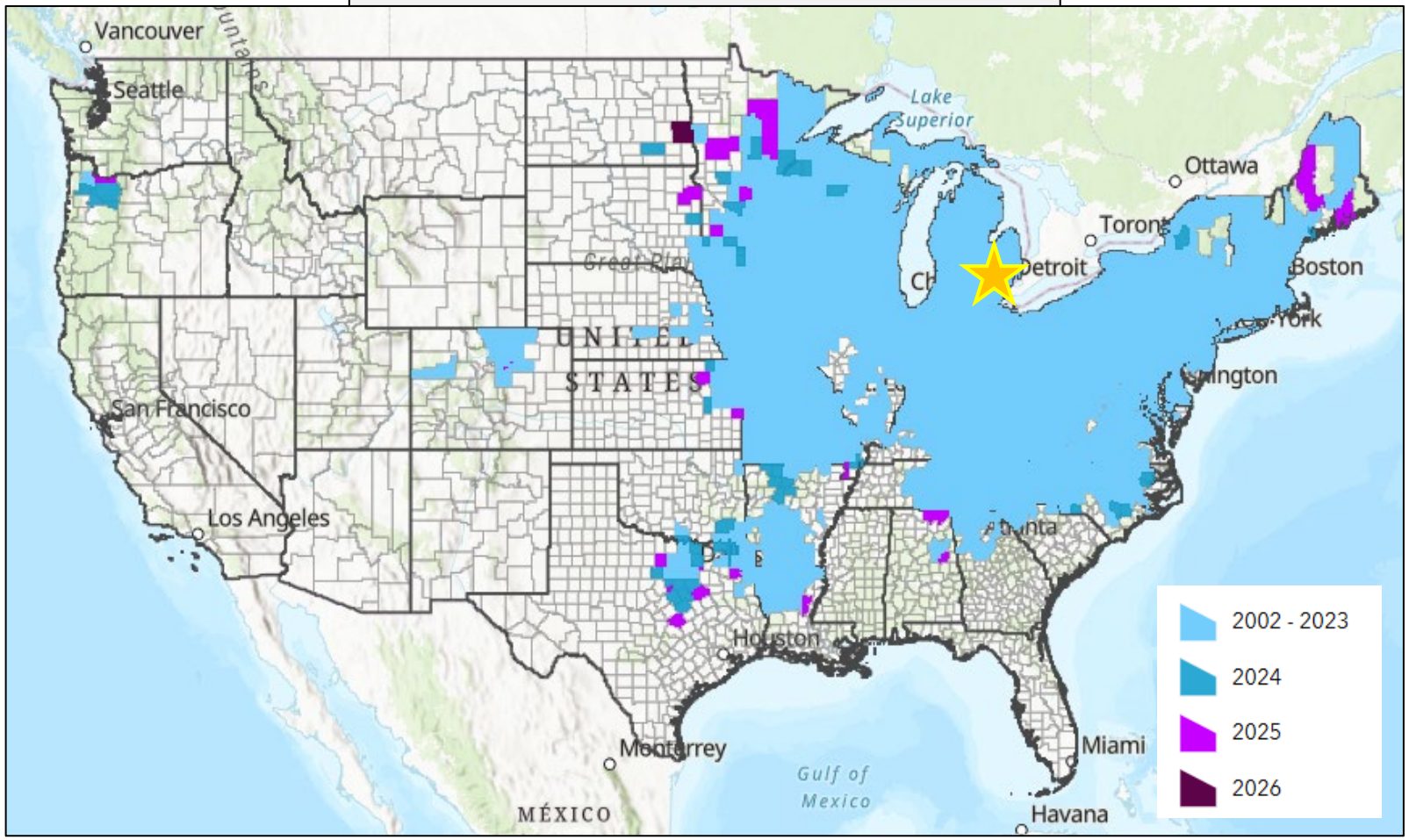
'Safeguarding Forests in Europe: Emerging Risks of *Agrilus* Wood Borers (Buprestidae)'

Vienna, 21-23 April 2026

EAB in North America

- First found in 2002 in Michigan and adjacent areas of Canada
- Likely arrived in the 1990s
- United States federal quarantine ended in 2021
- To date, EAB has been found in **38** States and six Canadian Provinces
- **Classical biological control is a USDA management priority.**

Known EAB-Infested Counties
as of April 2026



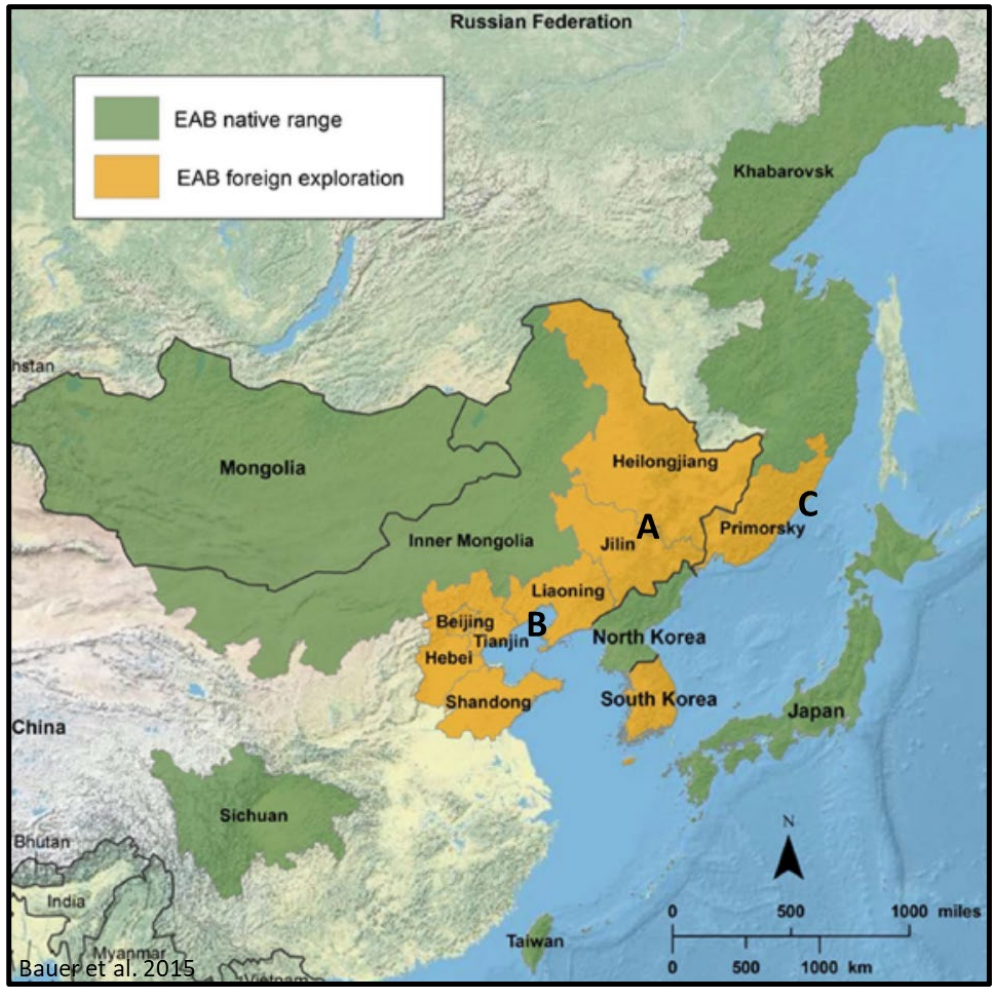
Classical biological control agents of EAB

Oobius agrili

Spathius agrili

Tetrastichus planipennisi

Spathius galinae



Bauer et al. 2015

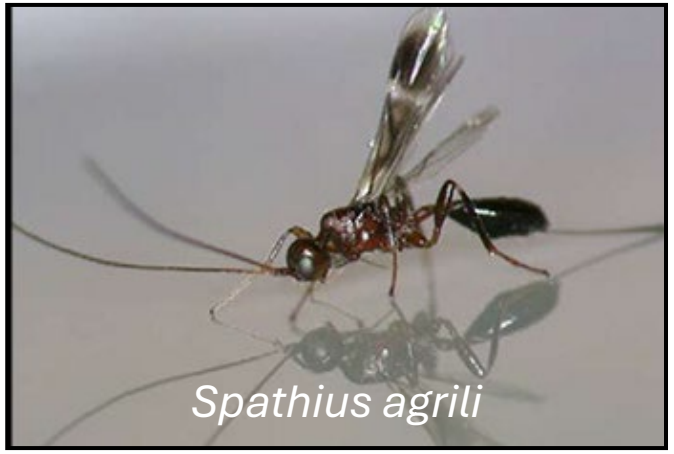
Oobius agrili (Encyrtidae)

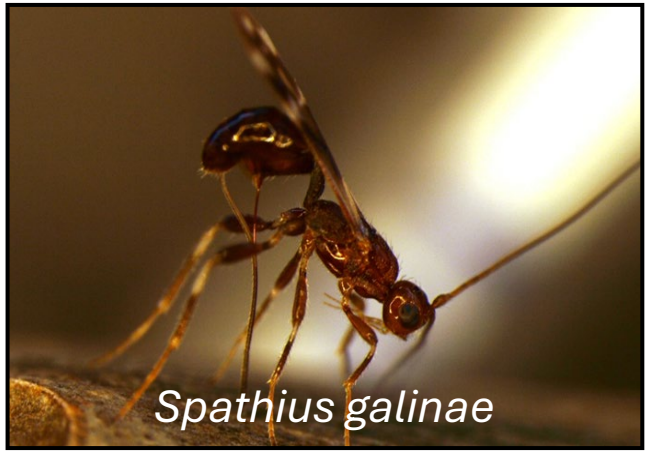
- Egg parasitoid
- Released starting in 2007
- Parthenogenetic

Tetrastichus planipennisi (Eulophidae)

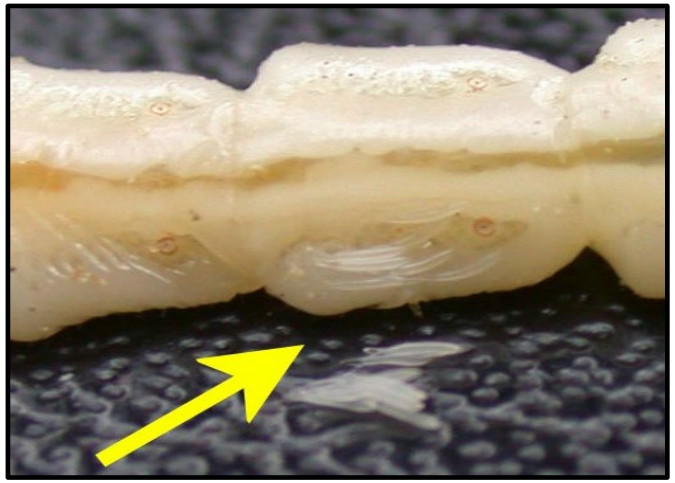
- Gregarious larval endoparasitoid
- Develops in 3rd and 4th instar larvae
- Released starting in 2007
- Short ovipositor

Spathius agrili and *Spathius galinae* (Braconidae)





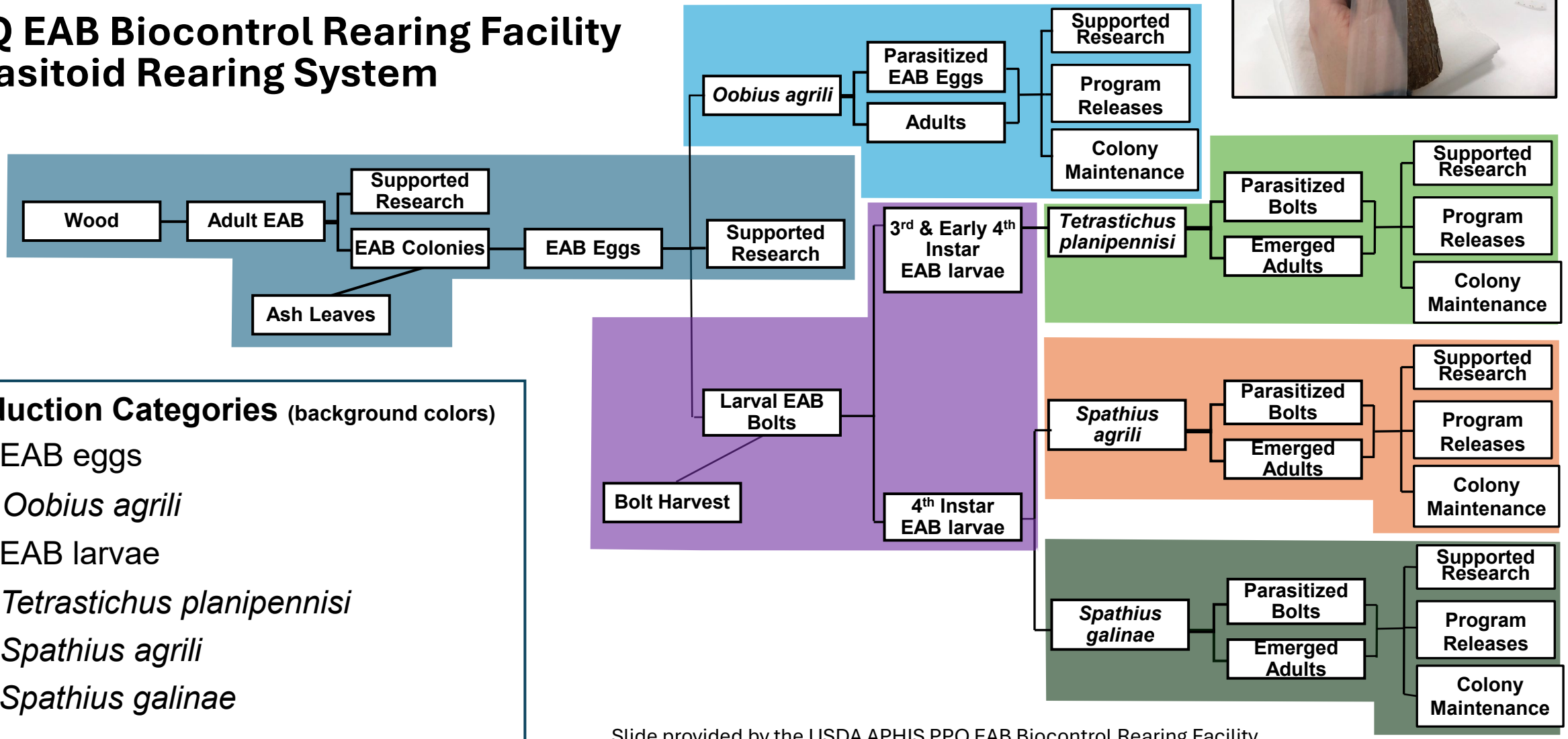
- Gregarious larval ectoparasitoids
- Develop in 3rd and 4th instar larvae
- *S. agrili* released starting in 2007
- *S. galinae* released starting in 2015
- Long ovipositors



PPQ EAB Biocontrol Rearing Facility

- Established in 2009 in Brighton, Michigan near epicenter
- Conducts studies to improve parasitoid production
- Must balance production to provide relevant parasitoids and complete releases at each eligible release site
- Program standard: **2 years of releases, followed by 2 years of recovery efforts.**

PPQ EAB Biocontrol Rearing Facility Parasitoid Rearing System



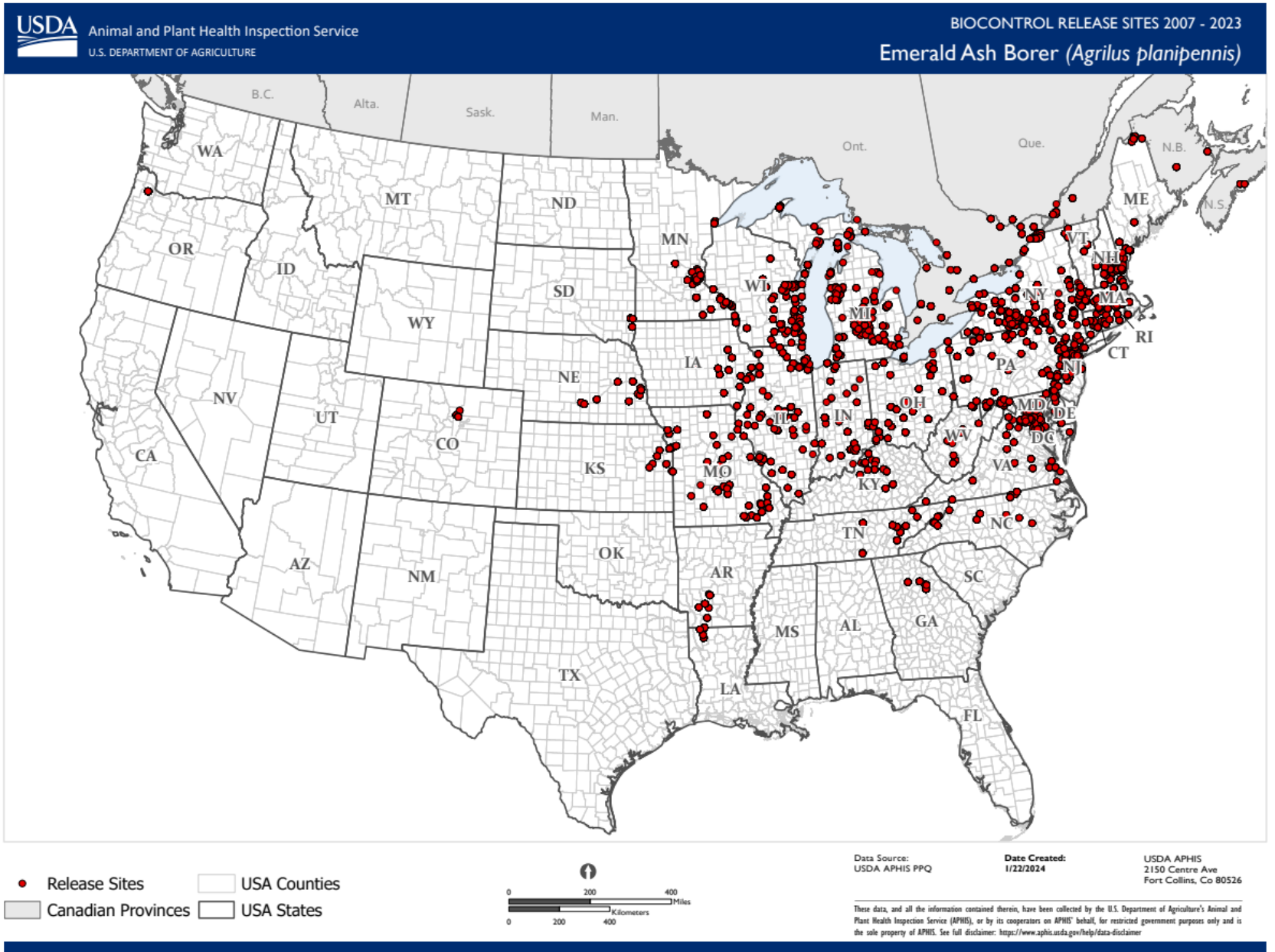
Production Categories (background colors)

- EAB eggs
- *Oobius agrili*
- EAB larvae
- *Tetrastichus planipennisi*
- *Spathius agrili*
- *Spathius galinae*

Slide provided by the USDA APHIS PPQ EAB Biocontrol Rearing Facility.

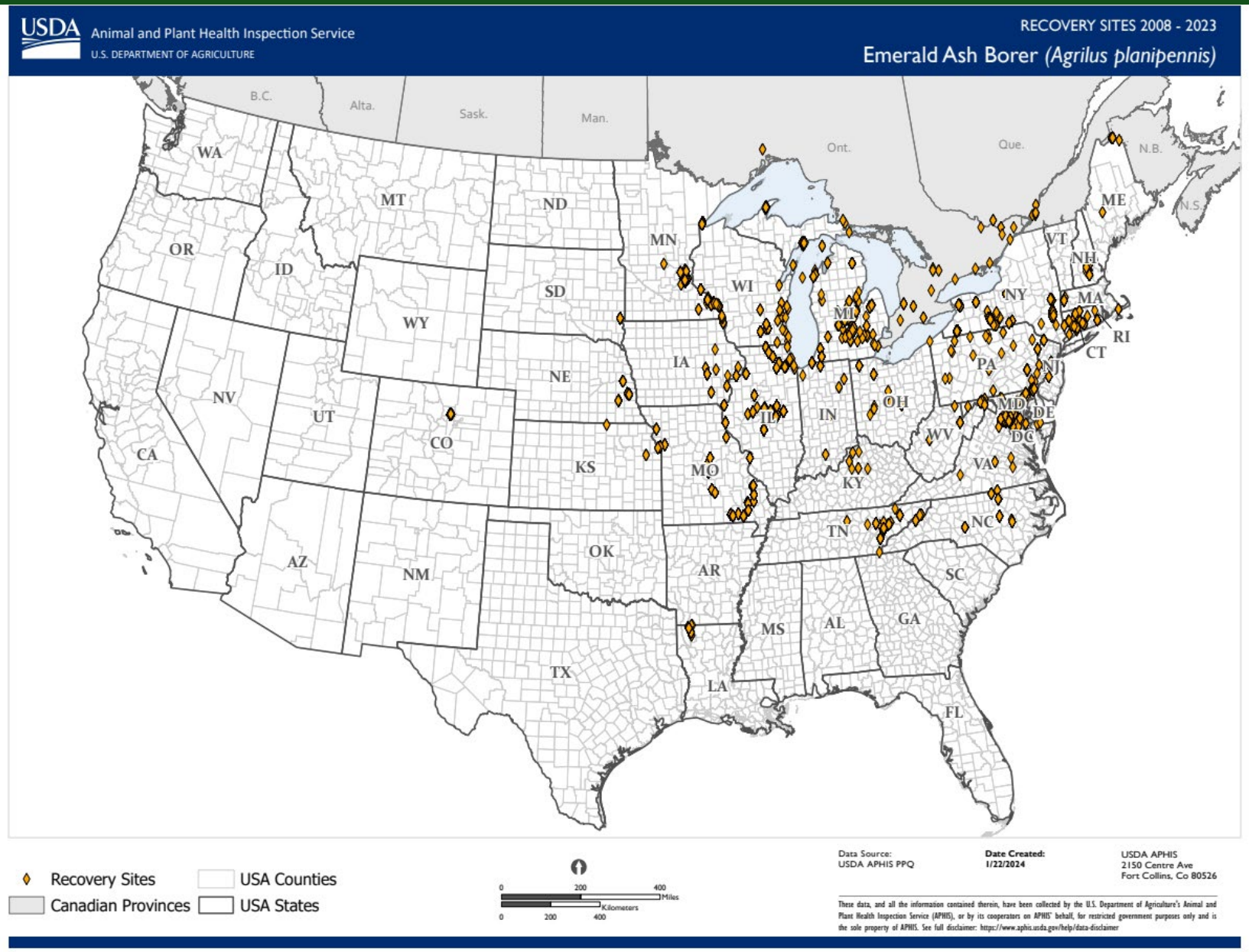
Biocontrol releases

- Nearing 20 years of parasitoid releases
- Cumulatively, over 9 million parasitoids released across 491 EAB-infested counties (33%)
- In 2025, APHIS provided 408,985 parasitoids to 135 release sites in 28 States (plus 1 in Canada)
- **Release capabilities are a major limiting factor in the program.**
  - Facility personnel
  - High-quality ash logs



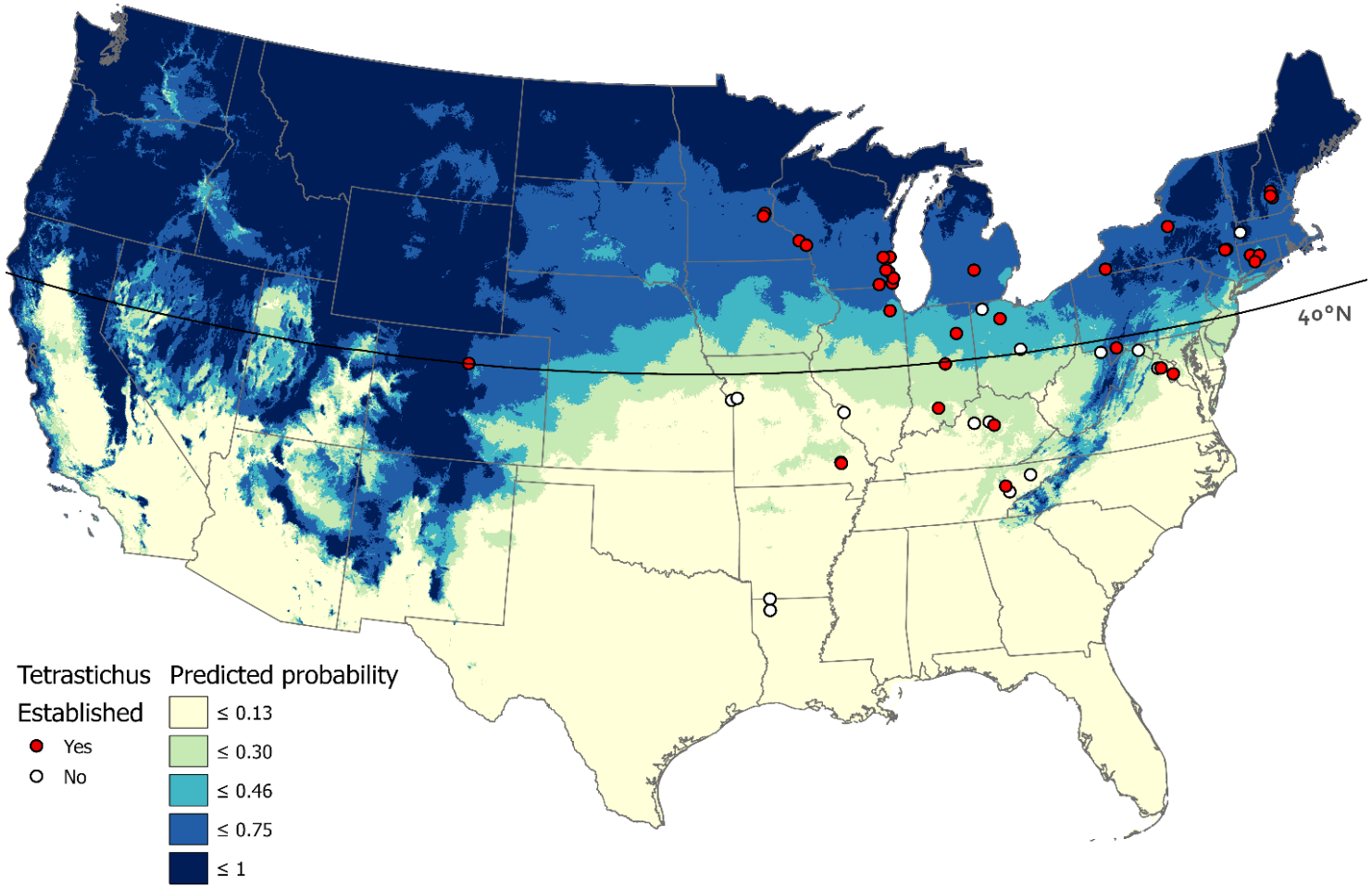
Parasitoid recoveries

- Recovery is the first step
- **Establishment:** Parasitoid recovery 2+ years after releases are finished



Parasitoid establishment

- ***Tetrastichus planipennisi*** and ***Spathius galinae*** establish best in areas where EAB has a two-year life cycle
  - ➢ Primarily released above 40th parallel north
- ***Spathius agrili*** aligns with EAB one-year life cycle. Can overwinter in the north, but populations did not persist.
  - ➢ Only released below 40th parallel north; mostly experimental
- ***Oobius agrili*** has photoperiod-induced diapause.
  - ➢ Released across the US

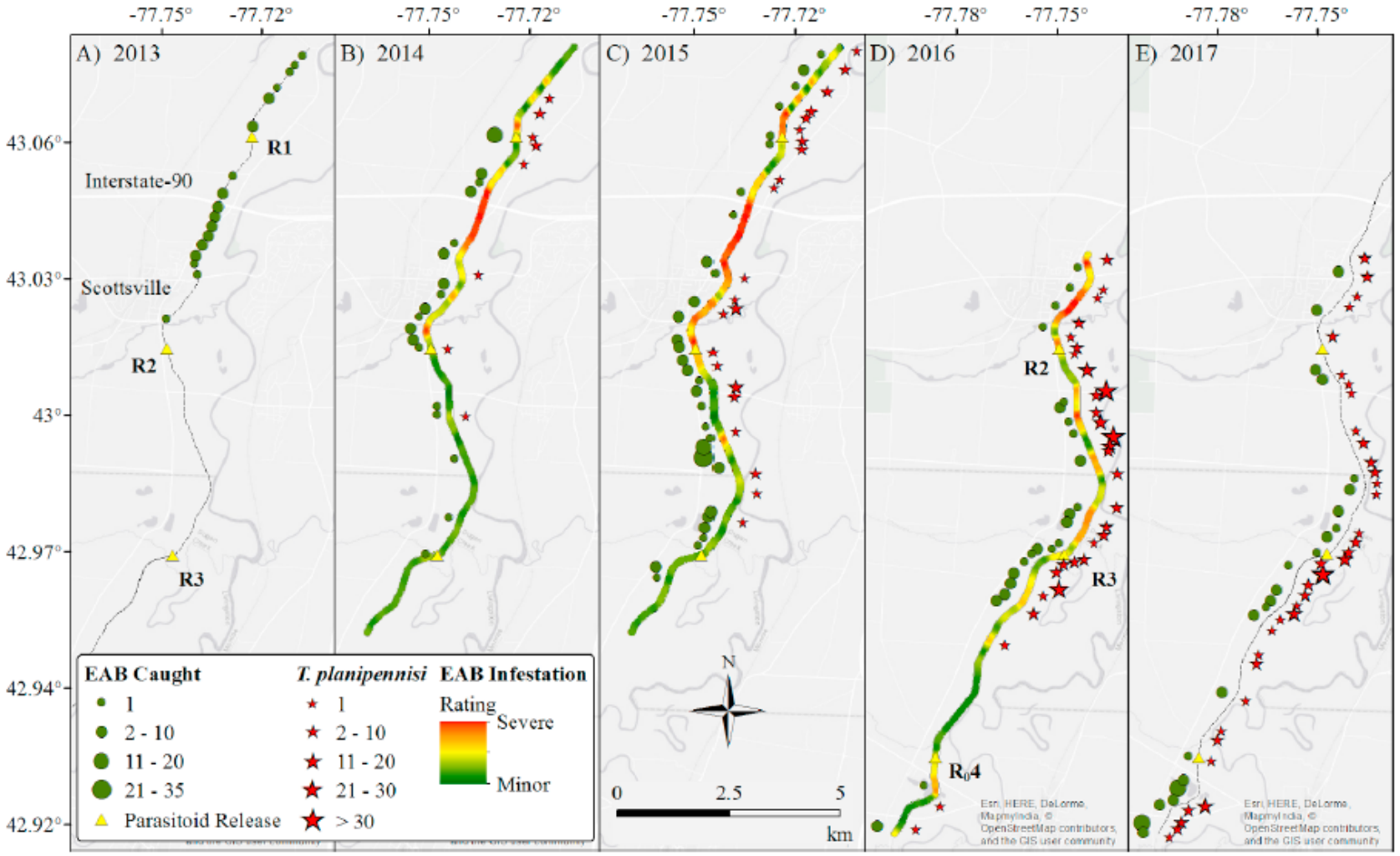


Predicted and observed establishment of *T. planipennisi* based on EAB phenology. Gould et al. (2020)

Petrice et al., *Biological Control* (2019); Gould et al., *J. Econ. Entomol.* (2020); Jones et al., *J. Econ. Entomol.* (2020)

Parasitoid dispersal

- *Tetrastichus planipennisi* spreads quickly (6 km/yr) and follows EAB dispersal
- *Spathius galinae* dispersal rate ~4 km/yr
- *Oobius agrili* spreads more slowly; 1-3 km within a few years



***T. planipennisi* following EAB down a corridor of ash.** Jones et al. (2019)

Jones et al., *Biological Control* (2019); Aker et al., *J. Econ. Entomol.* (2022); Quinn et al., *Biological Control* (2022); Abell et al., *Biological Control* (2014)

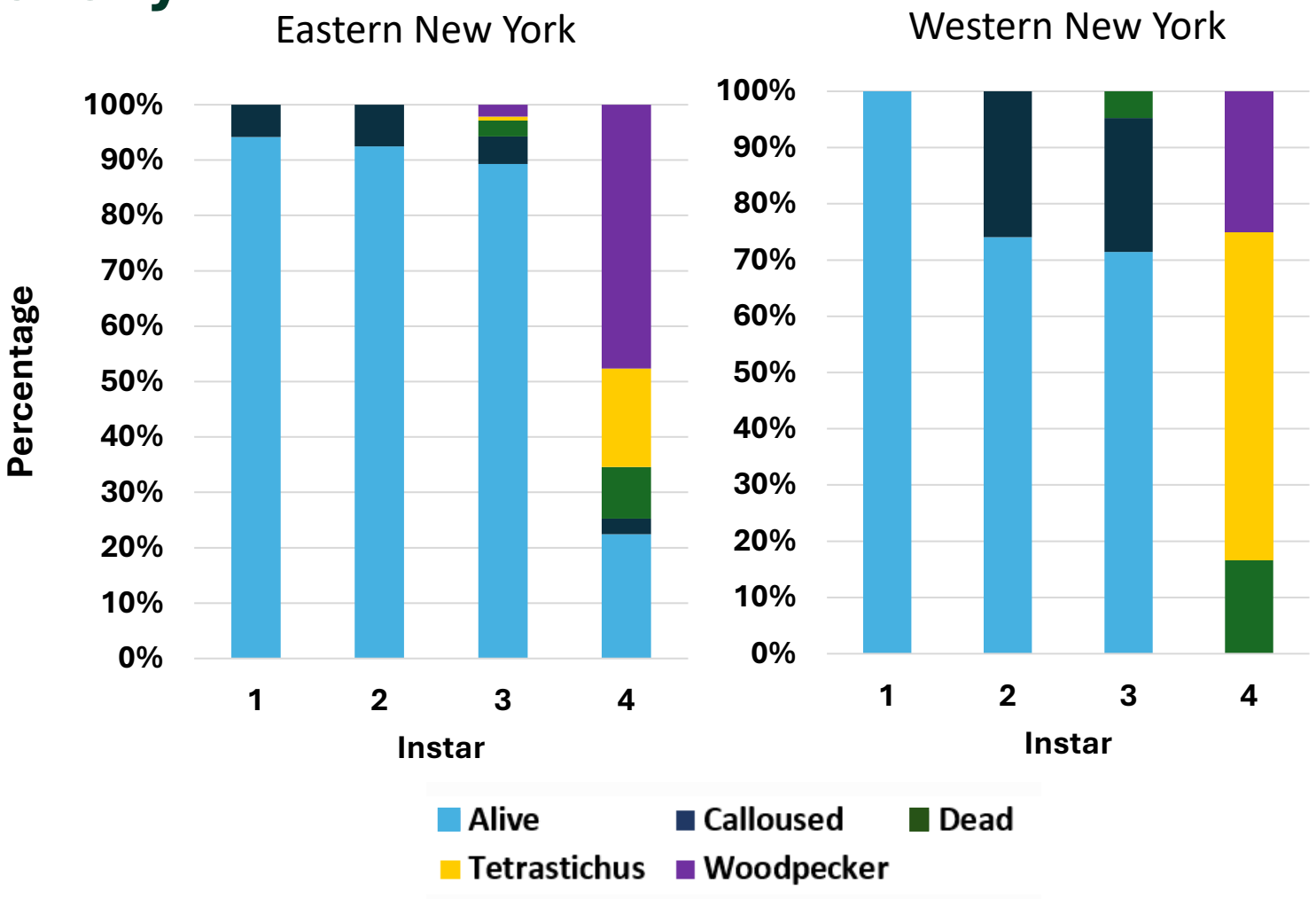
Ash survival and regeneration

- Mature ash trees still being killed by EAB at high rate
- Releasing thousands of parasitoids against millions of EAB
- **The future of ash as a viable component of North American forests will depend on the survival of ash seedlings and saplings following the initial EAB outbreak.**
- Long-term field studies have shown that ash regeneration is plentiful
  - Sapling density increased at release sites compared to non-release sites

Morris et al., *For. Ecol. Manag.* (2023); Kashian et al., *Forests* (2018); Wilson et al., *For. Ecol. Manag.* (2025)

Parasitoid reduction of EAB density

- Life table studies suggest larval parasitoids significantly reduce EAB population growth rates (R_0)
- Reported field parasitism highly variable
  - *T. planipennisi*: 40-60%
  - *S. galinae*: 13-78%
  - *O. agrili*: 2-51%
- Growing body of evidence that parasitoids contribute significantly to EAB population control, especially in ash saplings and post-invasion "aftermath" forests
  - APHIS guidelines now include post-invasion forests as qualifying release sites



Gould et al., *J. Econ. Entomol.* (2022); Duan et al., *For. Ecol. Manag.* (2017); Morris et al., *J. Econ. Entomol.* (2023); Duan et al., *J. Appl. Econ.* (2015); Duan et al., *J. Econ. Entomol.* (2019); Duan et al., *J. Pest Sci.* (2022)

How to protect mature trees? Developing EAB IPM in forests

- Treat trees with trunk injections of systemic insecticides while parasitoids are being released
- Stop treating trees once parasitoids are established
- **Can parasitoids protect ash after tree treatments cease?**
- Long-term study underway in green ash (*Fraxinus pennsylvanica*) and black ash (*Fraxinus nigra*) forest sites
  - Critically endangered (IUCN)
  - Black ash has cultural and economic importance for many indigenous communities in northeastern North America


Zoe Albion, UMaine

Morris et al. 2024. Managing emerald ash borer in urban forests: Integrating biocontrol and insecticide treatments. *Biological Control* 199.

Limitations of the biocontrol program in the United States

- Started late – probably at least 10 years after EAB arrived
- Large geographical area to cover, with many different climate zones
- Parasitoid production and release are resource-limited
- Robust impact data exists for only 2 of the 4 parasitoids
  - Invested a lot of time and effort into *Spathius agrili* in early years of the program, but it didn't establish
  - Recovery of *Oobius agrili* is particularly difficult due to its tiny size

Encouraging findings

- ✓ *Spathius galinae* establishing well alongside *Tetrastichus planipennisi* for EAB control in northern North America
- ✓ Parasitoids disperse and spread readily
- ✓ Parasitoids reduce EAB density and population growth rate, especially in saplings and regenerating ash
- ✓ Ash regeneration is plentiful in post-invasion forests

Everett Booth, USDA

PPQ program priorities

- Maximize biocontrol releases and recovery efforts in EAB-infested counties nationwide
  - How far from release sites have parasitoids spread?
- Continuing research programs with cooperators
  - Parasitoid establishment and efficacy under different field conditions, especially for *Oobius agrili* and *Spathius agrili*
  - Predictive modeling for parasitoid establishment in different climate zones
  - Long-term impact studies
- Methods development and optimization
  - Artificial diet for rearing EAB (and parasitoids?)
  - Development of forest IPM strategies

Acknowledgments

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USDA ARS: Jian Duan

USDA Forest Service: Toby Petrice, Nate Siegert

Countless collaborators in USDA, PPQ Field Operations, State Departments of Agriculture

Current research collaborators: