



Threats, Impacts, and Management of Invasive Species With Highlights on Developing an Integrated Management Program for Emerald Ash Borer

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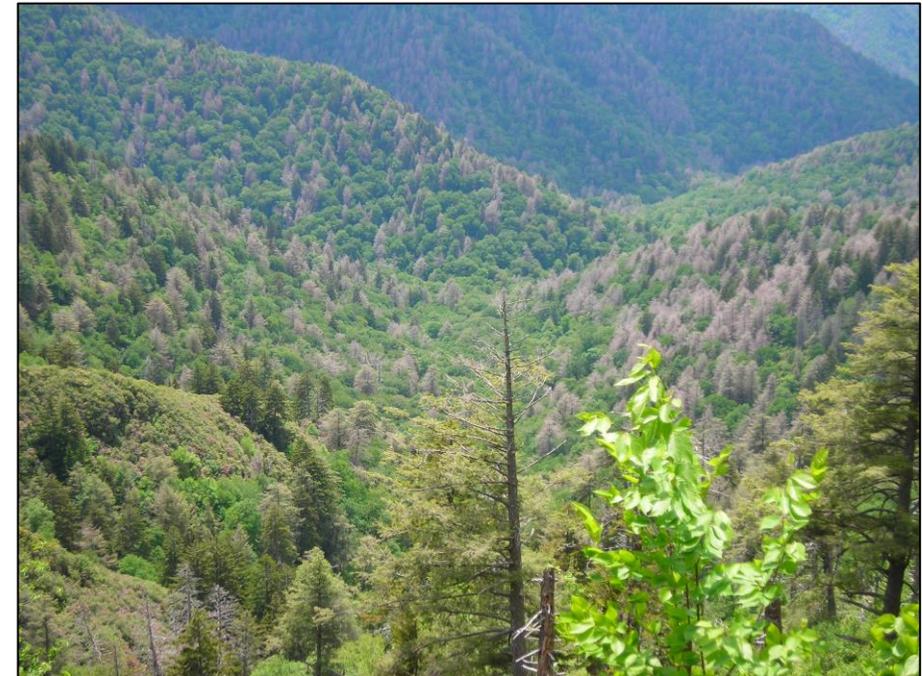
Invasive Species

- Alien (non-native) species that have intentionally or unintentionally entered a new ecosystem and are likely to cause economic or environmental harm or harm to human health
- > 450 Species of non-native insects, 197 pathogens, 1600 invasive plants, 261 terrestrial vertebrates and 186 species of invasive aquatic organisms in the US
- Numbers continue to increase with ever-expanding world trade and there appears to be no sign of saturation for most taxonomic groups



Economic Impacts

- Estimated to cause \$120 billion of damage per year
- Prevention and management activities cost Federal Agencies over \$600 million in 2000
- Losses to forest products and ranching industries, and other sectors of the US economy such as energy, utilities, and transportation
- Impact non-market values such as recreation, aesthetics, and factors associated with human health



Ecological Impacts

- Often more successful in new ecosystem due to lack of co-evolved host resistance, predators, and other natural enemies
- Alter nutrient cycling, biodiversity, tree mortality, forest dynamics, fire regimes, and hydrology
- May have greater adaptive plasticity to new habitats and rapid environmental changes or climatic variability
- Invasive forest insects and diseases kill about 12 million tons of trees annually, releasing stored carbon equivalent to emissions from 4.4 million cars

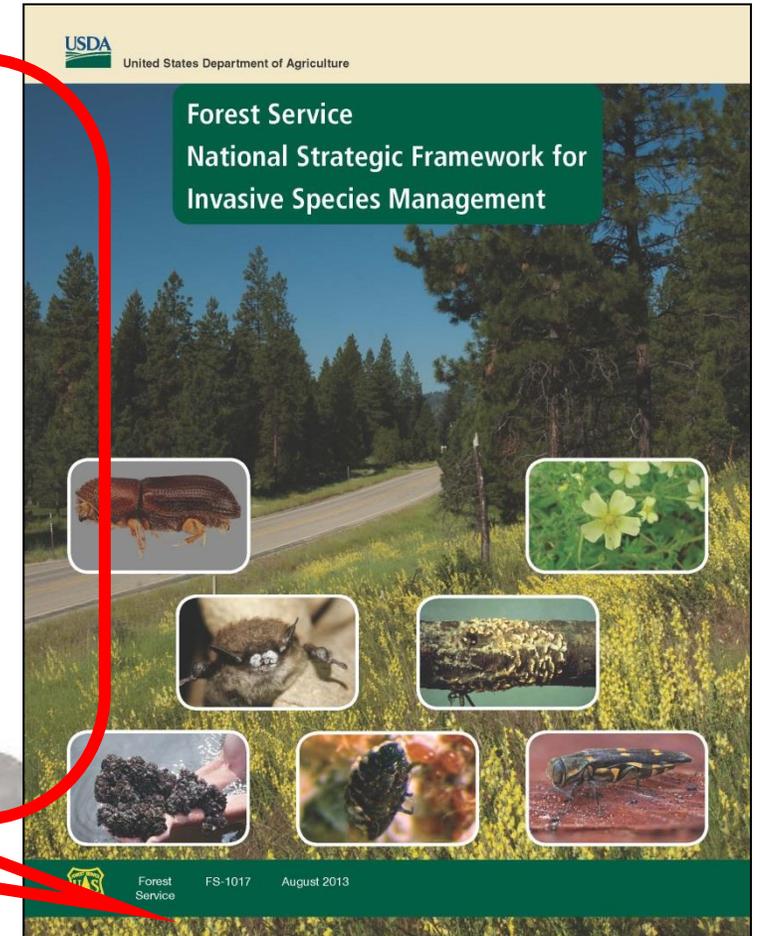


Managing Invasive Species

Invasive Species Systems Approach Elements

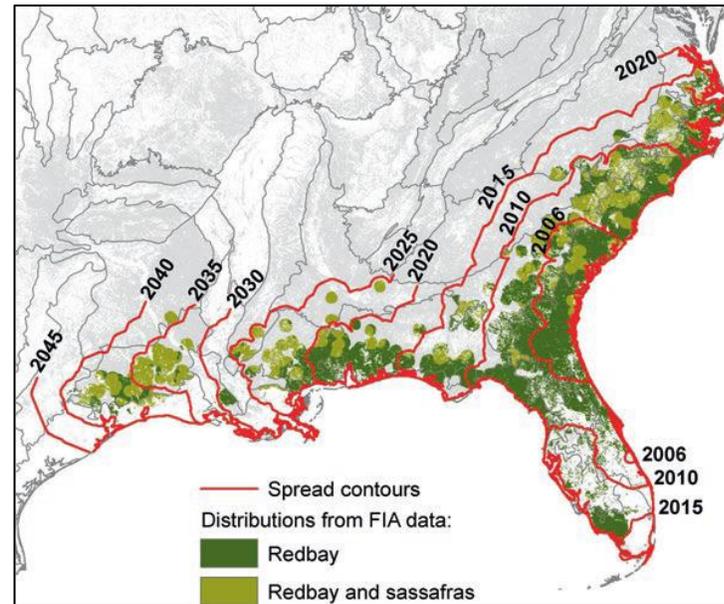
The Forest Service will focus on four key elements for invasive species research and management.

1. Prevention
2. Detection
3. Control and Management
4. Restoration and Rehabilitation



Early Intervention

- Early intervention through pest risk assessments, improved biosecurity surveillance, and rapid response is the most cost-effective approach to invasive species management



Management Approaches

- Regulatory – avoid/exclude pest
- Cultural – modify habitat, sanitation, silviculture
- Biological – natural enemies “PPPs”
- Host Resistance – select & breed for resistance
- Chemical – conventional & microbial pesticides
- Behavioral – modify pest behavior
- Integrated – combination of control tactics





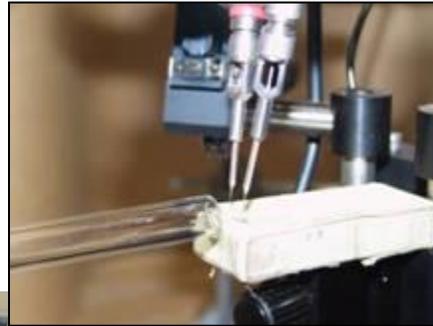
Emerald Ash Borer

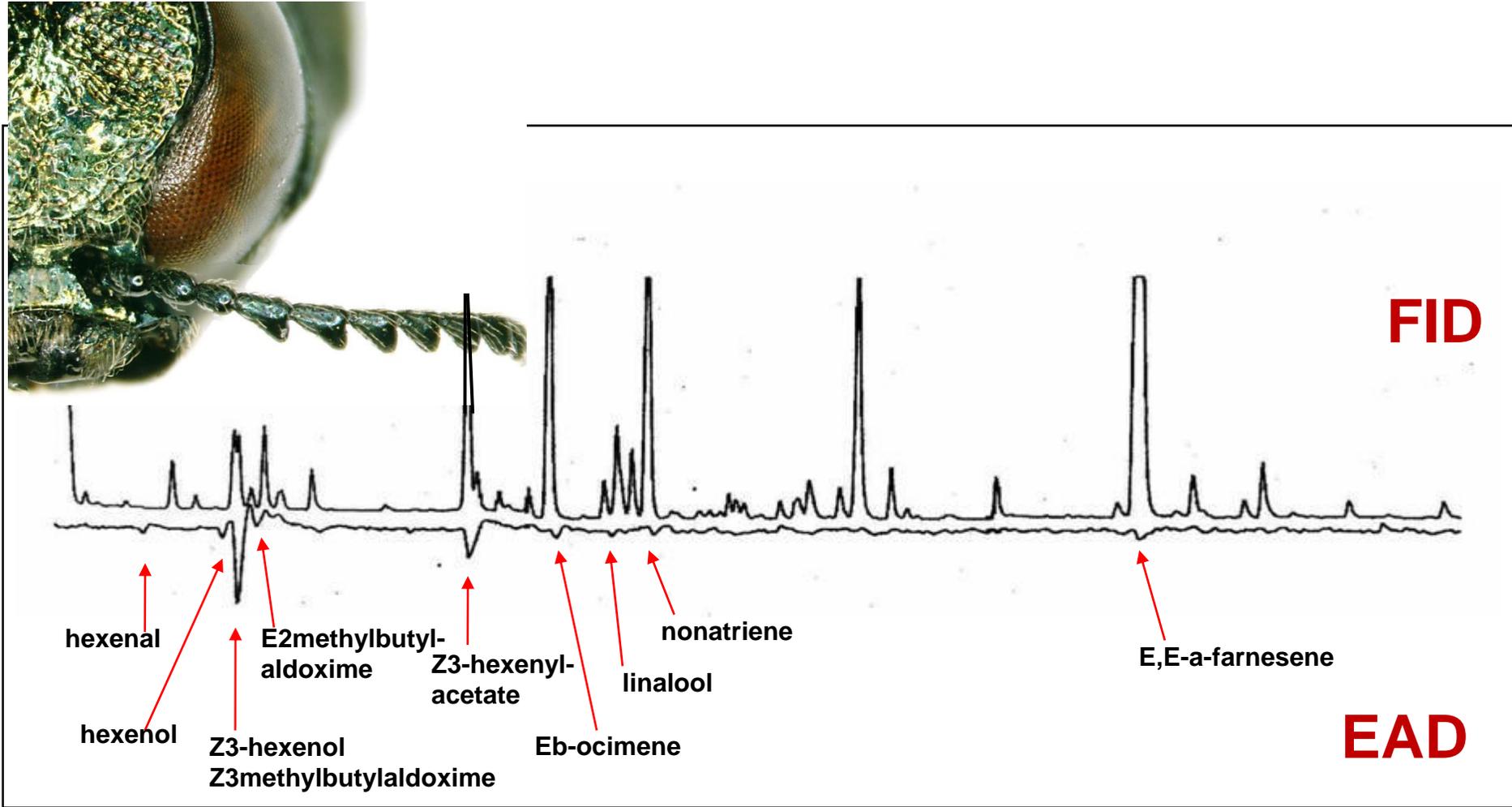
- Most destructive invasive forest insect pest ever in N. America
- Has killed hundreds of millions of ash trees
- Continues to spread and threatens ash resource nationwide



Detection Tools

- Identify host and insect volatile attractants
- Test different trap types and colors





Most Promising Traps & Lures



cis-3-Lactone
female
short-range
pheromone



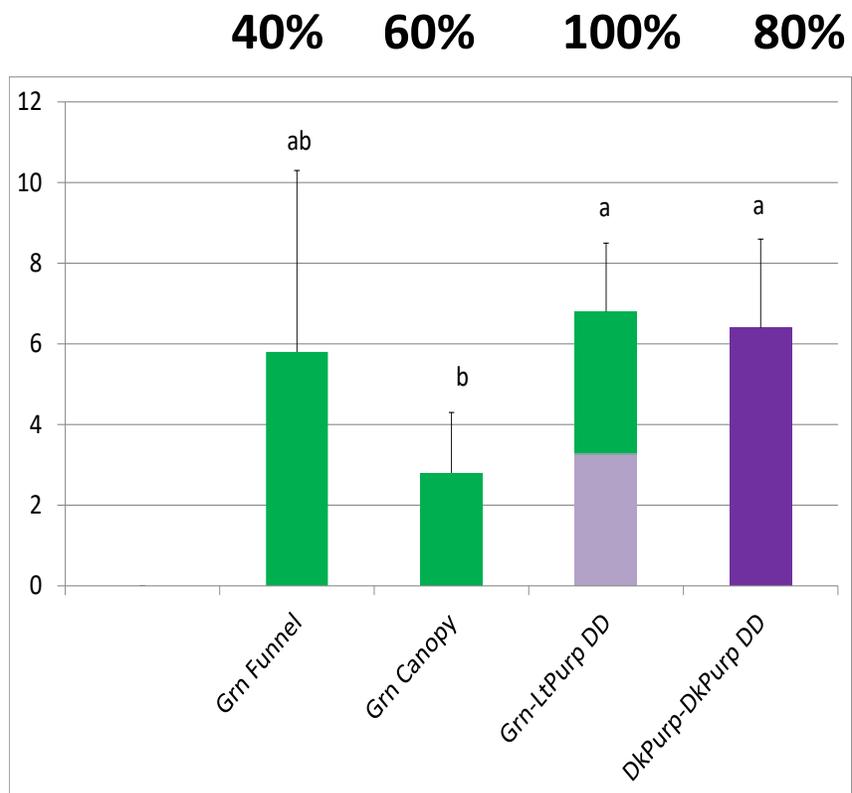
cis-3-Hexenol
Leaf volatile



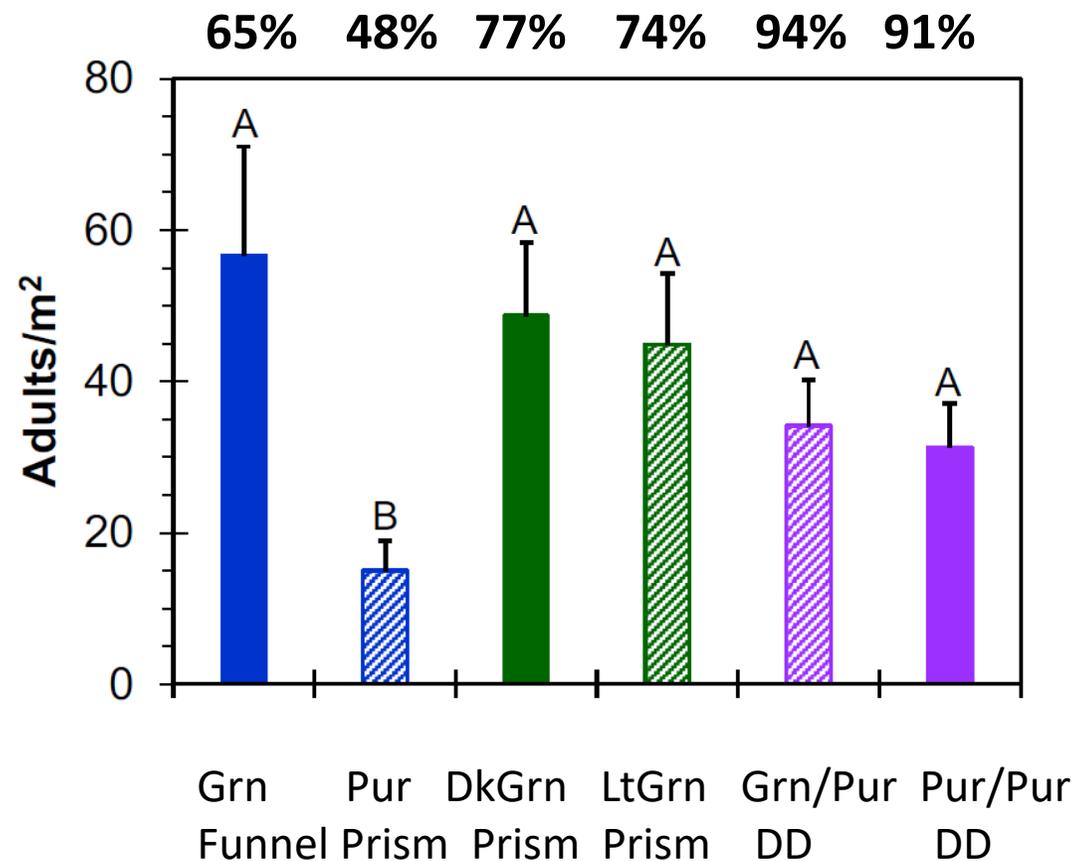
Manuka oil
Bark volatile



Traps with EAB



Traps with EAB



<https://www.jove.com/t/55252/building-double-decker-traps-for-early-detection-of-emerald-ash-borer>

Insecticidal Control

- Dinotefuran (Safari basal trunk spray)
- Imidacloprid (Mauget Imicide)
- Emamectin benzoate (TREEage tree IV or injection)





Control



Imicide



Dinotefuran

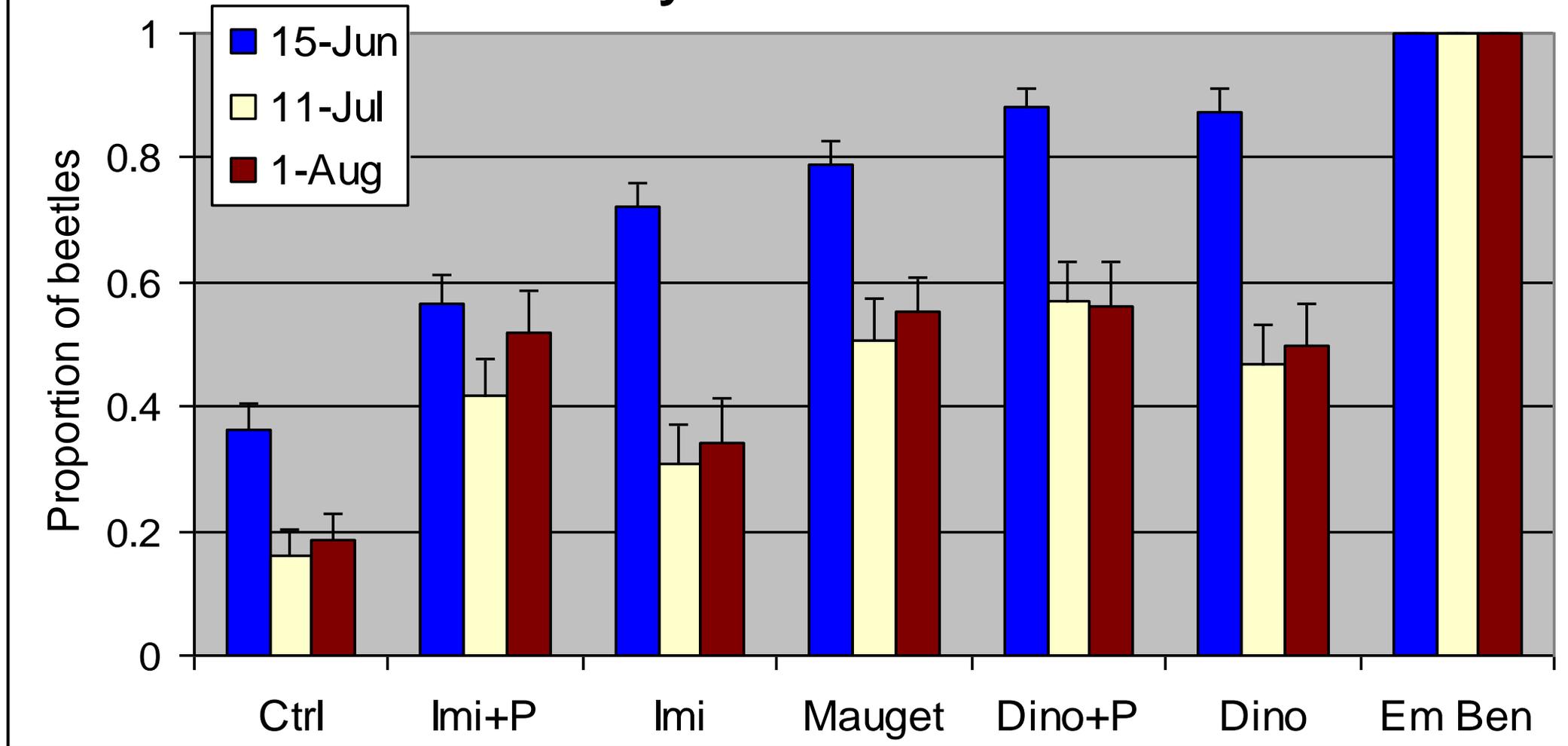


Emamectin benzoate



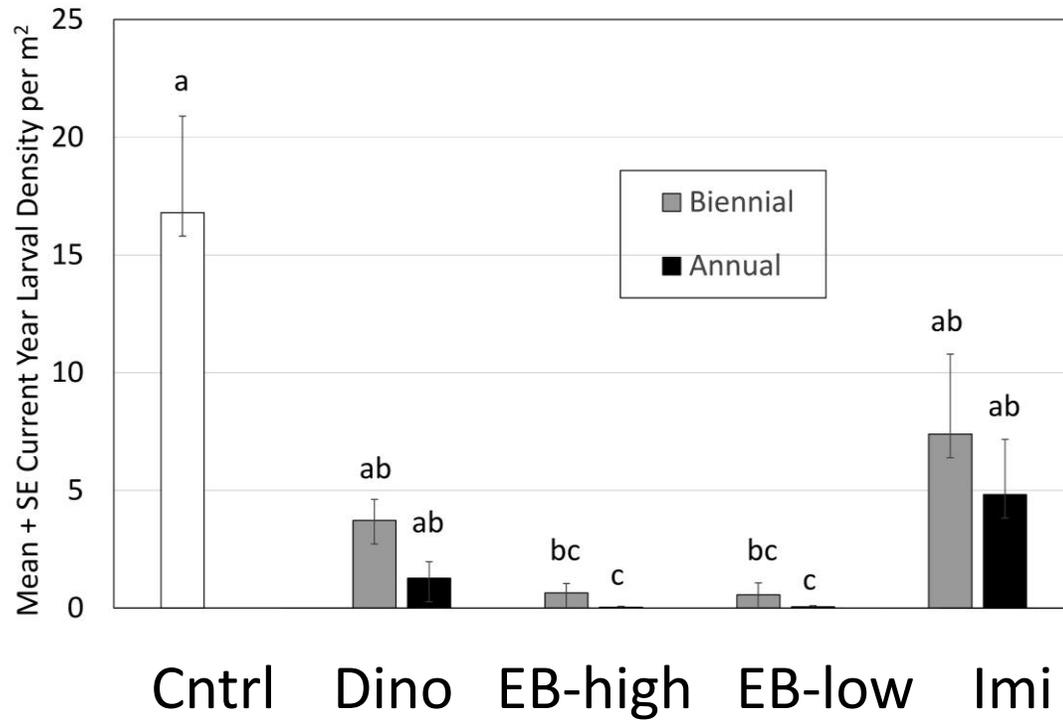


2007 Adult EAB Mortality on Day 4 by Treatment & Date

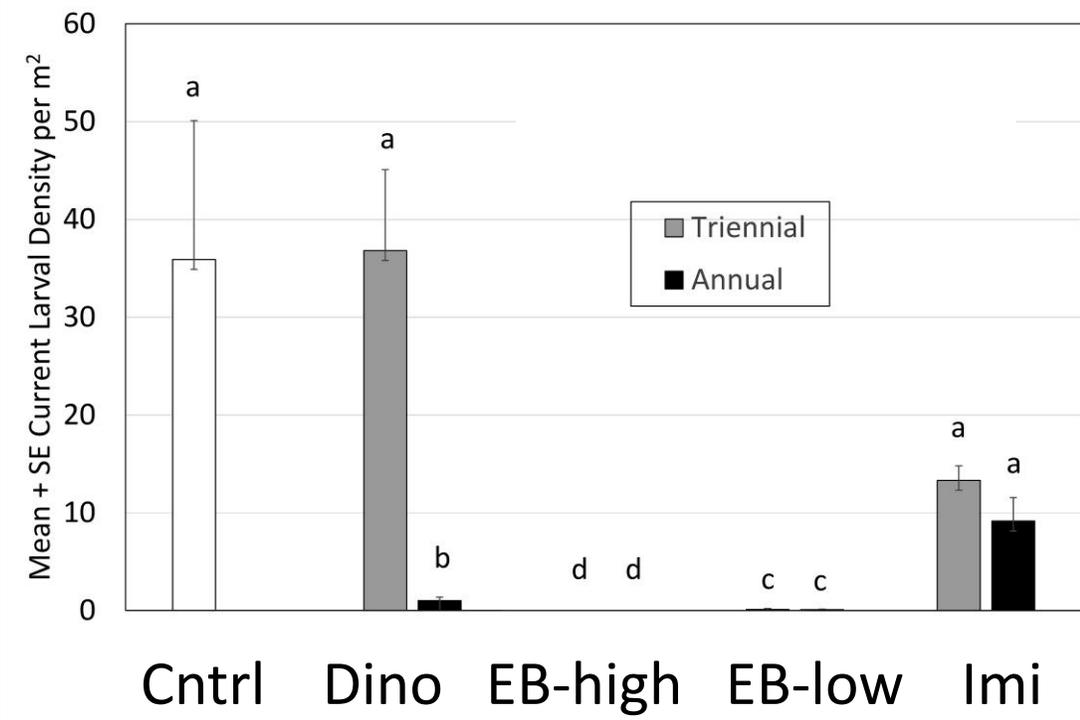




Annual vs Every 2 Years

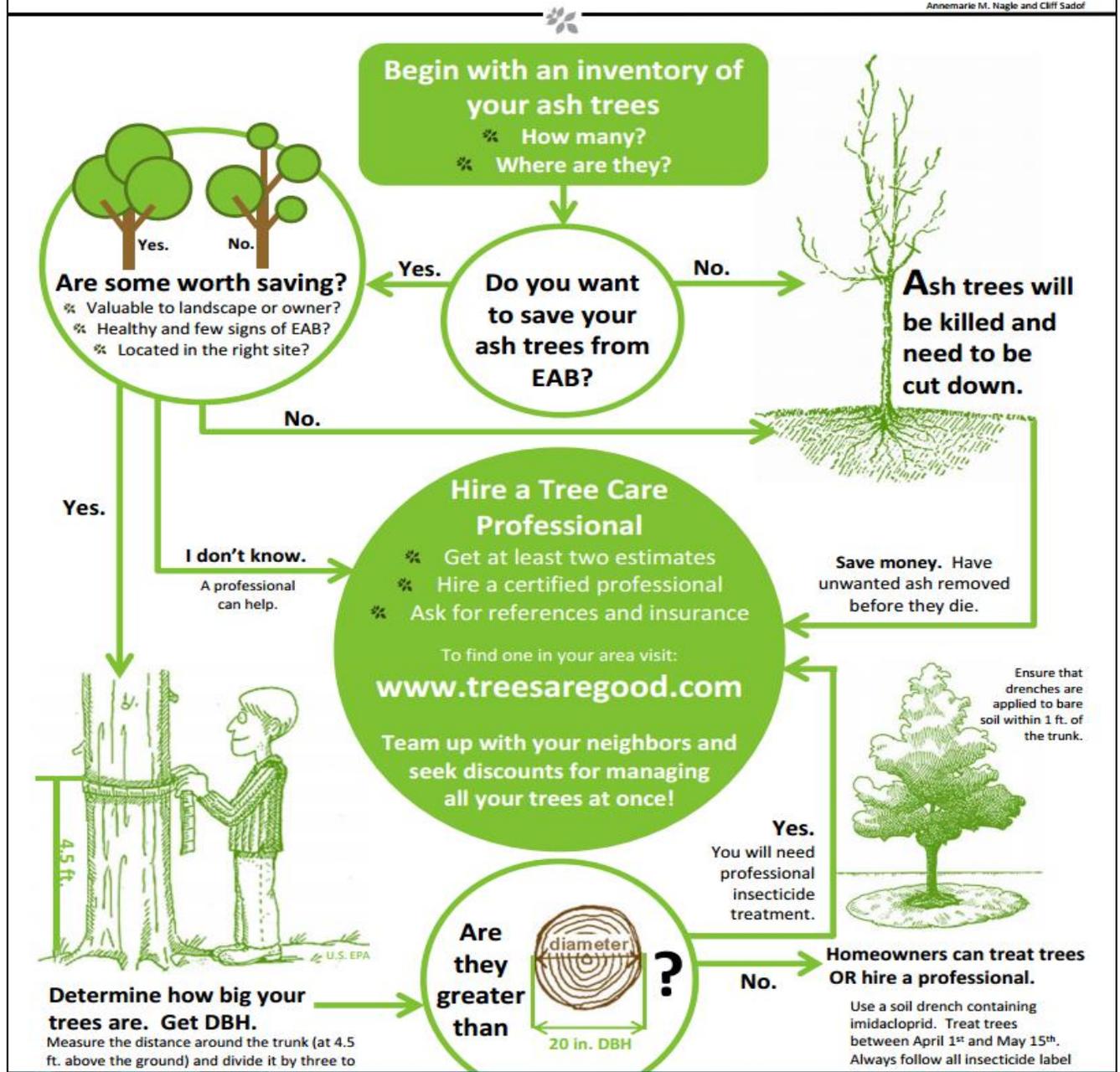


Annual vs Every 3 Years





Insecticide Guidelines



https://extension.entm.purdue.edu/EAB/PDF/NABB_DecisionGuide.pdf



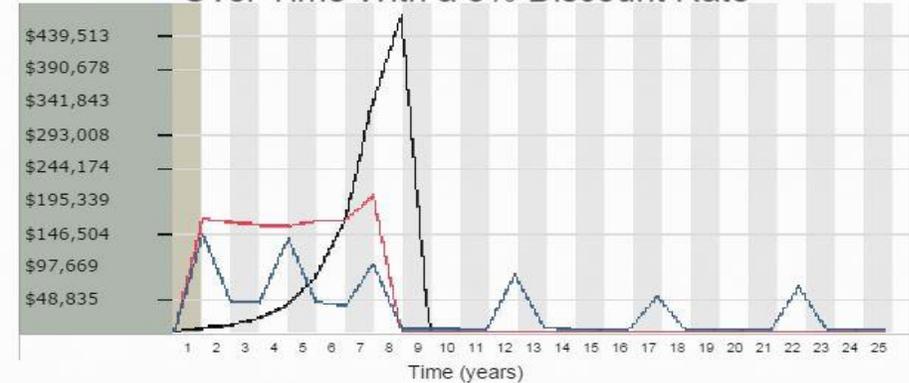
EAB Cost Calculator

Sample output comparing annual and cumulative costs for 3 different treatment options

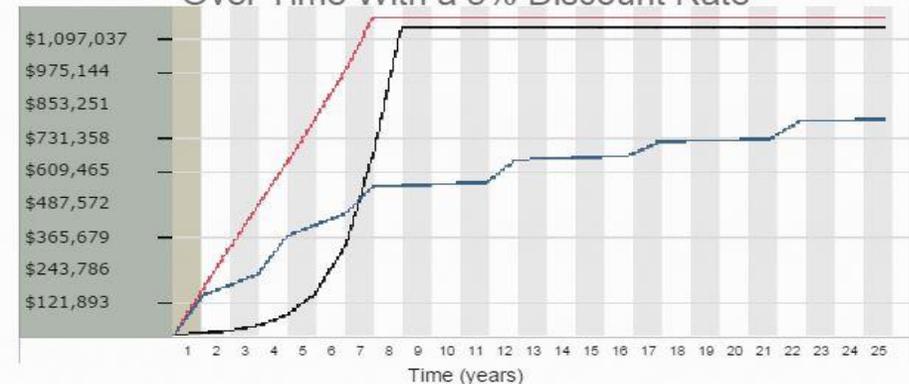
<https://int.entm.purdue.edu/ext/treecomputer/>

Option 1	Option 2	Option 3
Remove All	Remove All	Remove All
Replace All	Replace All	Replace All
Treat All	Treat All	Treat All
Remove Unsafe Ash	Remove Unsafe Ash	Remove Unsafe Ash
Replace Unsafe Ash	Replace Unsafe Ash	Replace Unsafe Ash
Save 80%	Save 80%	Save 80%
Replace <12	Replace <12	Replace <12
Save 50%	Save 50%	Save 50%
URBAN SLAM	URBAN SLAM	URBAN SLAM

Annual Cost Comparison in Today's Dollars Over Time With a 3% Discount Rate



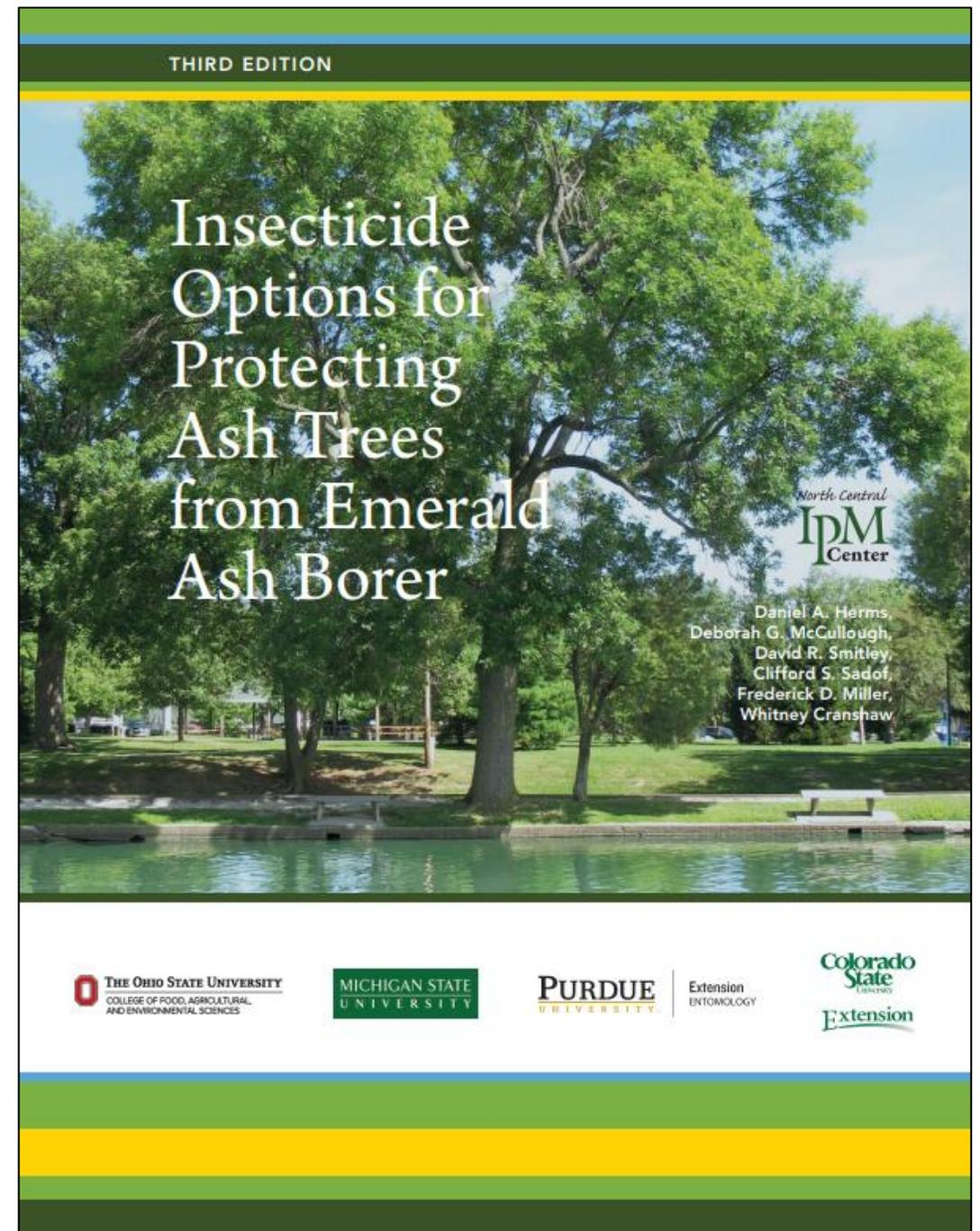
Cumulative Cost Comparison in Today's Dollars Over Time With a 3% Discount Rate





Insecticide Options

[http://www.emeraldashborer.info/documents/
Multistate EAB Insecticide Fact Sheet.pdf](http://www.emeraldashborer.info/documents/Multistate_EAB_Insecticide_Fact_Sheet.pdf)





Insecticide Options

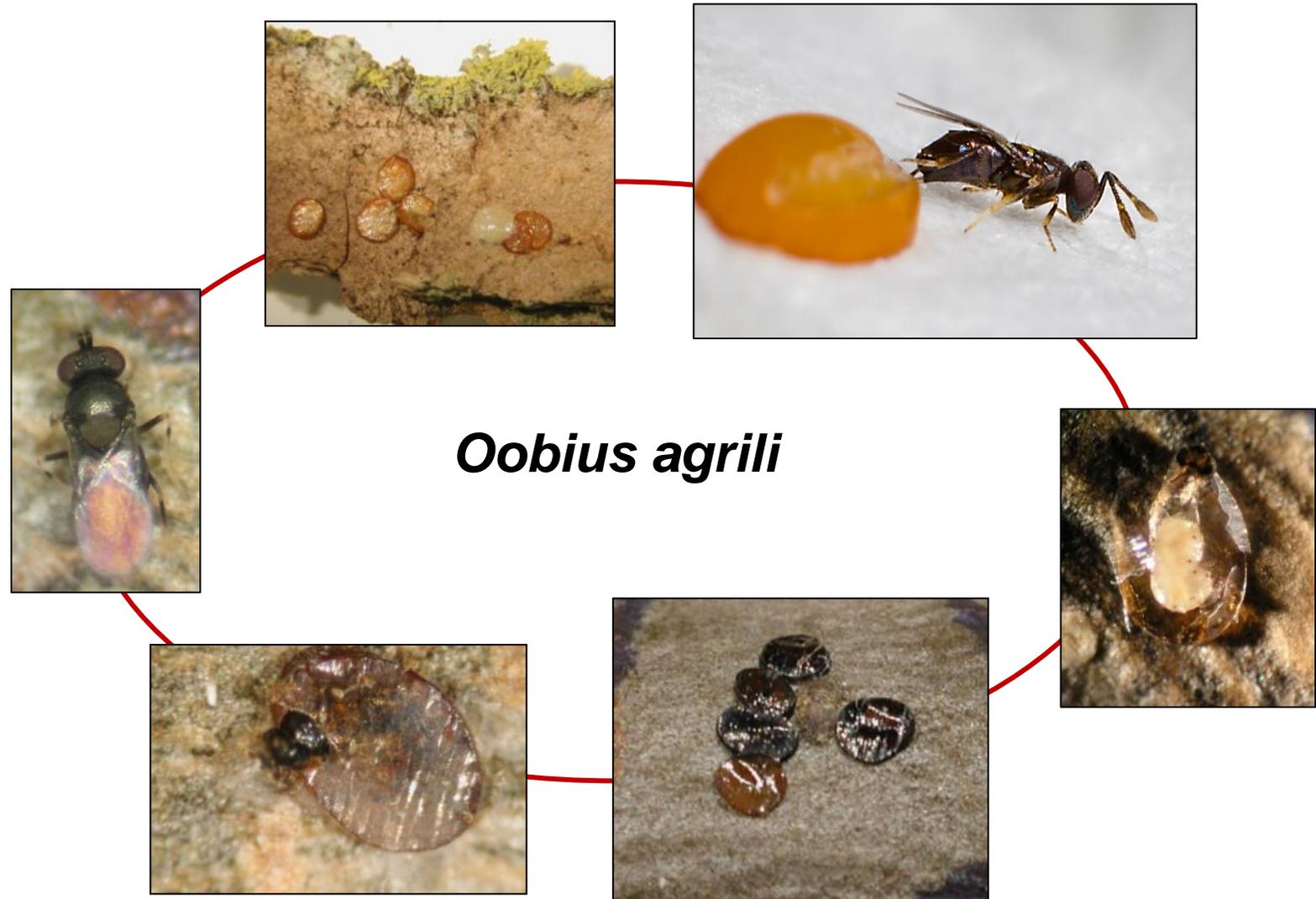
Table 1. Insecticide options for professionals and homeowners for controlling EAB that have been tested in multiple university trials. Some products may not be labeled for use in all states. Inclusion of a product in this table does not imply that it is endorsed by the authors or has been consistently effective for EAB control. See text of "Insecticide Options for Protecting Ash Trees From Emerald Ash Borer, 2014 2nd Edition" for more information and details.

Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
<i>Products Intended for Sale to Professional Applicators</i>			
Merit [®] (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Early to mid- spring or mid-fall
Safari [™] (20 SG)	Dinotefuran	Soil injection or drench	Mid- to late spring
Transect [™] (70WSP)	Dinotefuran	Soil injection or drench	Mid- to late spring
Xylam [®] Liquid Systemic Insecticide	Dinotefuran	Soil injection or drench	Mid- to late spring
Xytect [™] (2F, 75WSP)	Imidacloprid	Soil injection or drench	Early to mid-spring or mid-fall
Azasol [™]	Azadiratin	Trunk injection	Mid- to late spring after trees have leafed out
Imicide [®]	Imidacloprid	Trunk injection	Mid- to late spring after trees have leafed out
TREE-age [™]	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
ArborMectin [™]	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
TreeAzin [®]	Azadiractin	Trunk injection	Mid- to late spring after trees have leafed out
Safari [™] (20 SG)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Transect (70 WSP)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Zylam [®] Liquid Systemic Insecticide	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Astro [®]	Permethrin		Two applications at 4-week intervals; first spray should occur at 450-550 degree days (50°F, Jan. 1); coincides with black locust blooming
Onyx [™]	Bifenthrin	Preventive trunk, branch, and foliage cover sprays	
Tempo [®]	Cyfluthrin		
Sevin [®] SL	Carbaryl		
<i>Products Intended for Sale to Homeowners¹</i>			
Bayer Advanced [™] Tree & Shrub Insect	Imidacloprid	Soil drench	Early to-mid-spring
Optrol [™]	Imidacloprid	Soil drench	Early to mid-spring
Ortho Tree and Shrub Insect Control Ready to Use Granules	Dinotefuran	Granules	Mid- to late spring

¹Additional imidacloprid and dinotefuran products intended for sale to homeowners may be available in your area.

[http://www.emeraldashborer.info/documents/Multistate EAB Insecticide Fact Sheet.pdf](http://www.emeraldashborer.info/documents/Multistate_EAB_Insecticide_Fact_Sheet.pdf)

Biological Control



Oobius agrili

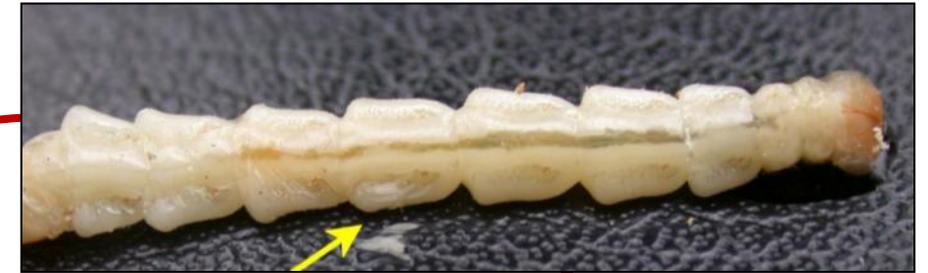
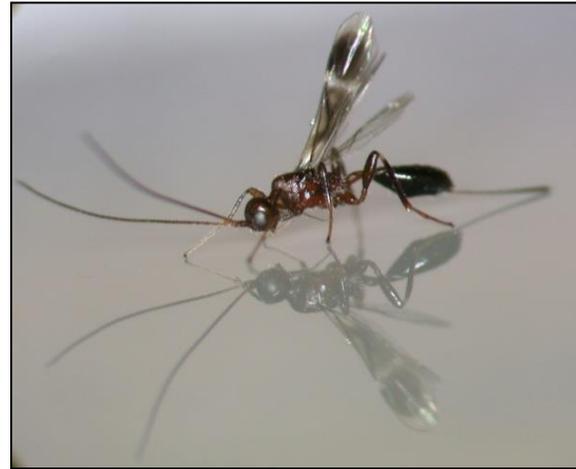
Biological Control



Tetrastichus planipennis



Biological Control



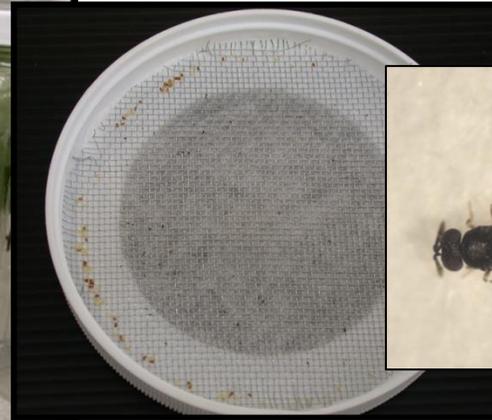
Spathius spp.



Rearing Methods



Rearing Methods





Release and Recovery Guidelines



https://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/EAB-FieldRelease-Guidelines.pdf

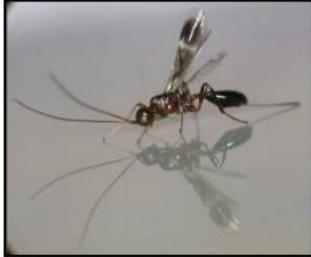
United States
Department of
Agriculture

Animal and
Plant Health
Inspection Service
Plant Protection
and Quarantine/
Agricultural Research
Service

US Forest Service

Cooperating State
Departments of
Agriculture

Emerald Ash Borer Biological Control Release and Recovery Guidelines



Recovery Methods





MapBioControl

Database for
EAB Biocontrol
Information,
Parasitoid
Requests,
and Entering
Release Data

<https://www.mapbiocontrol.org/>

mapBioControl: EAB | x
www.mapbiocontrol.org/eab/
Apps Suggested Sites Imported Fro...

Welcome to mapBioControl, Leah | Logout

mapBioControl

HOME RELEASE RECOVERY MAPVIEWER CONTACT HELP

Welcome to the EAB Biological Control Release and Recovery section of the mapBioControl website.

As a user of this website you have agreed to maintain your release and recovery data through the mapBioControl website as a condition of receiving biological control agents from the APHIS rearing facility in Brighton, Michigan. Your timely entering of data will help aid in the successful management of this national program.

You are encouraged to start by reading the APHIS release guidelines provided below. Any questions on using this site can be directed to project support by using the contact form provided.

Photo Credit: Deborah Miller

Using the Website

Available Soon

ID	NAME	STATE	DATE	LOCATION
2134	Washita	OK	12 May 12	Washita National Forest Watershed
2135	Washita	OK	12 May 12	Washita National Forest Watershed
2136	Washita_2	OK	12 May 12	Washita National Forest Watershed
2137	Washita_2	OK	12 May 12	Washita National Forest Watershed
2138	Washita_2	OK	12 May 12	Washita National Forest Watershed
2139	Washita_2	OK	12 May 12	Washita National Forest Watershed
2140	Washita_2	OK	12 May 12	Washita National Forest Watershed
2141	Washita_2	OK	12 May 12	Washita National Forest Watershed
2142	Washita_2	OK	12 May 12	Washita National Forest Watershed
2143	Washita_2	OK	12 May 12	Washita National Forest Watershed
2144	Washita_2	OK	12 May 12	Washita National Forest Watershed
2145	Washita_2	OK	12 May 12	Washita National Forest Watershed
2146	Washita_2	OK	12 May 12	Washita National Forest Watershed
2147	Washita_2	OK	12 May 12	Washita National Forest Watershed
2148	Washita_2	OK	12 May 12	Washita National Forest Watershed
2149	Washita_2	OK	12 May 12	Washita National Forest Watershed
2150	Washita_2	OK	12 May 12	Washita National Forest Watershed

APHIS Program Guidelines

Emerald Ash Borer Biological Control Release and Recovery Guidelines

Review the release and recovery guidelines for a program overview and detailed instructions regarding data collection.

Current Maps

View Maps

Partners

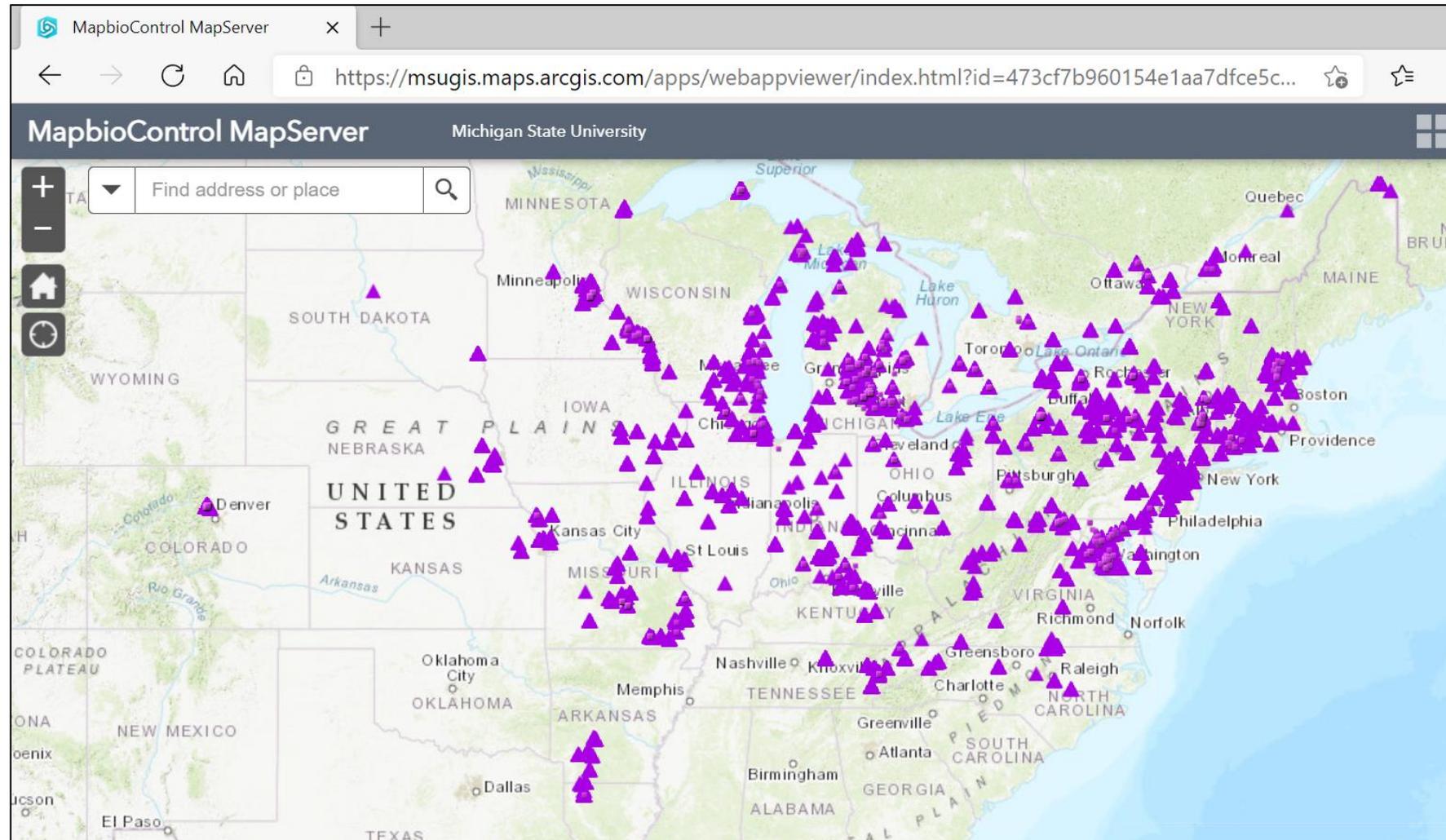
MICHIGAN STATE UNIVERSITY

APHIS

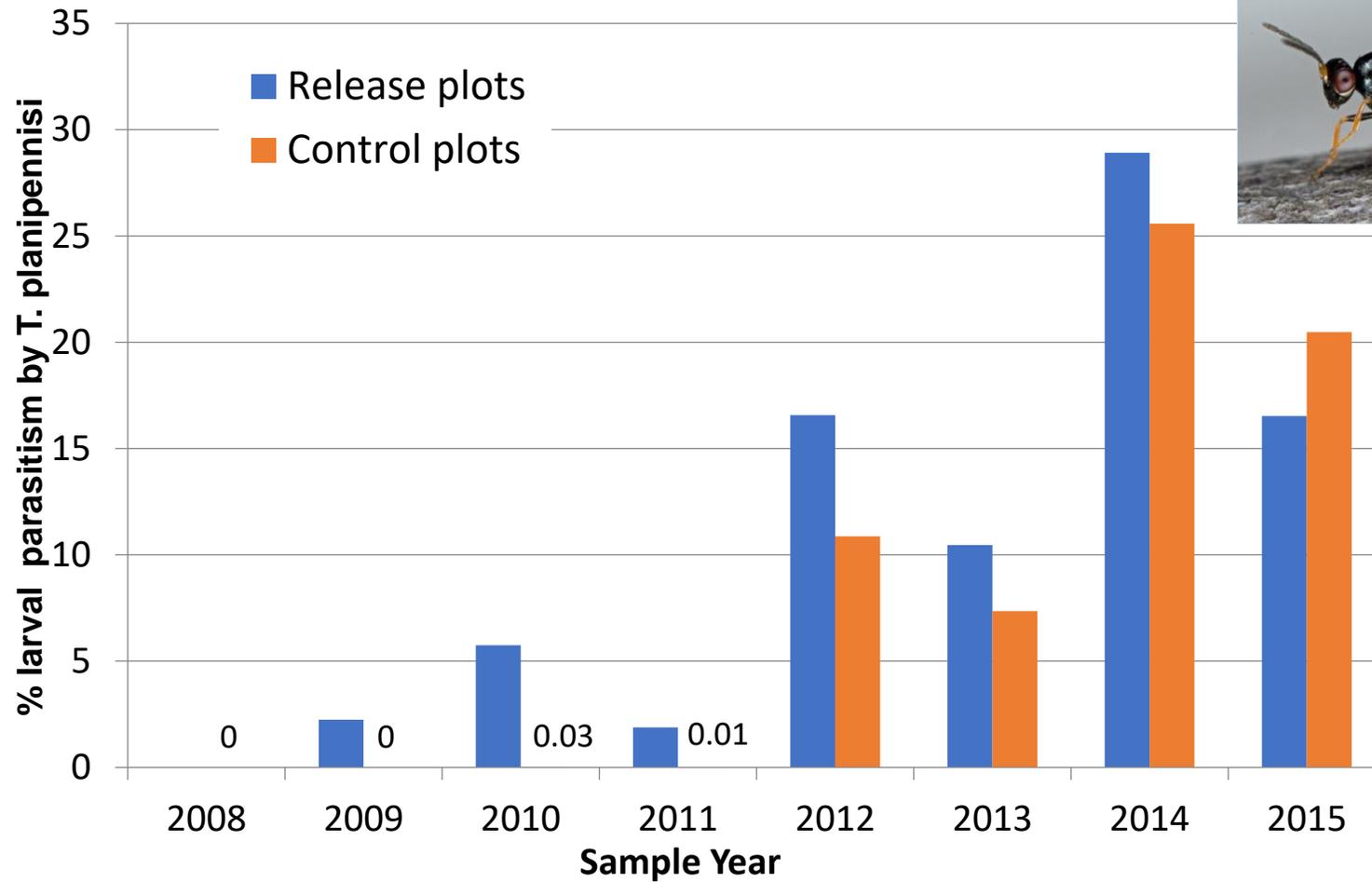
PPQ Plant Protection and Quarantine



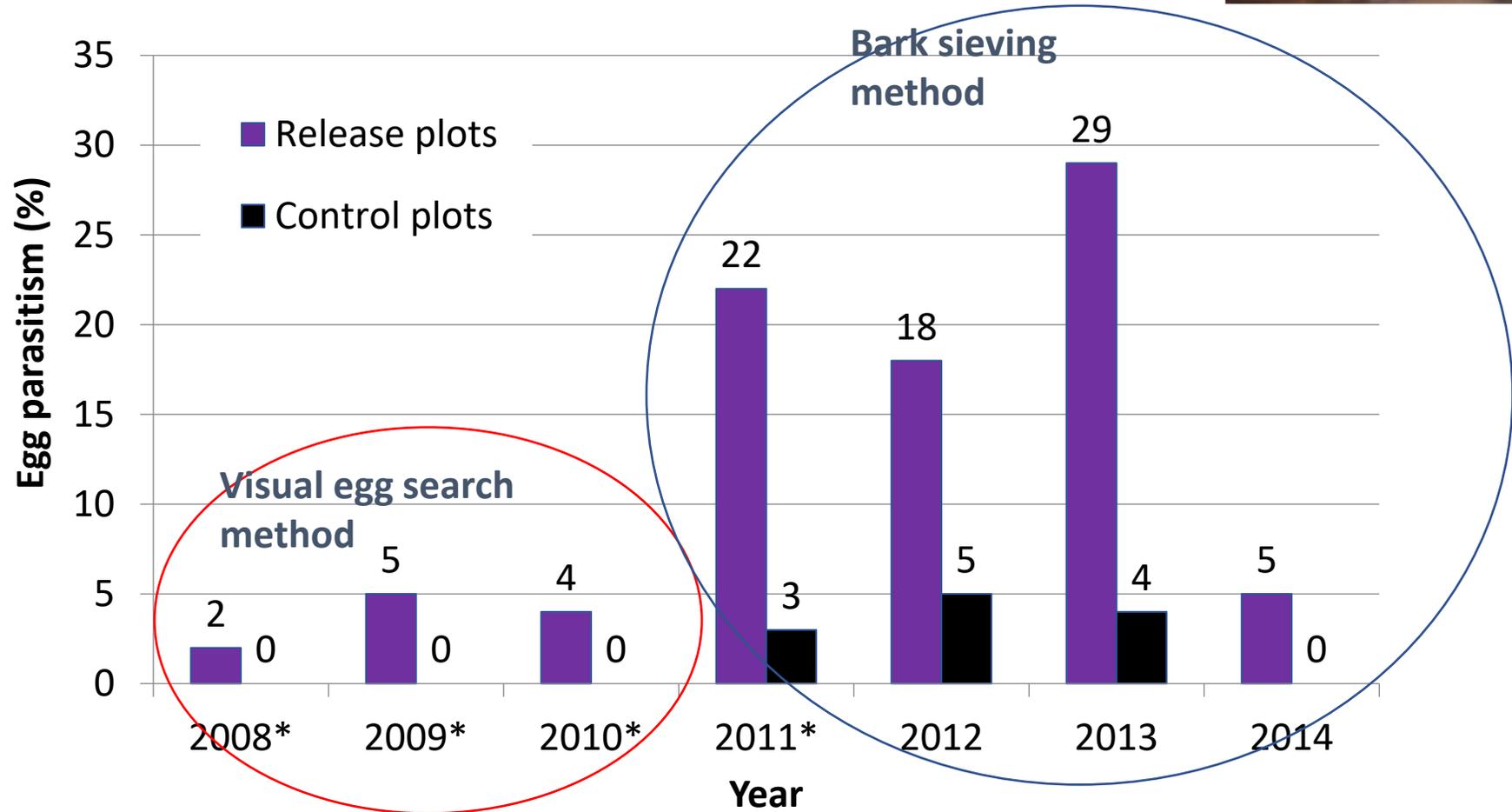
Parasitoid Releases and Recoveries



Percent Parasitism



Percent Parasitism



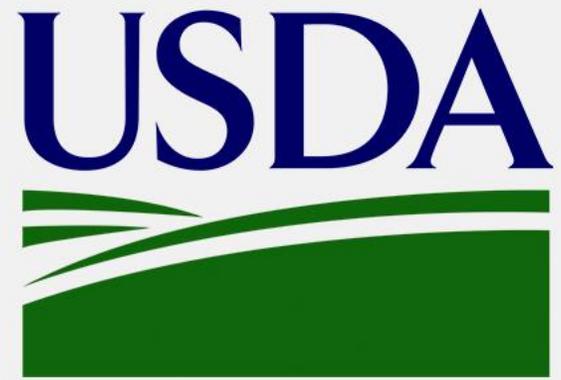


Resources

- www.emeraldashborer.info
- <https://extension.entm.purdue.edu/EAB/Management.html>
- <https://www.jove.com/t/55252/building-double-decker-traps-for-early-detection-of-emerald-ash-borer>
- https://extension.entm.purdue.edu/EAB/PDF/NABB_DecisionGuide.pdf
- <https://int.entm.purdue.edu/ext/treecomputer/>
- http://www.emeraldashborer.info/documents/Multistate_EAB_Insecticide_Fact_Sheet.pdf
- <https://extension.entm.purdue.edu/EAB/PDF/PotentialSideEffectsofEABInsecticidesFAQ.pdf>
- https://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/EAB-FieldRelease-Guidelines.pdf
- <https://www.mapbiocontrol.org/>



Thank you !



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