Biological Control of Emerald Ash Borer in Connecticut

Claire Rutledge, PhD

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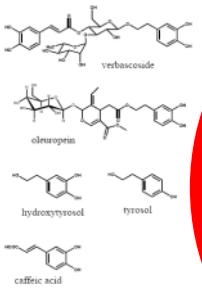
Top Down vs. Bottom Up Control

Predators

Herbivores

Plants



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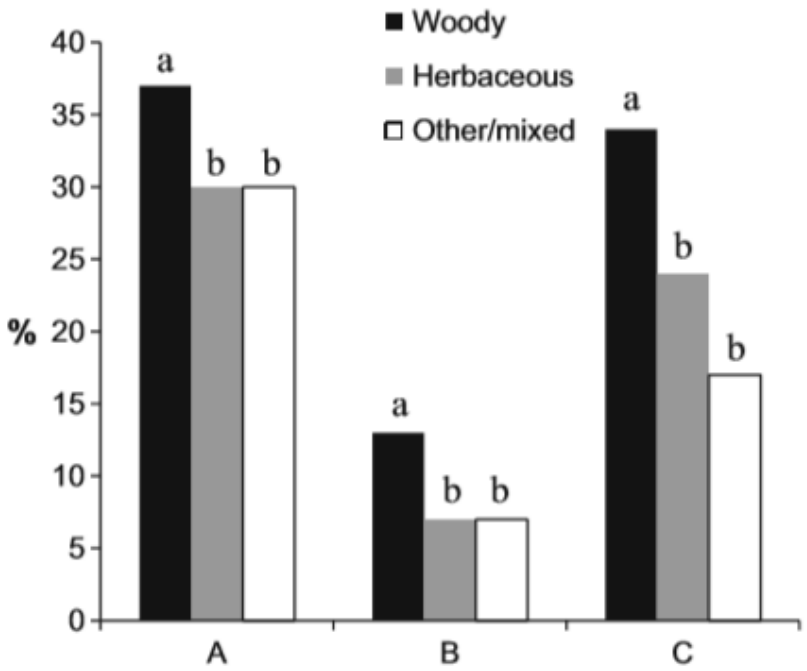
What is Biological Control?

- Using one organism to manage another. Targets can be plants, animals, fungus or bacteria
- Three Major Types
  - Classical Biological Control
    - invasive pest
    - biocontrol organisms come from native range of pest
    - Permanent solution
  - Conservation Biological Control
    - Manage environment to benefit natural enemies e.g. reduced pesticides, planting food plants
  - Augmentative Biological Control
    - Invasive or native pest
    - Mass reared natural enemies released
    - Control organisms not expected to establish

Classical Biological Control

- In practice since late 1800's
- Has an overall success rate of about 30%
- Used in many types of systems



A – introductions leading to establishment
B – intro's leading to success
C – target species controlled

Kenis et al. 2016

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Steps of Classical Biological Control

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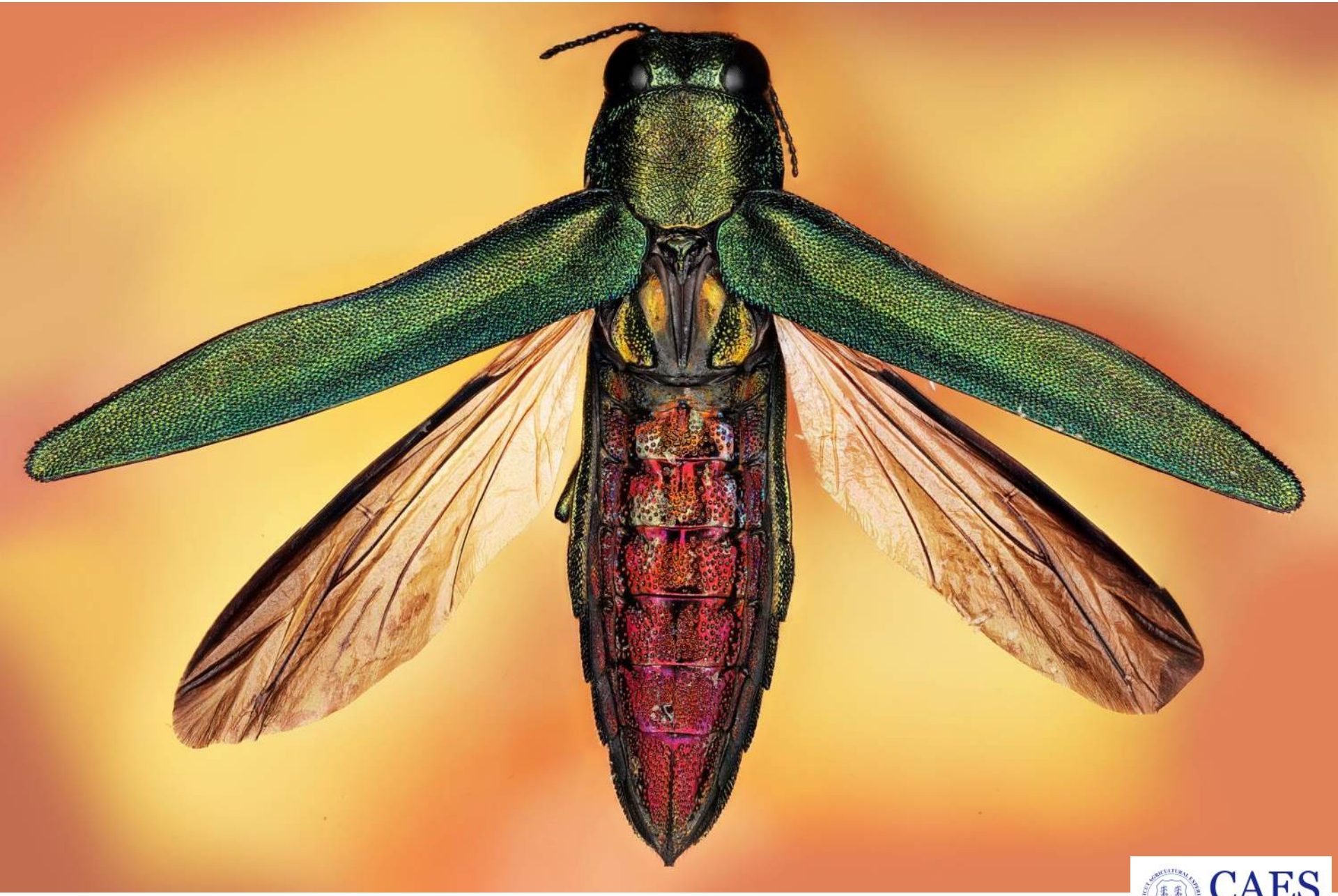

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Host Trees

- All Ashes: *Fraxinus* spp
  -Green, Black, White
- White Fringe Tree
- Olive
- And nothing else
  – Mountain ash is not a true ash!

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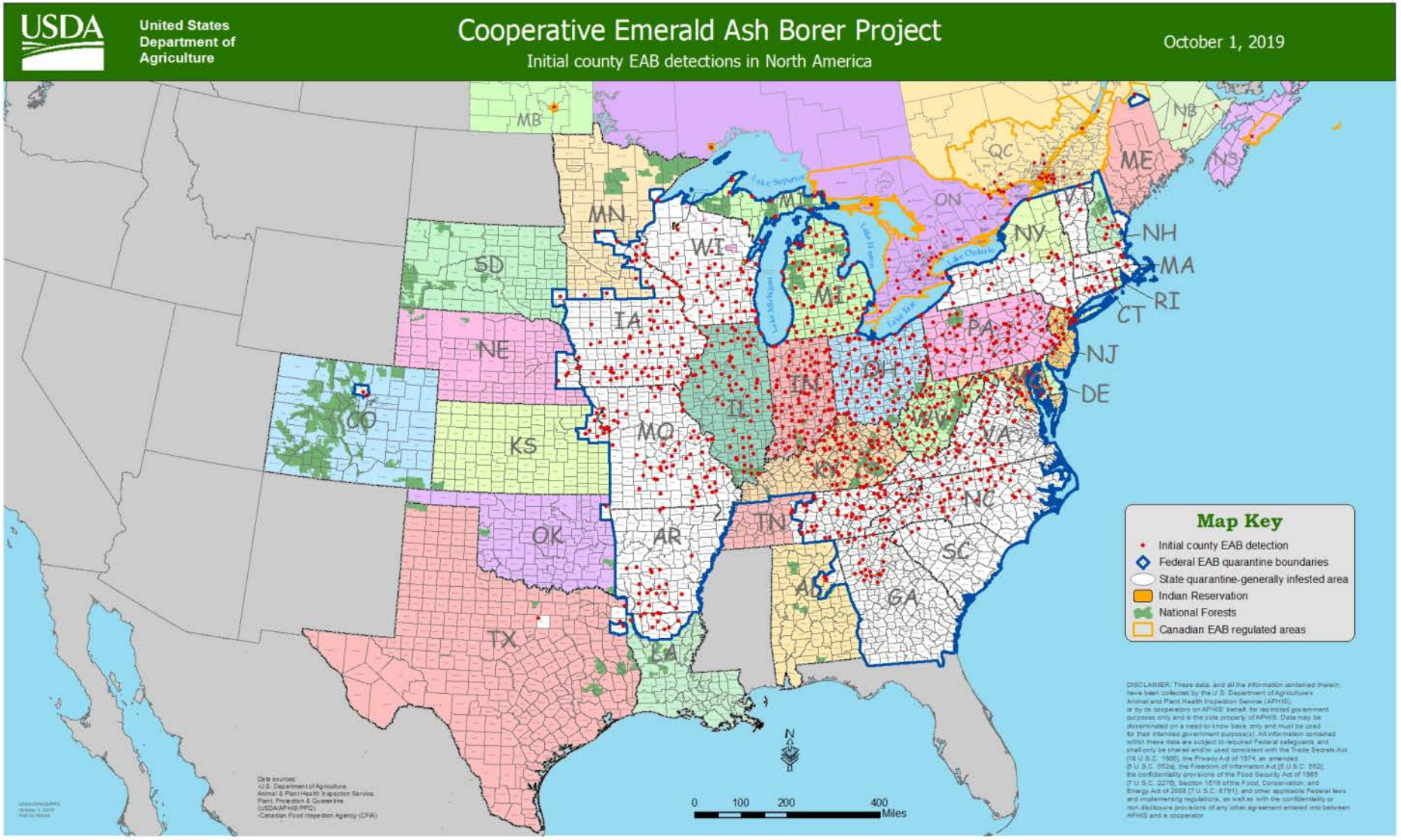
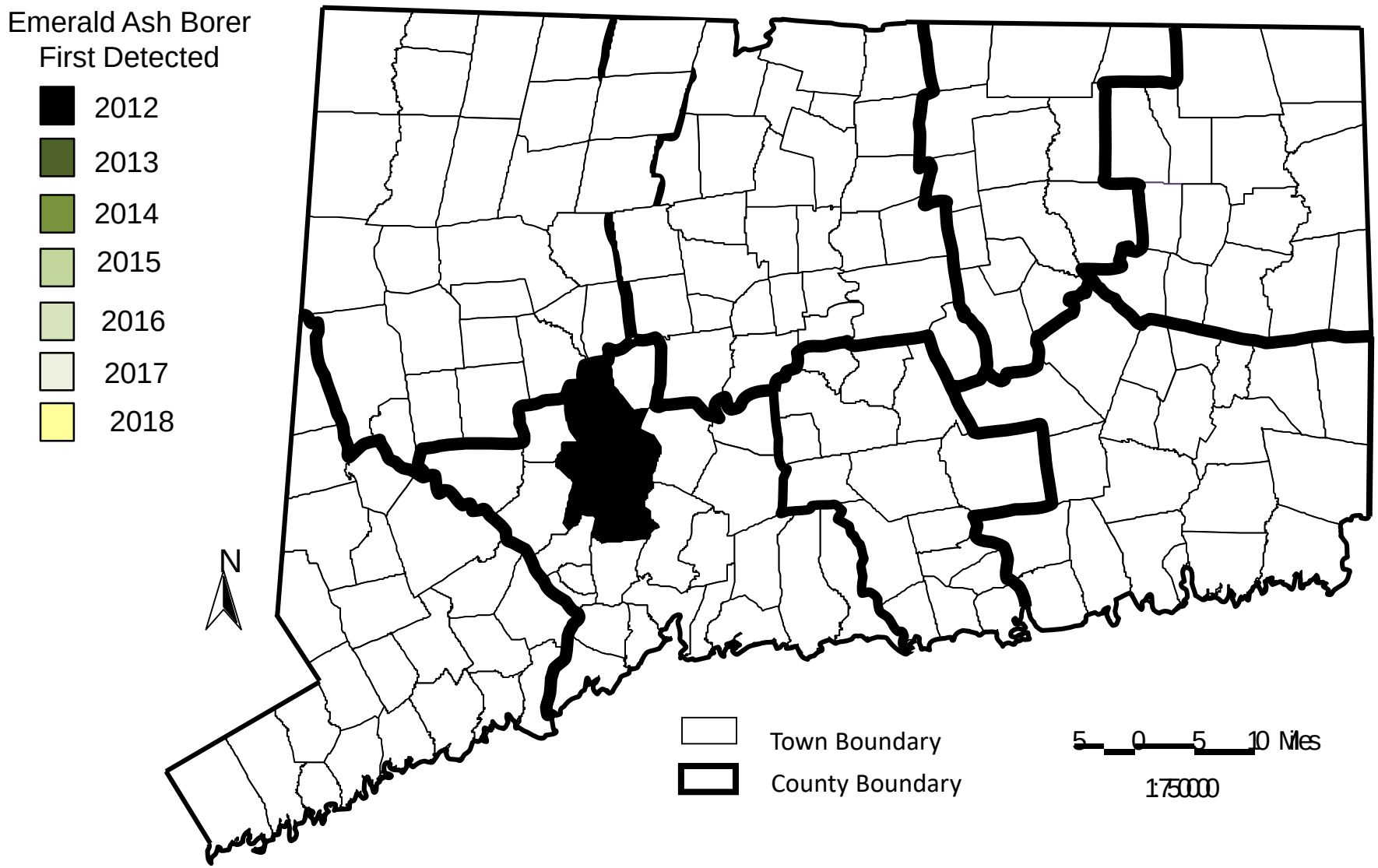
Mating and Eggs

Larvae (immatures)

Adults

Pupae


USDA
United States Department of Agriculture
Cooperative Emerald Ash Borer Project
Initial county EAB detections in North America
October 1, 2019
MB
NB
QC
ME
NS
ON
MN
MI
VT
NY
NH
WI
SD
MA
RI
CT
IA
PA
NJ
NE
IN
OH
DE
CO
IL
MD
KS
MO
WV
VA
KY
NC
OK
TN
AR
SC
MS
AL
GA
TX
LA
Map Key
Initial county EAB detection
Federal EAB quarantine boundaries
State quarantine-generally infested area
Indian Reservation
National Forests
Canadian EAB regulated areas
N
0 100 200 400
Miles
Data sources:
-U.S. Department of Agriculture, Animal & Plant Health Inspection Service, Plant Protection & Quarantine (USDA/APHIS/PPQ)
-Canadian Food Inspection Agency (CFIA)
DISCLAIMER: These data, and all the information contained therein, have been collected by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), or by its cooperators on APHIS' behalf, for restricted government purposes only and is the sole property of APHIS. Data may be disseminated on a need-to-know basis only and must be used for their intended government purpose(s). All information contained within these data are subject to required Federal safeguards and shall only be shared and/or used consistent with the Trade Secrets Act (18 U.S.C. 1905), the Privacy Act of 1974, as amended (5 U.S.C. 552a), the Freedom of Information Act (5 U.S.C. 552), the confidentiality provisions of the Food Security Act of 1985 (7 U.S.C. 2276), Section 1619 of the Food, Conservation, and Energy Act of 2008 (7 U.S.C. 8791), and other applicable Federal laws and implementing regulations, as well as with the confidentiality or non-disclosure provisions of any other agreement entered into between APHIS and a cooperator.



2012

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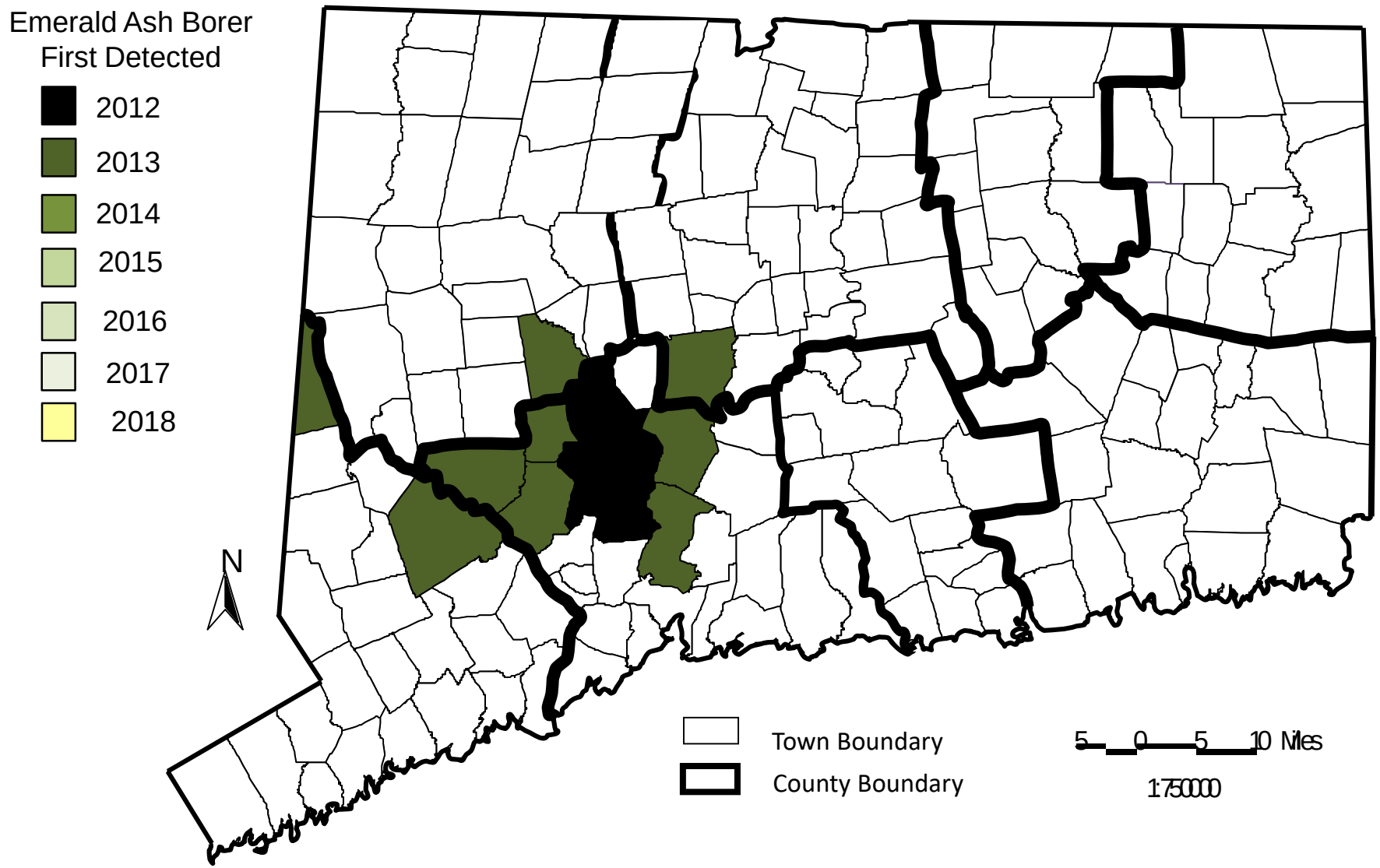

2013

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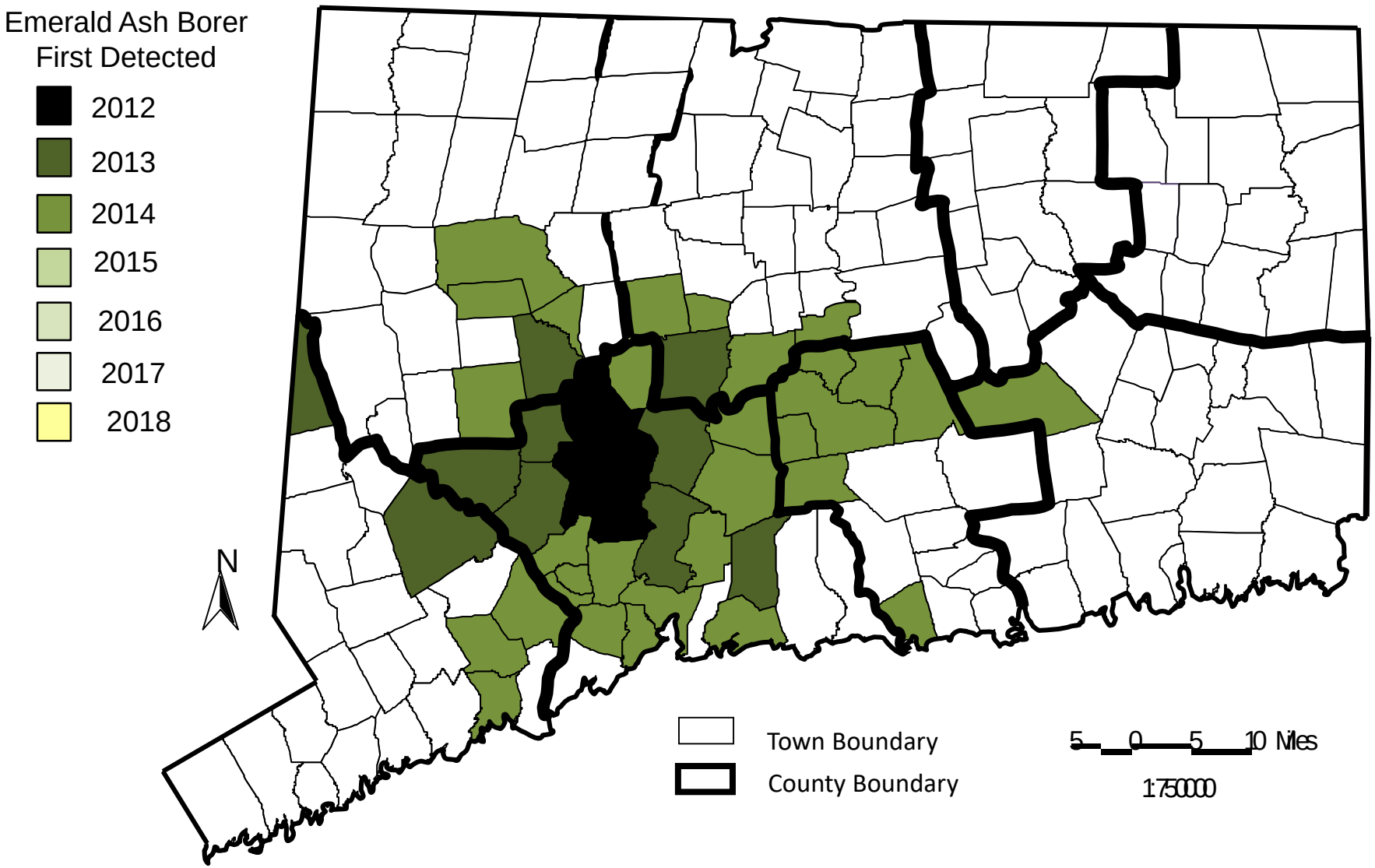

2014

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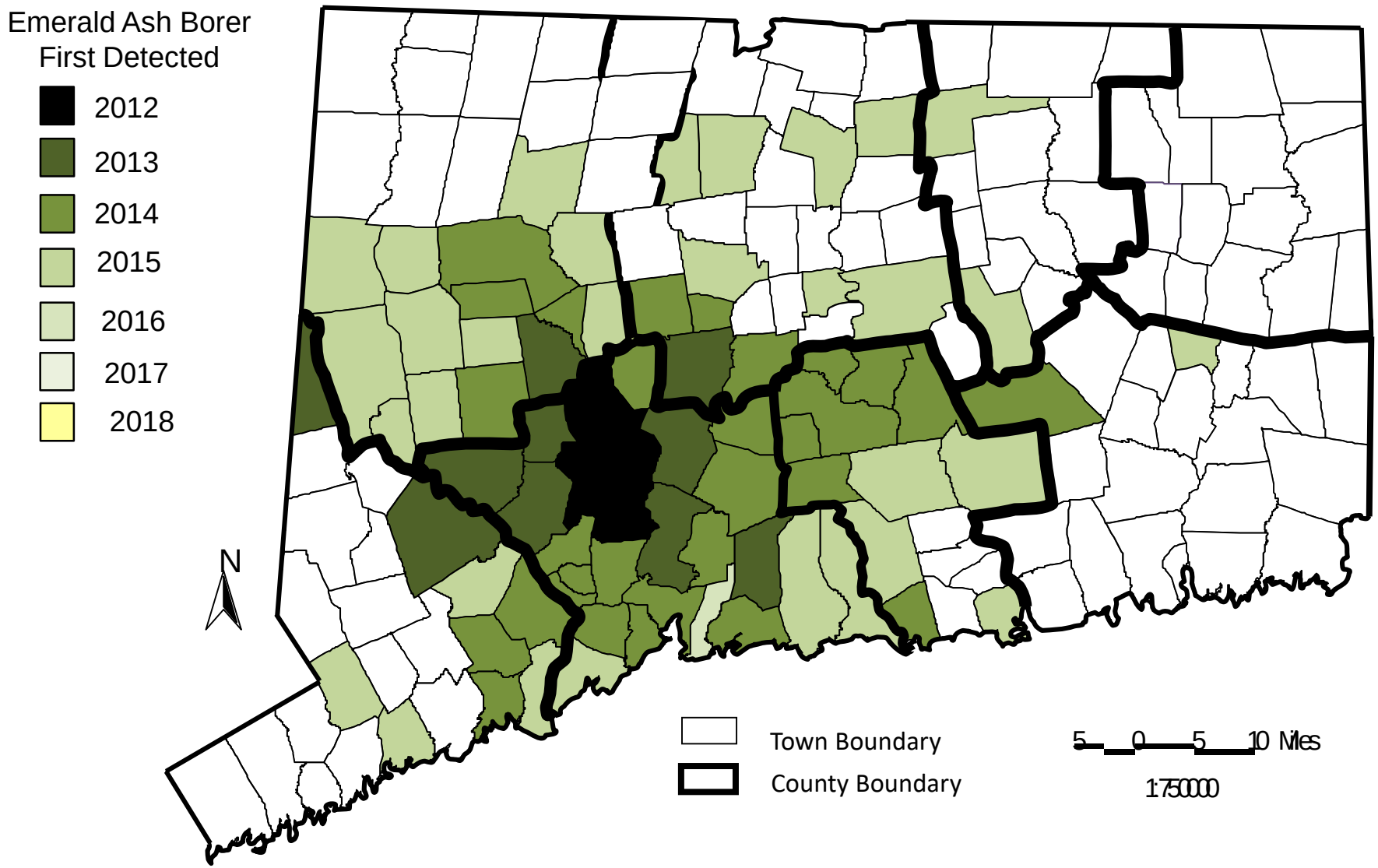

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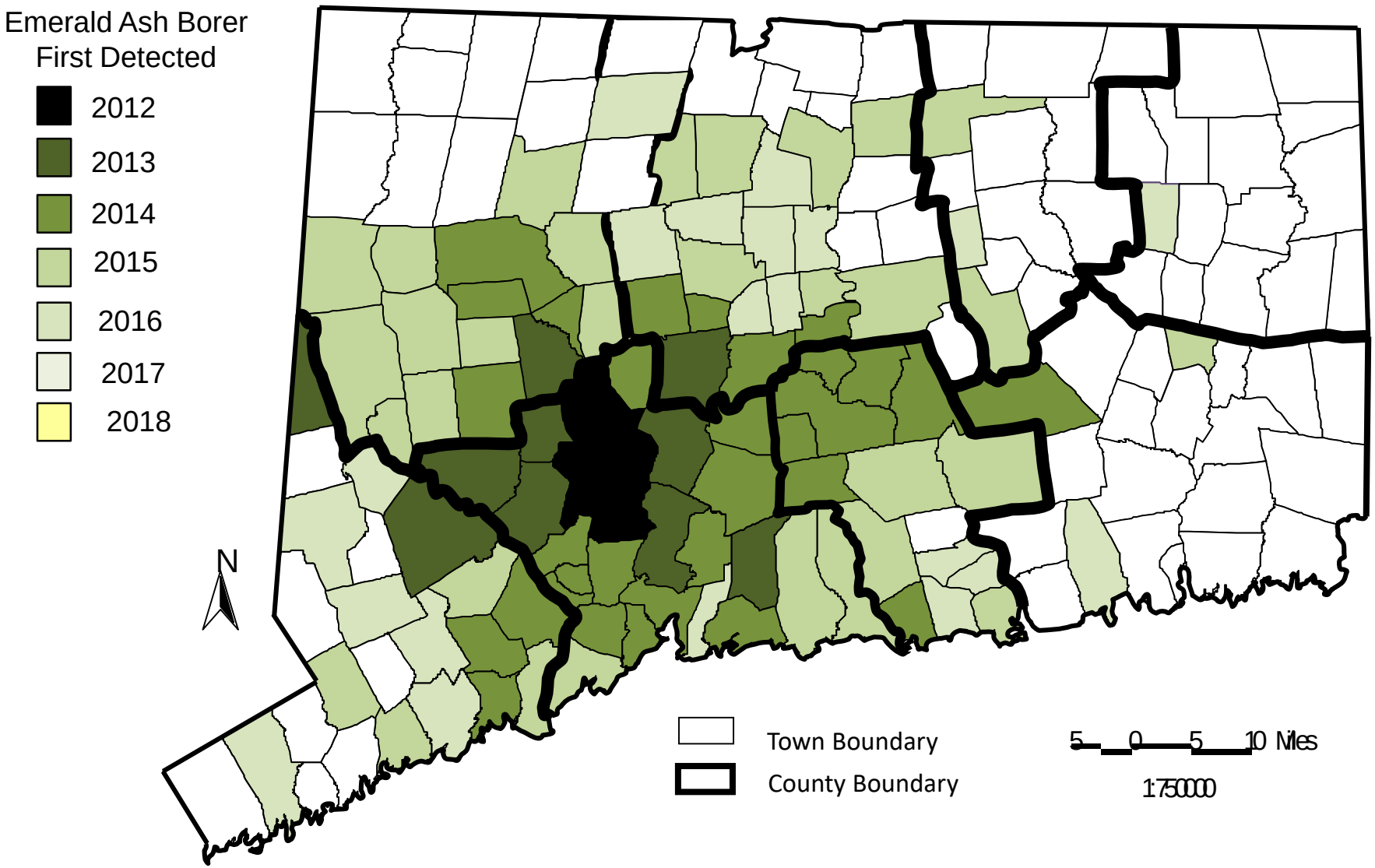

2016

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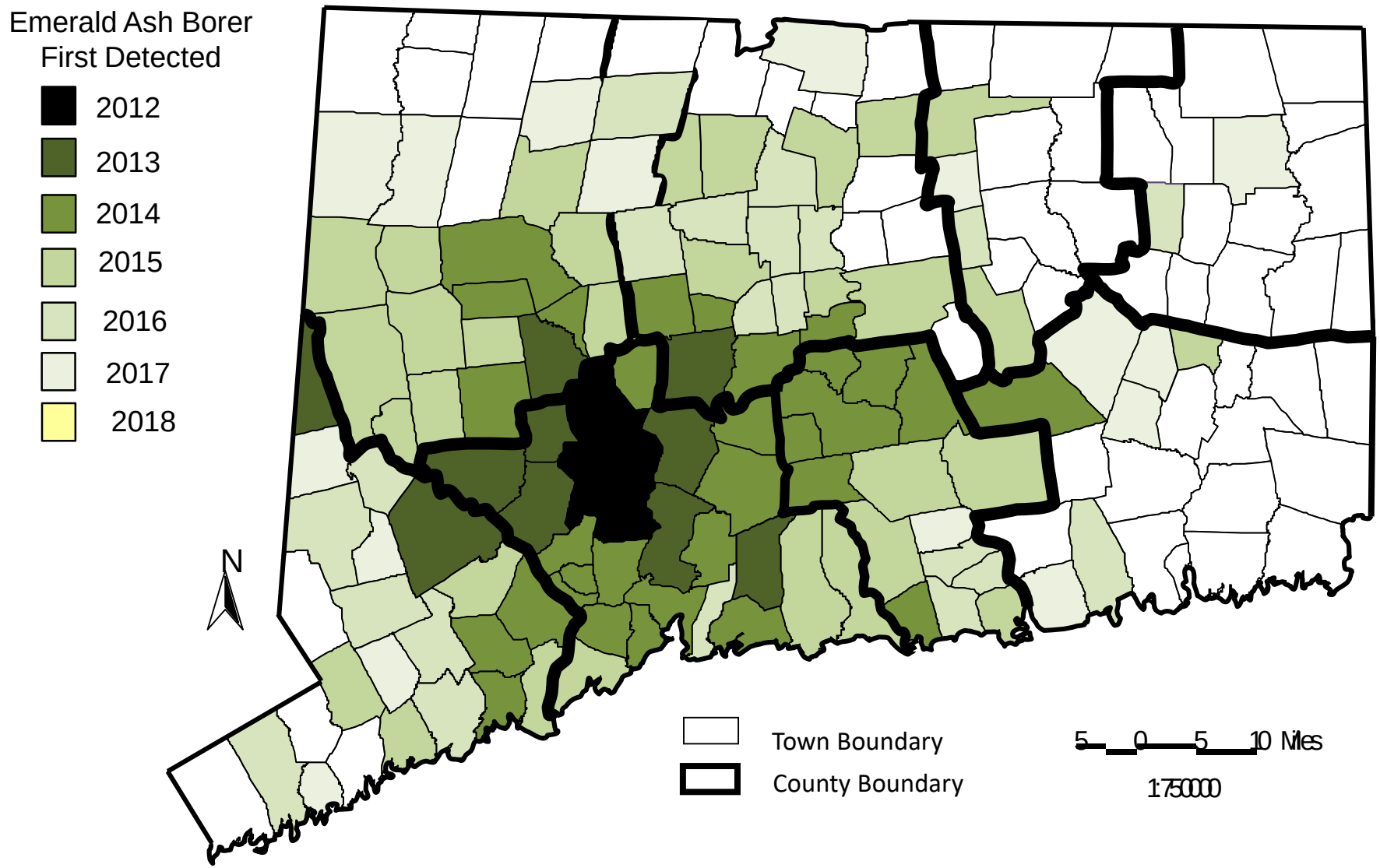

2017

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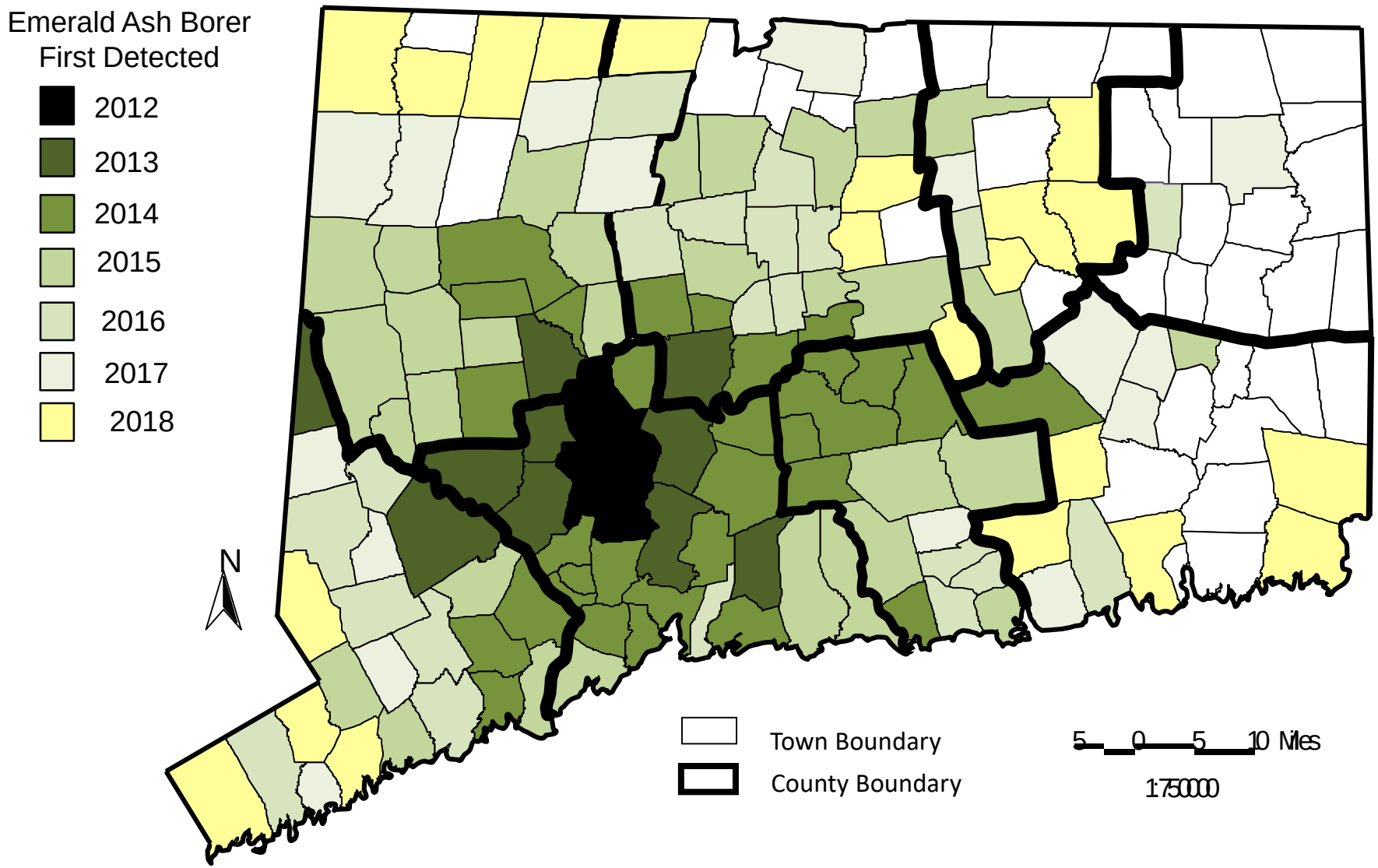

2018

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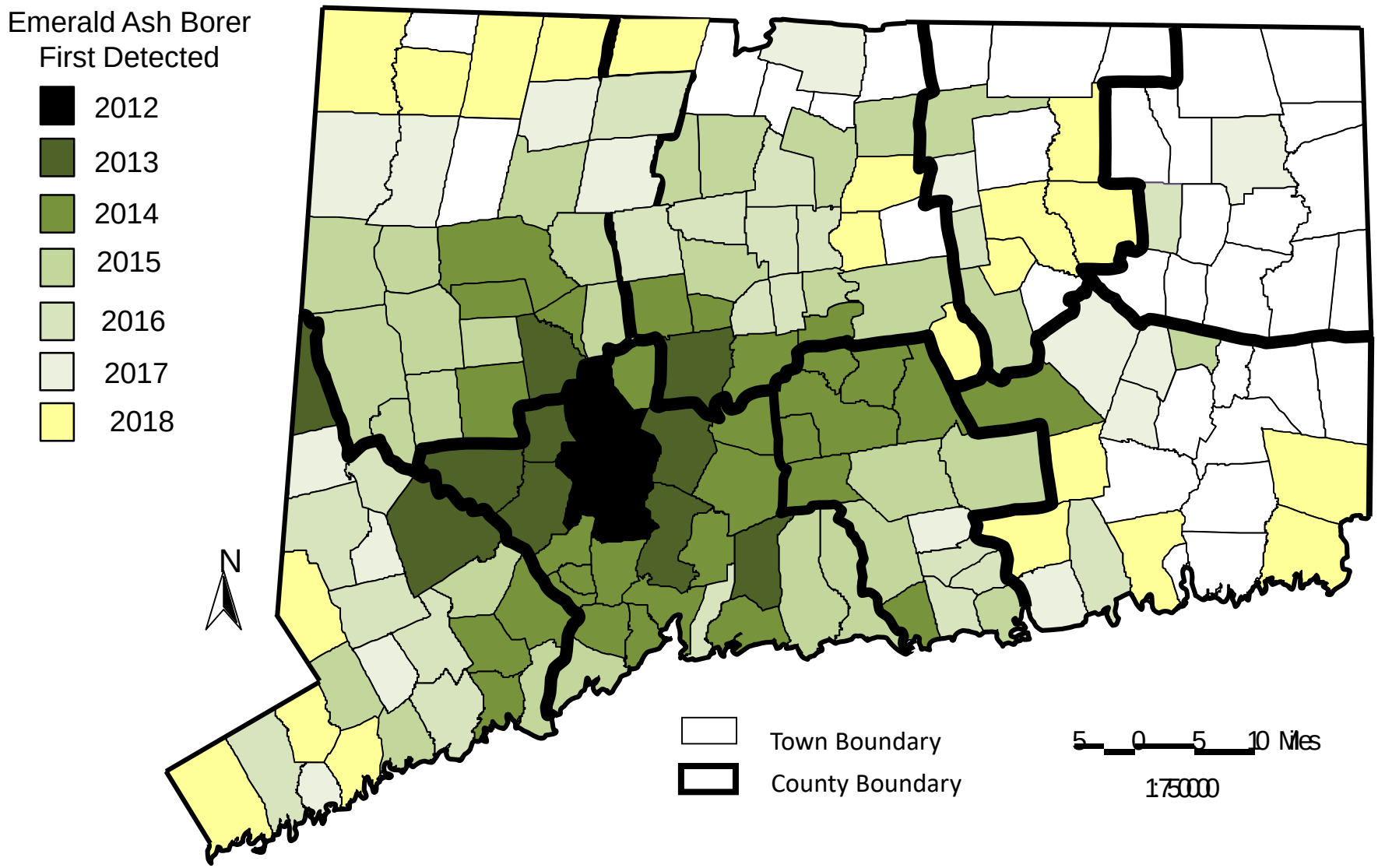

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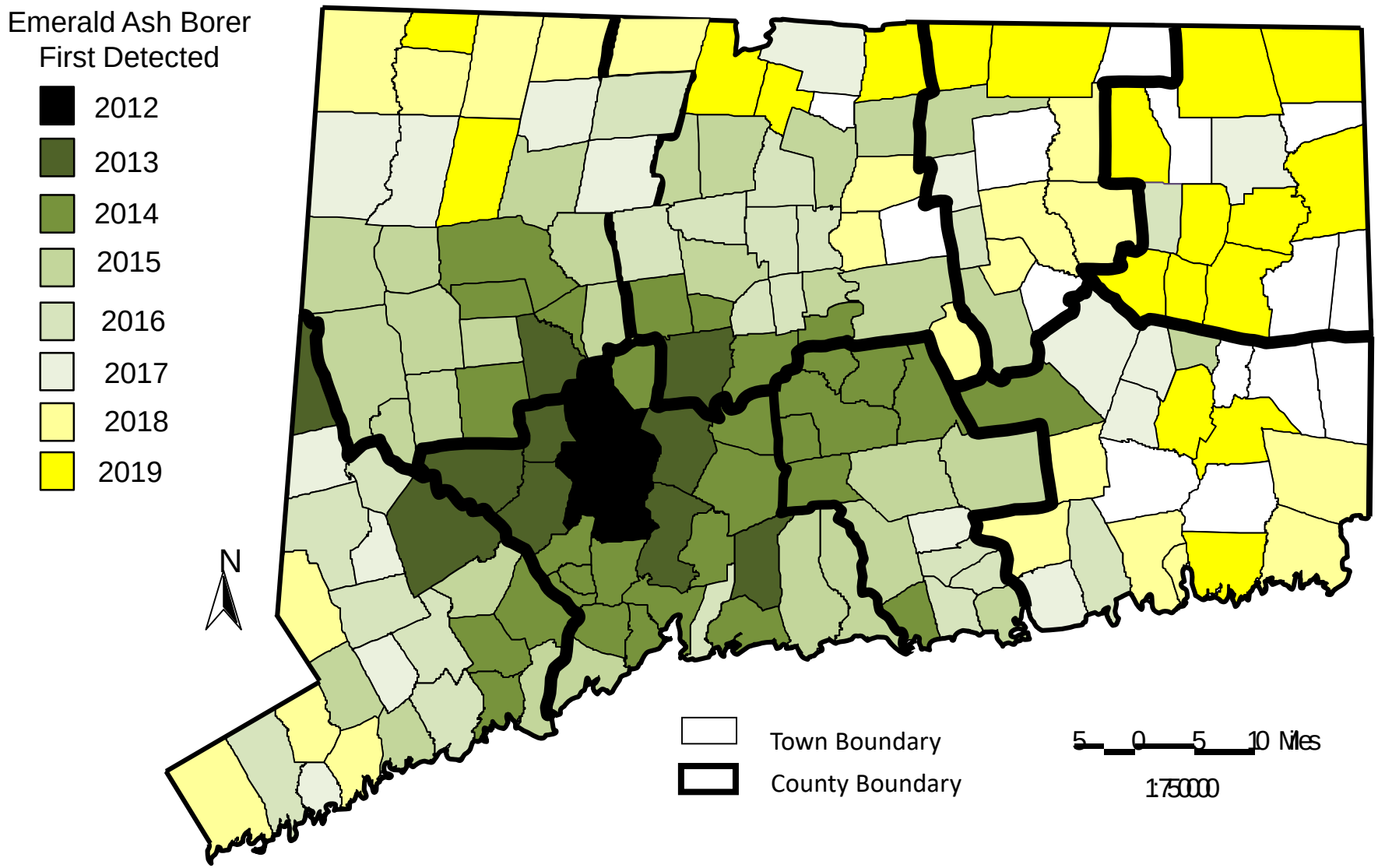

2019

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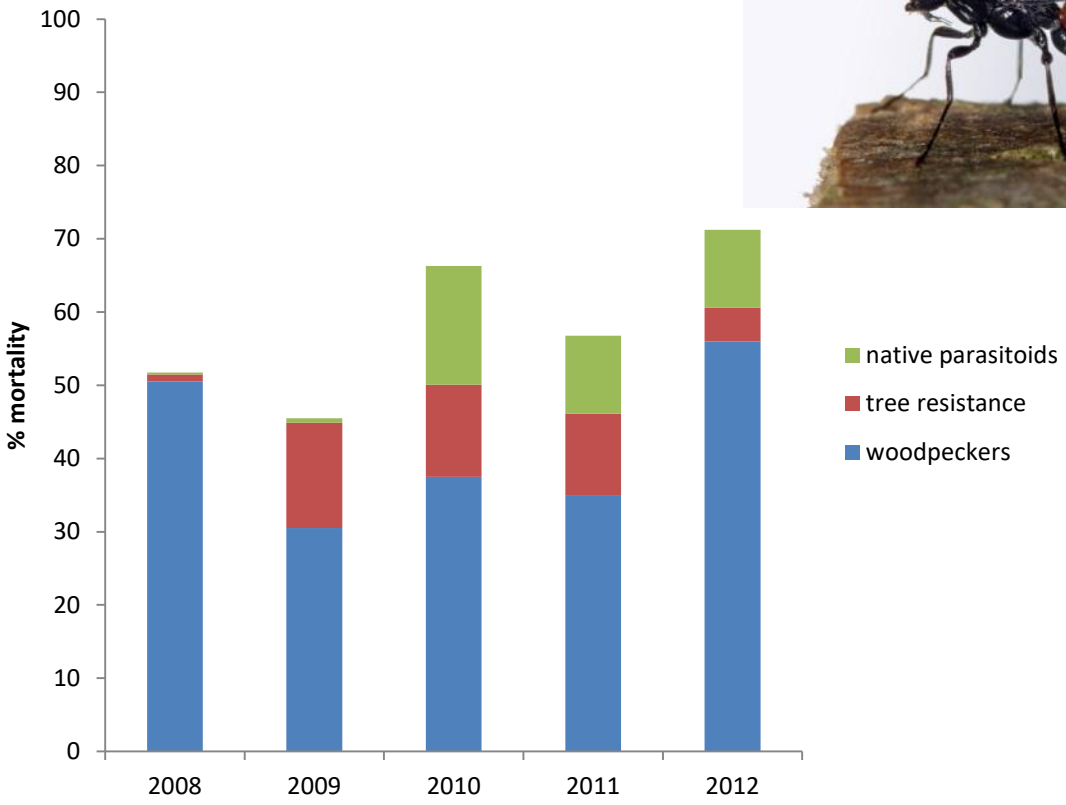
Mortality of EAB in North America



Duan et al. 2013

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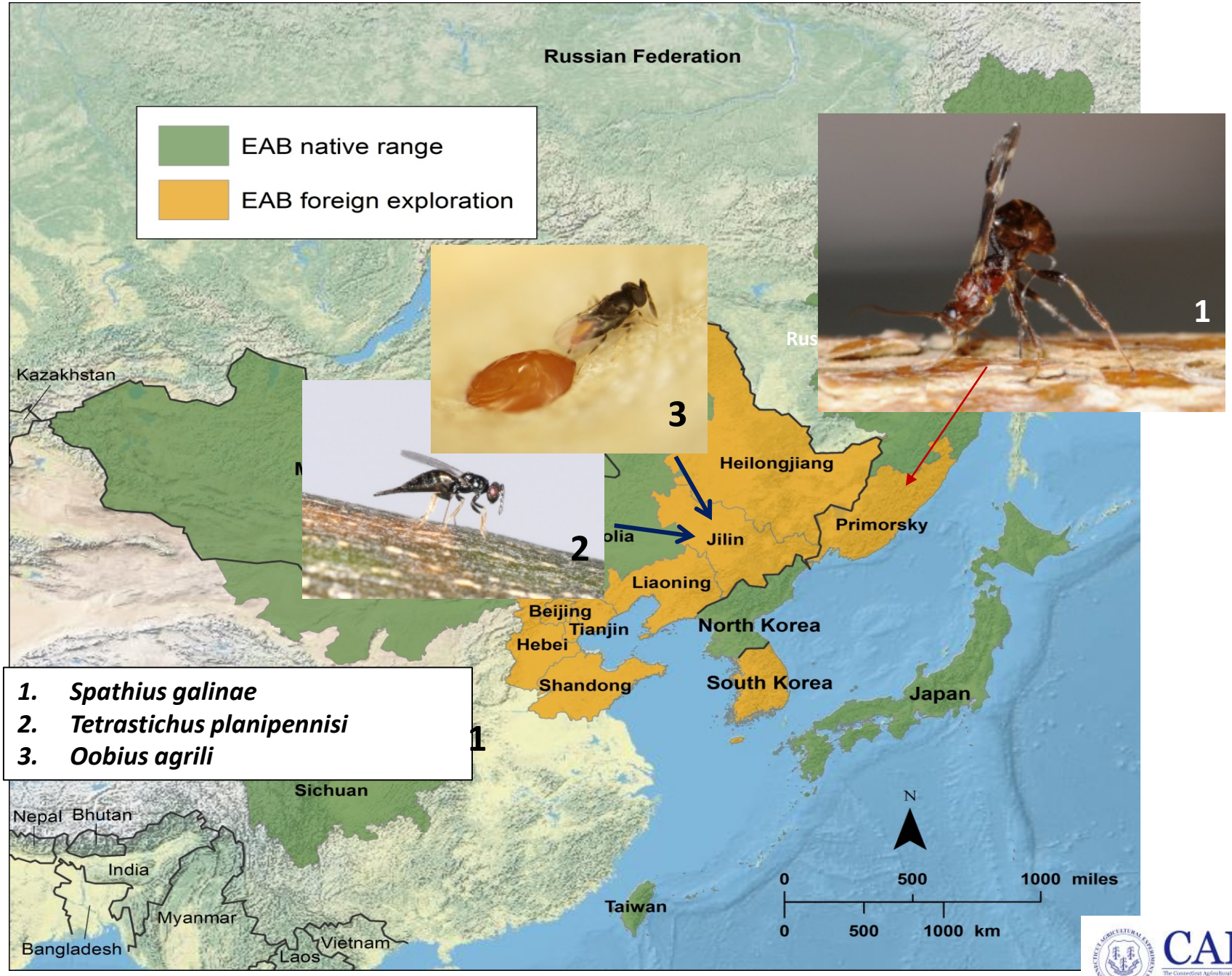
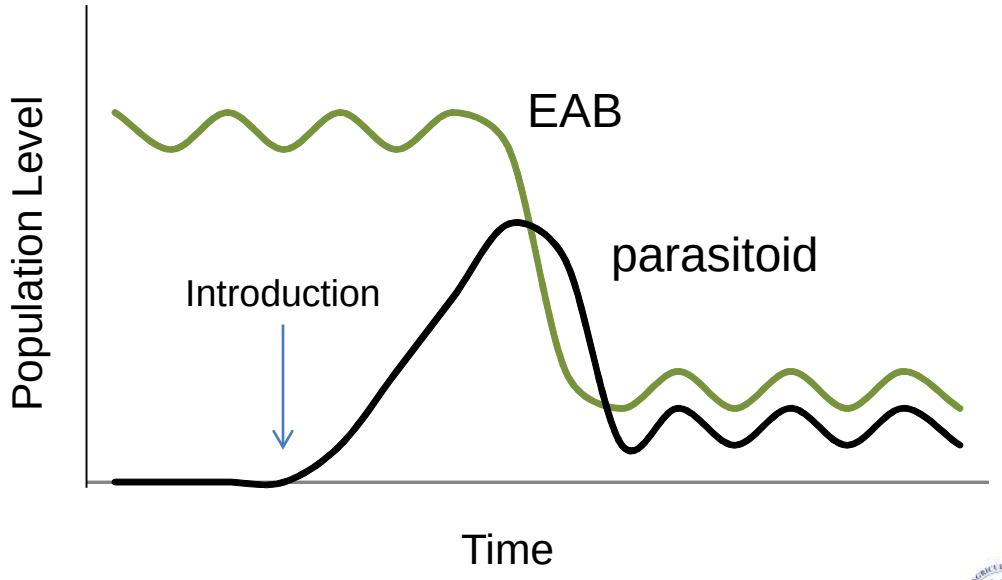


From Van Driesch 2019

Why Parasitoids?

- Tightly linked physiologically with hosts
- Tightly linked with host habitat
- Limited ability to switch hosts
- High fecundity



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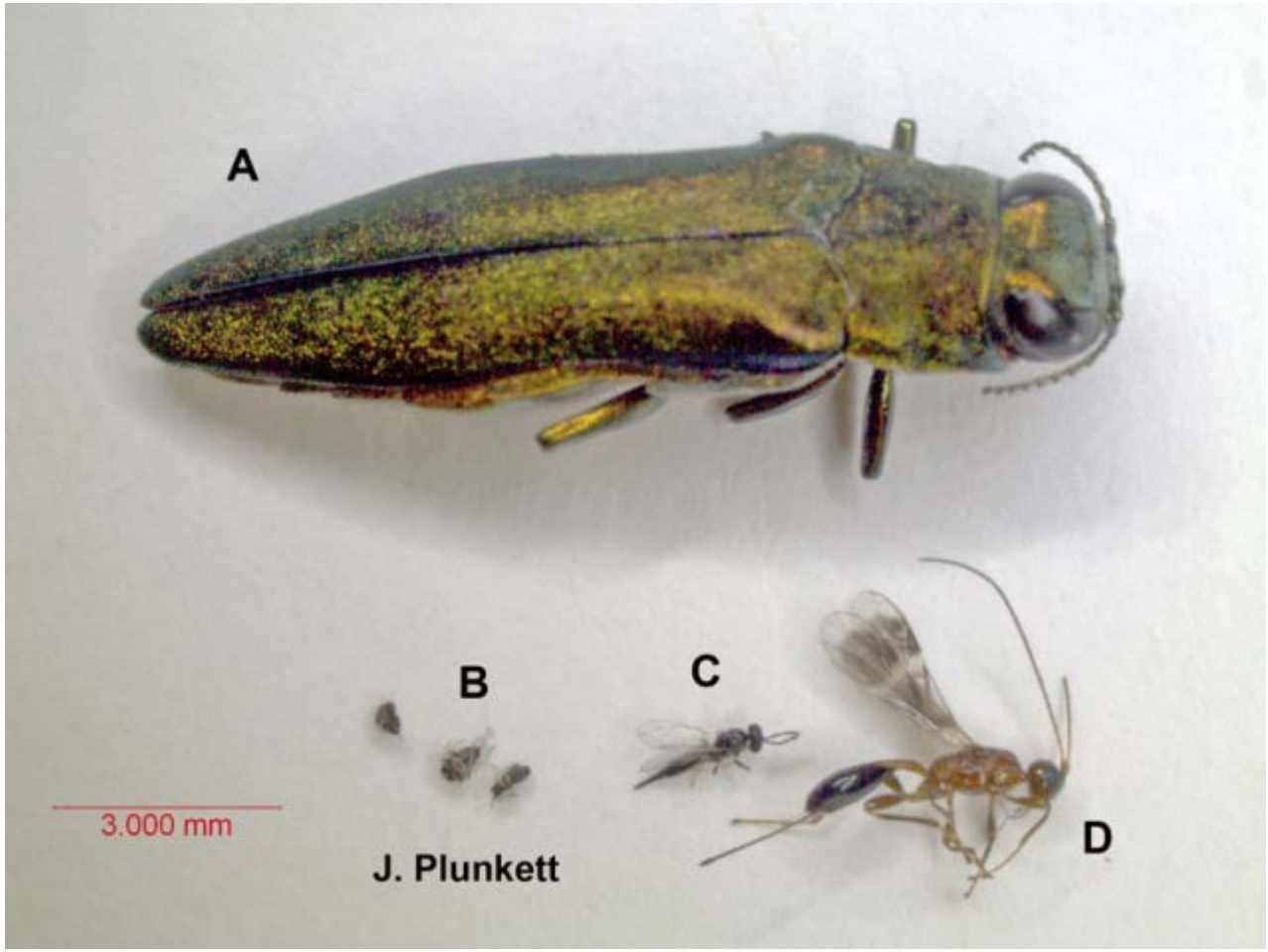
Emerald Ash Borer Parasitoids



Emerald Ash Borer Parasitoids

Tetrastichus planipennisi

T. planipennisi larvae mature inside an EAB larva

Tetrastichus planipennisi

- Endoparasitoid of EAB from China
- Attacks and kills up to 50 percent of EAB larvae.
- The female parasitoid lays eggs inside EAB larvae
- *Tetrastichus* completes at least four generations each year
- One EAB larva can produce up to 127 *Tetrastichus* adults.
- They survive the winter as larvae inside their host or host gallery under the bark of ash trees.

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Spathius galinae

- *Spathius* spp. have a longer ovipositor than *Tetrastichus*, can parastize larvae in bigger trees
- *Spathius galinae* - collected from EAB populations infesting *Fraxinus pennsylvanica* trees in the Vladivostok area (Duan et al., 2012a).
- *Spathius galinae* - ectoparasitoid attacking 2nd to 4th instar EAB larvae
- Started releases in 2016

Emerald Ash Borer Parasitoids

Oobius agrili

- Kills up to 60 percent of EAB eggs laid
- Search the bark of ash trees for EAB eggs, it injects its own egg inside where it will hatch, grow, and kill the host egg.
- At least two generations during the EAB egg-laying season.
- Each *Oobius* adult can parasitize up to 62 EAB eggs during its life time.
- *Oobius* spends the winter as larvae inside EAB eggs and emerge the following spring as adults.

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Larval parasitoid
Tetrastichus plannipenisi

- **No attacks** on 3 species in other orders (2 moths, one sawfly)
- **No attacks** on 5 species of longhorned borers (Cerambycidae)
- **No attacks** on 8 other buprestids (5 spp. *Agrilus* and 3 *Chrysobothris*)

)

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Spathius galinae

Approved for release in 2015
First released in 2016

Host range test results

- **No attacks** on 2 borers in other orders (one moth, one sawfly)
- **No attacks** on 8 borers in other beetle families
- **No attacks** on 4 species of *Agrilus* or 1 of *Chrysobothris* (Buprestidae)
- **Attack** on 1 pest *Agrilus* species (*Agrilus auroguttatus*)

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Egg parasitoid
Oobius agrili

- **No attacks** on moth eggs
- **No attacks** on long horned beetle eggs
- Attacks on eggs of other similar-sized *Agrilus* (bronze birch borer, two-lined chestnut borer, and red-necked cane borer)
- **No attacks** on dissimilar-sized *Agrilus* (*A. cyanescens*, *A. egenus*, *A. subcinctus*)
- **Preference for EAB eggs**. In choice tests, there was either no attack or a strong preference for EAB

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United States
Department of
Agriculture

Marketing and
Regulatory
Programs

Animal and
Plant Health
Inspection
Service

Proposed Release of Three Parasitoids for the Biological Control of the Emerald Ash Borer (*Agrilus planipennis*) in the Continental United States

Environmental Assessment, April 2, 2007

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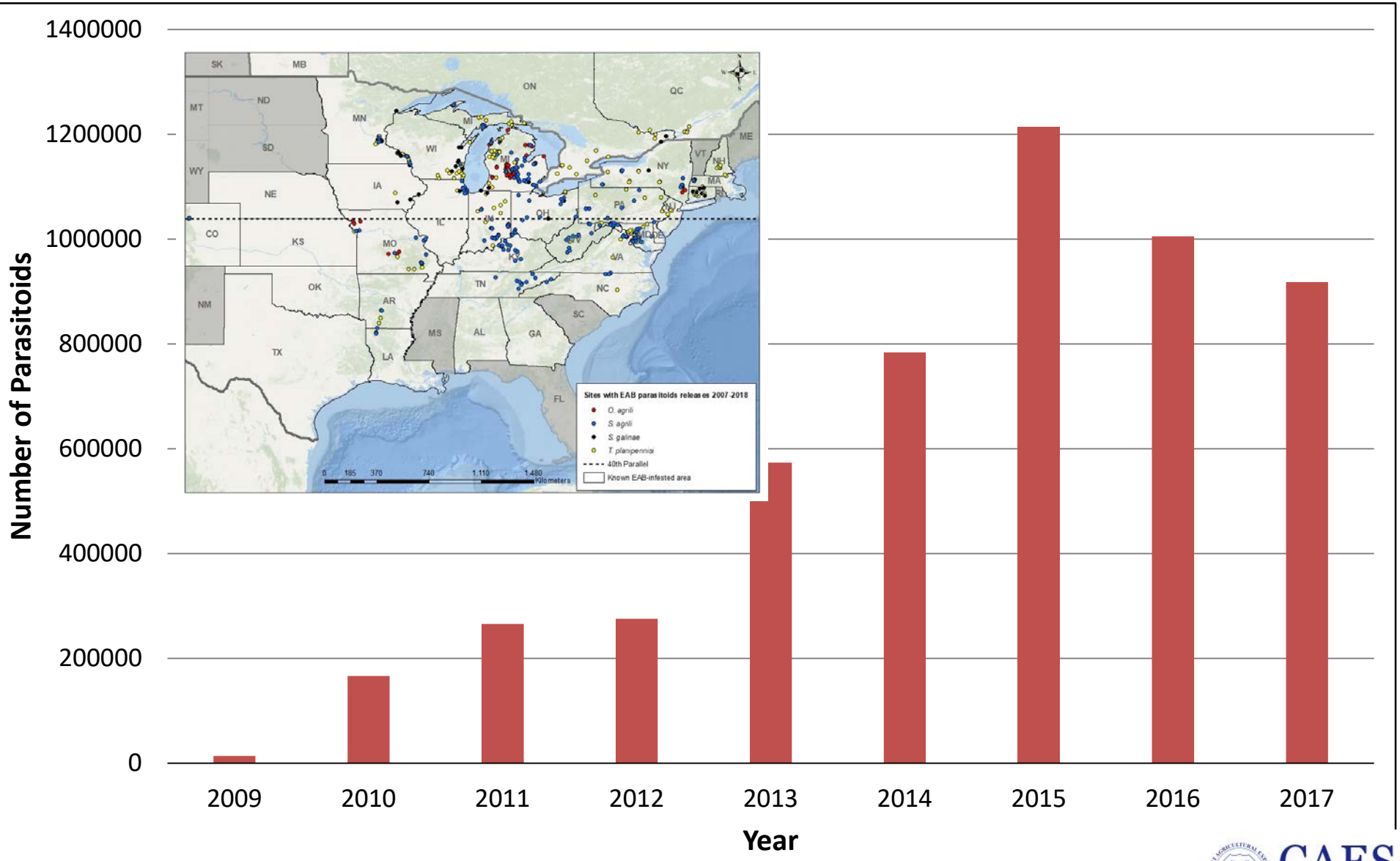
APHIS mass rearing lab in Brighton, MI



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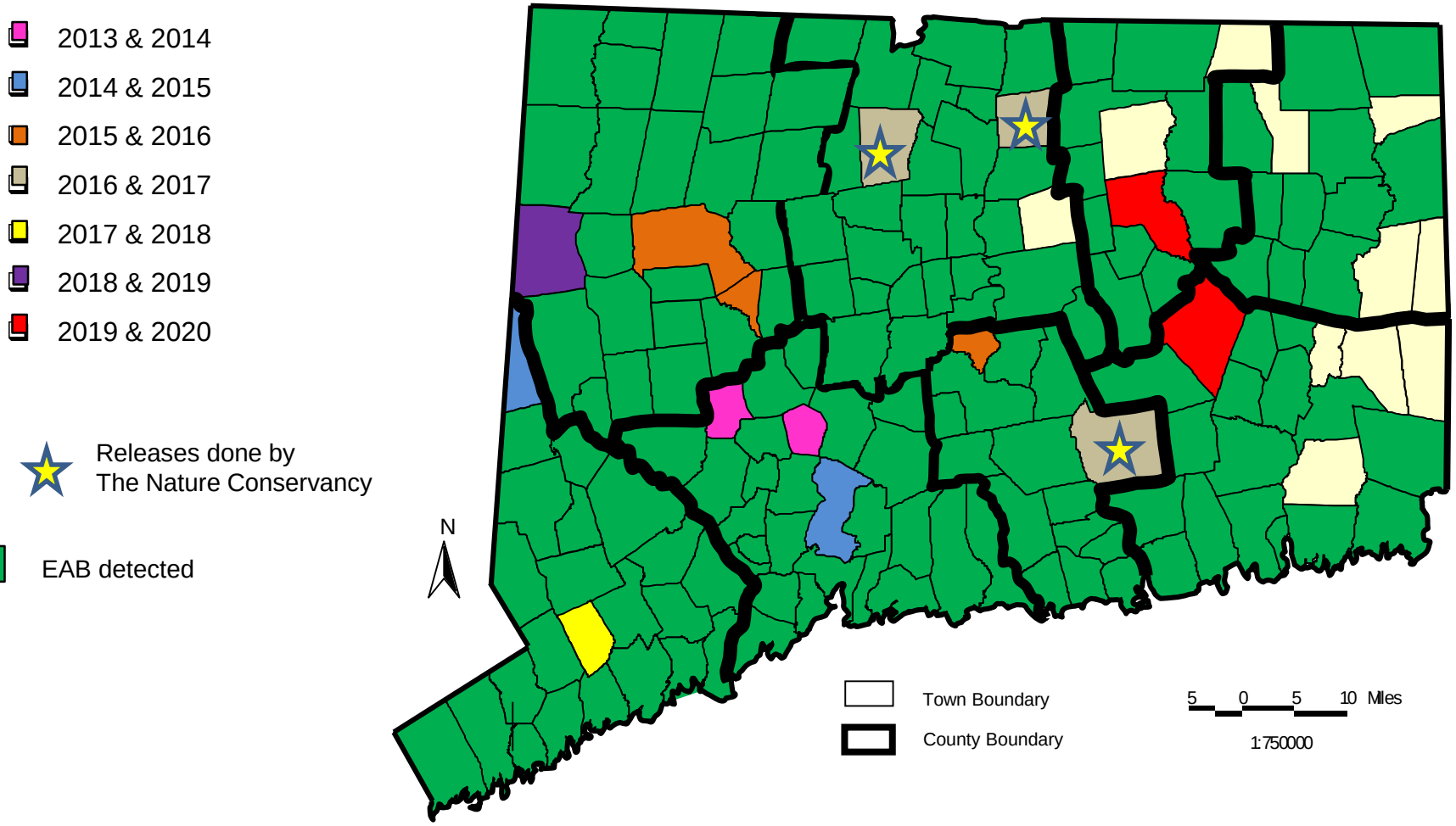
Parasitoid Releases Connecticut



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Town	Year	Tets	Oobius	Spathius
Middlebury	2013	4,663	1,702	
	2014	14,580	4300	
Prospect	2013	5,582	1,176	
	2014	14,580	4550	
Hamden	2014	14,580	4550	
	2015	11427	2220	
Sherman	2014	312	450	
	2015	6592	1040	
Cromwell	2015	11511	2220	
Litchfield	2015	11511	2120	
	2016	4754	3700	305
East Haddam	2016	4754	3700	305
	2017	6864	2800	1522
East Windsor	2016	4753.75	3700	305
	2017	6864	2800	1522
Simsbury	2016	4753.75	3700	305
	2017	6864	2800	1097
Weston	2017	6864	2800	1522
	2018	5382	1662	1701
Kent	2018	10139	2800	2483
		147,191	51,990	8,584

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Parasitoid Recovery – Peeling

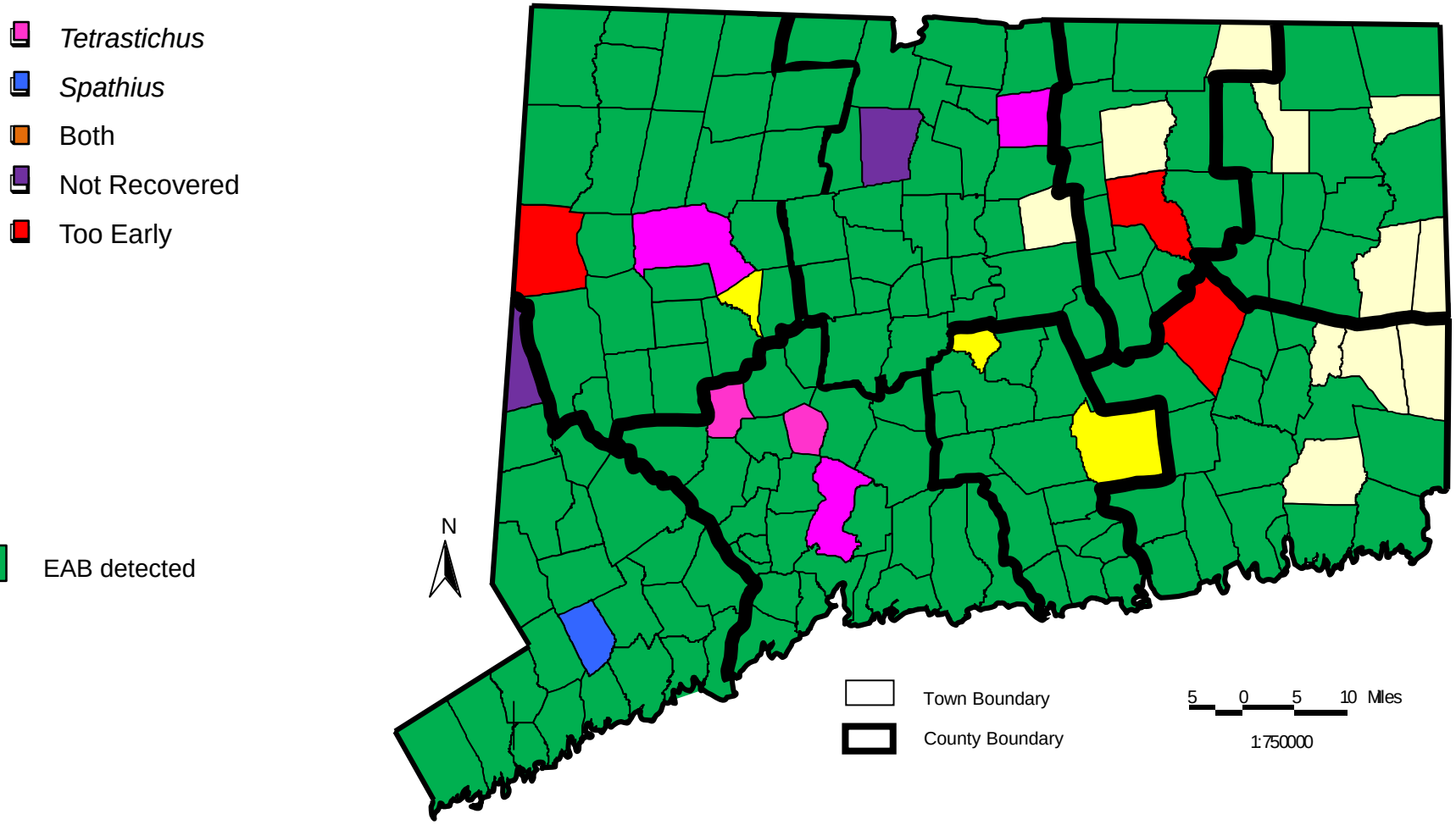
Larval parasitoids

Healthy EAB

Whittemore Rd.
Middlebury, CT

South Eagle St.
Plymouth, CT

Parasitoid Recovery in Connecticut



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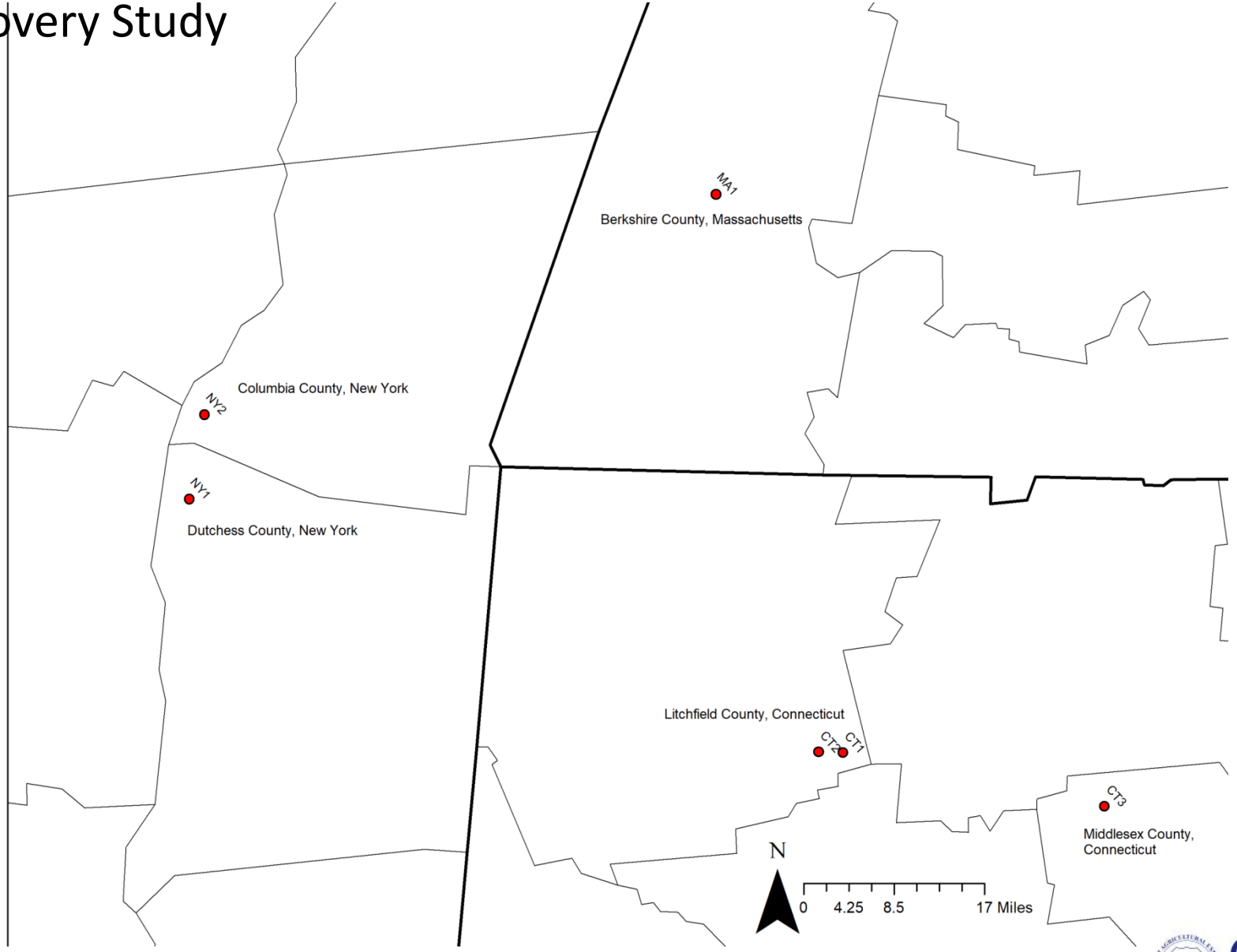
Study Sites for Intensive Recovery Study



Duan et al. 2019

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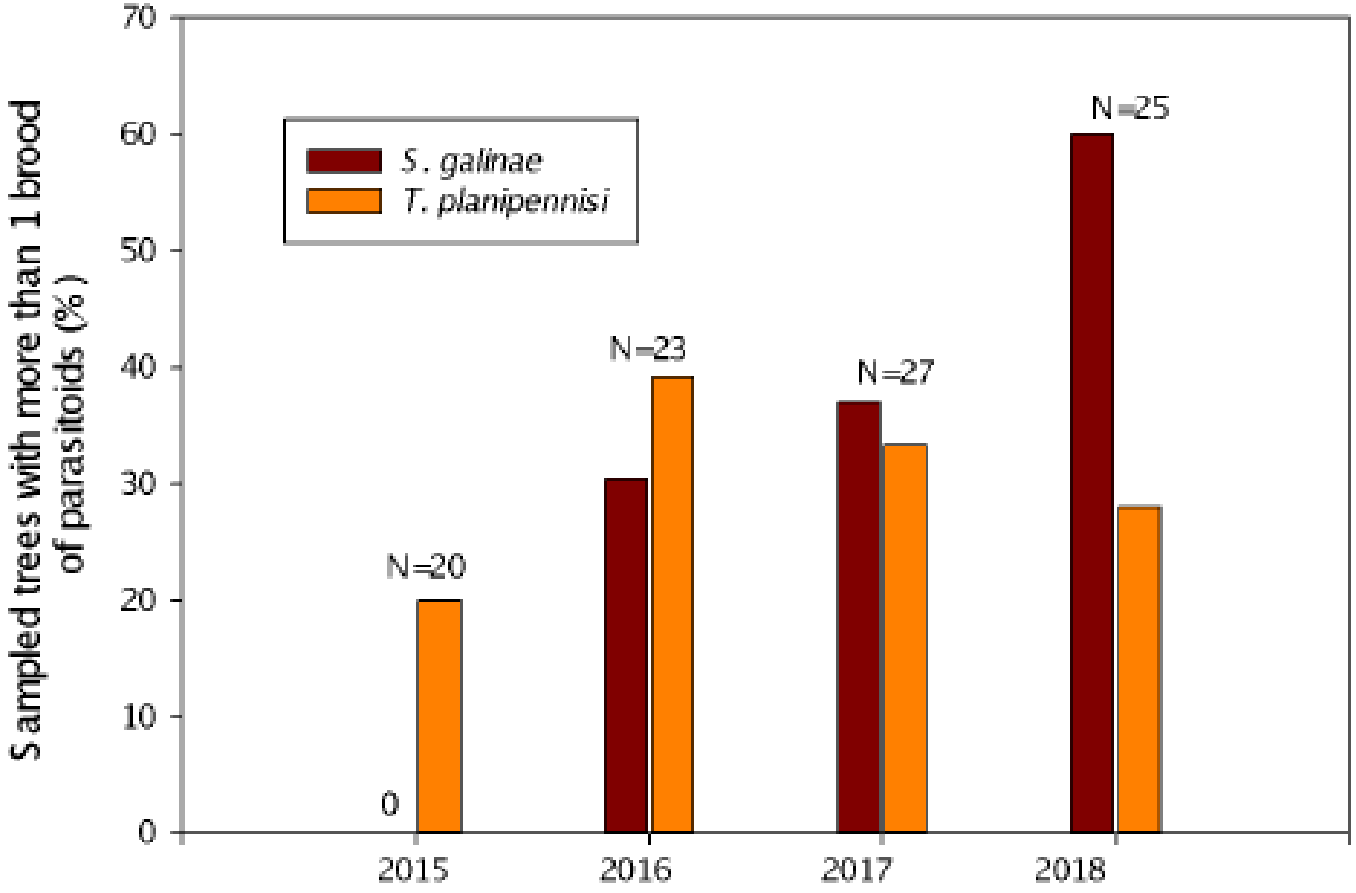

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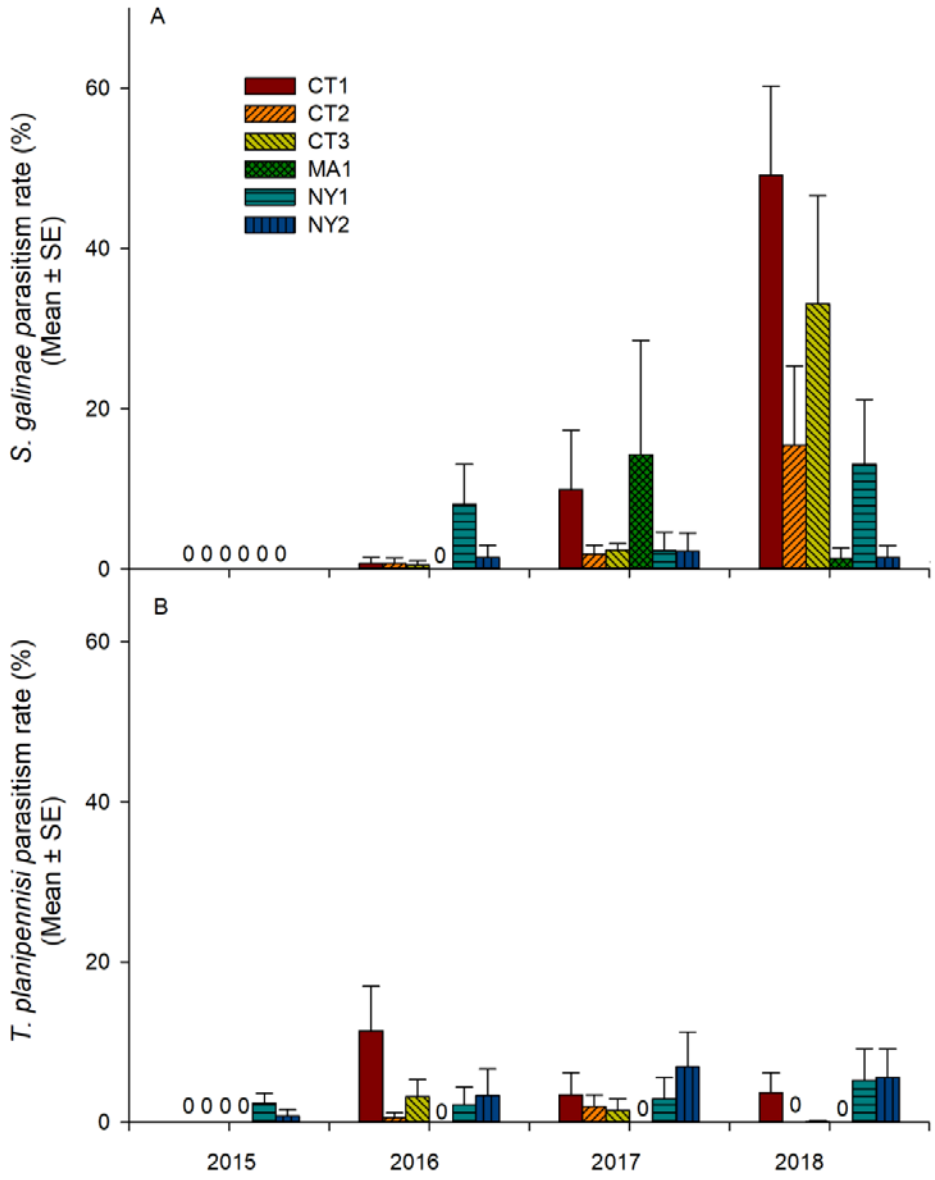

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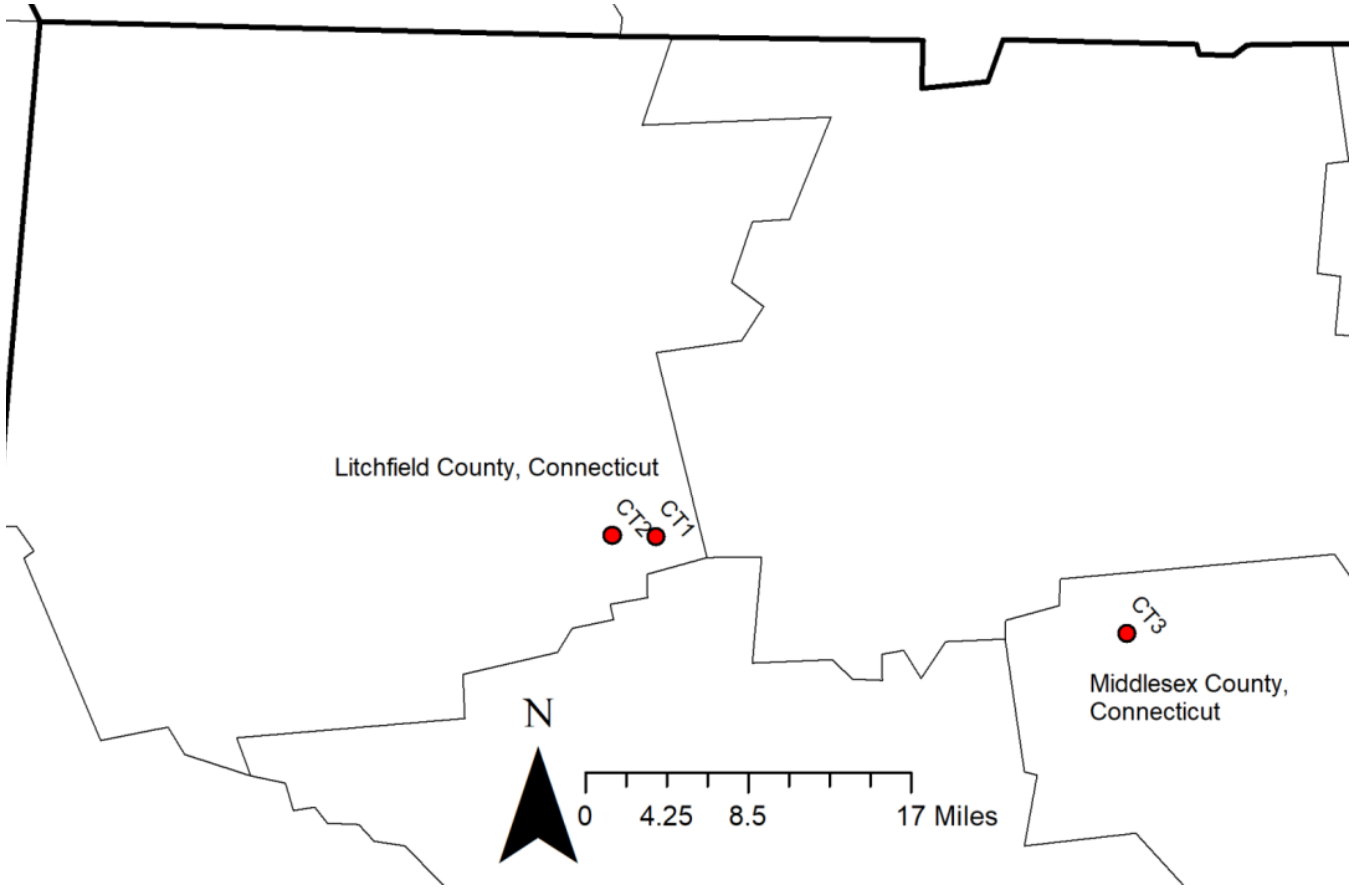
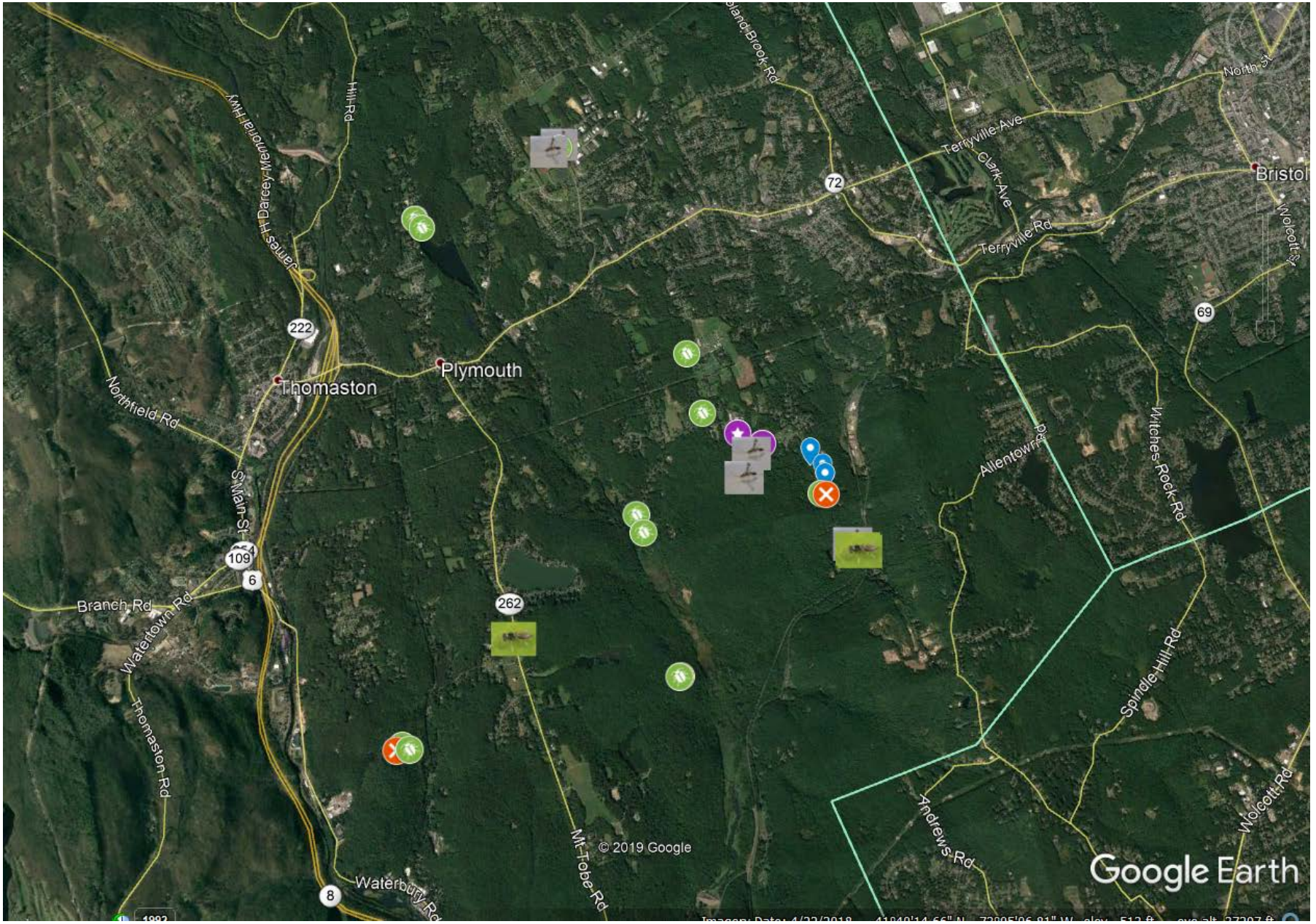
Study Sites for Spread Study



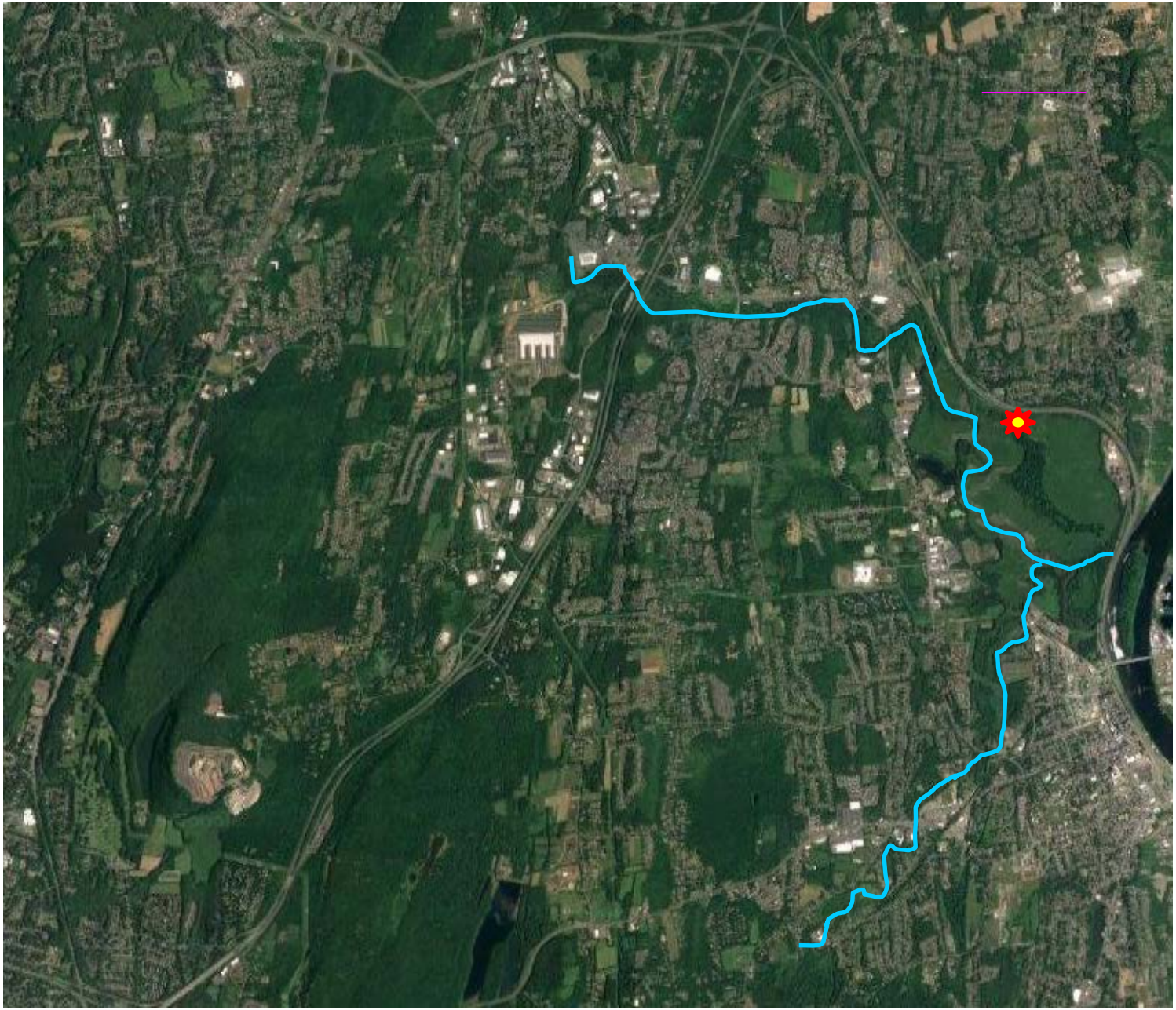
Parasitoid Recovery – Tree Peeling

- Peeled 71 trees
- Pole sized
- Looked for trees with signs of EAB infestation
- Bottom 2 meters peeled

Spathius Spread Study: Plymouth Overall rate Spathius 20%, Tets 6%



Spathius Spread Study: Cromwell

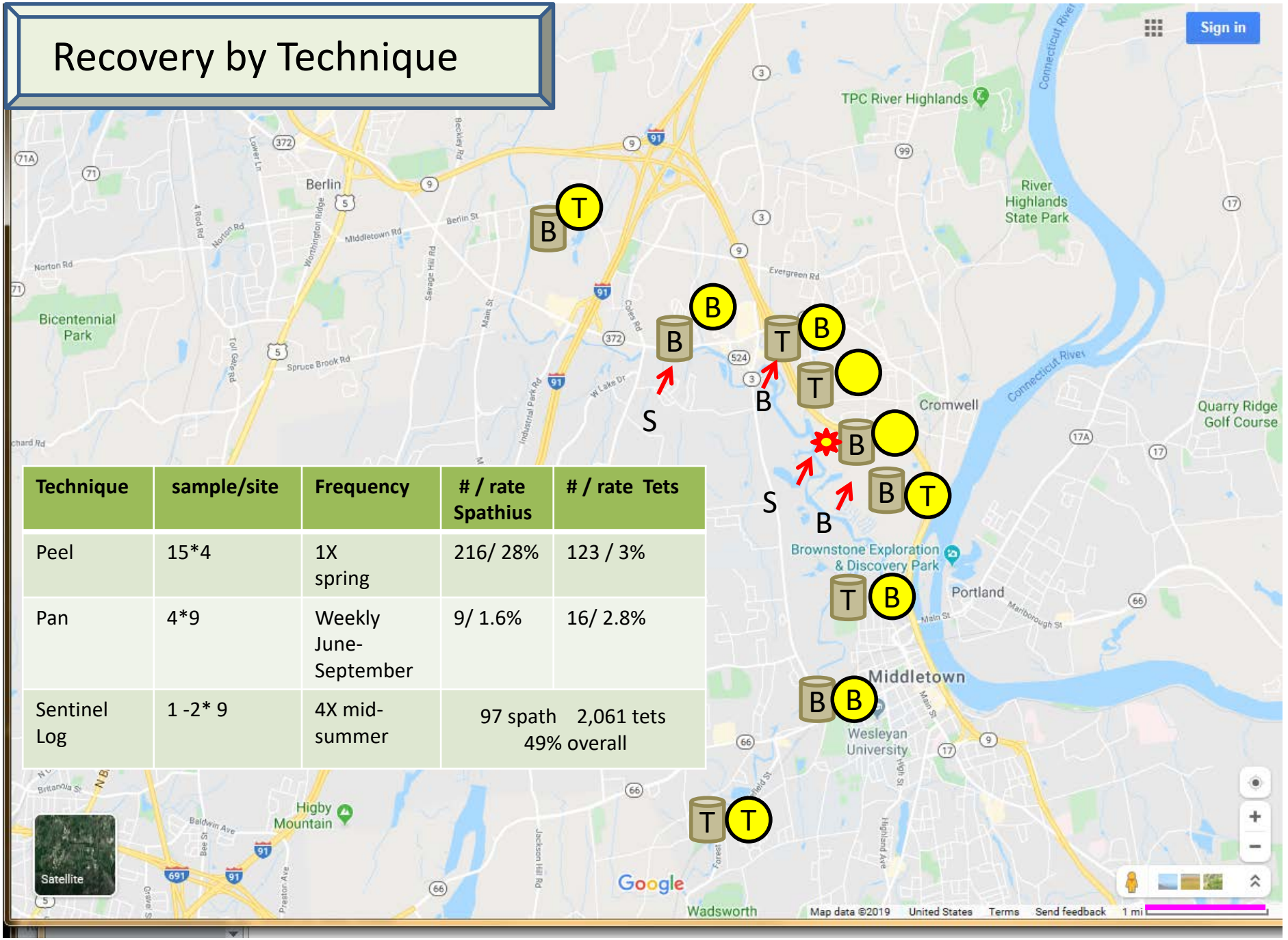


Parasitoid Recovery – Pan Trap and Sentinel Logs

- Pan Traps – weekly
- June – September
- 9 sites
- 4 pans/ site

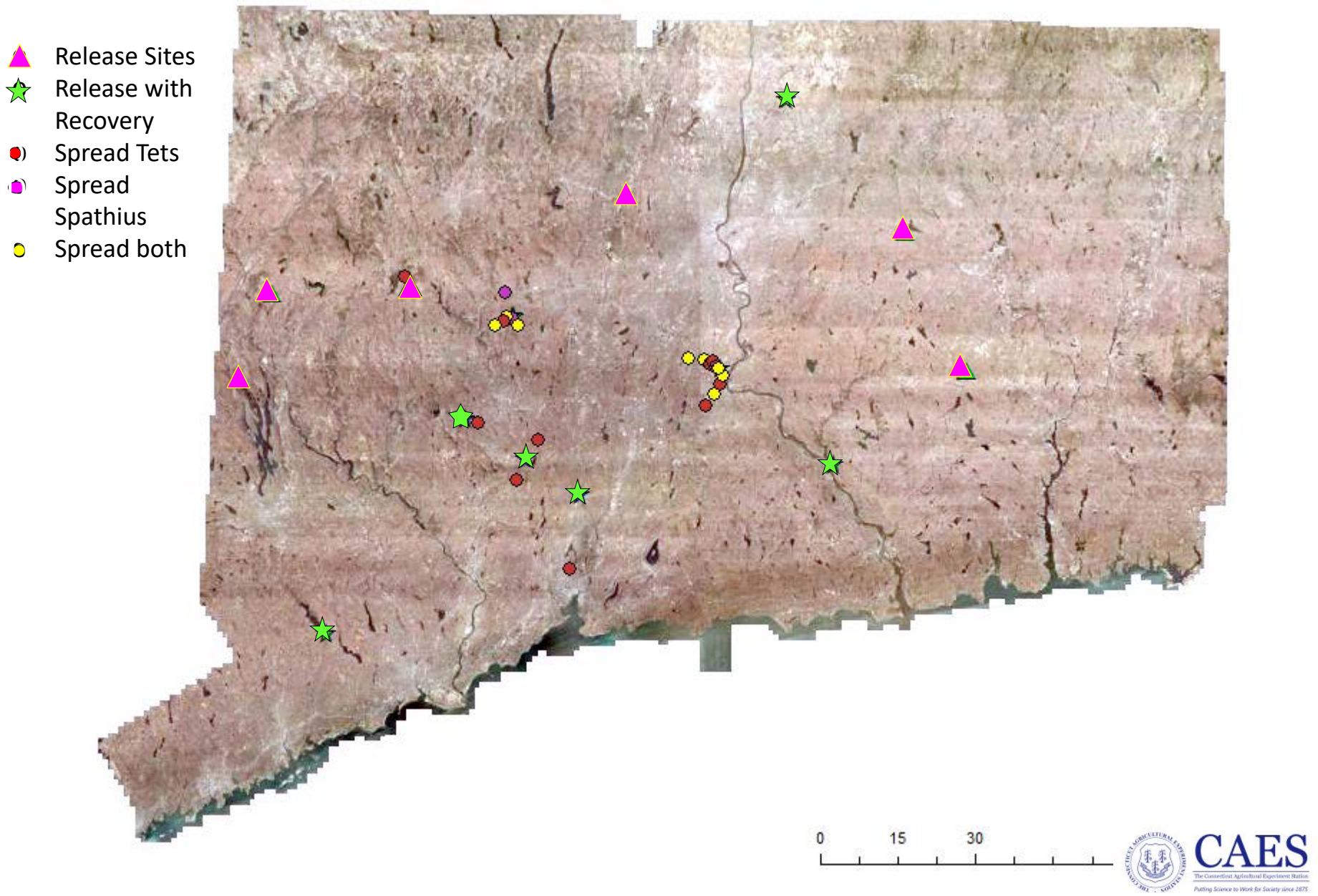
- Sentinel Logs
- 4, 2-week periods
- 9 sites
- 1-2 logs/ site

Recovery by Technique



Technique	sample/site	Frequency	# / rate Spathius	# / rate Tets
Peel	15*4	1X spring	216/ 28%	123 / 3%
Pan	4*9	Weekly June-September	9/ 1.6%	16/ 2.8%
Sentinel Log	1 -2* 9	4X mid-summer	97 spath 2,061 tets 49% overall	

Parasitoid Recoveries



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Current Studies

- Lifetable studies 5 sites in NE (CT, MA, NY)
- Sapling sampling, 17 sites
- Egg parasitism sampling,17 sites
- Attack rates of *S. galinae* in large trees (2 CT, 1 NY sites)
- Monitoring regrowth of ash in areas with and without parasitoids (5 CT)

Acknowledgements

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- Esther Kim
- Ashley Martone
- Jonathon Schmude

Funding

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- McIntire-Stennis, USDA