Expanding the Range of the Parasitoid Wasp, *Trissolcus japonicus*, (Hymenoptera: Scelionidae) in NYS.

Photograph: Elijah J. Talamas, ARS USDA.

Photograph: **Christopher Hedstrom** USDA-APHIS Quarantine Facility, Corvallis, Oregon

Peter J. Jentsch

2018 Horticultural Days - Southwest Michigan
Lake Michigan College, Mendel Center
Benton Harbor, MI

Brown Marmorated Stink Bug
Whats the Problem ??

Invasive Insect Success

- Few constraints (limited natural biological controls)
  - Native predator and parasitoid survey – increase in biocontrol
- Abundance of host plants and ideal environmental conditions

Brown Marmorated Stink Bug: Host Plants - Food for Success

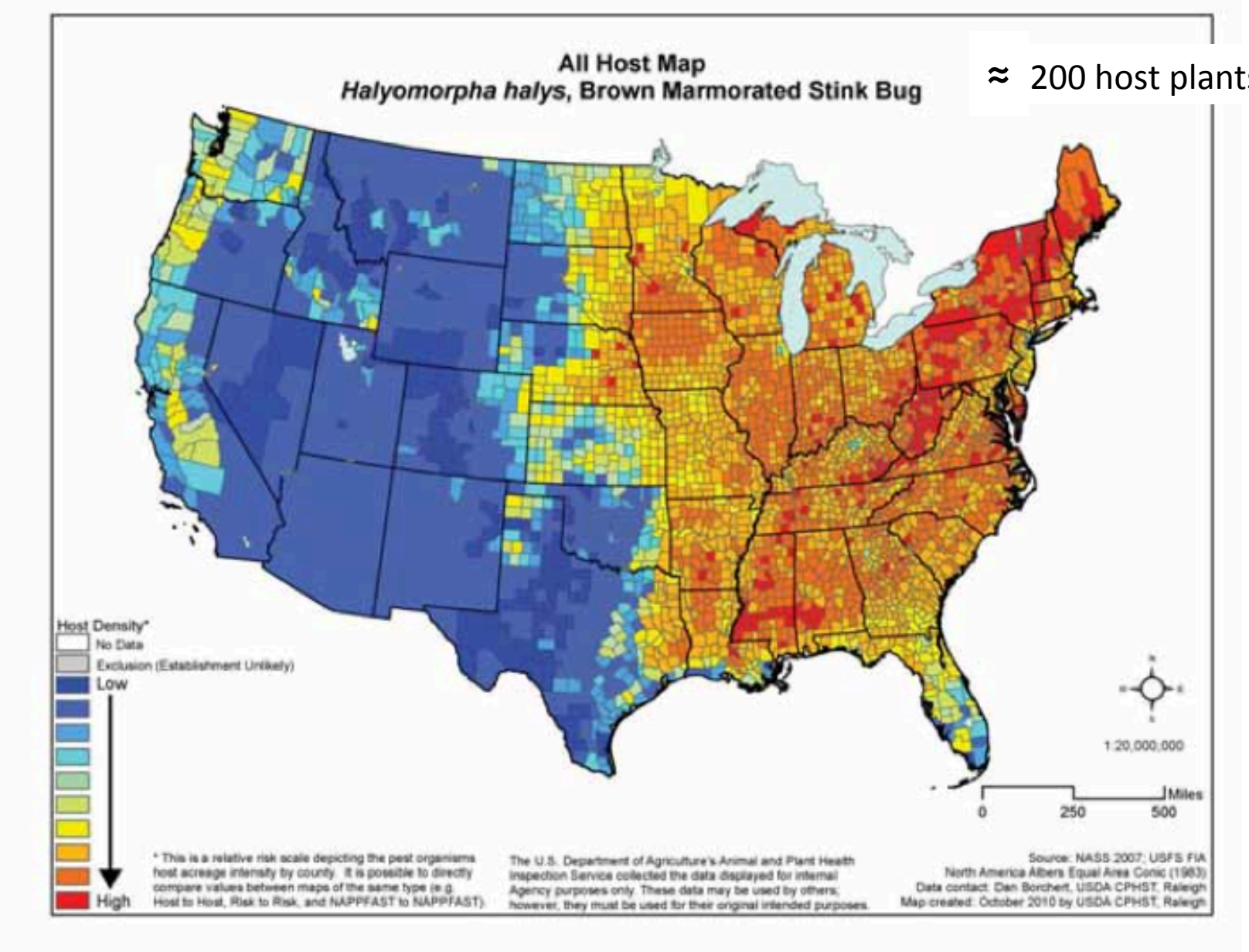
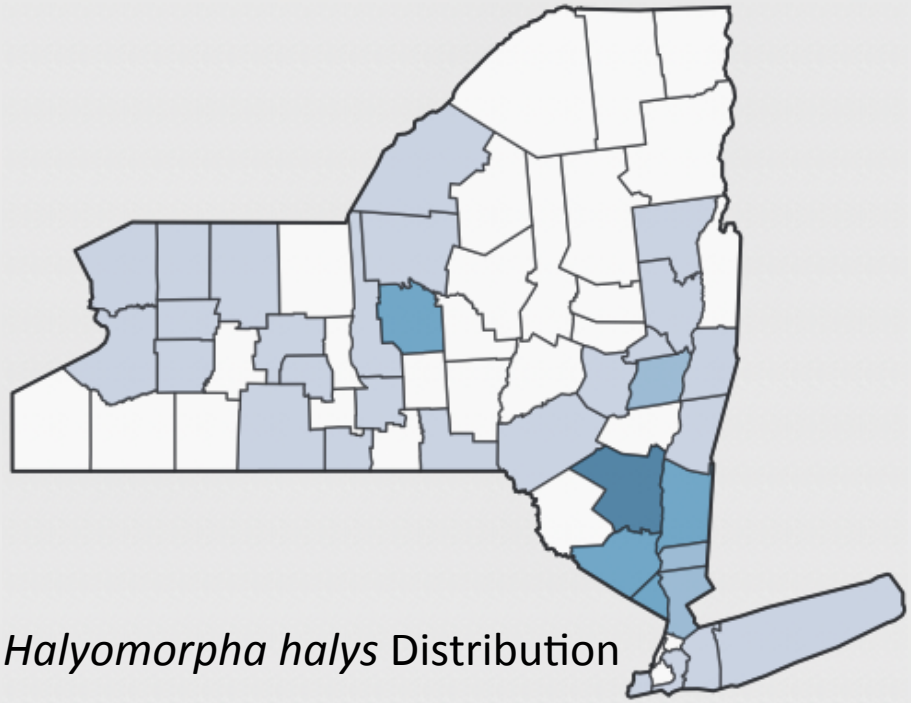
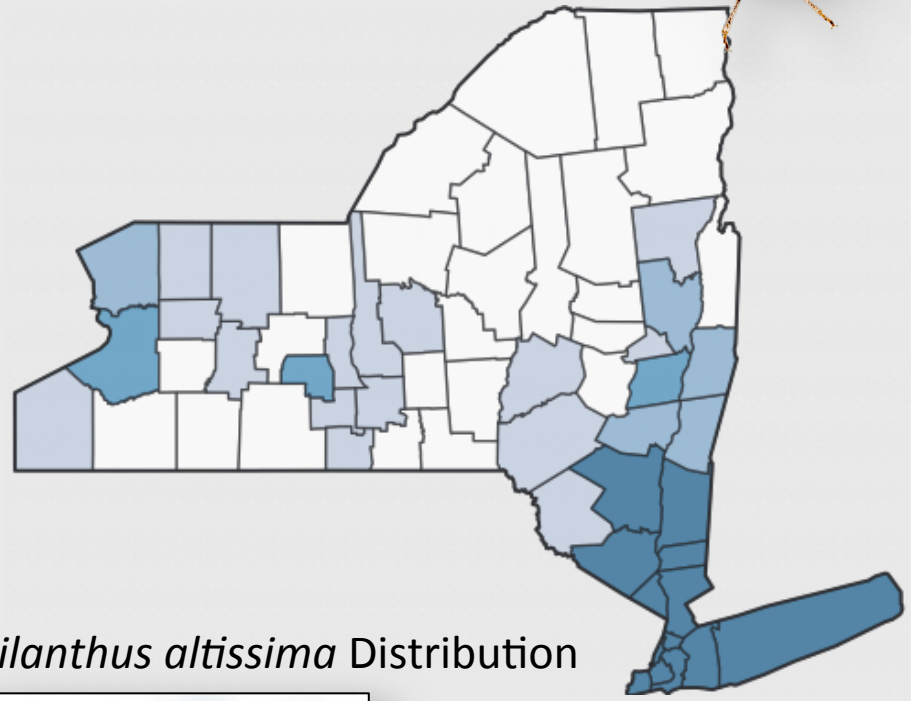


Figure 1: Risk maps displaying the relative density of field, vegetable, and fruit crop hosts plants of BMSB throughout the United States.

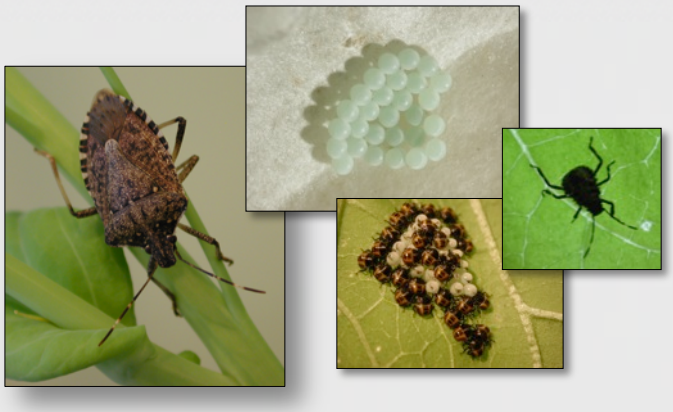
New York Invasive Species Public Map
BMSB Distribution in NYS



Halyomorpha halys Distribution



Ailanthus altissima Distribution



Brown Marmorated Stink Bug
Whats the Problem ??

Invasive Insect

- Few constraints (limited natural control-biological controls)
- Abundance of host plants and ideal environmental conditions
- Overwinters in man made sturctures and woodland trees

Move Over, Bedbugs: Stink Bugs Have Landed

Published: September 26, 2010

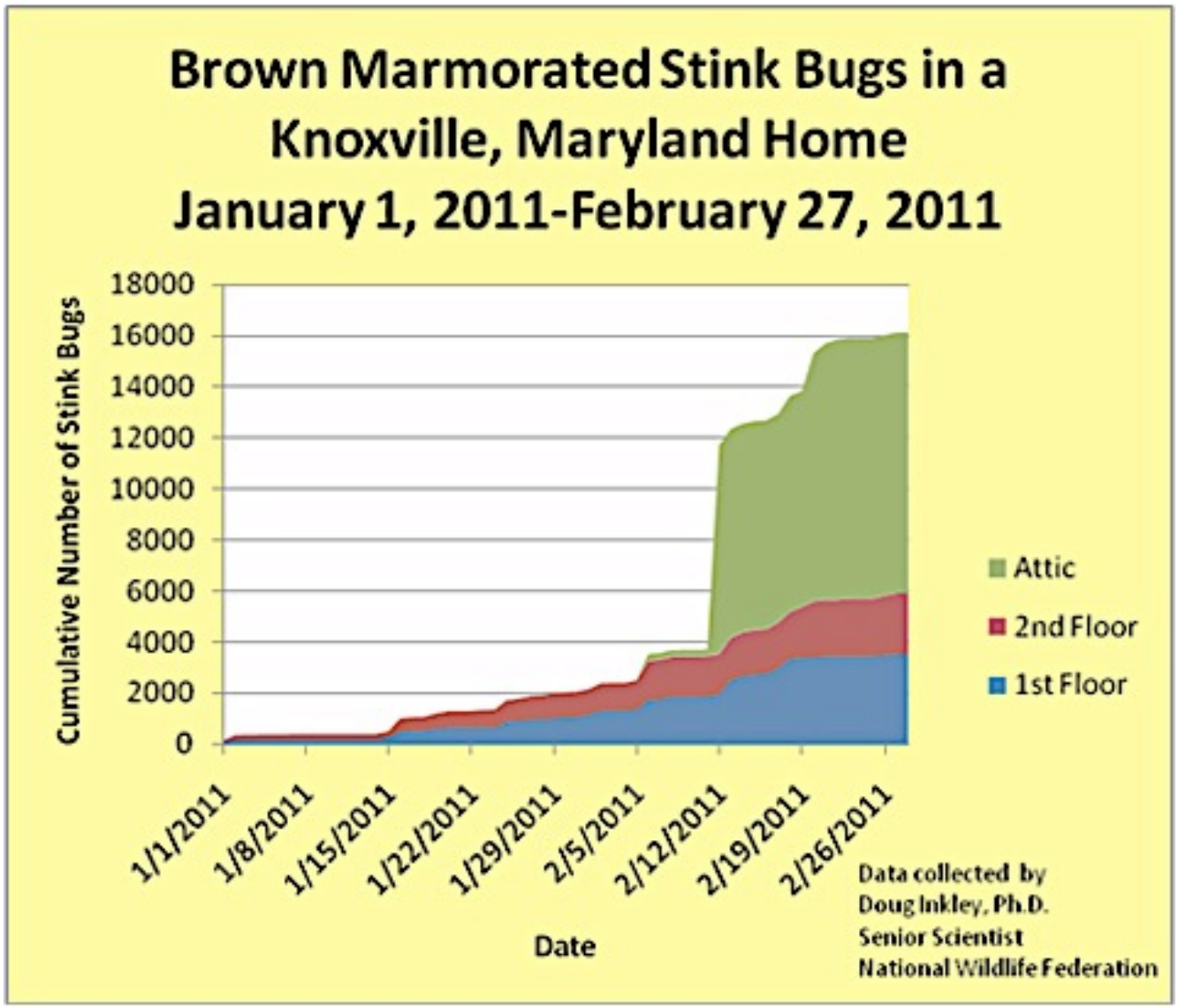
Steve Ruark for The New York Times

Kelli Wilson and her father, Richard Lee Pry, cleared stink bugs from her porch Friday in Burkittsville, Md. The shield-shaped invaders have damaged fruit and vegetable crops.

By KEN MAGUIRE
Published: September 26, 2010

Managing the Invasive Brown Marmorated Stink Bug Across the Urban Agricultural Interface 2017.

The Brown Marmorated Stink Bug in the Urban Environment



>22,000 BMSB collected from 1 home in Maryland 2011

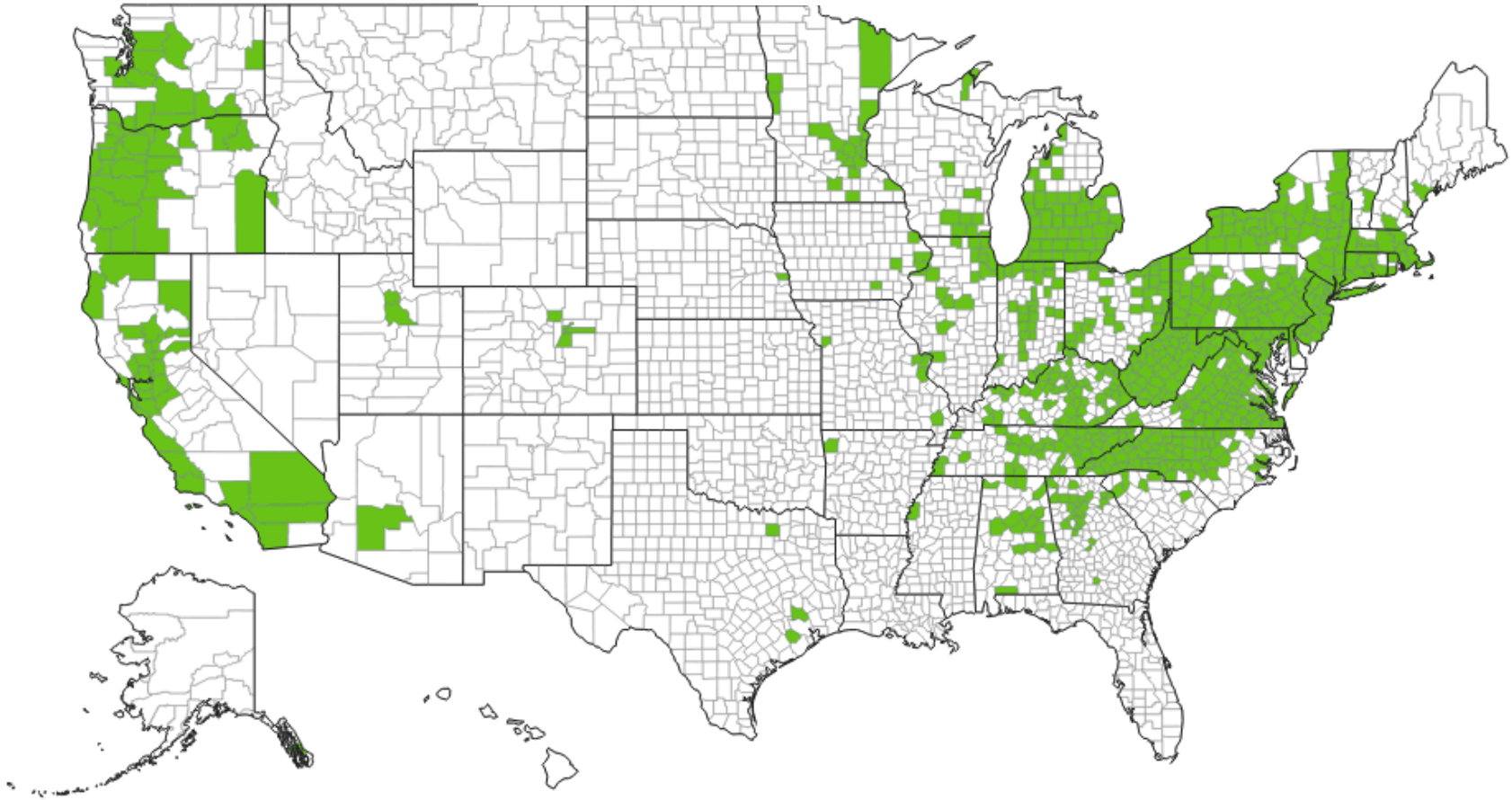
EDDMapS
Early Detection & Distribution Mapping System

Home | Report Sightings | Distribution Maps | Species Information | Tools & Training | My EDDMapS | About | sign out

brown marmorated stink bug
***Halyomorpha halys* (Stal)**

States | Counties | Points | List

Citizen Science Project Participation (Homeowners)
BMSB has been detected in all but 6 of 62 counties in NYS
And 48 of 83 counties in Michigan



Legend
No Data
Species Reported

Factors for BMSB Success: Overwintering

Overwintering habitat

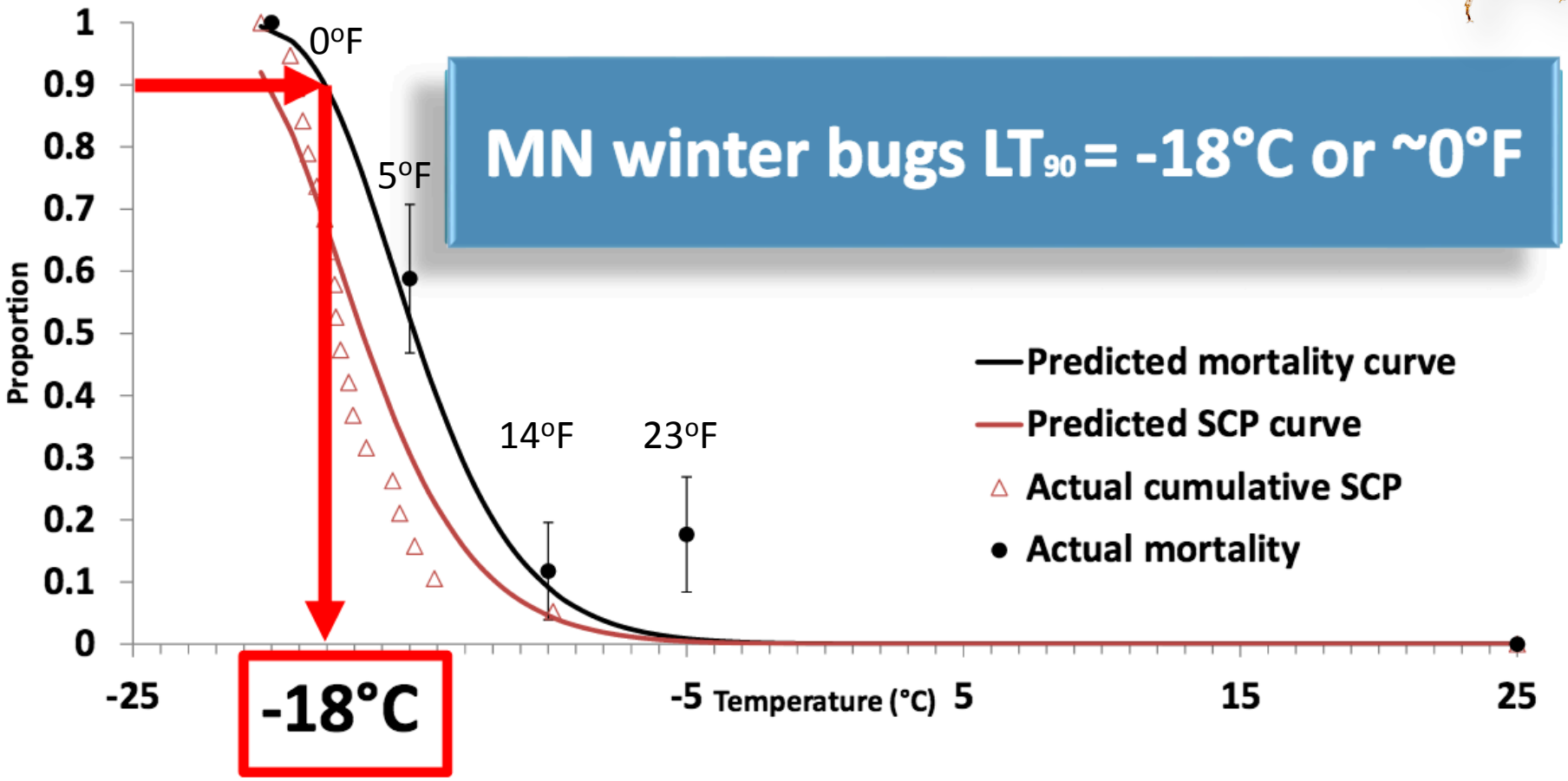
- The majority of BMSB reside in the woodland habitat (Standing Dead Oak (*Quercus* spp.), Locust (*Robinia* spp.) Lee, Doo-Hyung et al. 2014)

- A smaller percent of the population will aggregate in buildings where temperature extremes allow for survival in northern climates

- In woodland habitat, temperatures below -18°C or -0.4°F will kill 90% of the population (Kuhar, T. 2016)

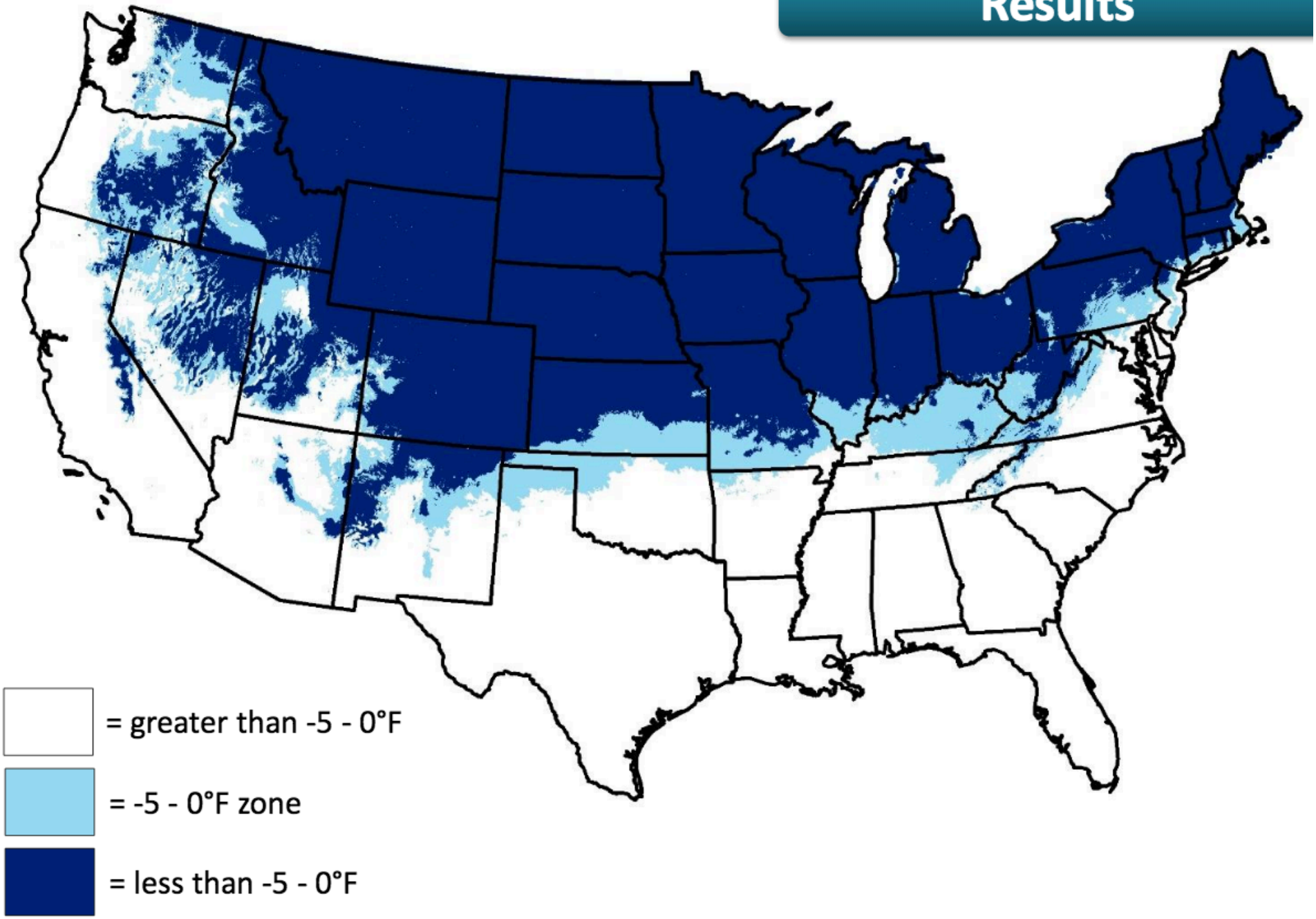
Factors for BMSB Success: Overwintering

Predicted and observed BMSB: Cumulative SCP & proportion mortality



SCP: n=19 bugs
Mortality: n=17 bugs/each temp (mean ± 95% confidence interval)
Regression curves fitted with a Weibull distribution

Results

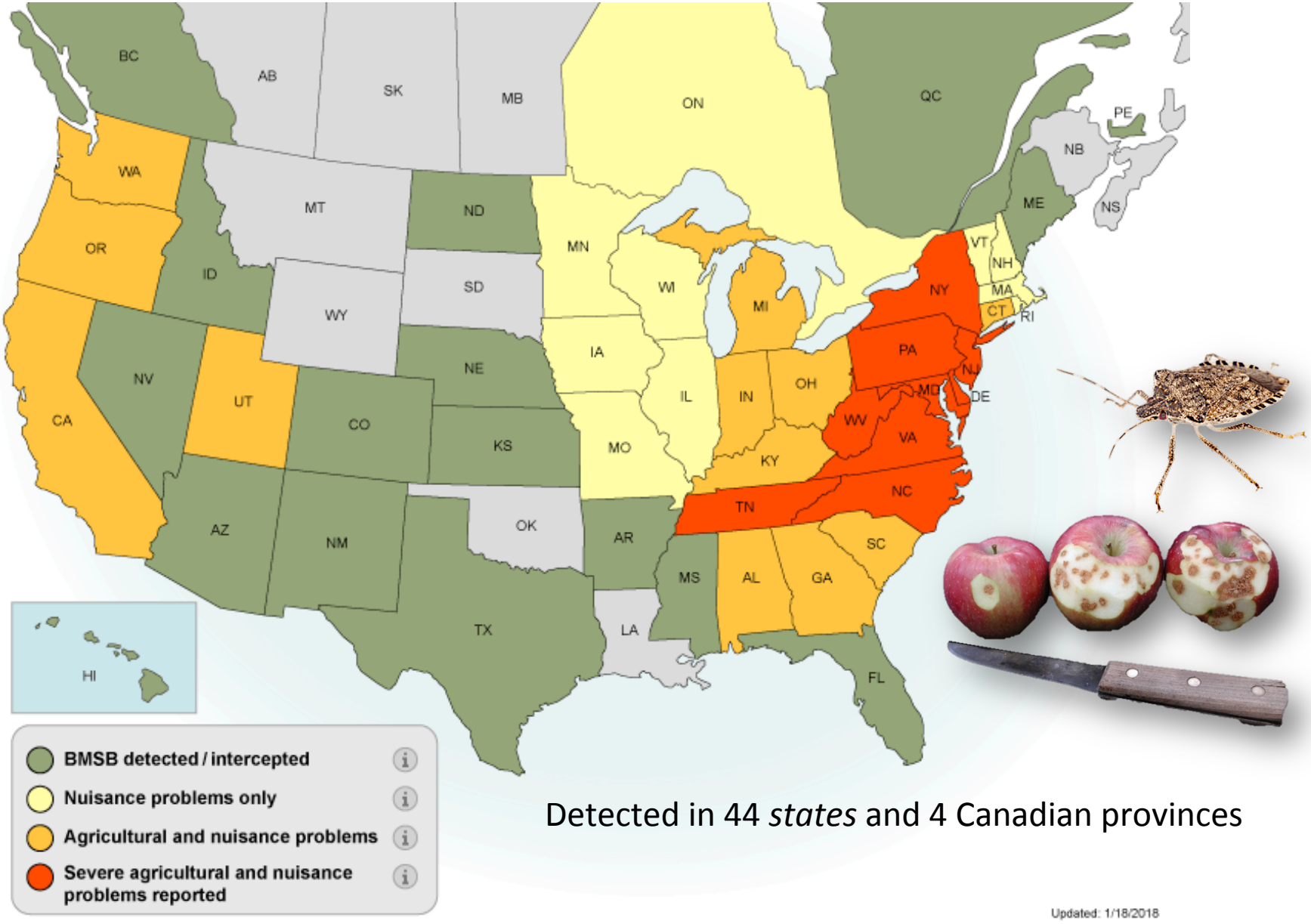


Brown Marmorated Stink Bug
Whats the Problem ??

Invasive Insect

- Few constraints (limited natural control-biological controls)
- Abundance of host plants and ideal environmental conditions
- Overwinters in woodland trees and man made sturctures
- Often causes ecological disruption, displacement of native spp; present in urban environments, cause damage to woodland and ornamental trees and crops.

The Brown Marmorated Stink Bug in the Ag. & Urban Environment



Detected in 44 *states* and 4 Canadian provinces

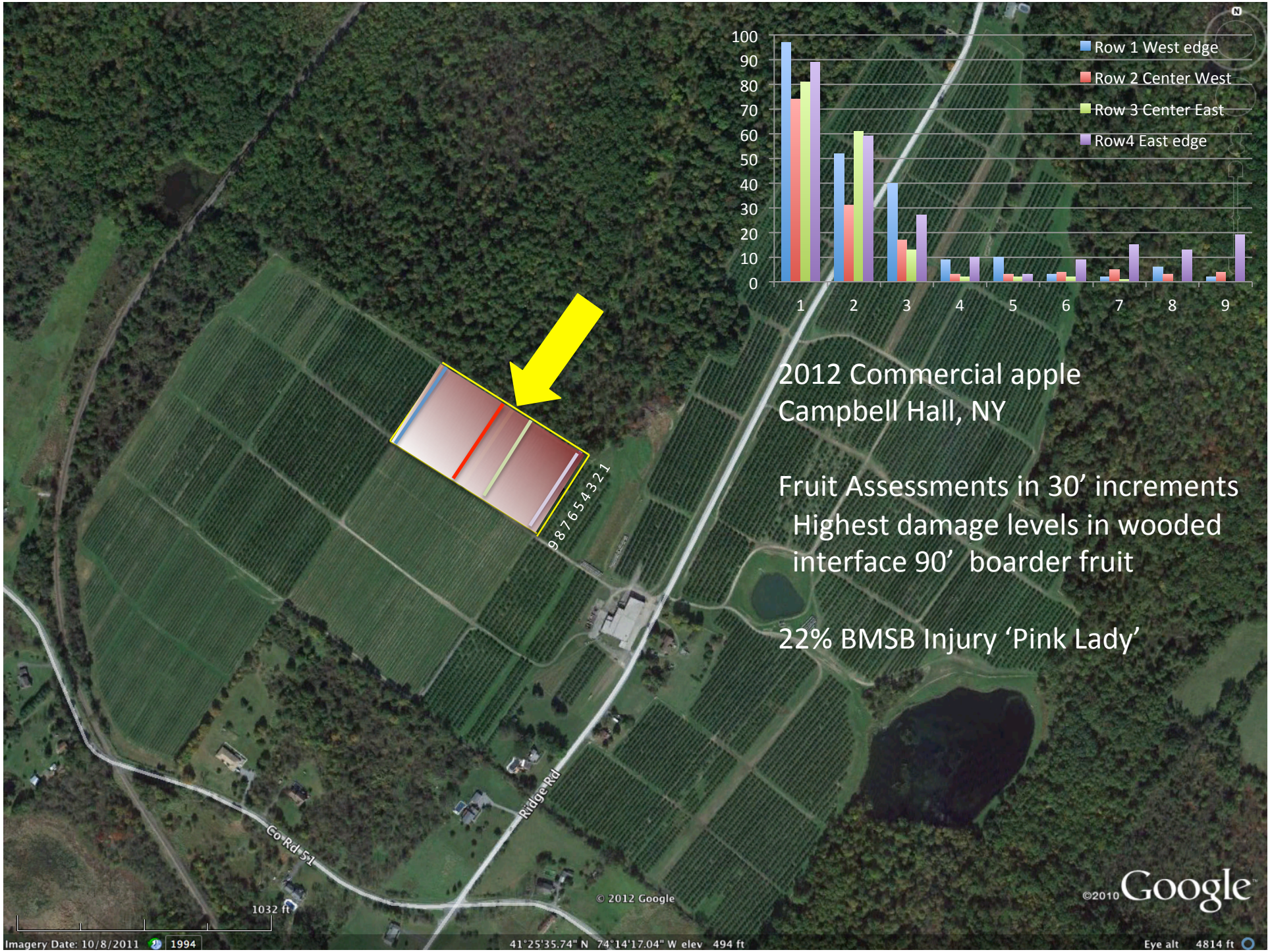
Updated: 1/18/2018

Golden Delicious Apple With BMSB Feeding Injury, Milton, NY October - 2012

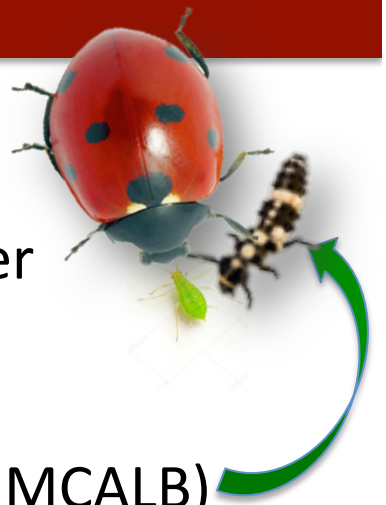
5 bins: Range from 38 – 57% damage

Pink Lady Apple With >20% BMSB Feeding Injury, Campbell Hall, NY November - 2012

BMSB Feeding Injury Assessment, Hudson Valley Research Lab, NY 2012


100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
Row 1 West edge
Row 2 Center West
Row 3 Center East
Row4 East edge
2012 Commercial apple
Campbell Hall, NY
Fruit Assessments in 30’ increments
Highest damage levels in wooded interface 90’ boarder fruit
22% BMSB Injury ‘Pink Lady’
9 8 7 6 5 4 3 2 1
Co Rd 51
Ridge Rd
1032 ft
© 2012 Google
©2010 Google
Imagery Date: 10/8/2011
1994
41°25'35.74" N 74°14'17.04" W elev 494 ft
Eye alt 4814 ft

What is Biological Control ?



What is Biological Control (Insect Pests)

Natural control in which one organism feeds on another

- Classic Bio-Control, Conservation, Augmentation
- Predators – feed directly on pest life stages (Mantis, MCALB)
- Pathogens – disease feeds within pest life stages (Fungal spores)
- Parasitoids – feeds within pest life stages (Wasp & Fly)

Why Use Biological Control ?

Reduce Pest Management Costs
Environmental Stewardship
Reduce Late Season MRL's
Integrate Management Diversity
Reduce Insecticide Resistance
Low-Cost Labor

Biological Control ?

What is Biological Control (Insect Pests) - natural control

- Conservation, Classic BC, Augmentation, Release of BC organism
- Predators – feed directly on pest life stages
- Parasitoids – feeds within pest life stages
- Pathogens – disease feeds within pest life stages

Why Manage Insects Using Biological Control ?

- **Benefit Must Outweigh the Risks**
  Increased Economics & Human Health
  Decrease Urban Pest Annoyance

Biological Control Risks

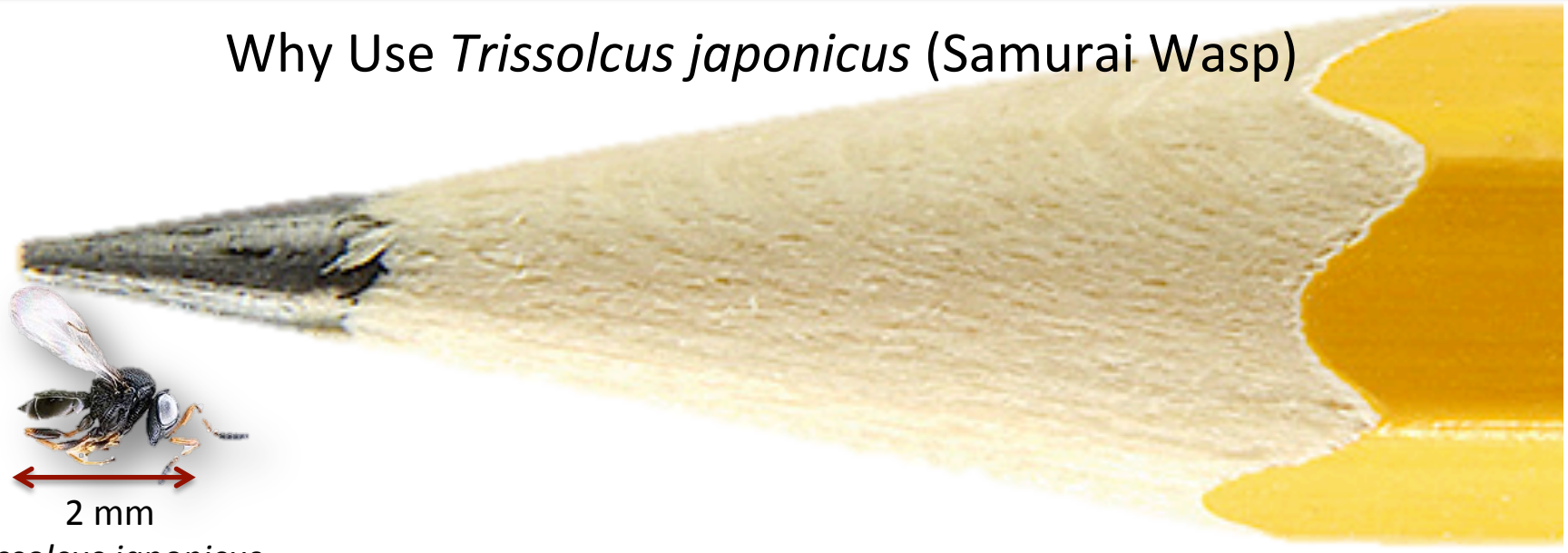
Multicolored Asian Lady Beetle
Late Season Damage to Apple

- Years of fall rains increase shoot growth
- Green aphid population increase
- Resulting in high beetle populations
- During pupation MCALB larva mouthparts bore into fruit
- Results in fruit injury

Economic Losses
Risks Outweigh the Benefits

Introduction to *Trissolcus japonicus* (Samurai Wasp) For BMSB Management ?

Why Use *Trissolcus japonicus* (Samurai Wasp)



2 mm
Trissolcus japonicus

Female Samurai Wasp
Lays Its Own Egg
Into BMSB eggs

Trissolcus japonicus, (Hymenoptera: Scelionidae)

Trissolcus japonicus

Background:

- Kim Hoelmer, USDA-ARS, Newark DE, Beneficial Insects Introduction Research. In 2007 he surveyed natural enemies of BMSB in Asia, returning with live parasitoid specimens, held in U.S. quarantine facilities.

- ***Trissolcus japonicus*** *(Samurai Wasp) was* found to be a highly successful parasitoid. Parasitism rates of *H. halys* eggs reported to be as high as 80% in China (Talamas et al. 2013).

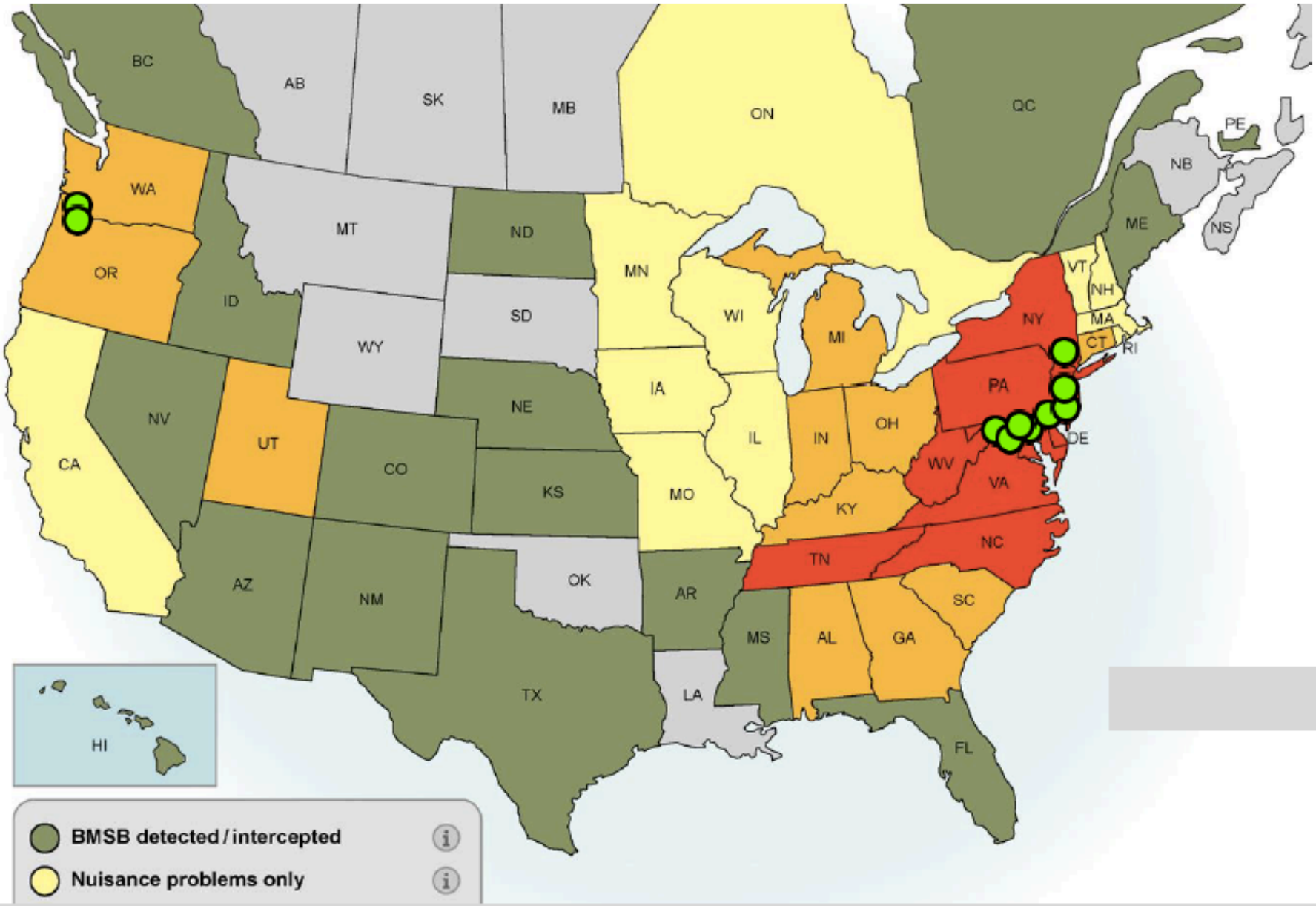
Host Specificity of the parasitoid wasp, *Trissolcus japonicus*, (Hymenoptera: Scelionidae)

- In choice and non-choice tests of parasitoid wasps species found *Trissolcus japonicus to be* **highly effective,** parasitizing 60-100% of the eggs in BMSB clusters.

- *T. japonicus is* **highly specific** in choice tests, choosing BMSB over other pentitomiid eggs. However, in *non-choice* tests *T. japonicus* will oviposit into the eggs of the preditory spined soldier bug, *Podisus maculiventris* (Say).

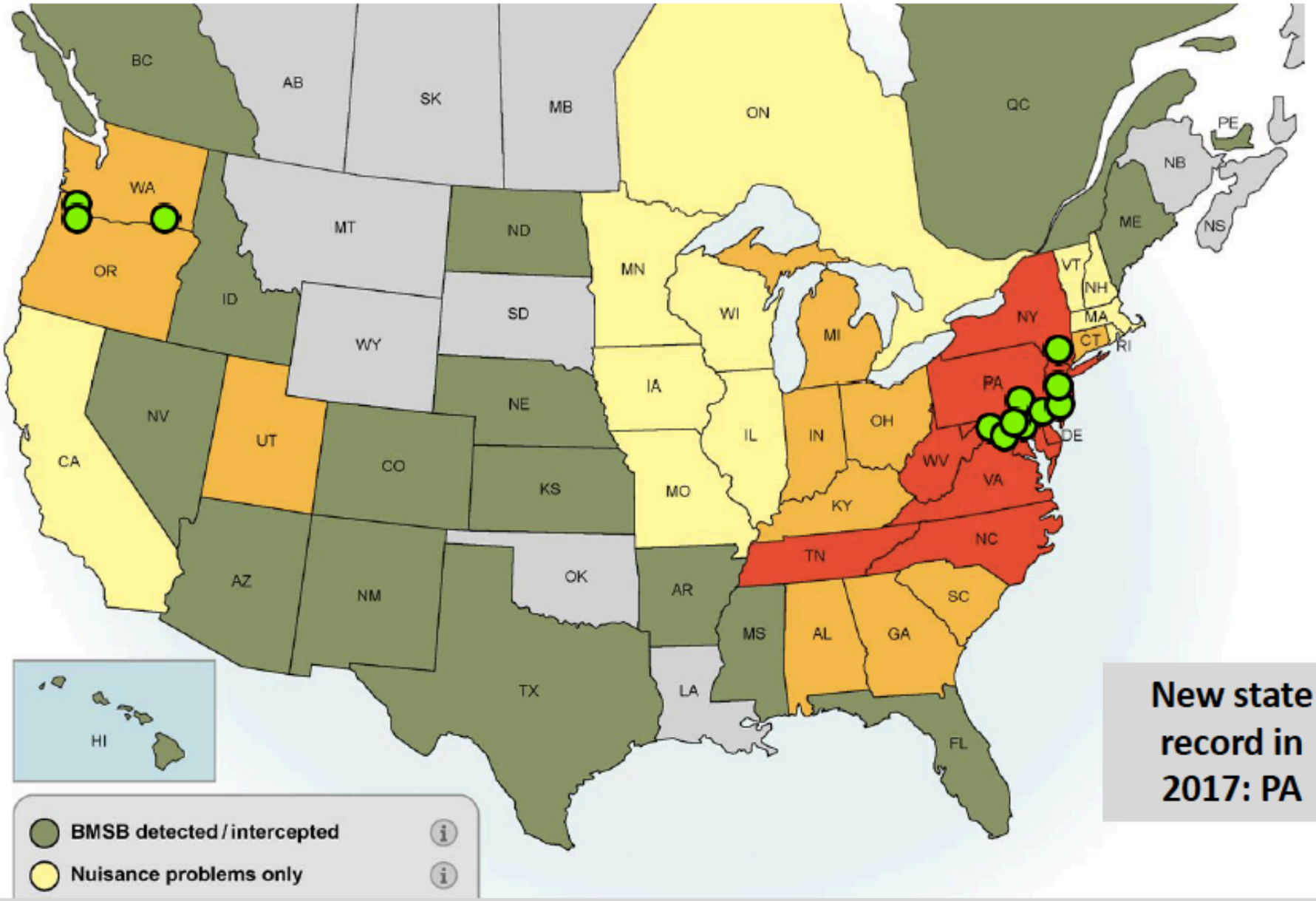
Trissolcus japonicus
Field Recovery Survey Sites in the US

- In 2014 **adventive** populations (wild) of *T. japonicus* were found in Beltsville, MD.
- In 2015 *T. japonicus* were found in Washington, DC and Winchester, VA,.
- In 2016, *T. japonicus was also found* in VA, WV, MD, DE NJ and NY in the East, and WA and OR in the West.



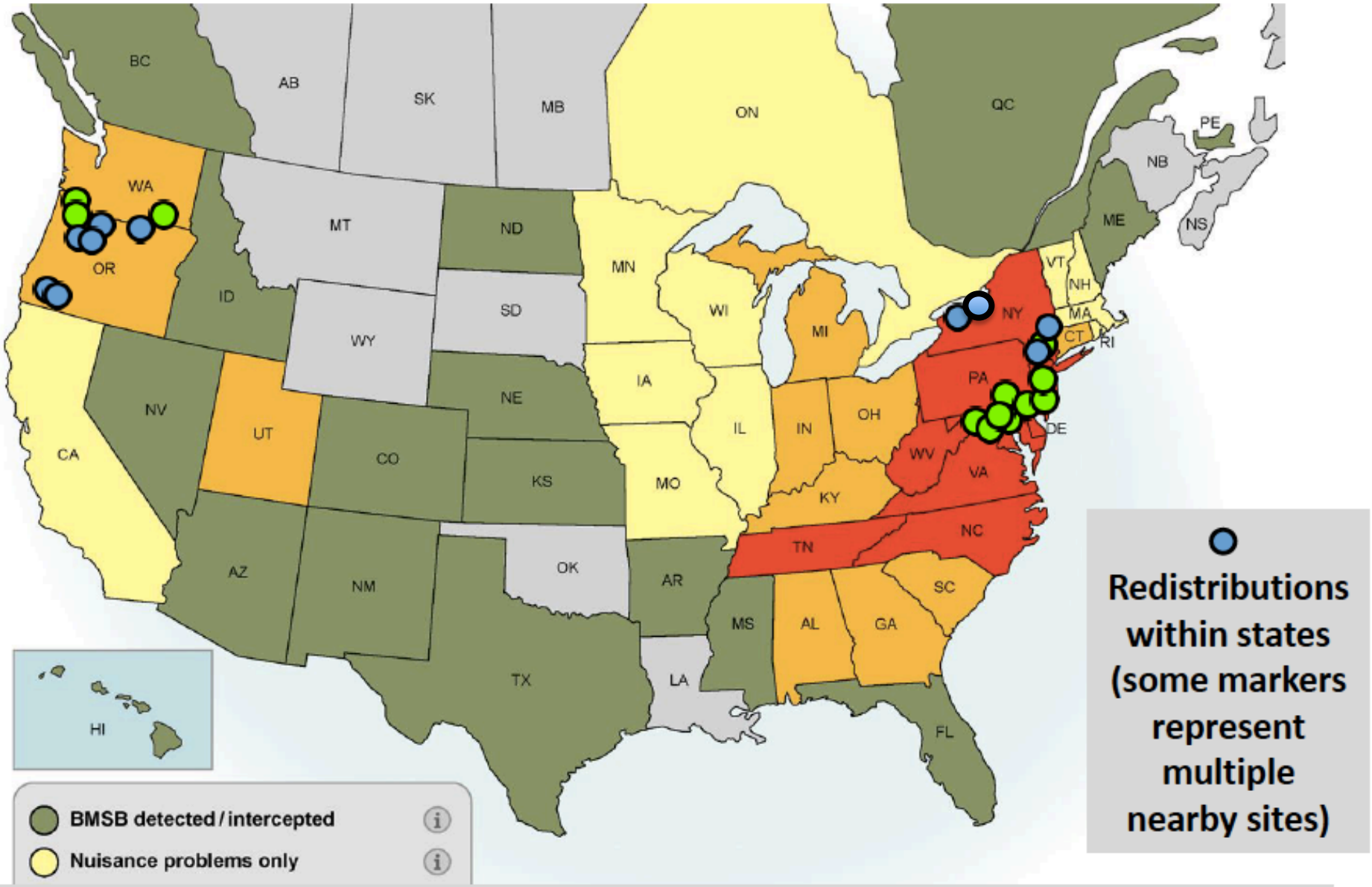
Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, NJ, NY, OR, WA (as of Dec. 2016)



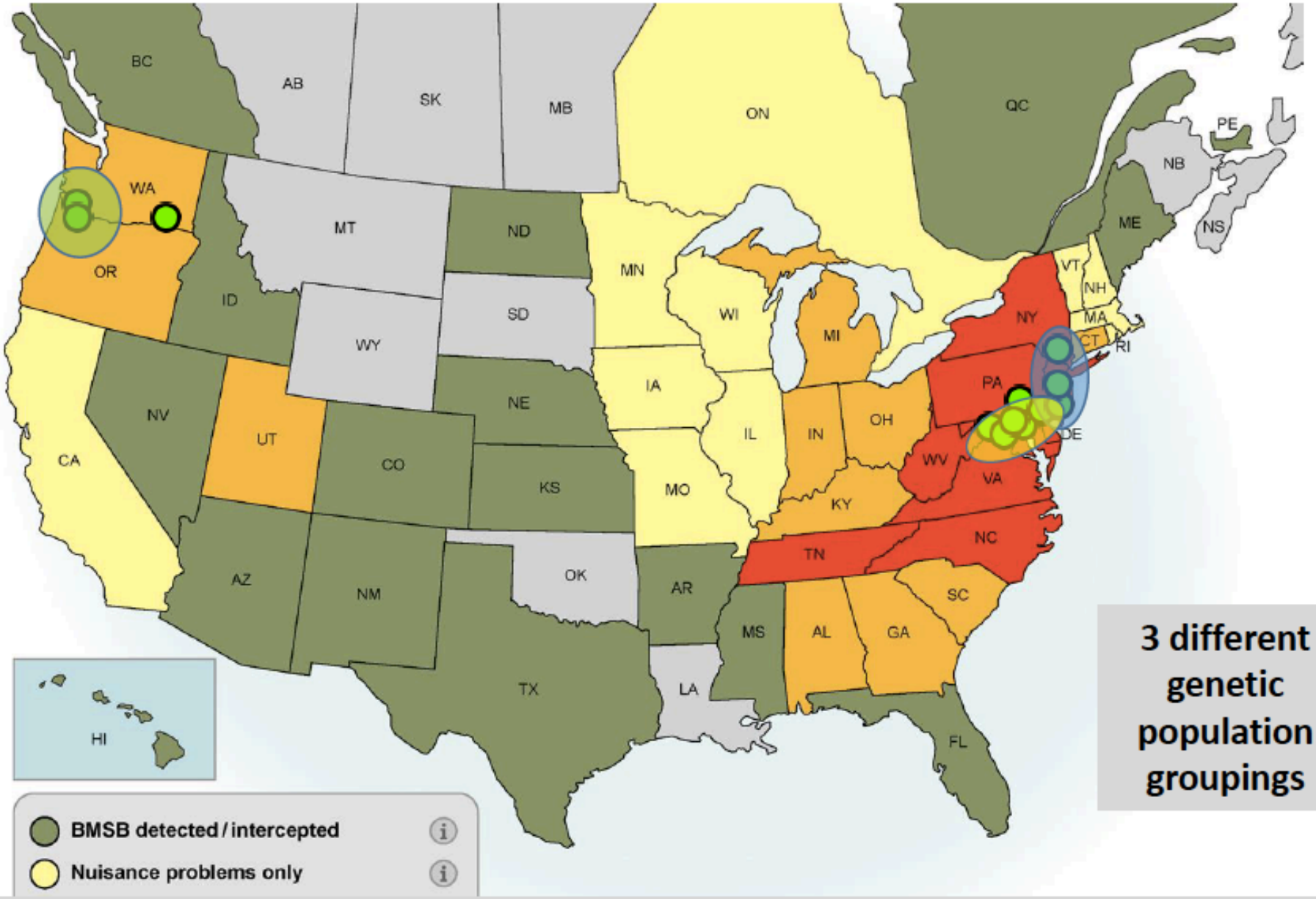
Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)



Field recoveries of *Trissolcus japonicus*

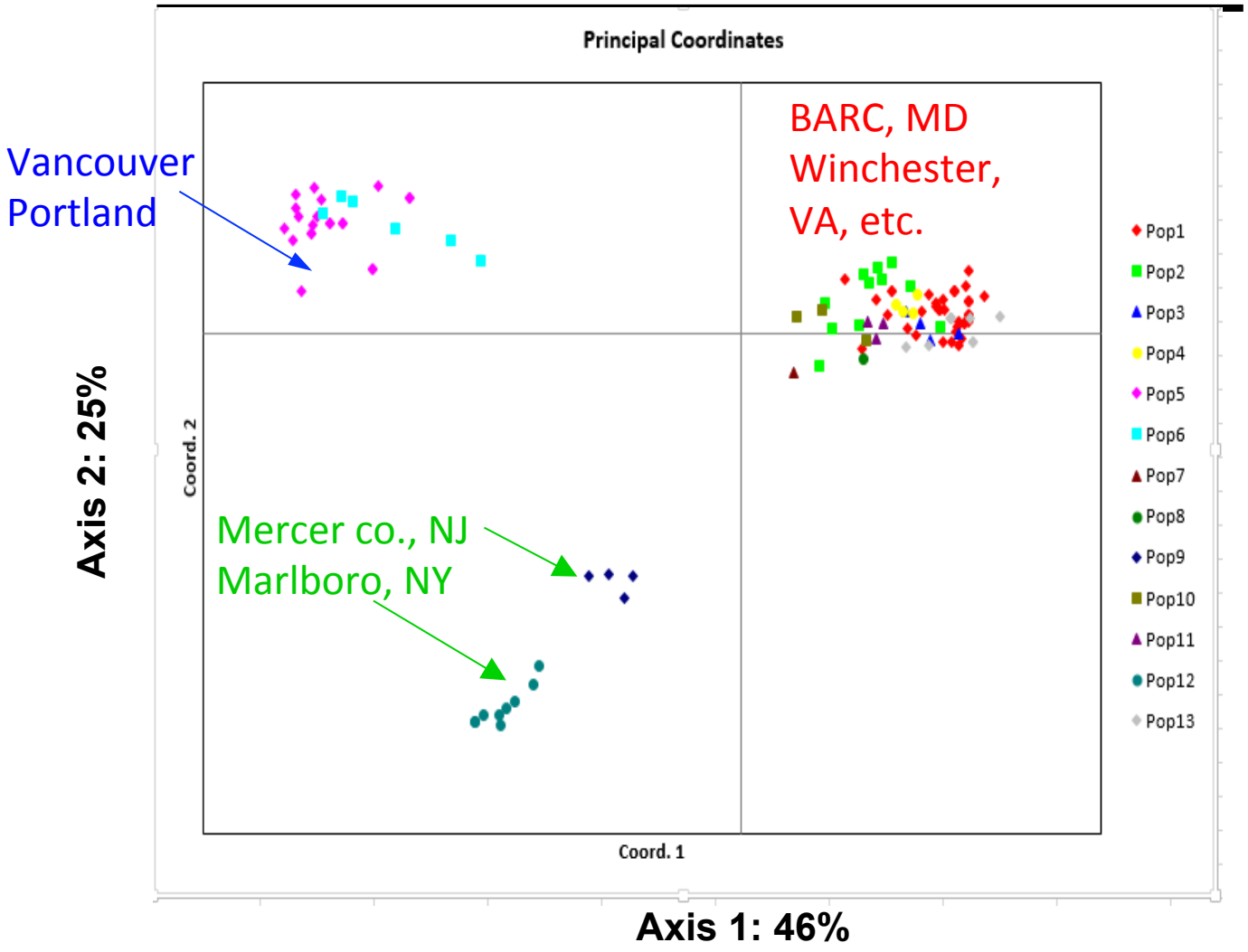
DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)



Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)

Principale Coordinate Analysis (PCoA)- 115 spécimens recovered in US génotype



Axis 1: Split between Western and 2 Eastern populations and all the others

Axis 2: Split between Western and the 2 Eastern populations

Dr. Marie-Claude Bon at the USDA-ARS European Biological Control Laboratory (Montpellier, France)
DNA specimen extractions employing 23 microsatellite gene markers to differentiate genotypes .

Trissolcus japonicus
Field Recovery Sites in the US

* Adventive specimens of *T. japonicus* from the US were sent to Marie-Claude Bon in USDA-ARS European Biological Control Laboratory (Montpellier, France)

* DNA from submitted *T. japonicus* specimens was extracted and characterized using 23 microsatellite gene markers from thirteen different Asian *T. japonicus* populations, including those in quarantine in the U.S. and others collected in Asia in 2012-2013 by Kim Hoelmer's team at the USDA-ARS Beneficial Insects Introduction Research Laboratory (Newark, DE).

* It was **determined none of the adventive finds originated from the populations held in quarantine** (unpubl.), and **thus represented independent introductions of *T. japonicus.***

(E. Beers. PROC. ENTOMOL. SOC. WASH. 118(3), 2016, pp. 466–470)

.

NYS DEC Liberation of Wildlife Permit

In July of 2017 HVRL applied for a 'Liberation of Wildlife' permit. After in-depth review of applicable provisions of the Environmental Conservation Law (ECL) and Codes, Rules and Regulations of the State of New York (NYCRR), **DEC has determined that its regulatory authority extends to the issuance of permits for the release of specifically defined species of wildlife and listed endangered, threatened, and/or invasive species.** Wildlife is defined in ECL S 1 1-0103. Endangered and threated species are identified in 6 NYCRR Part 182, and listed **invasive species are identified in 6 NYCRR Part 575.**

DEC has recently concluded that their statutory and regulatory framework around the Liberation of Wildlife Permit regulating release of biologicals such as insects does not generally apply to releasing insects into the wild, so long as the proposed release is not of an insect that is listed on either the endangered or invasive species listings.

Upon review by the DEC, the adventive *T. japonicus population does not require a* license or permit from DEC to undertake the movement and release of the Samurai wasp, as it is not listed within 6 NYCRR 575.

Expanding the Range of the Parasitoid Wasp, *Trissolcus japonicus*, (Hymenoptera: Scelionidae) in NYS.

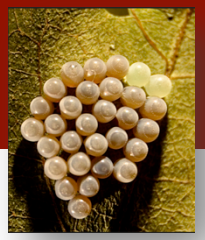
1. Monitored BMSB to determine agricultural presence. (2010)
   Established BMSB colony adult and nymphs for bioassay studies.
   Employ BMSB eggs lain on Jalapeno leaves as sentinel eggs (2016)

2. Survey the native and adventive parasitoid complex using sentinel egg to attract *Trissolcus japonicus* in NYS. (frozen -80C, 4min.) (2016)

3. Developed *T. japonicus* colony, began establishing release sites. Art Agnello (CALS – NYSAES), Tessa Grasswitz, CCE-LOFT, Debbie Breth, CCE-LOFT Ret. (2017)

4. Determine *T. japonicus* establishment in release sites (2017)

H. halys Sentinel Egg Production and Deployment



Sentinel Egg Survey: Field Deployment

- **July 28th – Oct 1st :** Weekly placement of eggs
- 7 WNY sentinel sites and 2 ENY sites were selected to survey for parasitoids (2017).
- Sentinel eggs fixed onto known BMSB host foliage (7 host plants). 2-3 clusters/site/wk.
- Sentinel eggs sent to cooperators in overnight shipping
- Placement in Wayne, Orleans, Ontario, Columbia, Ulster & Dutchess counties
- Recollection of eggs sent and reared at the HVRL, placed in petri dishes and held in a controlled environment chamber at 25 ° C. for 5-7d,
- Monitored for emergence of parasitoids, identified by E. Talamas (U.of Fl. Gainesville).
- Adults parasitoids reared from sentinel egg masses were provided 90% honey-water solution in 1uL droplets on dish for survival and reproduction.

Establish Baseline Survey of Native and Invasive Parasitoids in New York State

Sentinel Egg Staple Attachment

Paper Clip Attachment

Baseline Sentinel *H. halys* Egg Survey Placement Sites in NYS

(N=10 Farms, 3-24 clusters/site/wk. N=2700 sentinel eggs)

Farm	Town	County	Plant Host Plant	Latitude	Longitude
Schutt Orchard	Webster	Monroe	Acer saccharum (*sugar maple)*	43°11'3.78"N	77° 26’ 56.76"W
Windmill Orchard	Ontario	Ontario	Acer saccharum (*sugar maple)*	43°15'50.27"N	77° 22’ 35.32"W
KM Davies	Williamson	Wayne	Acer saccharum (*sugar maple)*	43°14'10.54"N	77 °11’ 23.63"W
Wooded	Holley	Orleans	Juglans nigra (black walnut)	43° 13' 59.52"N	78° 18' 7.27"W
Wooded	Lyndonville	Orleans	Malus sp. (crab apple)	43° 19' 38.28"N	-78° 19' 33.96"W
Wooded	Medina	Orleans	Ailanthus altissima (tree of heaven)	43°12'1.79"N	78° 23’ 36.81"W
Hepworth Farms	Marlboro	Ulster	Robinia pseudoacacia (black locust)	41°40'14.72"N	74° 5’ 11.21"W
Hepworth Farms	Marlboro	Ulster	Ailanthus altissima (tree of heaven)	41°40'14.72"N	74° 5’ 11.21"W
Crist Orchard	Walden	Orange	Ailanthus altissima (tree of heaven)	41°33'2.64"N	74° 9’ 50.72"W
Minard Orchard	New Paltz	Ulster	Vitis sp. (wild grape)	41°42'1.47"N	74° 4’ 24.13"W

Baseline Sentinel *H. halys* Egg Survey Placement Sites in New York State

2017 Sentinel Egg Emergence

Native

Trissolcus euschisti (6/23) (N=1)

Telenomus podisi (6/30) (N=3)

Asian Invasive

Trissolcus japonicus (7/7)

Marlboro, Ulster Co. (N=96)

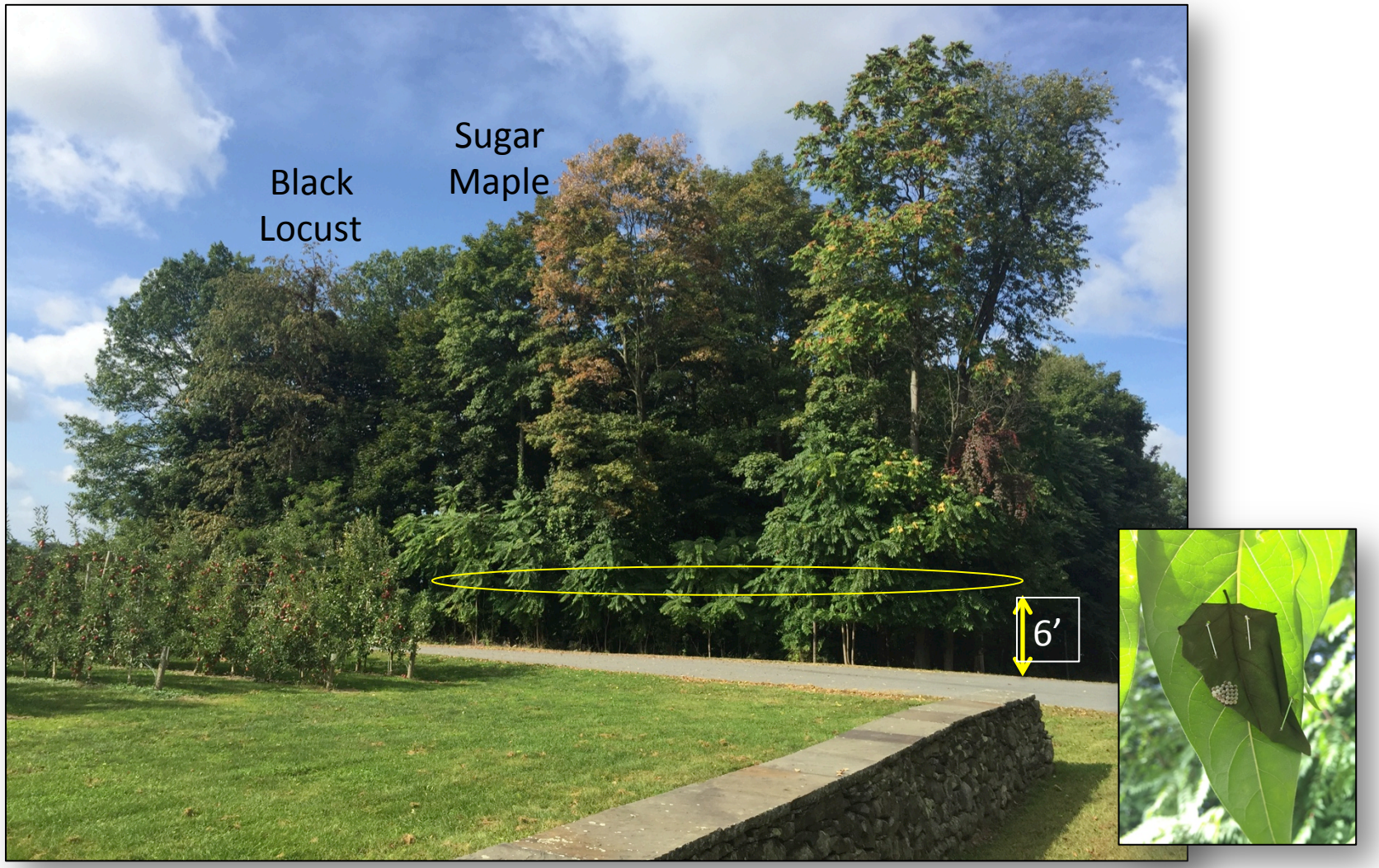
Trissolcus japonicus Release Sites in New York State

Phase II – 2017
Parasitized Egg Parasitoid Release
'Redistribution'

T. Japonicus Egg Placement

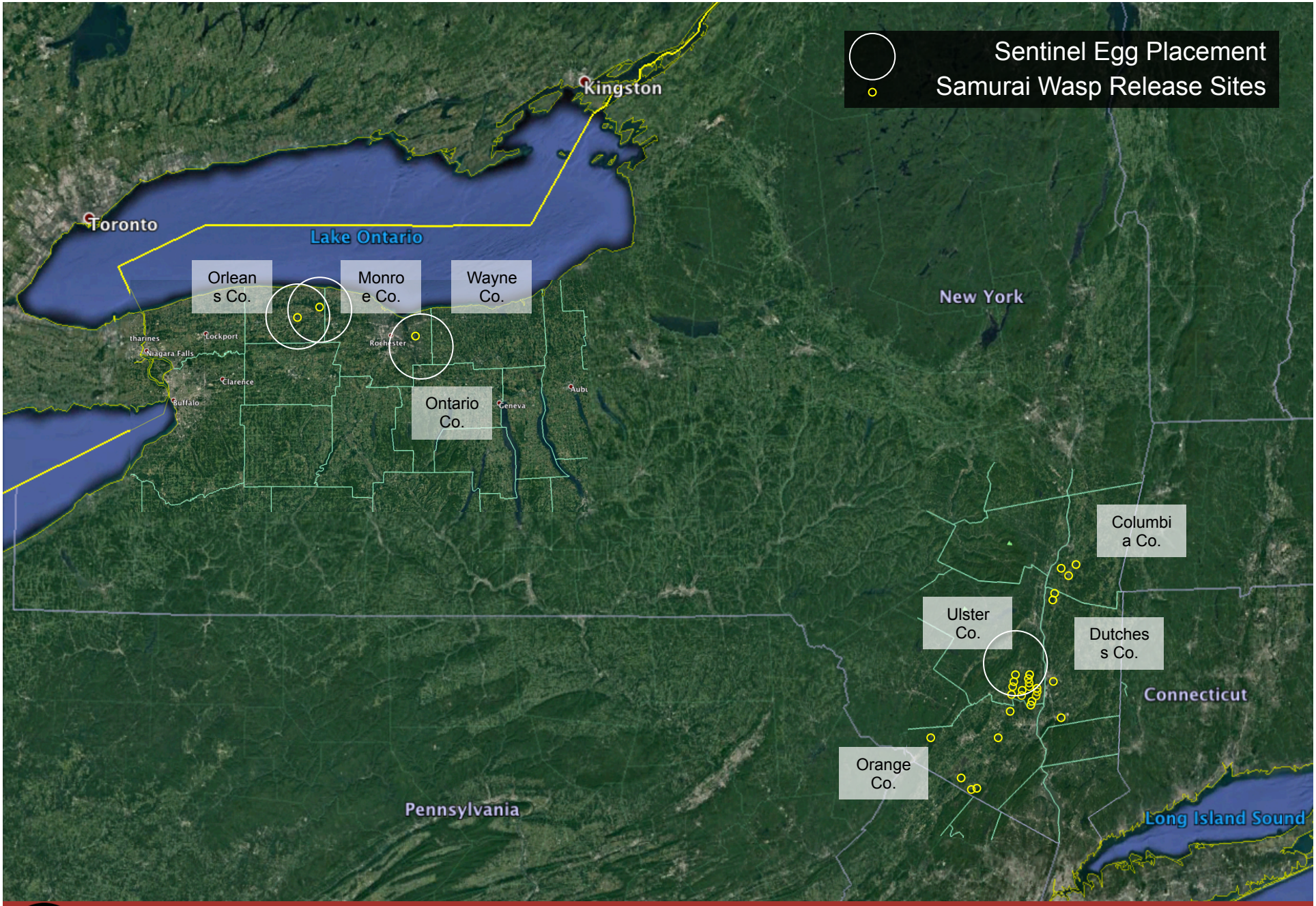
- **Captured adventive *T. japonicus* from Hepworth Farms in Marlboro, NY on July 7th 2017.**
- Wasps reared and used to parasitize frozen BMSB eggs.
- 1st parasitized eggs sent to cooperators beginning on 15th September.
- Parasitized eggs placed onto 32 sites, on 25 farms in 5 NY counties.

Trissolcus japonicus Release Sites in New York State



Placement Sites of *T. Japonicus parasitized eggs* in NYS
(N=24 Farms, 6 NY counties on 32 sites using ≈ 2300 eggs onto 7 host plant *sp.*)

Site	Town	County	Date	Clusters	Eggs	Placement / Host Plant	Latitude	Longitude
1	Webster	Monroe	15-Sep	3	78	Acer saccharum (*sugar maple)*	43°11'3.78"N	77°26'56.76"W
2	Holley	Orleans	22-Sep	3	84	Black Walnut	43°14'0.42"N	78° 1'10.46"W
3	Modena	Ulster	22-Sep	3	89	Vitis riparia (Native grape)	41°41'25.15"N	74° 4'3.51"W
4	New Paltz	Ulster	22-Sep	3	76	Vitis riparia (Native grape)	41°42'1.57"N	74° 4'24.22"W
5	Clintondale	Ulster	22-Sep	3	72	Acer saccharum (*sugar maple)*	41°41'32.91"N	74° 3'18.67"W
6	Walden	Orange	22-Sep	2	54	A. altissima (Tree of Heaven)	41°33'1.34"N	74° 9'36.77"W
7	Gardener	Ulster	23-Sep	3	74	Robinia pseudoacacia (Black Locust)	41°40'14.72"N	74° 5'11.21"W
8	Warwick	Orange	23-Sep	2	56	A. altissima (Tree of Heaven)	41°13'55.83"N	74°22'0.66"W
9	Warwick	Orange	23-Sep	2	56	A. altissima (Tree of Heaven)	41°13'52.59"N	74°23'11.62"W
10	Fishkill	Dutchess	24-Sep	3	73	Robinia pseudoacacia (Black Locust)	41°31'12.02"N	73°49'40.04"W
11	Hudson	Columbia	24-Sep	2	56	Vitis riparia (Native grape)	42°11'6.33"N	73°49'47.25"W
12	Hudson	Columbia	24-Sep	2	54	A. altissima (Tree of Heaven)	42°11'16.36"N	73°49'58.86"W
13	Marlboro	Ulster	24-Sep	2	56	Rhus sp. (Sumac)	41°38'13.67"N	74° 0'24.57"W
14	Milton	Ulster	24-Sep	3	78	A. altissima (Tree of Heaven)	41°39'4.29"N	73°59'33.93"W
15	Milton	Ulster	24-Sep	3	74	Robinia pseudoacacia (Black Locust)	41°38'43.94"N	73°59'24.84"W
16	Modena	Ulster	24-Sep	2	59	A. altissima (Tree of Heaven)	41°40'1.19"N	74° 7'44.19"W
17	Red Hook	Dutchess	24-Sep	3	73	A. altissima (Tree of Heaven)	42° 3'14.98"N	73°50'55.49"W
18	Tivoli	Dutchess	24-Sep	3	72	Robinia pseudoacacia	42° 2'56.09"N	73°52'59.69"W
19	Valatia	Columbia	24-Sep	2	59	A. altissima (Tree of Heaven)	42°14'48.18"N	73°43'25.07"W
20	Milton	Ulster	26-Sep	3	87	Acer saccharum (*Sugar Maple)*	41°38'39.48"N	73°58'6.6"W
21	Poughkeepsie	Dutchess	28-Sep	3	76	Robinia pseudoacacia (Black Locust)	41°40'40.28"N	73°53'50.91"W
22	Clintondale	Ulster	29-Sep	3	82	Acer saccharum (*Sugar Maple)*	41°40'39.00"N	74° 3'19.43"W
23	Clintondale	Ulster	29-Sep	3	84	Vitis riparia (Native Grape)	41°40'24.16"N	74° 3'30.29"W
24	Highland	Ulster	29-Sep	3	84	A. altissima (Tree of Heaven)	41°41'59.76"N	74° 3'7.90"W
25	Modena	Ulster	29-Sep	2	58	Robinia pseudoacacia (Black Locust)	41°40'6.74"N	73°59'39.28"W
26	New Paltz	Ulster	29-Sep	3	81	Juglans nigra (eastern black walnut)	41°42'43.82"N	74° 6'48.75"W
27	New Paltz	Ulster	29-Sep	3	86	Juglans nigra (eastern black walnut)	41°41'30.84"N	74° 7'43.96"W
28	Campbell Hall	Orange	6-Oct	3	71	Deer Fence	41°25'36.84"N	74°14'21.00"W
29	Cuddebackville	Orange	6-Oct	3	71	Corylus avellana (Hazelnut)	41°27'45.22"N	74°36'57.16"W
30	Cuddebackville	Orange	6-Oct	3	74	Corylus avellana (Hazelnut)	41°27'41.78"N	74°36'57.28"W
31	Cuddebackville	Orange	6-Oct	3	77	Corylus avellana (Hazelnut)	41°27'40.97"N	74°36'52.20"W
32	Warwick	Orange	6-Oct	3	76	Acer saccharum (*sugar maple)*	41°17'31.47"N	74°26'15.06"W



Cornell University

Hudson Valley Research Laboratory

Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

Photograph: **Christopher Hedstrom**
USDA-APHIS Quarantine Facility,
Corvallis, Oregon

'17 Recollection of Parasitized Eggs

- Parasitized eggs collected in 11 of 32 sites in late October & November to determine % emergence.
- Of the 11 sites, 77% of clusters recovered.
- In 3 of the 11 sites Samurai Wasps was found guarding egg clusters

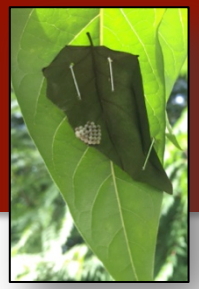
Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

Photograph: **Christopher Hedstrom**
USDA-APHIS Quarantine Facility,
Corvallis, Oregon

'17 Recollection of Parasitized Eggs

- 168 or 24.4% (N=719) successfully emerge as adults
- 0.7% partially emerged from the egg
- 66.4% of the eggs showing no sign of emergence; eggs were parasitized and unsuccessful in development

Release Site Confirmation of Samurai Wasp Using Post Emergence Sentinel Eggs*



- Upon emergence, sentinel eggs were placed 30 meters from *T. japonicus* in two of the release sites .

- Egg parasitism by *T. japonicus* was observed in these 2 release sites from 15th September to 3rd October.

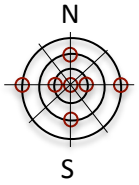
Site	County	Google Earth Coordinates	Sentinel Eggs Placed (date)
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	9-15-2017
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	9-22-2017
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	10-3-2017
Holly	Orleans	43°13'59.52"N 78°18'7.271"W	10-3-2017

Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

Photograph: **Christopher Hedstrom**
USDA-APHIS Quarantine Facility,
Corvallis, Oregon

2018 Protocols (‘17 sites)

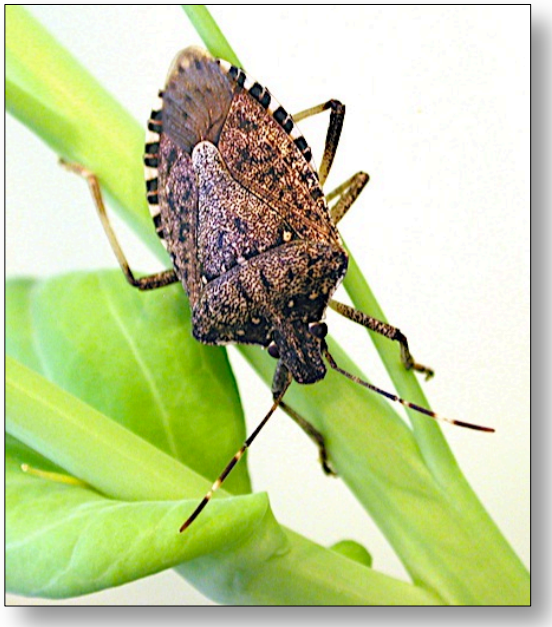
- Placement of sentinel egg masses in 2017 release sites for recapture of *T. japonicus*.



- 5d field exposure & return to HVRL.
- Rear eggs to confirm *T.* Japonicus presence to determine successful establishment.
- Re-establish sites as needed.
- Early establishment of additional sites (≈ 200). T.j. parasitized eggs to NY growers upon request.

Questions??

E-mail: pjj5@cornell.edu



The National March Madness
Citizen Science Project
To Find
The Brown Marmorated Stink Bug

Trissolcus japonicus

Thanks to the staff at the HVRL for all their support:

Research Support Specialist I	Dana Acimovic
Laboratory Technician	Lydia Brown
Research Assistant	Christopher Leffelman
Research Assistant	Lucas Canino
Research Assistant	Ben Lee
Research Assistant	Addie Kurchin
Summer Research Intern	Cameron Fuhr
Farm Manager	Albert Woelfersheim
Administrative Assistant	Erica Kane
Administrative Assistant	Christine Kane
HRVL & NEWA Weather Data.....	Christopher Leffelman, Albert Woelfersheim

Support from NYS Ag. & Mkts, ARDP, Dow AgroSciences, Bayer, NYS SCRI, NYS Orchards & Farmers NY farm viability INSTITUTE