

# Invasive Insect Tsunami: Managing Brown Marmorated Stink Bug in NYS Orchards



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**2019 ENYCHP Winter Fruit Schools  
Desmond Hotel & Conf Ctr, Albany , NY**



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Photograph: **Christopher Hedstrom**  
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# Brown Marmorated Stink Bug Management



- **BMSB Ecology & Biology**
- **Monitoring / Scouting**
- **Stink Bug Injury Diagnostics**
- **Insecticide Efficacy Studies**
- **Biological Control**
- **Novel / Innovation Mgt. Research**





# Hudson Valley Stink Bug Complex (Pentatomidae)

## Species Of Economic Importance

### Stink Bug Biology

- Large 'Shield' bug body form (3.5 cm)
- Proboscis (moutparts) shielded prior to insertion into fruit
- Body held above the surface of foliage and fruit
- Tarsi hold insect on small segments onto smooth surfaces
- Limited exposure to residual insecticides





# Hudson Valley Stink Bug Complex (Pentatomidae)

## Species Of Economic Importance

### Brown Stink Bug, *Euschistus servus* (Say)



- Native to North America
- Feeds on broad leaf plant & seed (Mullen, Dock, Plantain)
- Moves to apple borders during periods of drought
- Pyrethroids, Pre-mix Neonic + Pyrethroid

### Green Stink Bug, *Acrosternum hilare* (Say).



- Native to North America
- Arboreal dwelling, feed on seed, stems and foliage
- Moves to apple borders during periods of drought

### Brown marmorated stink bug, *Halyomorpha halys* (Stål)



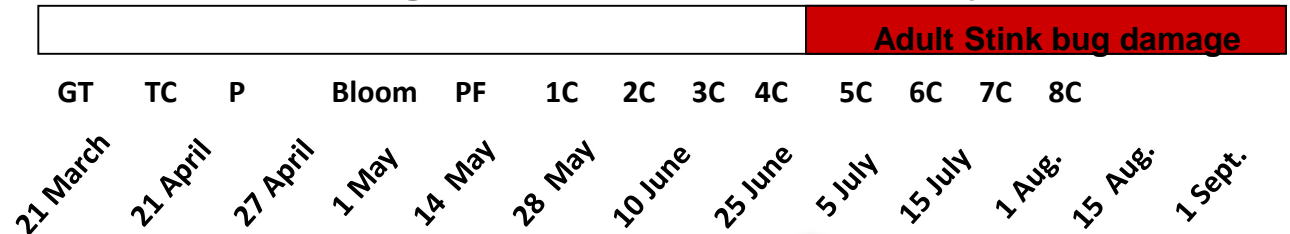
- Newly invasive in North America
- Arboreal dwelling, feed on seed, stems and foliage
- Moves to apple borders during periods of high population, drought



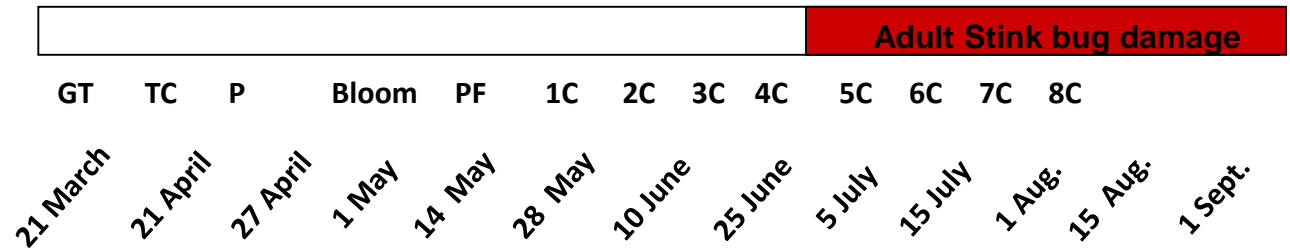
# Hudson Valley Stink Bug Complex Species Of Economic Importance



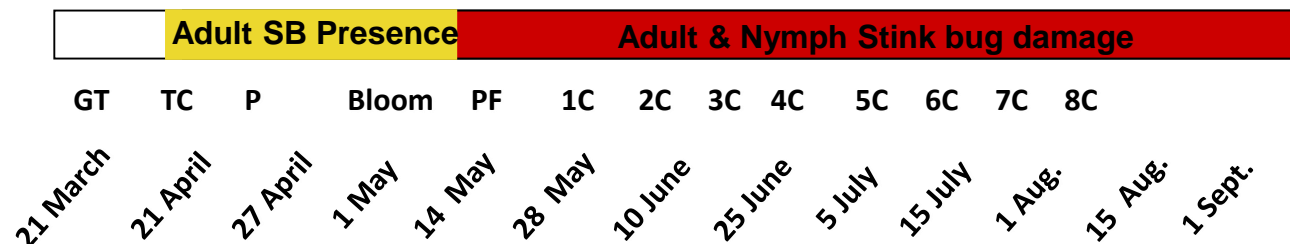
## Brown Stink Bug, *Euschistus servus* (Say)



## Green Stink Bug, *Acrosternum hilare* (Say).



## Brown marmorated stink bug, *Halyomorpha halys* (Stål)

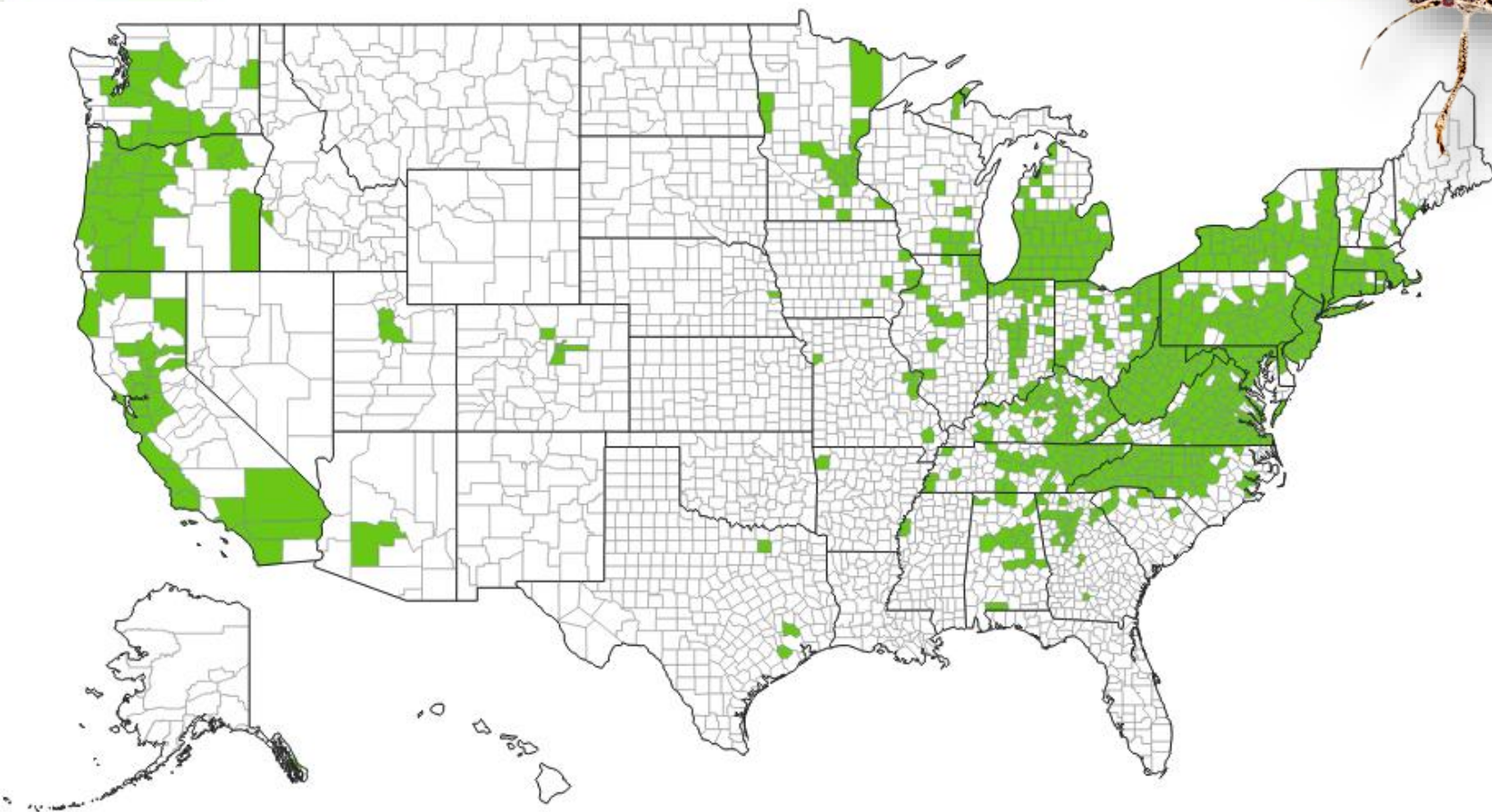




**brown marmorated stink bug**  
*Halyomorpha halys* (Stal)

States **Counties** Points List

Species Information



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

**Legend**

- No Data
- Species Reported



# Factors for BMSB Success: Overwintering



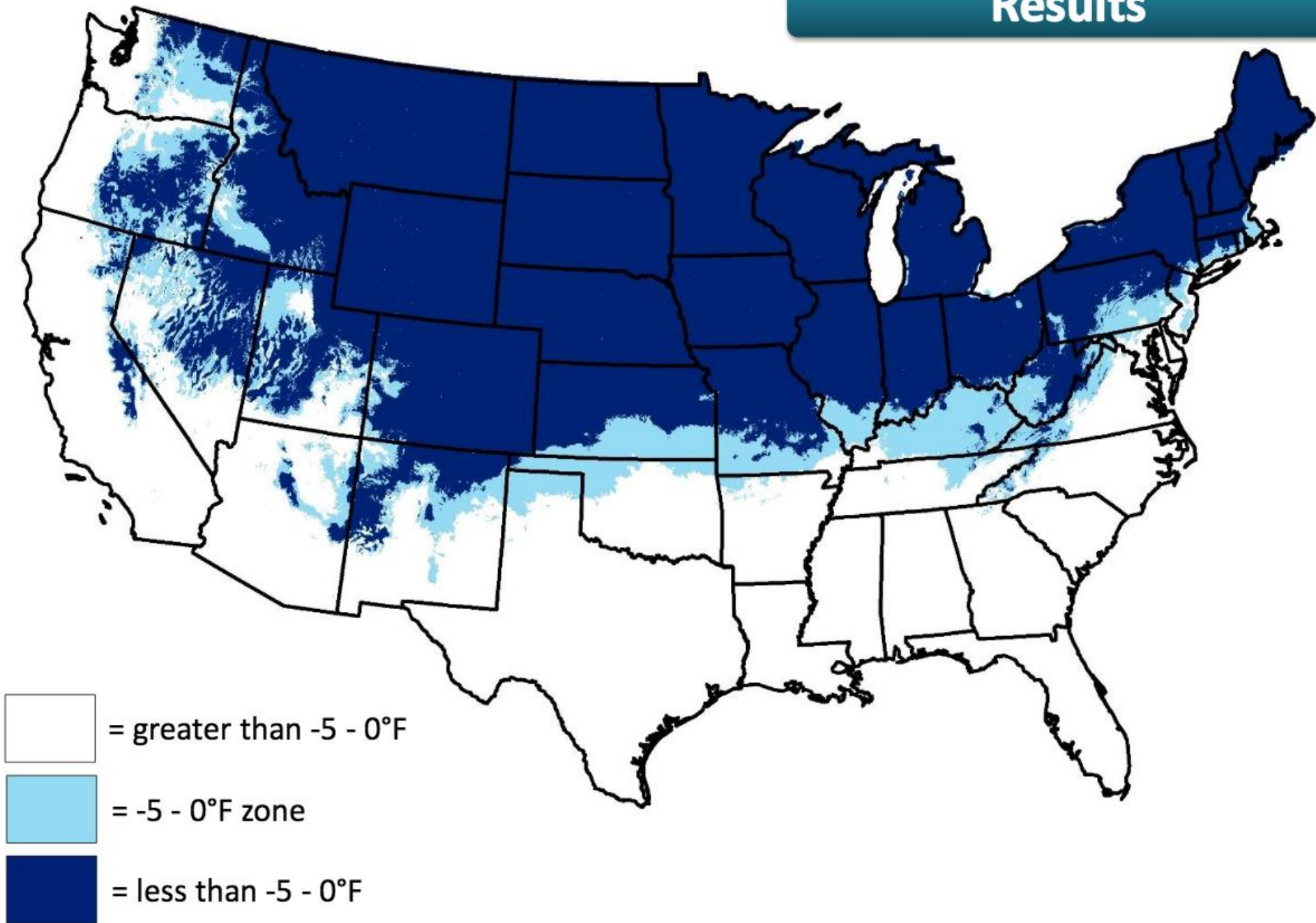
## Overwintering habitat

- A small percent of the population will aggregate in buildings where temperature extremes allow for survival in northern climates, **potentially creating localized cluster points for Ag. infestations.**
- The majority of BMSB reside in the woodland habitat (Standing Dead Oak (*Quercus* spp.), Locust (*Robinia* spp.) Lee, Doo-Hyung et al. 2014)
- In woodland habitat, temperatures below  $-18^{\circ}\text{C}$  or  $-0.4^{\circ}\text{F}$  will kill 90% of the population (Kuhar, T. 2016)



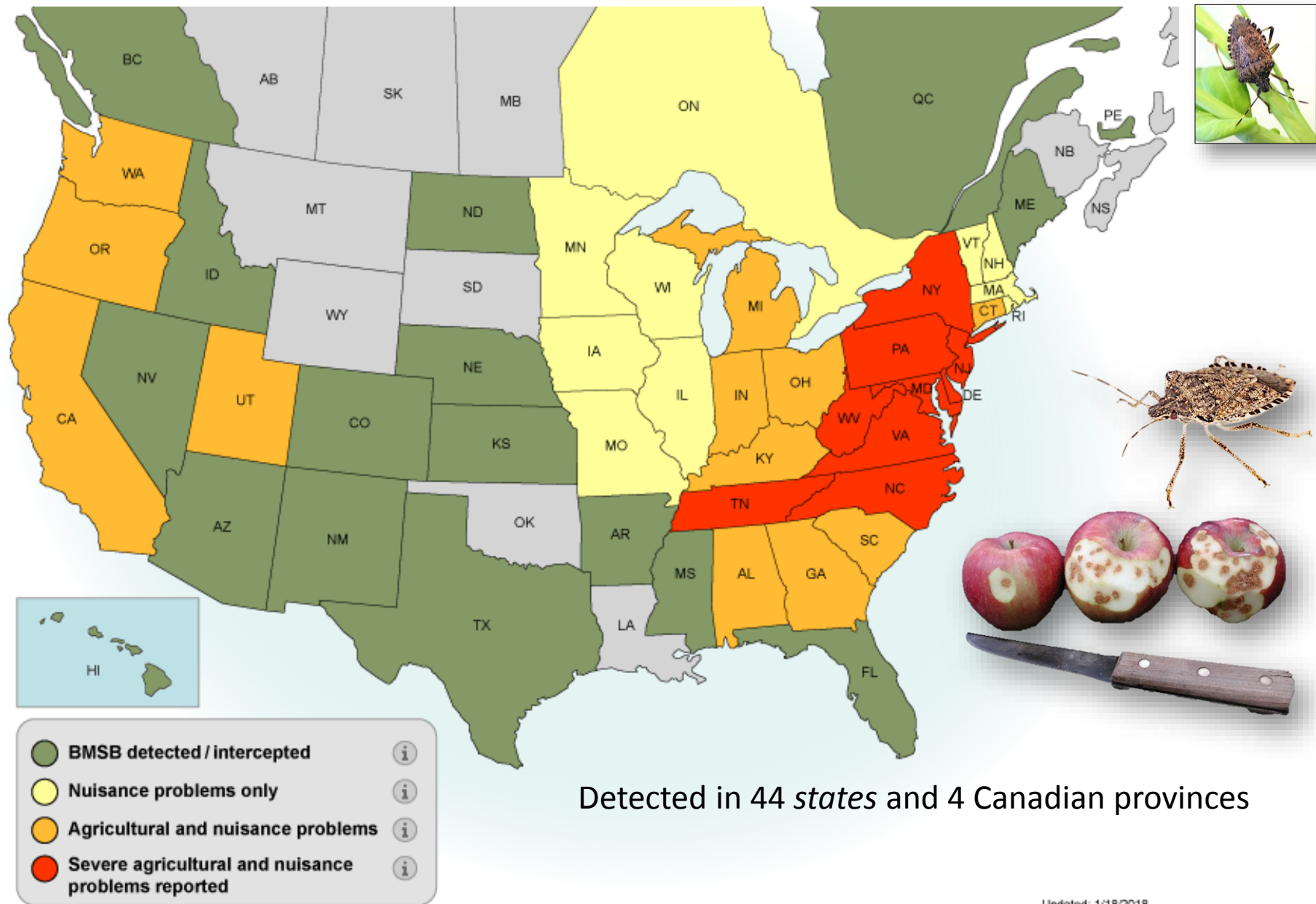


## Results





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





# Factors for BMSB Success: # of Generations

- **Sunlight / Day length** (BMSB adult mating)
  - **13.5h day length** for mating and egg laying to begin
  - Geneva, NY      April 29<sup>th</sup> – Aug 13<sup>th</sup>
  - HVRL Highland    May 1<sup>st</sup> – Aug. 11<sup>th</sup>

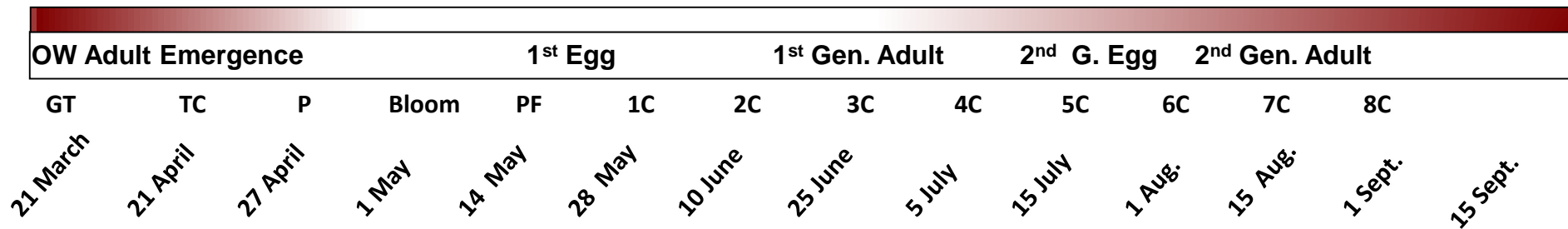




# Factors for BMSB Success: # of Generations

- **Degree Day Accumulations**

- It requires **538 degree days** (DD – based 50°F) to develop from egg to adult.
- An additional **148 DD** are required for female maturation **at 77°F**.
- Total of **686 DD<sub>50</sub>** for 1 generation;
- **1224 DD<sub>50</sub>** for a **2<sup>nd</sup>** complete the adult OW population





# Brown Marmorated Stink Bug Management



- BMSB Ecology & Biology
- **Monitoring / Scouting**
- **Stink Bug Injury Diagnostics**
- **Insecticide Efficacy Studies**
- **Biological Control**
- **Novel / Innovation Mgt. Research**





# State-wide Trap Monitoring of BMSB in NY

## USDA #10 Lure & MDT Using Tedders Traps



Vented trap container holding duel lure

Killing strip of Vapona; bungi cord straps

Pyrimid black base to mimmic tree trunk

Screened base to **reduce weeds** and provide contrast for crawling SB

**Placed along deciduous woodland / orchard edge**

**AgBio-inc.com**

**Trap, lures, kill strip**

Treatment Threshold: 10 adults / trap / week





# Green & Brown Marmorated Stink Bug: Monitoring

Tedders Trap  
\*duel pheromone



Sticky Card Trap  
\*duel pheromone



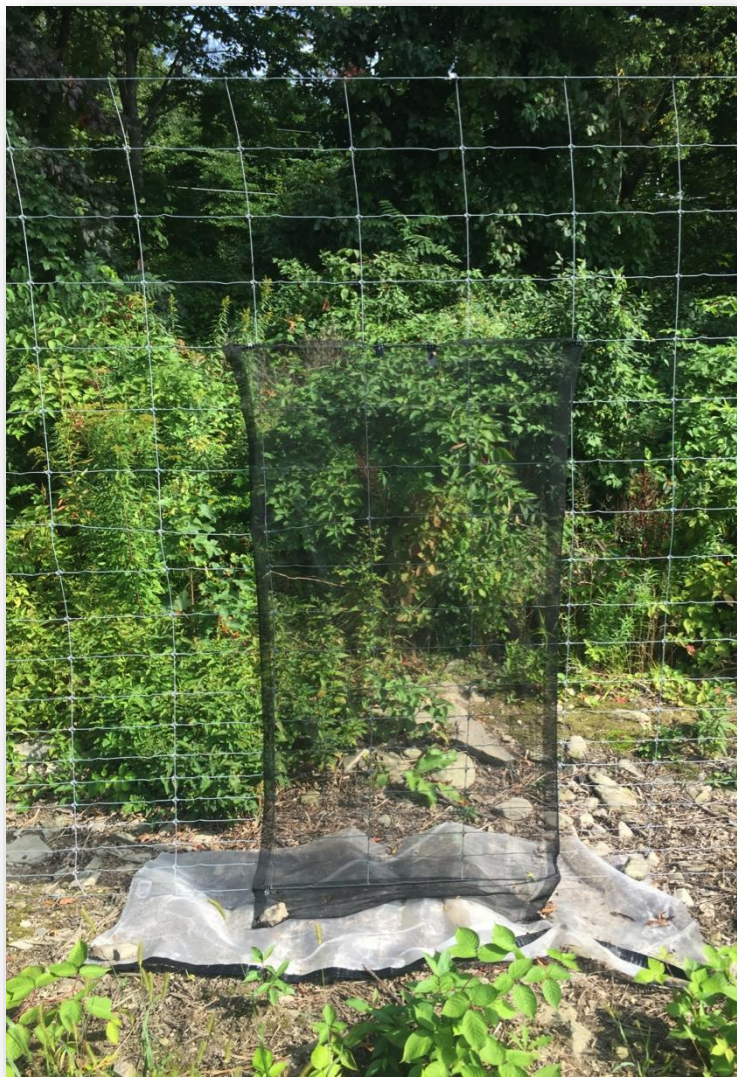
Threshold: 10 adults / trap / week

AtK Trap (Vestegaard)  
\*duel pheromone  
\*deltamethrin-Incorporated net





# Green & Brown Marmorated Stink Bug: Monitoring





# Green & Brown Marmorated Stink Bug: Monitoring





# Brown Marmorated Stink Bug Management



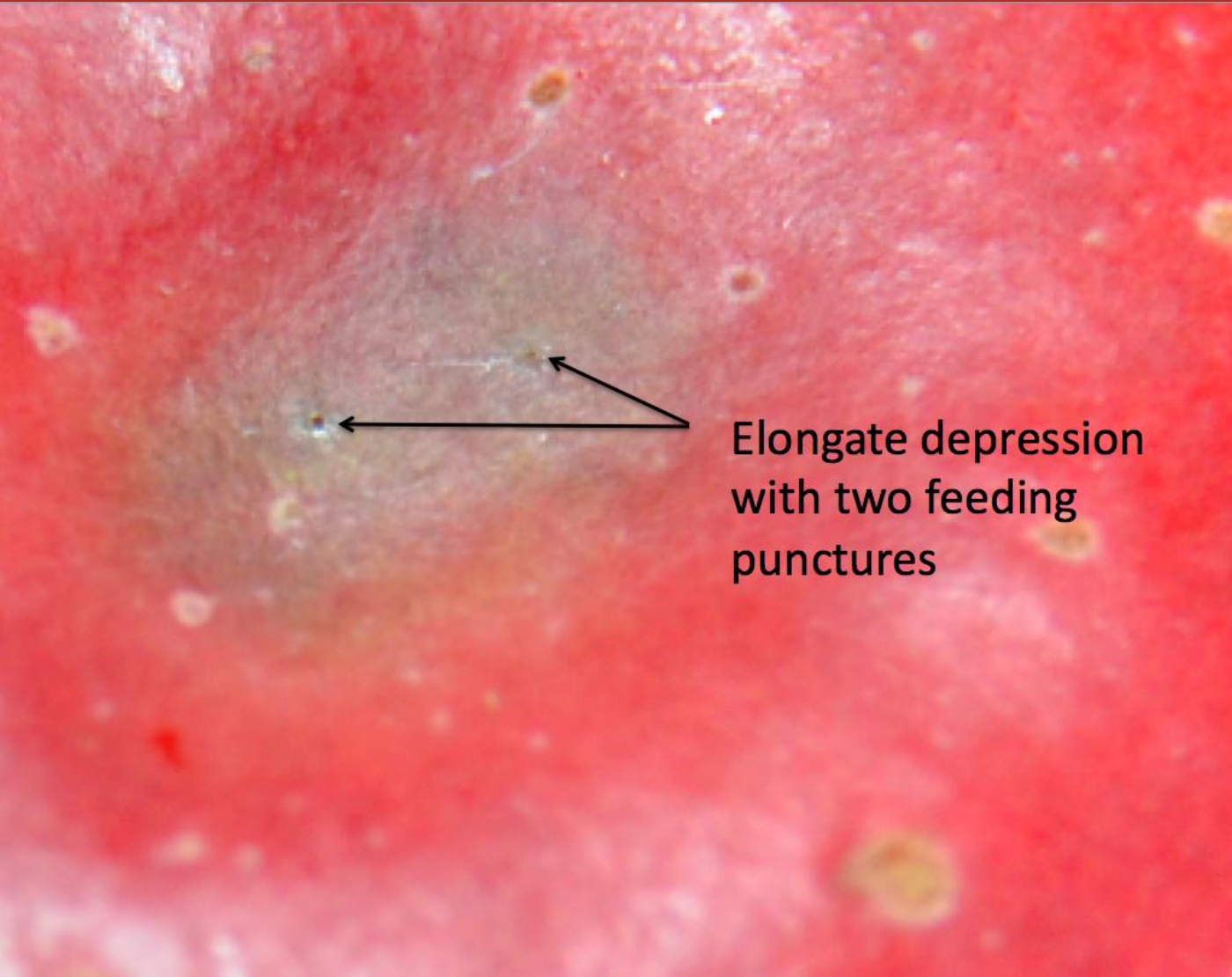
- BMSB Ecology & Biology
- Monitoring / Scouting
- **Stink Bug Injury Diagnostics**
- Insecticide Efficacy Studies
- Biological Control
- Novel / Innovation Mgt. Research





# BMSB: Defining Injury

## Stink Bug, Hail, Bitter Pit, Maggot



Elongate depression  
with two feeding  
punctures

### Stink Bug:

- Discolored shallow depression
- Corking to skin surface
- **Feeding puncture**





# BMSB: Defining Injury

## Stink Bug, Hail, Bitter Pit, Maggot



Hail Injury



### Hail injury:

- Discolored shallow depression
- Corking to skin surface
- **No feeding puncture**





# BMSB: Defining Injury

## Stink Bug, Hail, Bitter Pit, Maggot



Bitter Pit  
Jonagold

### **Bitter Pit:**

- Discolored shallow depression
- **Corking not to skin surface**
- **No feeding puncture**





# BMSB: Defining Injury

## Stink Bug, Hail, Bitter Pit, Maggot



### **Apple Maggot:**

- Sting  
Depression

- **No skin**

### **Discoloration**

- **No corking**
- Oxidized  
tunneling or  
trails





# Brown Marmorated Stink Bug Management

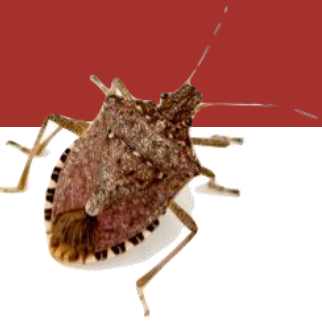


- BMSB Ecology & Biology
- Monitoring / Scouting
- Stink Bug Injury Diagnostics
- **Insecticide Efficacy** Biological Control
- Novel / Innovation Mgt. Research





# Management Options



<b>Insecticide Group</b>	<b>Product</b>	<b>Active Ingredient</b>	<b>% Adult BMSB Mortality<sup>1</sup></b>
<b>Pyrethroid</b>	<b>Bifenture</b>	bifenthrin	100
	<b>Danitol</b>	fenpropathrin	95
	<b>Warrior II</b>	lambda-cyhalothrin	73
<b>Carbmate</b>	<b>Lannate</b>	methomyl	92
	<b>Vydate</b>	oxymyl	68
<b>Neonicotinoid</b>	<b>Actara</b>	thiamethoxam	92
	<b>Assail</b>	acetamiprid	87
<b>Pre-mix</b>	<b>Leverage 360</b>	imidacloprid and $\beta$ -cyfluthrin	95
	<b>Endigo</b>	lambda-cyhaloth	98
	<b>Voliam Flexi</b>	chlorantraniliprole and thiamethoxam	98

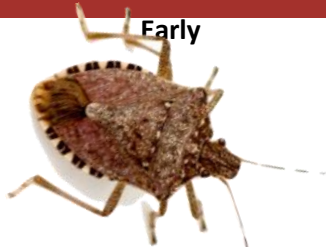
**1. Direct contact activity of insecticides against BMSB adults in a lab setting may be very high, yet the activity of field-aged residue may, over time, quickly becomes ineffective at preventing feeding injury.**





# NY BMSB Management Options

**August**



**Early**

**Mid**

**Late**

Blondee  
Sansa

Blondee  
Paulared  
Tydeman  
Zestar

**WHOLE ORCHARD** application early-mid August  
Trap Threshold + observation  
Egg laying in orchard possible  
14-7d PHI

**September**

Autmn Crisp  
Blondee  
Gala  
Ginger Gold

Autmn Crisp  
Cortland  
Empire  
Honeycrisp

Ambrosia  
Autmn Crisp  
Braeburn  
Golden Delicious

2-4 applications beginning in early August  
**Perimeter Row applications**  
35-7d PHI

Golden Supreme  
Greening  
Jonamac  
McIntosh  
Twenty Ounce  
Tydeman

Macoun  
Shamrock  
Snow Sweet  
Tydeman

Jonagold  
Mutsu/Crispin  
Pinova  
Red Delicious  
Ruby Frost™  
Ruby Jon  
Snap Dragon™  
Snow Sweet

**October**

Braeburn  
Cameo  
Fortune  
Idared  
Northern Spy  
Rome  
Ruby Frost™  
Shizuka  
Snap Dragon™  
Snow Sweet

Braeburn  
Cameo  
Fuji  
Granny Smith  
Ruby Frost™  
Shizuka  
Spigold  
Suncrisp

Braeburn  
Cameo  
Fuji  
Granny Smith  
Spigold  
Suncrisp

5-8 applications beginning in early August  
**Perimeter Row applications**  
35-7d PHI

>6 applications beginning in early August  
**Perimeter Row applications**

**November**

Pink Lady

35-7d PHI



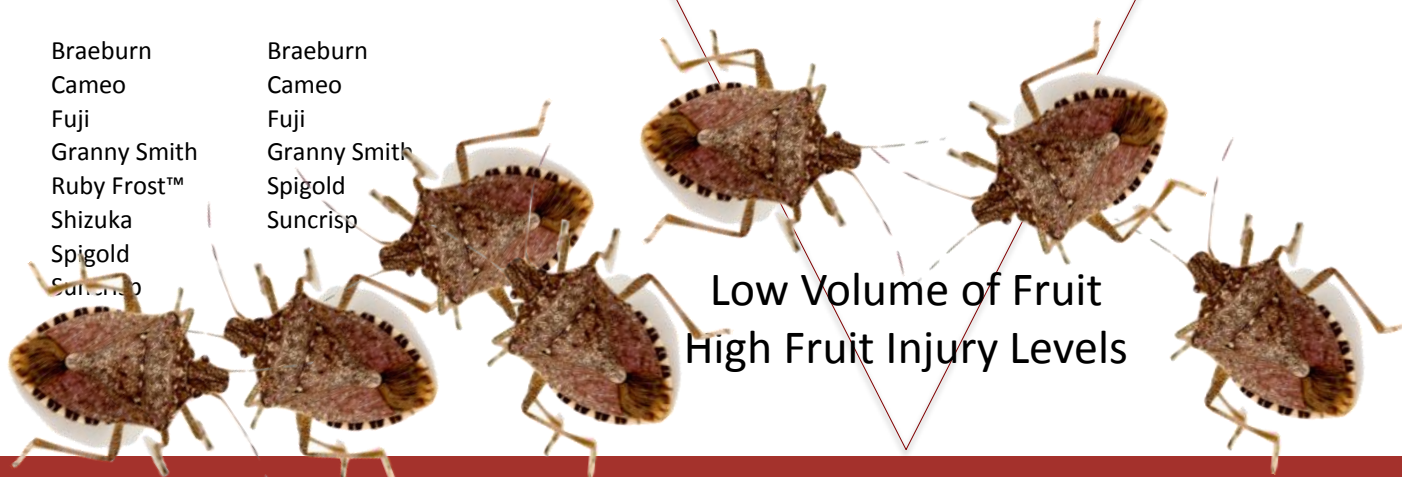
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# NY BMSB Management Options

	Early	Mid	Late	
<b>August</b>		Blondee Sansa	Blondee Paulared Tydeman Zestar	<div>High Volume of Fruit</div> <div>Low Injury Level</div>
<b>September</b>	Autmn Crisp Blondee Gala Ginger Gold  Golden Supreme Greening Jonamac McIntosh Twenty Ounce Tydeman	Autmn Crisp Cortland Empire Honeycrisp  Macoun Shamrock Snow Sweet Tydeman	Ambrosia Autmn Crisp Braeburn Golden Delicious  Jonagold Mutsu/Crispin Pinova Red Delicious Ruby Frost™ Ruby Jon Snap Dragon™ Snow Sweet	
<b>October</b>	Braeburn Cameo Fortune Idared Northern Spy Rome Ruby Frost™ Shizuka Snap Dragon™ Snow Sweet	Braeburn Cameo Fuji Granny Smith Ruby Frost™ Shizuka Spigold Suncrisp	Braeburn Cameo Fuji Granny Smith Spigold Suncrisp	<div>Low Volume of Fruit</div> <div>High Fruit Injury Levels</div>
<b>November</b>	Pink Lady			





# NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Besiege	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
Bifenture EC	Bifenthrin	5.2-12.8 fl oz/A	12	14	++++	32 fl ozs (0.50 lbs ai)	30d
Bifenture 10DF	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Brigade WSB	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Danitol 2.4EC	Fenpropathrin	10.66-21.33 fl oz/A	24	14	+++	42.56 fl ozs (0.80 lbs ai)	10d
Endigo ZC	Thiamethoxam / Lambda-cyhalothrin	5-6 fl fl oz/A	24	35	++++	19 fl oz./A (0.172 lb ai) NY	10d
Gladiator EC	Zeta-Cyfluthrin / Avermectin B1	19.0 fl.oz./A	12	28	++	38.0 fl oz/A	21d
Lannate 2.4LV*	Methomyl	2.25 pt/A	72	14	++++	240 ozs (0.50 lbs ai)	7d
Lannate 90SP*	Methomyl	0.75 lb./A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d

\* Although these materials have excellent topical ratings in lab bioassay studies, field efficacy studies have shown economic fruit injury from BMSB feeding, suggesting low residual levels.

\*\* Post bloom applications

(+) low to (++++ ) high efficacy



## Early-mid August

- Single Application (Thiamethoxam)
- NYS total 11.0 oz./A of Actara WDG
- 35 DTH



# NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Besiege	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
Bifenture EC	Bifenthrin	5.2-12.8 fl oz/A	12	14	++++	32 fl ozs (0.50 lbs ai)	30d
Bifenture 10DF	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Brigade WSB	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Danitol 2.4EC	Fenpropathrin	10.66-21.33 fl oz/A	24	14	+++	42.56 fl ozs (0.80 lbs ai)	10d
Endigo ZC	Thiamethoxam / Lambda-cyhalothrin	5-6 fl fl oz/A	24	35	++++	19 fl oz./A (0.172 lb ai) NY	10d
Gladiator EC	Zeta-Cyfluthrin / Avermectin B1	19.0 fl.oz./A	12	28	++	38.0 fl oz/A	21d
Lannate 2.4LV*	Methomyl	2.25 pt/A	72	14	++++	240 ozs (0.50 lbs ai)	7d
Lannate 90SP*	Methomyl	0.75 lb./A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d

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\*\* Post bloom applications

(+) low to (++++ ) high efficacy



## Mid-late August

- 5-10 d application schedule
- 21 DTH





# NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
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Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d

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(+) low to (++++ ) high efficacy



## Late August-Early September

- 5-10 d application schedule
- Bifenthrin (30d Re-application)
- 14 DTH



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# NY Management Options

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\*\* Post bloom applications

(+) low to (++++ ) high efficacy



## Mid-September

- 5-10 d application schedule
- 7 DTH



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# Brown Marmorated Stink Bug Management



- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- Defining Stink Bug Injury
- Directed Applications & Efficacy
- **Novel / Innovation (Research)**





# Attract and Kill Netting in Orchard

## Duel Pheromone + Insecticide





# Attract and Kill Netting in Orchard

## Duel Pheromone + Insecticide



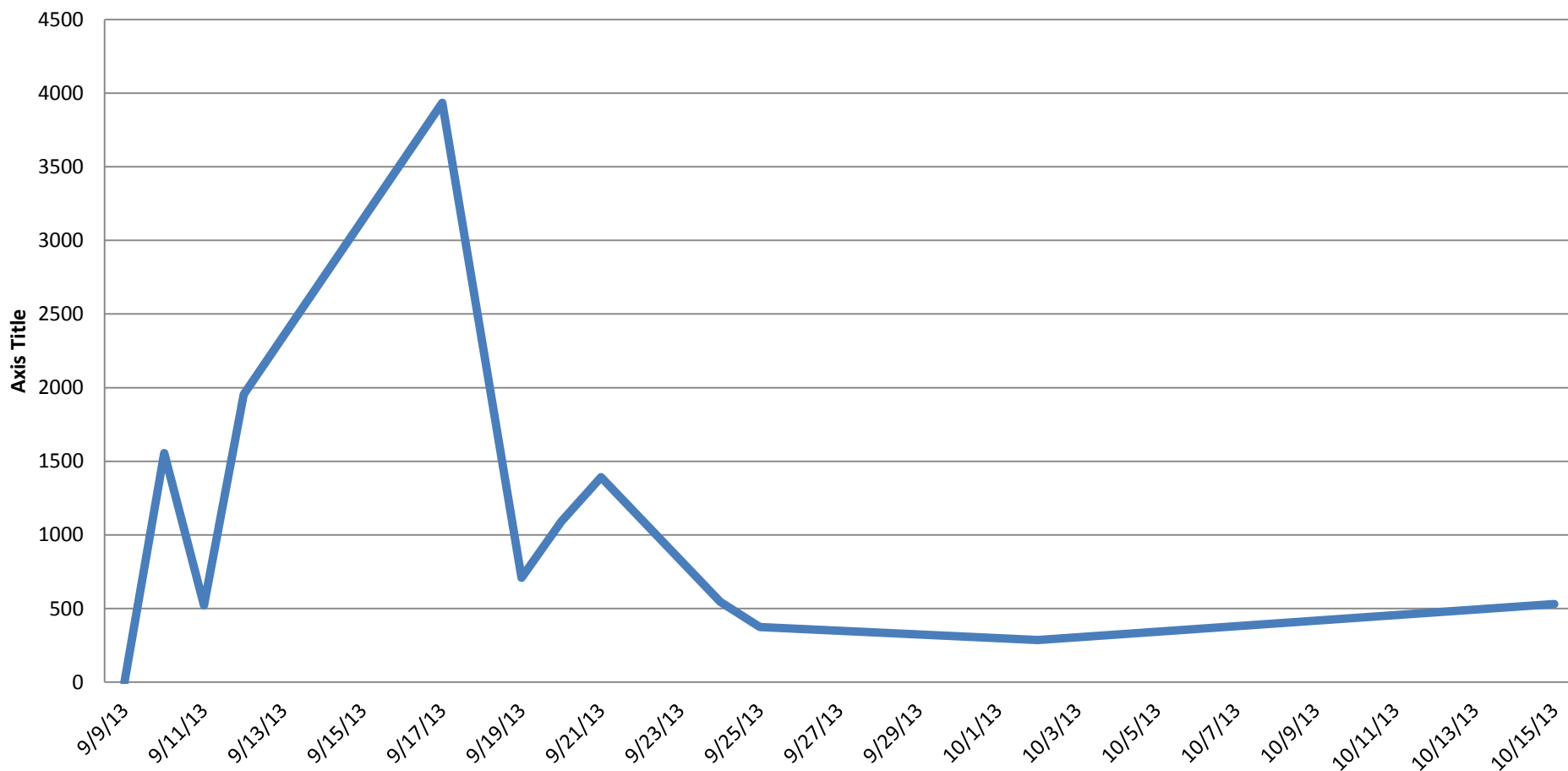
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# Studies of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål), in New York State 2016

## Combined Seasonal Trap Captures Using Pheromone and Pheromone + Light



( September – 15 October: Total BMSB = 12,894

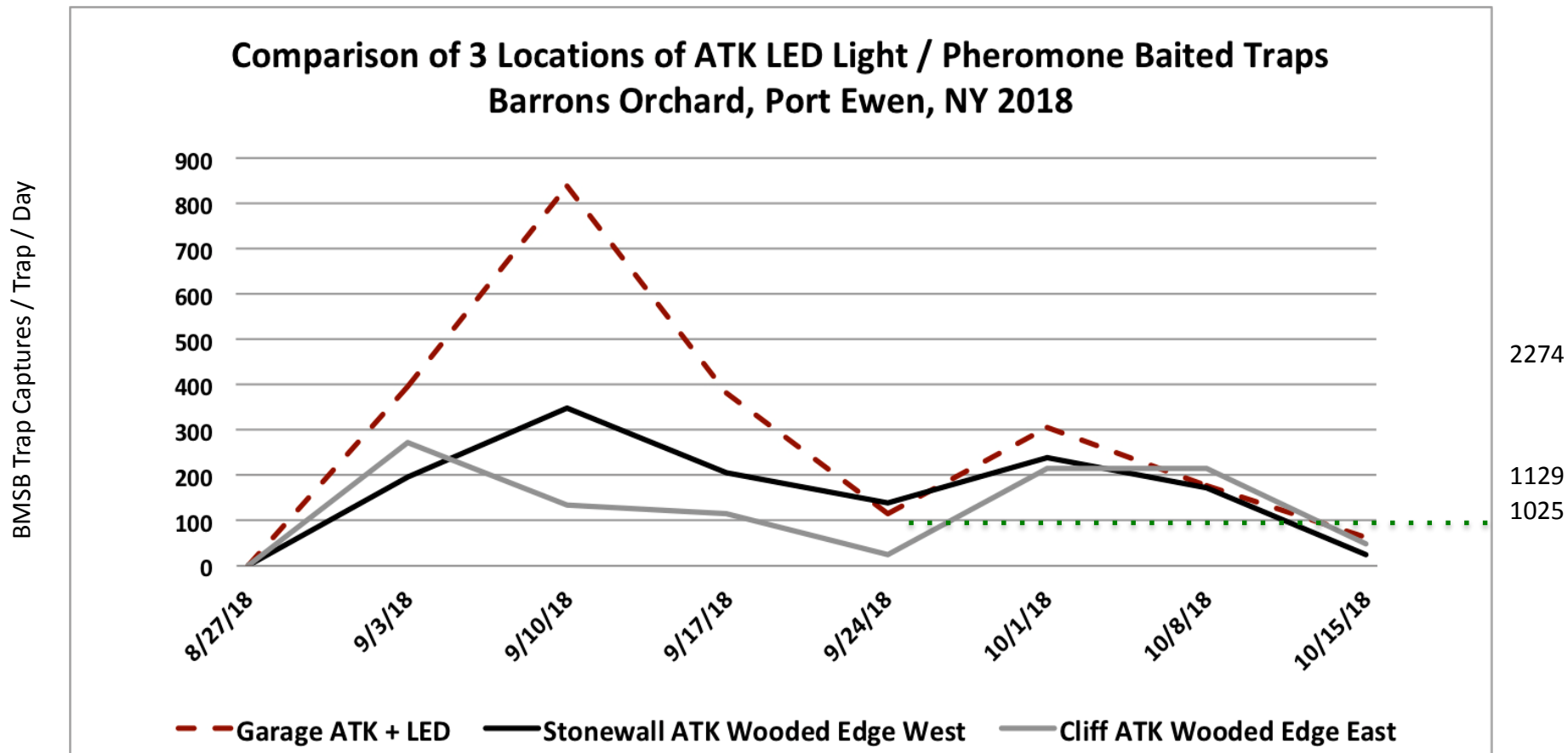


# Monitoring *the* Stink Bug Complex Using Free Standing Solar LED ATK + Phermone





# Attract & Kill of the Stink Bug Complex To Reduce BMSB Populations Along the Orchard Edge

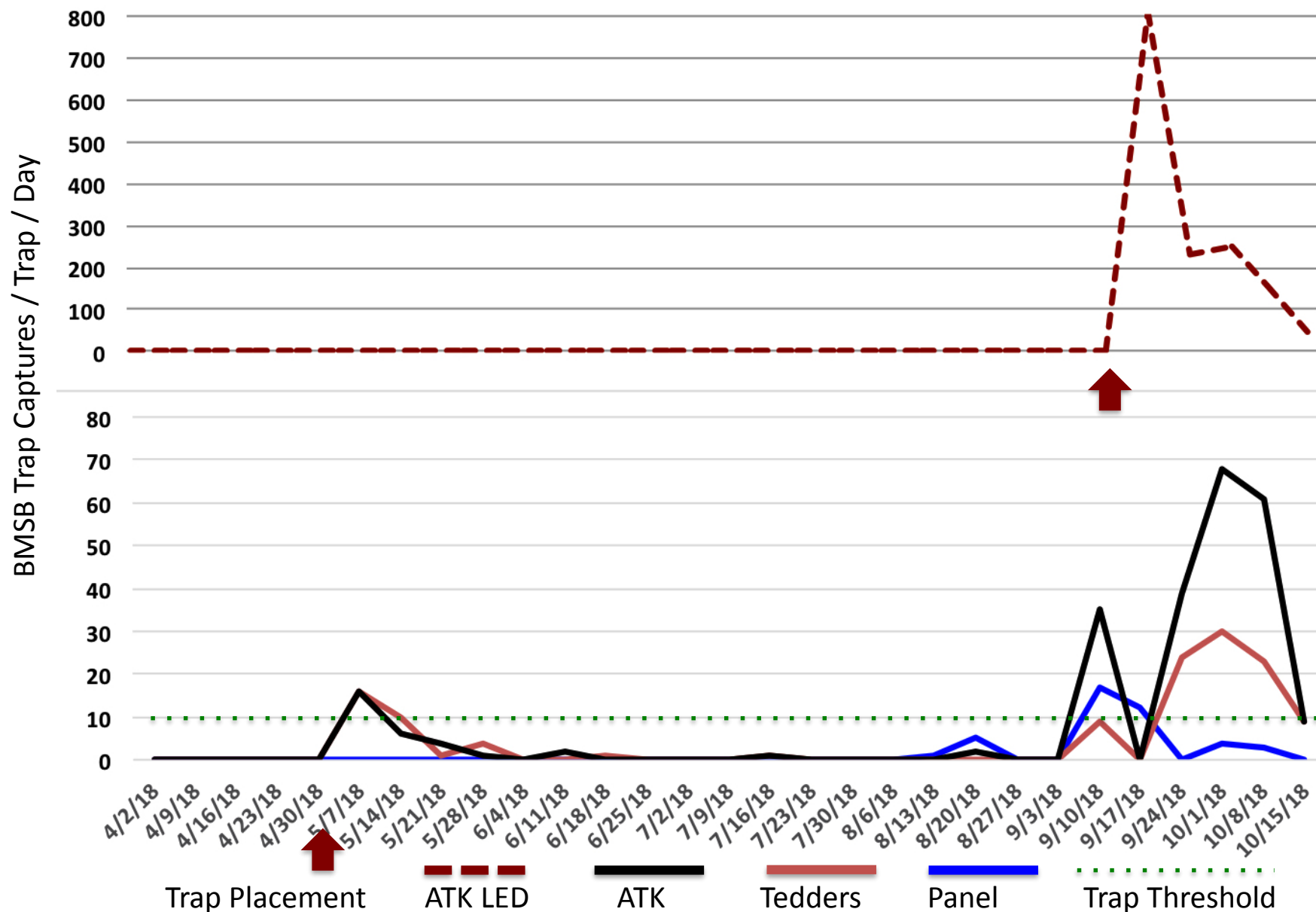


Including Solar LED auto-on with ATK / pher. increases BMSB captures





# Comparison of 4 BMSB Pheromone Baited Traps Hepworth's Organic Vegetable, Marlboro, NY 2018





# ***Redistribution of Samurai Wasp, Trissolcus japonicus (Ashmead) In NYS***



- Samurai wasp, *Trissolcus japonicus*, is an egg parasitoid of the BMSB
- Lays 1 egg into each BMSB egg
- Wasp larva feed on BMSB nymph
- Adult wasp emerges from BMSB eggs
- Can have 5 generations / year





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**Live along the wooded edge of Ag.  
Resides in BMSB deciduous tree hosts  
Limited exposure to insecticides**





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





# *Trissolcus japonicus*

## Field Recovery Sites in the US



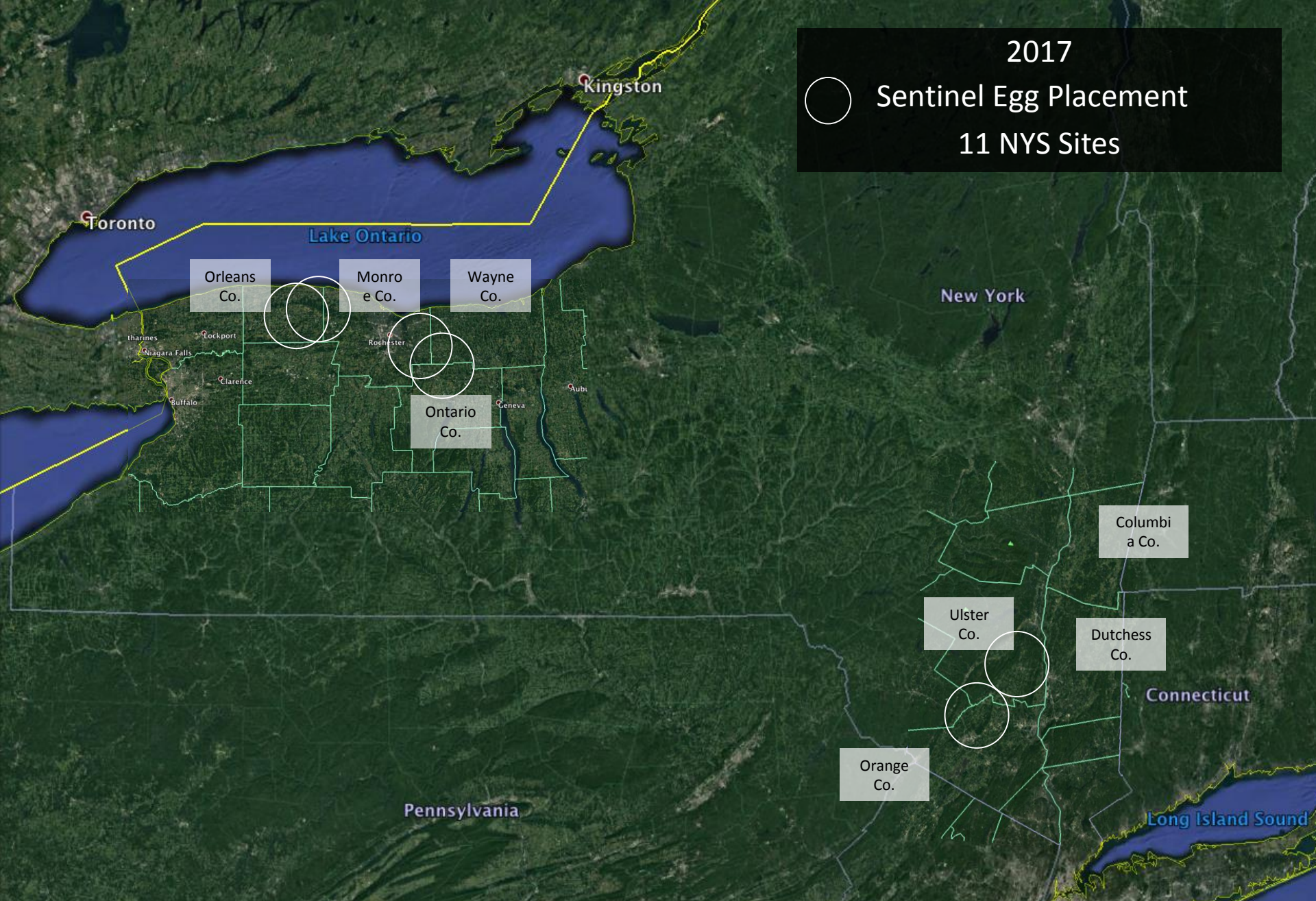
- In 2014 **adventive** populations (wild) of *T. japonicus* were found in Beltsville, MD using sentinel BMSB eggs

(Talamas EJ, Herlihy MV, Dieckhoff C, Hoelmer KA, Buffington ML, Bon M-C, Weber DC (2015) *Trissolcus japonicus* (Ashmead) emerges in North America. Journal of Hymenoptera Research 43: 119-128. <https://doi.org/10.3897/JHR.43.4661>)

- In 2015 *T. japonicus* were found in Vancouver, WA, Washington DC and Winchester, VA,.
- In 2016, *T. japonicus* was also found in WV, MD, NJ and NY in the East, and OR in the West.







2017  
○ Sentinel Egg Placement  
11 NYS Sites





# NYS DEC Liberation of Wildlife Permit (July 2017)

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 concluded 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 threatened species are identified in 6 NYCRR Part 182, and listed **invasive species are identified in 6 NYCRR Part 575.**

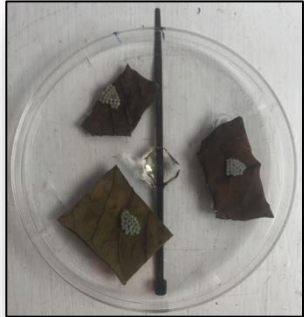
**DEC has recently concluded that their statutory and regulatory framework around the Liberation of Wildlife Permit regulating release of biologicals such as insects does not generally apply to releasing insects into the wild, so long as the proposed release is not of an insect that is listed on either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





# 2017 Parasitized Egg Parasitoid Release 'Redistribution'



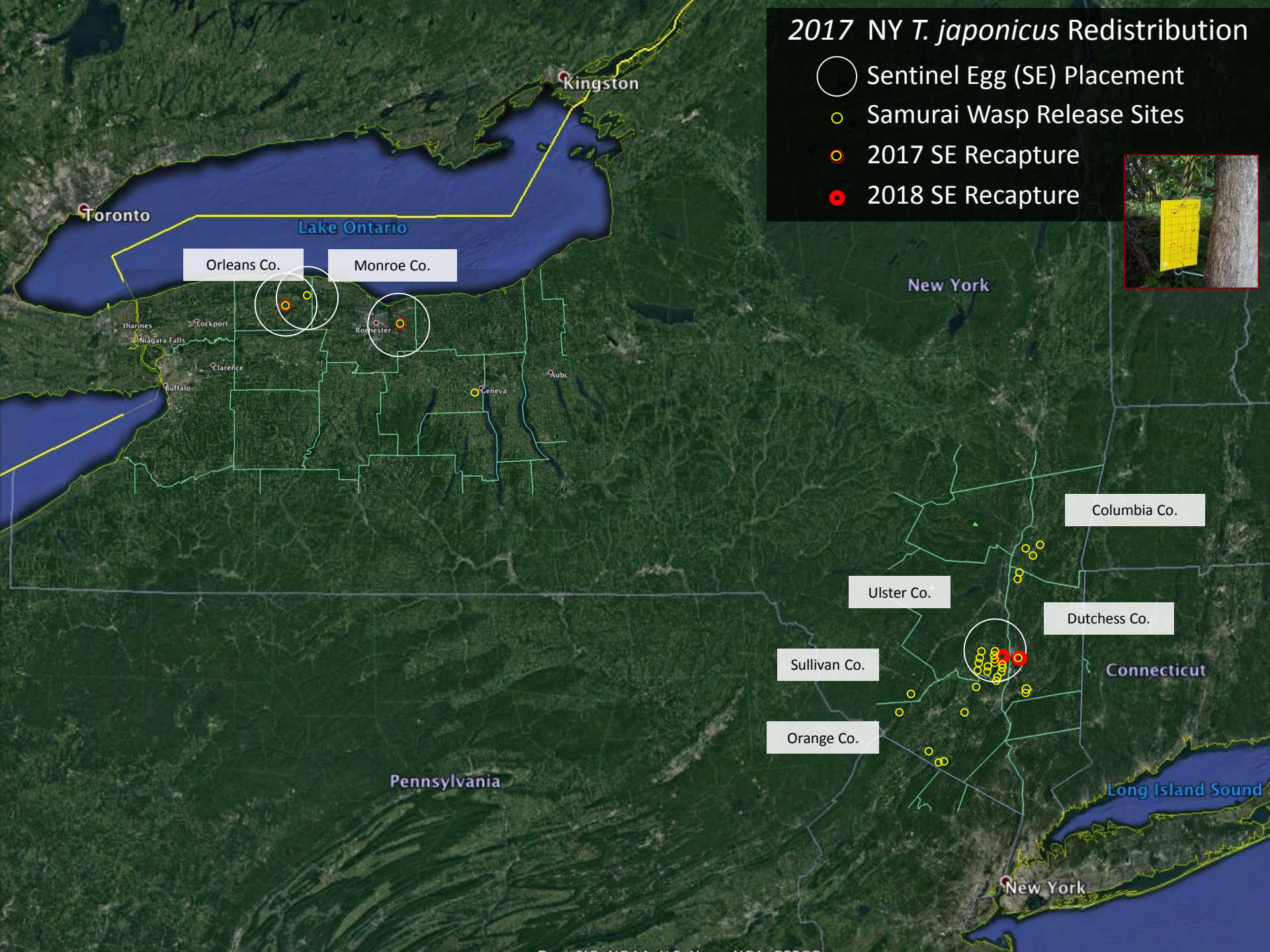
- Marlboro *T. japonicus* used to develop colony and parasitize -80°C BMSB eggs.
- Fixed parasitized eggs to petri dish lid added zip tie for RT mailing and emergence.
- Parasitized eggs sent to cooperators on **15<sup>th</sup> September**.
- Parasitized eggs placed on 32 sites of 25 farms in 5 NY counties.





# 2017 NY *T. japonicus* Redistribution

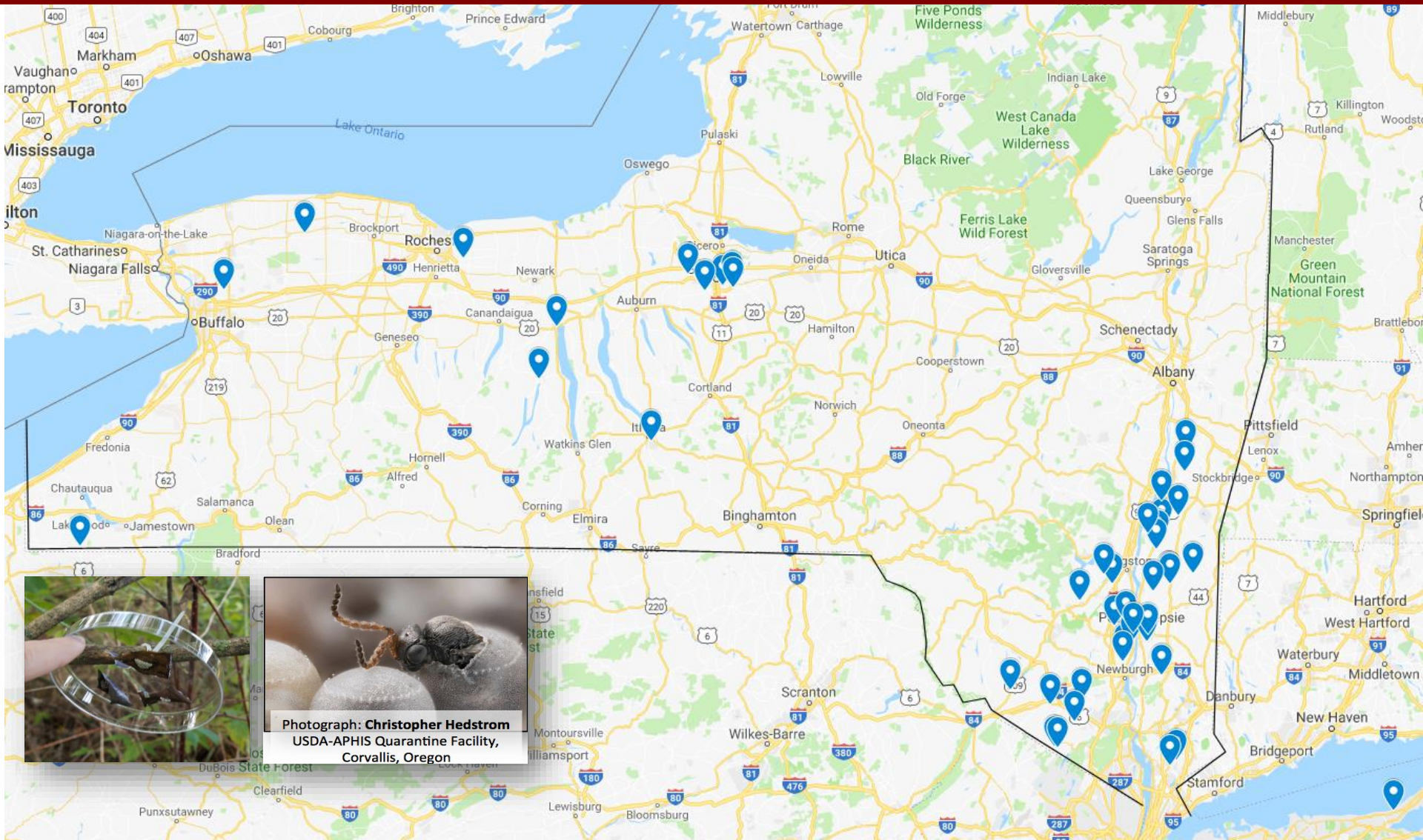
- Sentinel Egg (SE) Placement
- Samurai Wasp Release Sites
- 2017 SE Recapture
- 2018 SE Recapture





# Samurai Wasp Redistribution Sites 2017-2018

## Citizen Science (N=29), Agricultural (N=34)





# Drape Net Insect Exclusion Study

## Stink Bug Exclusion





# Drape Net Insect Exclusion Study

## Stink Bug Exclusion





South Half						
ROW	2	4	6	8	10	12
REP I	REP II	REP III	REP IV	REP V	REP VI	
1	5	1	3	10	7	8
2	7	8	2	4	9	10
3	1	9	1	9	3	4
4	4	6	4	7	4	6
5	9	5	6	5	6	1
Cross Drive						
6	6	2	7	1	8	9
7	10	7	8	6	1	7
8	3	4	9	8	10	5
9	8	10	5	3	2	3
10	2	3	10	2	5	2
REP I	REP II	REP III	REP IV	REP V	REP VI	
ROW	2	4	6	8	10	12
North Half						

#### Varieties

- 1 (Winecrisp) PRISTINE
- 2 (Pixie Crunch) RED-FREE
- 3 (Topaz) NOVAMAC
- 4 NOVA EASYGRO
- 5 HONEYCRISP
- 6 CRIMSON CRISP
- 7 LIBERTY
- 8 SCARLET O'HARA
- 9 FLORINA QUERINA
- 10 ENTERPRISE
- 11 GOLDRUSH

## Hudson Valley Research Lab

- Scab Resistant Block
- 11 Varieties on G.11
  - 2018 Drape Net Study
  - Insect Exclusion





# Drape Net Insect Exclusion Study

## Samurai Wasp Conservation

Results of 2018 Insecticide and Acaricide Studies in Eastern New York. Jentsch et. al.

**Table 1** Management of the Apple Insect Complex Using 'Drape Net' IPM / Organic Split and Season Long IPM Management .  
Hudson Valley Research Laboratory, Highland, NY - 2018

Net Type Treatment / Rate	Incidence (%) of insect damaged cluster fruit											
	PC	EAS	TPB	Lf.Rlr	Int. Lep	Ext.Lep	CM	AM.P	AM.T	SJS	SB	Clean
1. Black Drape Early Season IPM	3.0 a	0.6 a	4.4 a	10.9 bc	2.2 b	18.8 b	11.3b	0.6 b	0.6 b	96.3 a	0.3 b	1.3 c
2. White Drape Early Season IPM	4.7 a	0.0 a	4.4 a	11.9 b	3.1 b	20.3 b	12.5 b	0.9 b	0.9 b	95.6 a	0.9 b	0.6 c
3. No Drape Early Season IPM	10.8 a	0.8 a	4.6 a	22.9 a	6.7 a	37.1 a	23.8 a	7.5 a	4.2a	83.8 b	3.8 a	1.3 c
4. Black Drape Season Long IPM	5.6 a	1.3 a	7.8 a	0.3 d	0.0 c	1.6 c	0.3 c	0.0 bc	0.0 b	6.6 d	0.0 b	82.5 a
5. White Drape Season Long IPM	7.8 a	0.9 a	7.8 a	0.3 d	0.0 c	0.6 c	0.0 c	0.3 b c	0.3 b	20.0 c	0.0 b	65.9 b
6. No Drape Season Long IPM	5.6 a	0.9 a	5.0 a	0.6 cd	0.3 c	1.3 c	0.0 c	0.6 b c	0.3 b	6.3 d	0.9 b	81.3 a
P value	0.2062	0.6565	0.5998	0.0001	0.0001	0.0001	0.0001	0.0001	0.0135	0.0001	0.0154	0.0001

<sup>a</sup> Evaluation made on 'Crimson Crisp, Honey Crisp & Gold Rush cultivars harvested on 29 September. Data were transformed using arcsine(sqrt(x)) prior to ANOVA ( $P \leq 0.05$ ). Means separation by Fisher Protected ( $P \leq 0.05$ ); treatment means followed by the same letter are not significantly different. Arithmetic means reported.

