Developing Behaviorally Based Monitoring and Management Tools for the Invasive Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål)

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Key Components of Trap-Based Monitoring Tools

- Visual Stimuli
- Olfactory Stimuli
- Capture Mechanism
- Deployment Strategy

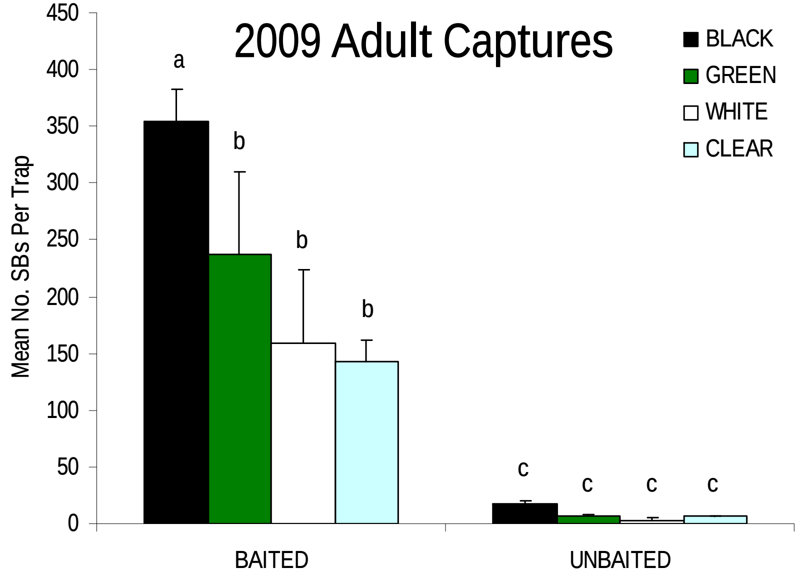
20009-2010 BMSB Response to Visual Stimuli

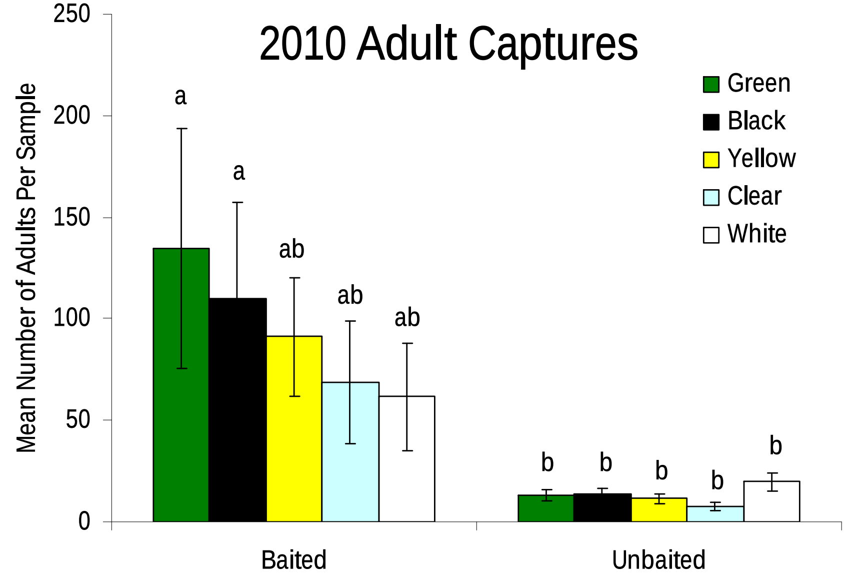
Black | Green | Yellow | White | Clear

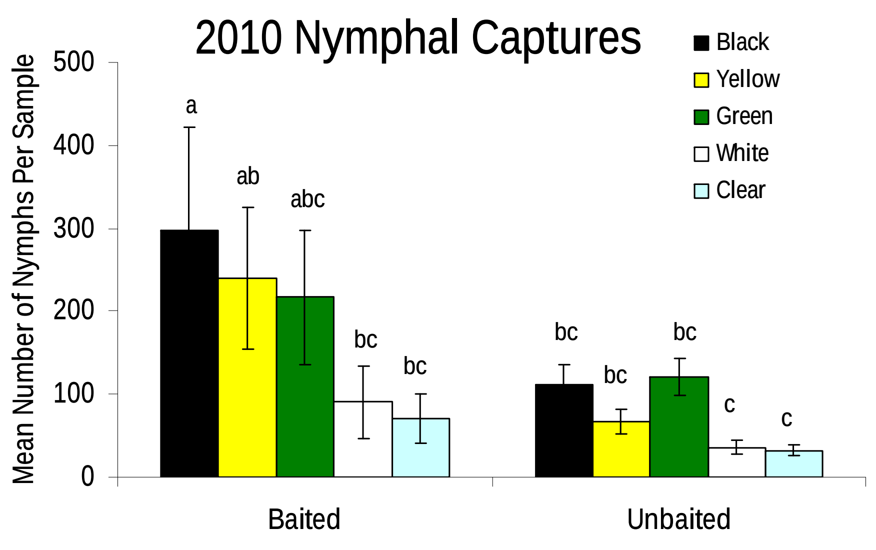
Trunk Mimic | Foliar Stimulus | Foliar Stimulus | Unapparent Stimulus | Unapparent Stimulus

- Responses to visual stimuli associated with trap bases.
- Baited and unbaited traps at the periphery of orchards. Four replicates. Sampled twice weekly.
- Captures from October 7-November 17, 2009 and July 23-October 14, 2010.

Adult and Nymphal Captures







Monitoring Adult and Nymphal Populations


- In preliminary study, presence of ear tag increased captures by 250%.
- Added ¼ piece of cattle ear tag (Double Barrel, 68% lambda-cyhalothrin and 14% pirimiphos-methyl) to reduce escape.

- <u>Visual Stimulus</u>
  - Large black pyramid
- <u>Olfactory Stimulus</u>
  - methyl (2E,4E,6Z)-decatrienoate
- <u>Capture Mechanism</u>
  - Tapered pyramid to inverted funnel jar with DDVP toxicant strip
- <u>Deployment Strategy</u>
  - Traps placed in peripheral row of orchard

Pheromone of *Plautia stali*

- Methyl (2E, 4E, 6Z)-decatrieonate.
- Cross attractive to brown marmorated stink bug and other pentatomids.

Will BMSB Respond to Methyl (2E, 4E, 6Z)-Decatrienoate early in the season?

- Reports of early-season attraction in Asia.

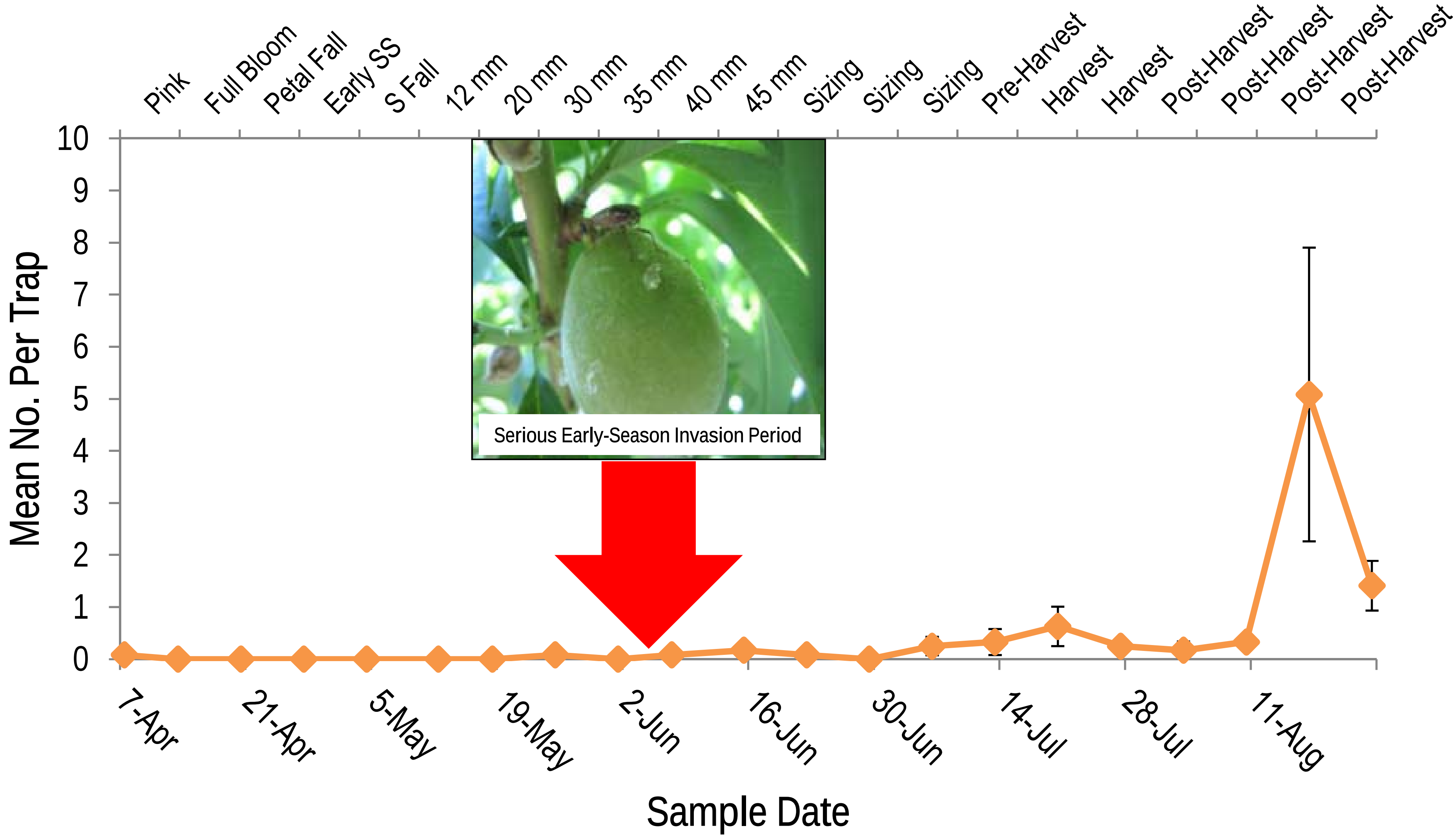
- Previous trials had relied on low doses (<5 mg).

- Evaluated 66 mg lures.

Despite Reports in the Asian Literature, Our Only Attractant Fails During the Early- and Mid-Season

Methyl (*2E,4E,6Z*)-decatrieonate (MDT) attractive to adults only during the late-season. Confirmed in MD, WV, NJ, PA, VA and other states in 2011. Not attractive to adults in early- and mid-season.

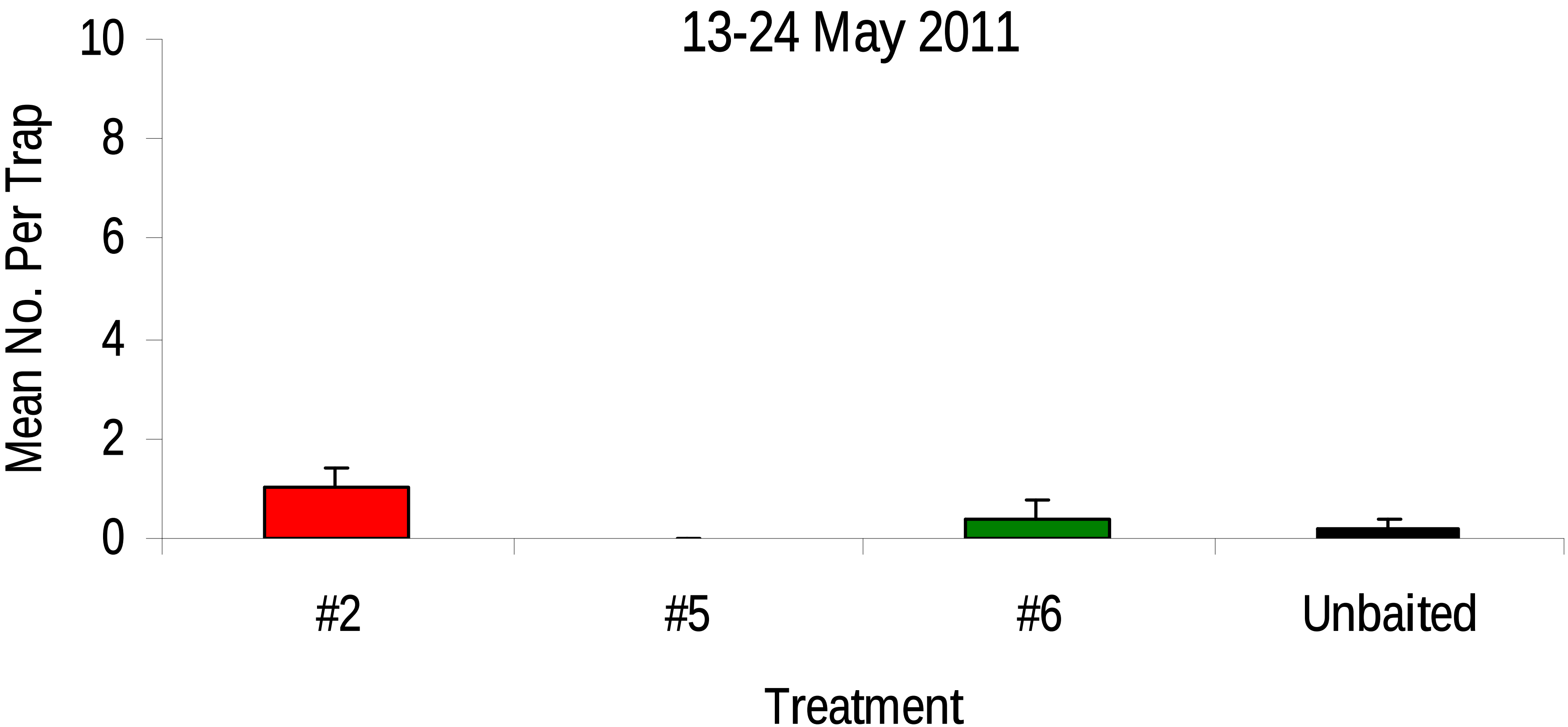
Almost No Captures in Traps Baited with MDT, Despite Very Large Immigrating Populations



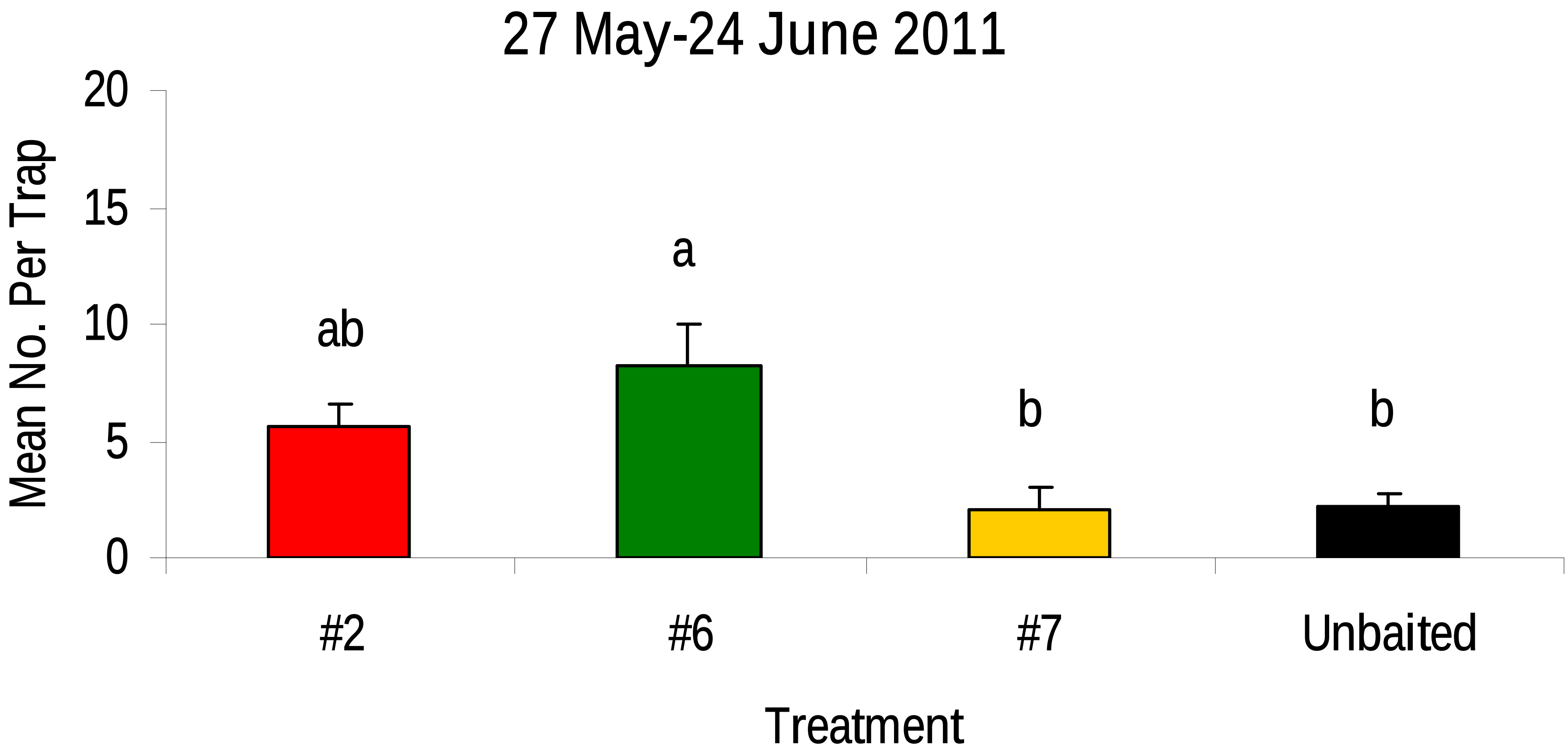
Progress Toward Identification of BMSB Aggregation Pheromone

USDA-ARS, Beltsville, MD and Kearneysville, WV

Early Season Trial Indicates Promising Activity

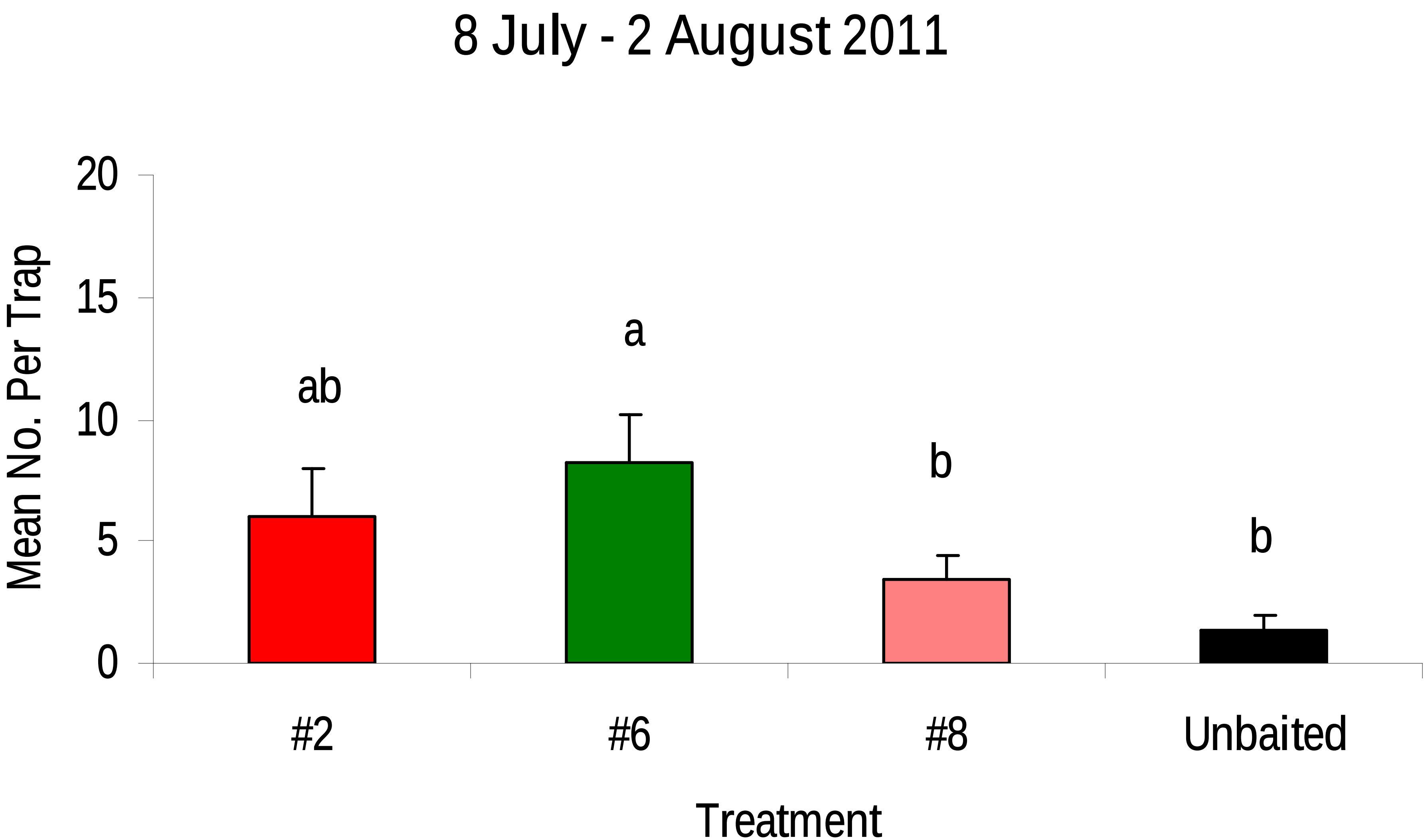


Two Treatments Show Significant Behavioral Activity



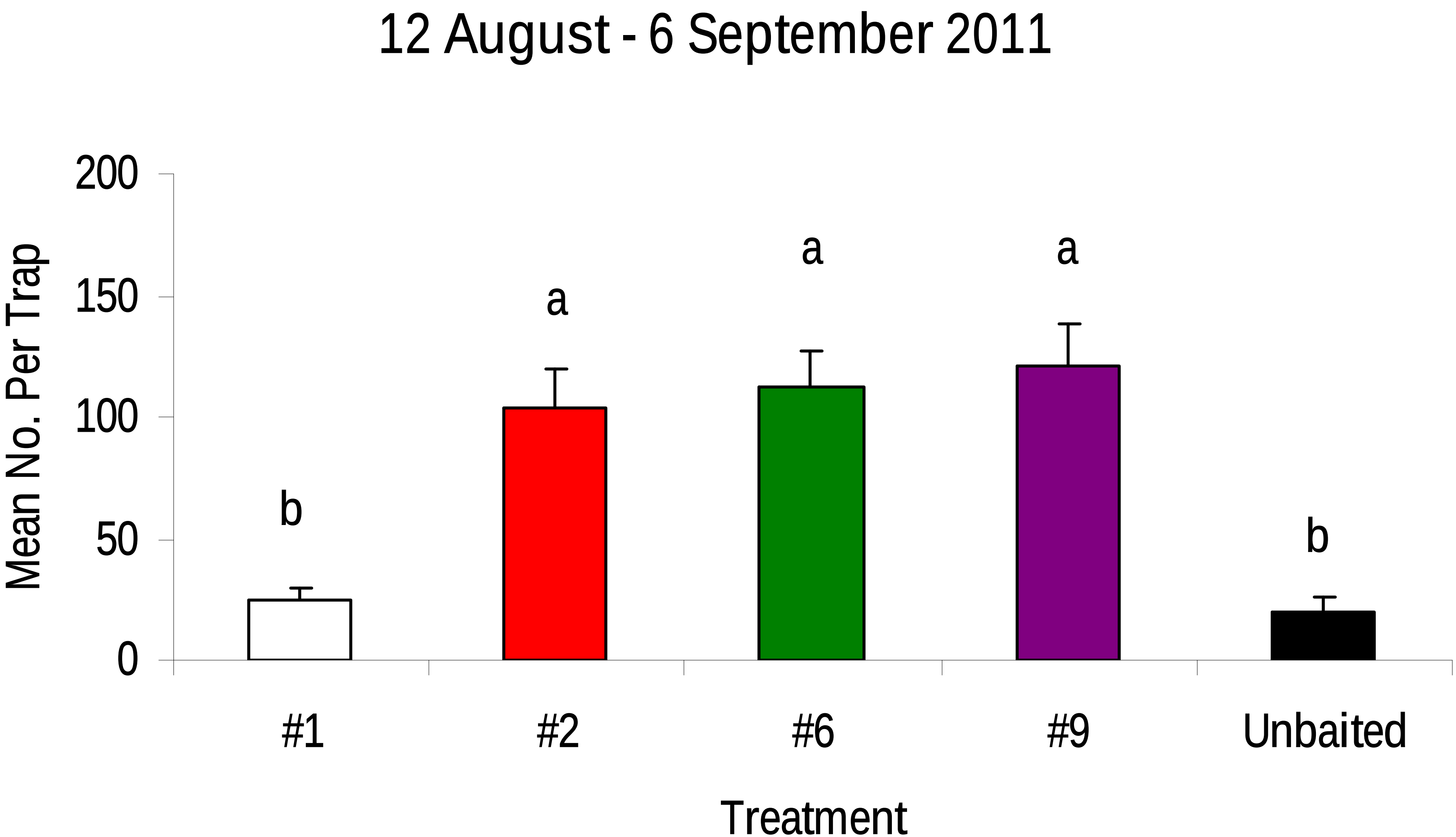
Traps baited with #6 capture ~4x more than control

#6 and #2 Continue to Demonstrate Significant Activity



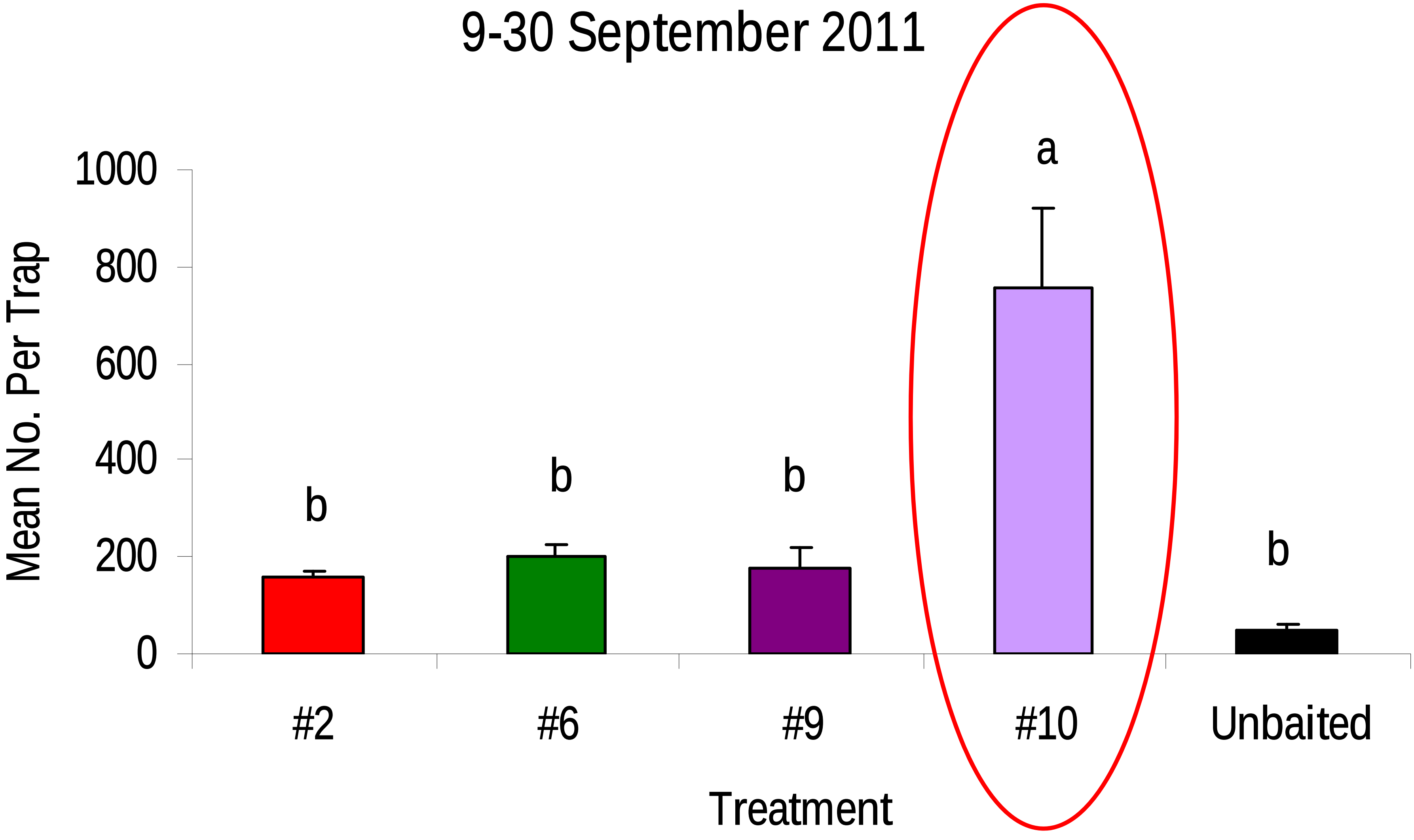
Traps baited with #6 capture ~6x more than control

Several Treatments Demonstrate Significant Activity



Traps baited with #2,6 and 9 capture ~6x more than control

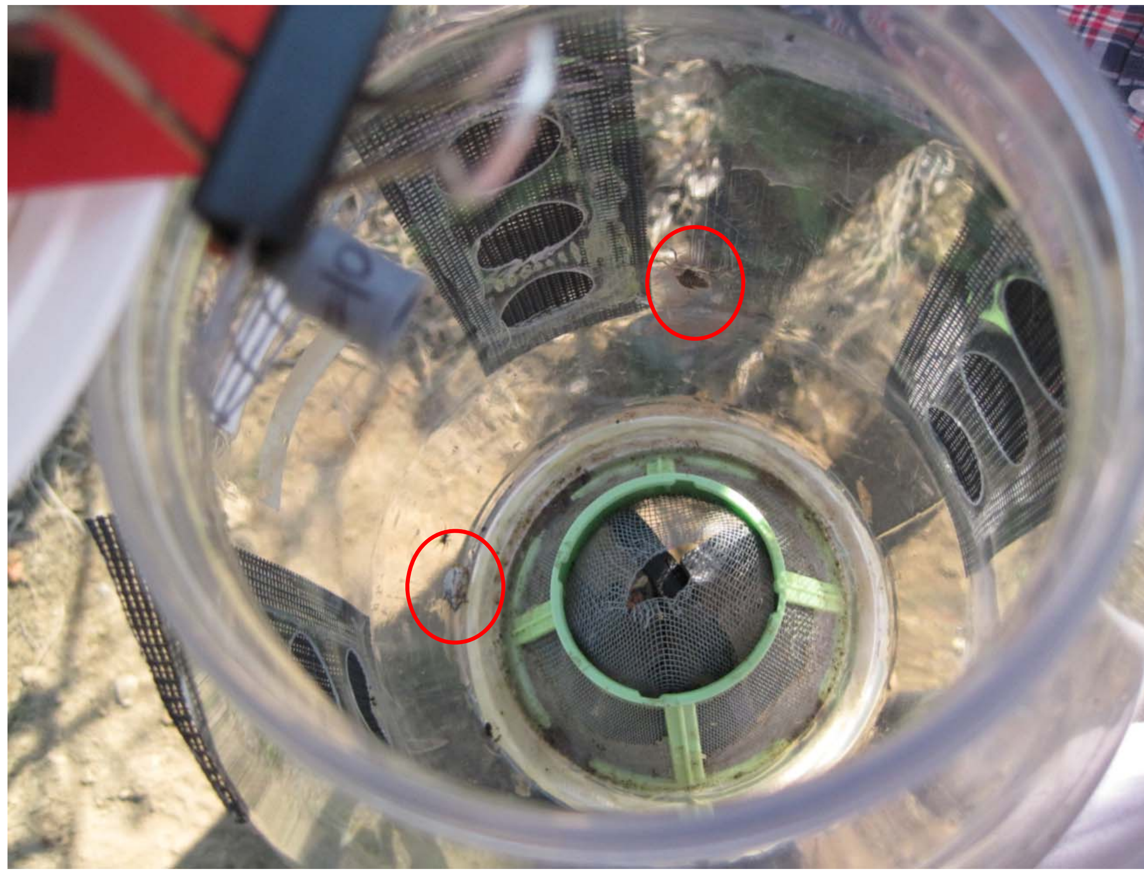
Identification of the BMSB Aggregation Pheromone



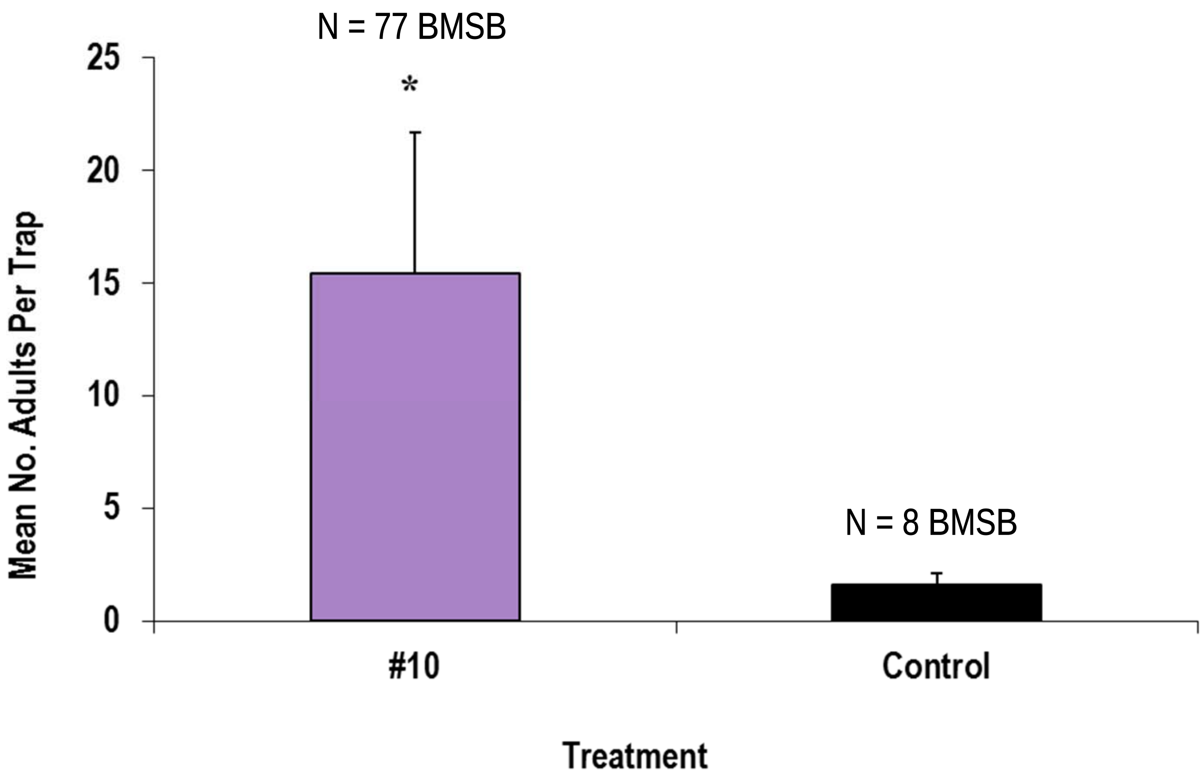
Traps baited with #10 captured ~15x more than control and ~3-4x more than other treatments.

Is #10 Attractive in the Early Season?

Pre-Trial (March 20-April 17, 2012)



Early Season Attraction Documented for BMSB March 20-April 17, 2012



Broad Validation in Multi-State Trial

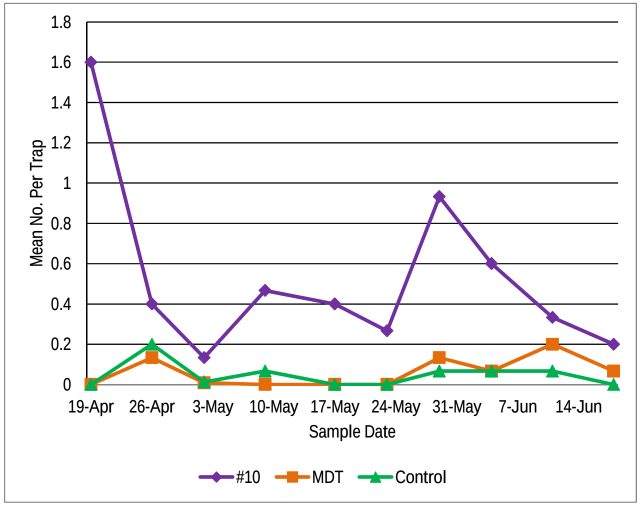
- Is BMSB attracted to #10 in the early season?
- Is BMSB attracted to #10 season-long?
- How attractive is this stimulus relative to MDT and unbaited traps?
- WV, MD, VA, PA, NJ, NY, DE, NC, OR, WA, and OH

General Protocol

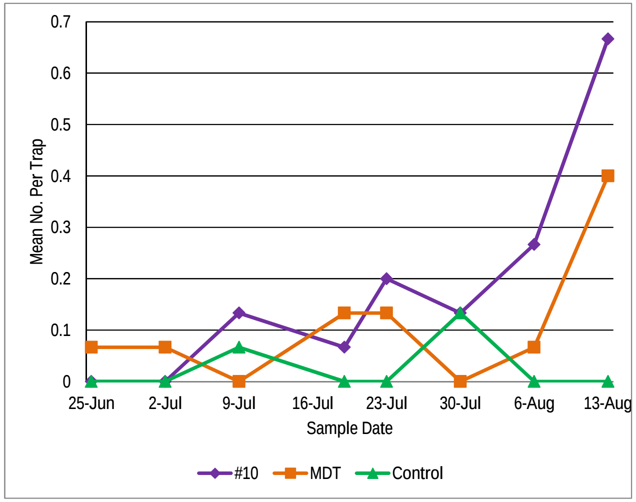
- Black pyramid traps
- Three odor treatments
  - 1) #10
  - 2) MDT
  - 3) unbaited control
- Traps are deployed between wild host habitat and agricultural production area.
- Traps were deployed in mid-April and left in place season-long.

Results From Season-Long Monitoring in Commercial Orchards

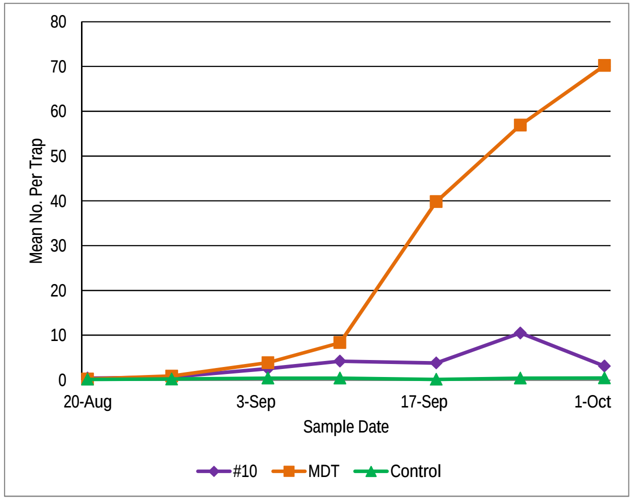
Early Season
Mid-April – Mid June



Mid-Season
Mid June - Mid August



Late Season
Mid-August – Early October

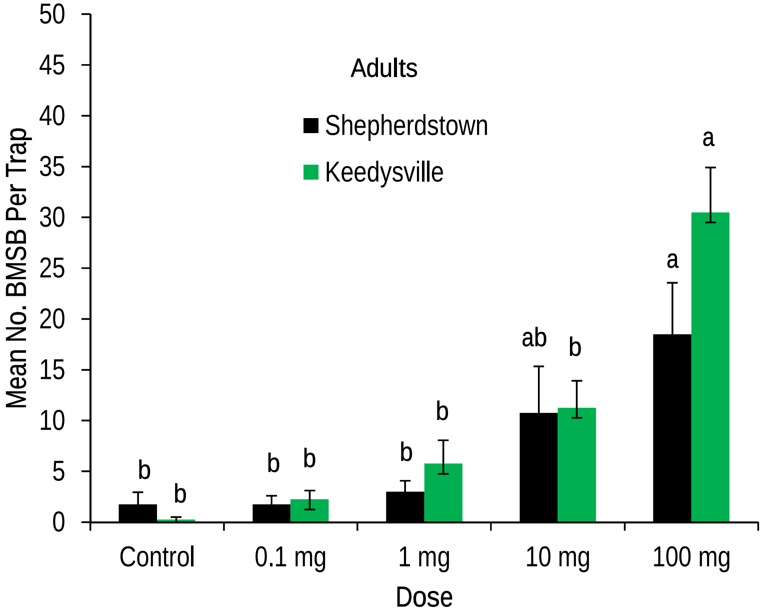


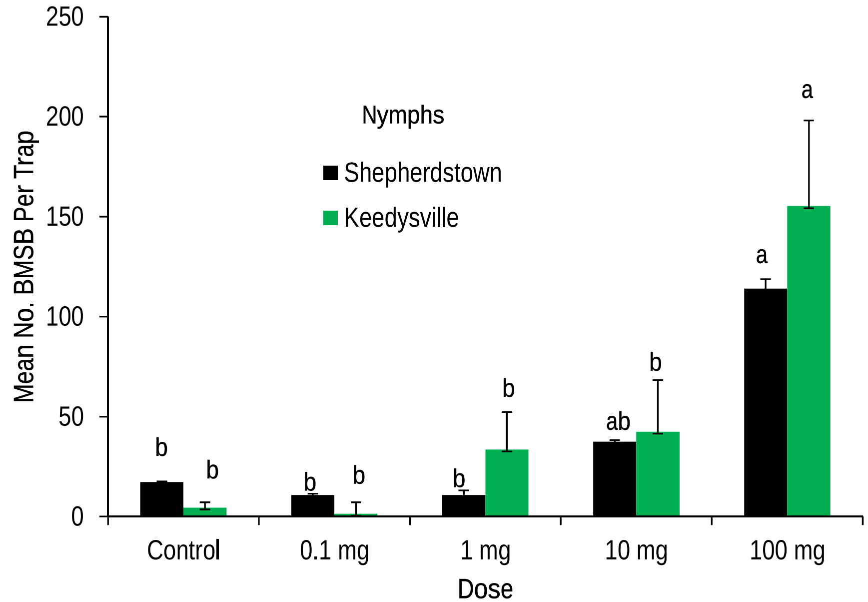
- BMSB reliably captured during early season.
- Low numbers during much of mid-season.
- MDT very attractive and #10 attractive in the late season.

Dose Response Trial

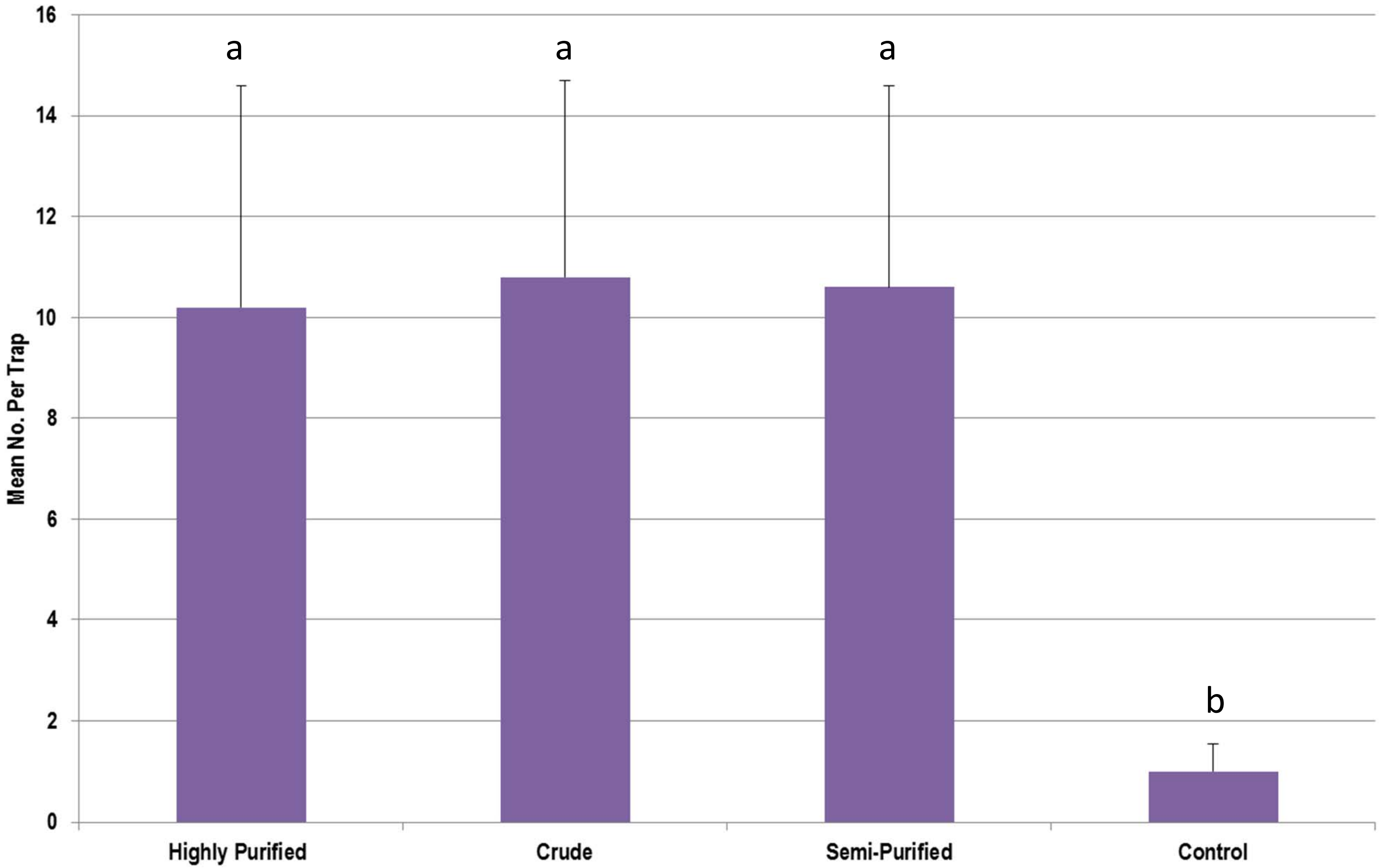
June 14-July 19, 2012

11:1 Ratio (Baited: Unbaited) for 10 mg lure
~25:1 Ratio (Baited: Unbaited) for 100 mg lure





Lure Affordability: Encouraging Results from Purity Trial



Conclusions

- Aggregation pheromone of BMSB has been identified.
- This stimulus provides reliable, season-long detection of BMSB.
- Likely will need a higher loading of material.
- Crude material can be used to formulate lures, reducing overall costs.

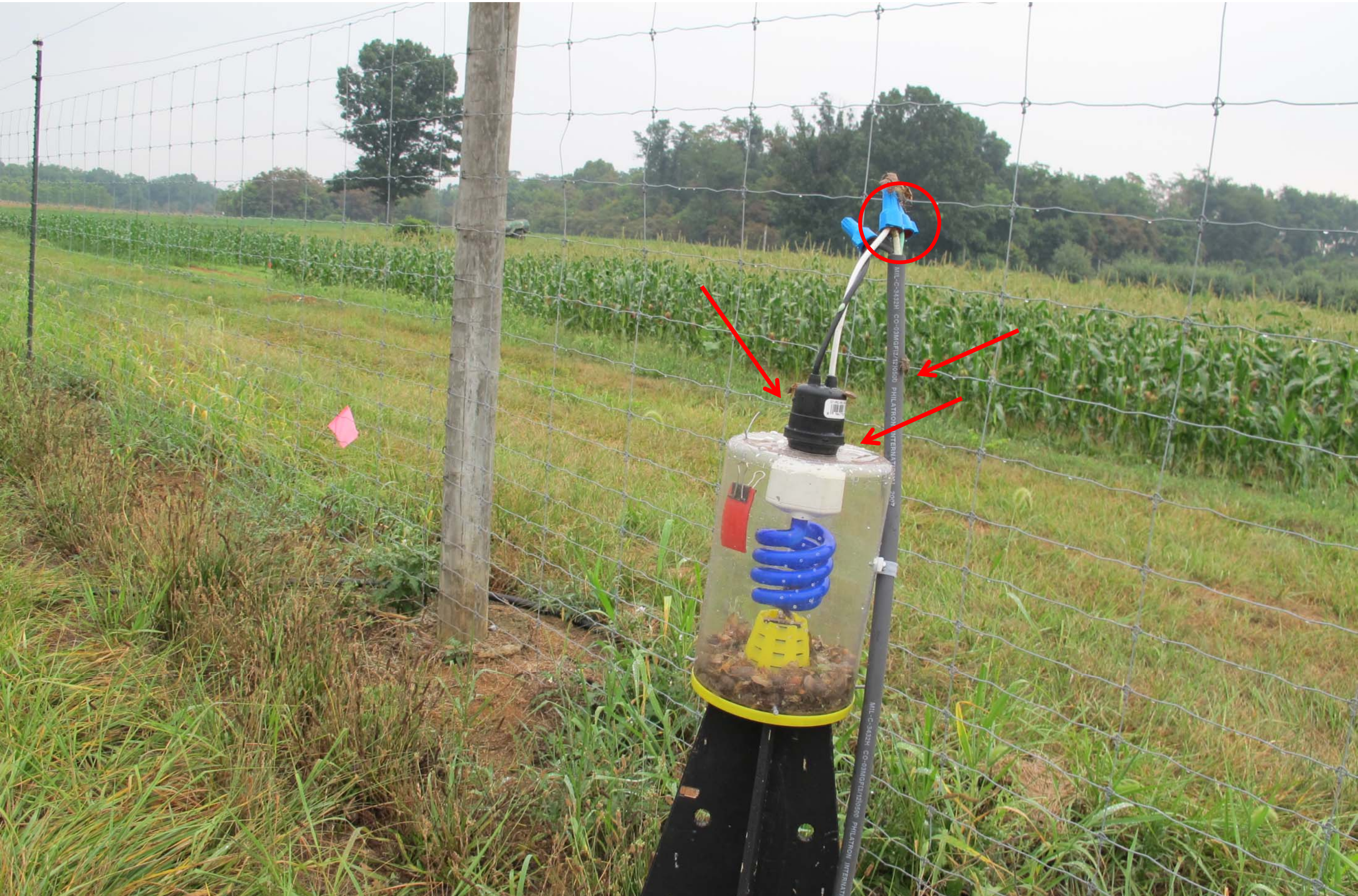
Visual Cues

Identifying Optimal Wavelengths and Intensities of Light

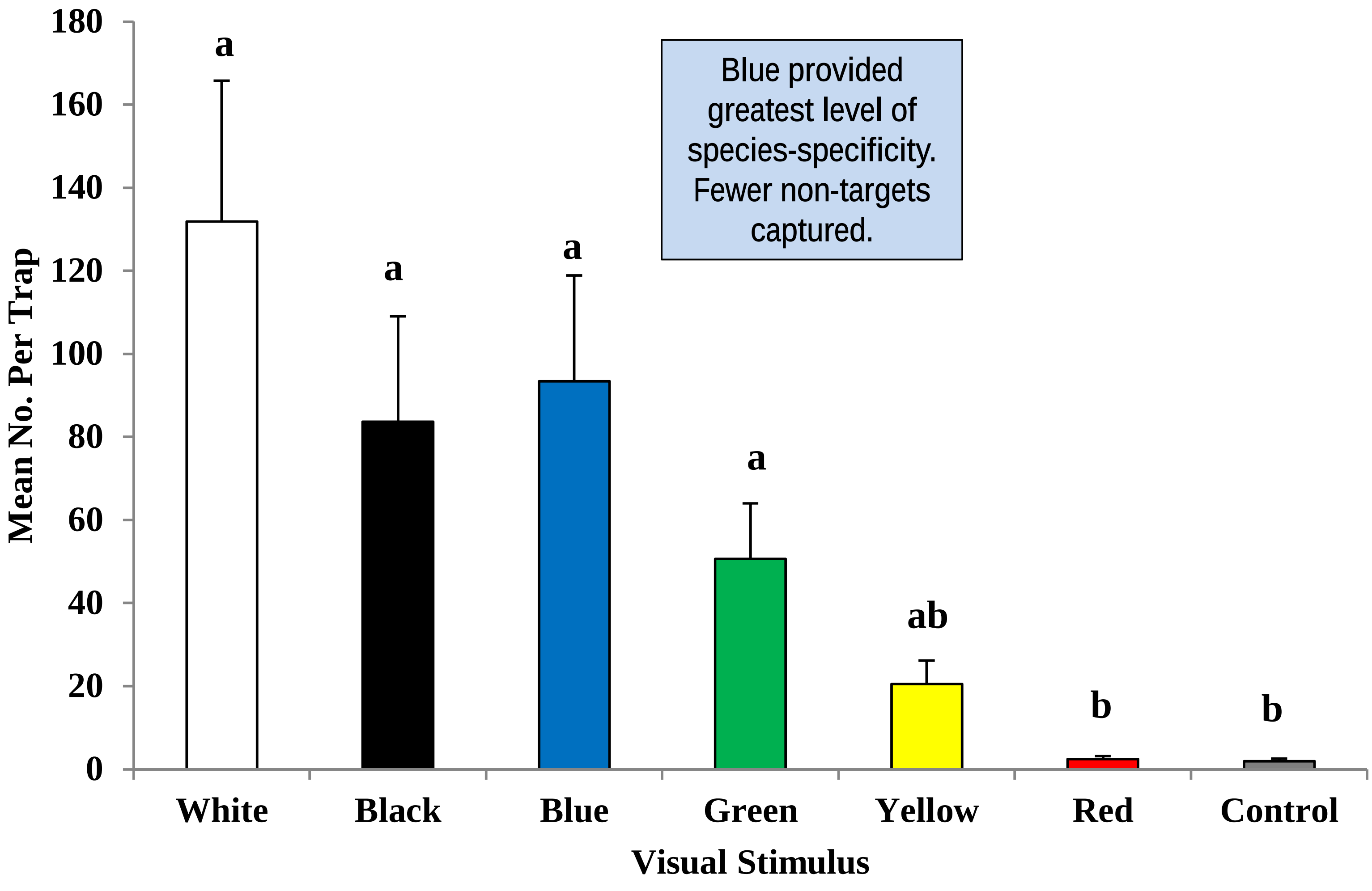
Field Trial Set-Up

Night View

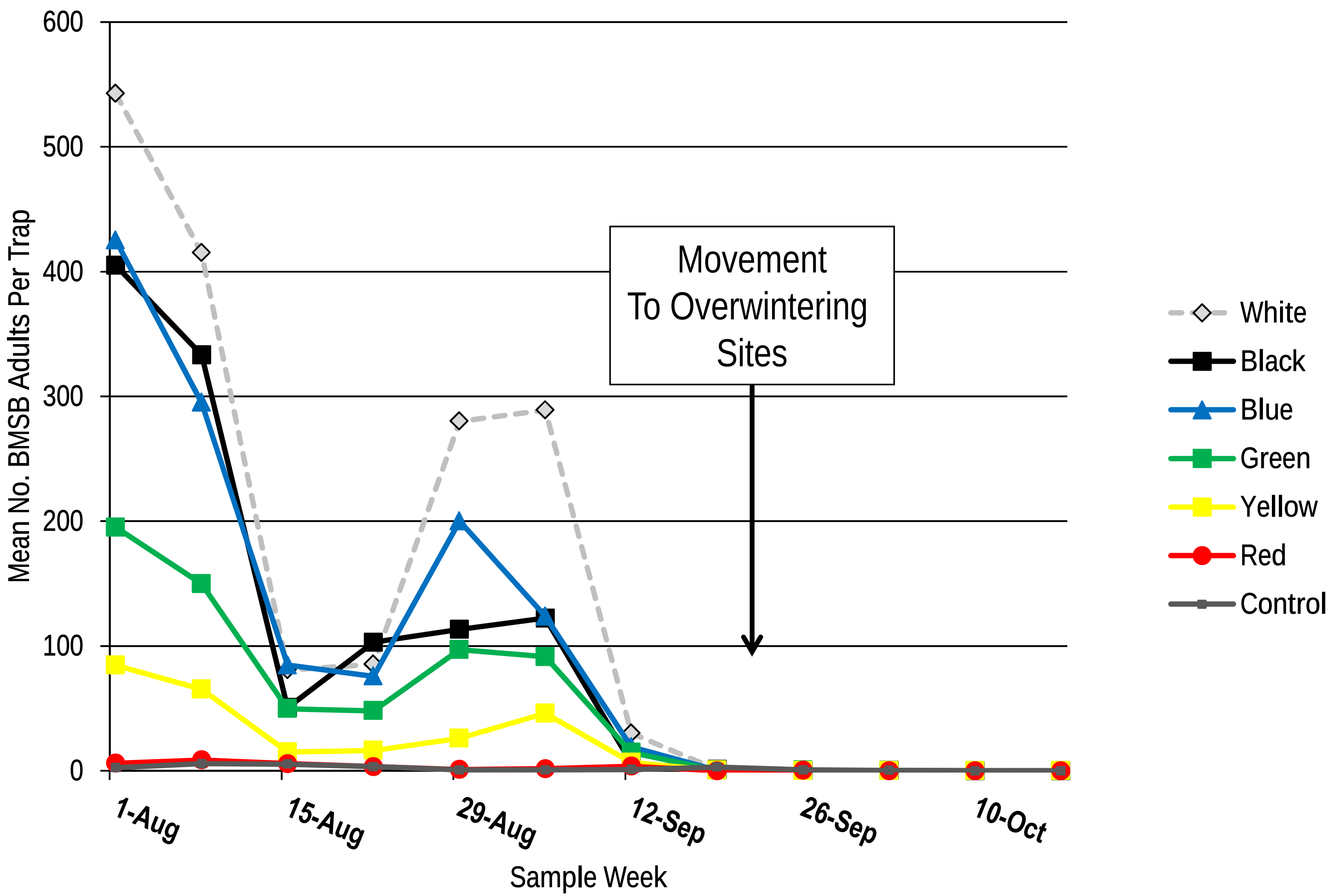
High Captures and Apparent Vicinity-Based Responders



A Total of 21 Traps Baited With Light-Based Stimuli Captured 13,457 Adult BMSB in ~6 Weeks During Late Summer

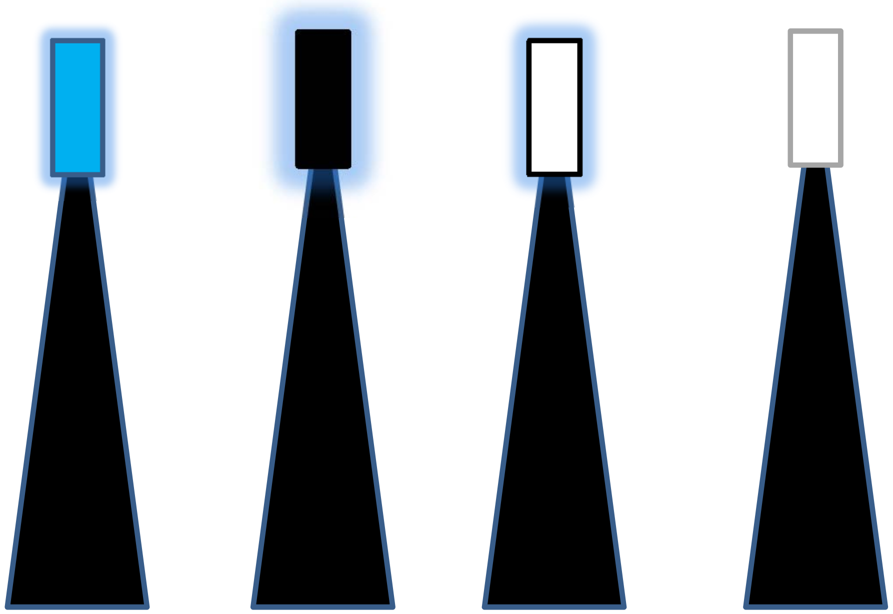


Very Large Numbers of Adults Captured and Consistent Capture Patterns Recorded Through Mid-September

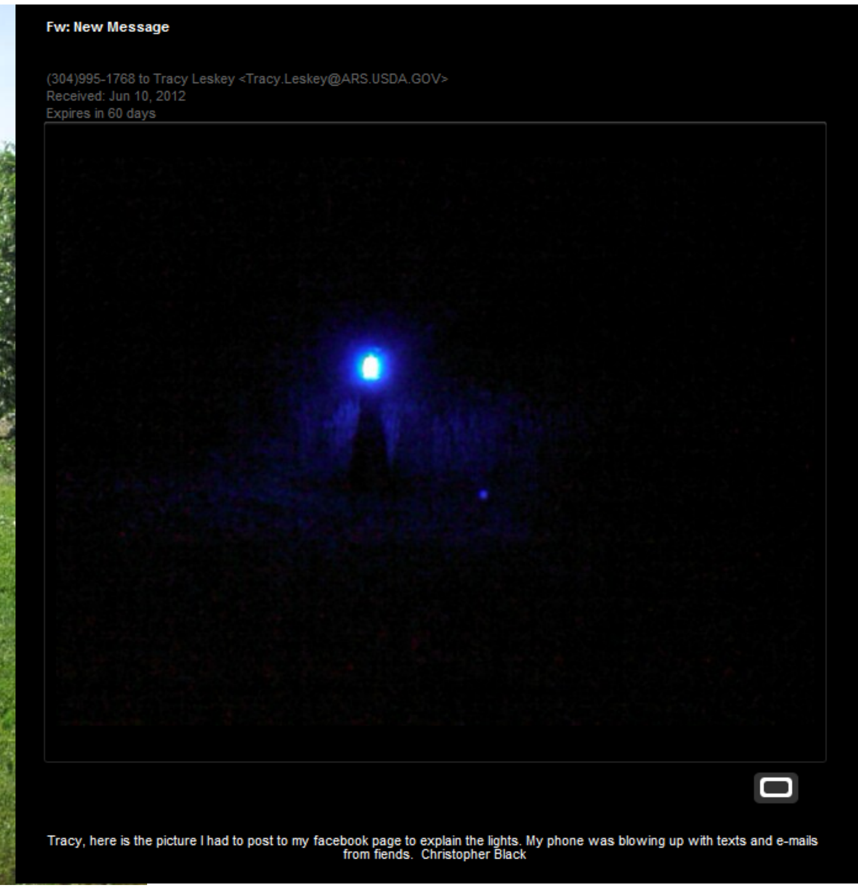


Season-Long Trial 2012

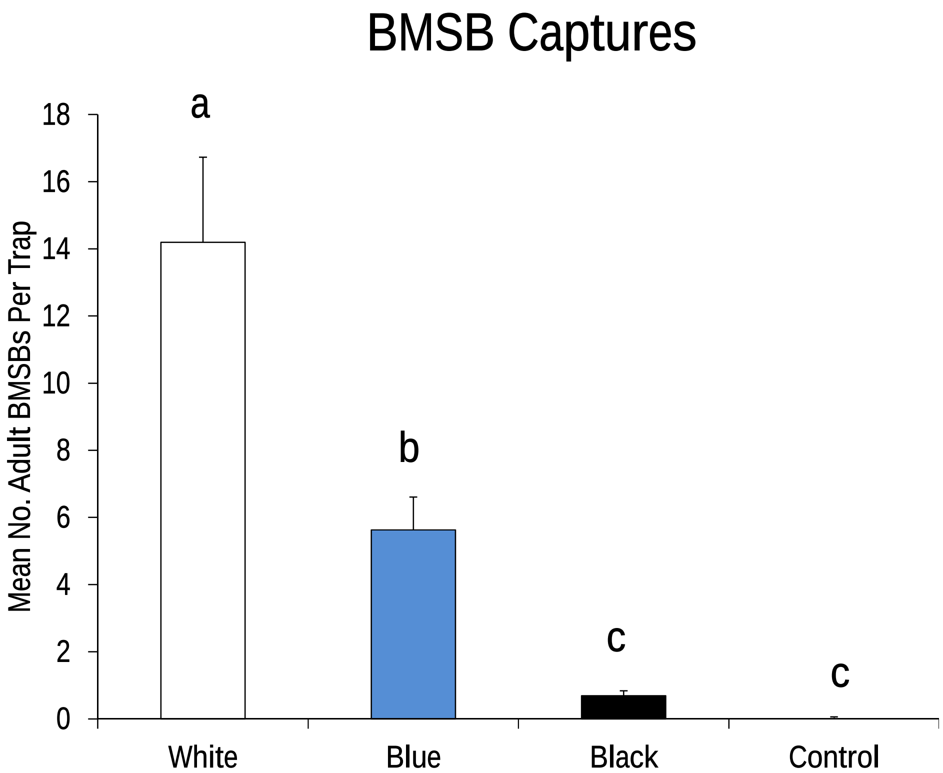
- Do we capture BMSB reliably with the most attractive stimuli?
- Species-specificity of most attractive visual stimuli?

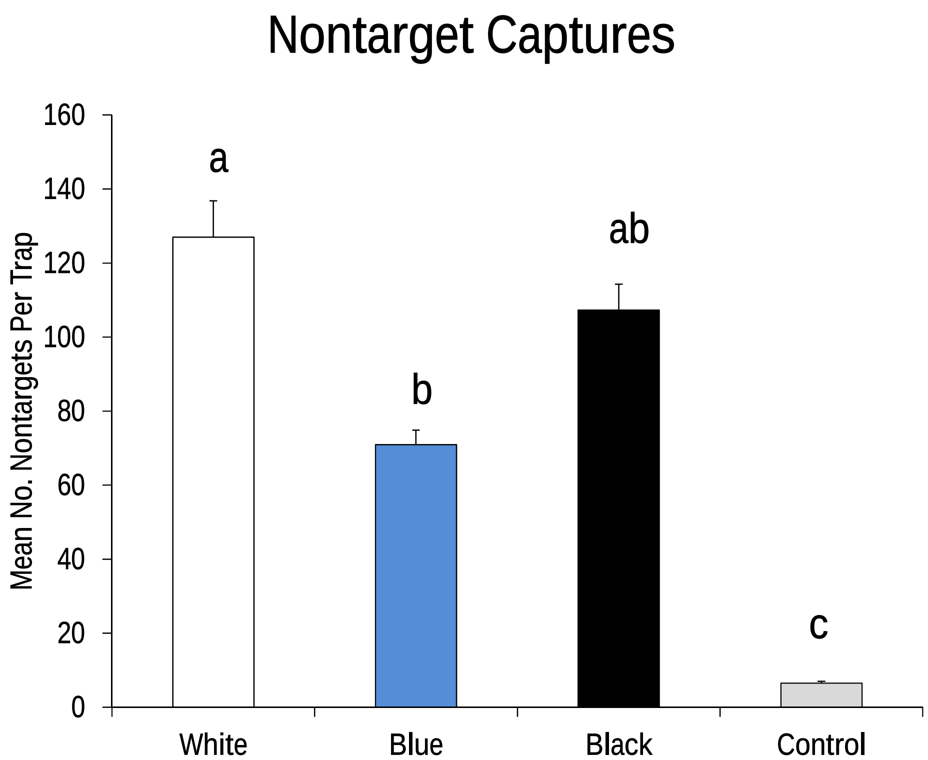


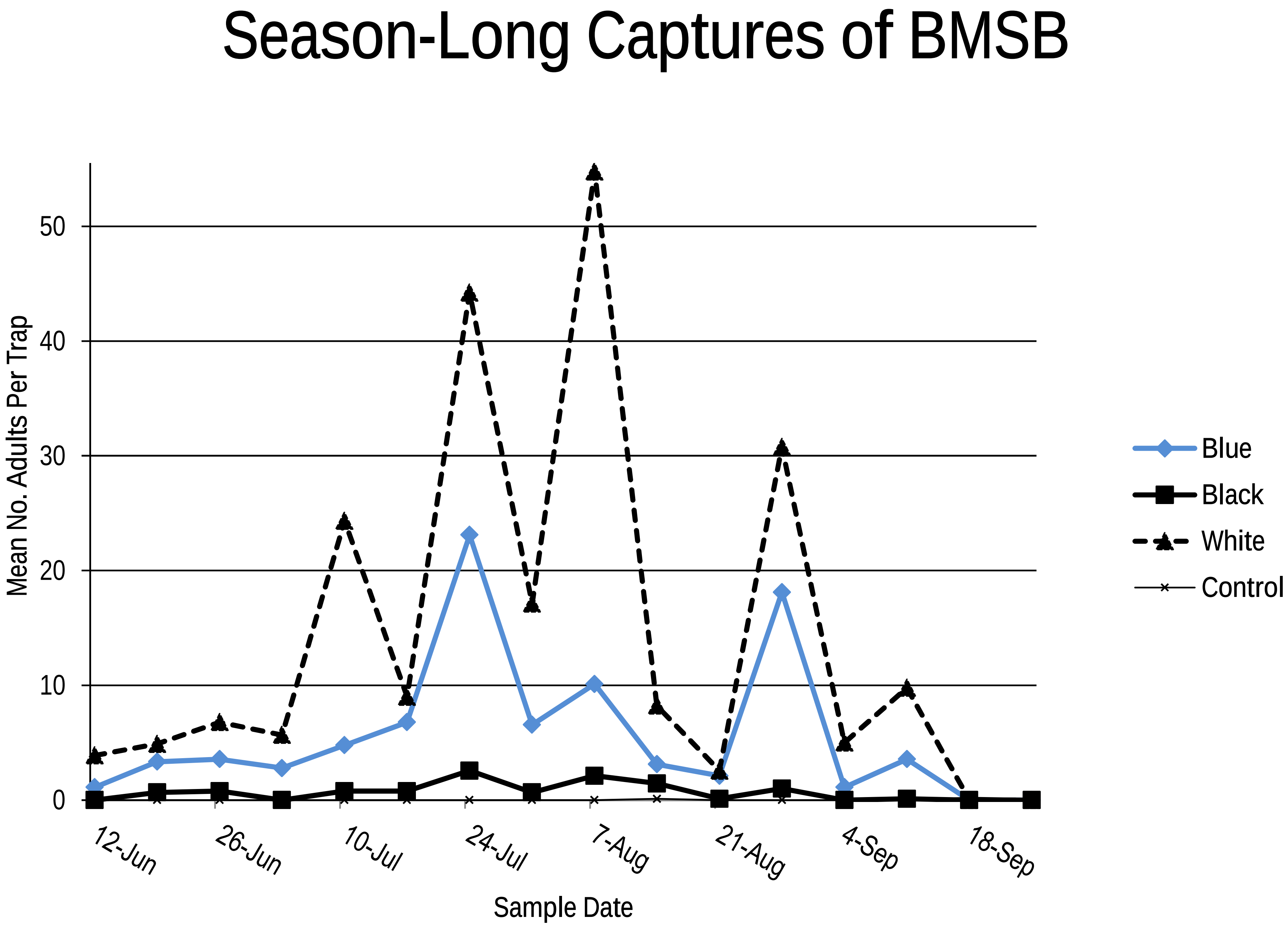
Species Specificity Trial
June 3 – September 30, 2012



Mean Weekly Captures






Season-Long Captures of BMSB
Mean No. Adults Per Trap
0
10
20
30
40
50
12-Jun
26-Jun
10-Jul
24-Jul
7-Aug
21-Aug
4-Sep
18-Sep
Sample Date
Blue
Black
White
Control

Conclusions

- Under competitive field-conditions, traps provisioned with a white light source captured significantly more BMSBs and non-targets.
- Traps provisioned with blue light sources captured fewer BMSBs, but also fewer nontargets.
- Although captures of BMSB were lower in traps provisioned with black light sources, patterns of capture are identical.
- White and blue light sources appear most promising.

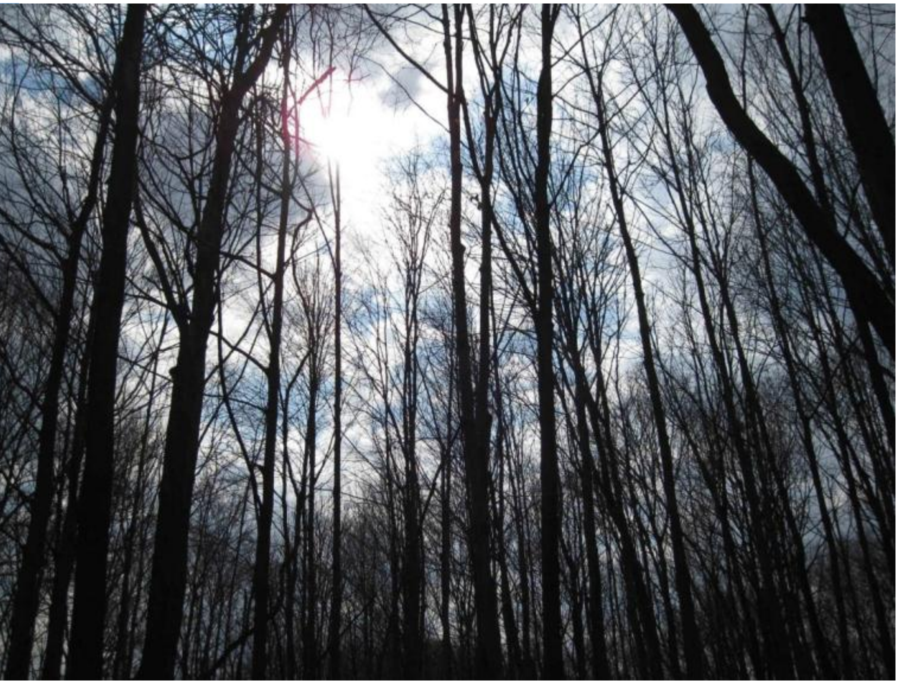
Next Steps

- Establish physiological and behavioral state of responders to different stimuli.

- Combining stimuli - #10, methyl-(*2E, 4E, 6Z*)-decatrioenate, and light-based sources.
  - Improve monitoring tools and develop attract and kill strategies.

BMSB is a Landscape-level Threat

Where Do BMSB Overwinter?



- Do BMSB overwinter in the natural landscape?
- Where do they overwinter in the natural landscape?
- How many BMSB could be overwintering in the natural landscape?

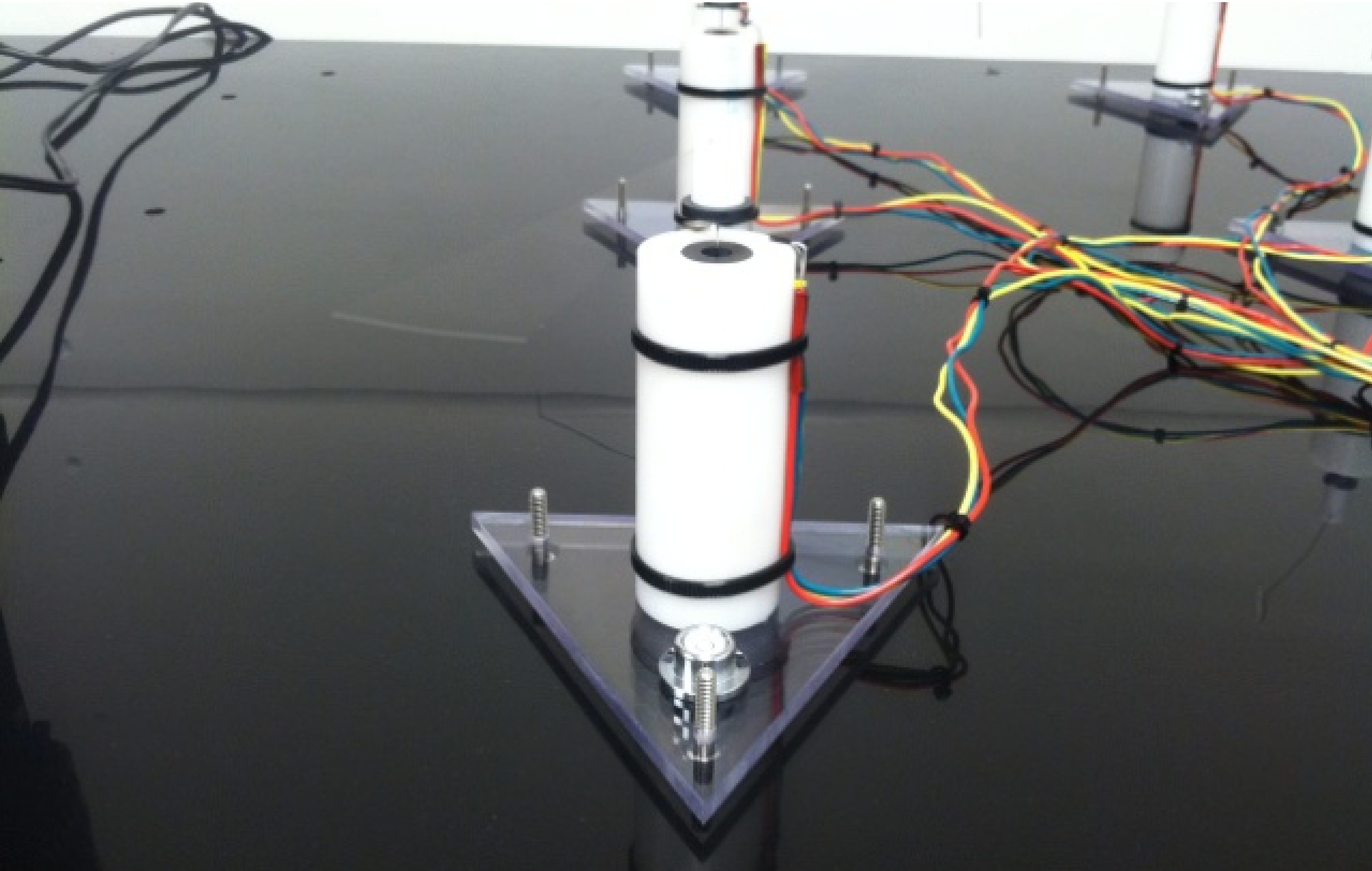

Woods
Orchard
Red Crest Dr
Arden Nollville Rd
Fox Chase Dr
© 2011 Google
Image © 2011 GeoEye
Image USDA Farm Service Agency
1133 ft
Imagery Date: 6/7/2009
39°27'18.46" N 78°01'59.78" W elev 704 ft
Eye alt 5729 ft
Google earth

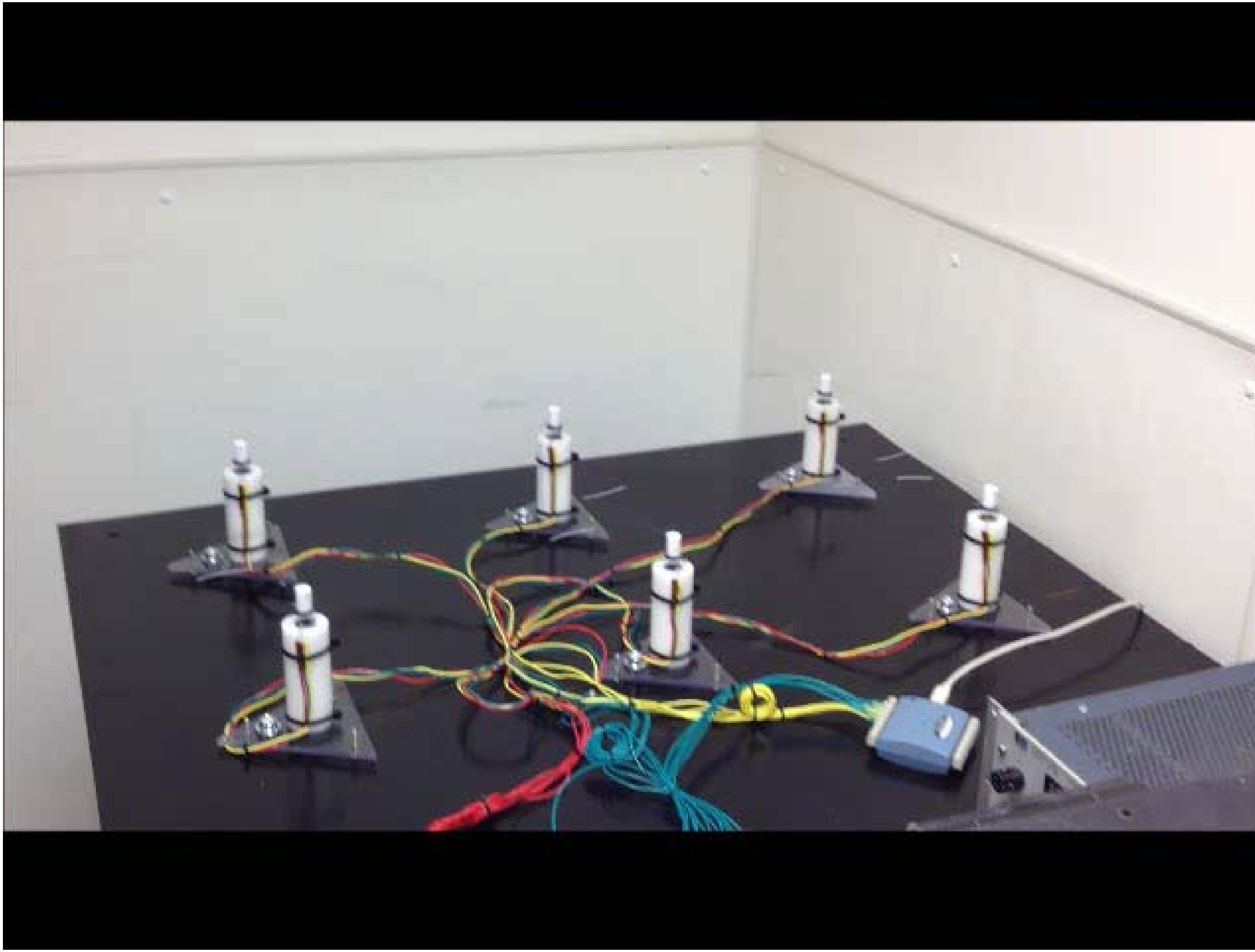
Detector Dogs for Locating BMSB

Why Is Dispersal Important?

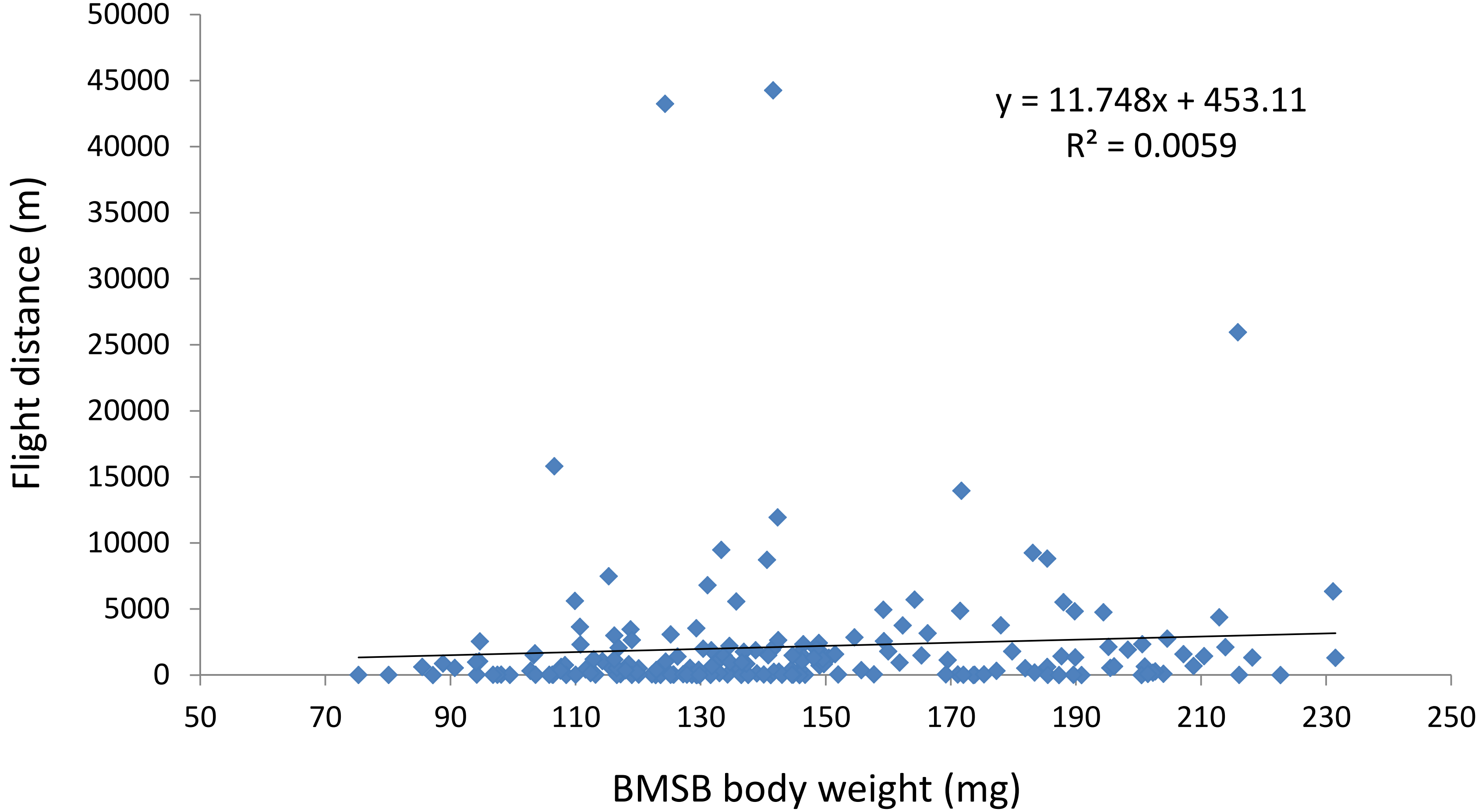
- How far can BMSB travel to reach crops or potential overwintering sites?
- How does biological activity in the natural landscape influence population dynamics?
- Establishing risk.

Laboratory-Based Flight Mill Studies To Measure Capacity



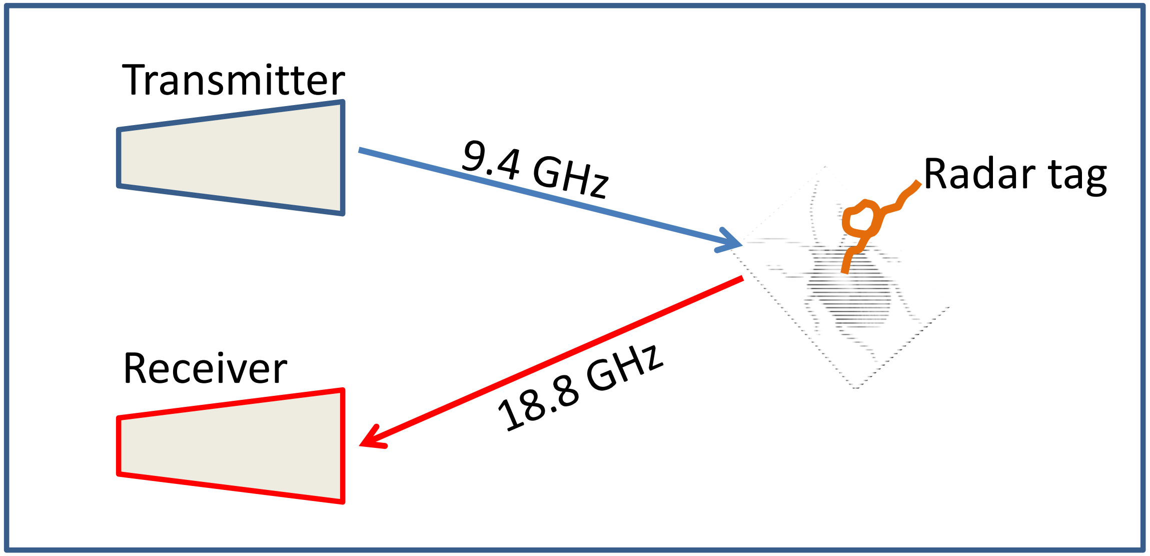


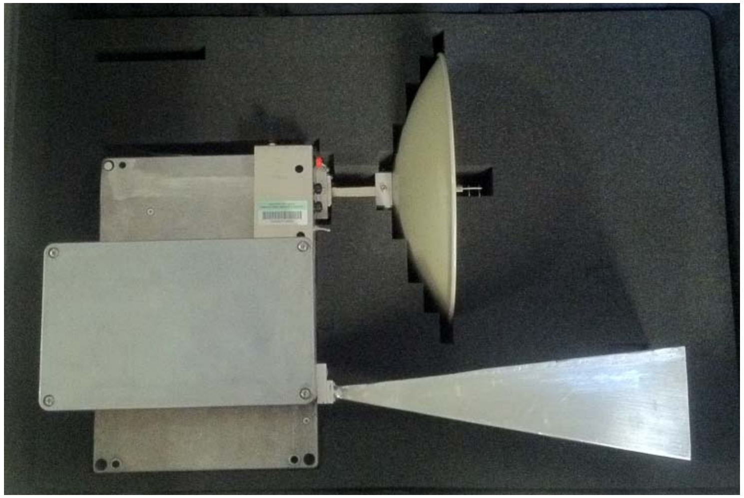
(N = 186)



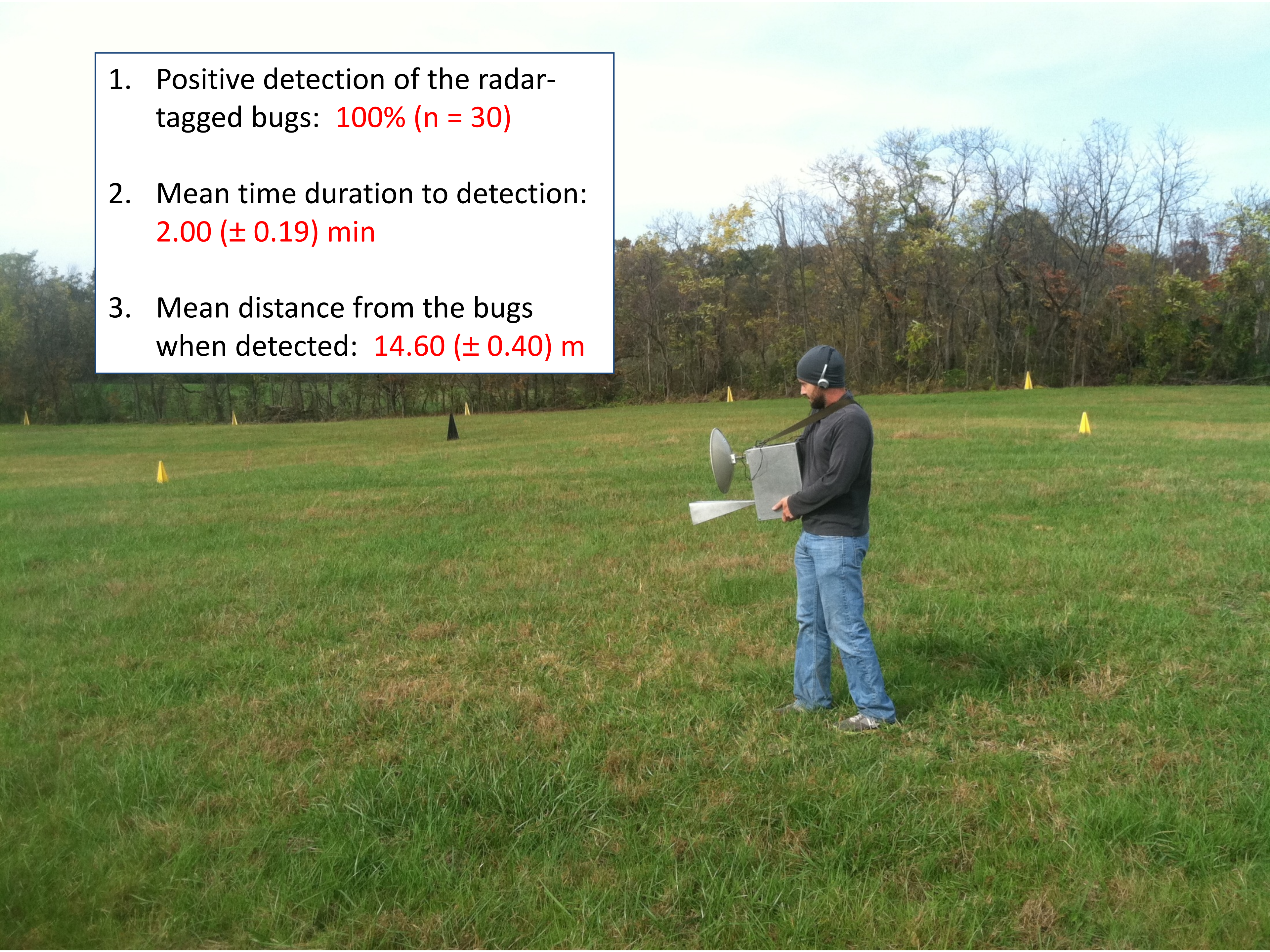
y = 11.748x + 453.11
R² = 0.0059
Flight distance (m)
BMSB body weight (mg)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
50
70
90
110
130
150
170
190
210
230
250

Semi-Field Observations of Individual Movements With Harmonic Radar





1. Positive detection of the radar-tagged bugs: 100% (n = 30)
2. Mean time duration to detection: 2.00 (± 0.19) min
3. Mean distance from the bugs when detected: 14.60 (± 0.40) m



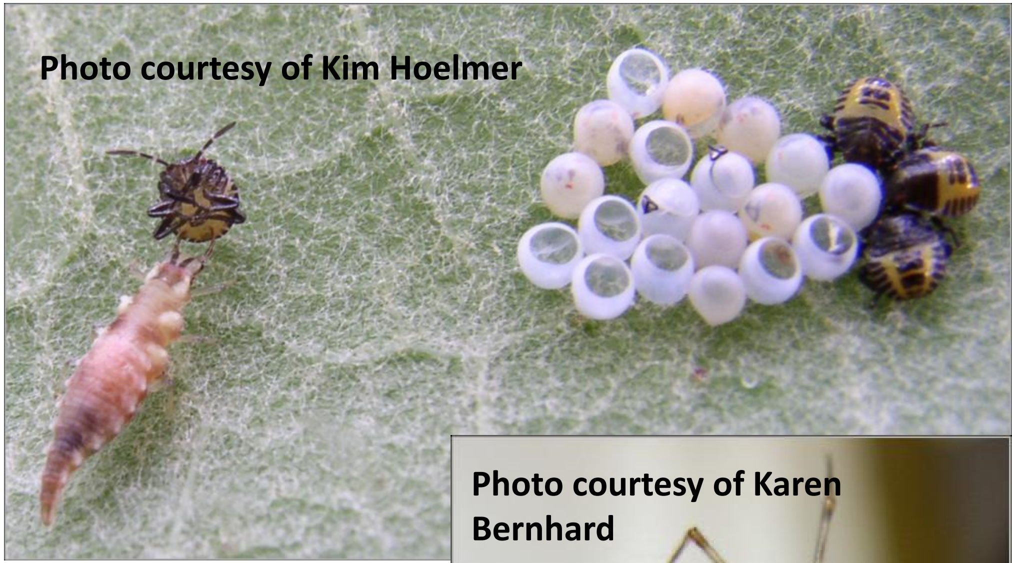
Biological Control Offers Long-Term Solution

Strategies To Reduce Populations Across Entire Landscape

Conservation Biological Control – Indigenous Predators

- **Arthropods.** Spiders, Assassin bugs, Wheel Bugs, Lacewings, Preying Mantids, and Ants.

- **Birds.** Grackles, Crows, Song birds, Chickens, Guinea hens.



Conservation Biological Control - Indigenous Parasites

- Tachinidae. Flies deposit eggs on adults. Very few complete development. Not very effective.

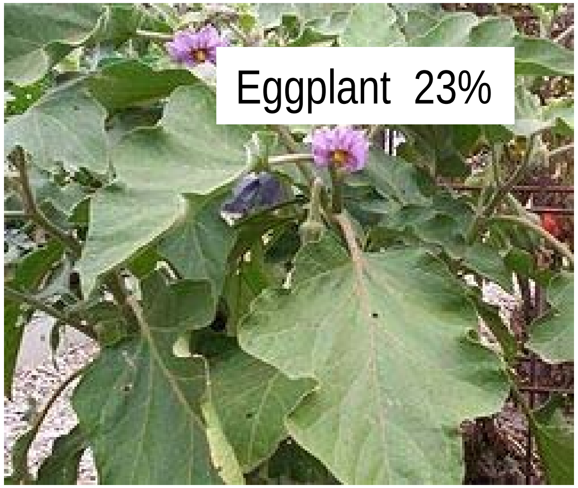
- Scelionidae. Parasitic Hymenoptera. *Trissolcus sp.*

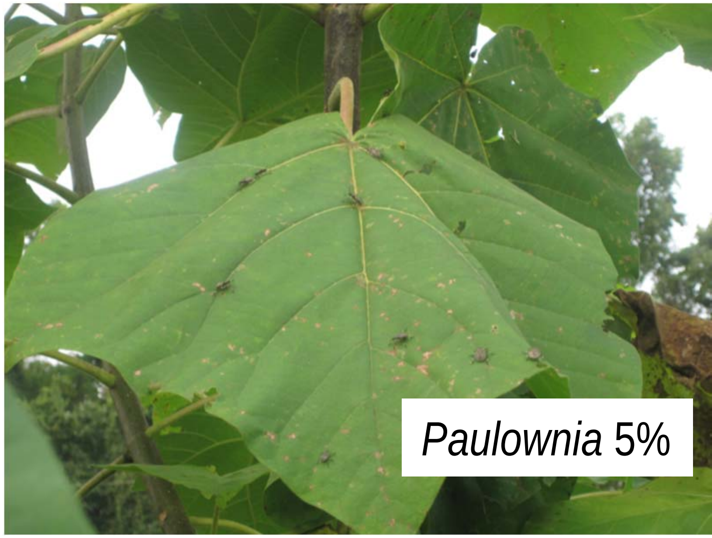
Photo courtesy of Jeff Aldrich

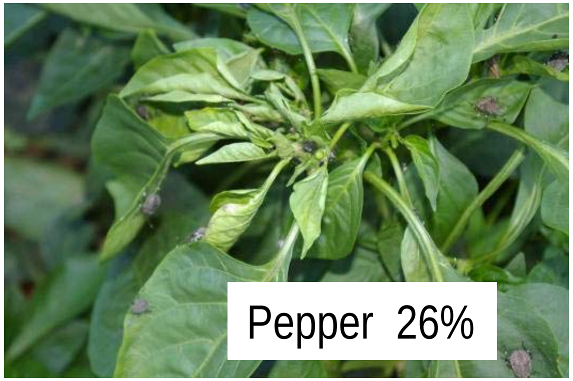
Photo courtesy of J. Wildonger

Photo courtesy of Kim Hoelmer

Parasitism and Predation Rates Vary Among Host Plants





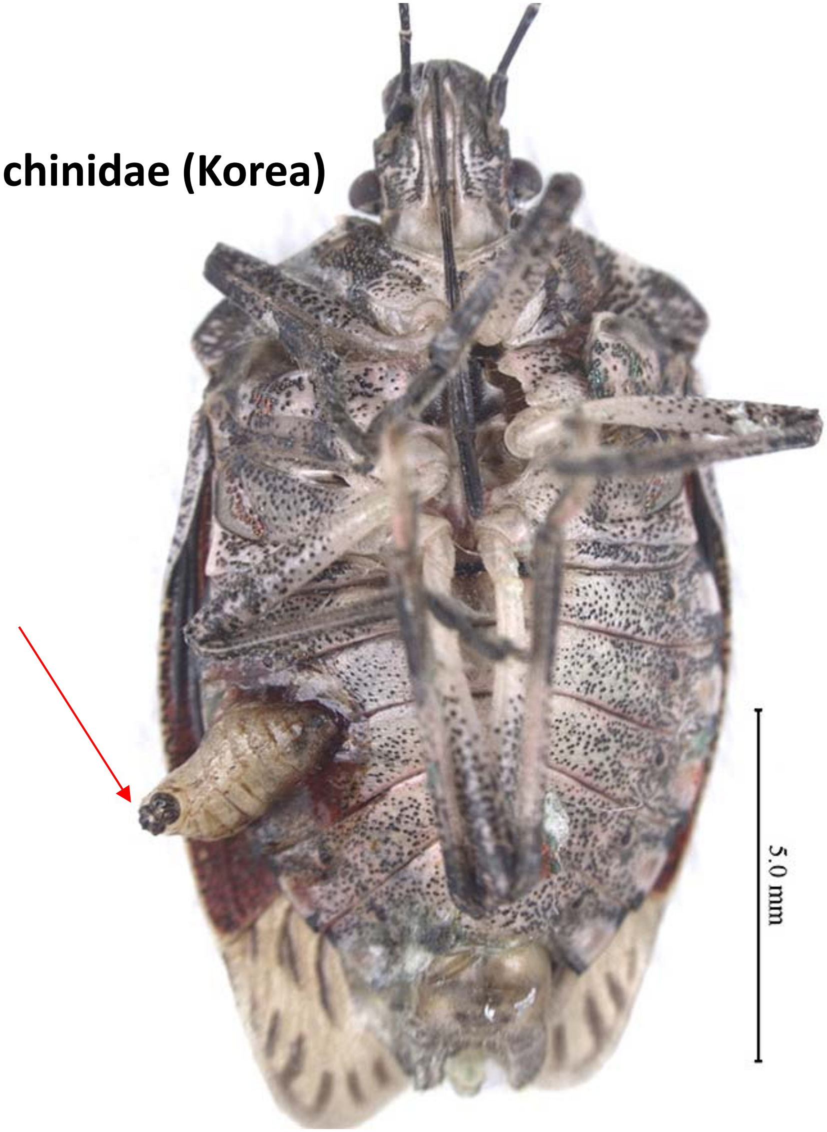


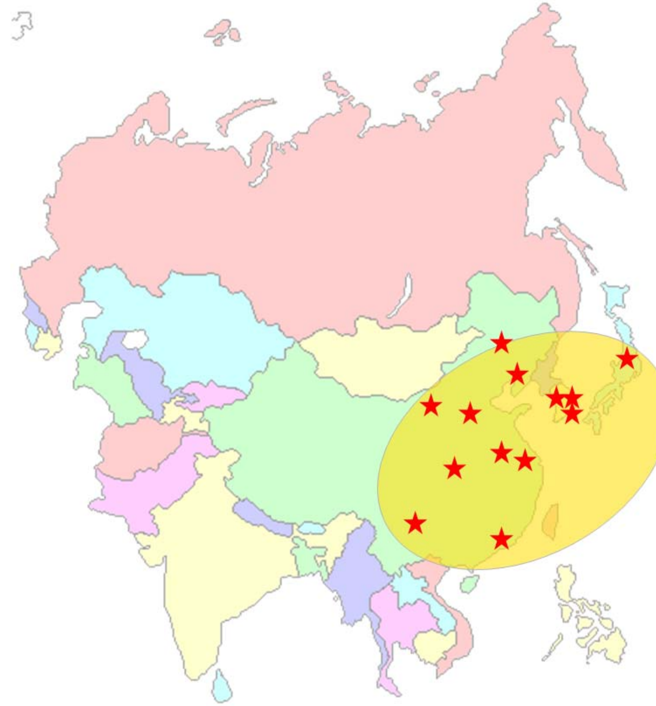
Conservation Biological Control - Indigenous Pathogens

Photo courtesy of Tom Kuhar

Classical Biological Control

Tachinidae (Korea)

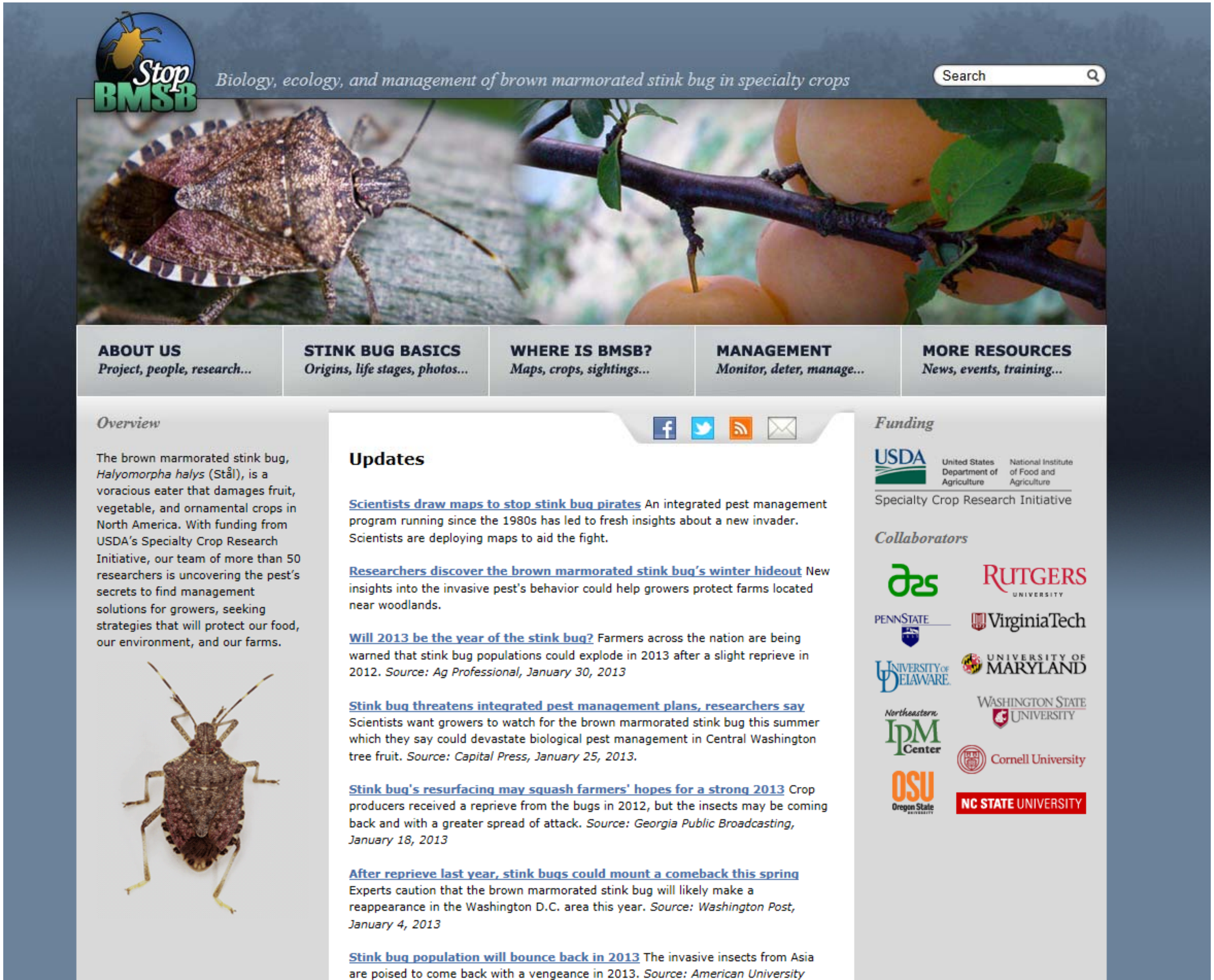




Scelionidae (Asia)

Photos courtesy of Kim Hoelmer

What’s Next?


Stop BMSB
Biology, ecology, and management of brown marmorated stink bug in specialty crops
Search
ABOUT US
Project, people, research...
STINK BUG BASICS
Origins, life stages, photos...
WHERE IS BMSB?
Maps, crops, sightings...
MANAGEMENT
Monitor, deter, manage...
MORE RESOURCES
News, events, training...
Overview
The brown marmorated stink bug, Halyomorpha halys (Stål), is a voracious eater that damages fruit, vegetable, and ornamental crops in North America. With funding from USDA’s Specialty Crop Research Initiative, our team of more than 50 researchers is uncovering the pest’s secrets to find management solutions for growers, seeking strategies that will protect our food, our environment, and our farms.
Updates
Scientists draw maps to stop stink bug pirates An integrated pest management program running since the 1980s has led to fresh insights about a new invader. Scientists are deploying maps to aid the fight.
Researchers discover the brown marmorated stink bug’s winter hideout New insights into the invasive pest's behavior could help growers protect farms located near woodlands.
Will 2013 be the year of the stink bug? Farmers across the nation are being warned that stink bug populations could explode in 2013 after a slight reprieve in 2012. Source: Ag Professional, January 30, 2013
Stink bug threatens integrated pest management plans, researchers say Scientists want growers to watch for the brown marmorated stink bug this summer which they say could devastate biological pest management in Central Washington tree fruit. Source: Capital Press, January 25, 2013.
Stink bug's resurfacing may squash farmers' hopes for a strong 2013 Crop producers received a reprieve from the bugs in 2012, but the insects may be coming back and with a greater spread of attack. Source: Georgia Public Broadcasting, January 18, 2013
After reprieve last year, stink bugs could mount a comeback this spring Experts caution that the brown marmorated stink bug will likely make a reappearance in the Washington D.C. area this year. Source: Washington Post, January 4, 2013
Stink bug population will bounce back in 2013 The invasive insects from Asia are poised to come back with a vengeance in 2013. Source: American University
Funding
USDA United States Department of Agriculture
National Institute of Food and Agriculture
Specialty Crop Research Initiative
Collaborators
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UNIVERSITY OF DELAWARE
UNIVERSITY OF MARYLAND
WASHINGTON STATE UNIVERSITY
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Cornell University
OSU Oregon State
NC STATE UNIVERSITY

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StopBMSB.org