Assessing the presence and distribution of *Trissolcus japonicus* using yellow sticky traps

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Status of BMSB Biocontrol

- Native biocontrol inadequate (Abram *et al.* 2017)
- In Asia, *Trissolcus japonicus* Ashmead (Hymenoptera: Scelionidae) effectively regulates BMSB population
  - up to 80% parasitization rates have been reported (Yang *et al.* 2009)
- Adventive US population of *T. japonicus* detected in Maryland in 2014 (Talamas *et al.* 2015)
- Detected in Winchester, VA 2015-2017
- Many other locations in the Mid-Atlantic, west coast (NY, PA, NJ, DE, WV, WA, OR)

Monitoring BMSB and its Natural Enemies

- Most BMSB trapping to date via ground-deployed traps
- Most sampling for BMSB parasitoids via sentinel eggs or wild egg mass collection
- Anecdotal and experimental observations suggest greater number of BMSB and injury at the tops of trees (Short, pers. comm, Joseph *et al.* 2014)
- Need to understand the distribution of BMSB natural enemies (especially *T. japonicus*) in host trees and monitor the spread of *T. japonicus*


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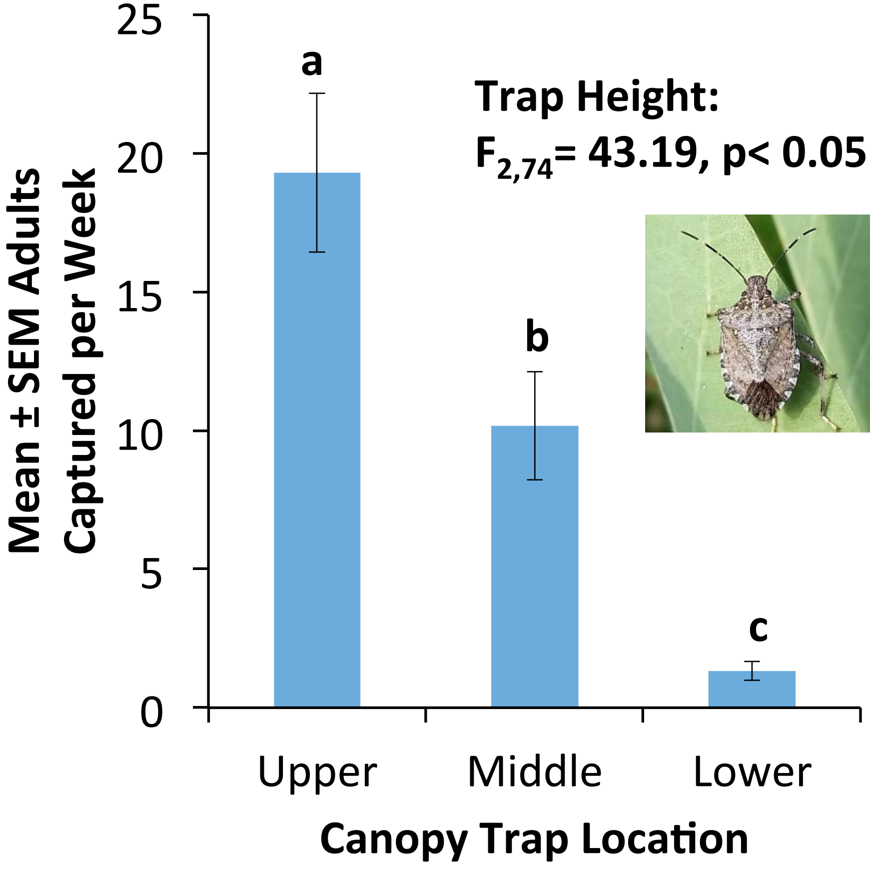
Where is *T. japonicus?*

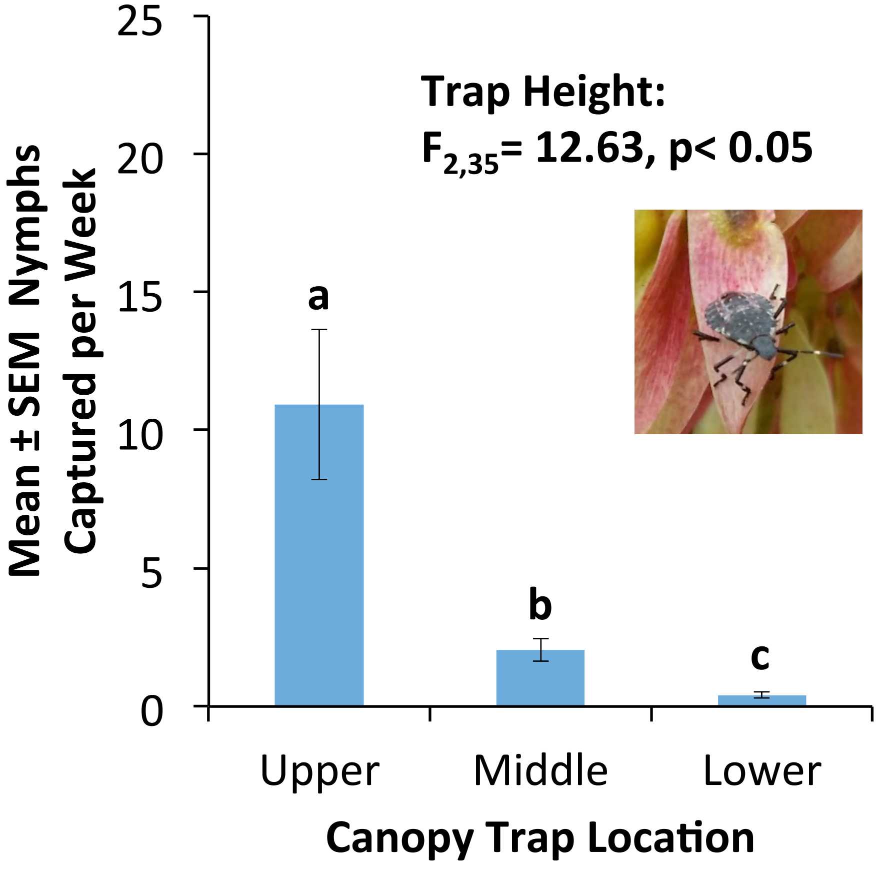
- Distribution and ecology of adventive U.S. population is unknown
  - Where are BMSB life stages in host tree canopies?
  - Where does *Tj* forage for BMSB eggs?
    - Within hosts
    - Among hosts
    - Spatial scales
  - Where is *Tj* in VA and beyond?
- **Need to sample a variety of host trees and regions**

Canopy Trapping for BMSB

- Female ToH located at woods edge next to apple orchards (n=5)
  - Same trees used in 2016 and 2017
- In each tree, a trap was deployed in the **upper, middle, and lower canopy**
  - Low dose pheromone lures and kill strips were changed every two weeks
- Deployed on a “pulley system”
- Number of BMSB per trap counted weekly mid-April to mid-October

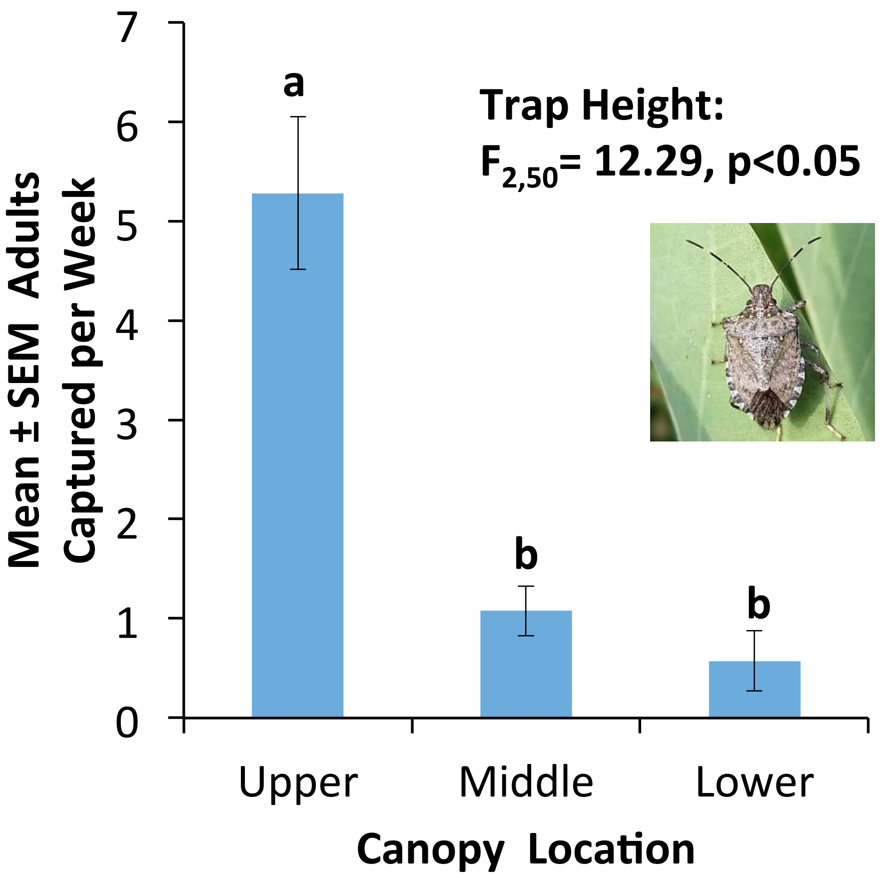
BMSB Captures in Female Tree of Heaven: 2016

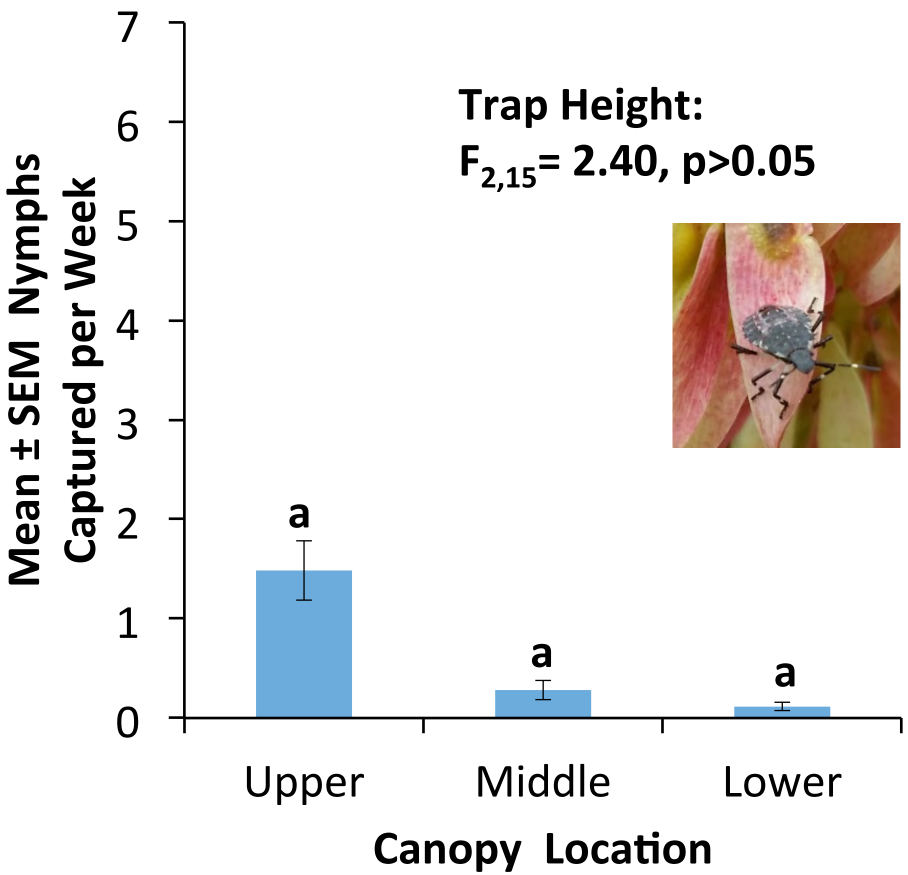




- Data were log transformed
- GLMMs: trap height blocked by tree and date
- Tukey–Kramer adjusted ls means

BMSB Captures in Female Tree of Heaven: 2017





- Data were log transformed
- GLMMs: trap height blocked by tree and date
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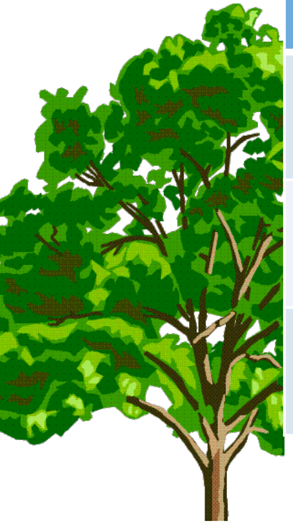
Destructive Sampling for BMSB Egg Masses

- 20 female ToH adjacent to peach or apple orchards
- Trees were similar in branch architecture
- Sampling occurred in late June (n=5) and early August (n=5) each year
- Trees felled, height of each branch measured
- BMSB egg masses collected from foliage
  - Eggs were maintained at 25°C
- Parasitoid ID confirmed by E. Talamas


ACE
EY

Destructive Sampling
BMSB Egg Mass Locations (2016 & 2017)



Canopy Location	Total # egg masses 	# Egg masses yielding *T. japonicus* 	# Egg masses yielding other parasitoids 	# Egg masses previously parasitized 
Upper	13	3	0	0
Middle	**28**	**7**	**3**	**3**
Lower	10	0	0	1

Numerically, but not significantly, greater levels of parasitism at mid-canopy
(Fisher's exact test, df = 6; p=0.27)

Sentinel Egg Deployment

- Egg cards deployed on foliage from cut ToH branches on pulley transects
- Retrieved after 72 hours
- Data collected:
    - Number of damaged and undamaged eggs remaining
    - Type of predation (Morrison *et al.* 2016)
    - Number of adult parasitoids that emerged
    - Parasitoid ID confirmed by E. Talamas

Parasitized egg masses recovered from sentinel egg canopy transects

2016:

- 135 egg masses deployed
- 4.4% (n = 6) of egg masses parasitized
- 2.2% (n = 3) of egg masses parasitized by *T. japonicus* (mid and upper canopy)

2017:

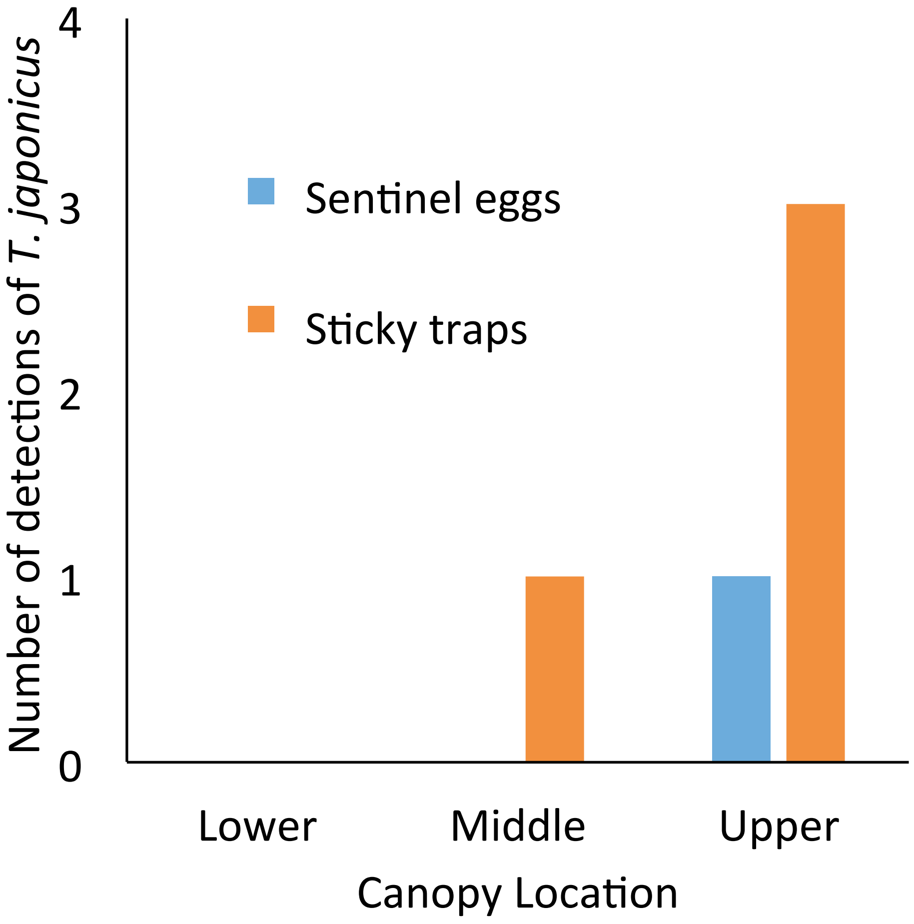
- 105 egg masses deployed
- 2.86% (n = 3) of egg masses parasitized
- 0.95% (n = 1) of egg masses parasitized by *T. japonicus* (upper-canopy)

Can we use sticky traps to monitor Tj?: 2016 preliminary study

- Replaced sentinel egg sampling at end of season (same trees, heights, pulley system)
- Half of a one-sided, yellow Alpha Scents sticky trap (23x14cm)
- Deployed for three, 1-week intervals Aug 12 – Sept 9
- Parasitoid specimens identified by E. Talamas

- **Three specimens captured**
  - 1 upper-canopy, 2 mid-canopy (same trap)
  - Study expanded in 2017

Sticky traps vs. sentinels deployed in tree transects in 2017



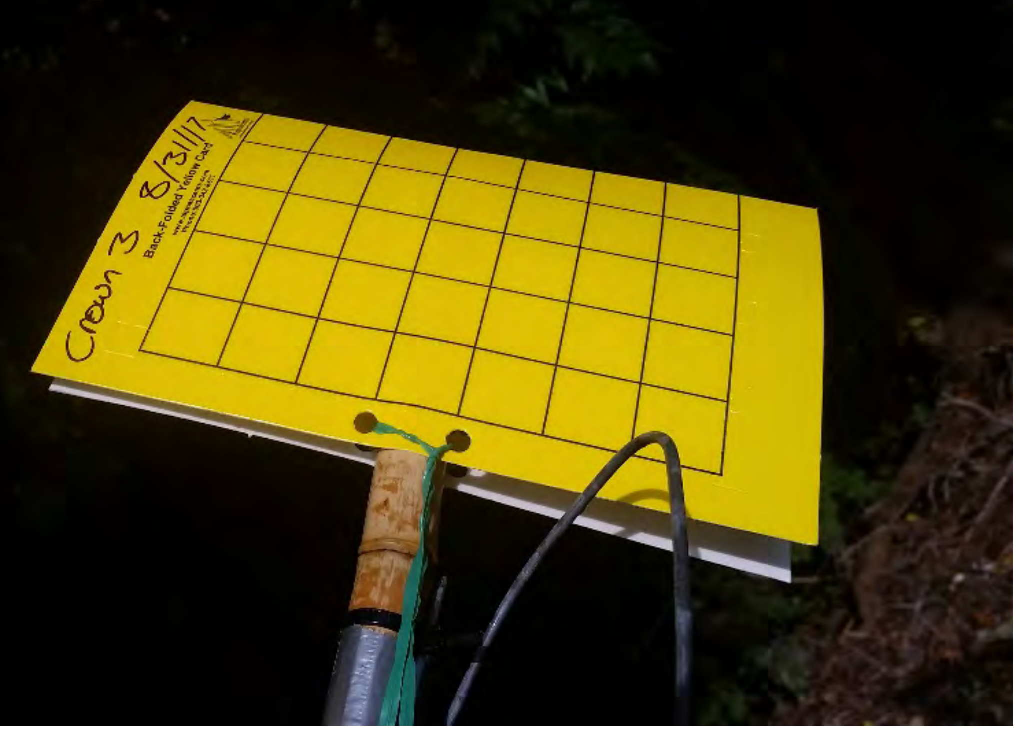
- No significant difference between sampling methods

Continuity adjusted χ^2 (1, n=255) = 0. 263, p = 0.61

- No significant effect of height on number of detections

χ^2 (2, n = 255) =1.63, p = 0.44

Mid-canopy sticky traps



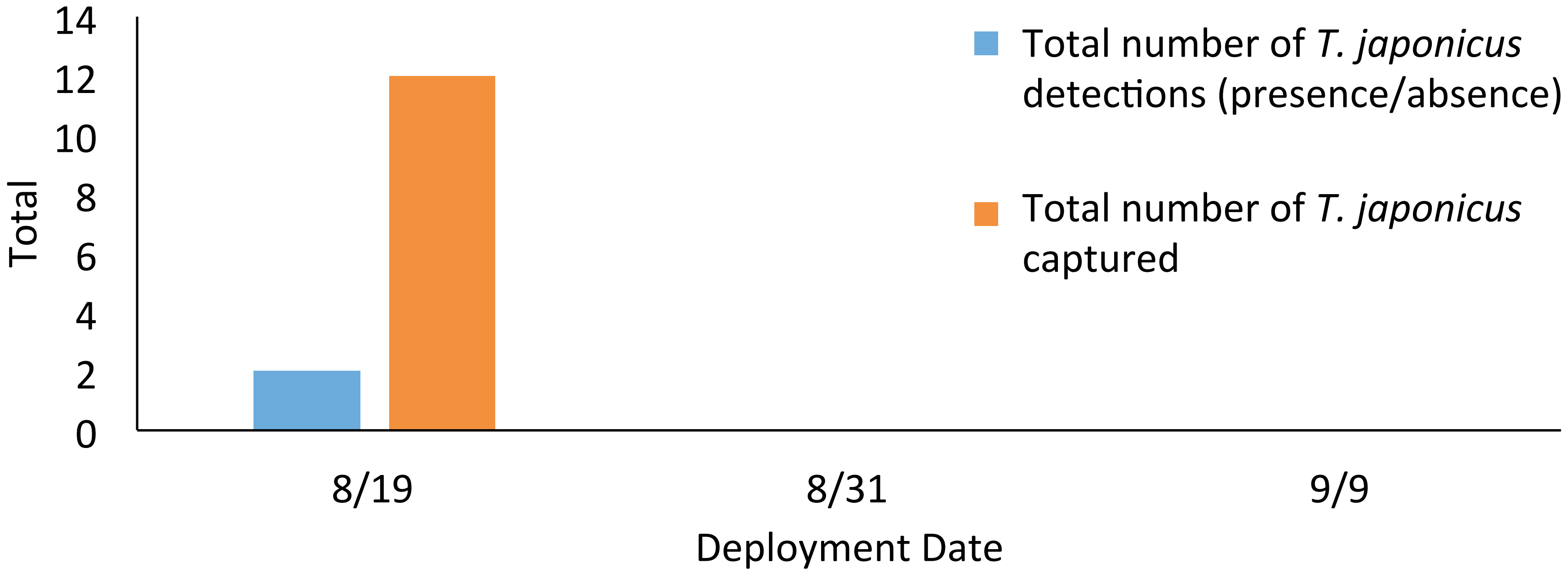
1. Assembly:
Sticky traps attached to 4.8m poles

2. Deployment:
At mid-canopy for 7 days

3. Processing:
Parasitoids removed and identified

Preliminary sticky traps (2017)

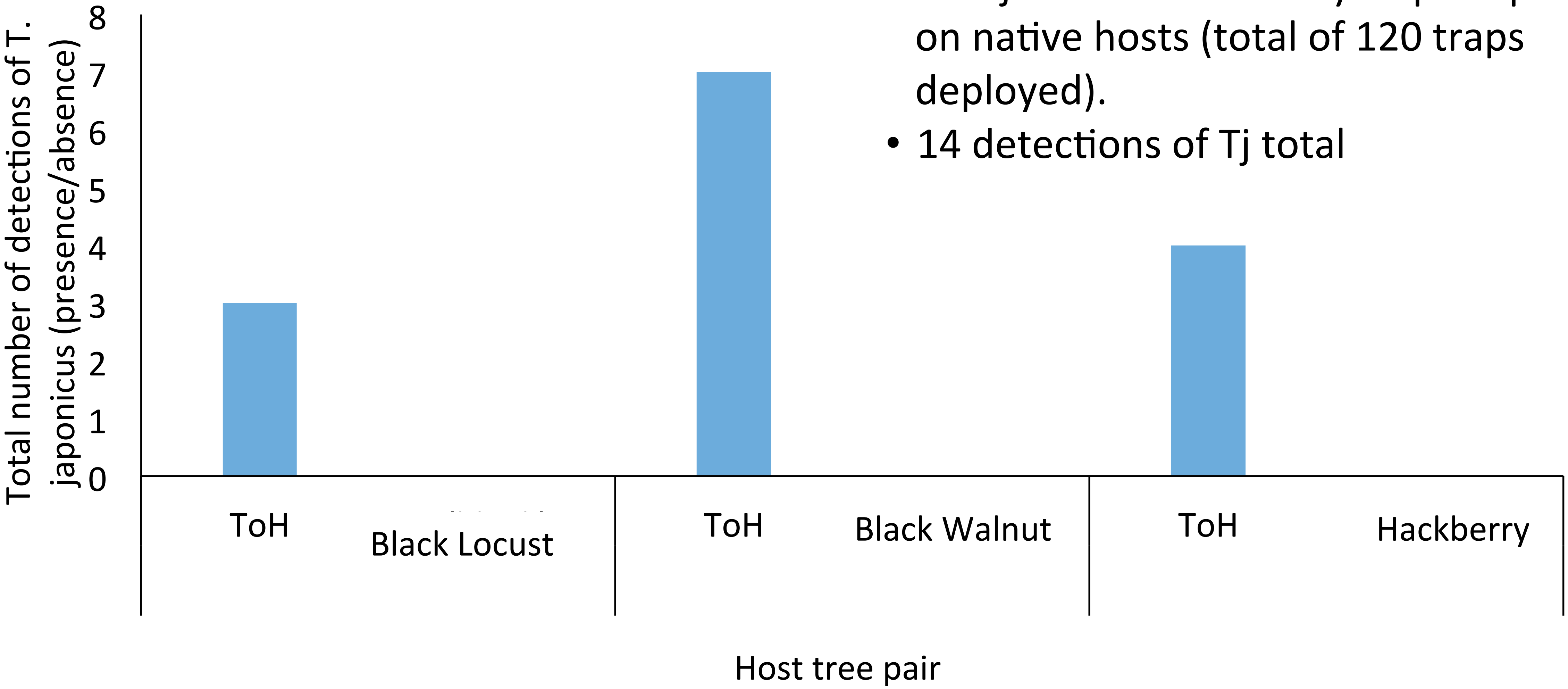
- 30 mid-canopy sticky traps deployed total (10 per week for 3 weeks)
- 2/30 traps captured *T. japonicus*
- 12 individuals captured total



Paired host plant comparisons using sticky traps

- Sticky traps deployed at mid-canopy in the following pairs:
  - Black walnut : Female tree of heaven (n=5 pairs)
  - Black locust : Female tree of heaven (n=5)
  - Hackberry : Female tree of heaven (n=5)
- Trees within the same pair were no closer than 10m and no father than 25m apart
- 5 weeks of sampling (-) for 7 days at a time

Host plant comparisons using sticky traps

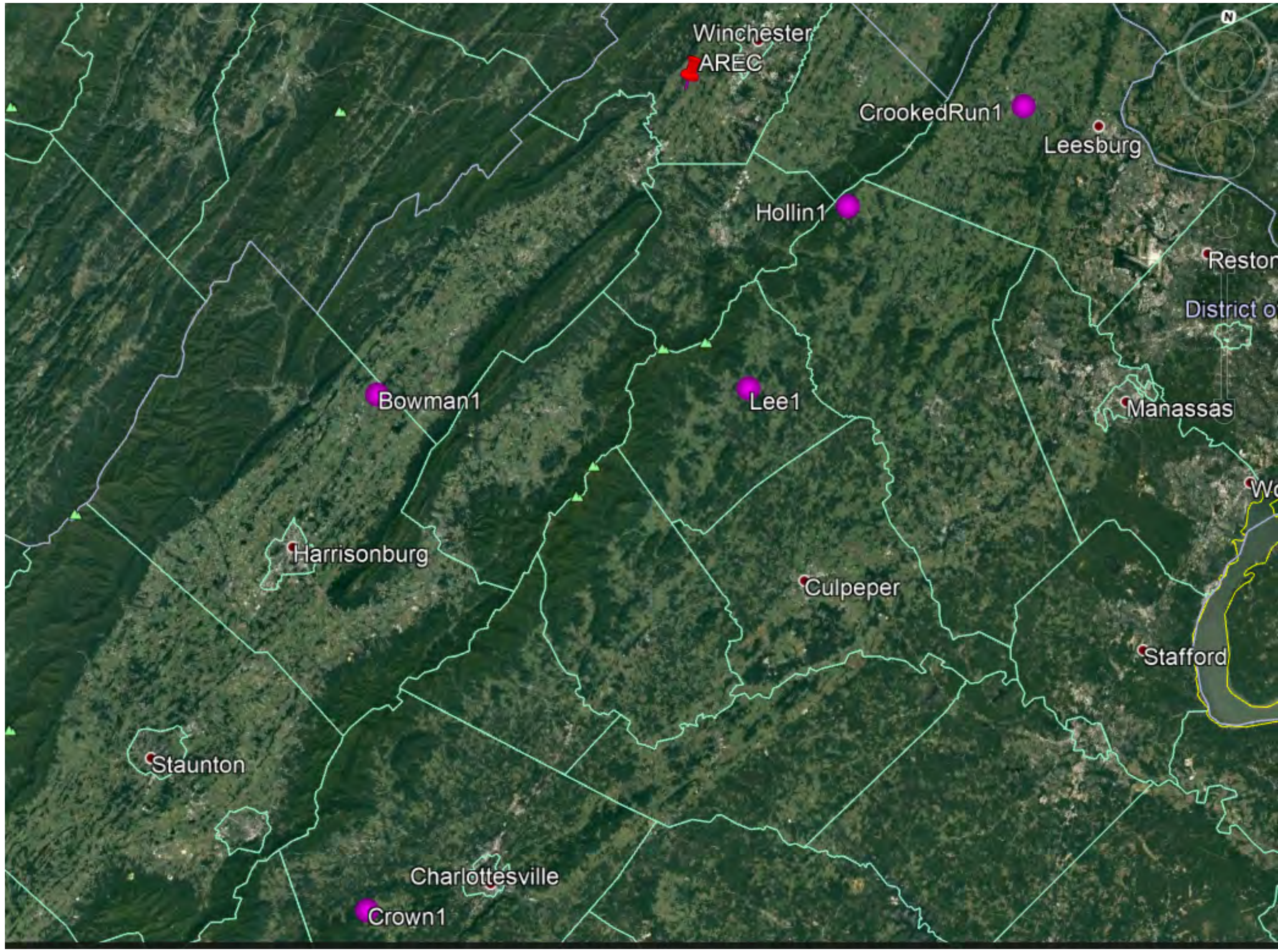


- No Tj detected on sticky traps deployed on native hosts (total of 120 traps deployed).
- 14 detections of Tj total

Mapping Tj's distribution in VA

- Selected 5 sites in nearby counties in 2017
- Deployed 3 mid-canopy yellow sticky traps per site in female ToH
- Three, 7-d intervals, Aug 23 – Sep 8
- n = 54 traps

Tj not detected outside of Frederick County in 2015-2017



Summary

- BMSB life stages are collected in greater numbers from the upper and middle of tree canopies than in the lower portion
- Tj is present in Frederick Co., Virginia and detected once again in 2017
- Yellow sticky traps are an effective monitoring tool
- Monitoring may be optimized by deploying detection tools in the mid-canopy of trees

Future directions

- What is the distribution of *T. japonicus* in VA?
  - Continue deploying sticky traps farther afield
- Do Tj prefer to forage on some host plants compared with others?
  - Lab and semi-field assays
    - Host plant effects on % parasitism and attack rates
    - Response of Tj to host plant volatiles
    - Mark-release-recapture
- Where does Tj prefer to overwinter?

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