Objective 1.1.2: Movement to and from overwintering sites and overwintering survivorship

Funding

USDA

United States Department of Agriculture

National Institute of Food and Agriculture

Specialty Crop Research Initiative

Grant #2011-01413-30937

Collaborating Institutions

University of Delaware

ars

Penn State

The State University of New Jersey Rutgers

Northeastern IPM Center

Washington State University

Cornell University

University of Maryland

Virginia Tech

OSU Oregon State University

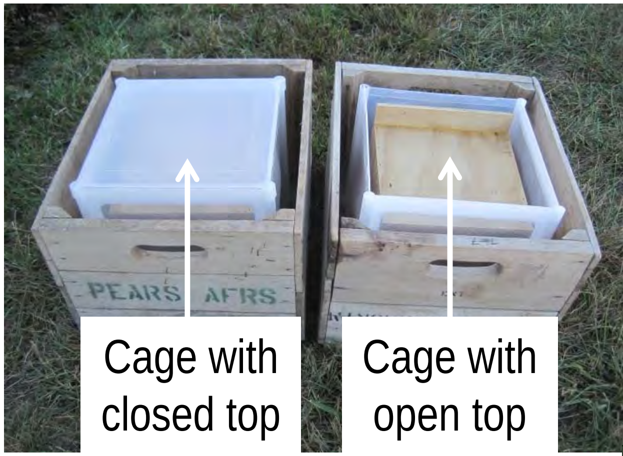
NC State University

StopBMSB.org

- When do adult BMSB emerge from overwintering sites?
- What is the duration of the emergence period?
- What factors influence emergence?
- Do captures in pheromone traps reflect emergence?

Adult BMSB collected from packing boxes in shed on fruit farm

Males and females marked with paint and placed in shelters



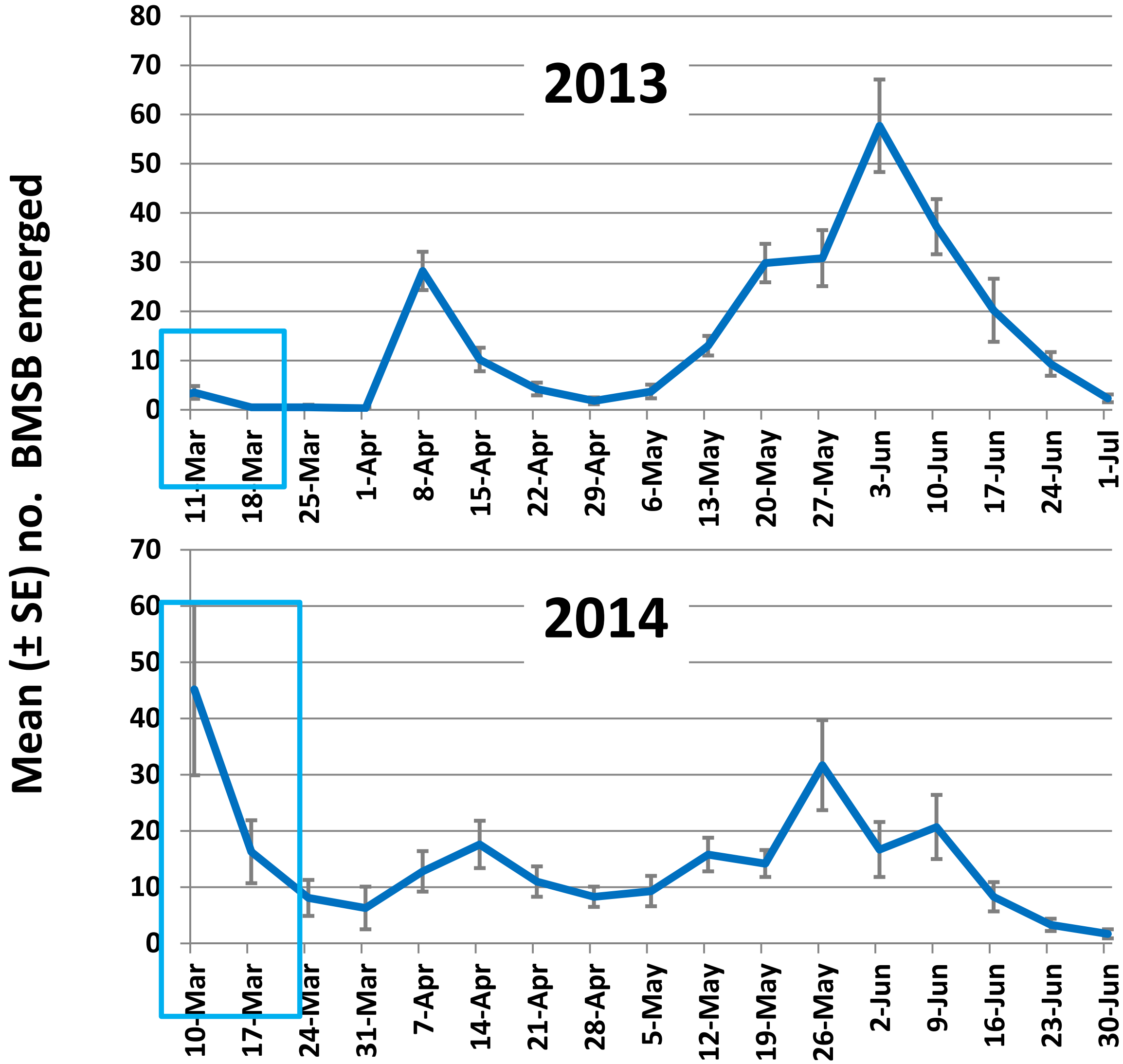
- Assumed similar emergence from shelters within in open and closed top cages

- Intention to simulate conditions in “natural” overwintering sites

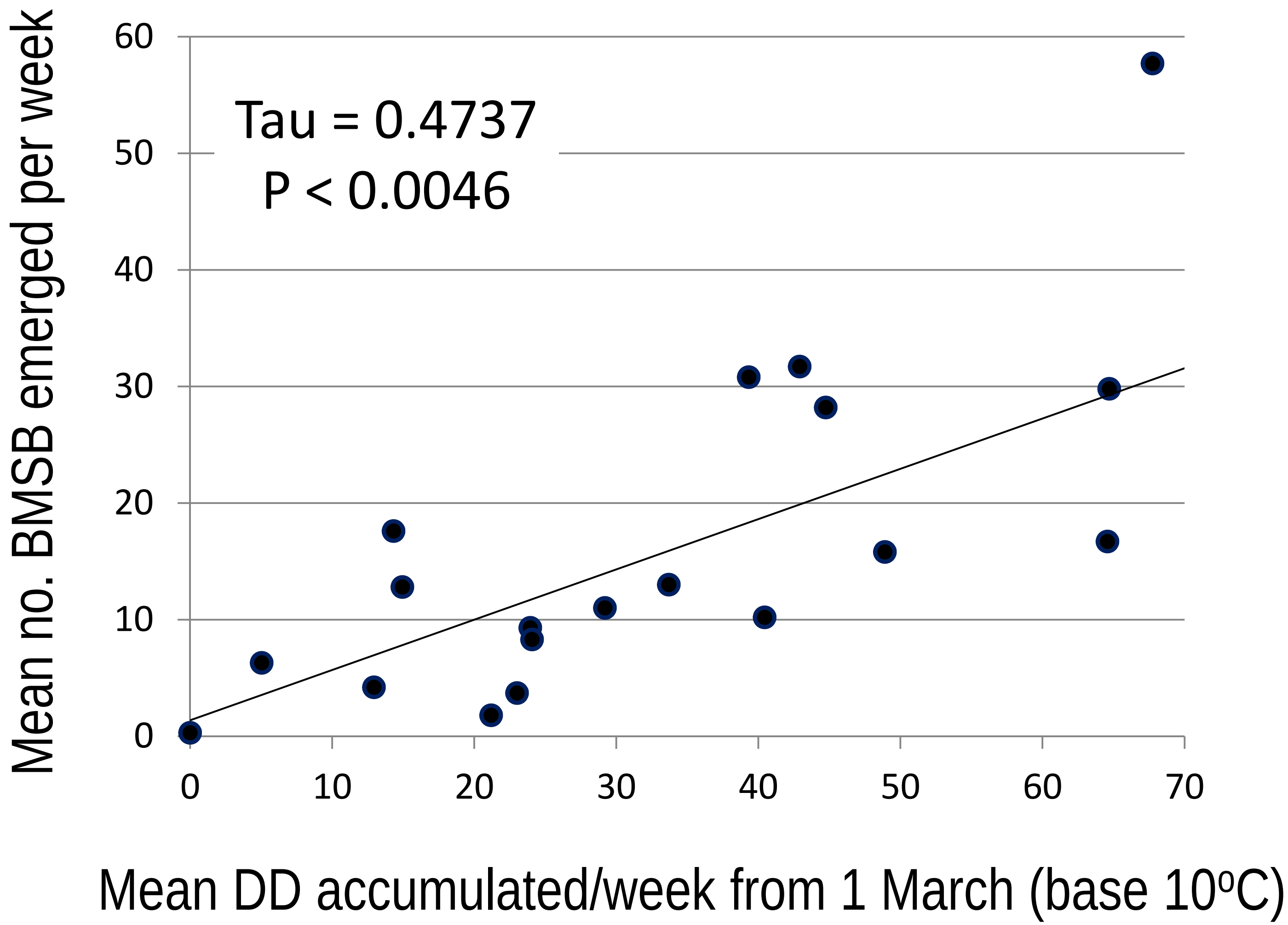
- Shelters deployed in pairs within protective domes at six woodland sites in late February
- Internal and external temperature sensors

- Baited (4) and unbaited (4) traps encircled shelter assemblies
- Weekly, then twice weekly BMSB collections from closed cages through end of June
- Weekly counts of BMSB in traps
- All shelters opened in early July, remaining BMSB counted

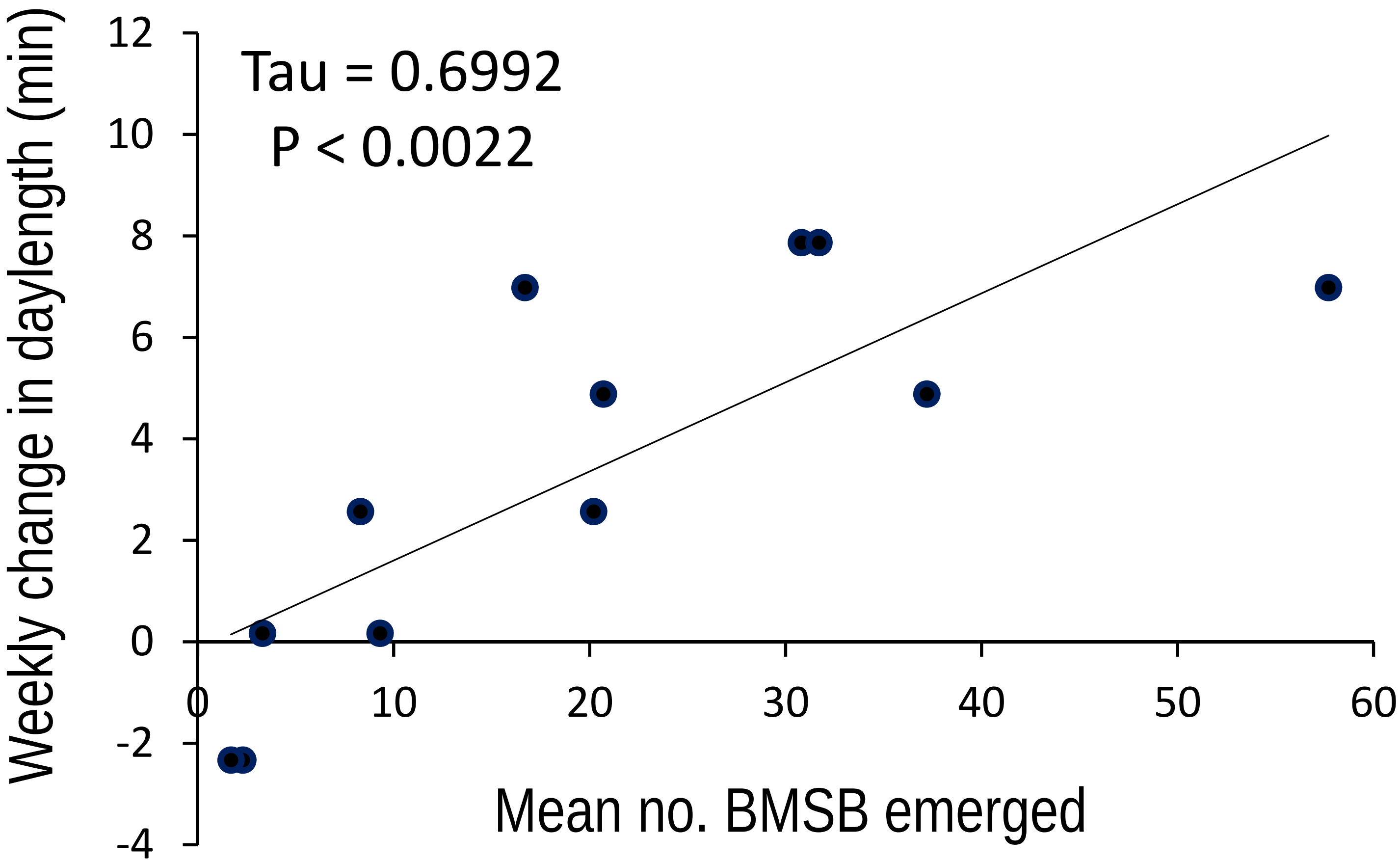
Mean no. BMSB emerged per week



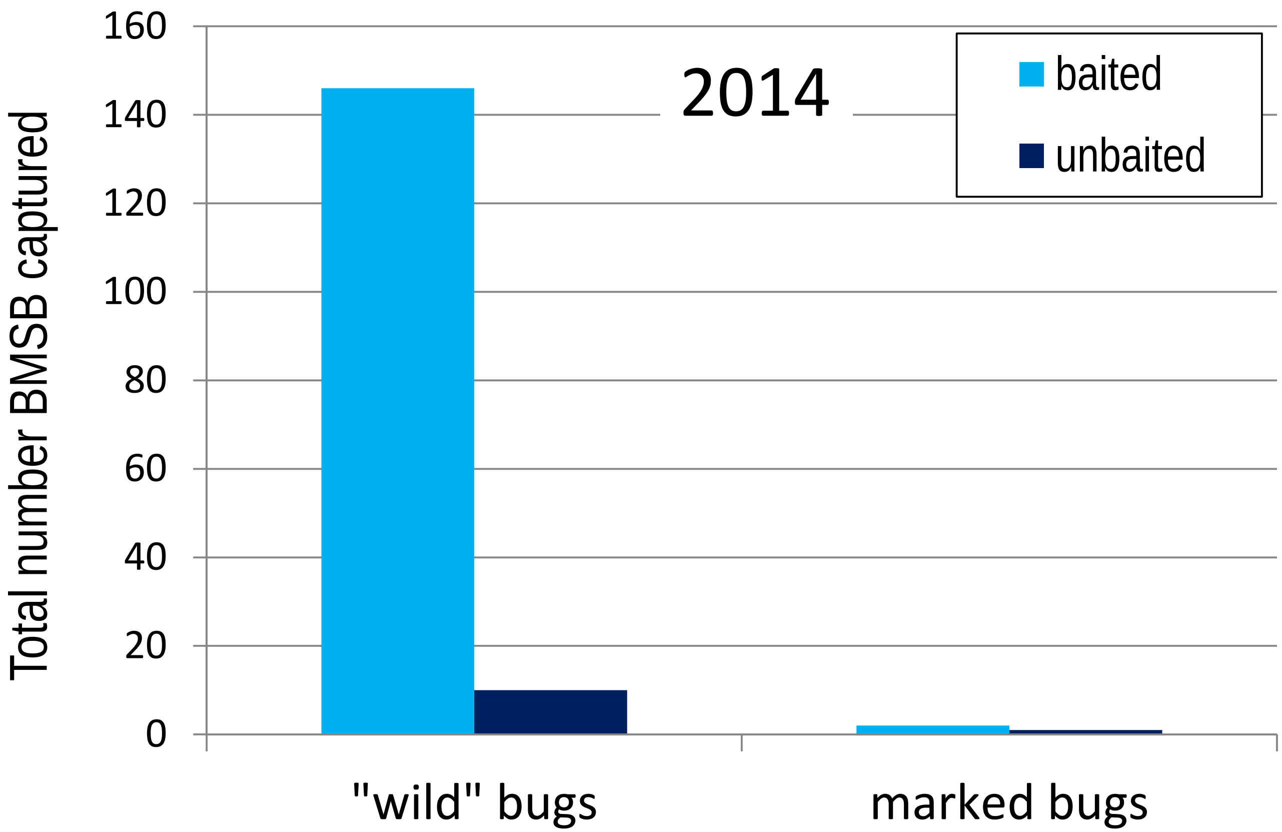
DD vs emergence: April 1 – June 1, 2013 and 2014



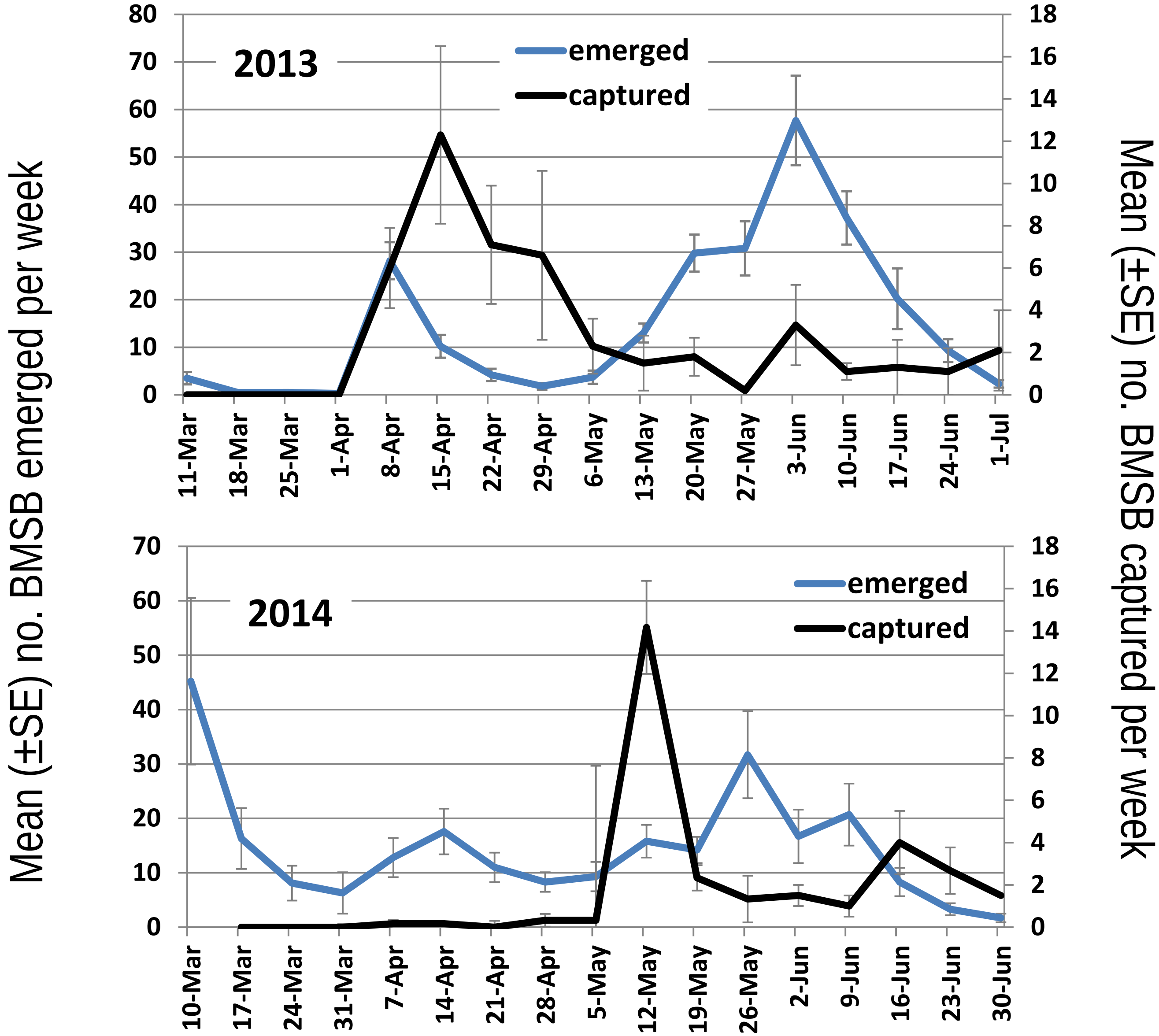
Daylength change vs emergence: May 26 – July 1, 2013 and 2014



Captures of “wild” and marked BMSB



No marked BMSB captured in 2013


2013
emerged
captured
2014
emerged
captured
Mean (±SE) no. BMSB emerged per week
Mean (±SE) no. BMSB captured per week
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
10-Mar
17-Mar
24-Mar
31-Mar
7-Apr
14-Apr
21-Apr
28-Apr
5-May
12-May
19-May
26-May
2-Jun
9-Jun
16-Jun
23-Jun
30-Jun

Summary

- Overwintering BMSB emerged over ~2.5 months
- Early, smaller peak of emergence appeared to be primarily associated with a period of warmer temperatures
- Later, larger peak appeared to be associated with temperature and/or a stabilization in photoperiod
- Pheromone traps appeared to reflect onset of emergence reasonably well
- Marked bugs assumed to have dispersed from emergence site

Implications and future directions

- Protracted period of emergence likely associated with overlapping generations through the summer, complicating potential for DD-based modeling/management
- Examine emergence of natural cohorts of BMSB (emergence in relation to gender, size/weight)
- Implications for modeling population dynamics
- Where do BMSB go after they emerge? Do they require a period of dispersal from the overwintering site before responding to pheromone traps?
- How do emergence patterns vary among locations in the eastern and western US?

Supercooling point

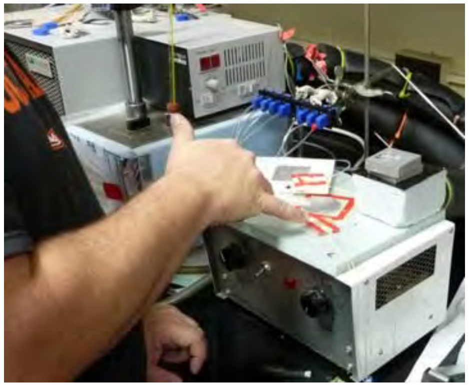
- Most insects in the northern hemisphere are freeze intolerant

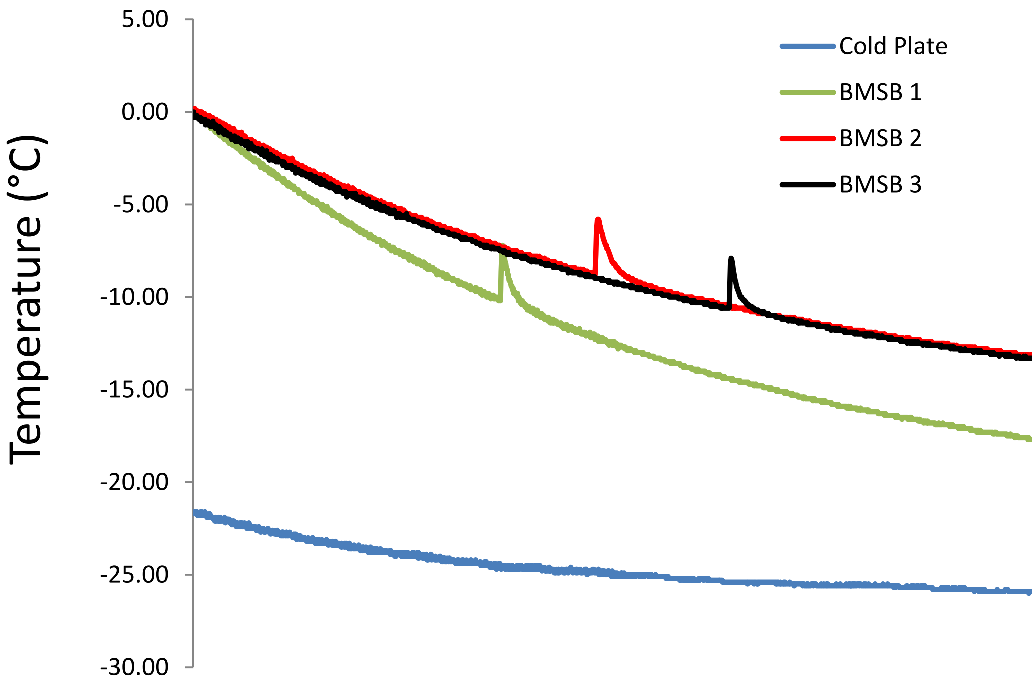
- To avoid freezing, various mechanisms such as the production of cryoprotectants are used to depress the insect's supercooling point (SCP) (i.e., the temperature at which body fluids begin to freeze)

- Identification of SCP can enable prediction of the effect of low temperature extremes on BMSB survival

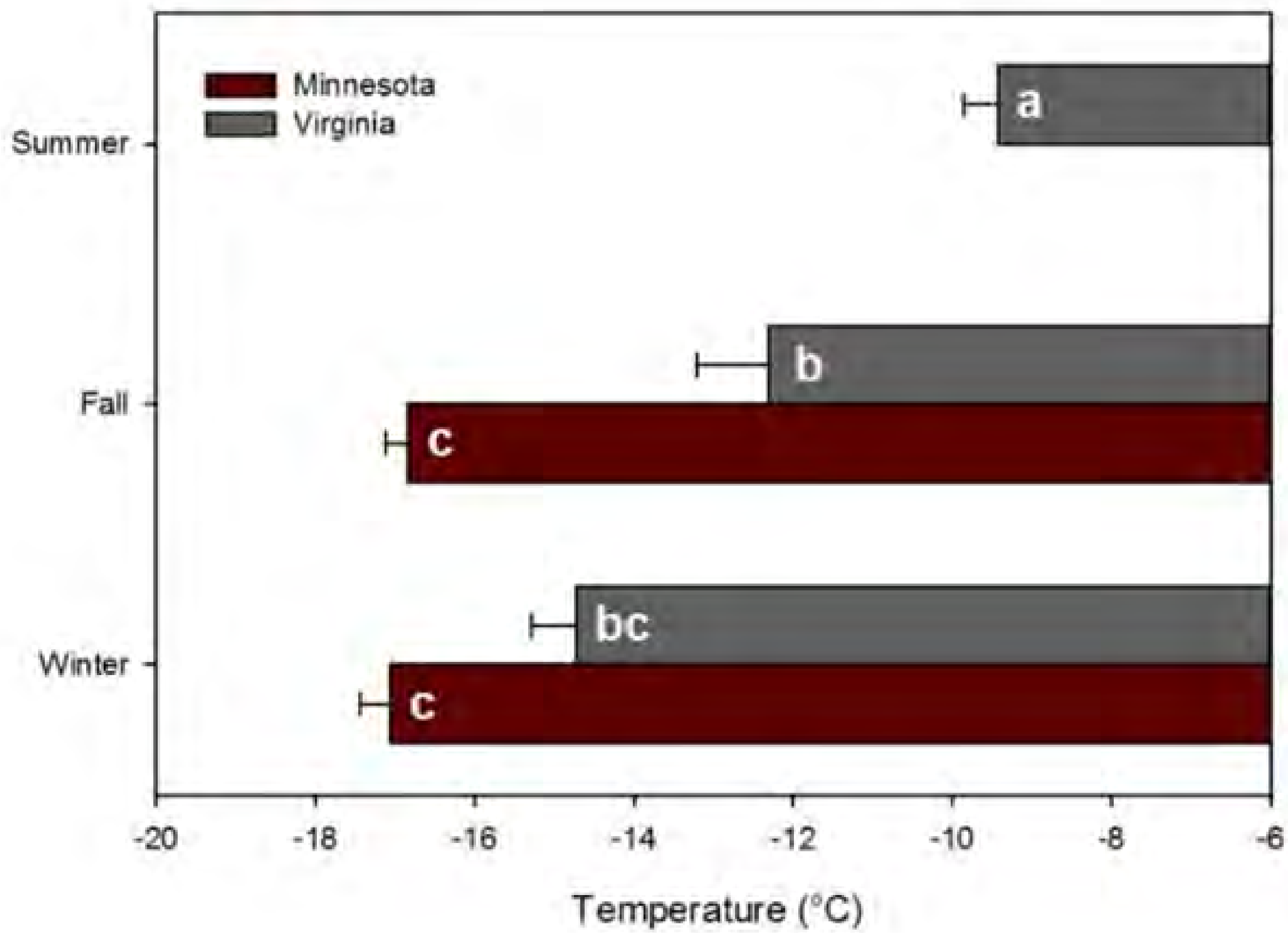
Supercooling Point Determination

- BMSB from populations that developed outdoors in VA and MN
- Supercooling points tested throughout the season
- Cold temperatures generated using a refrigerated water/ethanol bath
  Cooling system provided temperatures down to -28°C
- Temperature data from copper thermocouples collected and integrated





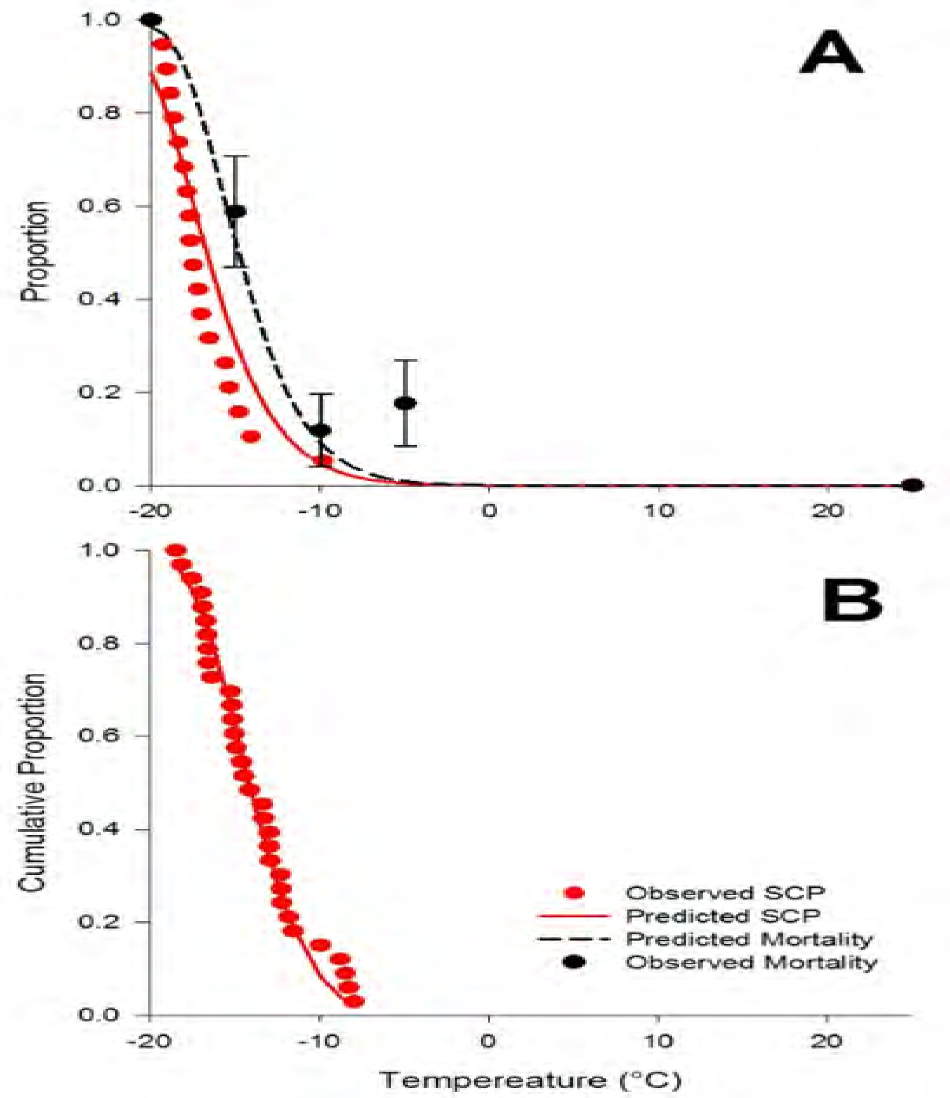
Supercooling points of adult *BMSB* from different acclimation locations across time



Cold tolerance of BMSB and the impact of a “polar vortex”

- “Polar vortex” of January 2014 brought cold temps to the northeast and midwest US
- BMSB shown to be chill intolerant
- Mortality from cold exposure of BMSB overwintering in shelters during the polar was 100% in MN and 97.6% in VA

Predicted and observed cumulative supercooling point and mortality distributions for adult BMSB in winter in MN (A) and VA (B)



Cira, T. et al. 2015. Cold tolerance of exotic invasive species: the impact of a “polar vortex” on brown marmorated stink bug (*Science* submitted)

Orchard Crops Research Update

Funding

USDA

United States Department of Agriculture

National Institute of Food and Agriculture

Specialty Crop Research Initiative

Grant #2011-01413-30937

Collaborating Institutions

University of Delaware

ars

Penn State

The State University of New Jersey Rutgers

Northeastern IPM Center

Washington State University

Cornell University

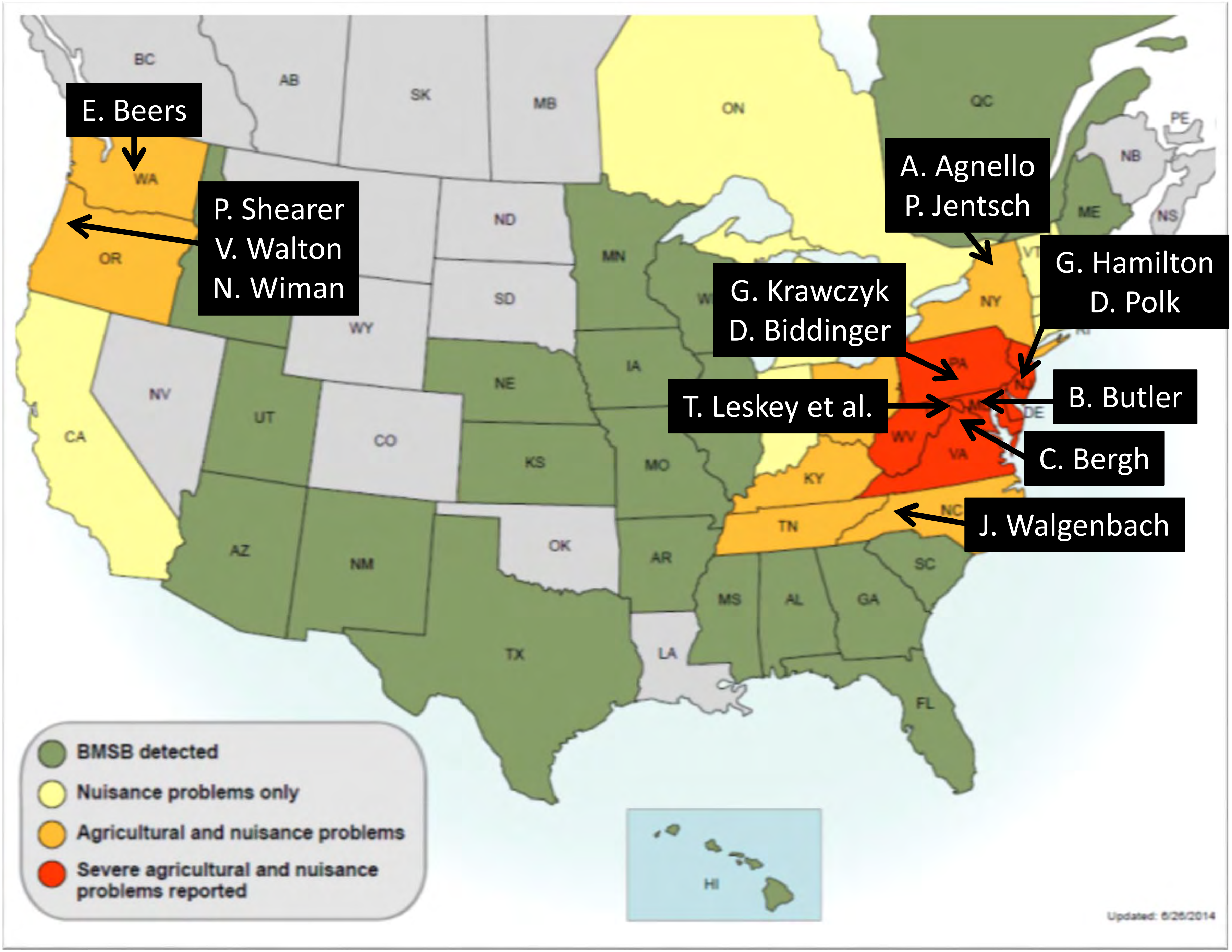
University of Maryland

Virginia Tech

OSU Oregon State University

NC State University

StopBMSB.org


E. Beers
P. Shearer
V. Walton
N. Wiman
A. Agnello
P. Jentsch
G. Hamilton
D. Polk
G. Krawczyk
D. Biddinger
T. Leskey et al.
B. Butler
C. Bergh
J. Walgenbach
BC
AB
SK
MB
ON
QC
NB
PE
NS
ME
VT
NY
PA
NJ
DE
MD
WV
VA
KY
TN
NC
SC
GA
AL
MS
FL
LA
AR
MO
IA
MN
WI
ND
SD
NE
KS
OK
TX
NM
CO
WY
UT
AZ
NV
CA
OR
WA
HI
BMSB detected
Nuisance problems only
Agricultural and nuisance problems
Severe agricultural and nuisance problems reported
Updated: 6/26/2014

Objectives and sub-objectives

Objective 1. Assess biology and phenology of BMSB

1.2 Establish the phenology of BMSB presence in and impact on specialty crops

1.3 Establish temporal and spatial patterns of crop-specific injury

Objective 2. Develop monitoring and management tools

2.1.4 Refine decision support tools (e.g. trap deployment strategy)

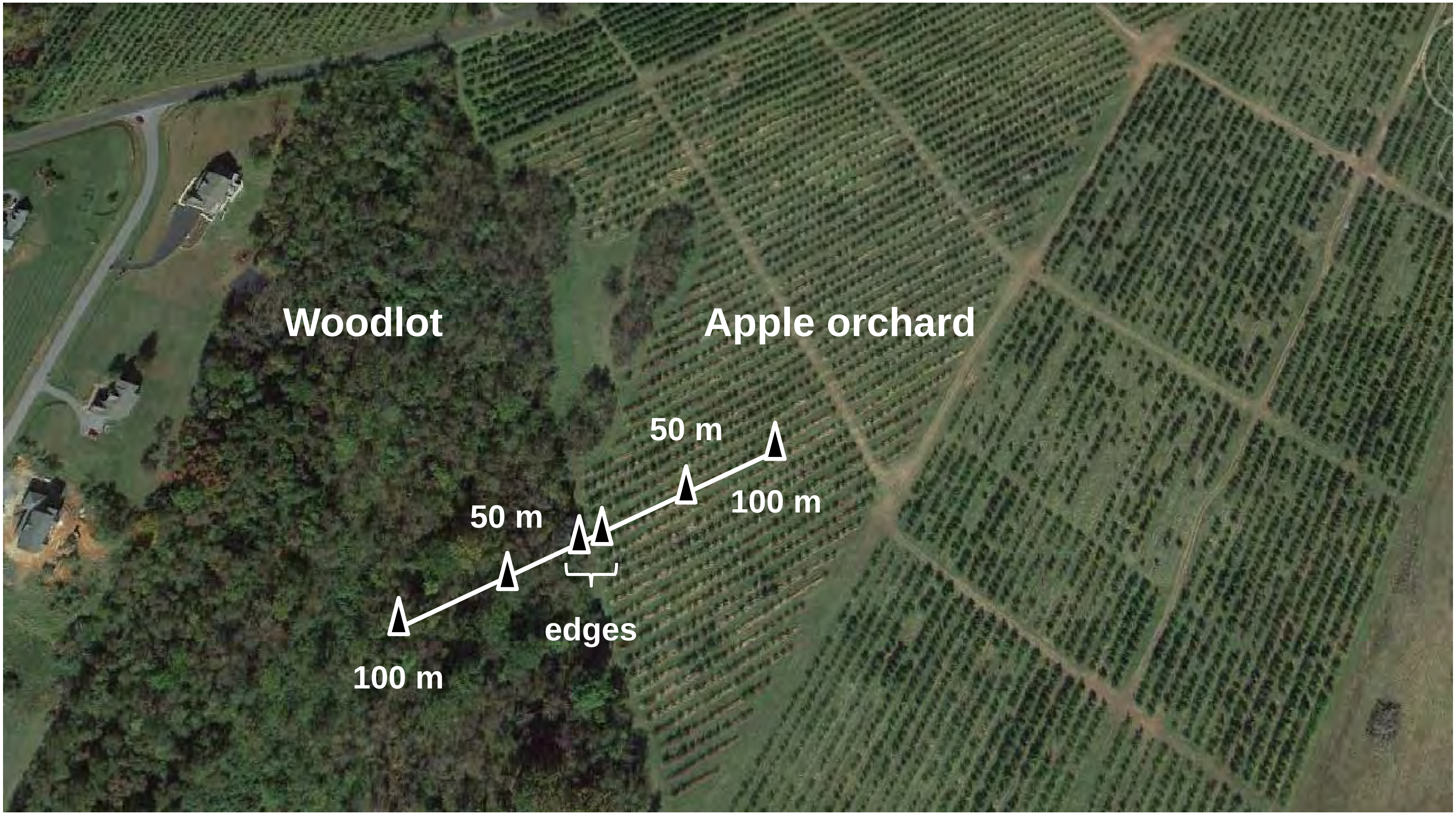
Objective 3. Develop effective management tools for BMSB

3.2 Refine management strategies based on use of BMSB monitoring tools to allow IPM practices to be resumed

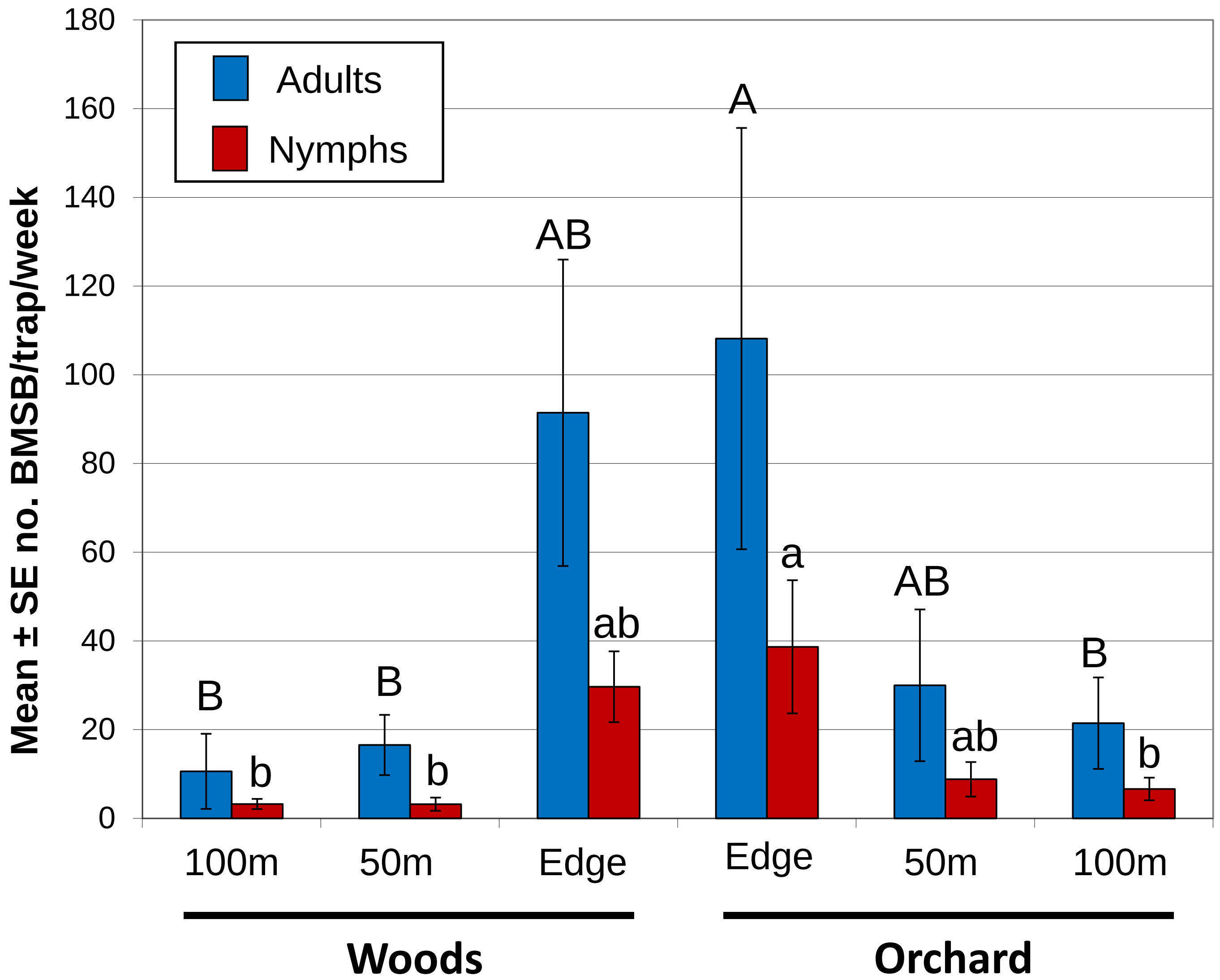
Refining the utility of pheromone traps for monitoring BMSB

- Do captures vary among traps along a woods-to-orchard transect?

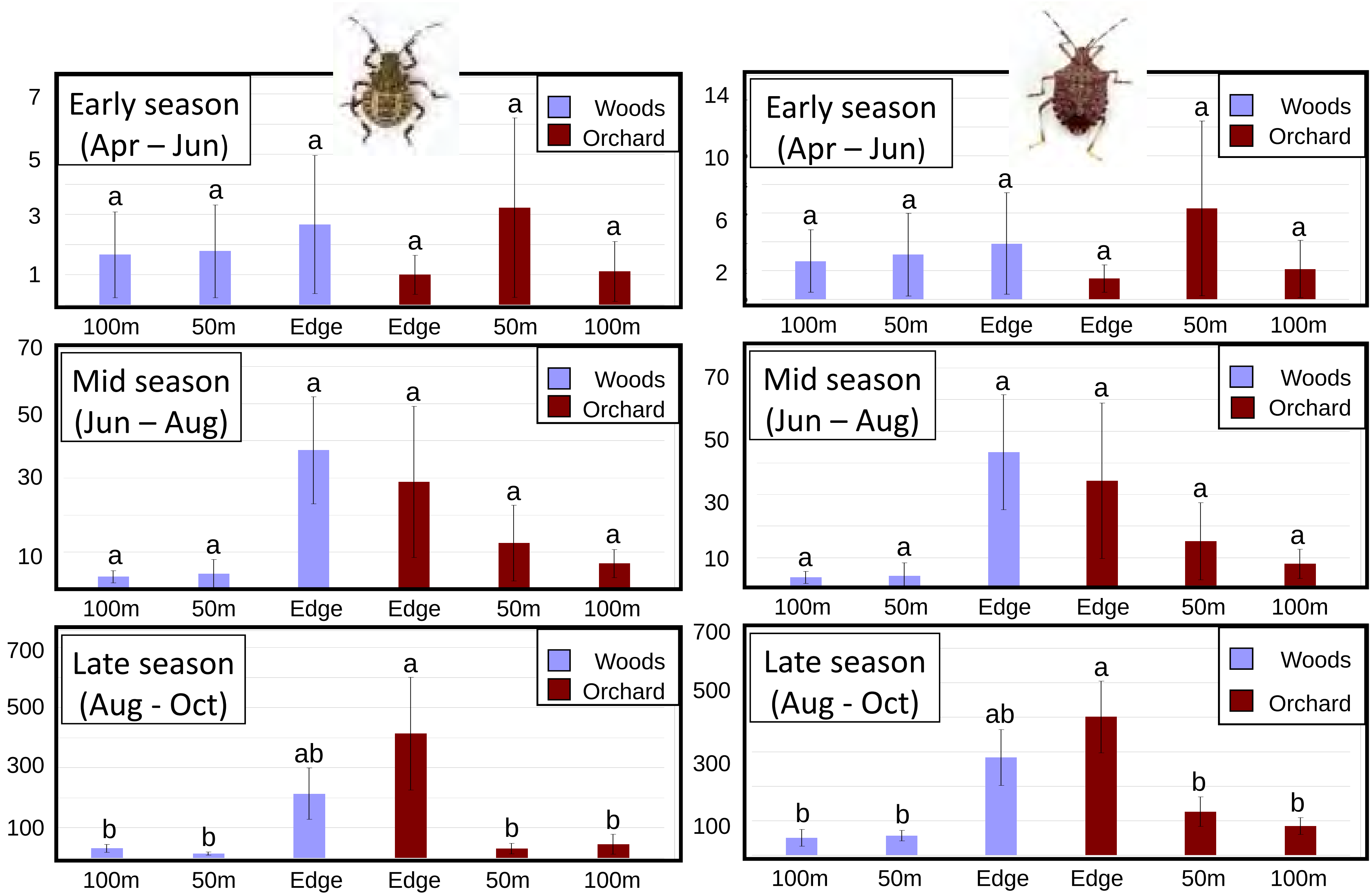
- Trap transects at 5 commercial apple farms
- Processing apples, therefore minimally sprayed for BMSB
- Captures recorded weekly (mid-April to mid-October)



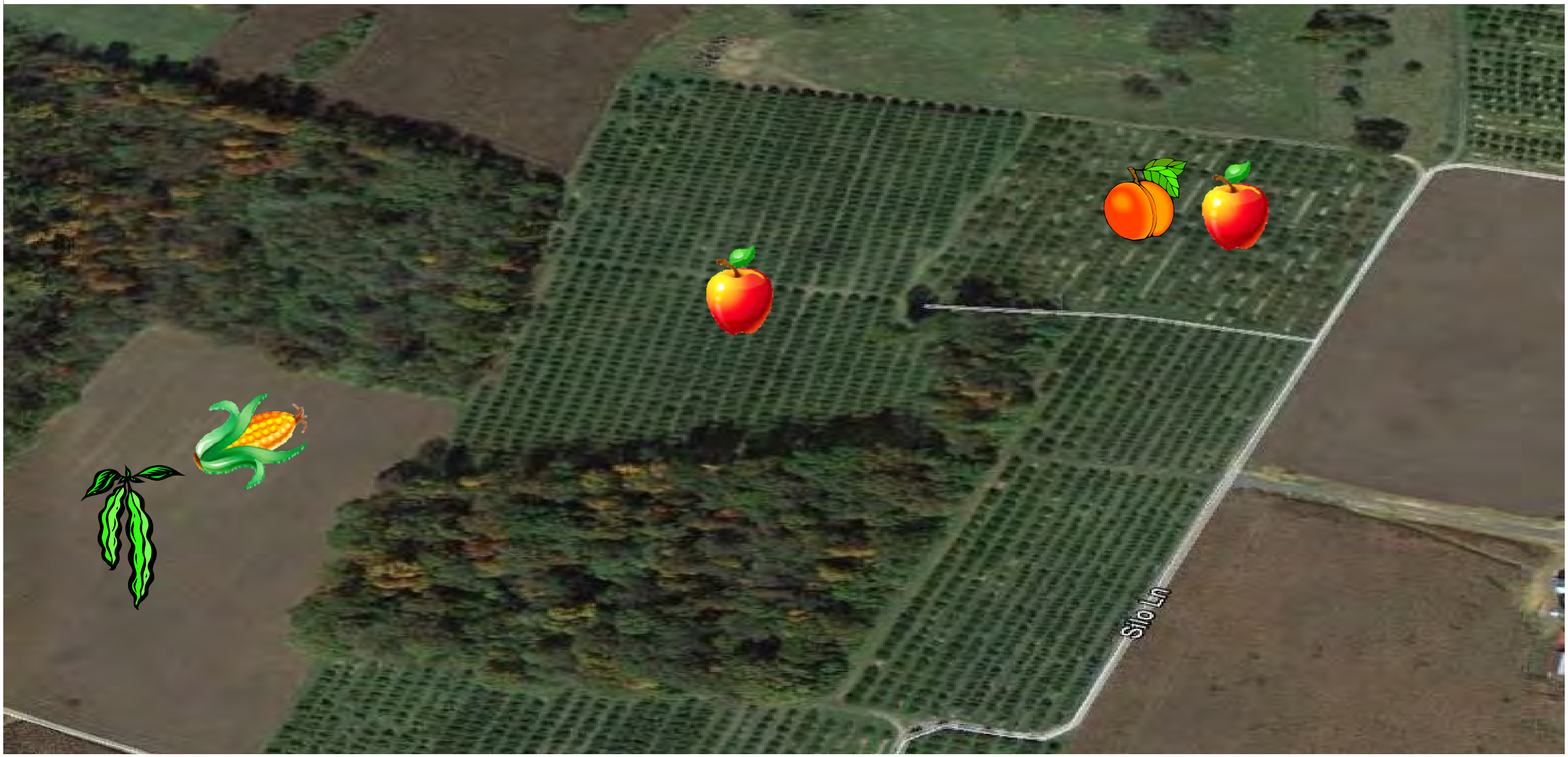
Full-season captures



Captures by 2-month interval



Effect of Border Habitat on BMSB Captures in Pheromone Traps and Fruit Injury



Mid-Atlantic apple blocks most commonly bordered by woods, adjacent tree fruit blocks, and/or field crops


Silo Ln


Silo Ln

BMSB invades orchards & crop fields from the perimeter

Does trap location affect BMSB captures?

- Orchard border vs interior
- Habitat bordering orchard

Is fruit injury affected by border habitat and/or proximity to traps?

Protocols: Orchard sites

- 10 commercial apple blocks (2013 and 2014)
- All with at least one woods border
- Habitat along other borders varied:
  - Field crop (corn, soybean)
  - Fruit orchard (apple, peach)
  - Other (urban, vegetables, small fruit, fallow field)

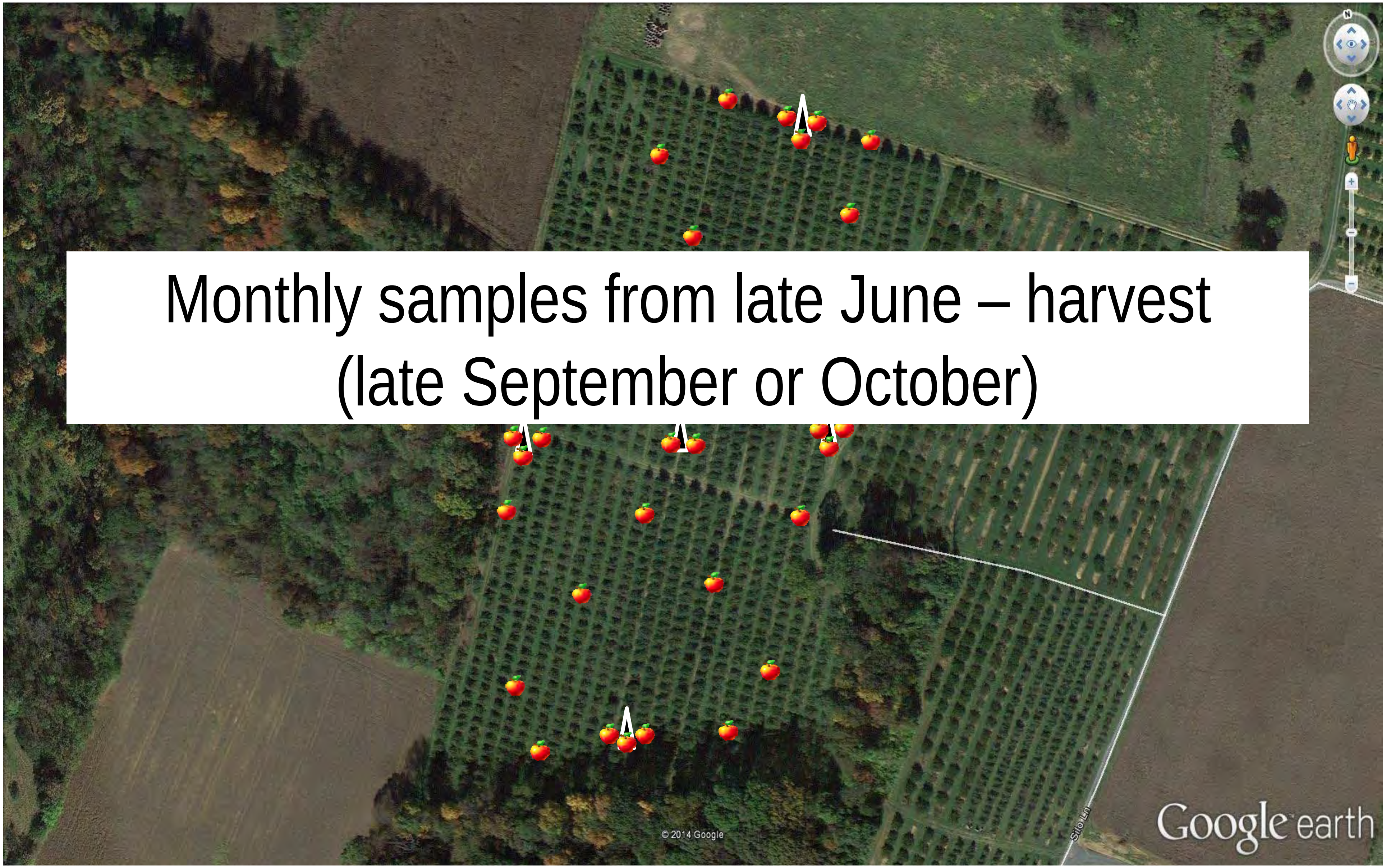
Protocols: Monitoring

- Pyramid trap at middle of each border row and block center
- Baited with pheromone + synergist
- Captures recorded weekly from April thro' harvest

Protocols: Fruit sampling, 2013

Protocols: Fruit sampling, 2014

Protocols: Fruit sampling, 2014



Monthly samples from late June – harvest (late September or October)

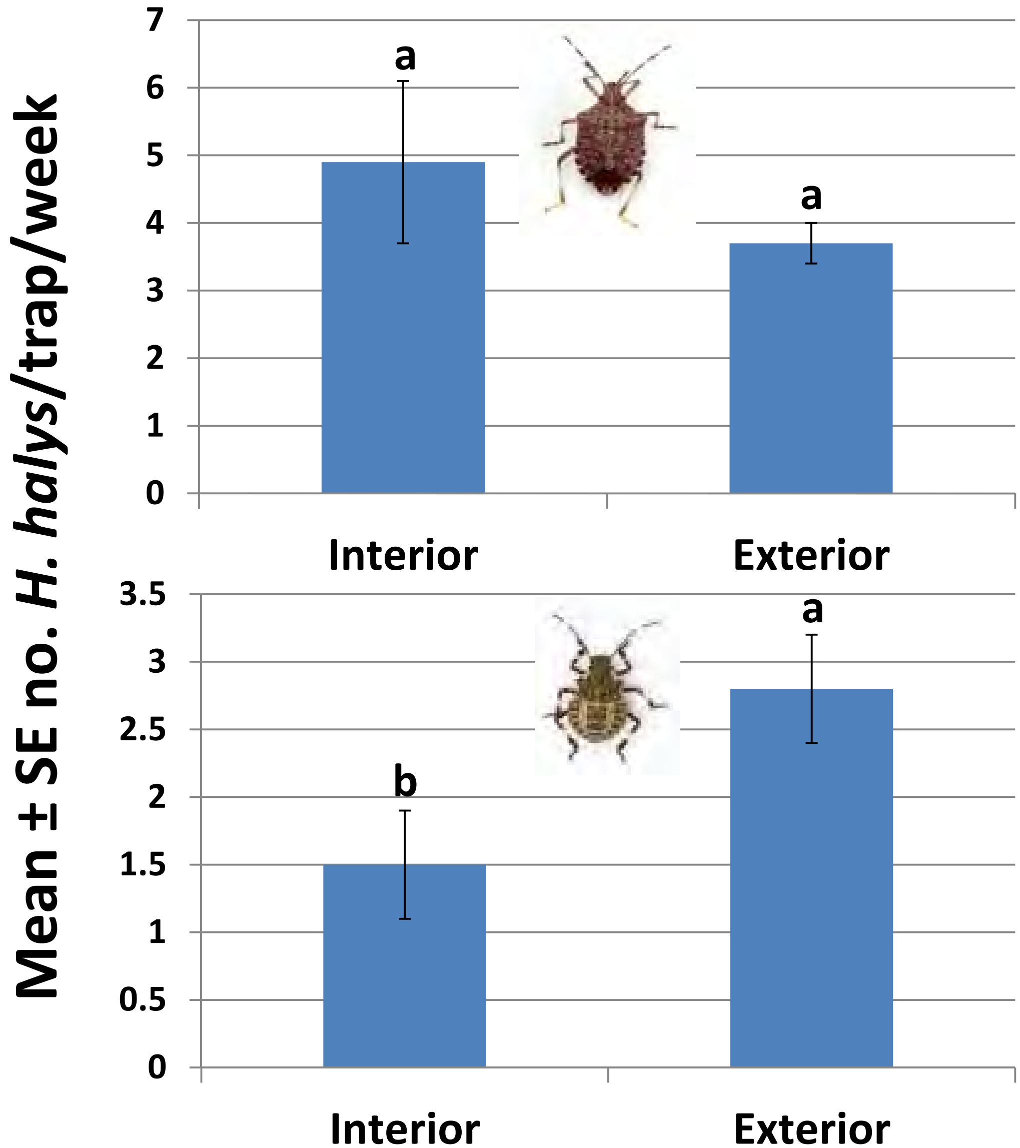
Protocols: Injury assessment

- Presence of external injury and internal corking
- No. of corked spots/corked fruit

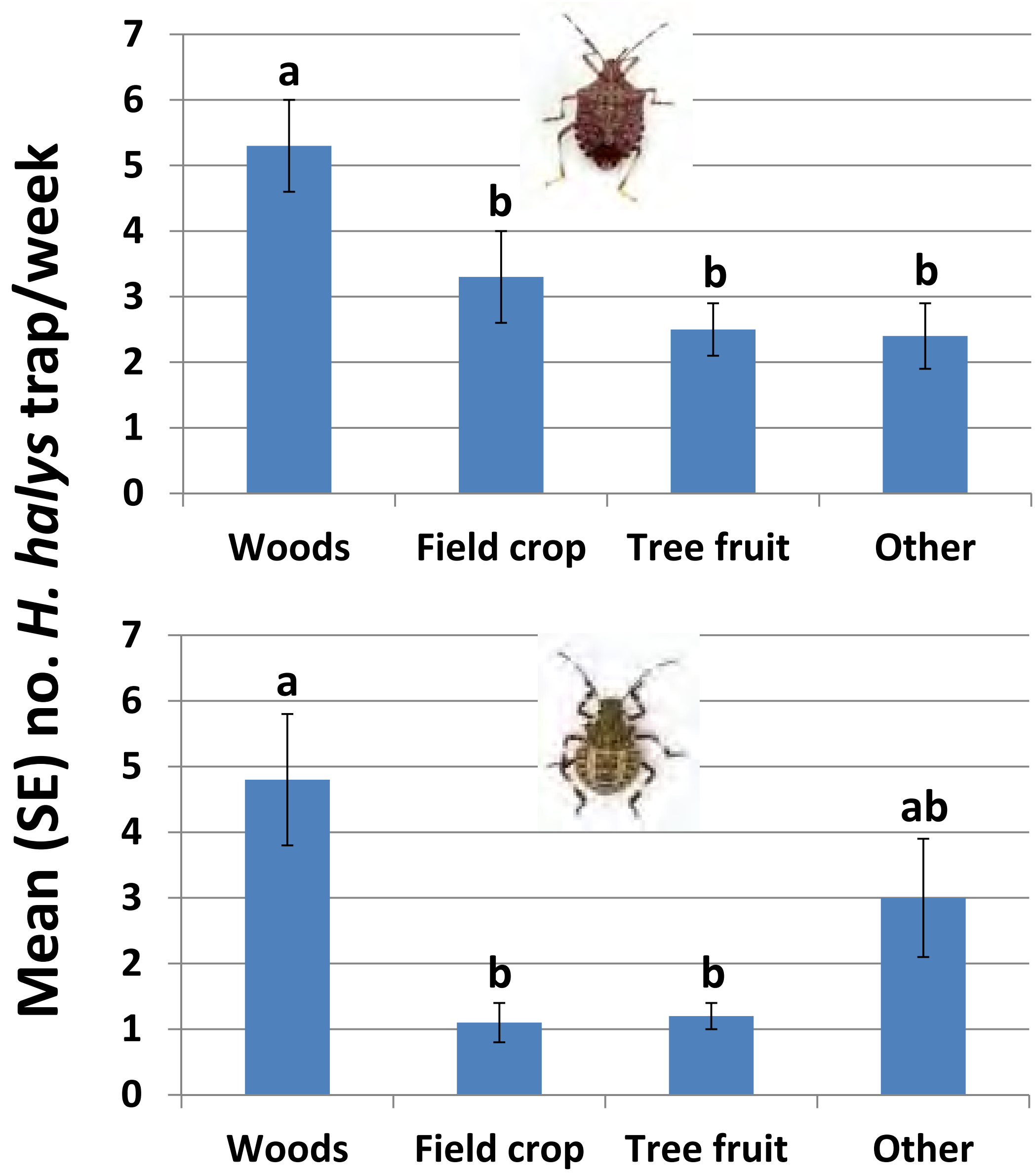
Overall summary of main results

- Combine data from VA and WV/MD
- Combine 2013 and 2014 for some data sets
- Only internal corking injury at harvest

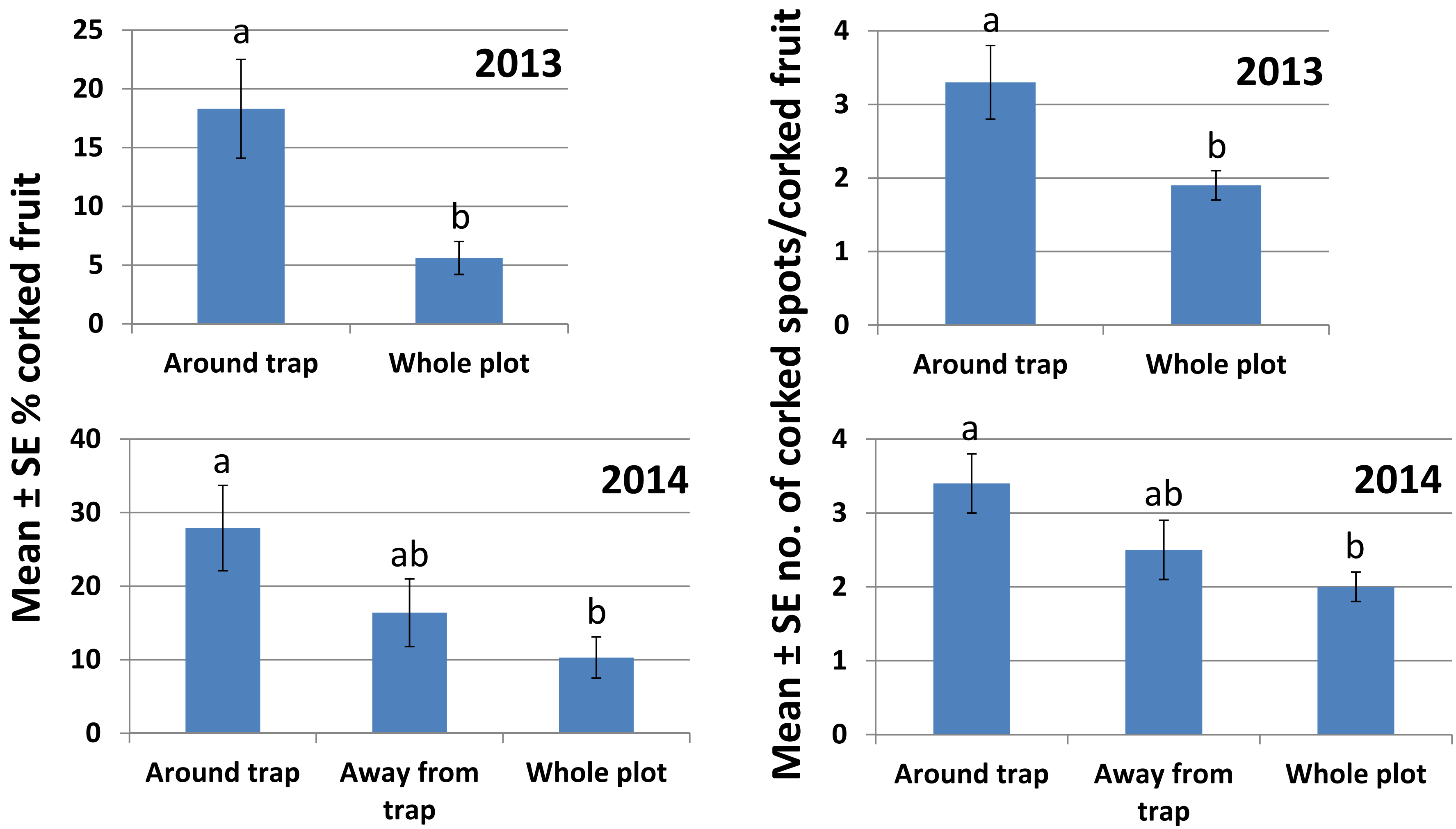
Full-season captures: Exterior vs interior



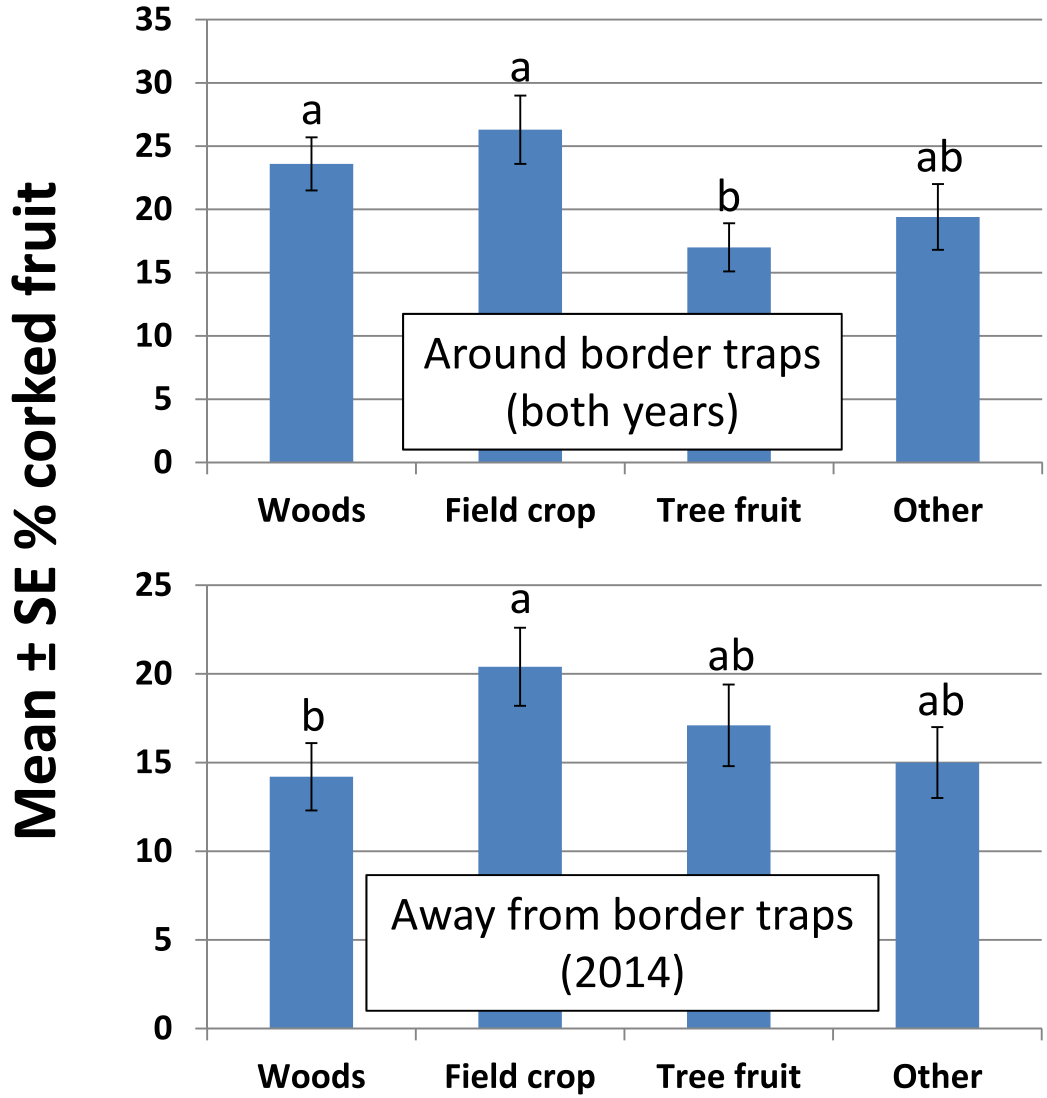
Full-season captures: Border habitat



Fruit injury at harvest: Border vs interior

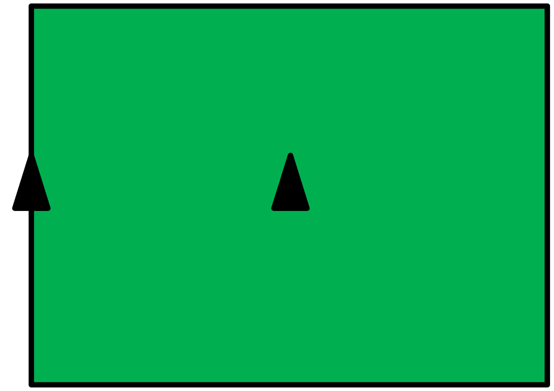


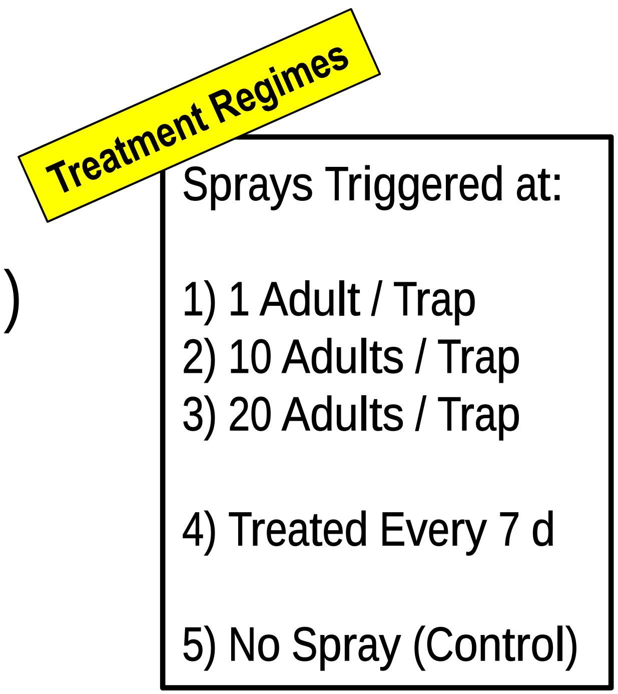
Percent injury to border row fruit at harvest: Habitat and proximity to trap



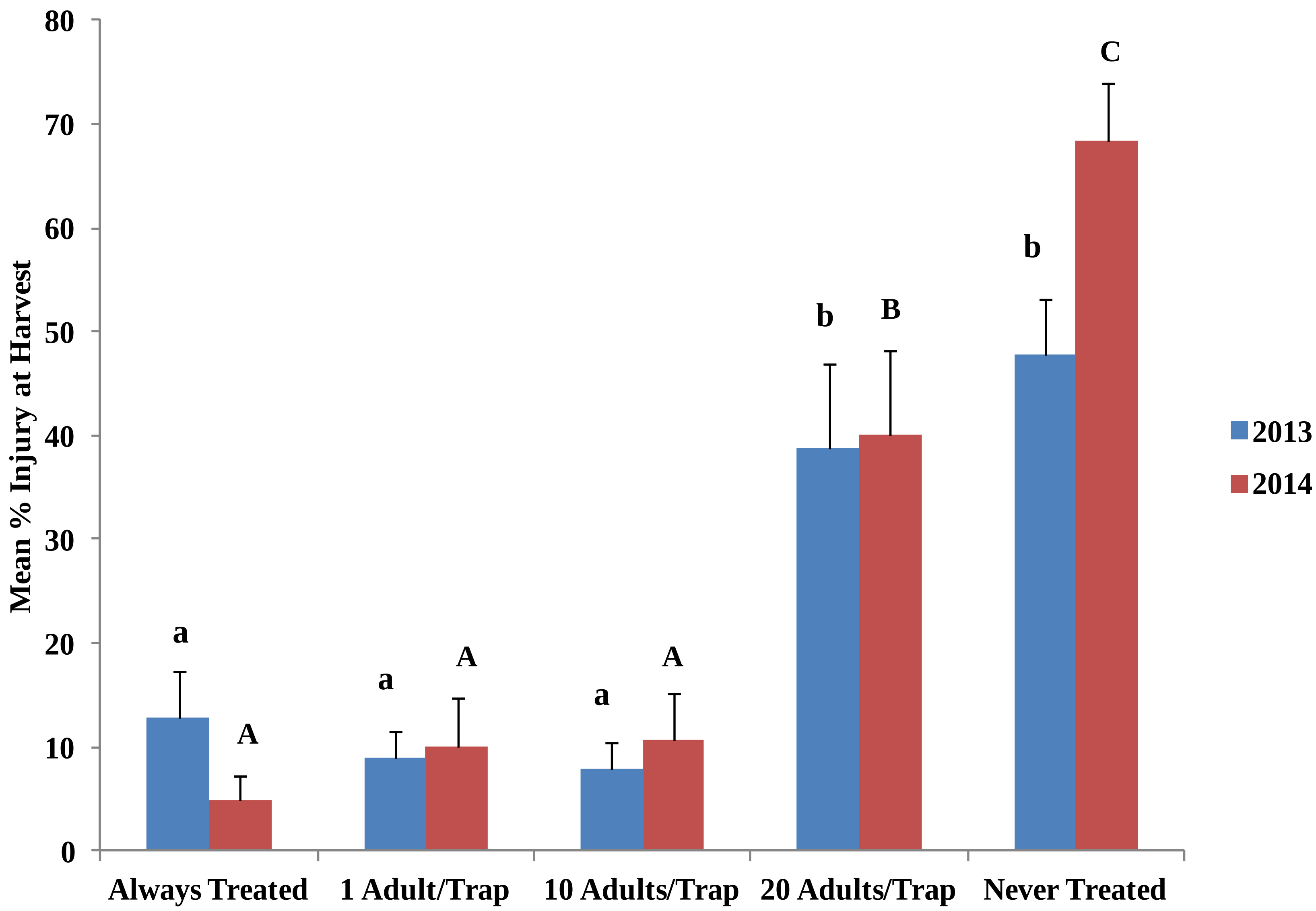
Can we use information provided by traps to guide management decisions?

- Apple blocks at AFRS, each monitored with 2 traps (pheromone + synergist)
- Captures recorded weekly
- When cumulative adult captures in either trap reached a set threshold, block treated with BMSB material (ARM)
- Block treated again 7-d later and threshold was reset

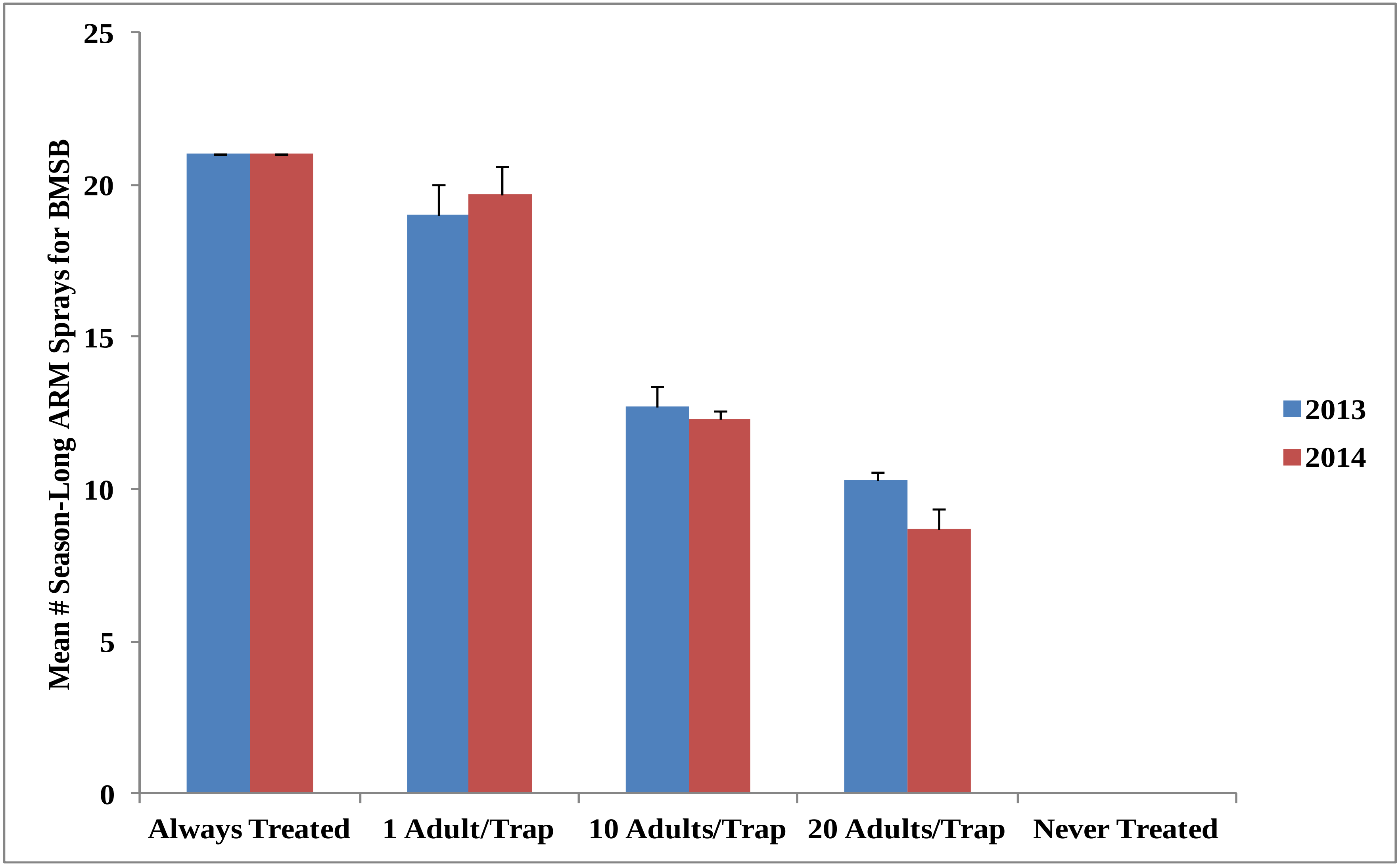




BMSB injury at harvest



Number of insecticide applications against BMSB



Summary from Mid-Atlantic apple orchards, 2014: Monitoring

- Strong effect of woods/orchard edge on captures starting mid-season
- Captures at orchard borders appeared to reflect adult pressure throughout the orchard
- Captures indicated higher nymphal pressure at borders
- Adult and nymphal pressure highest along woods border

Summary from Mid-Atlantic apple orchards, 2014: Injury

- More injury to border than interior fruit
- More injury to border fruit from trees around than away from traps
- Fruit from borders next to all habitats showed injury at harvest
- Despite differences in BMSB pressure among bordering habitats, no consistent indication of border habitat effect on injury at harvest
- Fruit from border rows, whether near or away from traps, will over-estimate whole-block injury

Summary from Mid-Atlantic apple orchards: Trap-based thresholds

- Captures can be used to trigger BMSB sprays
- Compared with weekly ARM, a threshold of 10 adults/trap reduced sprays by 40%, with no difference in injury at harvest
- Threshold of 1 adult/trap too sensitive (triggered more sprays without reductions injury)
- Threshold of 20 adults/trap not sensitive enough (missed key sprays from mid-July onward)
- Growers using the 10 adults/trap threshold in 2014 had no difference in injury between “standard” and “threshold” blocks

Implications and future directions

- Appropriate to deploy BMSB traps at apple orchard borders
- Traps along borders next to woods will best reflect pressure
- Highest captures at edge of woods and orchard support research on orchard perimeter-based management tactics
- Trap-based thresholds a promising management refinement
- As commercial companies refine lure formulations, thresholds may need to be recalibrated

Implications and future directions

- Continue to enhance the “user-friendliness” and cost-effectiveness of traps and the interpretation of the biological information they provide
- Despite lower BMSB pressure in 2014 and reduced need for intervention, another summer with hot and dry conditions may result in increased pressure

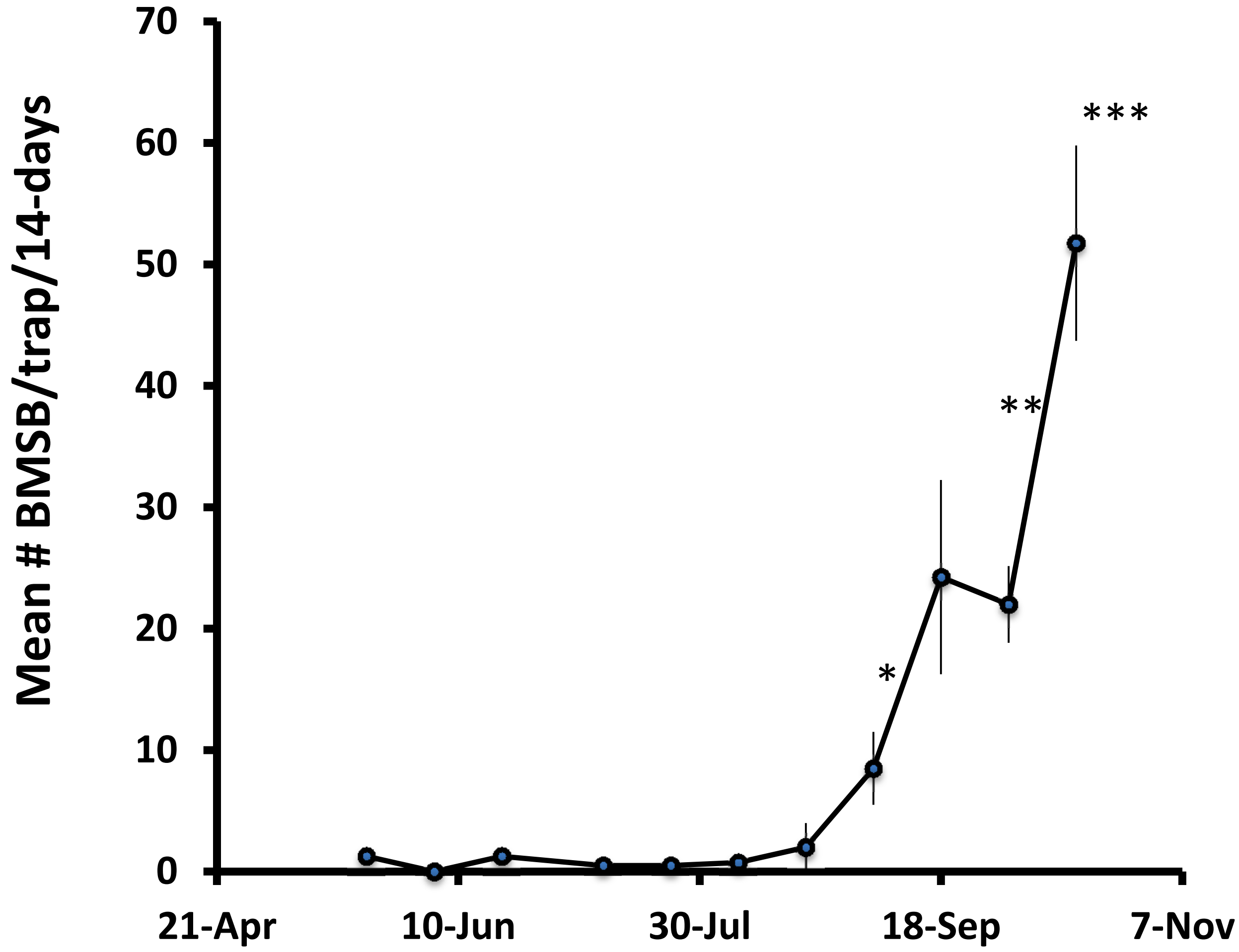
BMSB economic impact to OR hazelnuts, 2014

- 2 pyramid traps in each of 2 orchards sampled at 14-d intervals
- 40 beat samples/orchard at 14-d intervals
- 20 nut clusters in upper third of tree bagged from Apr - Oct
- Collected bagged and unbagged nuts at harvest
- Classified damage (undamaged, blanks, shriveled, corked nuts)

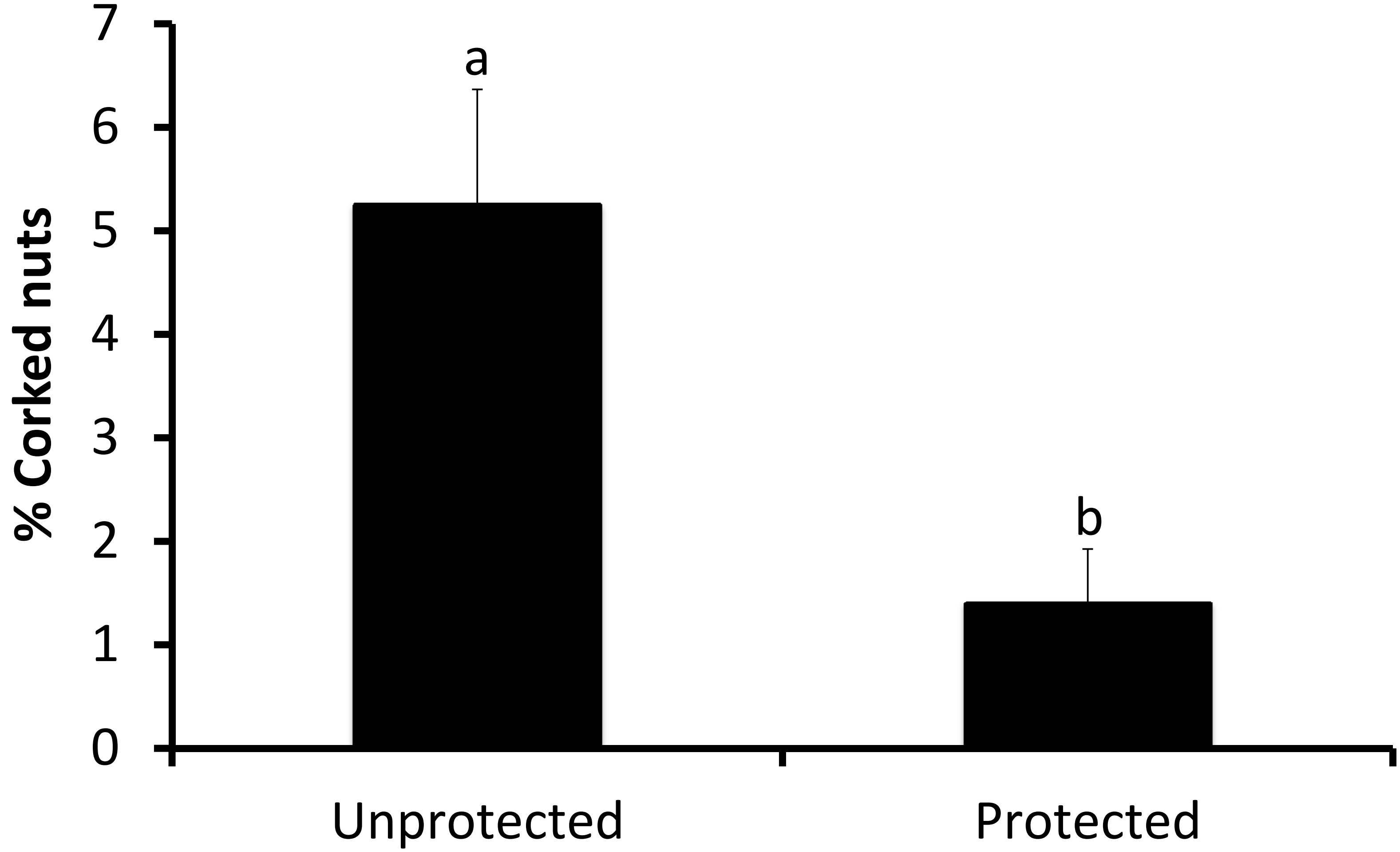
Deploying exclusion sleeves in hazelnuts in 2012

Pyramid trapping 2014

(no BMSB found via beat sheet sampling)



Nut damage 2014: % corked nuts



Summary and impacts from hazelnut, 2014

- First record of commercially important BMSB injury in hazelnut in 2014
- Beat sheeting not a viable monitoring method
- Increased captures in pheromone traps in September
- Injury included 5% corking (>1.5% corking from any pest considered unacceptable)
- Growers concerned about increasing BMSB pressure
- Want more focus on parasitoids other than *T. japonicus*
- Chemical control needs to be optimized
- Attract-and-kill is of interest as a low input method