Brown Marmorated Stink Bug
IPM Working Group Meeting

Cook Campus Center, Multi-purpose Room A

Rutgers – The State University of New Jersey

59 Biel Road, New Brunswick, NJ 08901

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Submitted by:

Dr. Tracy Leskey
Brown Marmorated Stink Bug Working Group
Research Entomologist
USDA-ARS
Appalachian Fruit Research Laboratory
2217 Wiltshire Road
Kearneysville WV 25430-2771 USA
TEL: 304-725-3451 x329
FAX: 304-728-2340
EMAIL: tracy.leskey@ars.usda.gov

Dr. George Hamilton
Brown Marmorated Stink Bug Working Group
Extension Specialist in Pest Management
Department of Entomology
96 Lipman Drive
Rutgers – The State University of New Jersey
New Brunswick, NJ 08901
TEL: 732-932-9774
PEST MANAGEMENT OFFICE: 732-932-9801
FAX: 732-932-9751
EMAIL: hamilton@aesop.rutgers.edu

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Workshop Participants List

Name	Affiliation	Address
Allen, McKenzie	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Road Kearneysville, WV 25430
Bohnenblust, Eric (Webinar)	US EPA EPA	US EPA 1200 Pennsylvania Ave, NW Washington, DC 20460
Boyle, Sean	University of Delaware	University of Delaware 250 Townsend Hall Newark, DE 19716
Buffington, Matt	Systematic Entomology Lab, USDA	Systematic Entomology Lab USDA 10th & Constitution Ave NW PO Box 37012 MRC-168 Washington, DC 20560
Chambers, Ben (Webinar)	Virginia Tech	406 Eastview Terrance Blacksburg, VA 24060
Cleeman, Jeremy	Rutgers University	Rutgers University 96 Lipman Drive New Brunswick, NJ 08901
Colavecchi, Ashley	USDA ARS BIIRU/University of Delaware	USDA ARS BIIRU 501 S. Chapel Street Newark, DE 19713
Concklin, Mary (Webinar)	University of Connecticut	University of Connecticut 1376 Storrs Road, Unit 4067 Storrs, CT 06269-4067
Dorsey, Thomas	NJ Dept of Ag Phillip Alampi Beneficial Insect Laboratory	NJ Dept of Ag Phillip Alampi Beneficial Insect Laboratory State Police Drive Trenton, NJ 08625
Duke, Savannah	Auburn University	202 Extension Hall Auburn University Auburn, AL 26849

Name	Affiliation	Address
Erwin, Nathan	USDA ARS BIIRU	USDA ARS BIIRU BARC-West, 10300 Baltimore Ave Beltsville, MD 20705
Fredricks, Ryan	Rutgers University	Rutgers University 96 Lipman Drive New Brunswick, NJ 08901
Gonzales, Chris	Northeastern IPM Center	Northeastern IPM Center Cornell University 340 Tower Road Ithaca, NY 14853
Hamilton, George	Rutgers University	Rutgers University 96 Lipman Drive New Brunswick, NJ 08901
Hanlon, Carlie	Rutgers University	Rutgers University 96 Lipman Drive New Brunswick, NJ 08901
Harper, Jayson	Pennsylvania State University	Pennsylvania State University 201-D Armsby Bldg University Park, PA 16802
Hedstrom, Chris	Oregon Department of Agriculture	Oregon Department of Agriculture 635 Capitol St. NE Salem, OR 97301
Hoelmer, Kim	USDA ARS BIIRU	USDA ARS BIIRU 501 S. Chapel St Newark, DE 19713
Ingels, Chuck	University of California Cooperative Extension, Sacramento County	University of California Cooperative Extension, Sacramento County 4145 Branch Center Rd Sacramento, CA 95827-3823
Jentsch, Peter (Webinar)	Cornell University	Cornell University Hudson Valley Research Lab 3357 US Route 9W Highland, NY 12528

Name	Affiliation	Address
Krawczyk, Greg	PSU FREC	FREC Pennsylvania State University 290 University Drive Biglerville PA 17307
Lampasona, Tim (Webinar)	Cornell University	Cornell University Hudson Valley Research Lab 3357 US Route 9W Highland, NY 12528
Legrand, Ana (Webinar)	University of Connecticut	University of Connecticut 1376 Storrs Rd, U-4067 Storrs, CT 06269
Lesieur, Vincent	USDA ARS European Biological Control Lab/Montpellier-SupAgro, UMR CBGP	European Biological Control Laboratory USDA-ARS, 810 Avenue du Campus Agropolis 34980 Montferrier sur Lez, France
Leskey, Tracy	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Rd Kearneysville, WV 25430
Lovero, Angela	NJ Department of Agriculture Phillip Alampi Beneficial Insect Laboratory	NJ Department of Agriculture Phillip Alampi Beneficial Insect Laboratory State Police Drive Trenton, NJ 08625
Lowenstein, David	Oregon State University	North Willamette Research and Extension Center Oregon State University 4109 ALS Corvalis, OR 97331
MacLean, Priscilla	Hercon Environmental	Hercon Environmental PO Box 435 Emigsville, PA 17318
Morin, Hillary	PSU FREC	FREC Pennsylvania State University 290 University Drive Biglerville PA 17307

Name	Affiliation	Address
Morrison, Rob	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Road Kearneysville, WV 25430
Pickett, Charles	California Department Food and Agriculture	California Department Food and Agriculture 3288 Meadowview Road Sacramento, CA 95632
Quinn, Nicole	Virginia Tech	Prince Hall, Room 216A, Virginia Tech 170 Drillfield Drive Blacksburg, VA 24061
Ramsey, Amanda	Scentry Biologicals, Inc	Scentry Biologicals, Inc 610 Central Ave Billings, MT 59102
Rentzel, Kay (Webinar)	National Peach Council	National Peach Council 22 Triplett Court Dillsburg, PA 17019
Rice, Kevin	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Rd Kearneysville, WV 25430
Rodriguez-Saona, Cesar	Rutgers University	P.E. Marucci Center Rutgers University 125A Lake Oswego Road, Chatsworth, NJ 08019
Rugh, Tony	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Rd Kearneysville, WV 25430
Short, Brent	USDA ARS AFRL	USDA ARS AFRL 2217 Wiltshire Rd Kearneysville, WV 25430
Talamas, Elijah	Systematic Entomology Lab, USDA	Systematic Entomology Lab USDA 10th & Constitution Ave NW PO Box 37012 MRC-168, Washington, DC 20560

Name	Affiliation	Address
Tatman, Kathleen	USDA ARS BIIRU	USDA ARS BIIRU 501 S. Chapel Street Newark, DE 19713
Glynn Tillman	USDA ARS CPMRU	USDA ARS CPMRU P.O. Box 748 2747 Davis Road – Bldg #1 Tifton, GA 31793
Villiard, Alexandra (Webinar)	NJ Department of Agriculture Phillip Alampi Beneficial Insect Laboratory	NJ Department of Agriculture Phillip Alampi Beneficial Insect Laboratory State Police Drive Trenton, NJ 08625
Weber, Don	USDA ARS Insect Biocontrol and Behavior Lab	USDA ARS Insect Biocontrol and Behavior Lab 10300 Baltimore Avenue Bldg. 007, RM. 301, BARC-West Beltsville MD 20705
Welty, Celeste (Webinar)	Ohio State University	Bee Laboratory Ohio State University 2501 Carmack Road Columbus, OH 43210
Zanelato Nunes, Marcelo	Pennsylvania State University Fruit Research & Extension Center	Pennsylvania State University Fruit Research & Extension Center 290 University Drive Biglerville PA 17307
Zinati, Gladis	Rodale Institute	Rodale Institute 611 Siegfriedale Road Kutztown, PA 19350

Executive Summary

The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) continues to spread throughout the United States. BMSB has been detected or intercepted in 42 states and 2 Canadian provinces, posing severe agricultural problems in 9 states and nuisance problems in 18 other states. Large populations are now established in DC, DE, MD, NC, NJ, PA, VA and WV; each state documented severe losses in crops and serious nuisance problems from BMSB since 2010. Agricultural and nuisance problems have been reported in CT, GA, KY, IN, MI, NY, OH, OR, TN, and WA. Though crop losses have not yet been reported, they are considered a nuisance problem in AL, CA, IL, NH, MA, MO, RI, SC, UT, VT and Ontario. In addition, BMSB has been detected in AR, AZ, FL, IA, ID, KS, ME, MN, MS, NE, NM, TX, WI and Quebec and has been intercepted in HI. The BMSB IPM Working Group updated the BMSB map that is published on the www.StopBMSB.org website.

The thirteenth formal BMSB Working Group meeting was held at the Rutgers University Cook Campus Center on June 16th, 2016. Research and extension personnel from Rutgers University, USDA-ARS, Auburn University, Penn State University, University of California Cooperative Extension, University of Delaware, Virginia Tech, Oregon State University, the California Department of Food and Agriculture, the New Jersey Department of Agriculture Phillip Alampi Beneficial Insect Laboratory, the Northeastern IPN Center, the Rodale Institute, the USDA Systematic Entomology Laboratory, and industry participants attended the meeting. In addition, participating through webinar were representatives from Cornell University, University of Connecticut, Ohio State University, Penn State University, Virginia Tech, the National Peach Council, the NJ Department of Agriculture Phillip Alampi Beneficial Insect Laboratory and EPA.

There were thirty-nine participants in attendance along with nine participating by webinar. The meeting was opened with welcoming remarks, followed by a discussion of the detection/nuisance/ag pest map and Northeast, Southern, North Central and Western updates. The afternoon session consisted of several talks involving biological control efforts in the US, rearing diet efficacy and a homeowner BMSB survey. Group discussions during the meeting included BMSB updates, EPA regulatory issues, BMSB biological control efforts, and priority development and rankings.

BMSB Presentations

Welcome/Opening Remarks/MAP

Presented by: Tracy Leskey[1] & George Hamilton[2]
USDA-ARS-AFRL[1] and Department of Entomology, Rutgers University[2]

Summary:

- Welcomed everyone to the 13th annual working group meeting
- Overview of day's schedule
- Updated Priorities
  - Reviewed priorities
  - Reranked priorities
- Hawaii has requested that the Hawaii detection be referred to as an interception

Northeast Pest Status Update

Presented by: George Hamilton
Rutgers University

Summary:

- Reviewed New England States – ME, VT, NH, MA, CT, RI
- Except for New England, populations appear to be higher than last year
- New York, Pennsylvania and New Jersey web reports are being handled by Bugwood/EDDMaps
- *Trissolcus japanicus* recovered in Delaware last fall
- An overview of the EDDMaps data for 2016 was presented

Southern Region BMSB Update

Presented by: Glynn Tillman
USDA-ARS-CPMRU

Summary:

- Received funding in 2016 to create Southern BMSB Working Group
  - Held 1st meeting in April
  - Tracking spread and providing information via EDDMapS
  - Created a BMSB ID brochure
- Southern region monitoring adults using AgBio combo lure
- Florida – 36 detections but no establishment so far, one detect in peaches
- Georgia – Reproducing populations in cotton, pecan, catalpa, ornamental hibiscus, apple,

soybean and peach
- South Carolina – Reproducing populations in cotton, soybeans, grain sorghum and peaches, nuisance pest in homes
- Alabama – Nymphs found in soybeans, damage occurring in soybeans, increase in damage in corn, serious nuisance pest in homes
- Tennessee - Found in over 30 counties, damaging corn and soybeans in eastern 1/3 of state, nuisance pest in remaining areas so far
- North Carolina – Found throughout most of the state, widespread ag and urban pest in western areas, reproducing and causing damage in apples, peaches, Asian pears, fruiting vegetables, corn, soybean, pecan and cotton

Status of BMSB in the Midwest

Presented by: Celeste Welty
The Ohio State University

Summary:

- Previous reports in MN, IA, WI, MI, IL, and IN, new reports in ND, SD, NE, KS and MO
- Ohio – BMSB recovered from pheromone traps in 18 counties, mostly in sweet corn and brambles
- Indiana – Confirmed in 33 counties (6 new detects), damage seen in apples, peppers, soybean, sweet corn and tomato
- Michigan – MOSIN web reports have increased from 9 in 2015 to 3,338 as of 6/10/16, detected in 48 counties, possible damage seen in 2015 in Berrien, Kent and Genesee County orchards
- Illinois – Confirmed in 8 counties, highest near St. Louis and Chicago, no significant damage reported
- Iowa - Found in 11 counties, all reports from buildings
- Wisconsin - Found in 13 counties (5 new), no damage reported, monitoring in apples in 2016
- Minnesota – Found in 15 counties, mostly adults in structures, 1 site has a reproducing population, no plant damage
- Missouri – Most reports come from St. Louis area, some reports from farms but no crop injury, currently trapping in 16 locations
- Kansas – At least one report but no establishment
- Nebraska – Found in 3 counties, all in structures and/or cargo, limited trapping survey in progress
- South Dakota – No detection yet but are monitoring
- North Dakota – Two detects from cargo, monitoring in soybean with no detections so far
- Change North Dakota from a no detect to detection only

BMSB Regional Update: Western Region

Presented by: Chuck Ingels
UC Cooperative Extension of
Sacramento County

Summary:

- Washington – BMSB are increasing and coming from numerous locations throughout the state
- Oregon – BMSB detected in 2 counties, established in 19 counties, new populations in coastal counties, ag/urban problems in Willamette Valley, damage in apples in Milton-Freewater area in east, additional damage seen in sweet cherries, hazelnuts
- Utah – New detections in 5 counties, have reproducing populations, using traps, beat sampling and citizen reports to find BMSB
- California – BMSB detected in 19 counties, established in 9 additional counties, the Sacramento population is increasing and expanding to new areas,
- California – A comparison of AgBio and double cone traps shows similar results although AgBio numbers are 14% higher, and are seeing two generations; in another study Recue lure caught more adults than Trece, AgBio and AlphaScents lures
- California – Damage seen on peach, Asian pear, nectarine, apples, persimmons, avocadoes, citrus, cracked citrus and Arizona walnut
- California – Seeing trunk feeding on cherry, orange, Shamel ash, crape myrtle and zelkova
- California – Seeing feeding on BMSB by ground beetles, *Astata sp.* and rats
- California – Conducting egg parasitoid choice and no choice tests with native stink bugs

BMSB Classical Biological Control: Status Report

Presented by: Kim Hoelmer
USDA-ARS-BIIR, Newark DE

Summary:

- Adventive *Trissolcus japonicus* populations found in MD, D.C., VA and DE in east, WA in west. PCoA shows east and west coast populations are different and not from US cultures, need to do more field surveys to detect new *T. japonicus* populations, still working toward release of Beijing collected parasitoids
- Choice/No Choice tests continue although lab tests can create false positives, field experiments in area of origin and behavioral studies are needed to confirm results
- Exposure time can influence host choice in tests

Update On the Genetic Characterization of West Coast BMSB and Adventive Populations of *Trissolcus japonicus*

Presented by: Vincent Lesieur
USDA-ARS-EBCL

Summary:

- Original eastern BMSB population likely introduced from Beijing, similar situation in Switzerland, Canadian population has a US origin
- Based on samples for OR, WA and CA, western BMSB population has more diversity that eastern population
- CA – BMSB H1 and H2 pattern similar to east and likely came from Beijing
- WA and OR – 6 BMSB haplotypes found, Beijing and Nanjing likely source areas but Japan is also implicated
- *Trissolcus japonicus* – strains from China, Japan and South Korea being used to evaluate host range/efficacy prior to release, however, the parasitoid has shown up in the US by itself on the east and west coasts
- *T. japonicus* microsatellite, CO1 sequencing and PCoA analysis show that wild population in US not an escape from quarantine labs
- *Trissolcus* Phylogeny – done using 1616 base pairs from mitochondrial and nuclear genes from 289 reveals 19 species (some new to science)

A Study of Native Parasitoids and Rearing Diet Efficacy for the Brown Marmorated Stink Bug *Halyomorpha halys*

Presented by: Ana Legrand
University of Connecticut

Summary:

- The objectives of this work was to determine the effect of rearing diets on BMSB survival and development, determine the parasitoids species found in our area; to determine which parasitoid species attack native stink bugs and BMSB; and to determine if there are parasitism and predation differences due to habitat
- Rearing diet study – 6 treatments (apple alone, carrot alone, bean alone, apple & carrot, apple & bean, bean & carrot), 25-29 egg masses per diet, nymphs kept at 24ºC and 14L:10D photoperiod
- Results - BMSB survival was lowest on apple diet possible due to phytosterol content of different food sources (carrots highest, apple lowest) or deterioration of apples in cold storage, a bean & carrot diet could be a good combination for survival and development time
- Parasitism & predation survey – used frozen sentinel egg masses of green, brown and brown marmorated stink bus placed in three habitats (field/wood borders, filed corn and ornamental landscapes), egg masses were removed after 48h and held at 24ºC until emergence of parasitoids occurred, unhatched eggs were evaluated for predation and dissected to look evidence of

parasitism

- Results – *Ooencyrtus sp.* was recovered from green stink bug eggs only, *Telenomus podisi* was recovered from all three species with the lowest number of parasitized eggs occurring with BMSB, mean days to hatching was seen with the green stink bug, predation rates were highest in ornamental habitats for all three species, parasitism rates were highest in field/wood borders for BMSB and green stink bug, statistical differences in % predation were seen between field/wood borders and ornamental habitats for all three species, statistical differences in % parasitism were seen between field/wood borders and ornamental habitats for green stink bug and BMSB only

Spiders as Natural Biological Control Agents In and Around Human Dwellings

Presented by: Rob Morrison
USDA-ARS-AFRS

Summary:

- Common U.S. BMSB natural enemies include parasitoids (*Anastatus reduvii*, *Trissolcus japonicus* and *T. brochymenae*) and predators (katydids, ground beetles and jumping spiders
- Nothing is known about natural enemies at overwintering sites, spiders may have a significant impact on BMSB at these sites
- BMSB adults were place in webs found in the landscape, building exteriors and building interiors and observed for 5 minutes at 0, 1, 2, and 24h after introduction, all spiders were collected, sorted by size class and identified
- Significantly more BMSB adults could escape from webs made by tetragnathid spiders, significantly more BMSB adults were eaten by pholcid and agelenid spiders
- Significantly more BMSB adults were able to escape from webs made by small and medium sized spiders, Large spiders were able to eat significantly more BMSB adults than small and medium spiders
- More BMSB adults were found in webs made on the exterior of building than either building interiors and landscapes

Making Sense of Brown Marmorated Stink Bug Biological Control

Presented by: Don Weber
USDA-ARS-IIBBL

Summary:

- Placed ≤ 24h BMSB eggs, ≤ 24h frozen BMSB eggs and ≤ 24h frozen *Podisus maculiventris* eggs in soybean, orchards and scattered trees, and woods from 2014-2015, once removed all unhatched eggs were dissected and evaluated
- Five native (*Anastatus reduvii, T. euschisti, T. brocymenae,* and *T. edessae*) and one adventive (*T. japonicus*) parasitoids were found to successfully emerge from fresh and frozen BMSB eggs and from fresh *P. maculiventris* eggs
- Data show that *T. japonicus* overwintered in MD and parasitizes BMSB and *P. maculiventris* eggs in the field
- All parasitoids showed habitat specificity and vary in successful emerging from BMSB eggs
- Future research: track population expansion of *T. japonicus*, use cages on existing vegetation to duplicate real world, examine semiochemical cues used by parasitoids, use molecular tools to track parasitism failures, and develop measure to improve parasitoid success.

BMSB Nuisance Survey Results

Presented by: Kevin Rice
USDA-ARS-AFRS

Summary:

- In 2015-2016, a survey was administered via StopBMSB.org using SurveyMonkey, website, media interviews and extension forums to gather descriptive data, and examine general public's perception of the seriousness of the BMSB nuisance problem, 527 people responded
- Results indicated that most respondents have a problem with BMSB, that the problem was mostly in their homes, and that they had had the problem for ~3 years
- Respondents tended to say that their problem was bad or somewhat annoying, that 40% had from 1-99 BMSB in their home, and that most had tried physical exclusion, insecticides or other techniques to mitigate the problem
- Overall 55% of respondents used physical exclusion, of those ~50% thought it was moderately effective, respondents also thought the use of insecticides was mostly ineffective or moderately effective, similar response rates were seen for the use professional services
- When asked to rate the effectiveness of outside trapping while 70% said it was not effective, 20% said it was moderately effective, inside 55% thought trapping was ineffective with 20% responding they were moderately effective
- When asked about the use of repellants 22 and 50% of respondents were either not satisfied or okay with their effectiveness, respectively, the perception of the seriousness of the problem also increased as numbers and length of infestation increased

Priority Development and Rankings

Instructions for Assessing Priorities

One of the key objectives for the BMSB Working Group meeting is to assess priorities based on outputs generated from a number of completed and ongoing projects on BMSB and on the pest status in new regions.
Consider the list of priorities identified within each category at the **December 2015 BMSB IPM Working Group Meeting** and follow the instructions below.

Scoring/Ranking Priorities

1. Within each category, score each priority from 0-100 on level of importance / relevance. This approach provides greater capacity to distinguish relative importance among priorities. *You can use the same score more than once.*
2. Consider all categories and indicate the top five priorities with an "*". They may be in a single category.

Post-Meeting Ranking of Priorities

1. Within each category, scores for each priority will be averaged to provide an overall rank among all priorities.
2. Across categories, all priorities receiving a "cross-category" high priority designation will be pulled and ranked according to total number of designations/votes received to provide an overall cross-category ranking.

Overall Top Five Research, Extension, Regulatory and Consumer Priorities Rankings, June 2016

Priority	Total
Biocontrol agents--identification and study of parasitoids, fungal pathogens, and predators (native and foreign)	15
Education programs to growers and the general public	14
Development of IPM-friendly management tactics	14
Evaluate efficacy and host range of candidate classical biological control agents	11
Development of IPM friendly management strategies (trap style and efficacy, overwintering site selection, insecticide timing, repellent - push/pull, efficacy of treating exterior plants/landscapes)	9
Deliver economic thresholds / action thresholds	9
Evaluation of parasitoid host specificity	9
Educating professionals to pest ID and diagnosis of injury	7

Research Priorities Rankings, June 2016

Priority	Title	Mean	Number Responding
2	Biocontrol agents--identification and study of parasitoids, fungal pathogens, and predators (native and foreign)	96	24
1	Development of IPM-friendly management tactics	91	23
5	Evaluate efficacy and host range of candidate classical biological control agents	84	24
18	Examine interactions between native and exotic parasitoids (additive, synergistic or antagonistic)	83	23
9	Evaluation of parasitoid host specificity	79	23
6	Further study of pheromone-based monitoring (e.g. active space, trap design, attractants)	77	24
16	Response of indigenous natural enemies in relation to BMSB densities and their potential for management	77	24
4	Studies of basic BMSB behavior (host preferences, movement, responses to visual cues)	75	24
8	Investigation of host-plant volatiles as attractants	75	23
11	Determine factors affecting population densities	72	24
7	Define damage diagnostics, economics of injury and threshold	71	23
12	Impact of landscape and habitat on population (local)	69	24
17	Host utilization, preference, and range	69	23
14	Develop economic models that include injury, monitoring and management costs	68	24
3	Examine overwintering biology (e.g. triggers for seeking and leaving sites; overwintering mortality factors)	68	23
19	Evaluate effects of BMSB management plans on beneficial agents, including pollinators	67	24
15	Crop susceptibility and timing	65	24
27	Determine conservation bio control efforts for indigenous natural enemies	64	23
13	Studies of basic BMSB biology (physiology, generations)	64	24
22	Assess secondary pest outbreaks related to chemical control of BMSB	60	23
32	Methods development and improve rearing protocol for long term sustainable colonies	60	23
24	Examination of potential for trap-cropping	59	23
26	Use of toxins in combination with attractants	58	23
21	Mapping and assessment of distribution	58	23
10	Identification of potential repellents	58	22
20	Develop forecasting models to ID new risk areas, presence and where BMSB is and will not be	57	23
25	Standardized sampling methods	56	23
33	Determine low and high temperature thresholds for all stages	56	23

23	Role of the gut symbionts and their potential for management	56	23
35	Study potential for damage of harvested/value-added crops by contamination with BMSB	54	23
42	Validate current physiology and phenology models in laboratory	54	24
40	Evaluate long term sub lethal effects on BMSB (e.g. effects on reproduction)	53	23
30	Evaluate potential impacts of cultural control measures	52	23
28	Determine how far will BMSB travel to overwintering sites	50	23
36	Develop baseline insecticide toxicity data for resistance monitoring	50	23
34	Determining monitoring strategies for urban areas	49	23
43	Risk analysis of overwintering populations in natural landscapes	49	23
39	Assessment of displacement of native stink bugs	49	23
37	Standardize multiple methods for screening of new insecticide materials	48	23
41	Evaluate regional landscape-level/watershed-scale population distribution	48	24
48	How far do BMSB travel after leaving overwintering sites?	47	24
38	Assessment of economic impact in urban environment	45	23
29	Determine why BMSB appears to not be present in coastal plains	45	23
44	Evaluate impact of orchard groundcover management	45	23
31	Determine the impact of elevation on overwintering sites	43	23
46	Examination of cross-attraction of BMSB and green stink bugs	37	23
47	Evaluate potential impact of vertebrate predation	34	23
45	Development of toxicants and inhibitors for plant transgenic delivery	29	23

Overall Top Five

Priority	Title	Total
2	Biocontrol agents--identification and study of parasitoids, fungal pathogens, and predators (native and foreign)	15
1	Development of IPM-friendly management tactics	14
5	Evaluate efficacy and host range of candidate classical biological control agents	11
9	Evaluation of parasitoid host specificity	9
17	Host utilization, preference, and range	6

Extension Priorities Rankings, June 2016

Priority	Title	Mean	Number Responding
1	Education programs to growers and the general public	93	24
2	Deliver economic thresholds / action thresholds	86	24
5	Educating professionals to pest ID and diagnosis of injury	82	23
6	Education programs relevant to development of biological control projects	79	23
4	Coordinate efforts of state and regional extension programs	79	24
3	Develop revised and unified management plans	78	23
7	Include education programs relevant to classical biological control	74	23
11	Educational programs relevant to invasive biology using BMSB	67	23
8	Develop treatment recommendations and guidelines for urban environments	67	23
12	Initiate public awareness campaigns - posters, public service announcements, educational materials, etc.	65	23
10	Educational programming for structural and landscape industries	65	23
9	Extension outreach and education programming for urban environment/homeowners	64	23
14	Raise awareness of importance of BMSB as pest - APHIS, local political channels, etc.	64	23
15	Use BMSB as an opportunity to educate children	57	23
13	Demonstrate field application techniques for chemical control	51	23
18	Establish links between eXtension community of practice (COP) and StopBMSB.org	49	23
19	Evaluate large scale treatment facilities of export cargo	47	23
16	Direct homeowners to local politicians for complaints	44	23
17	Structure extension groups by commodity or region	42	23

Overall Top Five

Priority	Title	Total
1	Education programs to growers and the general public	14
2	Deliver economic thresholds / action thresholds	9
5	Educating professionals to pest ID and diagnosis of injury	7
3	Develop revised and unified management plans	6
6	Education programs relevant to development of biological control projects	6

11	Educational programs relevant to invasive biology using BMSB	5

Regulatory Priorities Rankings, June 2016

Priority	Title	Mean	Number Responding
1	Product testing and labeling of new active ingredients/products - only low toxicity/IPM compatible	75	21
3	Define the economic and ecological threat	74	21
2	Use of toxins in combination with attractants (regulatory status)	70	21
5	Coordinate interagency and interdisciplinary funding	68	21
4	Expand use of existing registered products	55	21

Overall Top Five

Priority	Title	Total
1	Product testing and labeling of new active ingredients/products - only low toxicity/IPM compatible	5
5	Coordinate interagency and interdisciplinary funding	5
3	Define the economic and ecological threat	4
2	Use of toxins in combination with attractants (regulatory status)	3
4	Expand use of existing registered products	3

Consumer/Urban Priorities Rankings, June 2016

Priority	Title	Mean	Number Responding
1	Development of IPM friendly management strategies (trap style and efficacy, overwintering site selection, insecticide timing, repellent -push/pull, efficacy of treating exterior plants/landscapes)	89	22
2	Preventative measures for reducing entry into human-made structures - outreach needed	76	22
3	Define triggers for movement into homes	72	22
4	Important biological control agents around residential areas	66	22
6	Evaluate efficacy of insecticides/killing agents for homeowners	58	23
7	Forecasting population size	56	22
9	Evaluate materials for home-garden and home-landscape protection	55	22
5	Determining repeated entry and exit by BMSB from overwintering sites	51	22
8	Evaluate the use of environmentally "friendlier" treatment options than insecticides such as heat	45	22

Overall Top Five

Priority	Title	Total
1	Development of IPM friendly management strategies (trap style and efficacy, overwintering site selection, insecticide timing, repellent -push/pull, efficacy of treating exterior plants/landscapes)	9
7	Preventative measures for reducing entry into human-made structures - outreach needed	6
9	Define triggers for movement into homes	6
2	Important biological control agents around residential areas	4
3	Evaluate efficacy of insecticides/killing agents for homeowners	4
4	Forecasting population size	4
5	Evaluate materials for home-garden and home-landscape protection	3
6	Determining repeated entry and exit by BMSB from overwintering sites	2
8	Evaluate the use of environmentally "friendlier" treatment options than insecticides such as heat	2