M.L. 2014, Chp.226, Sec. 2, Subd. 04f-2 Project Abstract
For the Period Ending June 30, 2017

PROJECT TITLE: Brown Marmorated Stink Bug Monitoring and Biocontrol Evaluation (MDA - Activity 1)
PROJECT MANAGER: Mark Abrahamson
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2014, Chp.226, Sec. 2, Subd. 04f-2

APPROPRIATION AMOUNT: $99,000.00
AMOUNT SPENT: $99,000.00
AMOUNT REMAINING: $0

Overall Project Outcomes and Results

Brown marmorated stink bug (BMSB) was first discovered in Minnesota in 2010. BMSB is a generalist that will feed on 300+ species of plants in natural and agricultural settings. Due to its large size and unpleasant odor, BMSB is also a nuisance home invader during the winter months. Based on experience with BMSB in other areas of the country, BMSB is expected to first become a household nuisance and then become a significant plant pest. MDA aimed to monitor BMSB to help track where problem areas are developing.

When MDA started this project in 2014, BMSB had been identified in 11 counties and has now been identified in 18. The goal of this project was to create a network of survey sites and place pheromone baited mini-tedder traps to detect BMSB and alert stakeholders to allow for targeted management. Traps were placed in the spring, serviced throughout the summer and removed in late October or early November 2014- 2016 and spring of 2017.

Over the course of the monitoring project, MDA placed and serviced 690 mini-tedder traps throughout the state. Trap catches were low the first two years of the project with one adult captured in 2014 and 2 captured in 2015. MDA did respond to increasing reports of BMSB throughout the state despite low trap catches these years. Most of these reports were of single insects that were likely brought into the state from elsewhere. In the fall of 2016, MDA trapped 200 adult BMSB and 47 nymphs between 9 locations in the metropolitan area.

The increase in reports of BMSB and trap catches, including nymphs, indicates growing activity in the metro area which this project was able to document. This information provides an opportunity to proactively focus biocontrol efforts in this area and provides an opportunity to avoid reactive use of insecticides by growers.

Project Results Use and Dissemination

Dissemination of information and data about BMSB has been ongoing throughout this entire project. Presentations were given at Minnesota Fruit and Vegetable Growers Association annual meetings, the Minnesota Organic Conference, the Minnesota Apple Growers Association annual meeting, and Forest Pest First Detector Trainings. Growers were engaged and updated via phone, email, special mailings such as the Minnesota Department of Agriculture's Plant Pest Insider, and through personal encounters in the field.

Throughout the project, the MDA has maintained online maps regarding the status of BMSB.

- Current BMSB activity: https://www.mda.state.mn.us/plants/insects/stinkbug.aspx
- Activity in past years: http://www.mda.state.mn.us/plants/insects/stinkbug/bmsbmonitoring.aspx

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2014 Work Plan Final Report

Date of Report: August 11, 2017

Date of Next Status Update Report: Final Report

Date of Work Plan Approval: June 4, 2014

Project Completion Date: June 30, 2017

Does this submission include an amendment request? Yes

PROJECT TITLE: Brown Marmorated Stink Bug Monitoring and Biocontrol Evaluation (MDA - Activity 1)

Project Manager: Mark Abrahamson

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Location: Statewide - Minnesota

Total ENRTF Project Budget:	**ENRTF Appropriation:**	**$99,000**
	Amount Spent:	**$99,000**
	Balance:	**$0**

Legal Citation: M.L. 2014, Chp.226, Sec. 2, Subd. 04f-2

Appropriation Language:
$99,000 the second year is from the trust fund to the commissioner of agriculture and $167,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to monitor for brown marmorated stink bugs to identify problem areas, target biocontrol efforts, and evaluate the suitability of candidate biological control agents for use in Minnesota. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Brown Marmorated Stink Bug Monitoring and Biocontrol Evaluation (MDA - Activity 1)

II. PROJECT STATEMENT:
Our project seeks to install a framework for monitoring brown marmorated stink bug (BMSB) (*Halyomorpha halys*) within Minnesota to identify developing problem areas and target implementation of biological control. We also propose to evaluate the suitability of biological control agents identified by USDA for use in Minnesota.

BMSB in Minnesota
BMSB was first discovered in Minnesota in 2010 (St. Paul) and is now in Anoka, Carver, Chisago, Dakota, Hennepin, Ramsey, Stearns, St. Louis, Washington, Wilkin and Winona counties. BMSB is a generalist will feed on and damage 300+ species of plants in natural, agricultural and horticultural settings, with potential to feed on many native plant species in Minnesota. Due to its unpleasant odor, large size and sheer numbers, BMSB is a nuisance home invader worse than Asian lady beetles or box elder bugs in the eastern U.S. As BMSB populations build in Minnesota, indirect impacts to environment and natural resources are likely to occur through increased pesticide use in homes, yards, agricultural fields and orchards to control this pest. For example, when Midwestern soybean was invaded by the soybean aphid (*Aphis glycines*), insecticide use increased 130-fold in that crop. In addition to soybean, BMSB attacks many other field, fruit and vegetable crops. Insecticide use in orchards in the Mid-Atlantic region has already increased fourfold due to BMSB. Direct impacts of BMSB to environment and natural resources are likely due to its broad host range including native plant species and potential for rapid population growth. A Federal risk assessment determined: "Heavy feeding pressure by BMSB could also damage or reduce native plant species and impact biodiversity throughout the United States." The same Federal document also states: "…it is reasonable to expect that BMSB could displace and directly compete with native stink bugs…"

Monitoring for BMSB – MDA Component
Based on experience with BMSB in other areas of the country, we expect BMSB to first become a household nuisance and then become a significant plant pest. We expect these adverse impacts to occur 5-10 years from initial discovery. It has been 3 years since discovery in Minnesota; therefore, it is imperative that a proactive response be implemented now. Monitoring for BMSB at the landscape level should help to predict where problem areas are developing; alerting stakeholders within the area and allowing targeted efforts at biological control to protect natural and agricultural resources. Research on a trap and lure for BMSB is reaching the point where this approach is feasible.

Biological control – UMN Component

Management of this pest in eastern states has relied primarily on insecticide use. Biological control has proven to be an environmentally sound and economical alternative in some systems. It is necessary to evaluate and identify appropriate biological control agents for use against BMSB in Minnesota before populations reach damaging levels. Federal researchers are evaluating 35 populations of 4 species of parasitic wasps (*Trissolcus* spp.) known to attack BMSB eggs in South Korea, Japan and China. This work is aimed to determine the potential efficacy and safety of these species as biological control agents for BMSB. The ability of the candidate biological control agents to survive winter conditions in northern states, such as Minnesota, remains undetermined and will be necessary for advancement to implementation. This project will examine the ability of the most promising candidate biological control agents to survive winter and use modeling techniques to determine the suitability of Minnesota for establishment.

III. PROJECT STATUS UPDATES:

Project Status as of November 15, 2014:
The monitoring component of the project is off to a good start and is on track with outlined goals. We created a network of apple, vegetable, vineyard, and berry growers to use for survey sites. Traps were placed between

August and September, checked once, and then taken down between October and early November. We were able to meet our goal of monitoring traps at 100 sites and so far have confirmed BMSB in 1 trap at a site with previously known BMSB activity.

Project Status as of May 15, 2015:
This project is proceeding as planned and is on schedule. Brown marmorated stink bug continues to be reported via various means (i.e. MDA's Arrest the Pest, University of Minnesota and Department of Natural Resources) across the state and so we are in good position to continue monitoring this insect as it becomes more abundant. Along with the established network of apple, vegetable, vineyard, and berry grower sites, we will change some sites for the 2015 field season to focus areas that are considered known "hotspots" or places where BMSB has been reported and confirmed. These are mainly private residences in urban settings. We will also add some sites at MN DOT rest stops and various campgrounds across the state to target places that have a high potential as introduction pathways for BMSB into Minnesota.

Project Status as of November 15, 2015:
This project is moving forward as planned. Brown marmorated stink bug reports are increasing in Minnesota and are being reported via MDA's Arrest the Pest, the University of Minnesota and Department of Natural Resources. Due to many reports being within the metro area or in close proximity, we added new sites to focus on apple, vegetable, vineyard, and berry grower sites that we have been using previously. Most reports were single adult finds at private residences in urban settings. We determined that many of the adult BMSB were "hitchhikers" and follow up with these reports often times revealed the residents or someone close to them had been traveling to the eastern part of the United States. Due to this, we also added sites at MN DOT rest stops campgrounds and state parks in close proximity to major interstate roadways in order to target places that have a high potential as introduction pathways for BMSB.

Project Status as of May 15, 2016:
This project is moving into its last monitoring season for BMSB. Brown marmorated stink bug continues to be reported via various means (i.e. MDA's Arrest the Pest, University of Minnesota and Department of Natural Resources) across the state and to date we have had detections in 14 counties. In this final season of monitoring we are going to concentrate trapping efforts for approximately 2 months in the early spring when insects are emerging and again for 2 months in the mid to late fall when insects are congregating to look for overwintering sites. We hope this will put us in the best position to catch the most insects and discover any new introductions. We have adjusted some sites for 2016 to refocus our efforts and removed some of the sites that were decided to be at lower risk for BMSB introduction.

Project Status as of November 15, 2016:

We are wrapping up the final season of the monitoring portion of this project. Traps are currently being removed and trap catch data and results from the 2016 fall field season will be available for the final report due June 30, 2017. Results from the 2016 spring trapping period will be discussed below, under Project Activities and Outcomes, Activity 1 Status. Brown marmorated stink bug populations continue to build in Minnesota and specifically in the Twin Cities metropolitan area. BMSB has now been confirmed in 15 MN counties and continues to be reported through entities such as MDA's Arrest the Pest, University of Minnesota and Department of Natural Resource. We also now know that there are multiple reproducing populations in the Twin Cities metropolitan area, as we are finding both adults and nymphs through our survey. The MDA's Pathway survey for pests in community gardens and community supported agriculture in metropolitan areas throughout the state has also picked up BMSB and there has been a first report of BMSB adults and nymphs from a MN soybean field.

Retroactive Amendment Request August 11, 2017:
We were able to greatly minimize travel costs for the project by utilizing department minipool vehicles when possible rather than long-term rentals. In hindsight, a budget amendment could have been requested in the November 2016 report as the discrepancy between planned and actual spending for salary and travel was apparent. Still, due to the cost savings in travel, we were able to extend the trapping portion of the project into a fourth season during 2017 which resulted in additional detections of BMSB. We request to use the funds saved in travel to utilize for salary ($6,229) and supplies ($134) to partially recover the costs associated with monitoring through June 30, 2017.

Overall Project Outcomes and Results:

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The increase in reports of BMSB and trap catches, including nymphs, indicates growing activity in the metro area which this project was able to document. This information provides an opportunity to proactively focus biocontrol efforts in this area and provides an opportunity to avoid reactive use of insecticides by growers.

Dissemination of information and data about BMSB has been ongoing throughout this entire project. Presentations were given at Minnesota Fruit and Vegetable Growers Association annual meetings, the Minnesota Organic Conference, the Minnesota Apple Growers Association annual meeting, and Forest Pest First Detector Trainings. Growers were engaged and updated via phone, email, special mailings such as the Minnesota Department of Agriculture's Plant Pest Insider, and through personal encounters in the field.

Throughout the project, the MDA has maintained online maps regarding the status of BMSB.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Monitoring for Brown Marmorated Stink Bug (BMSB)
Description:
Minnesota Department of Agriculture will engage First Detectors, citizen scientists, producers and other volunteers to monitor for BMSB with a standardized process across Minnesota. Monitoring sites will be identified based on estimates of BMSB spread within the state.

- MDA will recruit sites for monitoring based on perceived risk from BMSB – i.e., we will use locations with positive BMSB finds as well as areas of favorable habitat for BMSB to identify the best sites for monitoring in each year.
- We will use the most efficacious and economical means of trapping. There is currently a trap and lure available for BMSB. If new trap/lure designs become available we will use the method that is most efficient.
- Initially MDA will set and maintain traps, by the end of this project we hope to have turned this function over to interested volunteers.
- MDA will visit monitoring sites during the field season to check traps, check on work by volunteers, and verify new finds when needed or for additional sampling if justified. For instance, if BMSB is found in a new area MDA will likely conduct additional sampling through other methods such as sweep netting or beat sampling (beating or shaking vegetation over a ground cloth) to determine the level of activity in the area.
- MDA will use data collected from MDA monitoring and from volunteers at regular intervals to publish the results via an Internet-based map.
- For traps maintained by volunteers, trap samples which will be screened by MDA for verification purposes – i.e., volunteers would report results during the growing season and the samples the reports were based on would be periodically screened by MDA to assure reporting was accurate.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 99,000
Amount Spent: $ 99,000
Balance: $ 0

Activity Completion Date: June 30, 2017

Outcome	Completion Date	Budget
1. Order supplies and implement first season of monitoring	October, 2014	$ 16,306
2. Field season review, verify trapping results, web mapping maintenance	January, 2015 - 2017	$ 21,223
3. Increase monitoring network and equip for field season	June, 2015 and 2016	$ 32,429
4. Maintain monitoring network through field season	October, 2015 and 2016	$ 29,042
5. Submit final report	June, 2017	$ 0

Activity Status as of November 15, 2014:
Although BMSB has a large range of host plants, the majority of the economic damage it causes to growers in the Mid-Atlantic States occurs in apple and peach orchards. Thus, we focused on recruiting apple orchards throughout the state as survey sites, with vegetable growers, vineyards, berry farms, and other locations being secondary targets (Table 1).

Table 1. Number of sites with BMSB host plants surveyed during the 2014 growing season. Number of sites totals is greater than total number of survey sites because some sites had more than one type of host plant.

Type of Host Plant	Number of Sites with Host
Apple Orchard	72
Vegetable Farm	36
Other Fruit (vineyard or berry farm)	38
Other (ornamental farm, residential, livestock)	8

In order to guide the geographic placement of survey sites, we created a risk map of BMSB occurrence by obtaining data on apple and vegetable farms from the Minnesota Grown directory, creating a density map of these farms and then overlaying confirmed occurrences of BMSB (Figure 1). In August, we used that map to recruit 100 sites with apples and/or vegetables with virtually all sites contacted showing an interest in the monitoring project.

Based on work conducted by USDA Agricultural Research Service, pyramid traps (2' tall black triangular base staked into the ground) were used with a collection cup on the top containing an aggregation pheromone and insecticidal strip. At each site, a trap was set in locations favorable as BMSB habitat such as forested edges near the orchard (or other host plants). Forested edges were chosen because studies in Mid-Atlantic States have observed that BMSB activity is often first seen along the edges of orchards.

The survey was conducted statewide, although the majority of sites were within driving distance of the Twin Cities as our preliminary assessment indicated this was the area of greatest risk. Trapping was conducted in 31 counties.

Placement and monitoring of traps was conducted in August 2014. Contact was made with growers at all of the sites, during which growers gave positive interactions and many offered to monitor traps, suggesting that we may be able to transition into a volunteer monitoring program at some point next season.

BMSB has been confirmed in a trap at a private residence in Wyoming, MN. BMSB was visually observed at this residence in the fall of 2013 and the residence again reported the presence of BMSB to MDA on September 20, 2014. We immediately placed a trap at the house and added a second two weeks later as an informal check on the efficacy of the trap. The traps at the Wyoming residence yielded a single BMSB catch, although adult and nymphal BMSB were visually observed at the property during weekly monitoring visits.

No other suspected BMSB were found when traps captures were collected, but other stink bugs were found and these remain to be screened to ensure that no BMSB were missed at the time of sample collection. Preliminary observations do indicate that predators go into the trap to prey on trap captures. This caused some congestion in traps that may have inhibited the aggregate pheromone, or led to detrimental circumstances for attracting BMSB. Therefore, checking traps and removing the contents more frequently could aid BMSB capture.

We will be making contacts with other states who are conducting monitoring studies for BMSB to compare results. Based on this year's work we have some concerns about trap efficacy as we only captured a single individual at a site (Wyoming) where BMSB was active and easily observed. Next year an enhanced pheromone lure should be commercially available, we will utilize that improvement and any others that we can ascertain prior to the next field season.

Activity Status as of May 15, 2015:

Since November 2015, efforts have focused on refining our methods for monitoring and detecting BMSB. This has been accomplished through contacting other experts who are conducting the most relevant and timely research such as USDA ARS in West Virginia and Michigan State. Through this communication we were able to learn that a new lure which consists of two pheromone components should provide better trapping results throughout the season. It has also been suggested that the trap area of influence for BMSB is probably fairly localized and that wild host presence is important.

We are going to reduce the number of overall sites to approximately 66 but increase the number of traps per site (3 per site and approximately 200 overall), use the two component lure and place traps whenever possible near potential wild host plants. We will also refocus some of the sampling to areas where BMSB has been reported and confirmed as well as some potential pathway sites such as MN DOT rest stops and campgrounds. We are focusing on areas where BMSB has been confirmed so that we can determine if populations have established at these locations or if the confirmations were of early introductions that did not establish. A better understanding of where BMSB populations have established will help to inform further monitoring efforts. At this time we only have one site (City of Wyoming) where we are certain BMSB is established due to the repeated recovery of multiple life stages.

Though we will reduce the number of sites where we trap this year, we are planning to remain engaged with all 100 of the sites where we worked last year. We will encourage them to report any possible sightings of BMSB and we anticipate working with these sites again in the future on monitoring efforts.

During this time period we have also completed the following:

- Contacted MN DOT for permission to set traps at rest stops, selected and contacted campgrounds regarding trapping, and contacted homeowners where BMSB has been confirmed to ask for participation in this year's monitoring survey.
- Updated website information for BMSB and developed a plan for providing current information during the growing season on BMSB activity and distribution.
- Ordered field supplies for trap monitoring this year – field monitoring is tentatively planned to start June 1.

Activity Status as of November 15, 2015:
Trap placement for BMSB began June 8, 2015. Approximately 3 traps were placed at 63 sites across the state. At some sites it was only feasible to place two traps. Sites consisted of 33 orchards, 12 parks and public property, 12 MN DOT rest areas and waysides, and 6 private residences. The same mini-tedder traps that were deployed for the 2014 field season were used again in 2015. Traps were baited with a two component lure and placed near potential host plants. This is the first year that this lure has been commercially available and has been shown to be the most effective lure available for BMSB. Traps were emptied every two weeks and the baits were changed monthly. All traps were removed by October 19, 2015.

We are still concerned about the efficacy of the mini-tedder trap and bait. Out of 184 traps only 2 caught BSMB in 2015. One was caught in Dakota County at the Lebanon Hills campground and the other was caught in Hennepin County at the University of Minnesota campus. One explanation may be that BMSB is not widespread enough yet in Minnesota to detect it often in the traps and populations maybe highly localized based on host distribution. However, we did not catch any BMSB at the site in the City of Wyoming where we have a known population of reproducing BMSB which calls into question the efficacy of this trapping system.

Despite the low trap captures, we continue to get many reports and confirmations of BMSB throughout Minnesota via the Arrest the Pest hotline. We have followed up on these reports to find out if the person reporting has been traveling out east or received any packages or visitors from that area of the country. For example, after researching one report from Faribault, Minnesota, it was determine that the insects were found on an RV and they had recently been traveling to Virginia. Another recent report yielded 8 adults. The resident has not been traveling and so it is probable that there is an established population at the home or in the surrounding area. We plan to do more intensive field sampling at this site next field season.

One major success we had this field season was the expansion of outreach about BMSB to MNDOT rest stops, campgrounds and State Parks which are prime spots for introductions from other established areas of the country. This was a natural result of refocusing our sites and we did receive more citizen reports from these areas. We feel this expanded outreach will yield future reports and possible trapping locations for next field season.

For the 2016 field season we plan to continue using the baited mini-tedder traps that were used previously as these have been determined by research to be the best monitoring tools available for BMSB. We also plan to add black light traps and conduct some vegetation sampling using beating sheets in order to see if these other methods provide better results here. Other researchers throughout the country have had good success using these other methods and so we will try them where it feasible and where we have good grower and/or resident participation. We may also try to add some BMSB door hangers in areas where BMSB has been confirmed to further engage private residents in these areas and determine if reproducing populations are present.

Activity Status as of May 15, 2016:

During this time period we have completed the following:

- Contacted MN DOT for permission to set traps at rest stops, selected and contacted campgrounds regarding trapping, and contacted homeowners where BMSB has been confirmed to ask for participation in the 2016 monitoring survey.
- Updated website to provide growers information during the growing season on BMSB activity and distribution.
- Ordered field supplies for trap monitoring this year.

Brown marmorated stink bug trap placement began in late April this year. Trapping will be conducted from late April to early June and again from early September to late October. The trapping duration was changed to concentrate on the times when stink bugs are leaving overwintering sites and congregating for overwintering. We hope that this improves the efficacy of the survey. Ninety- two traps have been placed at 58 different sites across the state. Sites consist of 30 orchards, 11 Public/campground/parks, 5 private residences, and 12 highway rest areas. The same mini-tedder traps that were deployed for the 2015 field season are being used again for 2016 and traps are again being baited with a two component lure and placed near potential host plants. This year we used 82 short mini-tedder traps, 8 tall tedder traps and one light trap was placed at an Apple Orchard where one specimen was recovered last summer. Traps will again be emptied approximately every two weeks and baits will be changed monthly.

Activity Status as of November 15, 2016:

No BMSB were caught during the 2016 spring trapping survey. Sites were chosen based on a number of criteria including: presence of host plants, proximity to a potential pathway of spread, and locations where BMSB has been previously found or reported. High density host sites for BMSB in Minnesota were primarily apple orchards. Sites that could also be pathways for spread of BMSB were also utilized and included highway rest areas and frequently visited parks that were in close proximity to interstate highways. Arrest the Pest had also been receiving frequent reports of BMBS prior to the 2016 trapping season. These sites were mostly residences, and so we selected 5 of these in the twin-cities metro area for early trapping because they had the highest likelihood of catching BMSB as they emerged from overwintering locations. The early traps were set on March 11, 2016. Only one tall tedder trap (Figure 3) was placed at these sites due to their small size. Traps were checked biweekly and re-baited monthly throughout the duration of the spring trapping season. Traps were disarmed (cup and bait removed) at all sites by the end of May.

Fall monitoring for BMSB began again on September 12, and all traps were re-baited and in place by September 27 (Figure 1). Traps will continue to be monitored until the end of November. Traps are being checked every two weeks and new lures were being added every two weeks. All monitoring sites for the fall were the same sites as spring, with one new residential site in Edina added on October 19. Fall trapping is being conducted at a total of 59 sites (with a total of 94 traps): 31 orchards, 12 rest areas, 11 public areas/campgrounds, and 6 residences. All samples from fall BMSB monitoring are currently being processed. So far, we have found adults in St. Paul, Roseville, Wyoming, Minneapolis, Lebanon Hills, and Edina. BMSB nymphs have been also been found in St. Paul, Roseville, and Wyoming, indicating the presence of reproducing populations (Figure 2).

Brown marmorated stink bug continues to be reported to the Minnesota Department of Agriculture through our Arrest the Pest Hotline. Since the last report the MDA has had had 25 reports of BMSB through our Arrest the Pest Hotline: 9 confirmed positive, 9 unconfirmed, and 7 negative. We have also begun receiving reports

through EddMaps which is an online repository for tracking invasive species. Reports are submitted online or via a smart phone application.

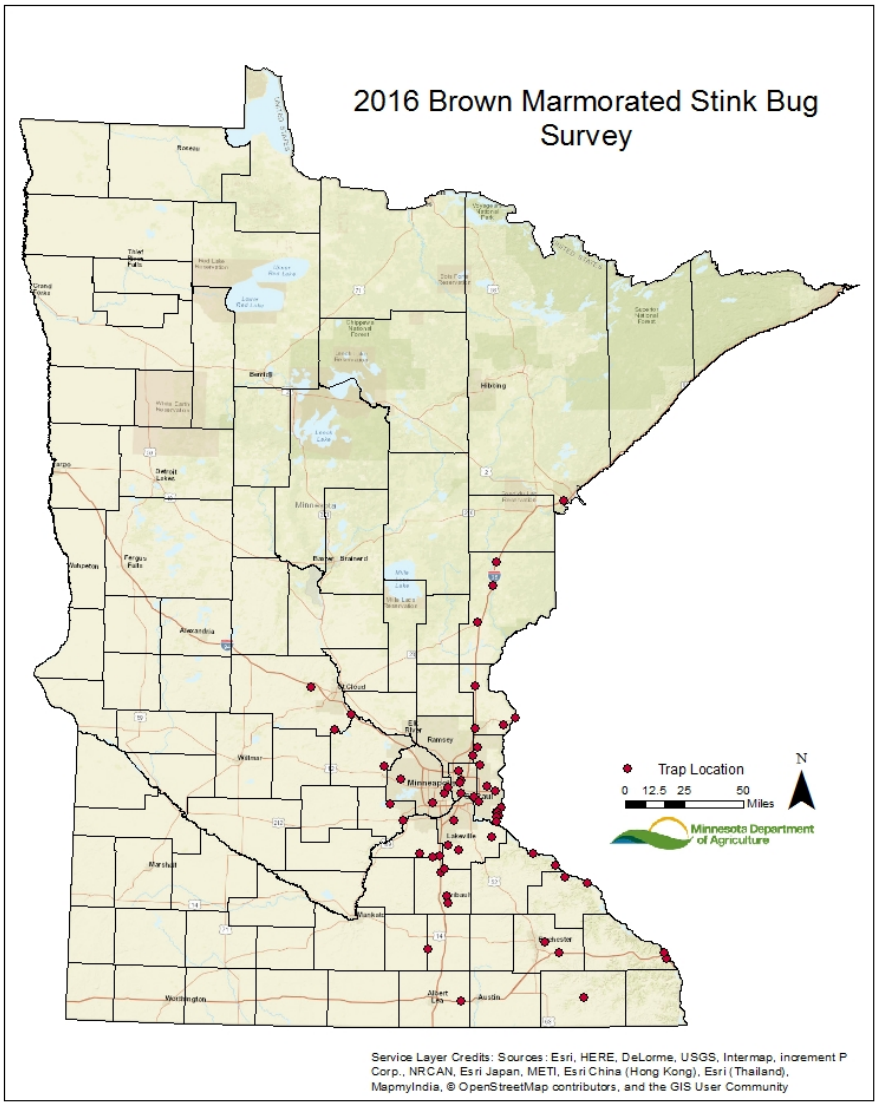


Figure 1. Brown marmorated stinkbug monitoring sites for 2016

Figure 2. Brown marmorated stink bug mini-tedder trap with adults and nymphs present.

Final Report Summary:

The BMSB monitoring project was initiated in the summer of 2014. MDA compiled a network of apple, berry and vegetable growers as well as vineyards to use as trapping locations. With this network, MDA was able to place detection traps at 100 locations throughout 31 counties (Figure 3). Based on work conducted by USDA Agricultural Research Service, mini-tedder traps (2' tall black triangular base staked into the ground) were used with a collection cup on the top containing an aggregation pheromone and insecticidal strip. Traps were set in August and September, checked once, and were removed in October and November.

BMSB was confirmed in one trap at a private residence in Wyoming, MN. BMSB had previously been reported at this residence in the fall of 2013 and homeowners reported the presence of BMSB again to MDA in September 20, 2014. A trap was placed at this location following the report of BMSB and yielded a single BMSB catch. No other suspected BMSB were captured in the state during this detection period.

Monitoring and detection methods were refined in preparation for the 2015 trapping season. Overall detection sites were decreased to 63 but the number of traps at each location was increased to three per site. MDA was also able to implement a new lure which consisted of two pheromone components in an attempt to provide better trapping results. Sampling areas were also refocused on locations where BMSB was reported to MDA and to include potential introduction pathway sites such as MN DOT rest stops and campgrounds. We planned to focus on areas with reports of BMSB to determine if populations have established at these locations of if the reports were of early introductions that did not establish. Determining the locations of established BMSB would help inform future monitoring efforts.

Trap placement for 2015 began in June. Approximately 3 traps were placed at 63 sites across the state for a total of 184 traps. Sites consisted of 33 orchards, 12 parks and public property, 12 MN DOT rest areas and waysides, and 6 private residences. The same mini-tedder traps were deployed for this trapping season. Two traps caught

BMSB in 2015. One was in Dakota County at Lebanon Hills campground and the other was caught in Hennepin County at the University of Minnesota campus. Despite the low trap catches, BMSB had been confirmed many times by reports to the MDA via Arrest the Pest. These reports were followed up to determine if the resident did any traveling out in the eastern US or had any packages or visitors arrive from regions with established BMSB. In some of these instances, the resident has recently driven a vehicle to the eastern U.S. and back.

Trapping for the 2016 season was split into a spring period and a fall period. The trapping duration was changed to concentrate on the times when stink bugs are leaving overwintering sites and congregating for overwintering. Traps were placed in late April and checked though early June and then checked from early September through late October. Ninety-two traps were placed at 58 different sites across the state consisting of 30 orchards, 11 public/campground/parks, 5 private residences, and 12 highway rest areas. The same mini-tedder trap was deployed this season and traps were emptied approximately every two weeks and baits changed monthly. No BMSB were trapped during the spring period. Fall monitoring for BMSB began again on September 12, and all traps were re-baited and in place by September 27.

Fall monitoring for 2016 was completed at the end of November. MDA trapped 200 adult BMSB among 9 sites in Eagan, Edina, Minneapolis, Roseville, Shoreview, St. Paul and Wyoming. Forty-seven BMSB nymphs were also detected at 5 of these 9 sites in Eagan, Roseville, St. Paul and Wyoming, indicating reproducing populations at those sites. Brown marmorated stink bug continued to be reported to MDA over the winter via our Arrest the Pest service. Since the November 2016 report, 11 confirmed reports of BMSB have been submitted to the MDA. We also continued to receive reports through EddMaps, an online repository for tracking invasive species. Reports are submitted online or via a smart phone application.

MDA has placed traps at 15 locations for the spring of 2017. Traps were set mid-April and checked weekly. One mini-tedder trap was placed at each location to attempt to determine when BMSB are leaving overwintering locations. These locations were chosen based on proximity to BMSB detections in the fall though trapping and reports from citizens. In addition to the mini-tedder traps, the University of Minnesota has supplied 3 clear sticky card traps to test at residential locations to determine if they are more effective. One adult BMSB was captured at a residence in Roseville between 5/31/17 and 6/8/17 using a clear sticky trap. All confirmed BMSB detections through June 2017 are displayed in Figure 4.

State general funds were used for administration and oversight of this project which included:

- ongoing evaluation of BMSB status and adjustment of monitoring tactics accordingly
- coordination with the University of Minnesota and others working with BMSB
- hiring and training temporary employees to implement monitoring work
- development and maintenance of online mapping and reporting systems
- budget administration and report submissions

The MDA also provided the use of office and lab space and equipment, as well as IT equipment and support for the temporary staff working on this project.

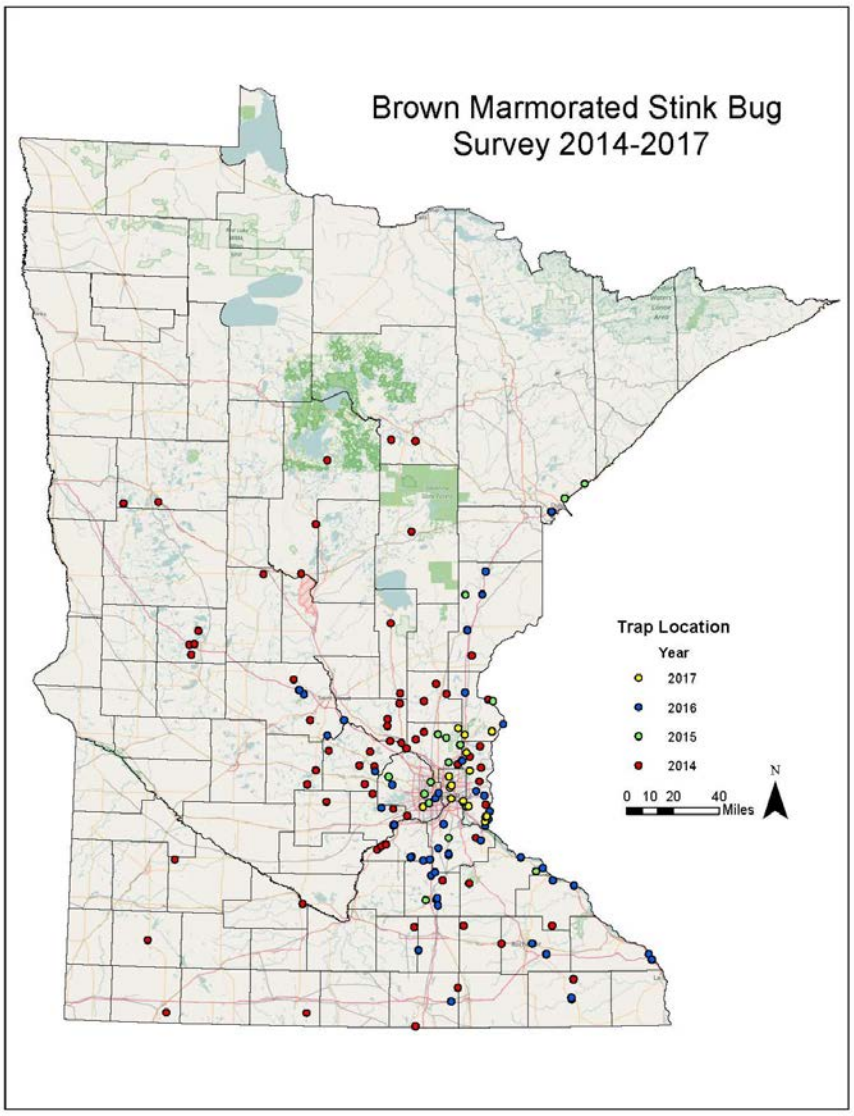


Figure 3. Brown marmorated stink bug monitoring traps through the state by year 2014-2017

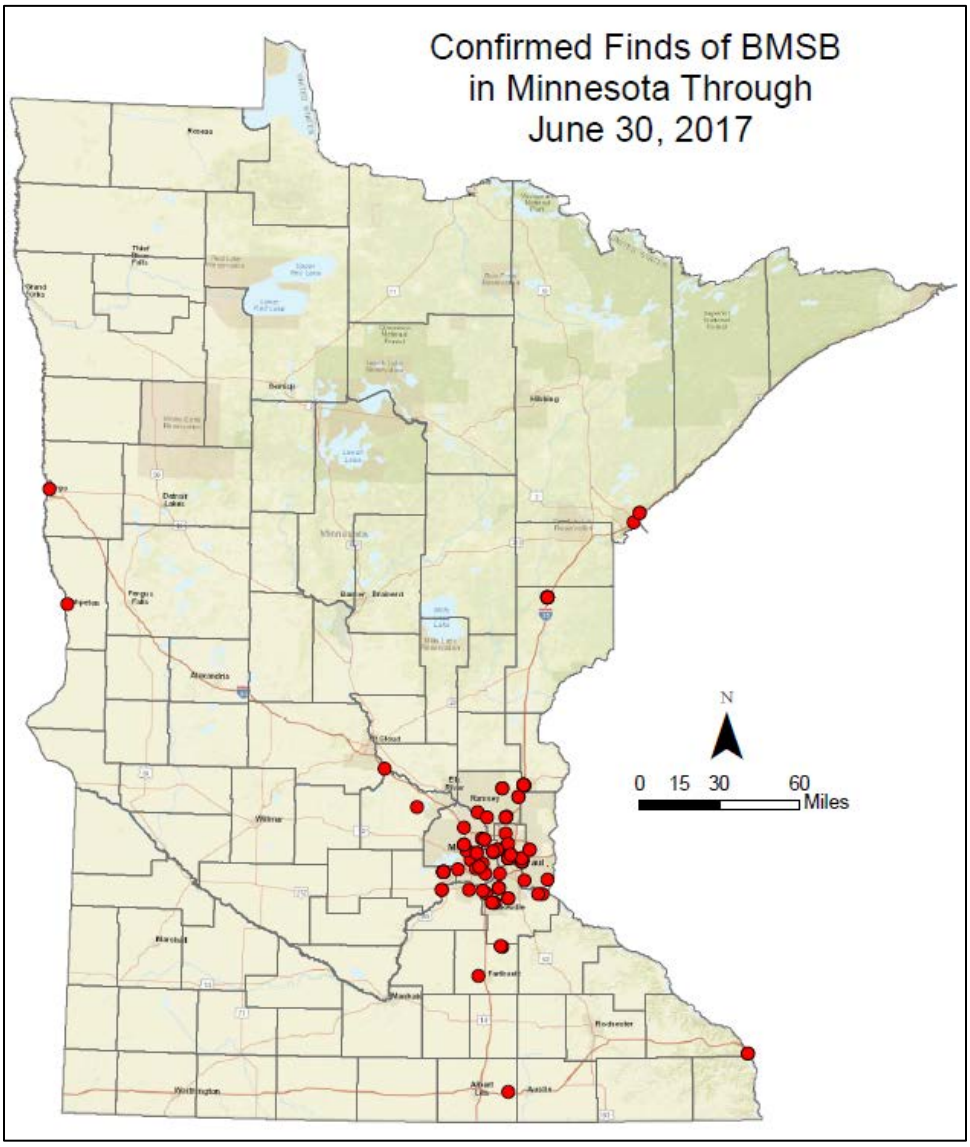


Figure 4. Brown marmorated stink bug confirmed finds through June, 30 2017.

ACTIVITY 2: Studies on overwintering potential of Brown Marmorated Stink Bug (BMSB) control agents in Minnesota

Description:

This activity will be carried out by UMN. See UMN work plan for project description and budget.

V. DISSEMINATION:

Description:

The primary audience for this work will be producers and hobby growers of fruits and vegetables. Monitoring information for BMSB will help to anticipate problem areas before they develop. In addition to commercial and hobby growers, others will also benefit from this information due to the nuisance behavior of this insect to invade structures in the fall. Identifying areas where this may become problematic and providing that information in advance of the problem may help to avoid negative reactions among residents of these areas. Information will be disseminated to these audiences through direct email communication, web site updates, social media and news releases. The updates on the monitoring network and biological control status will be reported at relevant meetings and conferences throughout the year. We anticipate that this work will also result

in an article in a scientific journal as well as presentations at national scientific meetings. However, ENRTF funds will not be used for travel to national meetings.

Status as of November 15, 2014:

Thus far, information about BMSB and our project was communicated to apple, vegetable, vineyard, and berry growers throughout the state in a number of ways:

- Growers were notified of our BMSB survey and given additional source material in an email requesting volunteers for our survey.
- Growers were contacted via phone to request volunteers for the survey, during which facts about BMSB were described.
- Upon meeting growers for surveys, growers were given a fact sheet and identification card for BMSB. In addition, they were given contact info for MDA and the UMN extension.
- Once sample processing is completed and results are available there will be additional opportunities to report on this year's work to various audiences.

Status as of May 15, 2015:
Information about BMSB continues to be communicated to apple, vegetable, vineyard, and berry growers throughout the state.

- Growers were emailed or direct mailed a copy of Minnesota Department of Agriculture's Stakeholder report entitled "Report on the status of invasive pests threatening fruit and vegetable production in Minnesota." A section of this report was devoted to BMSB.
- The BMSB monitoring project was highlighted to growers at the 2015 Minnesota Fruit and Vegetable Growers Association meeting and the Minnesota Organic Conference.
- This project was also highlighted in the Forest Pest First Detector Workshops held at 4 locations throughout the state in cooperation with the University of Minnesota Extension.
- New contacts were developed with private homeowners and organizations such as MNDOT to further engage potential volunteers who can monitor for BMSB across the state
- Shared results and plans for the 2015 field season with University of Minnesota cooperators.

Status as of November 15, 2015:
Information about BMSB continues to be communicated to apple, vegetable, vineyard, and berry growers throughout the state.

- Growers were notified of the creation of an online BMSB map. This map is updated any time a report of BMSB is confirmed in the state of MN. If the insect has been detected the city or township is shaded red. Growers can click on a particular find and find out in what year the insect was confirmed:
    - http://www.mda.state.mn.us/plants/insects/stinkbug.aspx
- This study was also highlighted in the Minnesota Department of Agriculture Plant Pest Insider February 2015 edition.
- A webpage was created on the MDA website to promote the project as well: http://www.mda.state.mn.us/en/plants/insects/stinkbug/bmsbmonitoring.aspx

Status as of May 15, 2016:
Information about BMSB continues to be communicated to apple, vegetable, vineyard, and berry growers throughout the state:

- Growers were emailed a link to our annual stakeholder report entitled "Status of Invasive Threats to Fruits and Vegetables in Minnesota." http://www.mda.state.mn.us/plants/pestmanagement/invasivesunit/~/media/Files/plants/invasives/statusrpt-invfrtveg.pdf

- This project was highlighted again in the 2016 Forest Pest First Detector Workshops held at 4 locations throughout the state in cooperation with the University of Minnesota Extension.
- The BMSB monitoring project was highlighted to growers at the 2016 Minnesota Fruit and Vegetable Growers Association meeting and the Minnesota Organic Conference.
- Information was delivered to growers in a presentation given at the Apple Growers Association of Minnesota annual meeting in Lacrosse, Wisconsin in January, 2016.
- This project was also talked about at Independent School District 196 and Inver Hills Community College's conference designed to motivate girls in grades 6-8 in the study of Science, Technology, Engineering, Agriculture and Math (STEAM) in April, 2016.
- Shared results and plans for the 2016 field season with University of Minnesota cooperators.

Status as of November 15, 2016:
Information regarding this project was disseminated to stakeholders in the following ways:

- This project was discussed via communication with land managers / owners for access to place traps.
- Updates about BMSB population abundance were provided in the May and October, 2016 editions of the Plant Pest Insider, an online newsletter.
  https://content.govdelivery.com/accounts/MNMDA/bulletins/14b2114
  https://content.govdelivery.com/accounts/MNMDA/bulletins/16f6f8f

Final Report Summary:
Dissemination of information and data about BMSB has been ongoing throughout this entire project. At no cost to this project, presentations were given at Minnesota Fruit and Vegetable Growers Association annual meetings, the Minnesota Organic Conference, the Minnesota Apple Growers Association annual meeting, trade shows and Forest Pest First Detector Trainings. Growers were engaged and updated via phone, email, special mailings such as the Minnesota Department of Agriculture's Plant Pest Insider, and through personal encounters in the field.

In addition to the dissemination listed through November 15, 2016, the MDA also provided an update in the May, 2017 Plant Pest Insider.
https://content.govdelivery.com/accounts/MNMDA/bulletins/19b351c

Throughout the project, the MDA has maintained online maps regarding the status of BMSB.

- Current BMSB activity: https://www.mda.state.mn.us/plants/insects/stinkbug.aspx
- Activity in past years: http://www.mda.state.mn.us/plants/insects/stinkbug/bmsbmonitoring.aspx

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Minnesota Department of Agriculture

Budget Category	$ Amount	Explanation
Personnel:	~~$71,122~~ $77,351	1 Survey coordinator (0.52 FTE): ~~Salary ($56,890 = $17.40/hr x 3,270 hrs) + Fringe ($14,225 = 25% of salary)~~ Salary + Fringe for 3171 hours (0.51 FTE) * $24.39 / hour.
Travel	~~$17,250~~ $10,762	- Vehicle rental and fuel (we will use the least expensive method of travel which will be either

		a state vehicle or a rented vehicle) approx. ~~$5,250~~ $3,100 per year * 3 years** - Meals and lodging as needed for MDA Coordinator (estimated 15 days of travel per year) approx. $500 per year * 3 years
Equipment/Tools/Supplies:	~~$10,628~~ $10,827	Supplies for conducting survey and sampling including traps, lures, bags, vials, and other supplies needed for maintaining monitoring network approx. $3,500 per year * 3 years
TOTAL ENRTF BUDGET:	**$ 99,000**	

**We generally have 3 vehicle options for travel needs:

- reimburse mileage costs for personal vehicle use
- state vehicle lease
- Enterprise vehicle rental

Reimbursing personal mileage is only cost effective when daily miles are relatively low (< 65 miles per day). State leased vehicles can be more cost effective at this point, but only if the vehicle can be leased for a sufficiently long time. If a state vehicle lease is not an option, the last option is and Enterprise rental vehicle. At 87 miles per day, an Enterprise rental is more cost effective than reimbursing personal miles. For this project we estimate 150 miles per day for average daily mileage based on past experience. We will use the most economical means of travel available to achieve the goals of this project.

Explanation of Use of Classified Staff:

Explanation of Capital Expenditures Greater Than $5,000: N.A.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:
MDA Survey Coordinator: 1.56 FTE over 3 years

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N.A.

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
	$20,000	$20,000	Project oversight
TOTAL OTHER FUNDS:	**$20,000**	**$20,000**	

VII. PROJECT STRATEGY:

A. Project Partners:

Receiving funds: Mark Abrahamson with MDA will lead the monitoring work (**receiving $99,000**). Dr. Robert Koch with U of MN will lead the work to evaluate potential biological control agents for suitability in Minnesota (**receiving $167,000**). Both organizations will provide in-kind equipment, facilities, and GIS/technical support.

Not receiving funds: For monitoring, we will draw volunteers from the various groups such as Master Gardeners, First Detectors and Producers. For evaluation of the biological control agents, Dr. Robert Venette with the USDA Forest Service will provide technical guidance on overwintering biology and cold hardiness. Dr. Kim Hoelmer of the USDA ARS will provide biological control agents for this work.

B. Project Impact and Long-term Strategy:
This project will put in place a monitoring network for BMSB that will likely prove useful for years to come and will be a first step towards implementation of biological control for BMSB, which is a critical need for proactively dealing with this pest in an economically and environmentally sustainable manner. This work will aid in selection of biological control agents for use in Minnesota. If one or more biological control agents show a high likelihood for survival in Minnesota, the next step will be work on implementation of a control program after approval for release has been granted.

C. Spending History:

Funding Source	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13	M.L. 2013 or FY14
USDA Specialty Crop Block Grant				$43,000	$57,000
State General Funds				$5,000	

VIII. ACQUISITION/RESTORATION LIST: N.A.

IX. VISUAL ELEMENT or MAP(S):
See attached graphic.

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET:
N.A.

XI. RESEARCH ADDENDUM:
N.A.

XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than 11/15/2014, 5/15/2015, 11/15/2015, 5/15/2016 and 11/15/2016. A final report and associated products will be submitted between June 30 and August 15, 2017.

Environment and Natural Resources Trust Fund

M.L. 2014 Project Budget

Project Title: Brown Marmorated Stink Bug Monitoring and Biocontrol Evaluation (MDA - Activity 1)

Legal Citation: M.L. 2014, Chp.226, Sec. 2, Subd. 04f-2

Project Manager: Mark Abrahamson

Organization: Minnesota Department of Agriculture

M.L. 2014 ENRTF Appropriation: $99,000

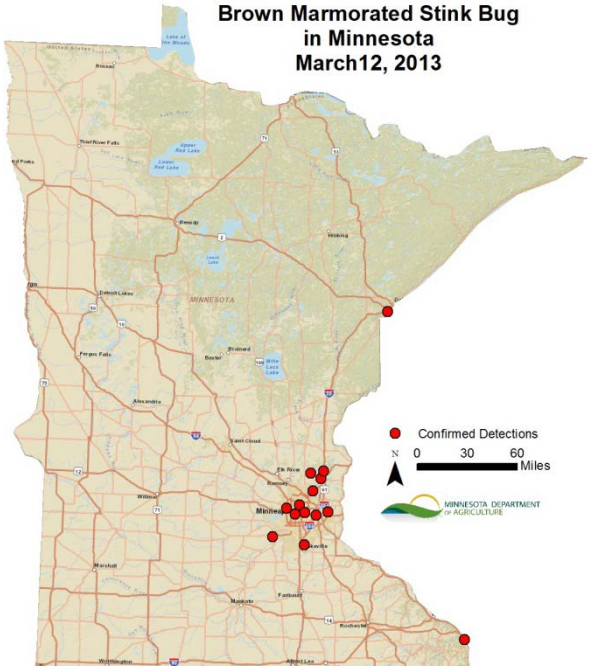
Project Length and Completion Date: 3 year project, to be completed June 30, 2017

Date of Report: August 11, 2017

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Revised Activity Budget 08/11/2017	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	**Establish and maintain a monitoring network for BMSB**				**Evaluate cold hardiness of potential biocontrol agents.**				
Personnel (Wages and Benefits) 1 Survey coordinator (0.52 FTE): Salary ($56,890 = $17.40/hr x 3,270 hrs) + Fringe ($14,225 = 25% of salary)	$71,122	$77,351	$77,351	$0				$71,122	$0
Equipment/Tools/Supplies Supplies for conducting survey and sampling including traps, lures, bags, vials, and other supplies needed for maintaining monitoring network approx. $3,500 per year * 3 years	$10,628	$10,772	$10,772	$0				$10,628	$0
Travel expenses in Minnesota - Vehicle rental and fuel (we will use the least expensive method of travel which will be either a state vehicle or a rented vehicle) approx. $5,250 per year * 3 years** - Meals and lodging as needed for MDA Coordinator (estimated 15 days of travel per year) approx. $500 per year * 3 years	$17,250	$10,877	$10,877	$0				$17,250	$0
COLUMN TOTAL	$99,000		$99,000	$0				$99,000	$0

Brown Marmorated Stink Bug Monitoring and Biocontrol Evaluation

Status in Minnesota



Current known distribution of BMSB in Minnesota.

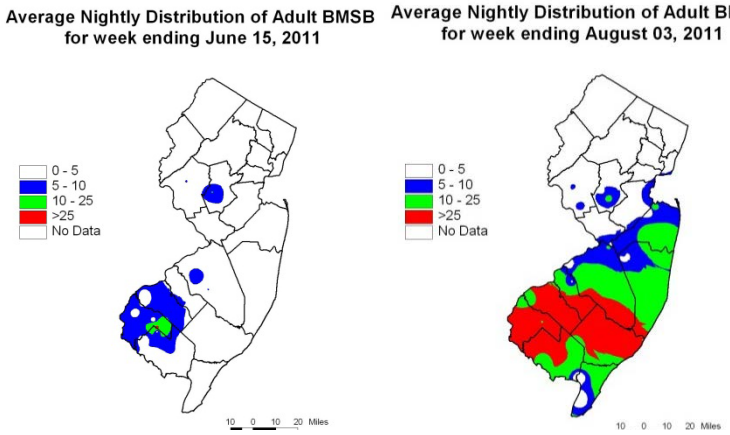
Potential Impacts

Federal risk assessment determined: *"Heavy feeding pressure by BMSB could also damage or reduce native plant species and impact biodiversity throughout the United States."*

Fall congregation of BMSB on a building (not in MN), photo by Leske, 2010.

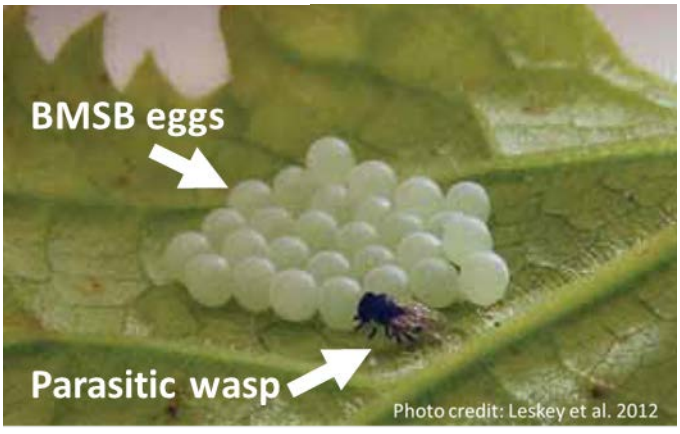
Monitoring Network

Trap used for monitoring BMSB populations.



Results from BMSB monitoring network in New Jersey predicting problem area. Maps by Rutgers University.

Biological Control



Potential biocontrol agent attacking BMSB eggs. Wasps are 1-2 mm long and cannot sting humans.

Brown Marmorated Stink Bug

Publication number: HHAL01-2012-12

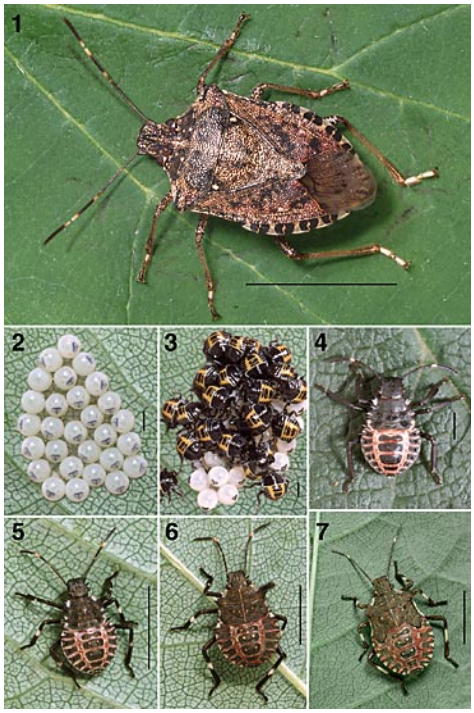


Figure 1: Life stages of the brown marmorated stink bug (adult [1]; eggs [2]; nymphs [3-7]). Photo credit: Kent Loeffler, Photo Lab, Department of Plant Pathology, Cornell University.

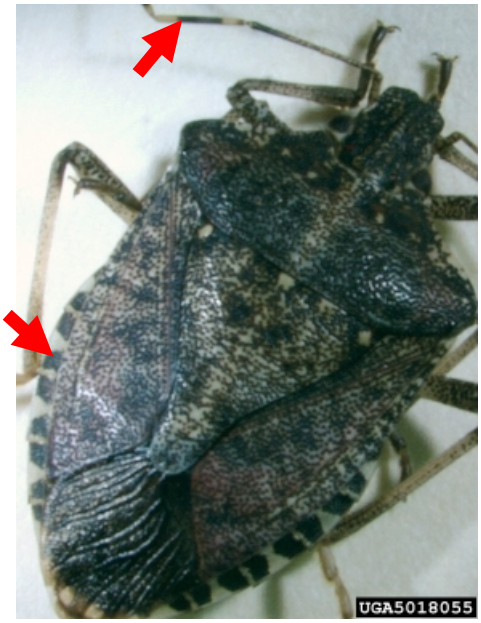


Figure 2: Coloration of adult brown marmorated stink bug; "marbled"-brown body with dark and light banding on antennae and edge of abdomen. Photo credit: Pennsylvania Department of Conservation & Natural Resources, bugwood.com

Scientific name: ***Halyomorpha halys***

History:

- Originally from China, Korea and Japan.
- First identified in the U.S. in Pennsylvania in 2001; however, it was likely there since the mid-1990's. It has since been reported from at least several mid-Atlantic states and Oregon.
- Spreads to new areas by flying and by acting as a stowaway on shipping containers or vehicles, where they aggregate to spend the winter.
- First identified in Minnesota in November 2010 in Ramsey County; and reported from Anoka, Carver, Chisago, Dakota, Hennepin, St. Louis, Washington and Winona counties by 2013.

Description:

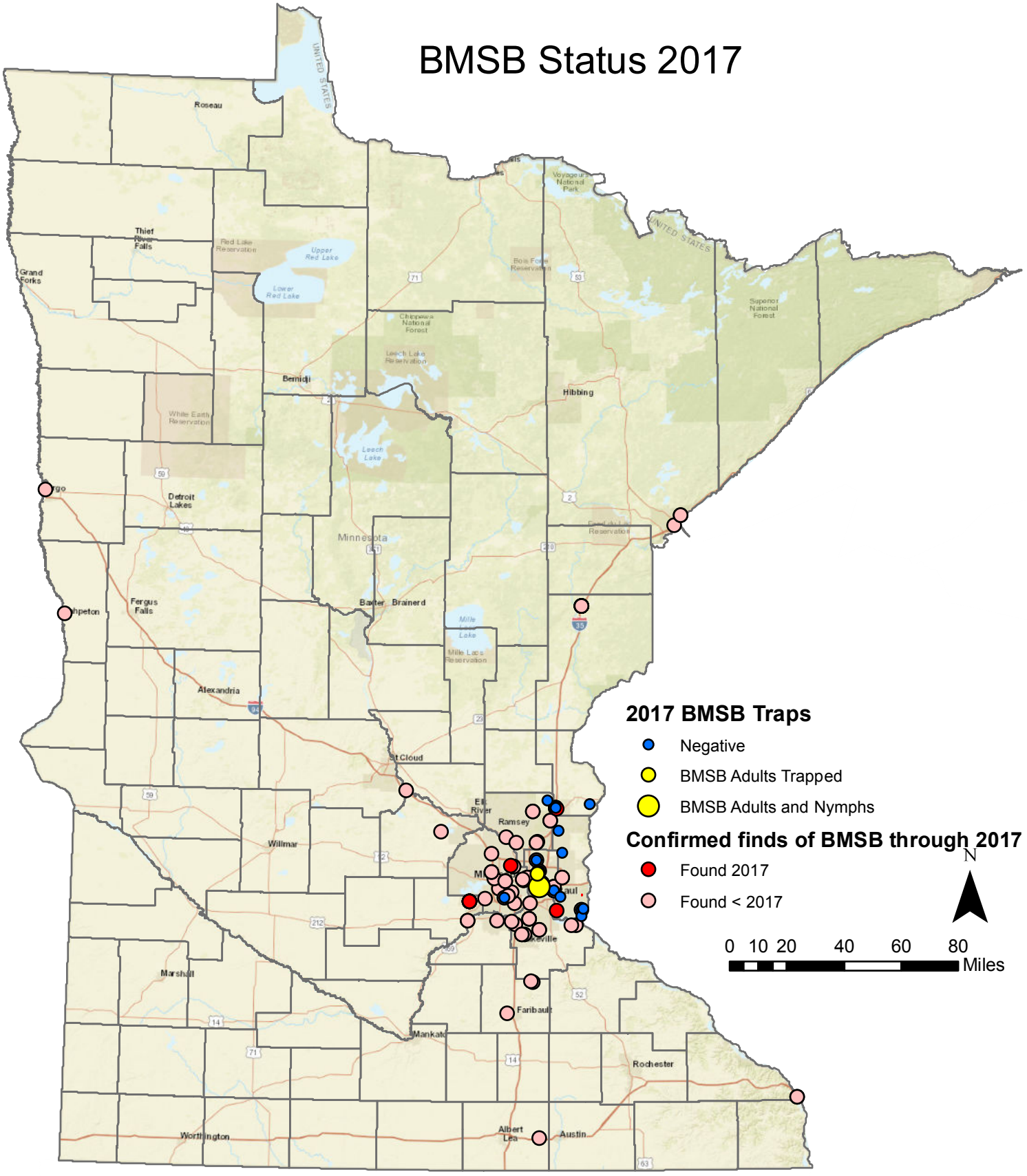
- Adults: ½-inch-long, shield-shaped, and "marbled" brown in color (figs. 1.1 & 2).
- To distinguish adults of this pest from other brown stink bugs, look for the alternating black and white color pattern on the margins of the abdomen, and the dark-colored antennae with light-colored bands (see red arrows in fig. 2).
- Eggs: white to light green in color, barrel-shaped, and laid in clusters of 20 to 30 eggs on the underside of leaves (fig. 1.2).
- Nymphs: have red and orange markings. They spend the first few days on the egg cluster (fig. 1.3) and later disperse. As the nymphs age, their coloration darkens (figs. 1.4-1.7).
- Life cycle: One generation per year. Overwintered adults emerge in March-April and produce offspring in June. Nymphs are present during summer and molt into adults. Autumn adults feed until September-October, and then seek overwintering sites (*Based on observations from New Jersey*).

Impacts:

- Feeds on the fruits, leaves, stems and seeds of a wide variety of plants and is known as a pest of fruit trees, vegetables and soybeans.
- Initial reports of damage to plants were minimal in the U.S. However, a growing number of reports from eastern states indicate this pest is causing significant crop damage, especially in orchards.
- Feeding results in necrotic spots on fruits and leaves, and in deformation of fruits.
- Common nuisance pest in houses and other buildings, much like the boxelder bug and multicolored Asian lady beetle.
- Release a foul-smelling odor when disturbed.

If you suspect you have seen this pest in Minnesota, contact the Minnesota Department of Agriculture
"Arrest the Pest"
Arrest.the.Pest@state.mn.us
1-888-545-6684 (Voicemail)

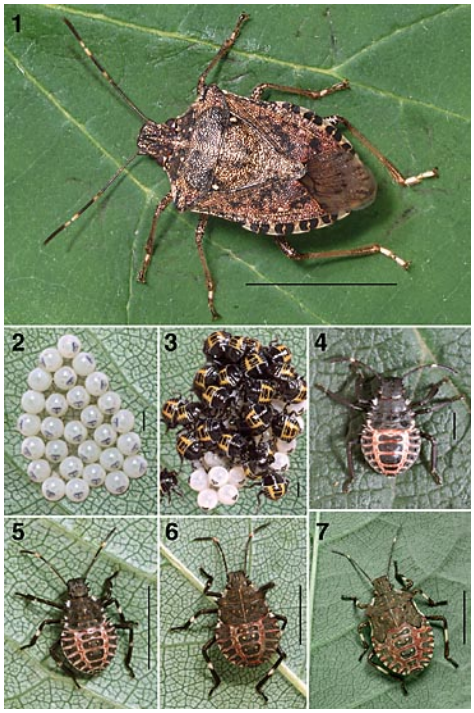
BMSB Status 2017



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Brown Marmorated Stink Bug

Publication number: HHAL01-2012-12



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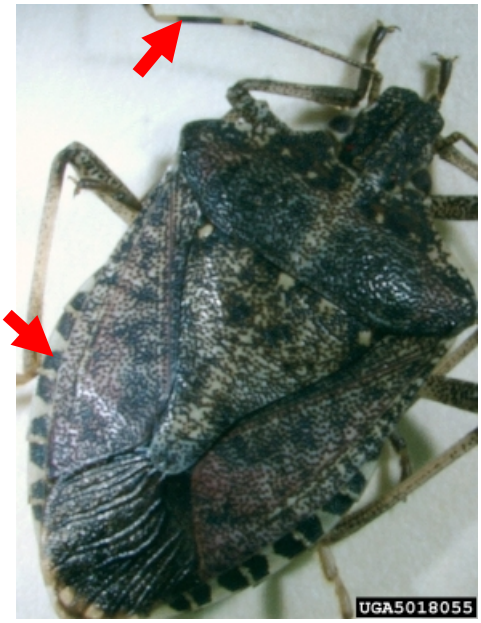

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1-888-545-6684 (Voicemail)

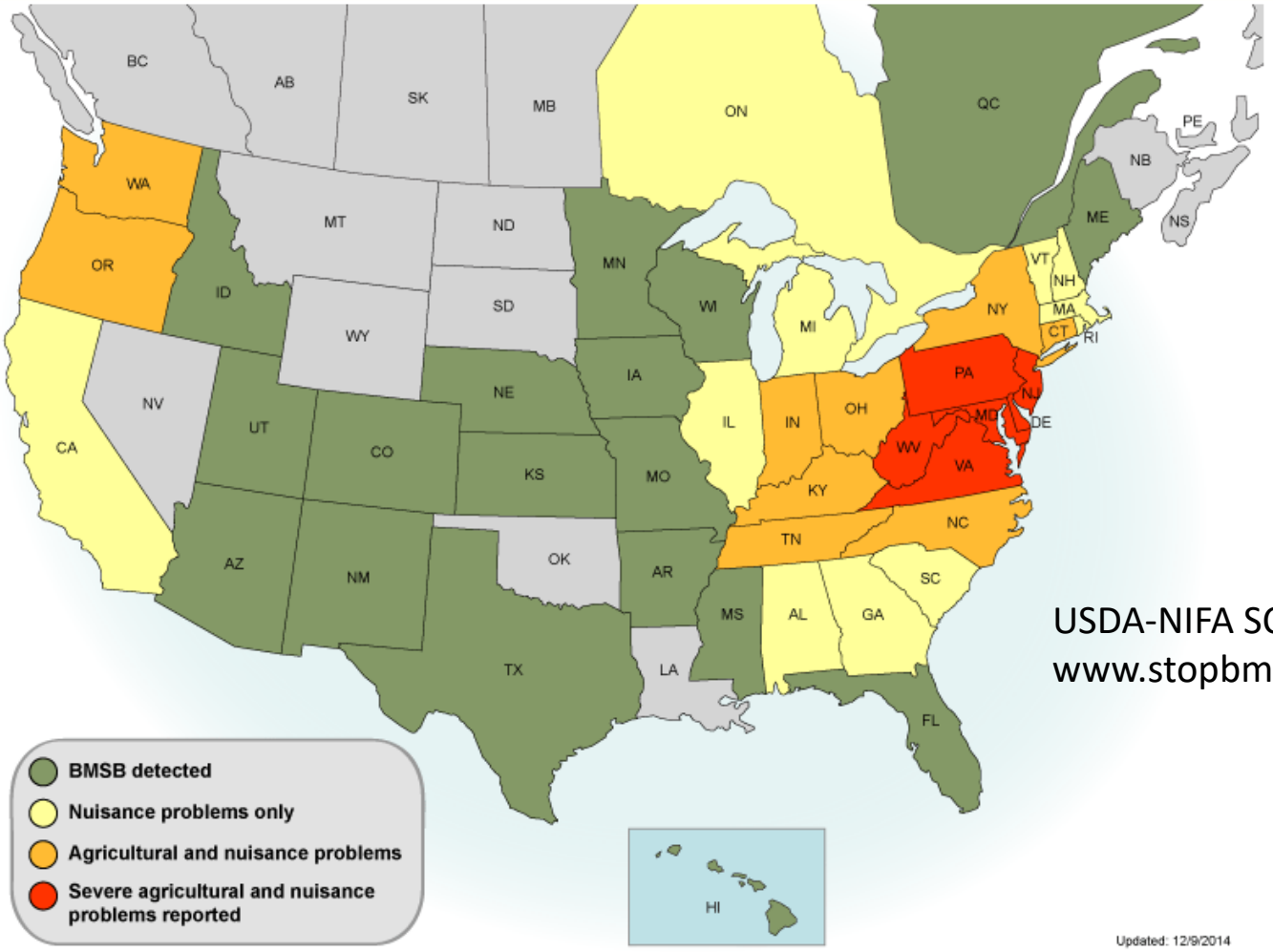
Minnesota Department of Agriculture

Invasive Plant Pests of Orchards: How the MDA Monitors and How You Can Help

Brown Marmorated Stink Bug

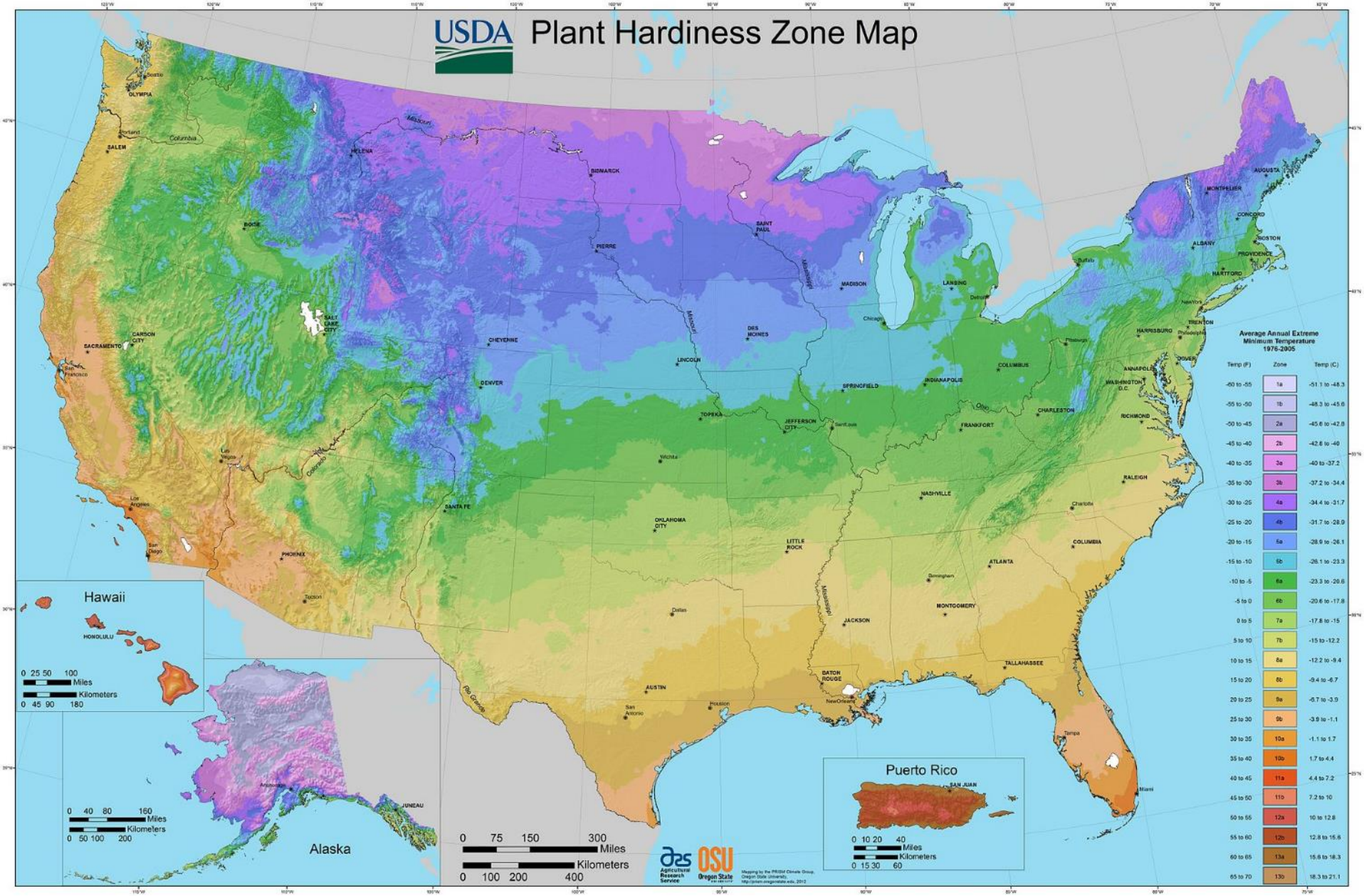
Distribution

First arrived in PA in mid-1990's

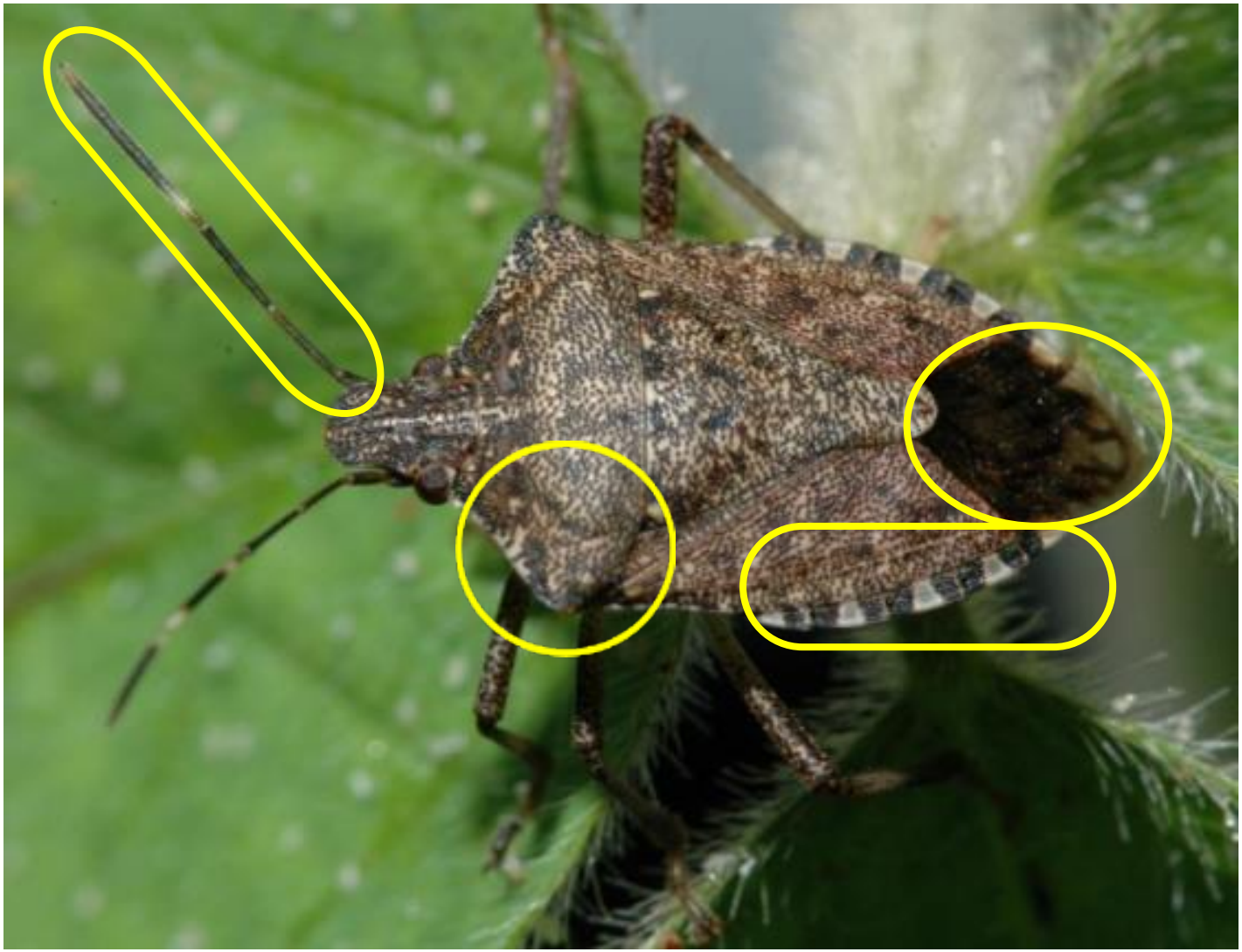


USDA-NIFA SCRI
www.stopbmsb.org

42 states and 2 provinces

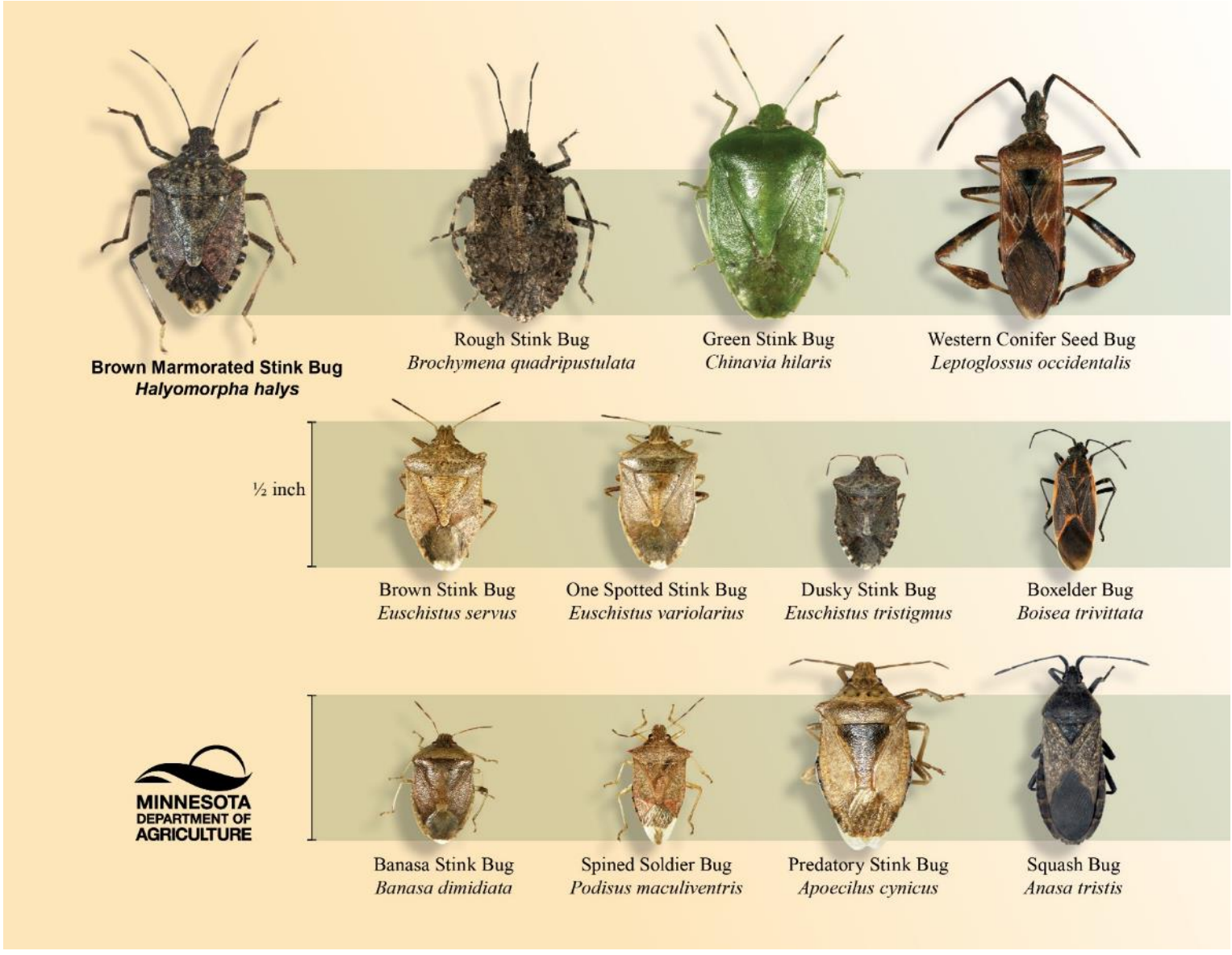

USDA Plant Hardiness Zone Map
Average Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-60 to -55 1a -51.1 to -48.3
-55 to -50 1b -48.3 to -45.6
-50 to -45 2a -45.6 to -42.8
-45 to -40 2b -42.8 to -40
-40 to -35 3a -40 to -37.2
-35 to -30 3b -37.2 to -34.4
-30 to -25 4a -34.4 to -31.7
-25 to -20 4b -31.7 to -28.9
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
5 to 10 7b -15 to -12.2
10 to 15 8a -12.2 to -9.4
15 to 20 8b -9.4 to -6.7
20 to 25 9a -6.7 to -3.9
25 to 30 9b -3.9 to -1.1
30 to 35 10a -1.1 to 1.7
35 to 40 10b 1.7 to 4.4
40 to 45 11a 4.4 to 7.2
45 to 50 11b 7.2 to 10
50 to 55 12a 10 to 12.8
55 to 60 12b 12.8 to 15.6
60 to 65 13a 15.6 to 18.3
65 to 70 13b 18.3 to 21.1
Hawaii
HONOLULU
0 25 50 100 Miles
0 45 90 180 Kilometers
Alaska
JUNEAU
0 40 80 160 Miles
0 50 100 200 Kilometers
Puerto Rico
SAN JUAN
0 10 20 40 Miles
0 15 30 60 Kilometers
0 75 150 300 Miles
0 100 200 400 Kilometers
Agricultural Research Service
OSU Oregon State University

BMSB Identification



BMSB Identification

Look - alikes


Brown Marmorated Stink Bug
Halyomorpha halys
Rough Stink Bug
Brochymena quadripustulata
Green Stink Bug
Chinavia hilaris
Western Conifer Seed Bug
Leptoglossus occidentalis
½ inch
Brown Stink Bug
Euschistus servus
One Spotted Stink Bug
Euschistus variolarius
Dusky Stink Bug
Euschistus tristigmus
Boxelder Bug
Boisea trivittata
MINNESOTA
DEPARTMENT OF
AGRICULTURE
Banasa Stink Bug
Banasa dimidiata
Spined Soldier Bug
Podisus maculiventris
Predatory Stink Bug
Apoecilus cynicus
Squash Bug
Anasa tristis

Life Cycle

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Feeding occurs

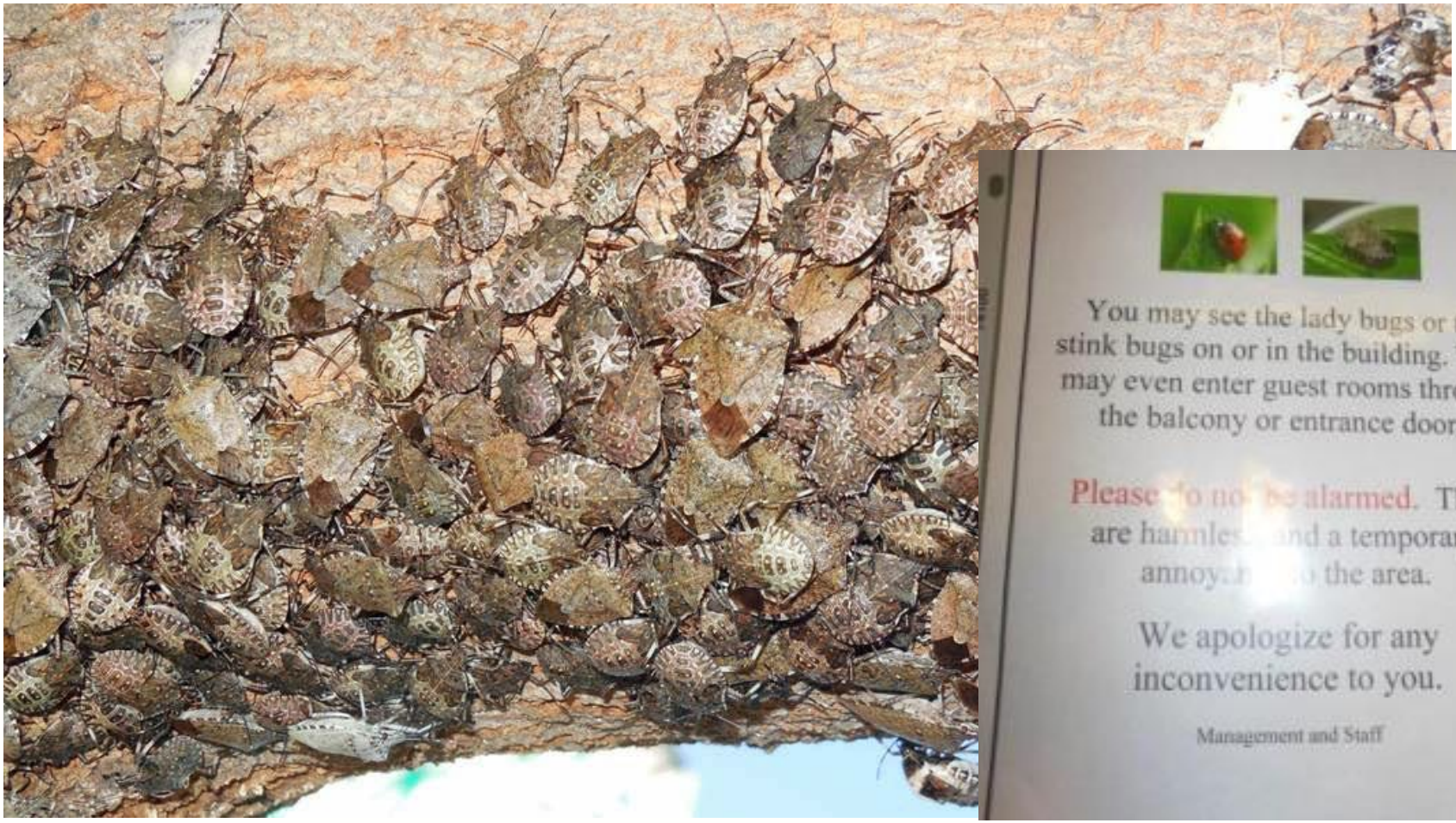
Active

Hibernating

BMSB Life Stages

www.stopbmsb.org

Why is BMSB a Pest?



http://ucanr.edu

Damage

http://ento.psu.edu/extension/factsheets/brown-marmorated-stink-bug

Bill Shane, MSU

Specialty Crops at Risk to BMSB Damage

HIGH RISK	apple, Asian pear, beans (green, pole, snap), bee-bee tree, edamame, eggplant, European pear, grape[1], hazelnut, Japanese pagoda tree, nectarine, okra, peach[2], Peking tree lilac, pepper, redbud, sweet corn, Swiss chard, tomato	
MODERATE RISK	apricot, asparagus, blueberries[1,3], broccoli, cauliflower, cherry[2], collard, cucumber, flowering dogwood, horseradish, lima bean, littleleaf linden, serviceberry, tomatillo	
LOW RISK	blackgum, carrot, cranberries, garlic, ginkgo, greens, Japanese maple, kohlrabi, kousa dogwood, leeks, lettuce, many gymnosperms, onion, potato, spinach, sweet potato, turnip	
UNKNOWN	almond, citrus, hops, kiwi, olive, pistachio, plum, strawberries, walnut	
HOSTS Non-Specialty Crop BMSB Hosts Contributing to Specialty Crops Risk	field corn, soybean	

1—Potential risk of taint/contamination. 2—Additional risk potential due to bark feeding. 3—Considered moderate-high risk.

USDA

Funded by USDA-NIFA SCRI Coordinated Agricultural Project, grant #2011-51181-30937. Image credits—sweet corn: Joe Zlomek; eggplant: Howard F. Schwartz, Colorado State University, Bugwood.org; apple, carrots: morguefile.com/creative/bekahboo42; flowering dogwood: Richard Floyd, Creative Ideas LLC, Bugwood.org; blueberries, cauliflower: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org; ginkgo: Jan Samanek, State Phytosanitary Administration, Bugwood.org; cranberries: Cjboffoli (CC-BY-3.0). Printed May 2015.

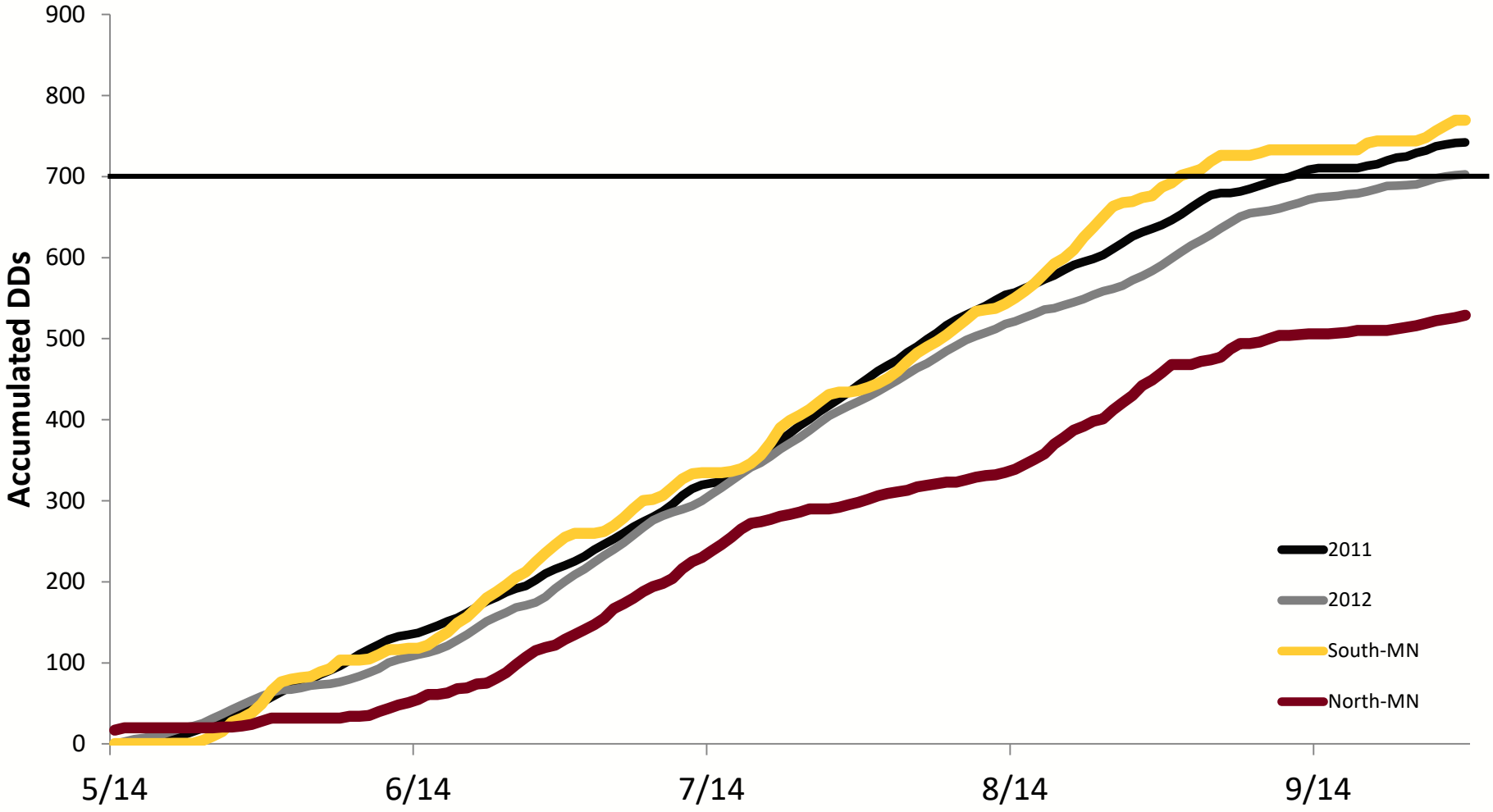
About BMSB

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 that will protect our food, our environment, and our farms.

Learn more at **StopBMSB.org**.

Stop BMSB

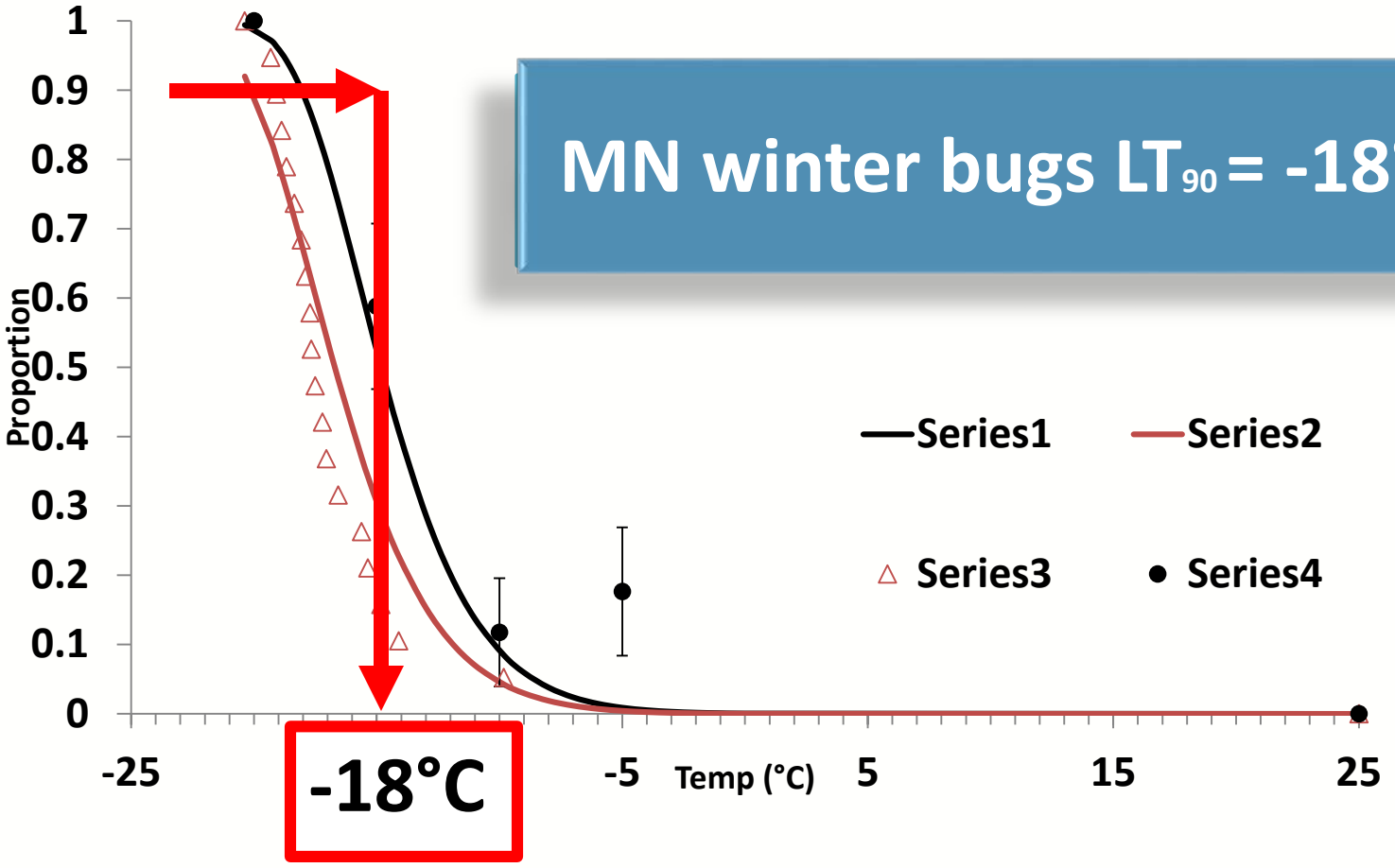
Minnesota Degree-days



Slide courtesy of Chris Phillips, University of Minnesota

Cold tolerance

Predicted and observed BMSB: Cumulative SCP & proportion mortality

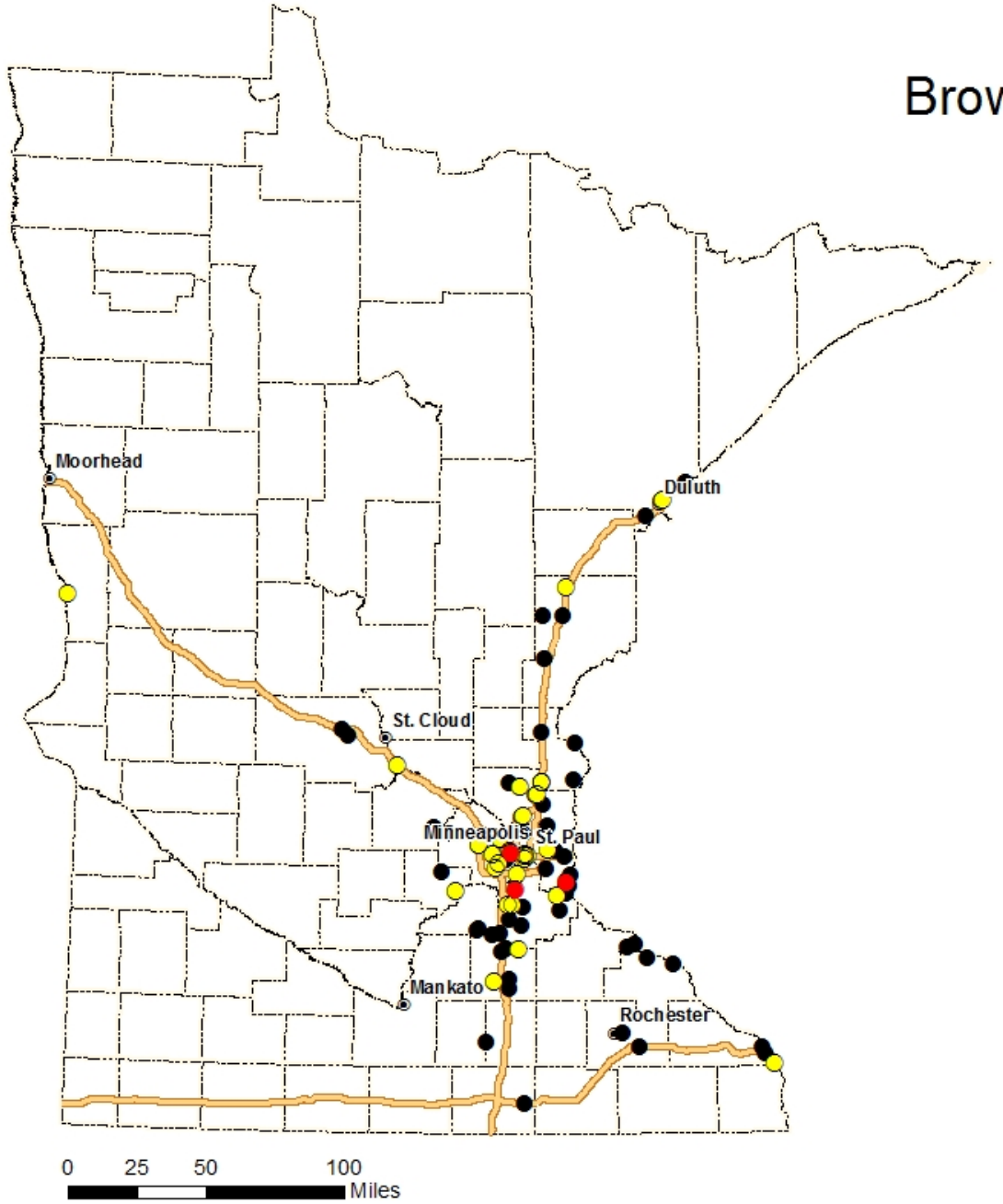


MN winter bugs LT_{90} = -18°C or ~0°F

Cira et al 2015
SCP: n=19 bugs
Mortality: n=17 bugs/each temp (mean ± 95% confidence interval)

BMSB Survey in 2015

Brown Marmorated Stink Bug Survey 2015



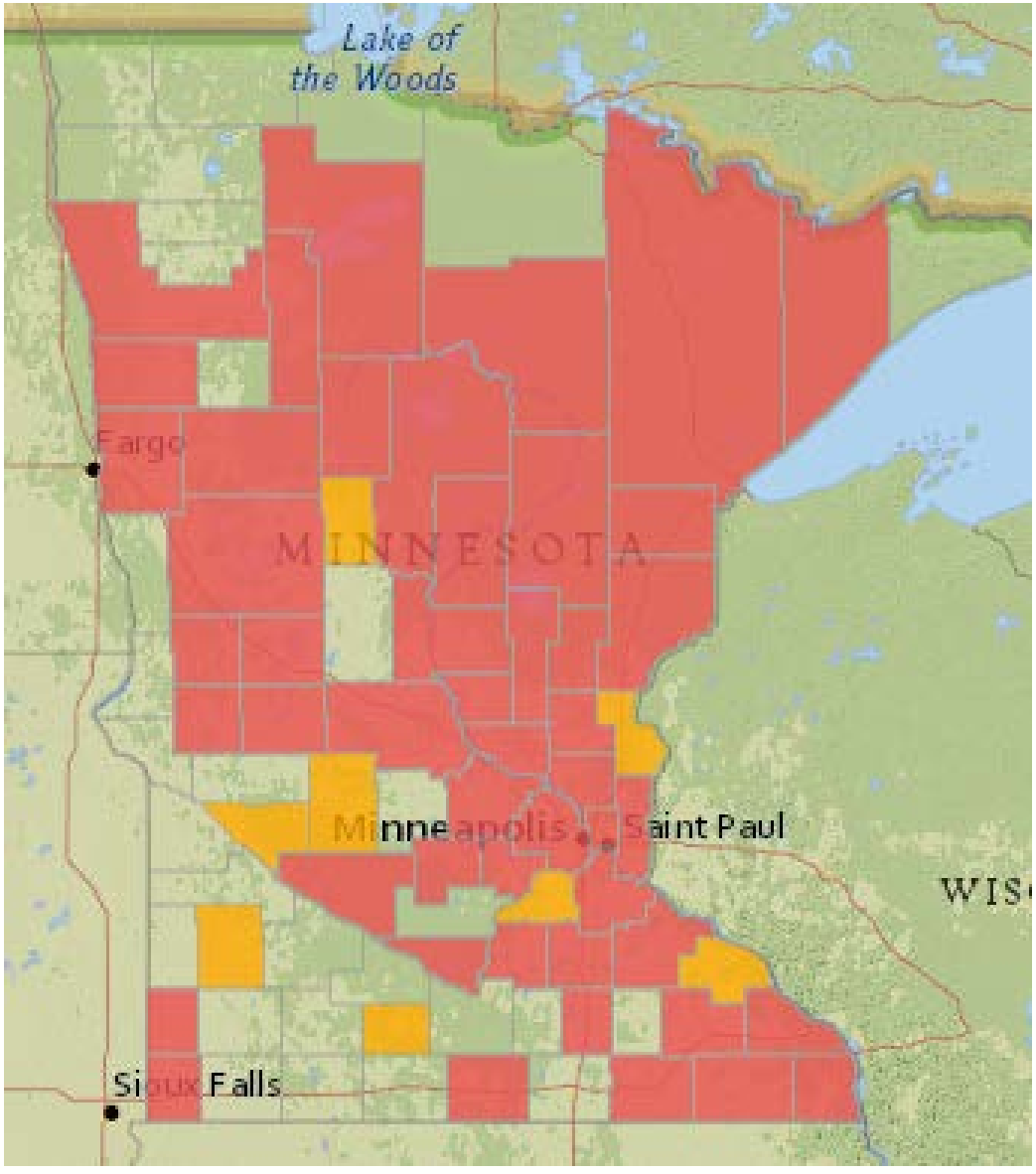
- Positive trap site
- Previously confirmed
- Negative trap site

N

Minnesota Department of Agriculture

Spotted Wing Drosophila

Distribution



Life Cycle

- Overwinter as adults
- Larvae tunnel in fruit
- Pupate in ground
- Life cycle 1 – 3 weeks
- 10 generations/year

Hannah Burrack, NCSU

Male Identification

Bob Koch, U of MN

Female Identification

Bob Koch, U of MN

Larva Identification

Bob Koch, Univ. of MN

SWD Host Plants in MN

Food Preference	Host
Top (Filet mignon)	Raspberries, blackberries, blueberries
	Plums, grapes, strawberries
	Apples and pears if damaged
Least (Hamburger) - Avoided	Cranberries Cherry Tomatoes

Injury

Brown sunken areas, that are soft and often decayed

Eric Burkness, U of MN

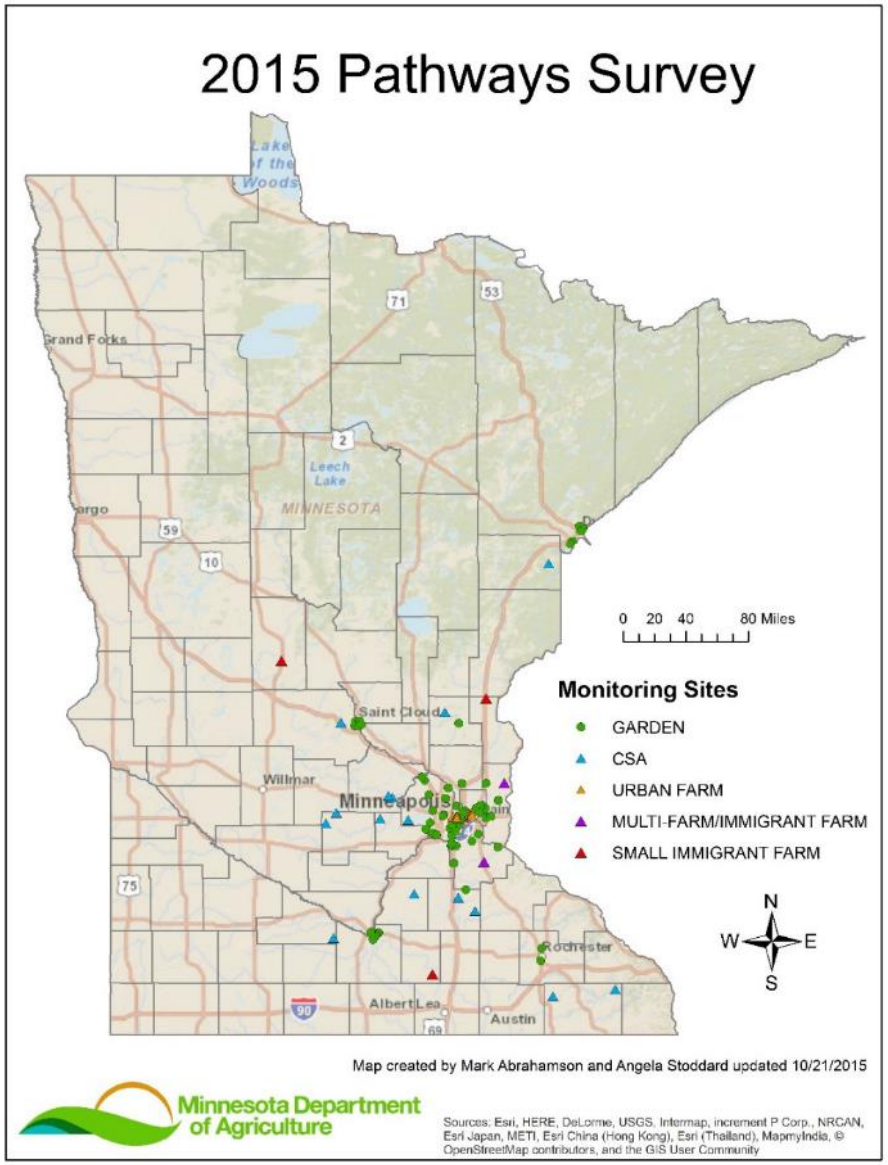
Management

Ipm.Missouri.edu

The Pathways Early Detection Survey:

New Approach

- Pathways-based approach
- Survey monitors for new and emerging pests near urban centers
- Community gardens, CSA farms, and small immigrant farms.
- First state in the nation to survey with this approach.

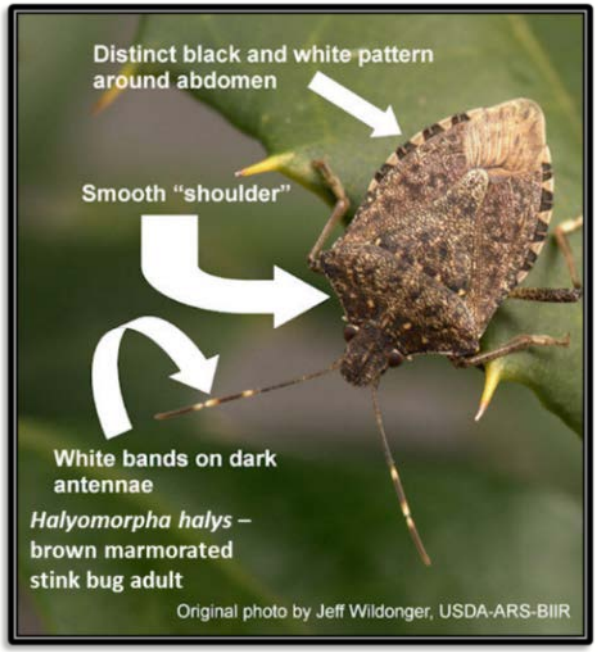


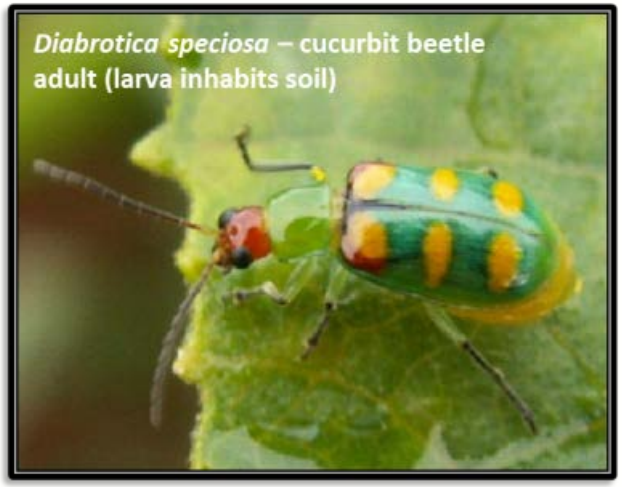
Multi-Pest, Bundled Survey

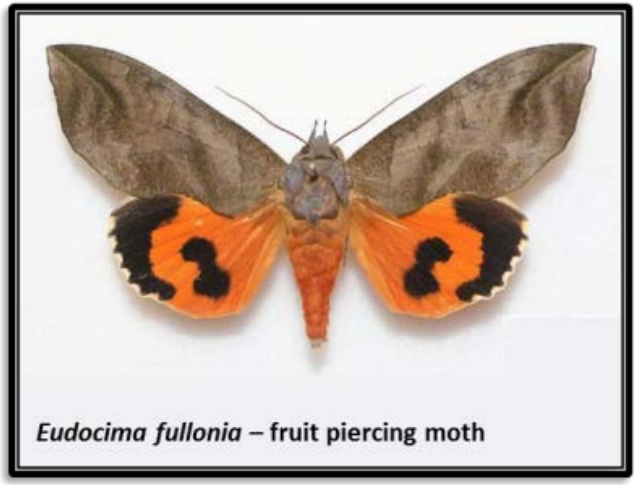
Insects - Trapping		
Common name	**Scientific name**	**Primary Hosts**
Golden twin spot moth	*Chrysodeixis chalcites*	Crucifers, tomato, strawberries
Swede midge	*Contarinia nasturtii*	Crucifers
Brown marmorated stink bug	*Halymorpha halys*	Corn, crucifers, legumes, onion, Solanaceae
Tomato fruit borer	*Neoleucinodes elegantalis*	Solanaceae

Multi-Pest, Bundled Survey

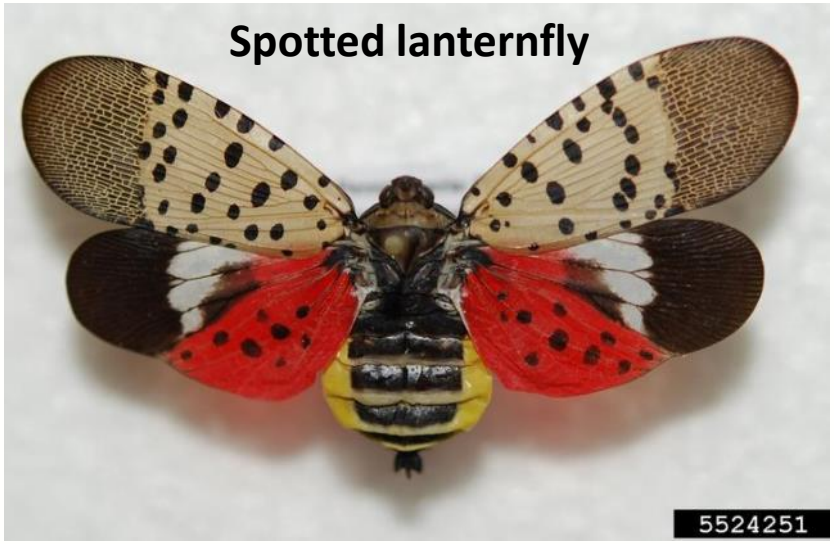
Insects - Visual Survey

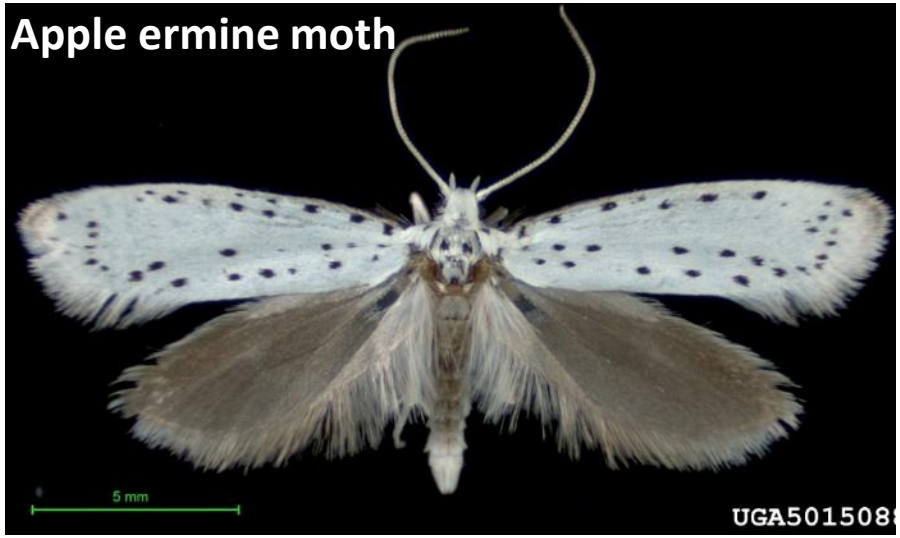






2016 Add Orchards



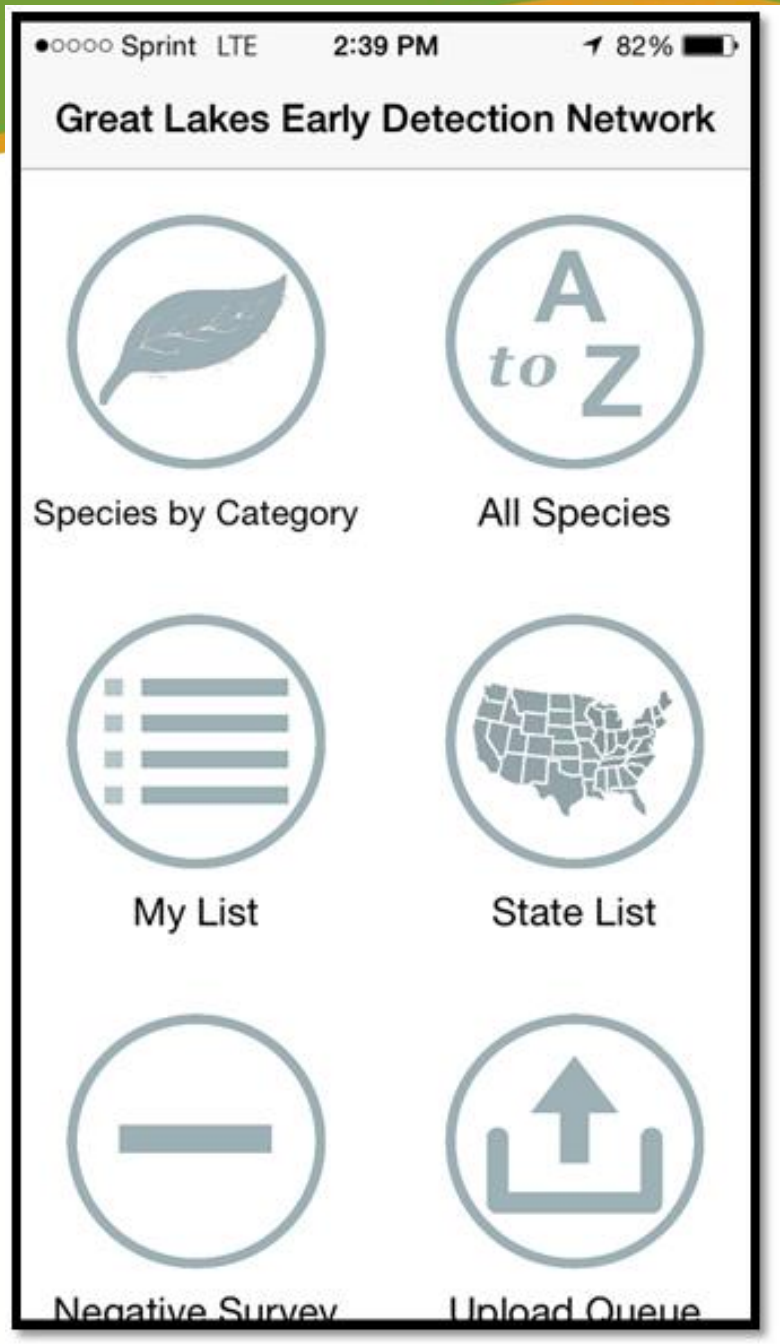


Reporting

Contact Arrest the Pest

- Take pictures and notes
- Capture the insect or take a sample of the plant
- Report
  - mda.state.mn.us/arrestthepest
  - arrest.the.pest@state.mn.us
  - GLEDN app
  - Call 888-545-6684 and leave a detailed voicemail


3G
9:41 AM
Great Lakes Early Detection Network
The Ohio State University
Great Lakes Restoration
Center for Invasive Species Ecosystem Health


Sprint LTE
2:39 PM
82%
Great Lakes Early Detection Network
Species by Category
A to Z
All Species
My List
State List
Negative Survey
Upload Queue


Questions?