2014 Project Abstract

For the Period Ending June 30, 2017

PROJECT TITLE: Biosurveillance and Biocontrol of Emerald Ash Borer – Phase 2
PROJECT MANAGER: Monika Chandler
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2014, Chp. 226, Sec. 2, Subd. 04d

APPROPRIATION AMOUNT: $447,000
AMOUNT SPENT: $446,810
AMOUNT REMAINING: $190

Overall Project Outcomes and Results

Emerald ash borer (EAB) populations have grown slower than expected in the Twin Cities metro region. To date, the insect has not spread as quickly in Minnesota as in other states. We were able to characterize this growth phase well with the continuing study on the infestation core commenced in Phase I of this project. Using annual branch sampling, we showed that after a decade of EAB presence in the Twin Cities metro region, half of the trees in the core area still did not exhibit easily-detectable levels of EAB, and canopy conditions remained quite good. We expect that EAB mortality due to extreme cold during the winter of 2013-2014 helped slow population growth. This slow growth continued to buy the state valuable time for implementing biological control and engaging the public in the fight against this insect, two other important strategies funded by this project. An astounding total of 450,000 larval and egg parasitoids were released at 33 sites during Phases 1 and 2 of this project. We are pleased that we documented established, reproducing populations of biological control agents at 5 sites in 2 counties. To document this, both larval parasitoids and the egg parasitoids were recovered with methods involving debarking ash branches and trunks, bark sifting, yellow pan traps and larval dissection. We also documented a native parasitoid, *Atanycolus simplex*, which can also attack EAB. We engaged a total of 128 citizen scientists using the biosurveillance program with smokey winged beetle bandit wasps, and collected more than two dozen species of buprestid beetles brought back to the nests by these wasps. We recovered ten species of *Agrilus* (in addition to EAB), providing important survey information on what other potential damaging wood borers in this family are present in the state. *Agrilus coxalis* is killing oaks in California, for example, but we have not found it in Minnesota to date.

Project Results Use and Dissemination

Our newly updated EAB management guidelines will be a valuable resource for people planning for or actively managing EAB. We incorporated findings from the project titled Improving EAB Detection in addition to Phase 1 and Phase 2 of our project. These guidelines provide information regarding EAB identification and reporting, detection methods and their relative efficiencies, recommended management tactics, including biocontrol, based on the infestation and site specifics. The guidelines will soon be available on MDA's EAB webpages (https://www.mda.state.mn.us/emeraldashborer).

We will build upon our accomplishments and learning with Phase 3: Assessment and Citizen Engagement.

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

Date of Report: November 30, 2016

Date of Final Report: August 1, 2017

Date of Work Plan Approval: June 4, 2014

Project Completion Date: June 30, 2017

Does this submission include an amendment request? Yes

PROJECT TITLE: Biosurveillance and Biocontrol of Emerald Ash Borer – Phase 2

Project Manager: Monika Chandler

Organization: Minnesota Department of Agriculture

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$ 447,000**
	Amount Spent:	**$ 446,810**
	Balance:	**$ 190**

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

Appropriation Language:
$447,000 the second year is from the trust fund to the commissioner of agriculture in cooperation with the University of Minnesota to continue to monitor ash tree and emerald ash borer populations and expand the biological control implementation for emerald ash borer management. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Biosurveillance and Biocontrol of Emerald Ash Borer – Phase 2

II. PROJECT STATEMENT:

Our project focuses on best management strategy implementation for the emerald ash borer (EAB), one of the most destructive non-native pests in North America. Minnesota has an estimated 1 billion ash trees at risk – more than any other state – and all of our native ash species are susceptible. Loss of our ash trees would result in ecosystem change, financial losses estimated in the hundreds of millions and the possible extinction of many species dependent on ash trees such as the banded ash clearwing moth.

In Michigan and Ohio, EAB infestations have killed 99% of all ash trees within six years after initial infestation resulting in the death of over 50 million ash trees to date. In Minnesota, we have seen very few trees killed by EAB and EAB seems to be spreading more slowly than in Michigan. EAB infestations have been aggressively managed in the Twin Cities and trees at southeast Minnesota biological control sites remain in visibly better condition than surrounding natural stands of infested ash. Still, there are many challenges that we must continue to address. EAB continues to spread. We do not know the full extent of existing infestations and it is too early to determine the long-term efficacy of biological control.

EAB biological control uses parasitoid wasps to reduce EAB populations and is still experimental in practice. However, biological control is the only practical EAB management strategy for natural forest ash and is a component of urban EAB management. We will improve biological control implementation with:

Biosurveillance of EAB: Engage citizen scientist volunteers to monitor EAB populations statewide using a native predatory wasp, the smoky winged beetle bandit. Our goals are to better delimit EAB populations and educate the public about EAB. Additionally, biosurveillance will monitor for similar high risk wood-boring beetles that are not documented in Minnesota such as the European oak borer that threatens our oaks and was detected with biosurveillance in Ontario and picked up on a trap in Michigan.

Track EAB infestation core: Continue monitoring ash health, EAB and EAB biological control agents in the core infested area of the Twin Cities. This study was initiated in 2011 with ENRTF funds and will provide answers about the importance of multiple management activities. This unique long-term study receives attention from national researchers.

Expand biological control implementation: Biological control was initiated in 2010 and biological control agents released at all known infestations. EAB is spreading so new detections are inevitable. The biological control effort will be expanded to address new EAB finds and continue existing site monitoring.

III. PROJECT STATUS UPDATES:

Amendment Request September 11, 2014: The requested work plan change pertains to the Research Scientist 1 position in Activity 3, Expand biological control implementation. The position is currently unclassified and filled by Jonathan Osthus. The Minnesota Department of Agriculture (MDA) plans to create a new, classified position for Jonathan Osthus. The working title is EAB Biocontrol Coordinator. The change in status would be effective 10/08/14. This classified position does not currently exist.

Amendment was approved on September 17, 2014.

Project Status as of November 26, 2014: This project smoothly transitioned from Phase 1 that was completed 06/30/14 to Phase 2 starting 07/01/14. Biosurveillance for EAB is a new activity in Phase 2. To begin our activity over the summer of 2014, the ENRTF appropriation was leveraged to secure bridge funds from the Renewable Resources Extension Act funding (RREA). University of Minnesota (U of M) received $11,930 to cover expenses for a part-time Wasp Watchers coordinator to begin in May 2014, prior to the availability of ENRTF dollars. A Wasp Watchers Program Coordinator, Jennifer Schultz, was hired and initiated biosurveillance. Biological control agent releases continued and ash health data were collected for Activities 2 and 3. Branch sampling to monitor for EAB and biological control agents (Activity 2) will begin after contracts with the Minneapolis Parks

and Recreation Board and the City of St. Paul are executed. MDA is in the process of hiring a student worker for Activities 2 and 3.

Contracts for branch sampling are in process. A contract with the U of M for Activity 1 and 2 funds was executed. Because it took some time to set up funding strings at the U of M, actual amounts spent during the project period are not available yet. The amounts spent by the U of M will be included in future status reports.

We plan to update our webpage www.mda.state.mn.us/plants/pestmanagement/eab/eabbiocontrol.aspx with a summary of Phase 1 and activities in progress for Phase 2.

Project Status as of May 29, 2015:
Our project is making good progress. The Wasp Watchers program (Activity 1) is ramping up for a large beetle bandit monitoring effort with 93 volunteers in 17 counties. Winter and spring branch sampling for Activity 2 was completed. An extensive survey of southeastern Minnesota was completed to define EAB infestations and search for potential new biocontrol release sites. There was a new EAB find in Rushford as a result of this survey. Bioagent releases for the 2015 season have started for Activity 3 and the egg parasitoid was documented in EAB eggs for the first time in Minnesota. In addition, we redesigned and updated our project webpage at www.mda.state.mn.us/plants/pestmanagement/eab/eabbiocontrol.aspx.

Project Status as of November 30, 2015:
Wasp Watchers completed its first full field season with a trained team of volunteers checking sites for beetle bandit colonies and monitoring colonies. Summer field season data were collected for Activities 2 and 3. Releases of biological control agents continued from late spring to early fall. Recoveries of biological control agents went very well. We found many more larval parasitoids in the fall of 2015 compared to the fall of 2014. This indicates that their population is established and growing at the site in southeastern Minnesota that was sampled.

Amendment Approved December 8, 2015
We have some salary savings from lower insurance costs than originally budgeted (single vs. dependent care coverage). This presents an opportunity to do more than originally planned. Starting in May 2016, we propose to hire an additional Research Scientist 1 to work on Activity 3. This position would do the following.

1. Activity 1: Intensively monitor a biosurveillance site during the 2016 field season. We are disappointed that volunteers have not collected EAB with biosurveillance. We attribute this to volunteers monitoring sites with low to no EAB in the area. We propose to select a site in a heavily infested area and monitor it at least twice per week. We would better understand EAB levels as they relate to biosurveillance.
2. Activity 3: Test a parasitoid recovery method using yellow pan traps. Traps would be placed and trap contents collected at three sites during the 2016 field season. The trap contents would be examined for parasitoids during the winter of 2016/2017. Researchers have had some success with this method, but it has not been used extensively.
3. Activity 3: Update guidelines for EAB management in Minnesota, including biological control. These guidelines would incorporate findings from the project titled Improving EAB Detection in addition to our project. Both projects are funded by ENRTF and have taught us much about EAB management. After guidelines are written, they will be reviewed by a multi-agency team of experts. Then a presentation with the information will be put on the MDA EAB webpage. This will make the information readily accessible for municipalities, counties and the public.

Activity budgetary changes:

- Add an approximately 80% time Research Scientist 1 position to Activities 1 and 3 from May 2016 to June 2017 (14 months).
- Activity 2 salary funds would be decreased by $27,860. $3,000 would go to Activity 1 salary and $24,860 would go to Activity 3.

- Activity 3 travel funds would be decreased by $3,460 with $800 going to MDA Activity 1 travel and $2,660 moved to Activity 3 personnel.
- Activity 3 supply funds would be decreased by $1,000 and moved to Activity 3 shipping ($500) and Activity 3 personnel ($500).

Project Status as of May 31, 2016:
Our project is progressing well. For biosurveillance (Activity 1), most of the beetles from the 2015 season were identified and we are geared up for the 2016 season. There was an emphasis on outreach and volunteer recruitment during the winter and spring. Field training for the volunteers is scheduled for summer 2016. We secured a DNR permit to conduct biosurveillance at specific parks and scientific and natural areas. Tracking the infestation core (Activity 2) continues to pleasantly surprise us. Predictions based upon experiences in Ohio and Michigan were that 99% study trees would have been infested by 2015. Instead, only 21% of study trees have been infested to date. Four new release sites were selected for bioagent releases starting in 2016 (Activity 3). Additionally, our website was enhanced and updated to provide more information with interactive mapping and a presentation on the bark sifting technique for detecting parasitized EAB eggs.

Project Status as of November 30, 2016:
We had a productive field season with a substantial increase in biosurveillance activities and sustained parasitoid releases and recoveries. We tested yellow pan trapping as a parasitoid recovery method and consider it to be a reasonable method. Continued parasitoid recoveries indicated an increased number of established populations. This was the first year that we released *Spathius galinae*, a newly approved larval parasitoid. We will be wrapping up Phase 2 of this project with final branch sampling and data collection followed by analysis of our long-term study of the EAB infestation core in the Twin Cities.

Amendment Request August 1, 2017
Activity 1: We overspent on personnel by $6,422. This included the addition of two summer student workers to monitor beetle bandit nests. The subcontract was underspent by $41 so would be reduced from $6,500 to $6,459. Equipment/tools/supplies were underspent by $1,715 so would be reduced from $2,900 to $1,185. Printing was underspent by $435so would be reduced from $4,500 to $4,065. Travel was underspent by $4,125 so would be reduced from $9,700 to $5,575. There were no shipping charges because volunteers handed in rather than shipped samples so shipping would be reduced from $1,000 to $0. Of the original Activity 1 budget of $107,000 only $106,810 was spent so $90 remains unspent.

Activity 3: Personnel was underspent by $798 so would be reduced from $164,560 to $163,762. We overspent $53 on supplies so supplies would be increased from $500 to $553. We overspent travel by $895 so it would be increased from $14,000 to $14,895. We underspent shipping by $151 so shipping would be reduced from $500 to $349.

Overall Project Outcomes and Results:
Emerald ash borer (EAB) populations have grown slower than expected in the Twin Cities metro region. To date, the insect has not spread as quickly in Minnesota as in other states. We were able to characterize this growth phase well with the continuing study on the infestation core commenced in Phase I of this project. Using annual branch sampling, we showed that after a decade of EAB presence in the Twin Cities metro region, half of the trees in the core area still did not exhibit easily-detectable levels of EAB, and canopy conditions remained quite good. We expect that EAB mortality due to extreme cold during the winter of 2013-2014 helped slow population growth. This slow growth continued to buy the state valuable time for implementing biological control and engaging the public in the fight against this insect, two other important strategies funded by this project. An astounding total of 450,000 larval and egg parasitoids were released at 33 sites during Phases 1 and 2 of this project. We are pleased that we documented established, reproducing populations of biological control agents at 5 sites in 2 counties. To document this, both larval parasitoids and the egg parasitoids were recovered with methods involving debarking ash branches and trunks, bark sifting, yellow pan traps and larval dissection.

We also documented a native parasitoid, *Atanycolus simplex*, which can also attack EAB. We engaged a total of 128 citizen scientists using the biosurveillance program with smokey winged beetle bandit wasps, and collected more than two dozen species of buprestid beetles brought back to the nests by these wasps. We recovered ten species of *Agrilus* (in addition to EAB), providing important survey information on what other potential damaging wood borers in this family are present in the state. *Agrilus coxalis* is killing oaks in California, for example, but we have not found it in Minnesota to date.

Our newly updated EAB management guidelines will be a valuable resource for people planning for or actively managing EAB. We incorporated findings from the project titled Improving EAB Detection in addition to Phase 1 and Phase 2 of our project. These guidelines provide information regarding EAB identification and reporting, detection methods and their relative efficiencies, recommended management tactics, including biocontrol, based on the infestation and site specifics. The guidelines will soon be available on MDA's EAB webpages.

We will build upon our accomplishments and learning with Phase 3: Assessment and Citizen Engagement.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Biosurveillance of EAB
Description:
The smoky winged beetle bandit, *Cerceris fumipennis*, can teach us which species of wood-boring beetles, including EAB, are in an area. This is a form of biosurveillance – using one organism, the beetle bandit wasp, to monitor for another organism - in this case EAB and related beetles. Monitoring beetle bandits in Connecticut yielded the first EAB find in the state. Additionally, beetle bandit biosurveillance will monitor for similar high risk wood-boring beetles that are not documented in Minnesota such as the European oak borer that threatens our oaks and was detected with biosurveillance in Ontario and picked up on a trap in Michigan.

The smoky winged beetle bandit is a native, ground nesting wasp. Females collect wood-boring beetles from wooded and forested areas then bring the beetles back to their nests to feed their young. Beetles from these wasps can be collected with the following methods. Beetle bandit wasps drop beetles they think were attacked by parasitic flies. Consuming parasitized beetles would kill developing beetle bandit wasps. Therefore, the adult wasps abandon suspect beetles outside of their nests. These abandoned beetles can be easily collected. Another way to collect beetles is to net the beetle bandit as it returns to its nest with a beetle. The wasps are docile and do not sting humans. They will immediately drop the beetle then the wasp can be released from the net.

University of Minnesota Extension (Extension) will lead the joint effort with MDA and USDA Forest Service (USFS) to monitor beetle bandit colonies in Minnesota. Citizen scientist volunteers proved in 2013 that they could find beetle bandit colonies in multiple areas of the state. A preferred habit of the ground nesting beetle bandit is minimally maintained baseball fields. The wasps like the sandy soils for nest building and the relatively undisturbed setting. Citizen scientists can be directed to search ball fields in high risk areas and report their finds. See www.myminnesotawoods.umn.edu/cerceris/ for more information. These same citizen scientists will be trained to monitor beetle bandit colonies. Collected beetles will be identified by a taxonomist and data will be entered into a Forest Service database. A Community Program Specialist will coordinate volunteers, process beetle samples and enter data.

Summary Budget Information for Activity 1:		
	~~**ENRTF Budget:**~~	~~**$ 107,000**~~
	ENRTF Budget	**$ 106,810**
	Amount Spent:	**$ 106,810**
	Balance:	**$ 0**

Activity Completion Date: 06/10/2017

Outcome	Completion Date	Budget
1. First Detector and other volunteer training and colony monitoring completed	09/30/2016	$ 95,700
2. Beetles identified and data entered into a Forest Service database	06/10/2017	$ 7,500
3. Intensively monitor a site with a high EAB population	11/01/2016	$ 3,800

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- A validation dataset for beetle bandit emergence in Minnesota was collected. An additional dataset will be collected in 2015 and provided to Dr. Claire Rutledge with the Connecticut Agricultural Experiment Station. Dr. Rutledge and her colleagues developed and are refining a degree day model to predict beetle bandit emergence. An accurate degree day model will enable us to efficiently utilize volunteers for monitoring colonies.
- The presence of beetle bandit colonies was checked at over 40 potential sites and confirmed at 10 sites. Over 60 buprestid beetles were collected and will be identified. None of the beetles appear to be EAB.
- A protocol was developed for beetle collection and submission. Many potential methods were tested.

Current and future project activities will be supported by ENRTF. The following activities will occur over the winter.

- Beetles collected during summer 2014 will be pinned, labelled and grouped by like types prior to identification.
- A taxonomist will be selected and contracted with for beetle identification.
- Beetles will be identified and data recorded.
- Kits containing beetle collection tools, supplies and educational materials will be assembled. They will be distributed to volunteers at training sessions.
- Training materials including a presentation and instructional handouts are being created.
- Volunteer recruitment is in process.

Activity Status as of May 29, 2015:

A taxonomist, Wayne Steffens, was contracted to identify beetles. Beetles collected summer 2014 were pinned and all were identified to genus and some to species. Work to identify the remaining Agrilus to species will continue. None of the beetles collected were EAB. The table below lists the collected beetles.

Species	Common Name	Total
Actenodes acornis	No common name	3
Agrilus bilineatus	Twolined chestnut borer	1
Agrilus politus	Willow gall limb	2
Agrilus quadriguttatus	No common name	16
Agrilus sp	(not identified to species yet)	17
Chrysobothris femorata	Flatheaded appletree borer	3
Chrysobothris sexsignata	No common name	4
Dicerca divaricata	Flatheaded hardwood borer	3
Dicerca tenebrica	Flatheaded poplar borer	8
Poecilonota cyanipes	Eastern poplar buprestid	7
	Total	**66**

Ten outreach presentations to over 500 people resulted in rapid growth of our Minnesota Wasp Watchers program. There are currently 93 volunteers in 17 counties. These volunteers will provide a valuable network for monitoring EAB and other buprestid beetles in 2015.

Summer plans include checking additional sites for beetle bandit colonies, managing volunteers and collecting a validation data set for a beetle bandit emergence model that is in development. Volunteers will check over 300 sites for the presence of beetle bandit colonies. These sites were identified with habitat favorable to beetle bandits.

Activity Status as of November 30, 2015:
This was the first full field season with a trained team of volunteers checking sites for beetle bandit colonies and monitoring colonies. Volunteers who check sites are called scouts and those who monitor are called surveyors. Surveyors collected 95 beetles. None of the beetles are EAB. Seven outreach presentation were given to a total audience of 246 people.

- 84 sites were checked in 27 different cities found in 11 different counties
- 13 new or confirmed beetle bandit sites found in Lakeville, Eden Praie, Wyoming, St. Paul, Afton, Frontenac, Red Wing, St. Cloud, Eagan, Wayzata, and Aitkin.
- There are now 31 confirmed to have beetle bandits and there are 15 additional sites of interest (sites that were not confirmed this summer or sites that have had beetle bandits in the past, but not this year). Confirmed sites are in the following 11 counties: Aitkin, Anoka, Benton, Chisago, Dakota, Goodhue, Hennepin, Le Sueur, Olmstead, Ramsey and Washington.
- 50 volunteers comprised of 23 adults and 27 youth conducted biosurveillance at 17 sites.
- 95 beetles captured (none EAB) from 14 different sites found in 9 different counties. These beetles are pinned and labeled and being identified by the project taxonomist.

We will try recruit volunteers in southeastern Minnesota to monitor sites where EAB densities are higher than at sites currently monitored. This will help us understand the sensitivity of this method.

<u>Beetle Bandit Emergence Tracking for Degree Day Modeling</u>
After consulting Claire Rutledge (CT Ag Exp Station) regarding the collected degree day data for beetle bandit emergence, it was determined that for the 2015 season, beetle bandit emergence occurred around **950-975F DD** in Minnesota. Claire's values for the New England/East Coast was around 865F DD. Wasp Watchers will continue to track emergence and gather more degree day data in 2016.

Activity Status as of May 31, 2016:
Outreach and volunteer recruitment was the focus of the last six months. There were 16 outreach events with 515 participants. Two events included two events were focused on park maintenance staff. Park maintenance staff groom the ball fields where many beetle bandit colonies are found. There will be an attempt in 2016 to groom the fields early in the morning, before the wasps are active. This should minimize disturbance to the beetle bandits. The online map of potential sites with beetle bandit colonies was updated to include hundreds of potential new sites.

Beetles collected summer 2015 were pinned and all were identified to genus and some to species. None of the beetles collected were EAB. A greater diversity of beetle species were collected in 2015 than 2014, probably because the beetles came from more sites in 2015. The table below lists the collected beetles.

Species	**Amount**
Actenodes acornis	3
Actenodes simi	1
Agrilus anxius	16
Agrilus arcuatus	1

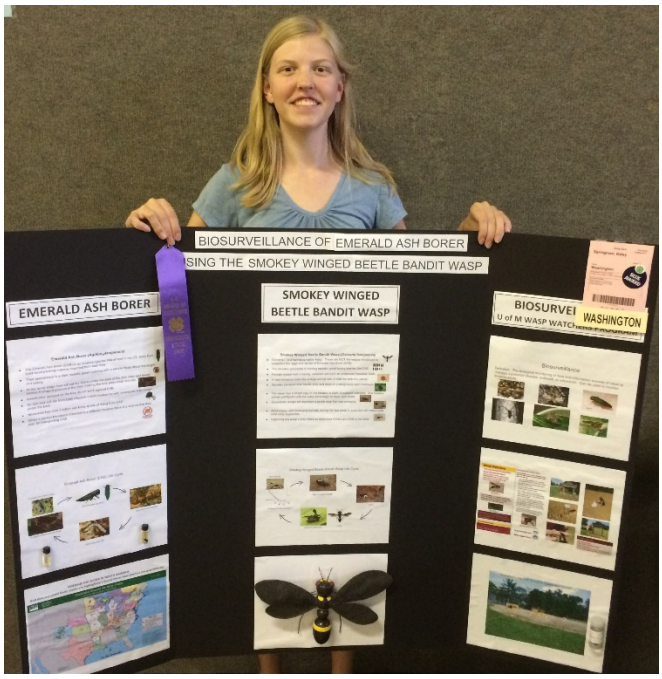
Species	Amount
Agrilus bilineatus	1
Agrilus difficilis	8
Agrilus obsoletoguttatus	2
Agrilus politus	1
Agrilus quadriguttatus	9
Agrilus sp. (politus group)	4
Buprestis consularis	2
Bupestis maculativentris	1
Chrysobothris femorata	1
Chrysobothris sexsignata	6
Chrysobothris rugosiceps	2
Chrysobothris sp.	1
Dicerca tenebrica	14
Dicerca tenebros	1
Dicerca sp	1
Poecilonota cyanipes	13
Total	**88**

Biosurveillance Plans for 2016:

- Collect emergence data beginning mid-June.
- U of MN student worker will be added to support biosurveillance efforts.
- Chris Mallet joined the project and will search for a beetle bandit colony in an area heavily infested with EAB. Once found, Chris will monitor the colony intensively to help us understand EAB levels as they relate to biosurveillance.
- Sites with more than 10 nest holes will be adopted and monitored by volunteers and/or staff.
    - Heights Park, Edina
    - Pinger's Plaza Park, Ham Lake
    - Purgatory Park, Minnetonka
    - Northdale Park, Oakdale
    - Battle Creek Middle School, St. Paul
    - Banta Park, Wyoming
    - Tolzmann Park, Wyoming
- Volunteers will be searching for new, large beetle bandit colonies to monitor, targeting areas near newer EAB finds (Plymouth, Prior Lake, Apple Valley, Duluth, Washington County, Wabasha County). Under-searched communities with EAB will also be searched more thoroughly (Rochester, Winona). Other areas of interest are along the following transportation corridors: Hwy 169North, I-94North, and I-35North.
- We received DNR permit 2016-8R for biosurveillance activities in select parks and scientific and natural areas during the 2016 field season.

Activity Status as of November 30, 2016:

We are pleased to report that four EAB were captured at Riverside Park in Minneapolis, demonstrating that biosurveillance is a valid EAB detection method in Minnesota. We expected this based upon experiences in other states but it was important to confirm our expectations. Biosurveillance won a championship ribbon at the Washington County Fair and a purple ribbon at the State Fair thanks to Kaley, a talented and dedicated 4H youth volunteer.



Award winning biosurveillance project that was displayed at the State Fair.

During this reporting period, there were five field trainings and three presentations. All of the outreach has paid off to substantially increase the biosurveillance effort in summer 2016. One super volunteer, Anna, from Rochester searched 35 sites in Olmsted, Fillmore and Winona Counties volunteering over 60 hours of her time.

Quantified	**2016**	**2015**
Buprestid beetles captured	183	95
Number of volunteers	65	50
Volunteer hours spent on beetle bandit scouting and monitoring	453	160
New sites checked for beetle bandit presence	219	87
New nesting sites found	29	13

A total of 20 sites were actively monitored in Aitkin, Anoka, Chisago, Crow Wing, Dakota, Hennepin, Ramsey, Washington and Winona Counties. Chris Mallet with MDA intensively monitored two sites near known EAB infestations three times per week during peak activity of the beetle bandits. These sites were Autumn Grove Park in Roseville and Riverside Park in Minneapolis.


Volunteers inspect a beetle bandit catch during a field training in Wyoming, MN.

Minnesota appears to have many small beetle bandit colonies. Of our 59 known sites, approximately 10% have more than 30 nests (large colonies), 20% have between 10-30 nests (medium colony), and 70% have between 1-9 nests (small colony). Because most colonies are small, we do not rule out monitoring small colonies in Minnesota as has happened in states that routinely find medium and large colonies.

Additionally, there are 53 sites of interest. The site may have had a colony previously but no colony was confirmed in 2016 or nests were found but it was not determined whether they were beetle bandit nests.

We theorize that heavy rainfall during peak beetle bandit activity may have had an impact. Many nests were washed out and not excavated by the wasps again. Here is a comparison of precipitation level by year in Minnesota.

Date	Statewide Average Precipitation	Statewide Average Precipitation Departure from Normal*
6/15/14-8/15/15	8.45 inches	+0.27 inches
6/15/15-8/15/15	7.89 inches	-0.21 inches
6/15/16-8/15/16	11.49 inches	+ 3.30 inches

http://www.dnr.state.mn.us/climate/historical/summary.html

* Climate Normals are three-decade averages of climatological variables including temperature and precipitation. (NOAA)

Final Report Summary:

Biosurveillance Activities from December 1 2016-June 30, 2017:

The winter and spring activities focused on buprestid beetle curation and identification as well as outreach, education, and volunteer management.

- There were 8 outreach events (trainings, presentations, educational exhibitions) with 362 participants.
- The University of Minnesota Entomology Department also hosted a volunteer appreciation event in March 2017. Volunteers were invited to tour the U of MN Insect Collection and meet outreach arthropods and their graduate student handlers.
- The database and map of known and negative beetle bandit sites were updated.
- Beetles collected summer 2016 were pinned and all were identified to genus and most of them to species. A total of 183 beetles were captured in the summer of 2016. Four of the beetles collected were EAB. These specimens were captured at Riverview Park in Minneapolis. There were a total of 183 beetles captured with 26 different buprestid species. Two new genera were found this year (*Eupristocerus and Spectralia).*

Species and quantity of beetles collected by Wasp Watchers

Species	Amount
Actenodes acornis	1
Agrilus anxius	4
Agrilus arcuatus	13
Agrilus bilineatus	8
Agrilus carpini	1
Agrilus difficilis	4
Agrilus liragus	27
Agrilus obsoletoguttatus	2
Agrilus olivaceoniger	1
Agrilus politus	1

Species	Amount
Agrilus planipennis	4
Agrilus quadriguttatus	3
Agrilus sp.	10
Buprestis consularis	2
Bupestis maculativentris	1
Chrysobothris femorata	2
Chrysobothris sexsignata	15
Chrysobothris viridiceps	2
Chrysobothris sp.	2
Dicerca asperata	1
Dicerca caudata	15
Dicerca divaricata	10
Dicerca tenebrica	31
Dicerca tenebrosa	3
Dicerca tuberculata	1
Dicerca sp	1
Eupristocerus cogitans	7
Poecilonota cyanipes	7
Spectralia gracilipes	4
Total	**183**

Wasp Watchers Program Summary:
The Wasp Watchers Program engaged citizen scientist volunteers in EAB biosurveillance from 2014-2017. During this period, there were 49 outreach and education events (trainings, presentations, educational exhibitions) with 1,720 participants. These events served to educate the general public about EAB and also recruit and train citizen scientist volunteers. The biosurveillance program from 2014-2017 has built a solid foundation for future EAB detection. Just two weeks after this grant ended (July 2017), Wasp Watchers captured EAB at three biosurveillance sites indicating new pockets of EAB infestations in Roseville, Shoreview, and Rochester. The Wasp Watchers Program is poised to mobilize a cadre of citizen scientist volunteers to continue to detect new EAB infestations with the help of the smoky winged beetle bandit in Phase 3 of our project. The tables below indicate the growth and accomplishments of the Wasp Watchers Program over the past three years.

Volunteer Efforts:
This grant began in July 2014 so the first field season was focused on establishing field protocols with a few volunteers. Volunteer recruitment and training increased in the following years.

Year	# of Volunteers	# of Volunteer Hours
2014	12	26
2015	51	160
2016	65	458

Beetle bandit search: Volunteers searched ballfields throughout Minnesota for the presence of the smoky winged beetle bandit wasp. Once discovered, a nesting site can be monitored for the presence of EAB in that area.

Year	# of sites searched	Accumulated positive beetle bandit nesting sites
2014	45 sites	15 positive sites
2015	88 sites	31 positive sites
2016	219 sites	59 positive sites

Biosurveillance sites and Buprestid beetles collected: As the number of known beetle bandit nesting sites increased, the number of biosurveillance sites and beetles increased as well. Each biosurveillance site is a location where volunteers captured Buprestid beetles to survey for the presence of EAB.

Beetle bandit prey species diversity: When the Buprestids (metallic wood-boring beetles) are captured from beetle bandit wasps, they are preserved, curated, and identified. Over the past three years, as the number of survey sites increased and expanded around the state, the diversity of Buprestid species increased and diversified as well.

Year	# of biosurveillance sites	# of beetles collected	# of different beetle species captured
2014	6 sites	65 beetles	11 beetle species
2015	17 sites	95 beetles	17 beetle species
2016	21 sites	183 beetles	26 beetle species

ACTIVITY 2: Track EAB infestation core
Description:
To track dispersal of EAB and biological control agents, project partners initiated long-term monitoring of ash health, EAB, and EAB biological control agents in the Twin Cities in 2011. This is a large, collaborative project with multiple partners including USDA Forest Service, University of Minnesota, Department of Natural Resources, and the cities of Falcon Heights, Minneapolis, Lauderdale, Roseville, and St. Paul. Three hundred ash trees were selected in the late summer of 2011. The selected trees were in the original EAB infestation area (the core infestation) and the surrounding area up to four kilometers from the core. Each tree is monitored for six years. We collect data on tree size and health. We are using branch sampling methodology to subsample ash trees for evidence of EAB and EAB biological control agents. Two branches per year are removed from each tree each year. A length is cut from each branch then peeled. Detailed information is collected on each EAB gallery, EAB larvae, biological control agent parasitoids, and native parasitoids. All study tree removals are noted in the database. Data collection for this study is coordinated by a Research Scientist 1 at MDA and will be analyzed by Drs. Aukema (U of M) and Venette (USFS).

Summary Budget Information for Activity 2:

ENRTF Budget:	**$ 160,440**
Amount Spent:	**$ 160,440**
Balance:	**$ 0**

Activity Completion Date: 06/10/2017

Outcome	Completion Date	Budget
1. Ash health and sample branches for EAB and biological control agents data collected	03/30/2017	$ 126,540
2. Data analyzed	06/10/2017	$ 33,900

Project Status as of November 26, 2014:
Ash health data were collected by Jonathan Osthus during summer 2014 for the remaining 155 study trees. In order to gain an understanding of the density and health of ash near study trees, Jonathan Osthus and Angela Gupta recruited and trained volunteers about ash health data collection. Volunteers collected data on 48 area ash trees. Track EAB Infestation Core Study results are available online and are shown in the map below.

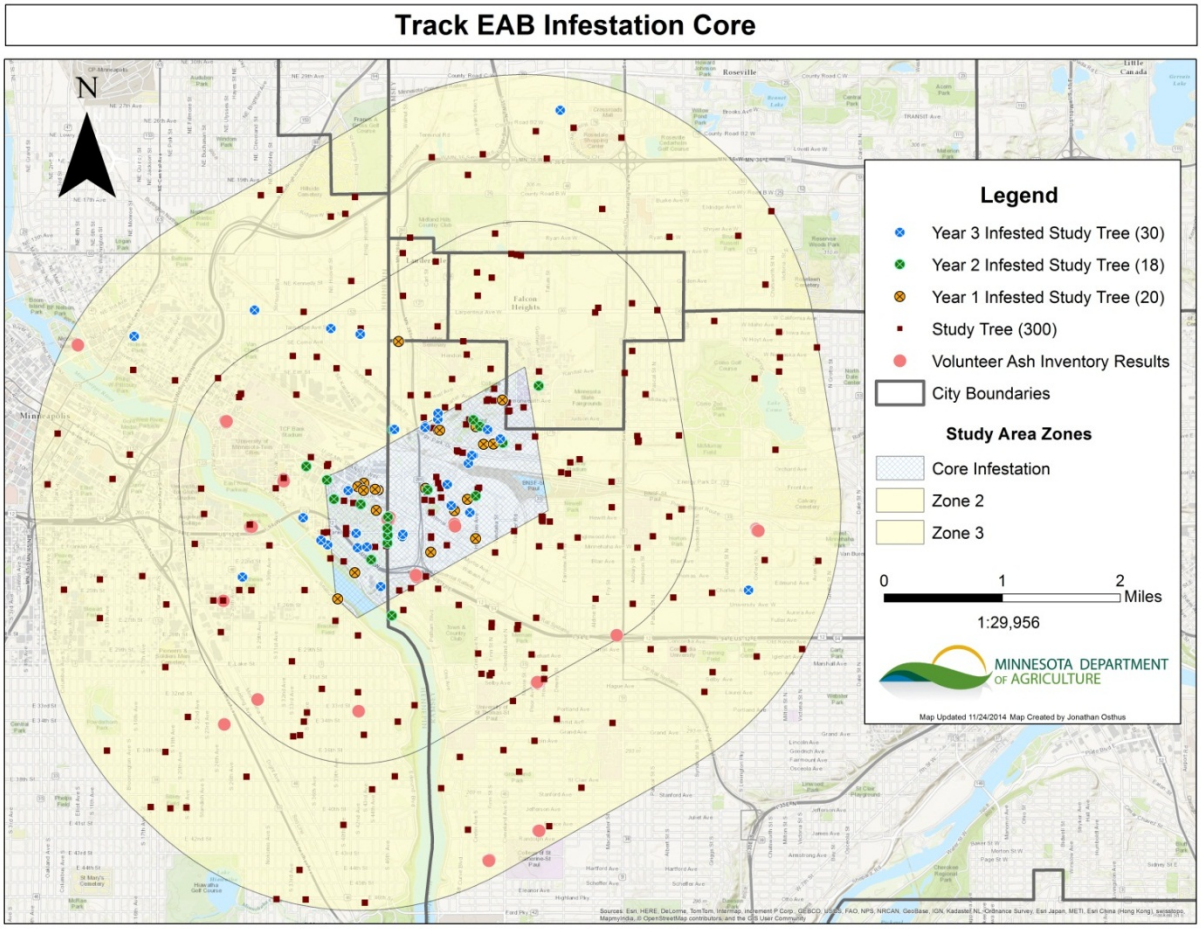
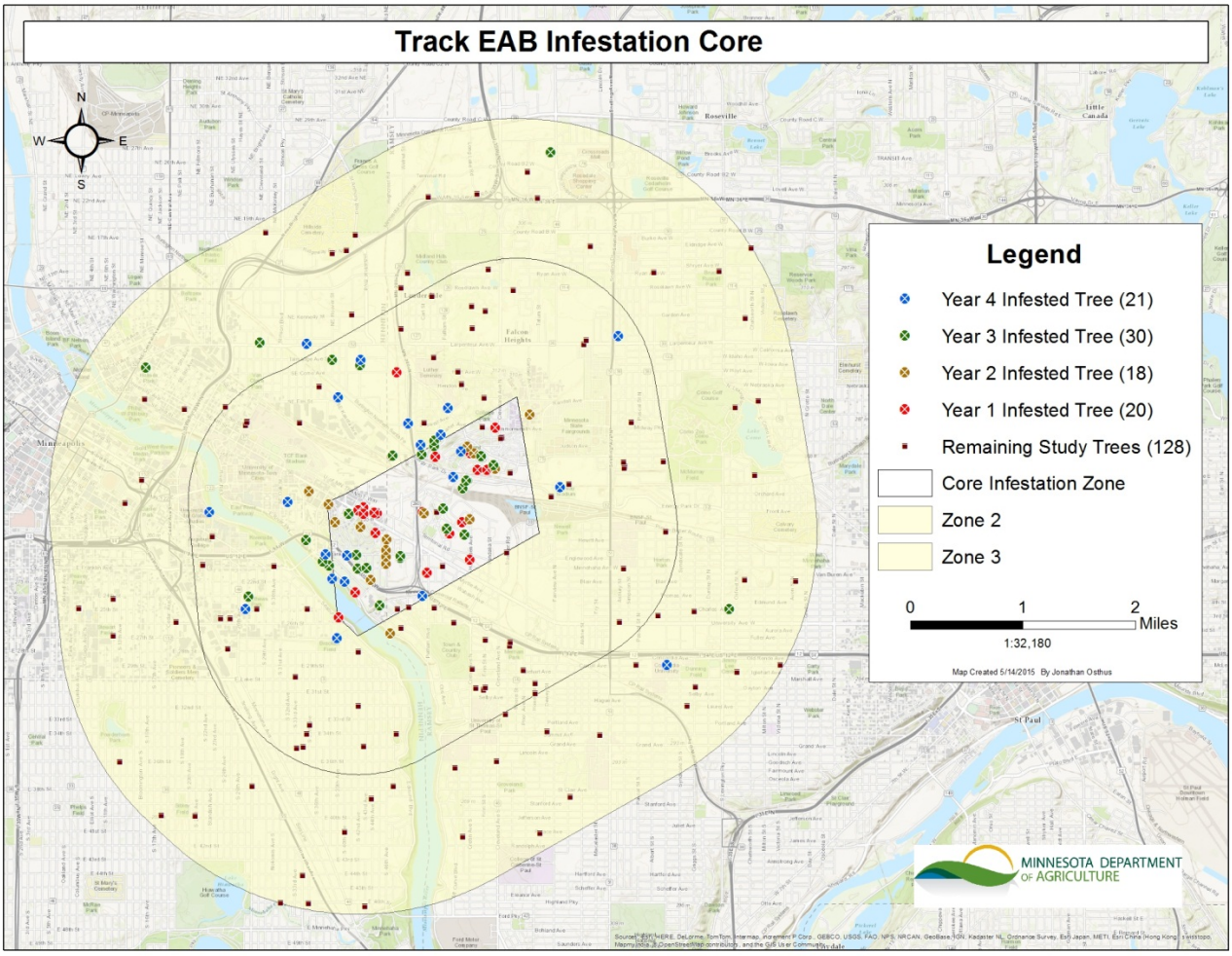


Figure 1: Map of study trees including trees that were found to be infested then removed.

Branch sampling is planned for fall and winter. Contracts with the City of St. Paul and the Minneapolis Parks and Recreation Board for branch sampling are in process. Branches will be peeled and data collected over the winter.

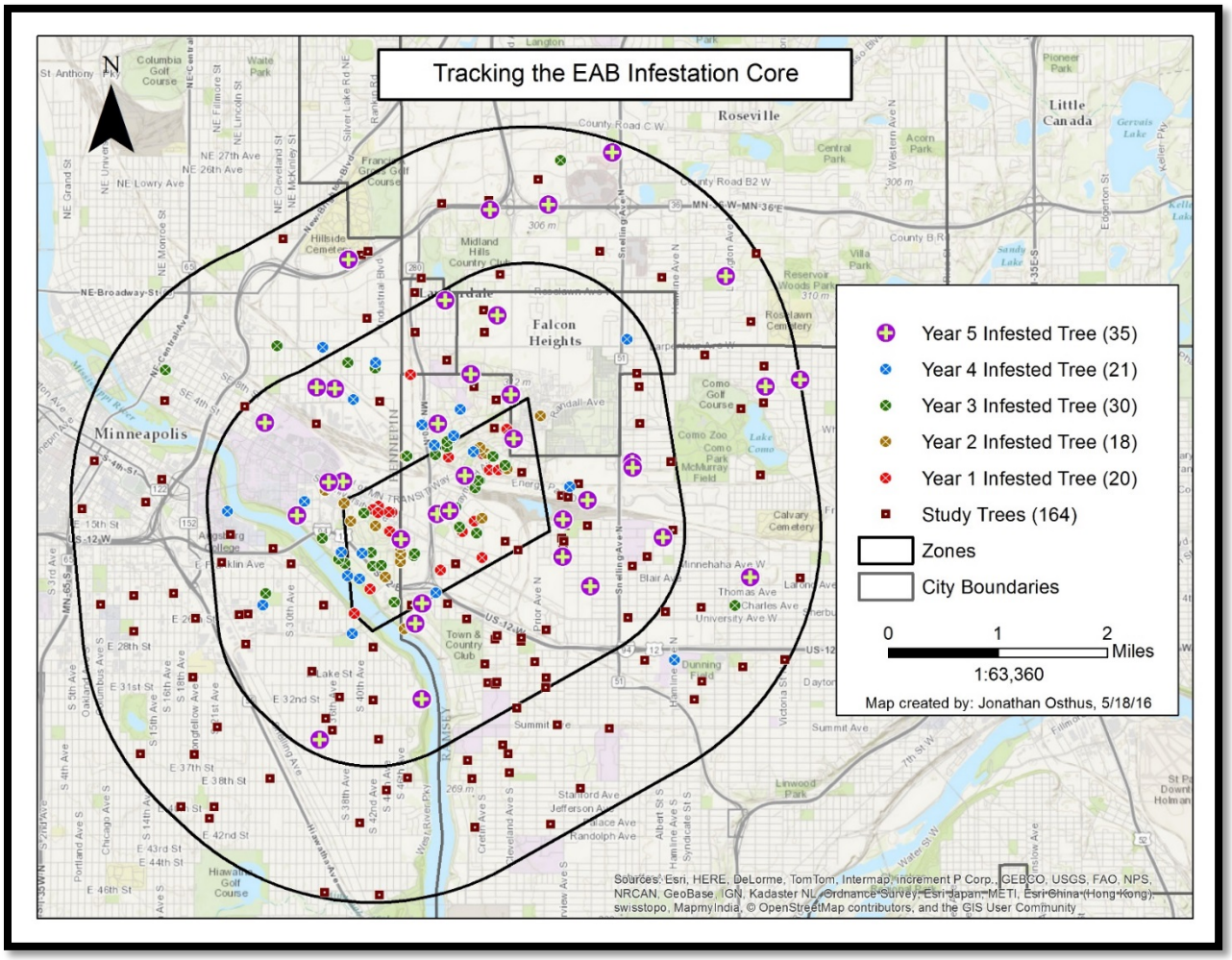
Activity Status as of May 29, 2015:
All remaining 149 study trees were branch sampled and the samples peeled for evidence of EAB and EAB bioagents. A total of 21 trees were identified as positive for EAB and no bioagents were recovered through the sampling process. Track EAB Infestation Core Study results are available online and shown in the map below. An additional 49 trees will be selected in zones 2 and 3 during the summer of 2015 to maintain the robust monitoring network within the study area. An ash inventory for zones 2 and 3 will be taken during the summer to look at potential total infested ash within each zone to reference with city management records and compare outcomes.



Activity Status as of November 30, 2015:
An additional 58 trees were selected in zones 2 and 3 in order to maintain the monitoring network within the study area. Ash health data were collected on all remaining and newly selected study trees. The total number of trees to be branch sampled this winter is 173. An ash inventory for zones 2 and 3 was completed over the summer by using 100 randomly generated polygons and assessing the presence of ash within those polygons. Data are being analyzed by Dr. Venette.

Branch sampling is scheduled to begin in early December 2015.

Activity Status as of May 31, 2016:
The remaining 164 study trees were branch sampled over the winter with the samples processed and debarked to look for evidence of EAB and EAB bioagents. A total of 35/164 study trees were identified as infested with EAB and no biaogents were recovered through the process. The proportion of infested study trees for each zone is as follows: Zone 1 = 50%, Zone 2 = 25% and Zone 3 = 11%. Overall, 21% of the study trees were found to be infested within the study area. The overall rate of infestation, especially in the core area, is still far lower than was expected this far along in the study.



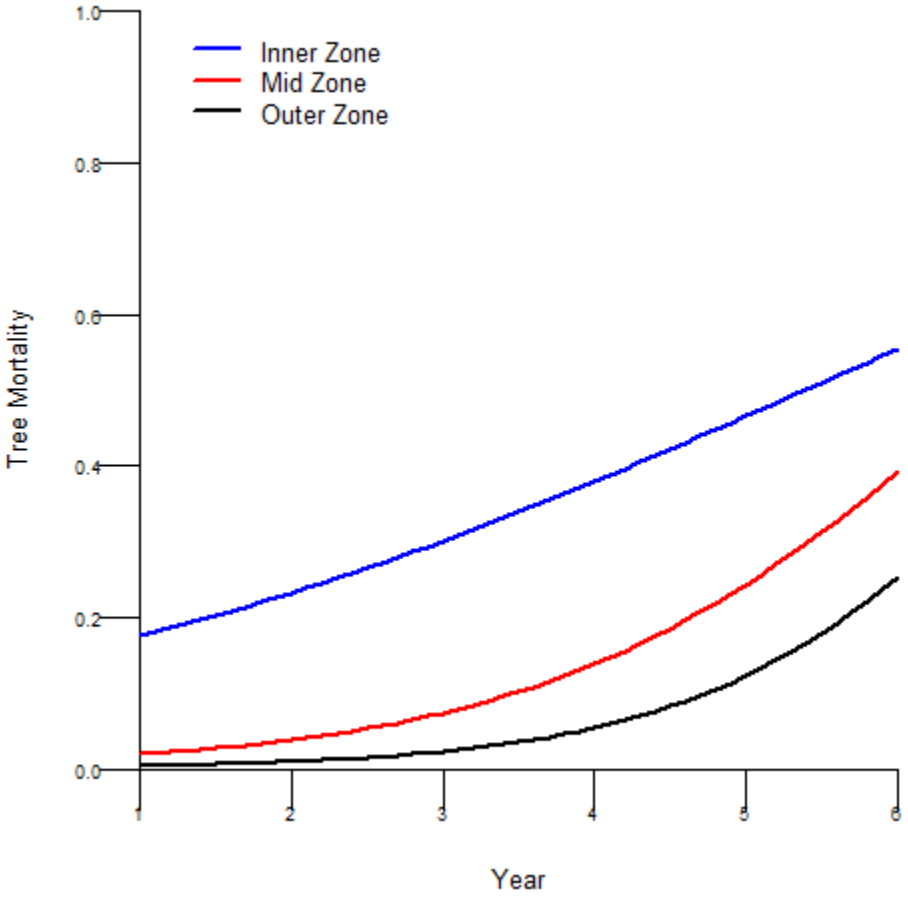
Activity Status as of November 30, 2016:
We are beginning to wrap up this activity with the final round of branch sampling this winter. There are 109 remaining study trees and none of these are in the core infested area. There are 51 in zone 2 and 58 in zone 3. Analysis will begin after final data collection.

Final Report Summary:
Emerald ash borer was first detected in the Twin Cities in 2009, although it likely arrived in the area at least three years prior to that date. As such, we expect that we are now entering the second decade with emerald ash borer present in the Twin Cities metro area. Substantial mortality across the metro area was expected by now.

Instead, populations of emerald ash borer – while increasing – have remained at low or undetectable levels in the majority of study trees after six years of study. The remaining study trees were branch sampled and processed during the winter of 2017. The final year of sampling results produced 32 infested trees out of the 109 trees remaining. No parasitoids were found through the branch sampling process and densities of EAB remained very low throughout the duration of the study. As shown in the graph below, only approximately 20% of trees in the outer zone, 30% of trees in the mid zone, and 50% of trees in the inner zone had detectable levels of emerald ash borer using annual branch sampling techniques by the end of the sixth year of this study. Statistically, we found that over this three mile radius, the rates of infestation through time were different in each of the three zones (χ^2_2=7.17, *P*=0.0277). We had expected to find, if not complete mortality, a uniform rate of increase over this relatively small area.

We suspect that cold weather during the winter of 2013-2014 slowed population growth considerably, and the insects are still rebounding.

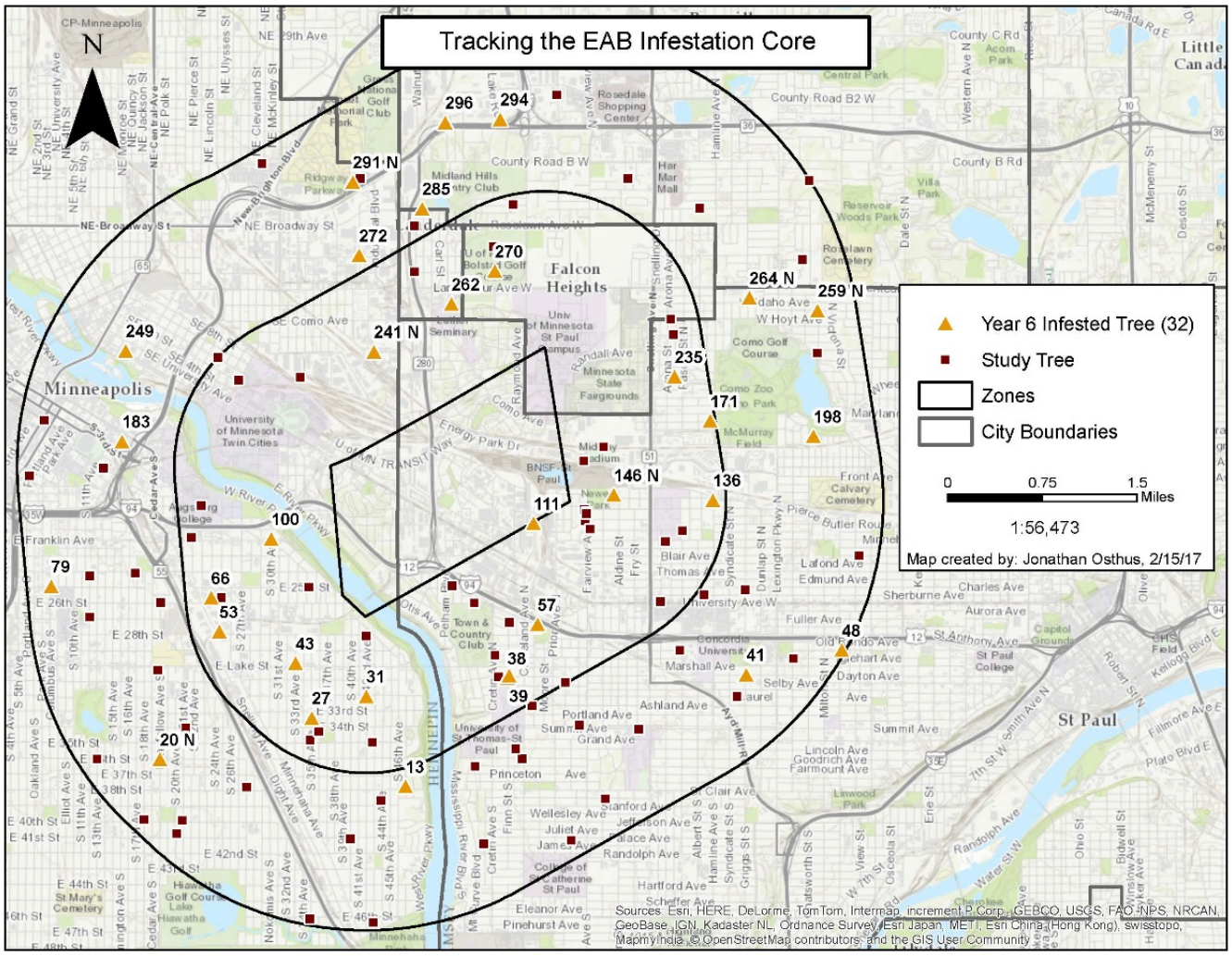
These results suggest that population growth in Minnesota – at the northwestern edge of populations of emerald ash borer nationally – may be slower than in other states. This may buy resource managers valuable time to plan an appropriate response to this insect, and allow critical time for further research efforts into biological control and resistance breeding by ourselves and colleagues nationally.



Caption: Infestation through time in each of the zones of the 300 tree study. Year one is 2011-12. All remaining trees were removed in the inner core zone in 2016-17.

Ash Health Rating (1 = Healthy and 5 = Dead) by Year and Zone

Year	Zone	# Trees	Mean	Std Error
2011	1	98	1.296	0.06487
2011	2	123	1.203	0.04735
2011	3	79	1.228	0.06686
2011	Combined	300	1.24	0.03378
2012	1	77	1.247	0.05853
2012	2	112	1.268	0.06311
2012	3	76	1.12	0.05607
2012	Combined	265	1.22	0.03572
2013	1	54	1.593	0.09629
2013	2	105	1.423	0.06725
2013	3	68	1.188	0.05172
2013	Combined	227	1.392	0.04273
2014	1	27	1.444	0.12096
2014	2	89	1.382	0.0584
2014	3	61	1.328	0.06847
2014	Combined	177	1.373	0.04205
2015	1	10	1.2	0.18974
2015	2	91	1.275	0.0517
2015	3	72	1.264	0.06512
2015	Combined	173	1.266	0.03995
2016	2	52	1.423	0.07857
2016	3	59	1.441	0.09669
2016	Combined	111	1.432	0.06322



ACTIVITY 3: Expand biological control implementation

Description:

The goal of EAB biological control is to use natural enemies to bring EAB populations into balance and reduce damage. In this case, two larval parasitoid species (wasps that attack EAB larvae under ash bark) and one egg parasitoid species (wasps that attack EAB eggs) have been released in Minnesota. These three species were tested to ensure that they will not negatively impact other species or the environment. USDA rears these biological control agents at a specialized facility and provides them to states with EAB infestations. Biological control implementation is a collaborative effort by local governments and state and federal agencies. MDA coordinates the statewide EAB biological control program. ENRTF funding has enabled Minnesota EAB biological control activities to date.

The larval parasitoid species are *Spathius agrili* and *Tetrastichus planipennisi*. Both species were released 2010 – 2012 in Minnesota. USDA decided in 2013 that they would continue releases of *S. agrili* south of the 40th parallel trying to better synchronize EAB and *S. agrili* lifecycles. Minnesota did not receive *S. agrili* for release in 2013 and there are no plans to release this species again north of the 40th parallel. Releases of *T. planipennisi* continued in 2013 and we anticipate continuing to release this species. We learned from cold tolerance studies of this species in Phase 1 of this project that spring releases are preferable. They allow the most time for multiple generations to reproduce over the summer season so that overwintering populations are sufficiently large to withstand some cold-induced mortality. The egg parasitoid, *Oobius agrili*, was released 2011-2013 and we anticipate continuing to release this species. Over 130,000 wasps were released at 20 sites with confirmed EAB infestations since 2010. *Tetrastichus planipennisi* larvae were recovered on two occasions at Great River

Bluffs State Park in southeastern Minnesota in the fall of 2013. These finds confirm that *T. planipennisi* is attacking EAB and reproducing in the field in Minnesota. Also, we know that the parasitoids are dispersing well. These larvae were found approximately 0.5 miles from the nearest release site.

Data are collected for all bioagent releases and recoveries. Ash health and EAB activity are monitored at release sites. These data are maintained in a MDA database and entered into a USDA database annually.

EAB is expected to continue to spread in Minnesota. We plan to expand the EAB biological control effort with new release sites to address EAB spread while continuing to monitor existing release sites. Biosurveillance (Activity 1) will inform biological control. A MDA Research Scientist 1 will expand biological control releases to new EAB finds and monitor existing sites.

Summary Budget Information for Activity 3:

ENRTF Budget:	**$ 179,560**
Amount Spent:	**$ 179,560**
Balance:	**$ 0**

Activity Completion Date: 06/10/2017

Outcome	Completion Date	Budget
1. New release sites established and existing sites monitored	10/31/2016	$ 130,000
2. Data entered into MDA database and channeled into a national database	06/10/2017	$ 2,500
3. Test parasitoid recovery method with yellow pan traps	06/10/2017	$ 27,060
4. Update Minnesota's EAB management guidelines to include latest information from three ENRTF EAB related projects.	06/30/2017	$ 20,000

Project Status as of November 26, 2014:
EAB was detected at sites in Bloomington, Houston, Rochester and Rushford. We anticipate biological control releases in these areas in 2015. EAB was found in and near Caledonia as well. We scouted the area and found insufficiently low quantities of ash stands for a biological control release at this time. Biological control agents were released at the following sites.

Summary of biological control agent releases from 07/01/14 to 09/10/14

	Location		*Tetrastichus*		Total
Site Name	Latitude	Longitude	*planipennisi*	*Oobius agrili*	Released
Como Park	44.97898	-93.14738	1,377	750	2,127
E. River Pkwy 3	44.9519	-93.20251	3,676	1,700	5,376
Ft. Snelling Hwy 5 Hillside	44.88491	-93.18779	7,836	2,550	10,386
Hwy 26	43.53996	-91.28052	4,249	1,879	6,128
Lake Winona	44.038721	-91.652942	5,421	2,483	7,904
Northwestern College	45.03636	-93.16732	682	300	982
W. River Pkwy 2	44.95102	-93.20656	3,915	1,400	5,315
Shepard's Road	44.912613	-93.140291	744	200	944

A total of 39,162 parasitoids were released seven sites in the Twin Cities and southeastern Minnesota. *Tetrastichus planipennisi* is a larval parasitoid and *Oobius agrili* is an egg parasitoid of EAB.

Biological control releases were initiated at one site in the fall of 2010. Since then, a total of 177,000 parasitoids were released at 22 sites. Parasitoids are released at a site for two complete summer field seasons to establish parasitoid populations. Ash health is monitored at all sites, including sites where parasitoids are no longer released. Ash health is declining at sites in southeastern Minnesota as EAB increases in density and distribution. Ash health is relatively constant at release sites in the Twin Cities. Removal of EAB infested trees is likely to be a factor for ash health in the Twin Cities.

Monitoring biological control releases is very challenging because the parasitoids are concealed by ash bark for part of their lifecycles and cannot be efficiently trapped during the mobile adult phase of their lifecycles. The parasitoids are very small and difficult to see. Also, the parasitoid populations are small at this time so there is a low probability of recovering parasitoids with most attempts. To increase the efficiency and efficacy of monitoring, Jonathan Osthus and Monika Chandler worked with experts in Michigan on monitoring methods that are in development. Working with Dr. Leah Bauer and her technician, Jonathan and Monika learned how to collect, prepare and inspect bark samples for evidence of the egg parasitoid. Dr. Bauer is with the USDA Forest Service and her lab is at Michigan State University in East Lansing. At a USDA APHIS lab in Brighton, Dr. Bauer taught Jonathan, Monika and their APHIS colleagues to dissect EAB larvae and look for both *Tetrastichus planipennisi* and native parasitoids. Parasitized EAB larvae may not display symptoms in the early stages of parasitoid development. It is essential to dissect each collected larva to understand the parasitism rate. In addition, Jonathan and Monika toured the USDA APHIS biological control agent rearing facility in Brighton. People at this facility provide all of the EAB parasitoids released in the United States. We exchanged information at the facility and decided that Minnesota will pioneer a new method of releasing *Oobius agrili* to increase its distribution. No ENRTF funds were used for the October 2014 travel in Michigan. A total of $1,128 ($850 meals and lodging, $218 car rental and $60 fuel) MDA general funds were used.

The parasitoid, *Tetrastichus planipennisi*, is reared on EAB larvae in sections of ash wood at a specialized USDA APHIS facility in Brighton, MI.

In November 2014 the larval parasitoid, *T. planipennisi*, was recovered at two sites in southeastern Minnesota. Both sites are at Great River Bluffs State Park. The parasitoids were found one year after they were released at the park. This demonstrated that populations of this species are establishing in the EAB population and the parasitoids successfully overwintered through the extreme cold winter of 2014. This finding is consistent with cold tolerance research on this species that was completed in Phase 1 of this project.

Bark samples were collected at Great River Bluffs State Park to monitor *O. agrili*. The samples are drying and will be processed by a student worker over the winter. MDA's seed lab is providing a high quality dissecting microscope station for this work.

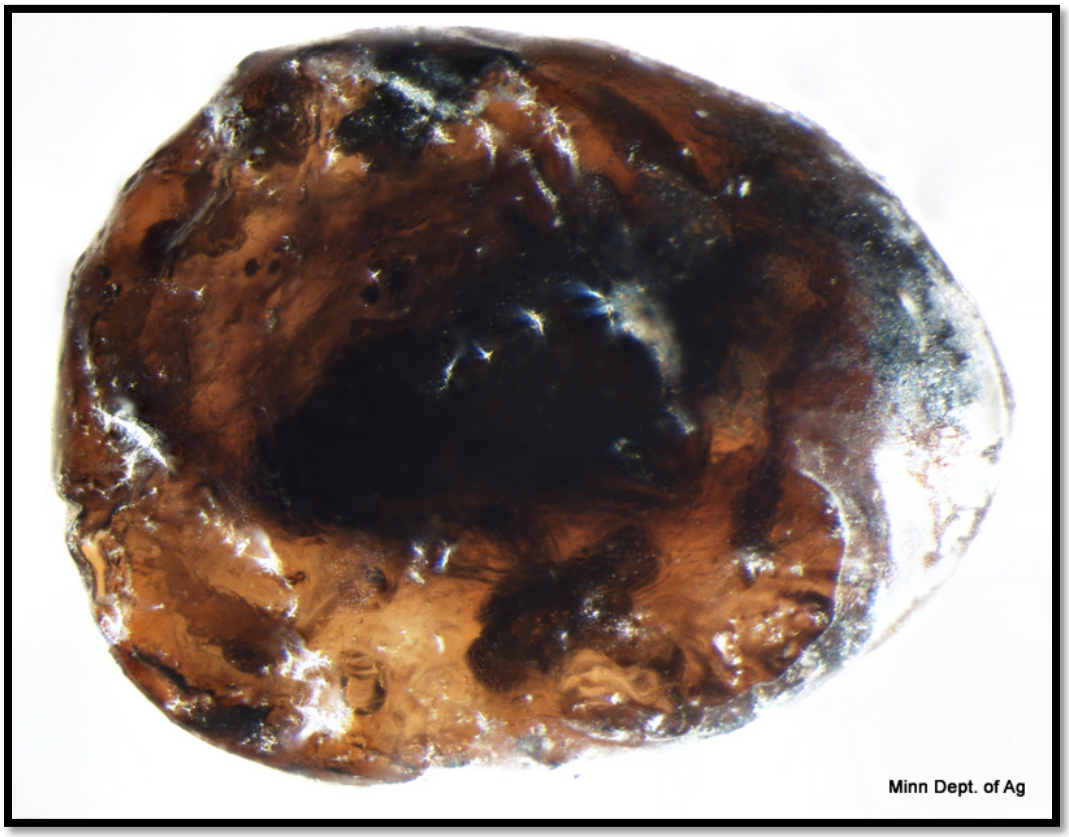
Activity Status as of May 29, 2015:
Multiple surveys were conducted to inform our biocontrol effort. An extensive survey for EAB in southeastern Minnesota with nine MDA experts on 04/22/15 and 04/23/15 defined a leading edge of EAB just north of Winona, found EAB in Rushford where it had not been previously detected and identified promising new sites for biocontrol releases. Since December of 2014, EAB was detected at two new locations in the cities of Ham Lake and Eagan. Areas were scouted for potential biological control release sites with one new site identified in Ham Lake. Sites in forested natural areas in Bloomington and Rochester were identified for future releases once EAB has spread from the street trees to these natural areas. Urban sites containing only boulevard and landscape ash are less than ideal due to other management activity that takes precedence resulting in those trees either being treated with insecticide or removed. Biological control agents were released at the following sites. Releases will continue over the summer field season.

Summary of biological control agent releases from 05/19/15 to 05/29/15

Site Name	Location		*Tetrastichus planipennisi*	*Oobius agrili*	Total Released
	Latitude	Longitude			
Lake Winona	44.038721	-91.652942	3,135	0	3,135
Prairie Island	44.080734	-91.690985	3,135	0	3,135
Reno to LaCrescent	43.604195	-91.271197	3,135	0	3,135
Ft Snelling Hwy 5 Hillside	44.88491	-93.18779	1,656	0	1,656
Shepard's Rd	44.912613	-93.140291	1,656	0	1,656
Hidden Falls Park	44.90956	-93.19195	1,656	0	1,656
Minnehaha Park	44.91806	-93.2065	1,656	0	1,656
Lake Harriet	44.929285	-93.299044	1,656	0	1,656
W. River Pkwy (2)	44.95102	-93.20656	1,656	0	1,656
Patricia's Wilderness Estates Park	45.230884	-93.169617	1,656	0	1,656

A total of 20,997 parasitoids were released at 10 sites in the Twin Cities and southeastern Minnesota. *Tetrastichus planipennisi* is a larval parasitoid and *Oobius agrili* is an egg parasitoid of EAB.

Since November 2014, bioagent recovery work for the egg parasitoid, *Oobius agrili*, has been underway. Using the bark sampling process learned from researchers in Michigan, MDA successfully recovered the egg parasitoid from sites in the southeast and Twin Cities. A total of four separate egg parasitoid recoveries were made since December of 2015. Initial samples were sent to Dr. Leah Bauer's Forest Service lab in East Lansing, MI for official confirmation. Recoveries of the larval parasitoid, *Tetrastichus planipennisi*, continued with branch sampling activities in southeast Minnesota. An additional four larval parasitoid recoveries were made from branch sampling and larval dissection at Great River Bluffs State Park.



The egg parasitoid, *Oobius agrili*, was found inside of this EAB egg recovered from Great River Bluffs State Park. The dark spot in the center of the egg is an adult *Oobius agrili*.

Activity Status as of November 30, 2015:

Bioagent releases continued through summer with the last releases taking place on 9/23/2015 in southeast Minnesota. The 2015 field season marked the biggest season of releases to date, completely eclipsing the number of bioagents released in the last four years combined. A total of eight new sites were initiated at locations in the Twin Cities and southeast Minnesota.

Summary of biological control agent releases from 5/30/2015 to 9/23/2015 *****New Site

Site Name	Latitude	Longitude	*Tetrastichus planipennisi*	*Oobius agrili*	Total Released
Lake Winona	44.038721	-91.652942	13,415	3,350	16,765
Homer, MN*	44.021025	-91.5448534	10,730	1,950	12,680
Prairie Island*	44.080734	-91.690985	15,482	4,650	20,132
Reno to LaCrescent*	43.604195	-91.271197	15,728	3,750	19,478
Ft Snelling Hwy 5 Hillside	44.88491	-93.18779	11,381	2,940	14,321
Shepard's Rd	44.912613	-93.140291	10,278	2,650	12,928
Minnehaha Park*	44.91806	-93.2065	12,279	2,750	15,029
Hidden Falls Park*	44.90956	-93.2065	12,024	2,750	14,774
Lake Harriet*	44.92985	-93.299044	11,470	2,650	14,120
W. River Pkwy (2)	44.95102	-93.20656	6,688	1,300	7,988
Patricia's Wilderness Estates Park*	45.230884	-93.169617	4,701	850	5,551
Wheelock Pkwy*	44.982776	-93.118431	5,849	1,900	7,749

A total of 161,515 parasitoids were released at 11 sites in the Twin Cities and southeast Minnesota.

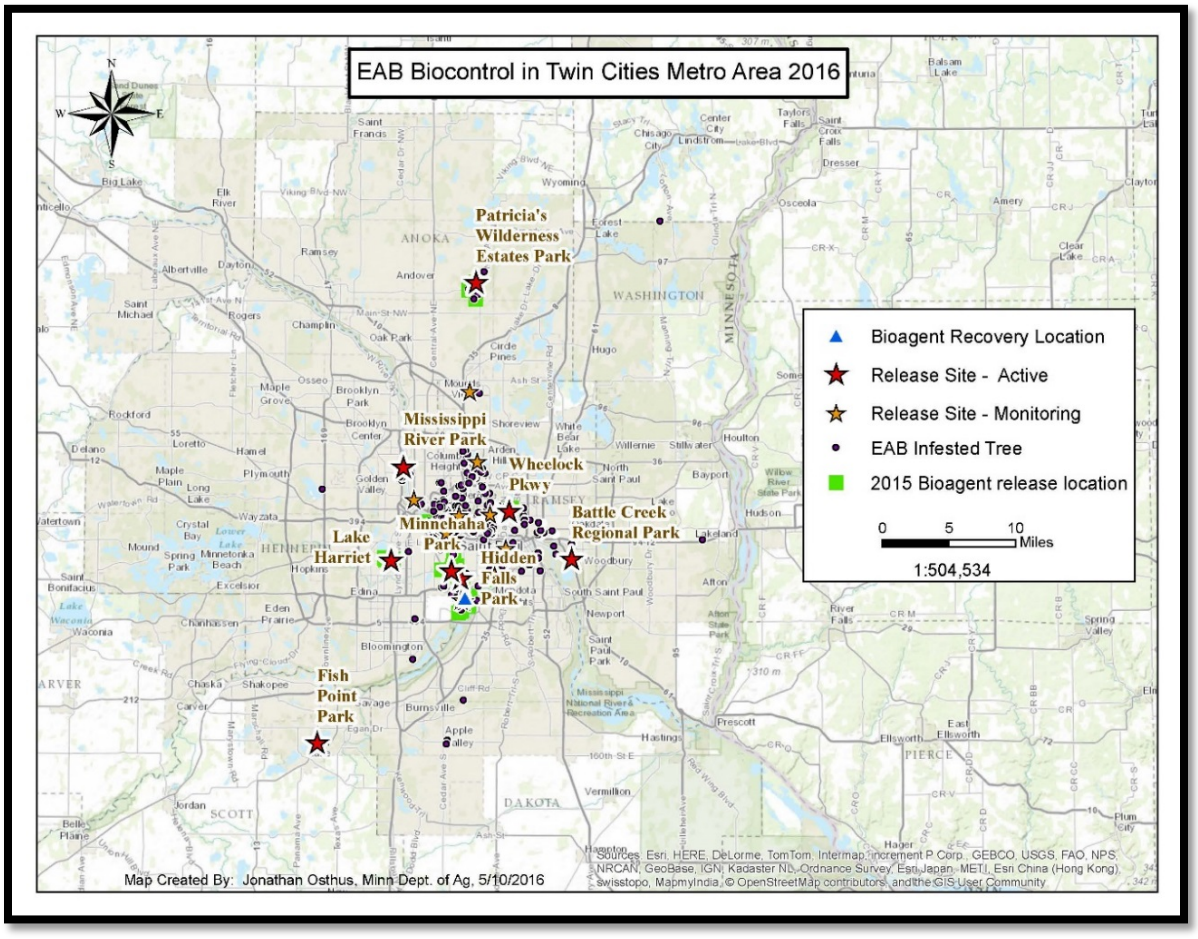
Bioagent recovery work resumed at the beginning of November at sites in southeast Minnesota. Branch sampling work at Great River Bluffs State Park was completed resulting in 29 recoveries of the larval parasitoid *Tetrastichus planipennisi*. This is a large and significant increase from the previous two years of sampling at the park. These results indicate a well-established parasitoid population that is sufficiently cold hardy and increasing in numbers. Bark samples have begun to be collected and processed from multiple sites in the Twin Cities and southeast Minnesota to continue recovery efforts of the egg parasitoid *Oobius agrili*.

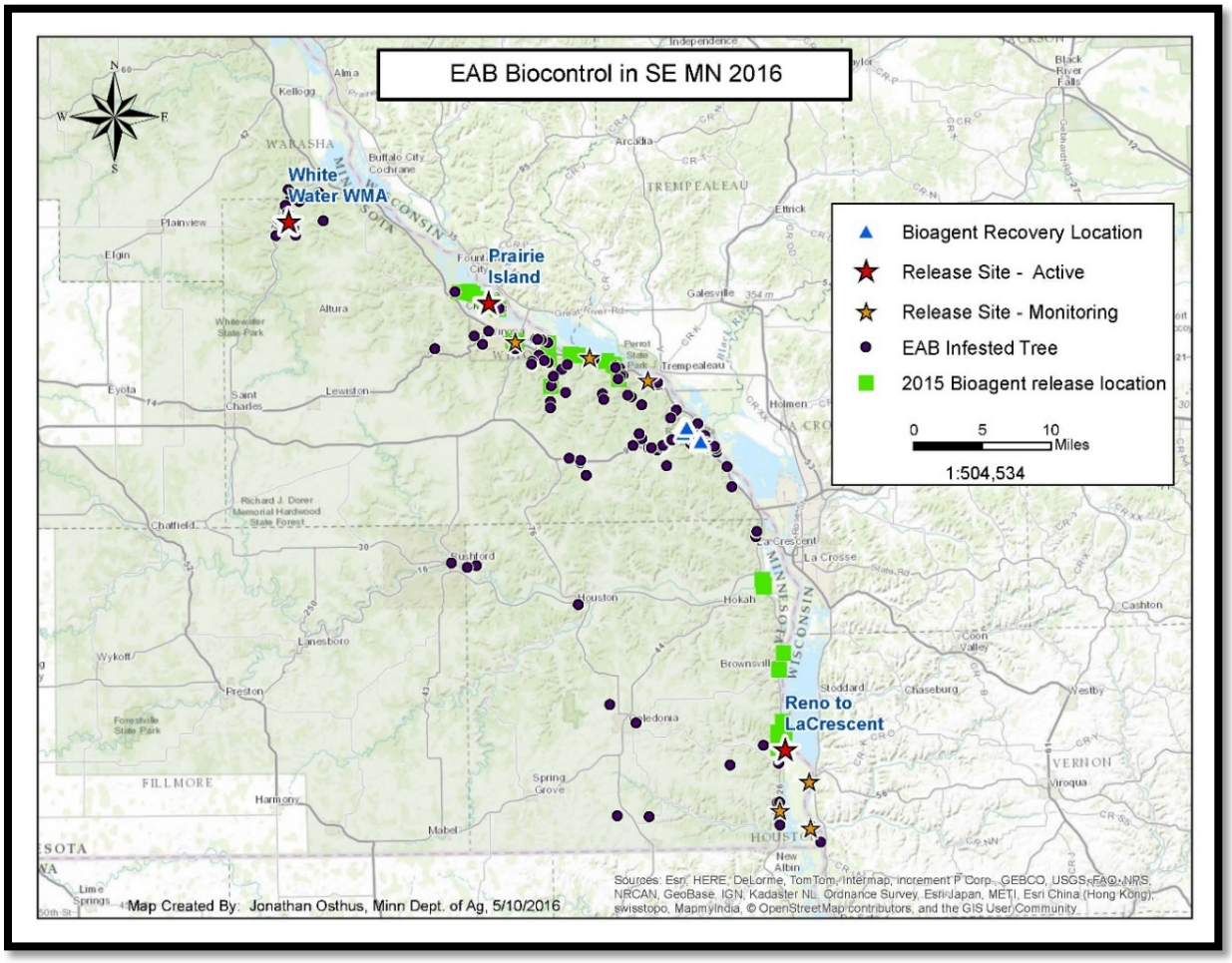
We are assessing sites and planning 2016 releases in response to the following new EAB finds.

- Two new EAB finds were discovered by trap survey in Chisago and Washington Counties. EAB was not previously confirmed in these counties.
- EAB was found in the cities of Prior Lake and Plymouth. EAB was confirmed in these previously but not in these cities.
- We conducted a joint MDA/DNR survey at Whitewater Wildlife Management Area (WMA) in the northwestern part of Winona County and infested trees were identified.

Activity Status as of May 31, 2016:

Bark samples were collected through the winter months from Great River Bluffs State Park 1, Hwy 26, Lake Winona and Lamoille release sites. Samples were collected from a total of 24 trees and are being stored in paper bags that allows the bark material to dry out making it easy to sift and sort once ready to be processed in the fall. New EAB biocontrol release sites were selected during the spring to continue implementation along the leading edges of EAB infestation in the state. Four new release sites were selected in Hennepin, Ramsey, Scott and Wabasha Counties. An interactive map of EAB biocontrol activities in Minnesota can be viewed at http://arcg.is/25hRRet.





We will begin testing yellow pan traps as a monitoring method for parasitoid recovery during the 2016 summer season.

Activity Status as of November 30, 2016:

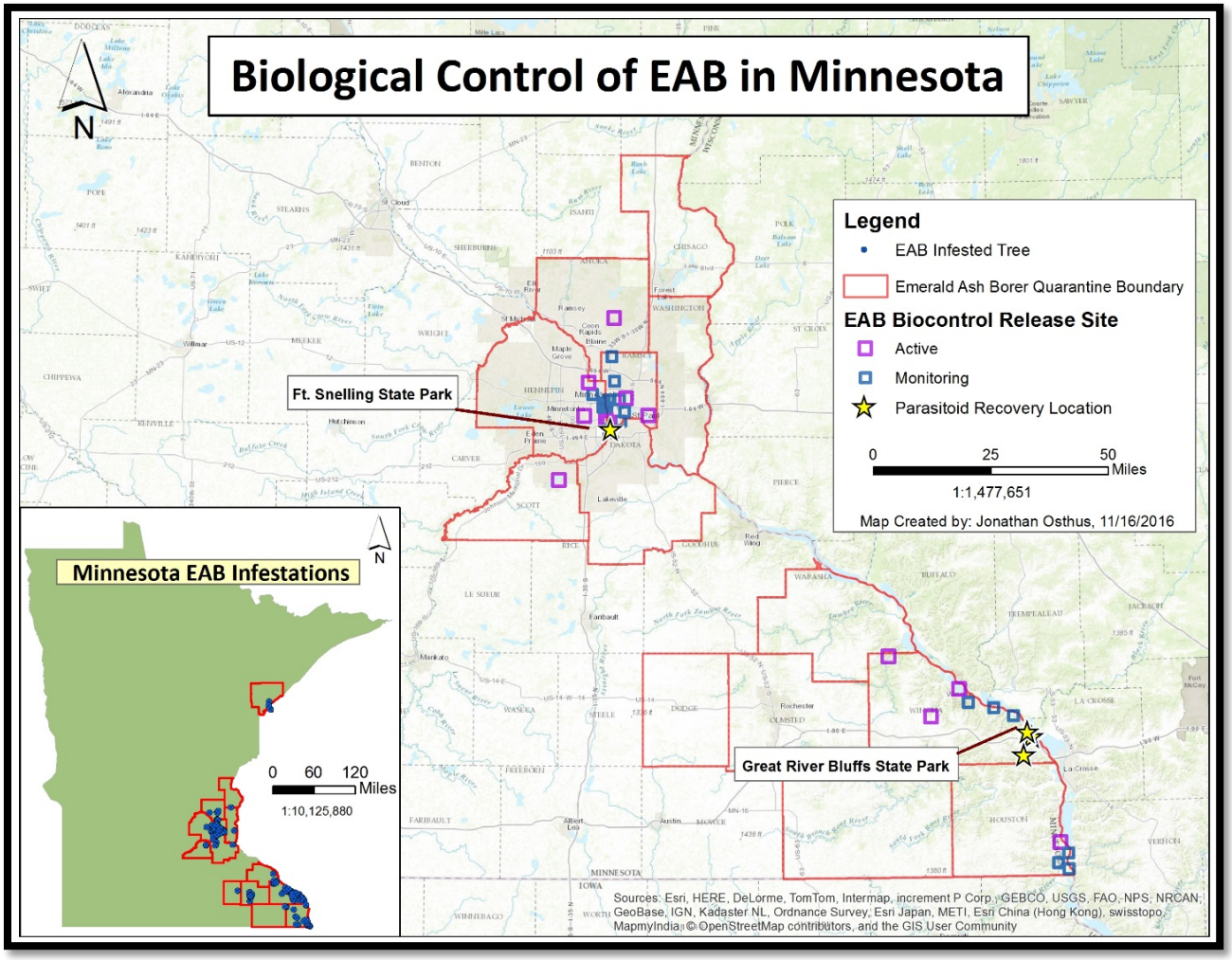
Parasitoid Releases

Parasitoid releases wrapped up for the season on 09/22/16. A total of 89,501 wasps were released at 12 sites in Minnesota. The 2016 field season marked the first time *Spathius galinae* was released in Minnesota. *Spathius galinae* is a newly approved larval parasitoid originating from the Russian Far East and was released at 3 sites located along the Mississippi River in the Twin Cities. Numbers of *S. galinae* releases are expected to increase in future seasons as production ramps up at the USDA EAB Parasitoid Rearing Facility in Brighton, MI. We did not receive as many *Tetrastichus planipennisi* as in 2015, possibly due to increased demand from other states.

EAB larval parasitoid, *Spathius galinae*

Biocontrol Release Summary by Year

Biocontrol Agent	2010	2011	2012	2013	2014	2015	2016	All
Tetrastichus planipennisi	2,154	19,480	19,822	42,579	34,434	151,022	45,288	314,779
Oobius agrili	0	3,641	10,241	8,597	12,062	31,490	42,600	108,631
Spathius agrili	1,172	7,596	15,258	0	0	0	0	24,026
Spathius galinae	0	0	0	0	0	0	1,613	1,613
Totals	**3,326**	**30,717**	**45,321**	**51,176**	**46,496**	**182,512**	**89,501**	**449,049**



Parasitoid Recovery

We tested yellow pan trapping and consider it a reasonable method of parasitoid recovery. Our methods were to install 30 yellow pan traps at Ft. Snelling State Park on 05/31/16. Pans were filled with propylene glycol to trap insects. The traps were sampled weekly from 06/03/16 to 09/09/16. Sampling involved pouring the propylene glycol through a filter then bagging and freezing the contents on the filter. Pans were refilled with new propylene glycol. A total of 870 samples were collected, frozen then examined in October and November.

Our preliminary identification is 14 *T. planipennisi* and 9 *Atanycolus*, a native parasitoid that we cannot identify to species. These recovered parasitoids were sent to Dr. Juli Gould with APHIS for expert identification.



Yellow pan trap on tree (left) and collecting contents from trap (right).

Sampling bark for the egg parasitoid, *Oobius agrili*, yielded one parasitized EAB egg from Ft. Snelling State Park. This was the second time parasitized EAB eggs were recovered from this park demonstrating that *O. agrili* is established at this site. To date in 2016, 28 samples have been processed from 6 release sites.

A clutch of *Tetrastichus planipennisi* was detected in an EAB gallery by a Forest Health Specialist with the MNDNR. It was found when ground-truthing aerial survey locations of potential ash mortality in southeast Minnesota. The detection is important as it was found 4.5 miles from the nearest parasitoid release location and continues to demonstrate the establishment and dispersal of the larval parasitoid *T. planipennisi.*

Final Report Summary:

Parasitoid Release

Minnesota continues to be one of the most active states in the nation implementing EAB biological control. A total of 21,368 wasps were released at 8 sites from May 16th to June 28th in 2017. Three new release sites were added in 2017 based on new detections of EAB. The addition of Hartley Park in Duluth marks the furthest north releases have been done to date. Hartley Park is also the first site dominated by black ash to receive biocontrol releases in the state. The total number of wasps released throughout the project period from July 1st, 2014 to June 30th, 2017 is 332,543 wasps at 25 sites statewide. Through discussions with colleagues in other states, it has become abundantly clear that having dedicated staff for implementing EAB biocontrol has been a huge advantage and benefit for the state of Minnesota. It has allowed for increased access to finite resources from the USDA EAB Parasitoid Rearing Facility in Brighton, MI and the ability to aggressively apply this management method throughout the known extent of EAB at early stages of infestation.

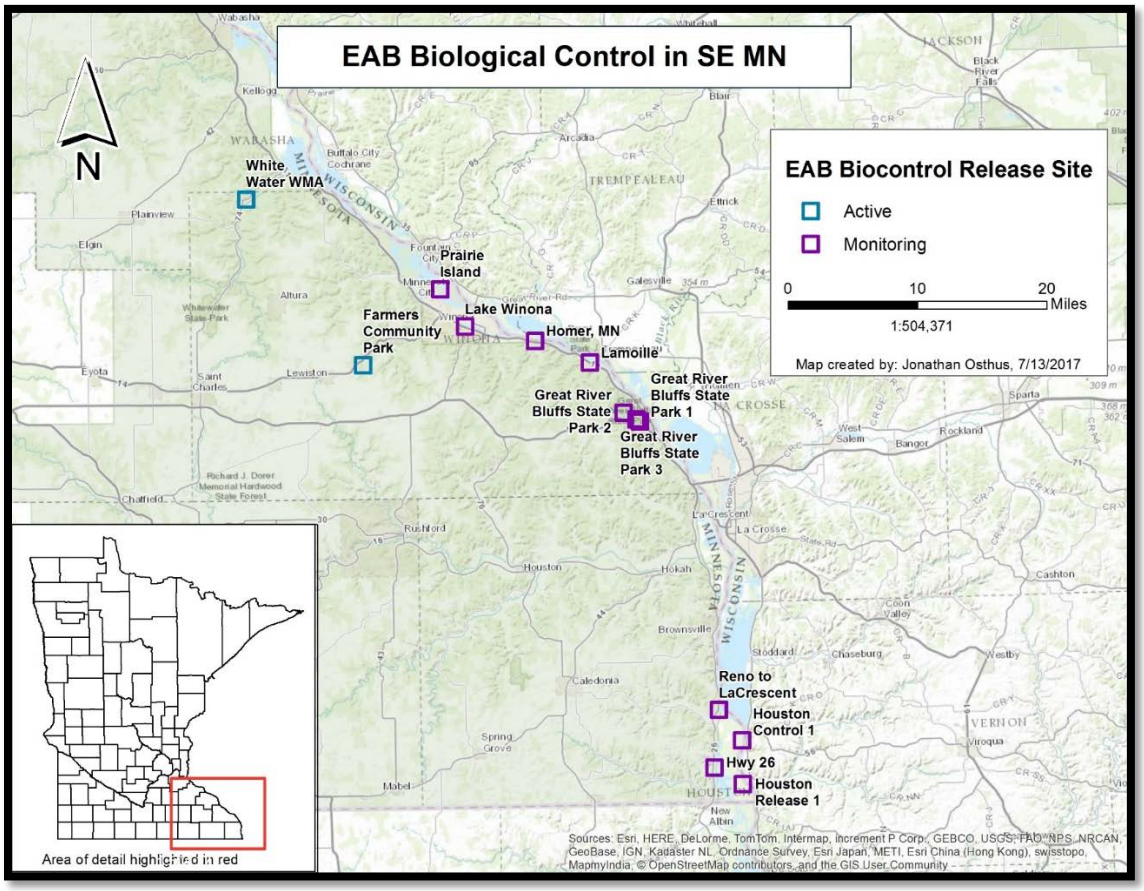
Biocontrol Release Summary by Year

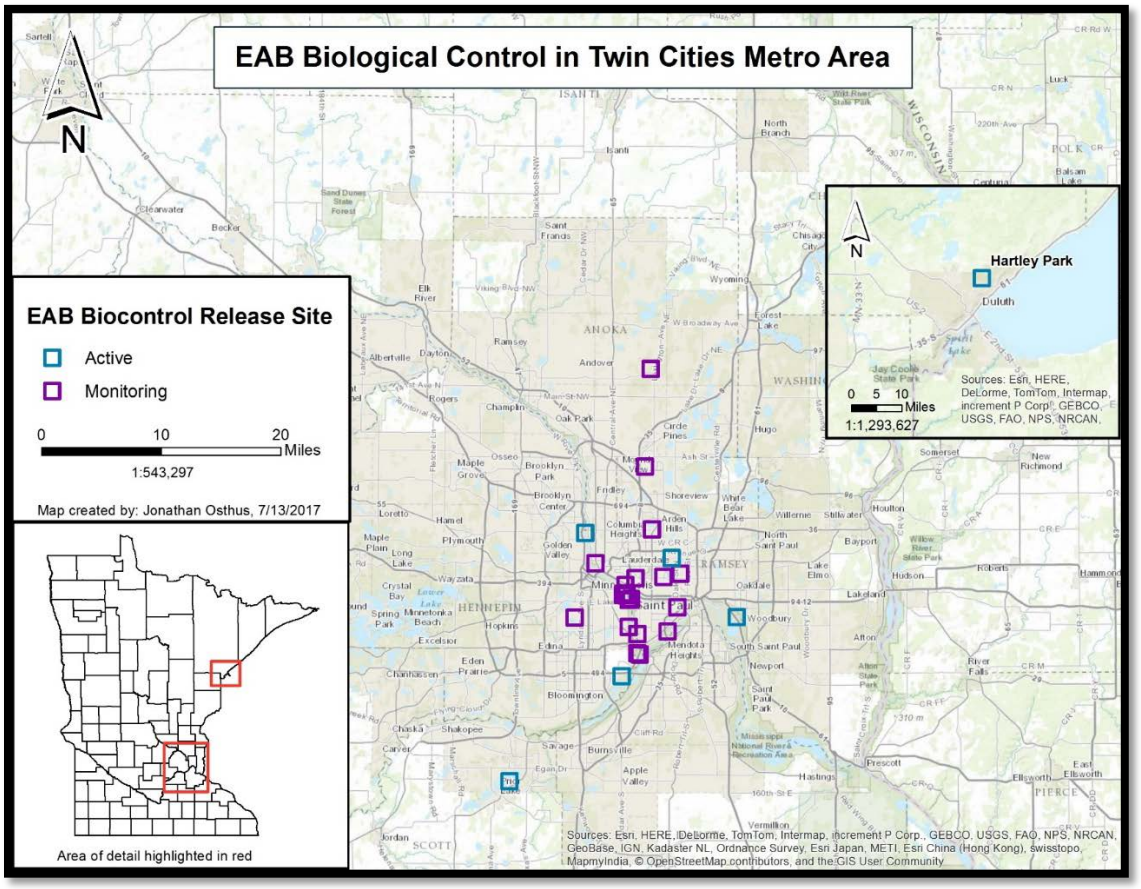
Biocontrol Agent	2010	2011	2012	2013	2014	2015	2016	2017 (up to June 30th)	All
Tetrastichus planipennisi	2,154	19,480	19,822	42,579	34,434	151,022	45,288	16,676	331,455
Oobius agrili	0	3,641	10,241	8,597	12,062	31,490	42,600	3,800	112,431
Spathius agrili	1,172	7,596	15,258	0	0	0	0	0	24,026
Spathius galinae	0	0	0	0	0	0	1,613	892	2,505
Totals	3,326	30,717	45,321	51,176	46,496	182,512	89,501	21,368	470,417

Even with bioagent releases, ash health declined at sites with high levels of EAB. Although we lost many ash trees at release sites, we remain hopeful that the establishment of biological control agents will help to protect future generations of ash trees.

Mean Ash Health at Biocontrol Sites (1=Healthy, 5=Dead)

Site	2010	Error	2011	Error	2012	Error	2013	Error	2014	Error	2015	Error	2016	Error
2nd Street NE	0	0	0	0	0	0	1.3	0.18	1.6	0.24	1.7	0.24	1.3	0.21
Battle Creek Reg. Park	0	0	0	0	0	0	0	0	0	0	0	0	1.5	0.15
Como Park	0	0	0	0	0	0	1.4	0.17	1.7	0.24	2.3	0.33	1.8	0.37
E. River Pkwy 1	0	0	1.6	0.26	1.4	0.31	2.1	0.35	2	0.37	2.1	0.31	2.6	0.31
E. River Pkwy 2	0	0	1.7	0.22	1.3	0.21	1.9	0.13	1.8	0.25	2.2	0.17	2.5	0.29
E. River Pkwy 3	0	0	0	0	0	0	1.6	0.24	1.6	0.18	2	0.29	2	0.29
Farmers Com. Park	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0.08
Fish Point Park	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0.08
Ft. Snelling Upper Post	0	0	0	0	1	0	1.2	0.15	2.2	0.32	3.3	0.29	4.1	0.26
Ft. Snelling Hwy 5	0	0	0	0	0	0	1.2	0.11	1.3	0.19	2.1	0.31	3	0.33
GRBSP1	0	0	1.6	0.29	1	0	1.7	0.19	2.9	0.34	3.6	0.29	4.8	0.11
GRBSP2	0	0	1.2	0.11	1.2	0.11	1.8	0.18	3	0.3	3.9	0.19	5	0
GRBSP3	0	0	0	0	1.7	0.12	2.2	0.17	3.3	0.23	3.1	0.52	4.6	0.2
Hidden Falls	0	0	0	0	0	0	0	0	0	0	2	0.28	2.6	0.26
Houston Release 1	1	0	1.4	0.26	1.3	0.14	2.4	0.45	3.2	0.36	4.1	0.17	0	0
Hwy 26	0	0	0	0	0	0	1.4	0.19	1.8	0.25	2.3	0.33	4	0.25
Lake harriet	0	0	0	0	0	0	0	0	0	0	1.8	0.24	1.6	0.15
Lake Winona	0	0	0	0	0	0	0	0	1.3	0.13	3.2	0.27	4.3	0.35
Lamoile	0	0	1	0	1	0	1	0	1.5	0.15	2.3	0.45	4	0.52
Langford Park	0	0	1.6	0.19	1.2	0.11	1.3	0.21	2	1	3	0	0	0
Minnehaha Park	0	0	0	0	0	0	0	0	0	0	1.8	0.25	2.1	0.29
Miss. River Park	0	0	0	0	0	0	0	0	0	0	0	0	1.9	0.23
Northwestern College	0	0	0	0	0	0	1.6	0.23	1.8	0.25	1.8	0.27	2.2	0.32
Prairie Island	0	0	0	0	0	0	0	0	0	0	1.2	0.11	1.3	0.14
Reno to LaCrescent	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Shepards Rd	0	0	0	0	0	0	0	0	0	0	3	0.33	4.2	0.37
Shoreview 1	0	0	1.3	0.13	1	0	1	0	1	0	1.2	0.11	1.2	0.17
Summit & Dale	0	0	1	0	1	0	1.5	0.19	1.8	0.25	2	0.27	2	0.27
Tower Hill Park	0	0	2.3	0.3	1.3	0.25	0	0	0	0	0	0	0	0
W. River Pkwy 1	0	0	2.5	0.19	2.4	0.26	0	0	0	0	0	0	0	0
W. River Pkwy 2	0	0	0	0	0	0	1.2	0.22	1.4	0.15	2	0.29	2	0.44
Wheelock Pkwy	0	0	0	0	0	0	0	0	0	0	0	0	2	0.25
Whitewater WMA	0	0	0	0	0	0	0	0	0	0	0	0	1.8	0.22


EAB Biological Control in SE MN
N
White Water WMA
Prairie Island
Lake Winona
Farmers Community Park
Homer, MN
Lamoille
Great River Bluffs State Park 1
Great River Bluffs State Park 2
Great River Bluffs State Park 3
Reno to LaCrescent
Houston Control 1
Hwy 26
Houston Release 1
EAB Biocontrol Release Site
Active
Monitoring
0 10 20 Miles
1:504,371
Map created by: Jonathan Osthus, 7/13/2017
Area of detail highlighted in red
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

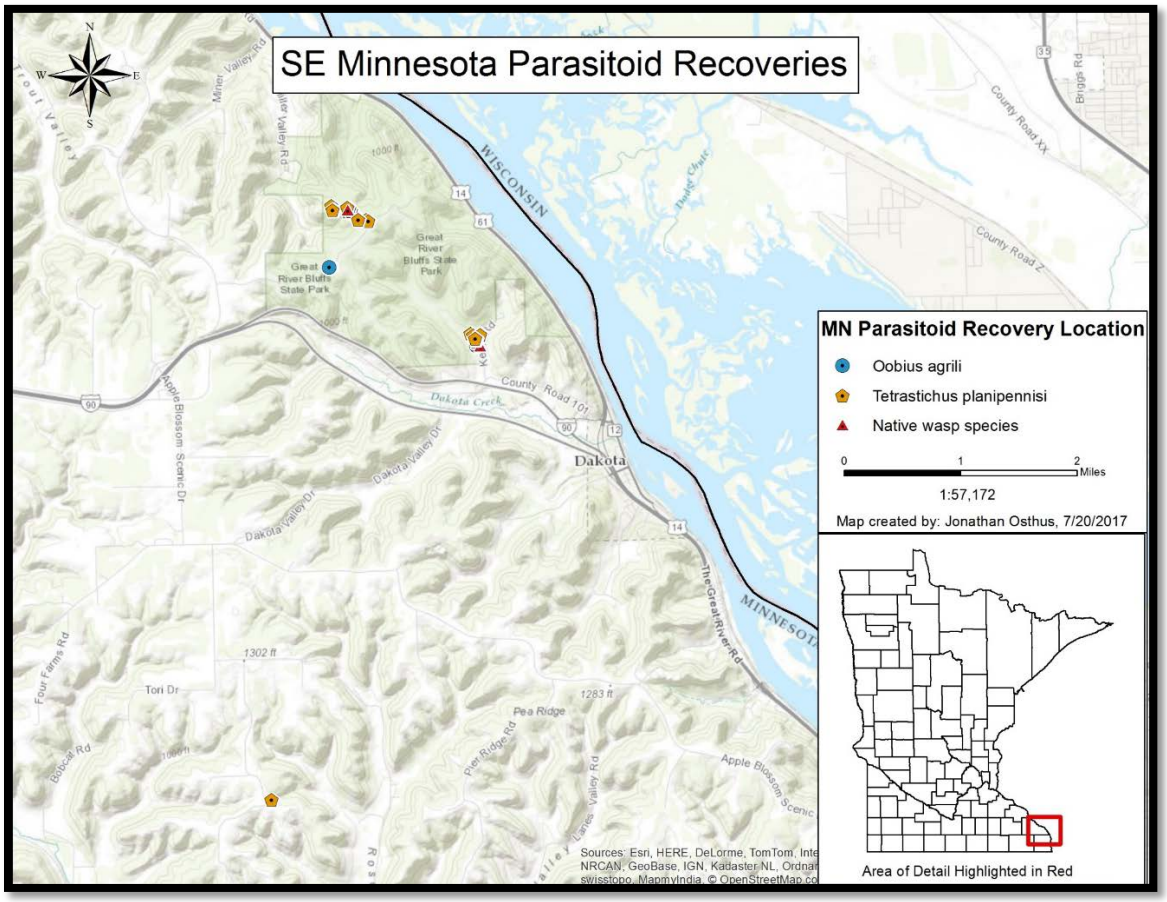

EAB Biological Control in Twin Cities Metro Area
N
Hartley Park
Duluth
EAB Biocontrol Release Site
Active
Monitoring
0 10 20 Miles
1:543,297
Map created by: Jonathan Osthus, 7/13/2017
0 5 10 Miles
1:1,293,627
Area of detail highlighted in red
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

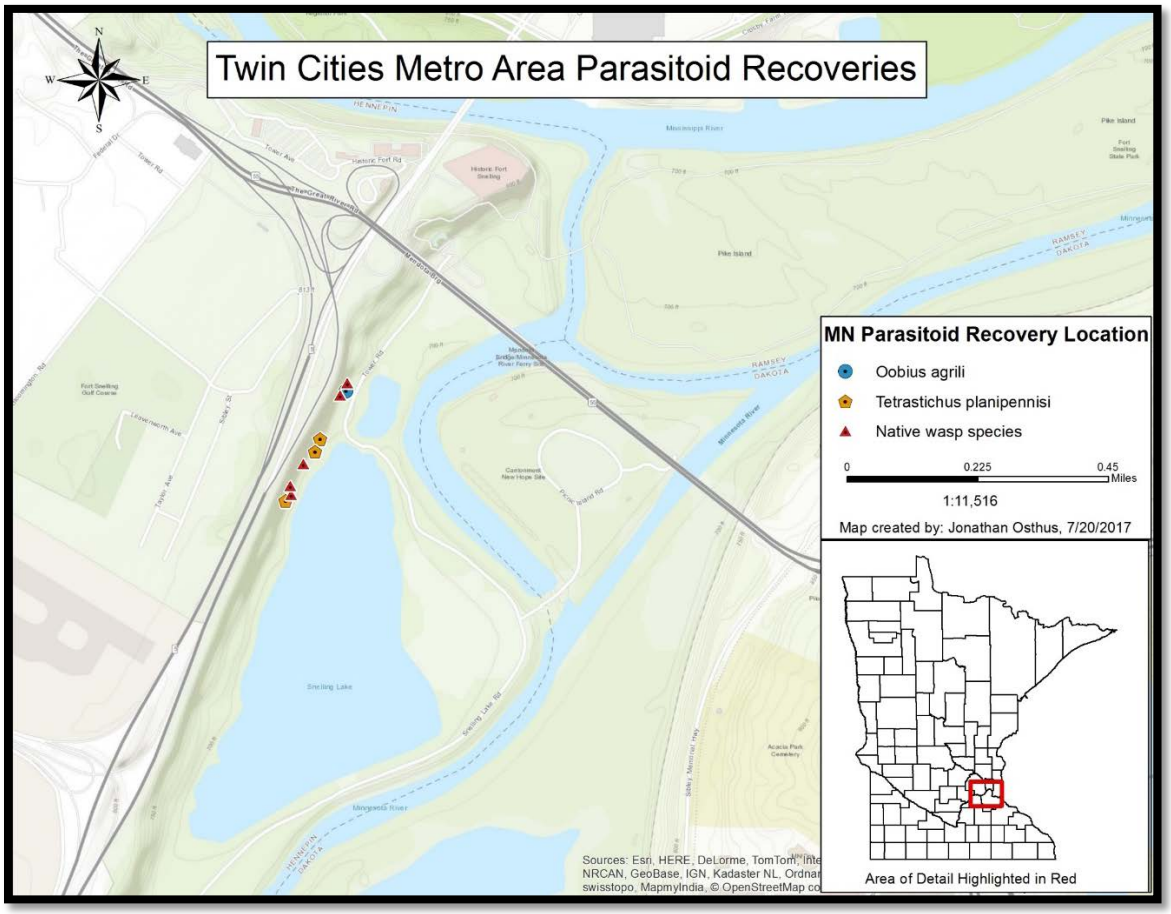
Parasitoid Recovery

Efforts to recover and document establishment of the parasitoid wasps released to combat EAB continues to move forward with each passing year. Several techniques have been implemented including branch sampling, larval dissection, bark sifting and yellow pan trapping. All have been successful in recovering parasitoid wasps throughout the project. In the winter of 2017, bark samples that were collected in fall of 2016 to look for the egg parasitoid *Oobius agrili* were processed with one parasitized egg confirmed. The confirmation of a parasitized egg again at Ft. Snelling State Park provided further evidence that it has established a reproducing population at the site. The recovery of *Tetrastichus planipennisi* at Ft. Snelling State Park through the use of yellow pan traps in the summer of 2016 was very important as well. The recovery marked the first time *T. planipennisi* had been recovered in the Twin Cities and demonstrated an established reproducing population at the site because releases were completed in 2015. Recovery efforts are continuing through the summer of 2017 with 30 yellow pan traps each deployed at two sites (Phase 3).

Parasitoid Recovery Summary

Year	*Tetrastichus planipennisi* (Recoveries)	Sampling Type	*Oobius agrili* (Recoveries)	Sampling Type	*Atanycolus simplex* - native wasp (Recoveries)	Sampling Type	Total by Year
2013	2	Tree debarking	-	-	-	-	2
2014	4	Tree debarking	-	-	-	-	4
2015	24	Tree debarking, larval dissection	3	Bark sifting	-	-	27
2016	6	Tree debarking, Yellow Pan Traps	-	-	9	Yellow Pan Traps	15
2017	-	-	1	Bark sifting	-	-	1
Total All Years	36	-	4	-	9	-	49

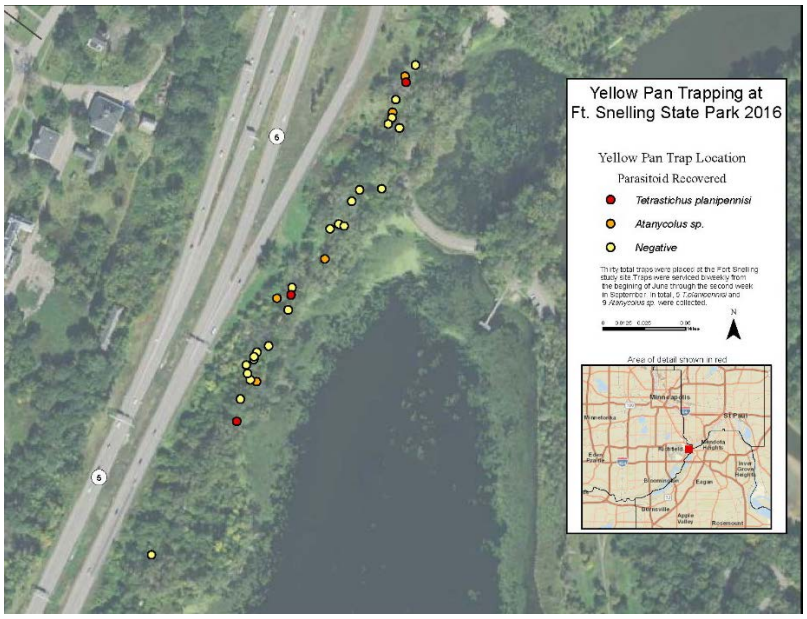

SE Minnesota Parasitoid Recoveries
WISCONSIN
MINNESOTA
Great River Bluffs State Park
Dakota
Dakota Creek
County Road 101
Pea Ridge
Tori Dr
Dakota Valley Dr
Apple Blossom Scenic Dr
Four Farms Rd
Bobcat Rd
Pier Ridge Rd
Valley Lanes Valley Rd
The Great River Rd
Miner Valley Rd
Trout Valley
County Road XX
County Road Z
Briggs Rd
1302 ft
1283 ft
MN Parasitoid Recovery Location
Oobius agrili
Tetrastichus planipennisi
Native wasp species
0
1
2
Miles
1:57,172
Map created by: Jonathan Osthus, 7/20/2017
Area of Detail Highlighted in Red
Sources: Esri, HERE, DeLorme, TomTom, Inte
NRCAN, GeoBase, IGN, Kadaster NL, Ordnat
swisstopo, MapmyIndia, © OpenStreetMap co

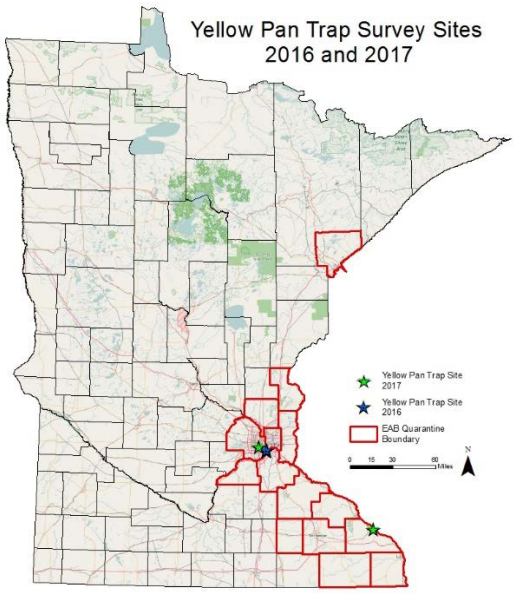

Twin Cities Metro Area Parasitoid Recoveries
HENNEPIN
RAMSEY
DAKOTA
Pike Island
Mississippi River
Minnesota River
Fort Snelling State Park
Historic Fort Snelling
Fort Snelling Golf Course
Snelling Lake
Acacia Park Cemetery
Minnehaha Creek
Trunk Hwy 55
MN Parasitoid Recovery Location
Oobius agrili
Tetrastichus planipennisi
Native wasp species
0
0.225
0.45
Miles
1:11,516
Map created by: Jonathan Osthus, 7/20/2017
Area of Detail Highlighted in Red
Sources: Esri, HERE, DeLorme, TomTom, Inte
NRCAN, GeoBase, IGN, Kadaster NL, Ordnat
swisstopo, MapmyIndia, © OpenStreetMap co

Yellow Pan Trapping Summary for Parasitoid Recovery
2016 Final Results
The Minnesota Department of Agriculture and Natural Resources partnered to test yellow pan trapping methods for parasitoid recovery over the summer of 2016. A protocol and pan traps were provided by USDA AHPIS. Yellow plastic bowls were attached to the stems of living ash trees using shelving brackets. The bowls were filled with a solution of clear propylene glycol to trap insects that were attracted to the yellow color. Samples were collected from the traps twice a week from 06/03/16 to 09/09/16. Sampling involved pouring the propylene glycol through a filter and then bagging and freezing contents. Pans were then cleaned and filled with new propylene glycol. A total of 870 samples were collected, frozen then examined in October and November. Samples were screened under a dissection scope for suspected parasitoids which were sent to USDA APHIS for identification

Yellow pan trap sample submissions were identified by Dr. Juli Gould with APHIS. This sampling method resulted in the positive identification of 5 *Tetrastichus planipennisi* and 9 *Atanycolus simplex* (a native parasitoid of EAB). The recovery of *T. planipennisi* was the first in the Twin Cities region.

2017 Traps
Yellow pan trapping was repeated for the summer of 2017 at two locations. Our methods were to place 30 traps at Roberts Bird Sanctuary near Lake Harriet in Minneapolis and at Prairie Island in Winona. Traps were placed in the beginning of June and will be sampled once a week until mid-September. Pans are filled with a propylene glycol solution to trap insects attracted to the yellow color. Sampling involves pouring the propylene glycol through a filter then bagging and freezing the contents on the filter. Samples will be screened in the fall under a dissection scope and suspected parasitoids will be sent off for identification by APHIS.





Management Guidelines
MDA staff updated and expanded guidelines for EAB management in Minnesota, including procedures for biological control. Over the course of this project, as well as the project titled Improving EAB Detection, we have learned much about EAB management. These guidelines incorporated information regarding EAB identification and reporting, detection methods and their relative efficiencies, recommended management tactics based on the infestation and site specifics. Associated costs were also included in the guidelines. The guidelines will be available on MDA's EAB webpages for municipalities, counties, the public and others.

V. DISSEMINATION:

Description: We will communicate about the biosurveillance and biocontrol of EAB with the public, land managers, and researchers. The web will be used for communication http://www.mda.state.mn.us/en/plants/pestmanagement/eab/eabbiocontrol.aspx and will be updated annually. Communication with the public will be via news media (print, television, and radio) and social media such as Facebook and Twitter. We will communicate updates with land managers at the multi-agency EAB Forum (meets 4 times/year) and in trade publications such as "The Scoop" published by the Minnesota Nursery Landscape Association. Updates and findings will be presented at a University of Minnesota seminar, the 2014 Upper Midwest Invasive Species Conference, and other meetings (LCCMR funding will not be used for meetings).

Project Status as of November 26, 2014:

Presentations

- EAB and EAB biocontrol were included in Invasive Blitz workshops at Spicer, MN on 09/13/14 (8 participants), Rochester, MN on 09/20/14 (11 participants) and Duluth, MN on 10/04/14 (7 participants).
- Extension Conference Lightening Talk by A. Gupta on EAB biosurveillance titled *Surprise!* on 10/06/14 (150 Extension educators).
- Gupta, A., J. Schultz, J. Hahn, and M. Chandler. 2014. Wasp Watchers: Minnesota's efforts to use citizen scientists to do EAB biosurveillance. University of Minnesota Extension Program Conference. Bloomington, MN October 8-10, 2014.
- Gupta, A. 2014. Communicating forestry through citizen science and invasive species. National Society of American Foresters Convention and Canadian Institute of Forestry/Instiut forestier du Canada Conference in Salt Lake City, UT, October 8-11, 2014.
- Forest Pest First Detector workshop in Rochester, MN on 11/05/14 (30 participants)
- Ash management workshop in Rochester, MN on 11/12/14 (15 participants)
- Gupta, A. 2014. Using volunteers for emerald ash borer and terrestrial invasive species early detection and management. Canadian Institute of Forestry webinar, November 19, 2014. (575 Canadian participants)

The following presentations were given at the Upper Midwest Invasive Species Conference in Duluth, MN, October 20-22, 2014. There were over 650 conference participants.

- Aukema, B., R. Venette, J. Hahn, M. Chandler, and M. Abrahamson. Mythbusters: Ten ideas about emerald ash borer that may not be true.
- Gupta, A. Engaging volunteers in early detection and management.
- Gupta, A., J. Schultz, J. Hahn, and M. Chandler. Wasp Watchers: Minnesota's efforts to use citizen scientists to do EAB biosurveillance.
- Osthus, J. Biological control of emerald ash borer (*Agrilus planipennis*) in Minnesota: A state update on parasitoid release, recovery and observations from the field.
- Venette, R., M. Abrahamson, and J. Osthus. Winter mortality of emerald ash borer in Minnesota: Lessons for managers.

Events

- Minnesota State Fair – MDA exhibit hosted information on EAB and EAB biocontrol at the Northwoods campground display 08/21/14 – 09/02/14.

Media

- The University of Minnesota's Urban Forestry program interviewed Jonathan Osthus for a short informational video on EAB biocontrol implementation in the Twin Cities.

Status as of May 29, 2015:

Presentations

- Osthus, J. Biological Control of EAB in Minnesota. Presented to Dakota County natural resource managers and staff on 01/08/15.
- Osthus, J. Tracking the EAB Infestation Core. Presented to the Minneapolis Tree Advisory Commission on 01/08/15.

- Osthus, J. Emerald Ash Borer Biological Control: Evolving strategies and observations from the field. Presented at South Dakota State University EAB workshop on 03/10/15. (Travel costs were paid by USDA.)
- **Wasp watcher outreach presentations**
  Brainerd Area Master Naturalists on 03/30/15 (25 participants), Stearns County Master Gardeners on 04/06/15 (35 participants), Scott and Carver Counties Master Gardeners on 04/13/15 (50 participants), Chisago County Master Gardeners on 04/14/15 (25 participants), Mower County Master Gardeners on 04/15/15 (15 participants), Steele County Master Gardeners on 04/20/15 (20 participants), Ramsey County Master Gardeners on 04/21/15 (75 participants), Hennepin County Master Gardeners on 05/04/15 (200+ participants), Master Naturalist Conference on 05/16/15 in Grand Rapids (20 participants), Winona County Master Gardeners on 05/19/15 (20 participants)
- Four Forest Pest First Detector workshops were held in Hutchinson on 02/19/15 (16 participants), Alexandria on 02/26/15 (9 participants), Cloquet on 03/03/15 (29 participants) and Shoreview on 03/04/15 (46 participants).

Training about EAB and EAB biocontrol

- City of Bloomington on 12/03/2015 (65 participants)
- City of Duluth on 01/22/2015 (20 participants)
- Dakota County sessions 01/29/15 – 02/16/15 (96 participants)
- City of Rochester on 02/04/15 (12 participants)
- Sherburne County volunteer training on 02/23/2015 (39 participants)
- EAB volunteer survey - held at Lebanon Hills Regional Park in Dakota County on 03/03/15 and Stewartville in Olmsted County on 03/05/15.
- Dakota County EAB meeting on 03/05/2015 (60 participants)
- EAB workshops (open to public) 04/13/15 – 04/17/15 (160 participants)
- Dakota County Master Naturalist on 04/27/2015 (16 participants)
- Anoka County EAB meeting on 04/30/2015 (30 participants)
- Anoka County training/scouting on 05/06/2015 (30 participants)
- Chanhassen EAB open house on 05/07/15 (6 participants)

Events

- MDA forest pest outreach (includes EAB biocontrol) had a booth at the following events. Farm Bill (federal) grant funds were used for these events.
  DaVinci Fest on 01/10/2015 (310 visitors), Northern Green Expo 01/14/15 – 01/16/16 (402 visitors), Explore Minnesota Tourism 02/03/15 – 02/04/15 (169 visitors), RV, Vacation & Camping Show 02/12/15 – 02/14/15 (1,335 visitors), Wabasha County Forestry Day on 02/13/15 (53 visitors), Home & Garden Show 02/25/15 – 03/01/15 (2,155 visitors), Shade Tree Short Course 03/17/15 – 03/19/15 (410 visitors), Lakeville Watershed Clean Up Day on 04/25/15 (300 visitors), Cinco De Mayo on 05/02/15 (600 visitors), Gathering Partners Natural Resources Conference 05/15/15 – 05/17/15 (260 visitors), Garlough Elementary Environmental Fair on 05/15/15 (185 visitors) and Mille Lacs County SWCD Conservation Day on 05/20/15 (300 visitors).

Media

Minnesota Public Radio interviewed Jennifer Schultz and ran a story on the Wasp Watchers program on 05/26/15.

Other

- Our project webpage at www.mda.state.mn.us/plants/pestmanagement/eab/eabbiocontrol.aspx was redesigned and updated.
- Biosurveillance will be featured in the 2016 Minnesota Invasive Species Advisory Council calendar. The calendar text and images were submitted.
- EAB forum meetings were held at MDA which included city, county, state and federal participants from around the state of Minnesota on 12/04/14, 02/12/15 and 04/09/15. Biocontrol updates were presented at each meeting.
- Gave updates on EAB biocontrol at the County Agricultural Inspector Board meeting on 12/10/15 and at the annual Camp Ripley and Arden Hills Army Training Site natural resources meeting on 03/26/15.

Status as of November 30, 2015:

Wasp watcher outreach presentations

Master Naturalist Conference on 05/16/15 (14 participants), Winona County Master Gardeners on 05/19/15 (20 participants), Arbor Day Event in St. Paul on 05/19/15 (25 participants), Dakota County Master Gardeners on 06/01/15 (90 participants), Goodhue County Master Gardeners on 06/02/15 (22 participants), Minnesota Zoo staff on 06/16/15 (15 participants), Cascade Meadows Environmental Learning Center in Rochester on 07/28/15 (15 participants), State Fair EcoExperience Sustainability Stage on 08/31/15 (30 participants) and Houston County Master Gardeners on 11/10/15 (15 participants). The total number of participants is 246.

EAB biocontrol presentation

- A coordinated multi-state approach to EAB biocontrol was presented to the Upper Mississippi River Basin Association on 11/17/15.

Events

- University of Minnesota Extension hosted an invasive species tour on 8/12/2015 for extension staff and made several stops at sites around the Twin Cities covering different invasive species and educational efforts. EAB biocontrol and biosurveillance were presented at one of the tour stops.

Media

- An article on biosurveillance were published on 07/14/15in the Rochester Post Bulletin
- A media event was held at Northdale Park in Oakdale, MN highlighting biosurveillance activities on 07/20/2015. Four local news stations covered the event with interviews of Jennifer Schultz and Jonathan Osthus airing on the six and ten o'clock news. Articles on biosurveillance were published in the Start Tribune (07/20/15) and Winona Daily News (07/30/15).
- An update on EAB biocontrol activities was sent out as part of the MDA's Plant Pest Insider October issue. The monthly publication goes out to state cooperators and stakeholders highlighting pest management updates around the state.
- A press release on EAB biocontrol efforts in the state was done on 11/17/2015 highlighting increased parasitoid recoveries in southeast Minnesota. It was picked up by numerous media sources around the state as well as news agencies in LaCrosse, WI, Sioux Falls, SD and Mason City, IA.

Status as of May 31, 2016:

Wasp watcher outreach presentations

Fillmore County Master Gardeners on 01/11/16 (6 participants), Blue Earth County/Minnesota Valley Master Gardeners on 01/18/16 (20 participants), Carlton County Master Gardeners and general public on 01/21/16 (19 participants), Pine County Master Gardeners on 02/09/16 (20 participants), Bloomington Home Improvement Fair on 02/20/16 (spoke with 25 people), Park maintenance staff in St. Louis Park on 03/30/16 (15 participants), Kanabec County Master Gardeners and general community on 03/31/16 (30 participants), Pine County Horticulture Day on 04/02/16 (35 participants), city of Chanhassen community members on 04/07/16 (40 participants), Houston County Horticulture Education Event on 04/09/16 (100 participants), Douglas County Master Gardeners on 04/22/16 (20 participants), Anoka County 4H (35 participants), Washington County Master Gardeners on 04/28/16 (80 participants), Edina Parks Maintenance Staff on 05/02/16 (20 participants), Otter Tail County Master Gardeners (webinar) on 05/03/16 (20 participants)

EAB biocontrol presentations

- Chandler, M. Regional Management of Riparian Ecosystems to Minimize Invasive Threats. Presented to the Upper Mississippi River Basin Association on 11/17/15 and addressed EAB, Japanese hops, Japanese knotweed and Oriental bittersweet.
- Osthus, J. How to report EAB using the Great Lakes Early Detection Application. Presented to the Minneapolis Parks and Recreation Forestry Department on 3/30/16.

Events

- Exhibitor: RV Show (2/11 – 2/14/16) and the Home and Garden Show (2/26 – 2/28/16 and 3/4 – 3/6/16) at the Minneapolis Convention Center.
- EAB workshops organized by Jennifer Burrington with the MDA were held in Apple Valley, Duluth and Winona in February and March of 2016. EAB management options including biocontrol were discussed in detail.
- Exhibitor: St. Louis Park Organic Living Workshop on 04/16/16 (spoke with 20 people)
- U of M Extension and MDA organized and held a volunteer survey for EAB in the Stillwater area on 4/18/2016. Trained volunteers looked for EAB infested trees in the area surrounding the rest stop location where EAB was found in 2015 along I-94 near the Minnesota/Wisconsin border. 10 volunteers covered over 100 miles of roadway during the one day survey.
- Exhibitor: U of M Ag Awareness Day in the Northrup Plaza on 4/19/2016. MDA's table contained information on invasive insect pests threatening Minnesota's forests and agriculture.
- Exhibitor: Bloomington Arbor Day Tree Sale on 05/07/16 (spoke with 10 people)
- Gathering Partners in Natural Resources Conference Field tour on 5/21/2016 in Winona, MN. EAB and EAB biocontrol activities were presented to the group of master woodland owners.

Media

- Kanabec County Times: Wasp Watchers monitor ash borer spread, April 10, 2016
- Pine City Pioneer: Naturalists prepare for invading Emerald Ash Borer, April 22, 2016
- Alexandria Echo Press: Slowing the spread of emerald ash borer, April 27, 2016
- Longfellow Messenger interviewed Jonathan Osthus about EAB biocontrol activities along the Mississippi River in Minneapolis on 5/4/2016. www.longfellownokomismessenger.com/good-bugs-face-off-bad-bugs-in-minneapolis-to-slow-eab-advance/
- WIZ Radio in LaCrosse, WI interviewed Jonathan Osthus about EAB biocontrol activities in southeast Minnesota on 5/25/16.

Other

- MDA's EAB biocontrol website was reformatted to provide a better user experience. Updates include more pictures of project activities, a drop-down tool bar for easier navigation and a summary table of statewide EAB biocontrol activities to date. A presentation Biological Control of Emerald Ash Borer: Bark sifting for Oobuis agrili was added to our website.
- Interactive maps have been created for both EAB biocontrol and Track EAB infestation core activities. The maps provide an easy way to communicate project results to all cooperators. EAB biocontrol map and Track EAB infestation core map.

Status as of November 30, 2016:

Presentations

- Anoka County Master Gardeners on 07/28/16 (60 participants)
- Schultz, J. 2016. Minnesota Wasp Watchers: An update on EAB Biosurveillance. Upper Midwest Invasive Species Conference, October 18, 2016 (40 participants).
- Minnesota Naturalist Association Conference in Finland, MN, November 13, 2016 (25 participants).
- Osthus, J., M. Chandler, A. Ambourn, B. Aukema, R. Venette. Implementation of EAB Biological Control in Minnesota. Poster presented at the Upper Midwest Invasive Species Conference, La Crosse, WI, October 16-19, 2016.

Events

- Five field trainings in July in Ham Lake, Oakdale, Wyoming and St. Paul (45 participants total)

Media

- Presentation recording about biosurveillance at QCTV cable station in Champlin, August 9, 2016
- Jon Osthus was interviewed by reporter Kevin Doran with KSTP News (Channels 5 & 45) on EAB biocontrol activities in Minnesota on 6/13/2016. The segment aired on 6/21/16 and can be viewed at http://kstp.com/news/parasitic-stingless-wasps-released-in-fight-against-emerald-ash-borer/4175999/?cat=12196

Final Report Summary:

Wasp watcher outreach presentations

There were 4 Wasp Watchers presentations (60-90 minutes) given during this period:

- Wargo Nature Center Staff on December 14, 2016 (10 participants)
- National Wildlife Refuge Citizen Science Day (Bloomington) on March 4, 2017 (10 participants)
- Minnesota Master Naturalist Class at Fort Snelling State Park on March 29, 2017 (21 participants)
- Volunteer Appreciation Event on March 7, 2017 (11 participants)

EAB Biocontrol Presentations

- Osthus, J. 3/15/17. Minnesota Shade Tree Short Course mini session.
- Ambourn, A. 4/6/17. Metro Mosquito Control District Conference.
- Osthus, J. 5/1817, 5/19/17 & 5/23/17. EAB Regional Meetings.
- Burrington, J. 1/12/17, 2/9/17, 4/6/17, 4/17/17, 4/21/17, 4/26/17, 5/3/17 & 5/11/17. EAB Municipal Staff trainings.

Events

- Wabasha County Forestry Day on February 10, 2017 (60 attendees)
- EAB detection and management workshops held in Twin Cities (2/27/17 - 3/3/17), Rochester (2/20/17 – 2/24/17) & Duluth/Superior, WI (3/7/17 – 3/9/17).
- Wright County Spring Days on March 4, 2017 (100 attendees)
- Rice County Horticulture Day on March 11, 2017 (75 attendees)
- U of MN CFANS Alumni Event: Classes Without Quizzes on April 1, 2017 (75 attendees)

Other

- A one page fact sheet on EAB biocontrol in Minnesota was created for dissemination at events and as a downloadable PDF for MDA's EAB biocontrol website.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Explanation
Personnel:	$ 360,900	**MDA** One 3 yr FTE Research Scientist 1 salary $44,500/yr & 48% fringe for Activity 3 **MDA** One 3 yr PTE-FTE undergrad student wages $13.70/hr & 7.65% fringe for Activity 3 **U of M** One 3 yr PTE-FTE Community Program Specialist wages $18/hr & 39.6% fringe for Activity 1 (40 weks @ 15-20 hrs/wk & 12 wks @ 40 hrs/wk) **U of M** One 3 yr PTE Insect Taxonomist wages $25/hr & 7.65% fringe for Activity 1

		U of M One 3 yr PTE technician salary $33,000/yr & 39.6% finge for Activity 2 **U of M** One 0.5 mo faculty summer salary $10,600/mo & 20% fringe for Activity 2
Professional/Technical/Service Contracts:	$ 45,000	**MDA** One 3 year contract with Minneapolis and St. Paul for branch sampling for Activity 2
Equipment/Tools/Supplies:	$ 5,900	**MDA** Supplies include draw knives, gloves, etc. **U of M** Supplies include nets, vials, insect collection supplies, etc. for Activity 1
Printing:	$ 4,500	**U of M** Printing manuals, id guides, signage and promotional patches for Activity 1
Travel Expenses in MN:	$ 29,400	**MDA** Milage for Activities 2 & 3 at 56.5 cents/mile **MDA** Meals and lodging for Activity 4 (approx. 20 days of travel/yr for 3 yr for the student worker and EAB biocontrol coordinator and 10 days of travel/yr for 3 yr for the PI and EAB Project Manager) **U of M** Milage at 56.5 cents/miles for Activity 1 **U of M** Meals and lodging for Activity 1 (approx. 10 days of travel/yr for program specialist and PIs)
Other:	$ 1,300	**MDA** Shipping bioagent transport coolers for Activity 3 **U of M** Shipping beetle samples overnight for Activity 1
TOTAL ENRTF BUDGET:	**$ 447,000**	

Explanation of Use of Classified Staff: Jonathan Osthus is the Research Scientist 1 on the project (Activity 3). His position is unclassified from 07/01/14 – 10/08/14. His position will be classified from 10/08/14 - 06/30/17. The working title is EAB Biocontrol Coordinator. This is a new, classified position at MDA.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:
One 3 yr full-time Research Scientist 1 = 2080*3 = 6,240 hrs
One 14 mo part-time Research Scientist 1 = 1,885 hrs
One 3 yr part-time undergrad student = 1000*3 = 3,000 hrs
One 3 yr part-time Community Program Specialist = 1040 * 3 = 3,120 hrs
One 3 yr part-time Insect Taxonomist = 80*3 = 240 hrs
One 3 yr part-time technician = 416*3 = 1,248 hrs
One 0.5 mo faculty(summer) = 80*3 = 240 hrs
Total hours = 15,973
Total FTEs = 14,088/2080 = 7.68

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:
MDA will contract with Minneapolis and St. Paul for branch sampling. Sampling and related work is estimated to require 500 hours over 3 years = 1,500 hours. Total FTE's = 1,500 hours/2080 per year = 0.72

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State (in-kind)			
MDA: Field equipment, computing/software, GIS and data management and project management ($40,000); U of M: Waived indirect costs ($17,628 at U of M), project coordination and computing ($10,000 at Extension); Minneapolis Parks & Rec and St. Paul Parks & Rec: Difference between actual branch sampling cost of $60,000 and contract total of $45,000 is $15,000; Volunteer participation estimated at $15,000	$ 97,630	$ 97,630	
TOTAL OTHER FUNDS:	**$ 97,630**	**$ 97,630**	

VII. PROJECT STRATEGY:

A. Project Partners:

Receiving funds: Angela Gupta, Jeffrey Hahn and Dr. Karen Oberhauser with Extension will lead EAB biosurveillance. Drs. Robert Venette and Brian Aukema with the U of M will lead the data analysis from tracking the EAB infestation core. Monika Chandler with MDA will lead biological control implementation and data collection for tracking the EAB infestation core. Minneapolis Parks and Recreation Board Forestry Division and St. Paul Parks and Recreation Forestry Unit will receive funds for collecting branch samples for tracking the EAB infestation core. All organizations will provide in-kind equipment, facilities, and GIS/technical support.

Not receiving funds: For EAB biosurveillance, we will draw volunteers from the Forest Pest First Detector and the Minnesota Master Naturalist programs, which have over 1,000 active volunteers. For all activities, we will collaborate with USDA APHIS and Forest Service EAB biocontrol researchers, DNR, Mn/DOT, other federal and state agencies, counties, municipalities, and private landowners.

B. Project Impact and Long-term Strategy:

EAB biocontrol is in the second phase of implementation. Management recommendations from Phase 1 research on parasitoid cold tolerance and dispersal will be incorporated in our Phase 2 plans. Biological control agent releases were initiated in Phase 1 at 20 sites. We plan to continue monitoring these sites to document the landscape level impact of biological control on EAB at these sites. We anticipate that EAB populations will increase in density and spread in Phase 2. We plan to utilize biosurveillance to better understand EAB population spread and density to guide biological control releases. We will release bioagents on leading edges of EAB populations with the aim of establishing bioagent populations that move and spread with EAB. In addition, we will continue to track the EAB infestation core of the Twin Cities. This will inform us about EAB and bioagent movement and spread and their resulting impact on ash trees. The information gained from this project will enable us to hone EAB biological control and increase the feasibility of successful EAB management.

It will likely take decades to fully determine whether EAB can be sufficiently managed with biological control at a national level. We have an advantage in Minnesota that we initiated biological control while EAB populations were relatively small. New biological control candidate species currently in testing may become available for future releases. We have the difficult challenge of learning whether and how we can effectively manage EAB before we lose our ash resources. We expect to continue to learn and improve our tactics over the coming decade. The stakes are high. Minnesota has approximately 1 billion ash trees. Urban ash trees provide oxygen, reduce pollution and erosion, lower air conditioning costs and contribute to an aesthetically pleasing environment. Increased human mortality from cardiovascular and lower respiratory tract illness was documented after the large-scale loss of ash trees in EAB impacted US counties. Woodland ash trees provide oxygen, sequester carbon, filter water, reduce floods, support wildlife, provide timber and are important for recreation and human culture such as tribal black ash basket making. Loss of Minnesota's ash trees would be catastrophic. Our project aims to mitigate EAB damage with biological control to prevent catastrophic loss. Unfortunately, we do not know at this time if biological control will be successful.

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**
Forest Service supplies and salary to initiate Phase 1			8,000		
U of M salary to initiate Phase 1			2,500		
MDA salary to initiate Phase 1			3,000		
LCCMR Emerald Ash Borer Biocontrol Research and Implementation project $500,000 from ENRTF				500,000	
USDA APHIS CPHST				70,160	
MDA in kind				15,000	
U of M waived indirect				162,550	
Minneapolis and St. Paul branch sampling				22,000	
LCCMR Improving Emerald Ash Borer Detection Efficacy for Control $600,000 from ENRTF					600,000

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): See final page

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 05/29/2015, 11/30/2015, 05/31/2016 and 11/30/2016. A final report and associated products will be submitted between June 30 and August 15, 2017.

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

Biosurveillance and Biocontrol of the Emerald Ash Borer

Activities inform biological control implementation

Adult EAB beetle

Biosurveillance for EAB detection and monitoring

Track EAB infestation core

Biological Control for EAB Management

The smoky winged beetle bandit wasp captures EAB and similar beetles (pictured above). Citizen scientist volunteers net the wasps. The wasps drop the beetles then the wasps are let go and the beetles collected. These wasps have been used for successful EAB detection and monitoring in 17 states and 3 Canadian provinces.

Biological Control Agents = Parasitoid Wasps

The egg parasitoid, *Oobius agrili*, (A) attacks EAB eggs. The larval parasitoids, *Tetrastichus planipennisi* (B) and *Spathius agrili* (C) attack EAB larvae under ash bark.

Monitoring for EAB larvae and EAB parasitoids

Partners

University of Minnesota Extension

University of Minnesota

Minnesota Department of Agriculture

Forest Service U.S. Department of Agriculture

Saint Paul — The Most Livable City in America

Minneapolis Park & Recreation Board

Environment and Natural Resources Trust Fund
M.L. 2014 Project Budget

Project Title: Biosurveillance and Biocontrol of Emerald Ash Borer - Phase 2
Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 04d
Project Manager: Monika Chandler
Organization: Minnesota Department of Agriculture
M.L. 2014 ENRTF Appropriation: $ 447,000 but $190 was not spent
Project Length and Completion Date: This is a 3 year project to be completed June 30, 2017
Date of Report: November 30, 2015

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Revised Activity 1 Budget 08/11/17	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Revised Activity 3 Budget 08/01/17	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM													
Personnel (Wages and Benefits) MDA	$3,000	$3,000	$3,000	$0	$77,800	$77,800	$0	~~$164,560~~	$163,762	$163,762	$0	$244,562	$0
Research Scientist 1: $150,000 (77% salary, 33% fringe); 100% FTE for 3 years													
Research Scientist 1: $50,860 (77% salary, 33% fringe); approximately 80% PTE for 14 months													
Student worker: $44,500 (92.35% salary, 7.65% fringe); 48% FTE for 3 years													
Equipment/Tools/Supplies													
Supplies include draw knives, gloves, etc.					$1,500	$1,500	$0	~~$500~~	$553	$553	$0	$2,053	$0
Travel expenses in Minnesota													
Milage, lodging, and meals for travel to EAB infestation and biological control sites	$800	$800	$800	$0	$2,240	$2,240	$0	~~$14,000~~	$14,895	$14,895	$0	$17,935	$0
Other - Shipping													
Shipping bioagent transport coolers								~~$500~~	$349	$349	$0	$349	$0
Professional/Technical/Service Contracts													
Contract with Minneapolis and St. Paul Total is $45,000													
Branch sampling for 3 years					$45,000	$45,000	$0					$45,000	$0
Contract with U of M Total is $137,100													
Personnel (Wages and Benefits) U of M	~~$78,600~~	$85,212	$85,022	$190	$33,900	$33,900	$0					$119,112	$190
Community Program Specialist: $78,600 (60.4% salary, 39.6% fringe), 50% FTE for 3 years													
Technician: $27,540 (60.4% salary, 39.6% fringe); 20% FTE for 3 years													
Faculty summer salary: $6,360 (80% salary, 20% fringe); 11.5% FTE for 1 year													
Two part-time summer student workers on project in 2016													
U of M Subcontract													

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Revised Activity 1 Budget 08/11/17	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Revised Activity 3 Budget 08/01/17	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM													
Insect Taxonomist: $6,500 (92.35% salary, 7.65% fringe); 4% FTE for 3 years	$6,500	$6,459	$6,459	$0								$6,459	$0
Equipment/Tools/Supplies U of M													
Supplies include nets, vials, insect collection and rearing supplies	$2,900	$1,889	$1,889	$0								$1,889	$0
Printing U of M													
Printing manuals, id guides, signage and promotional patches	$4,500	$4,065	$4,065	$0								$4,065	$0
Travel expenses in Minnesota U of M													
Milage, lodging and meals for travel to volunteer training sessions and Cerceris monitoring sites	$9,700	$5,575	$5,575	$0								$5,575	$0
Other - Shipping U of M													
Shipping beetle samples overnight	$1,000	$0	$0	$0								$0	$0
COLUMN TOTAL	**$107,000**	**$107,000**	**$106,810**	**$190**	**$160,440**	**$160,440**	**$0**	**$179,560**	**$179,560**	**$179,560**	**$0**	**$447,000**	**$190**

EAB BIOLOGICAL CONTROL

DEPARTMENT OF AGRICULTURE

The goal of Emerald Ash Borer (EAB) biological control is to reduce EAB populations through the use of natural enemies. Biological control is the only management option for EAB that can be applied at the forest landscape level.

- Three parasitoid wasp species are released in Minnesota. Two species attack the larval stage of EAB under the ash bark. The other species kills EAB eggs that are in bark crevices. These wasps are small like gnats and do not harm humans.

Figure 1. Adult Oobius agrili, egg parasitoid of EAB. (~1mm)

Figure 2. Adult Spathius galinae, larval parasitoid of EAB. (~4mm)

Figure 3. Adult Tetrastichus planipennisi, larval parasitoid of EAB. (2-4mm)

- They were selected by the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) and Forest Service and tested extensively to ensure that they will not negatively impact other species or the environment. APHIS rears these biological control agents at a specialized facility in Brighton, MI and provides them to states with EAB infestations.

COORDINATION

After a viable biological control site is identified, coordination by the Minnesota Department of Agriculture with local natural resource managers, property owners and the USDA EAB Parasitoid Rearing Facility are necessary. At each site one has to obtain permission, guarantee access and ensure other management objectives won't interfere with implementation.

EXPECTATIONS

Although it is premature to talk about the wasps' effect on EAB populations, recently published studies report that stingless wasp populations in Michigan are increasing and spreading to adjacent areas. Minnesota has confirmed establishment of two of the parasitoid wasps at sites in the Twin Cities and southeast Minnesota.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as appropriated by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

For more information on EAB biological control in Minnesota please visit our website www.mda.state.mn.us/plants/pestmanagement/eab/eabbiocontrol.aspx

Jonathan Osthus, EAB Biocontrol Coordinator

Minnesota Department of Agriculture, Plant Protection Division

Office #: 651-201-6248 or jonathan.osthus@state.mn.us

File Name: EAB Biological Control.indd

5.1.17

DEPARTMENT OF AGRICULTURE

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

APHIS

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

UNIVERSITY OF MINNESOTA Driven to Discover℠

Biological Control of Emerald Ash Borer: Bark sifting for *Oobius agrili*

Anna Hansen, Jonathan Osthus, and Monika Chandler
Minnesota Department of Agriculture

Minnesota Department of Agriculture

Special Acknowledgements

- MDA would like to thank Leah Bauer and Deborah Miller with the U.S. Forest Service Northern Research Station in Lansing, MI for invaluable training and expertise that have led to increased parasitoid recovery in the field.

Emerald Ash Borer (EAB)

- *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae)
- Invasive phloem feeding beetle that attacks ash trees
  - Larval stage (yellow arrows) most damaging
- Discovered in U.S.A. in 2002
  - As of February 2015, EAB infestations found in 25 states (Bauer et al., 2015)

A. Hansen, Minn Dept. of Ag


M. Chandler, Minn Dept. of Ag

EAB Infested Ash Trees

- Larval galleries cut off water and nutrients
  - Ash tree slowly starves
- MN has highest volume of ash trees in U.S. with ~ 1 billion trees (Minn Dept. of Ag)
  - Devastating economic and environmental impacts

Healthy ash tree

Infested ash tree

Minnesota Department of Agriculture

Biological Control of EAB

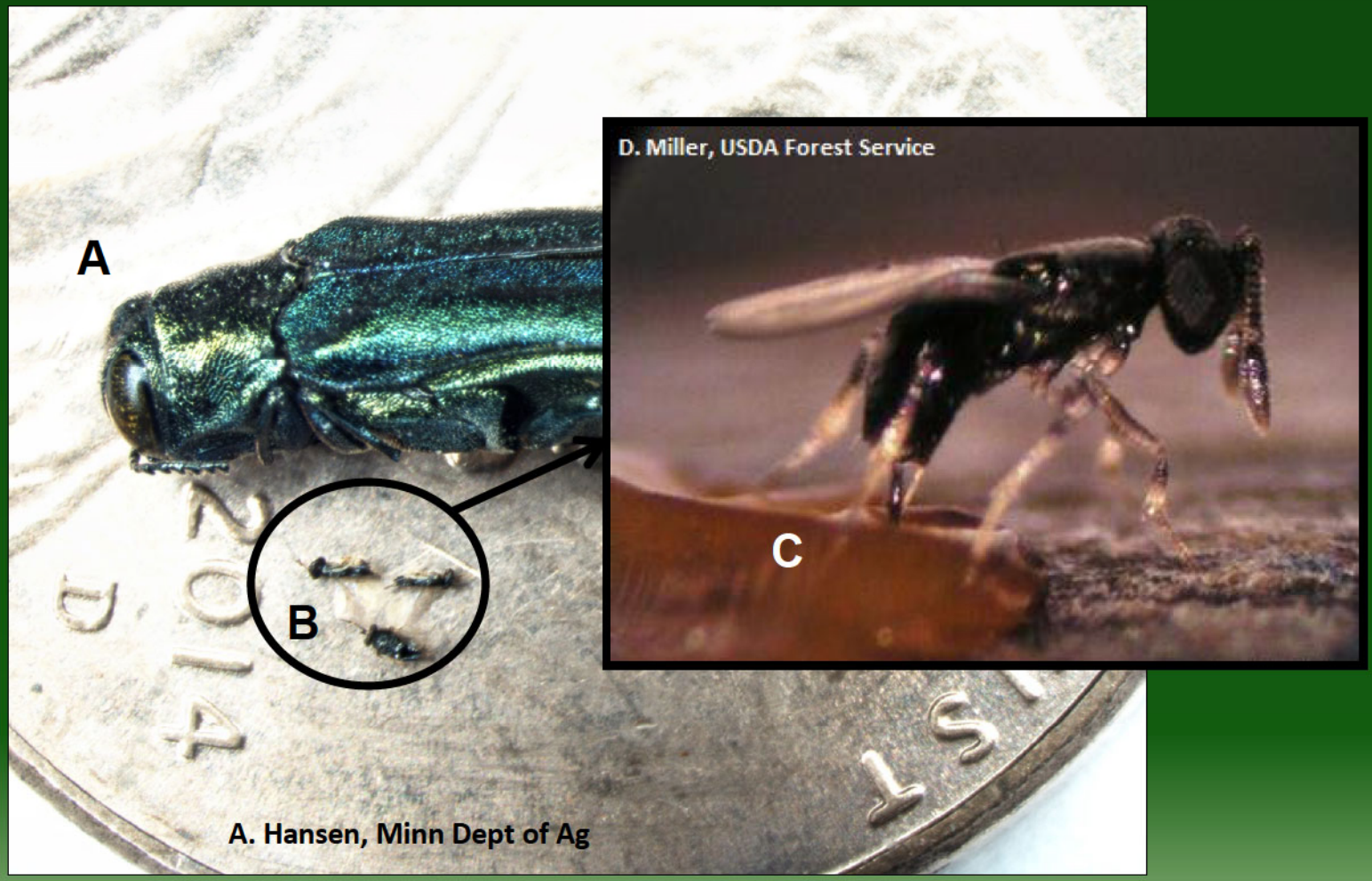
A- Emerald Ash Borer; B- *Oobius agrili*; C- *Tetrastichus planipennisi*

A. Hansen, Minn Dept of Ag

Minnesota Department of Agriculture

Biological Control Agents of EAB

A- Emerald Ash Borer; B- *Oobius agrili*; C- *Tetrastichus planipennisi*



Minnesota Department of Agriculture

Oobius agrili (Hymenoptera: Encyrtidae)

- Solitary egg parasitoid found in China
  - Very small, stingless wasp
- Adult wasp lays eggs inside EAB egg
  - Developing wasp kills EAB larva before it hatches
- Released as an EAB biocontrol agent in U.S. since 2007 and Canada since 2015 (USDA APHIS, 2007)

J Duan, USDA ARS BIIR

Oobius agrili parasitizing EAB egg

Minnesota Department of Agriculture

Bark Sifting Protocol

- Evaluate field performance of *Oobius agrili*
  - Determine establishment and prevalence of released parasitoids (Duan et al., 2012)
  - Labor intensive due to small size of EAB egg and parasitoid (Duan et al., 2012)
- Bark sifting method developed in 2012 as more effective alternative to visual egg searches (Abell et al., 2014)

Minnesota Department of Agriculture

Collecting the Bark

- Collect bark in field, sift in lab
- Select live ash trees showing signs and symptoms of EAB attack
- Measure 10 x 50cm area on trunk. Shear off with draw knife
  - Sample from S, SW or W side of tree
- Plastic sheet set to collect sheared bark
  - Transfer bark to labeled paper bag
- Once sample has been collected and transferred to paper bag, let dry and store in cardboard box to avoid mold growing in the sample

Minnesota Department of Agriculture

Preparing the Sample: Defense Against Static

- Static makes transferring fine debris and eggs difficult
  - Static can send eggs flying!
- Use anti-static dryer sheet to wipe surfaces of sieve and containers

Minnesota Department of Agriculture

Bark Sifting: Preparing the Sieve

USDA Standard Testing Sieve No. 14

- Place sheared bark into top half of sieve
  - Longer pieces of bark may need to be broken down
  - 2-3” pieces
- Avoid over-packing
  - Bark needs room to move during shaking
- Bark may need to be divided into subsamples
  - Label accordingly

Minnesota Department of Agriculture

Preparing the Sample: Sieving

A. Hansen, Minn Dept. of Ag

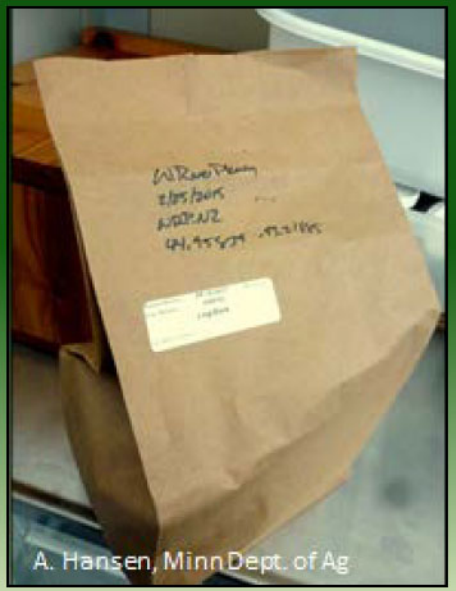
- Shake for 2 minutes
  - 15 seconds up and down
  - 15 seconds side to side
  - Repeat 3x

Minnesota Department of Agriculture

Transferring the Sifted Bark Sample

- Transfer fine, sifted bark debris into a white ceramic dish for sorting, and the remaining bark into a paper bag for storage

- (Optional) Record weight of debris and leftover bark
  - On spreadsheet



Minnesota Department of Agriculture

Bark Sifting: Preparing for Sorting

- Useful tools:
  - Dissecting microscope
  - Ceramic dish
    - Ceramic is non-static
  - Permanent marker
  - Small petri dishes
  - Forceps (for larger insects)
  - Paintbrushes
    - 1” brush
      - moving large amounts of bark
    - Size 00 round brush
      - moving small amounts of bark
    - Size 0000 round brush
      - transferring eggs

Minnesota Department of Agriculture

Sorting Fine Bark Debris

- Sorting is done using a dissecting microscope due to small size of debris and EAB eggs

Minnesota Department of Agriculture

Debris Sorting: Arranging the Bark

Minimize concealing and missing eggs!

- Arrange debris in thin line along the dish
  - Be able to see entire width with one pass under scope
    - Dish should only have to move from left to right
- Ensure that debris is 1 layer thick
  - See individual particles with minimal manipulation

Minnesota Department of Agriculture

First Glance Under Scope

- The Bark:
  - Sample will primarily contain fine bark and lichen
  - Assortment of shapes and colors

- Size 00 paintbrush useful in moving small amounts of bark
- Size 0000 paintbrush useful in removing eggs/insects

Minnesota Department of Agriculture

Debris Sorting: What You'll See

EAB egg among debris

- EAB eggs are ~1mm in length
- Distinct shape and amber color (usually)

Minnesota Department of Agriculture

Debris Sorting: What to Collect

EAB egg among debris

- Collect all insects, eggs, and any fragments that appear to be eggs
- Transfer to labelled petri dish for further examination
  - If in doubt, collect it

Minnesota Department of Agriculture

Debris Sorting: Collecting

- Use fine paintbrush to transfer eggs
  - Size 0000
  - Using a paintbrush will help avoid damage to eggs
  - Moistened paintbrush may help facilitate removal

EAB egg in transfer

Minnesota Department of Agriculture

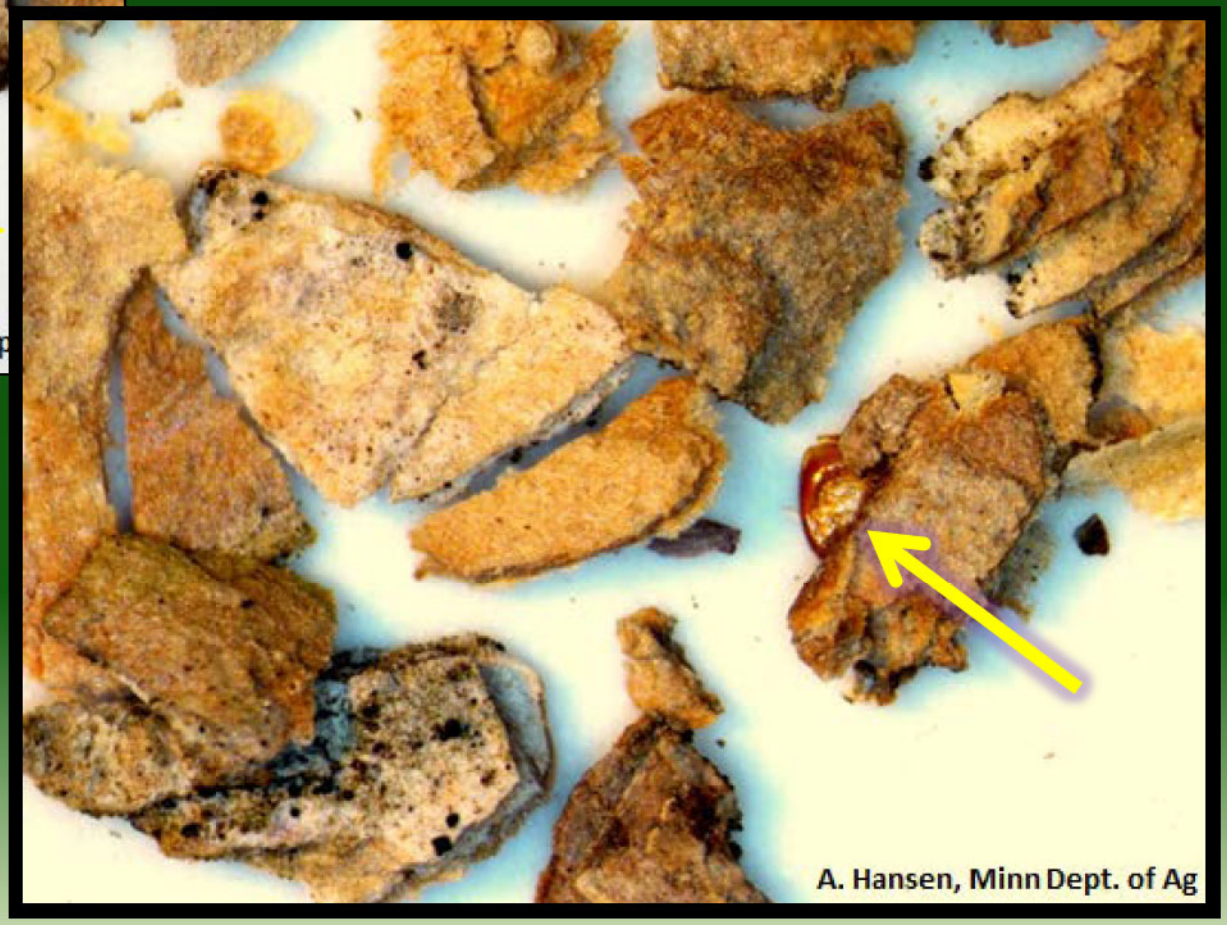
Concealed EAB eggs

Partially concealed EAB eggs can be difficult to spot. Sort carefully.

Minnesota Department of Agriculture

Concealed EAB eggs cont.

Partially concealed EAB eggs can be difficult to spot. Sort carefully.



Minnesota Department of Agriculture

Debris Sorting

- When you've sorted the current line:

- Use 1" paintbrush to sweep debris to the bottom of the ceramic dish
  - Time efficient
  - Eliminates need for additional container
- Add new line of debris and repeat until all debris is sorted

Minnesota Department of Agriculture

What You'll See: EAB Eggs

- Adult EAB females lay eggs in bark crevices and between bark layers

- Eggs often adhere to flakes of bark
  - Collect egg on bark flake (to avoid damage, try to see signs/symptoms of parasitism w/o removal)

J. Osthus, Minn Dept. of Ag

J. Osthus, Minn Dept. of Ag

Minnesota Department of Agriculture

Non-parasitized EAB Eggs

Hatched vs. Unhatched

Top view Bottom view

Hatched eggs have larval exit hole on bottom where packed frass (larval waste) is visible

Bottom view Top view

No exit hole, no frass = unhatched egg

Minnesota Department of Agriculture

Hatched vs. Unhatched

Top view Bottom view

Exit hole with packed frass circled in yellow

Bottom view Top view

EAB eggs may not hatch for several reasons

Minnesota Department of Agriculture

EAB Egg Fragments

- Not all eggs are recovered intact…


D. Miller, USDA Forest Service

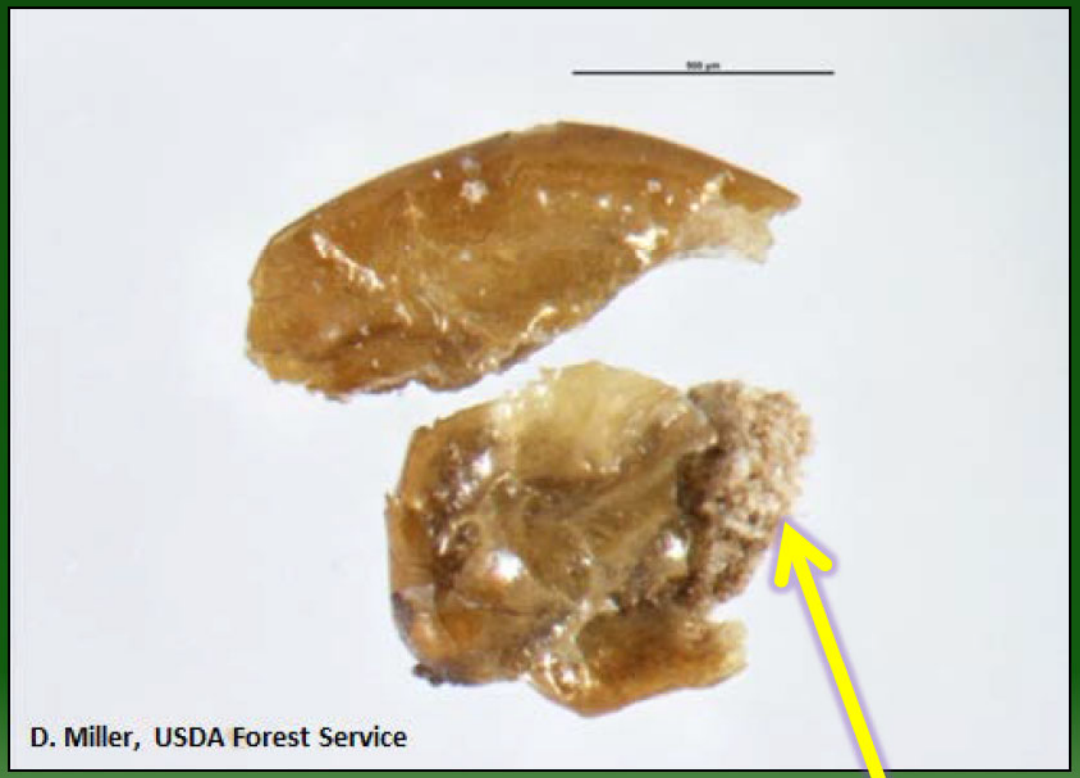

A. Hansen, Minn Dept. of Ag


A. Hansen, Minn Dept. of Ag

Minnesota Department of Agriculture

Examining EAB Egg Fragments

- Hatched or not?
  - Sometimes packed frass is visible. Fragments can be tricky



Visible packed frass

Minnesota Department of Agriculture

Parasitized EAB Eggs

- Before parasitism, EAB eggs have amber coloration

- Most EAB eggs turn dark after parasitism

Healthy EAB egg, hatched

Lab parasitized egg above

Minnesota Department of Agriculture

Parasitized EAB Eggs cont.

- Most EAB eggs turn dark after parasitism
- Parasitoid exit hole circled in yellow

Healthy EAB egg, hatched

Lab parasitized egg above

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Other Parasitized EAB Eggs

- Not all EAB eggs turn black after parasitism…

Lab parasitized egg above

Look for dark areas inside eggs and/or adult parasitoid exit hole

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Parasitized Egg That Did Not Change Color

Lab parasitized egg above

Parasitoid meconium (larval waste) circled in yellow

Round adult parasitoid exit hole circled in green

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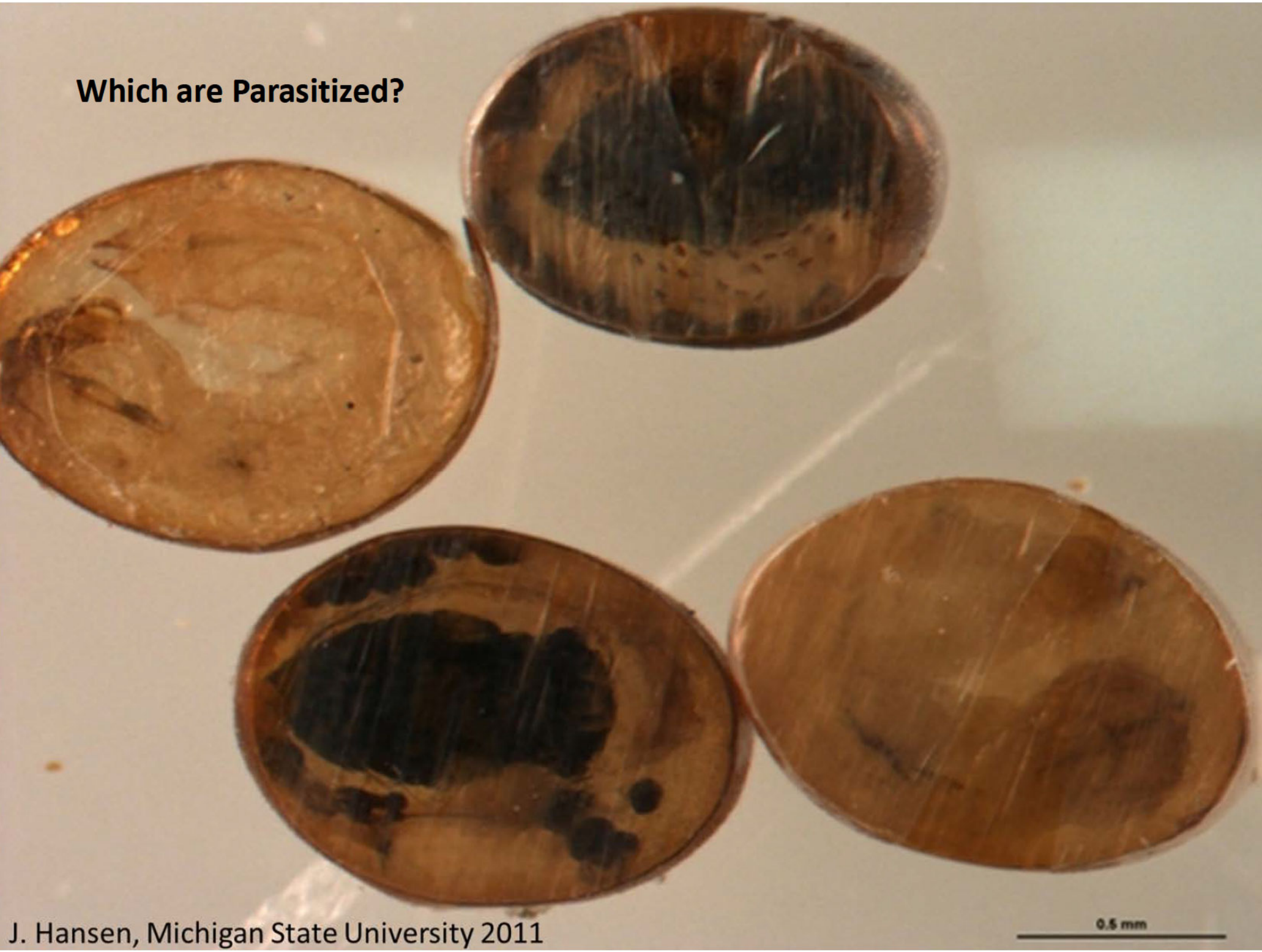
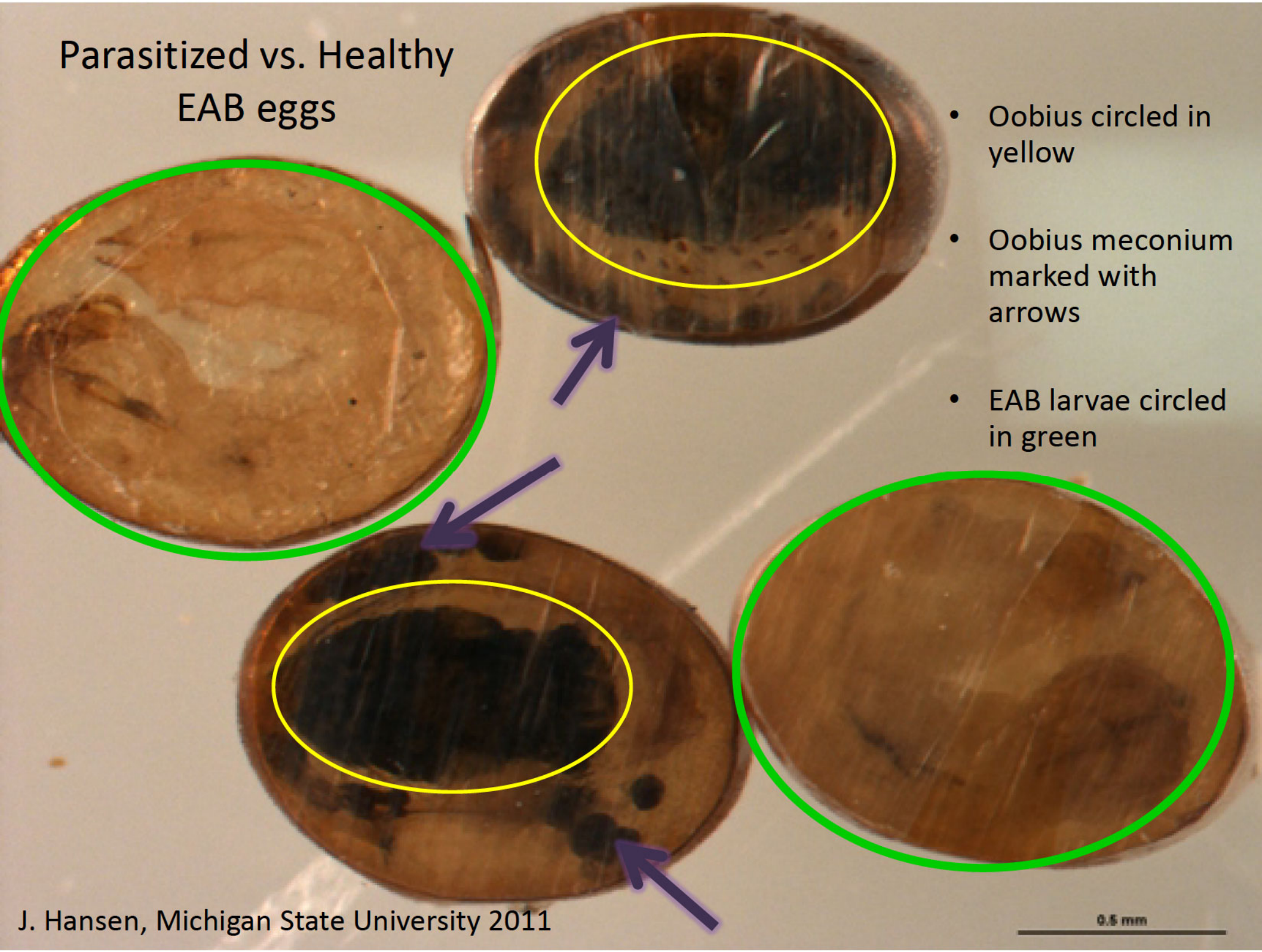

Which are Parasitized?
J. Hansen, Michigan State University 2011
0.5 mm


Parasitized vs. Healthy EAB eggs
• Oobius circled in yellow
• Oobius meconium marked with arrows
• EAB larvae circled in green
J. Hansen, Michigan State University 2011
0.5 mm

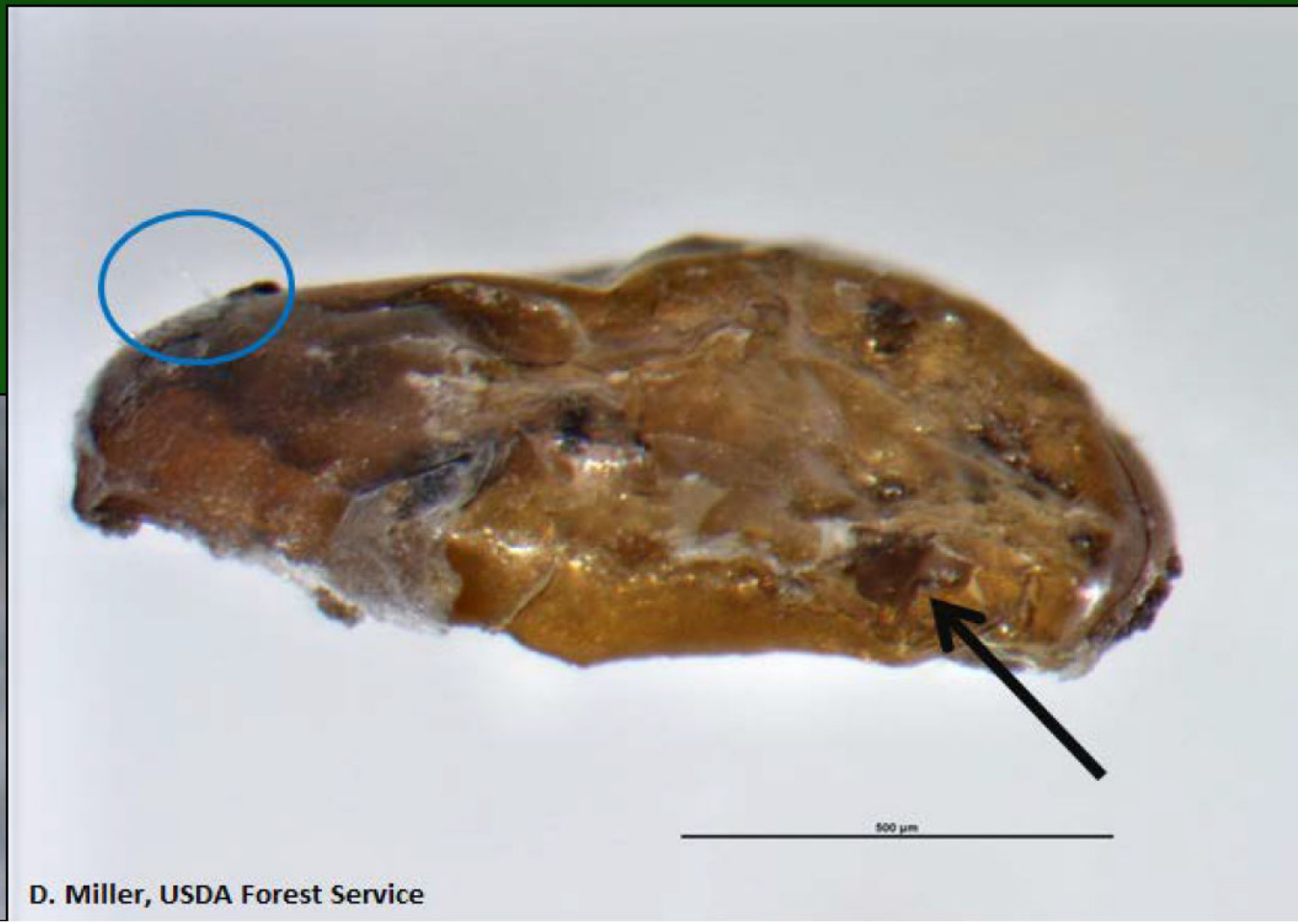
A Closer Look at Parasitized EAB Egg

- Egg recovered from Great River Bluffs State Park, MN in February, 2015
- Most parasitized eggs recovered in the field are often **reddish brown** rather than solid black, as usually seen in the lab
- **Dark areas = suspect for parasitism**

A Closer Look cont.

- Parasitoid air tube (circled in blue)
- Broken chorion with visible meconium (arrow)

No exit hole…*Oobius* still inside



Dissecting Parasitized EAB Eggs

Dissecting eggs confirms *Oobius* presence and life stage

- **Parasitized egg recovered from Ft. Snelling State Park, MN.**
- **Dissection revealed adult *Oobius* inside**

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Dissecting Parasitized EAB Eggs Revealed

Dissecting eggs confirms *Oobius* presence and life stage

- Recovered egg not completely black, but suspect for parasitism due to dark shadow (yellow circle)
- Dark shadow in center was adult Oobius (yellow arrow)

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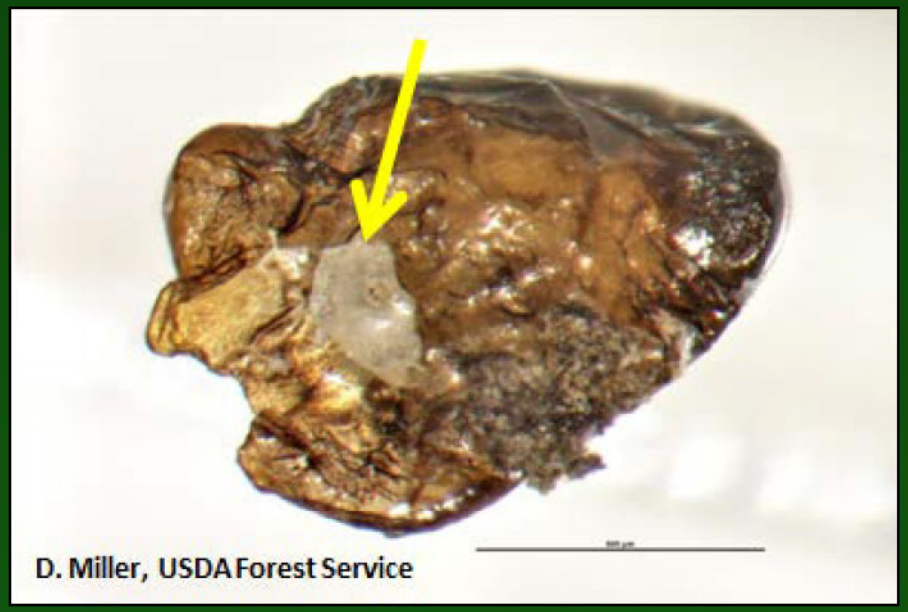
Dissecting Parasitized EAB Eggs cont.

- *Oobius* larvae dissected from parasitized EAB eggs (arrows)



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EAB Eggs: Parasitized or Not??

One of these 3 eggs from Great River Bluffs State Park, MN is NOT parasitized.

Which one?

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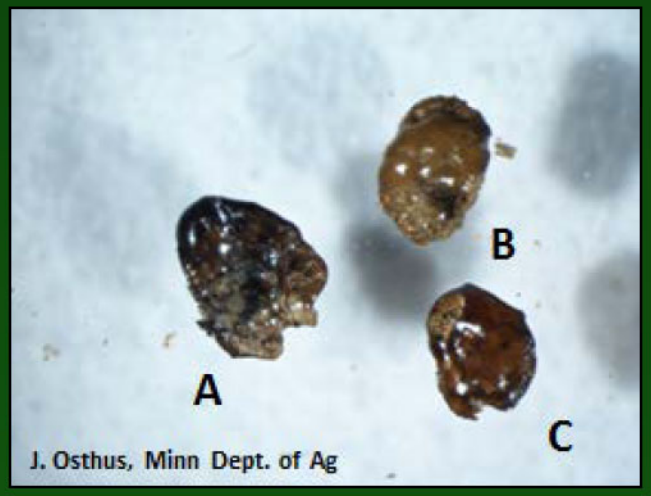
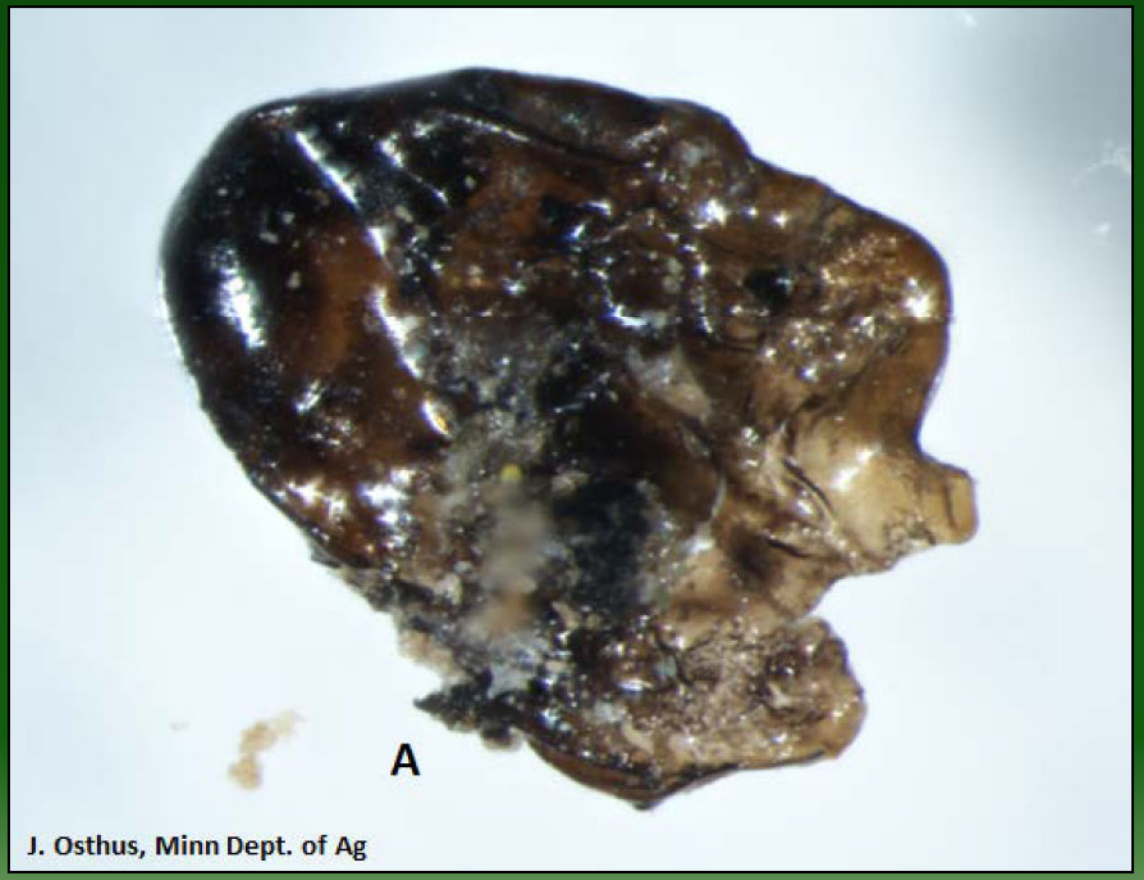
Which Egg is NOT Parasitized?



Egg A is NOT parasitized!



- Close inspection shows that Egg A is hatched
- **Sometimes EAB frass becomes dark**

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EAB Eggs Suspect for Parasitism

Santa promises gifts, then delivers coal…more EAB eggs that are suspicious, but are NOT parasitized


D. Miller, USDA Forest Service


D. Miller, USDA Forest Service


A. Hansen, Minn Dept. of Ag


A. Hansen, Minn Dept. of Ag

Minnesota Department of Agriculture

EAB Eggs Suspect for Parasitism Revealed

These eggs are all hatched with dark frass…NOT parasitized!

– frass marked with arrows

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Unusual EAB Eggs

Unknown organism chewed through EAB egg

EAB egg fragment with fungi

EAB eggs with faded coloration

**None of these eggs are parasitized

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EAB Egg Look-alike: Scale Insect

- Scale can be easily confused for EAB eggs
- Similar size and color
- Distinguished by pointed end (scale mouthparts), wavy margin, segmented body

Scale insect even also contain a tiny black parasitoid, meconium, and/or round adult parasitoid exit hole

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Scale vs. EAB Egg

Look for pointed end and other subtle differences to help distinguish

Fragments can be tricky

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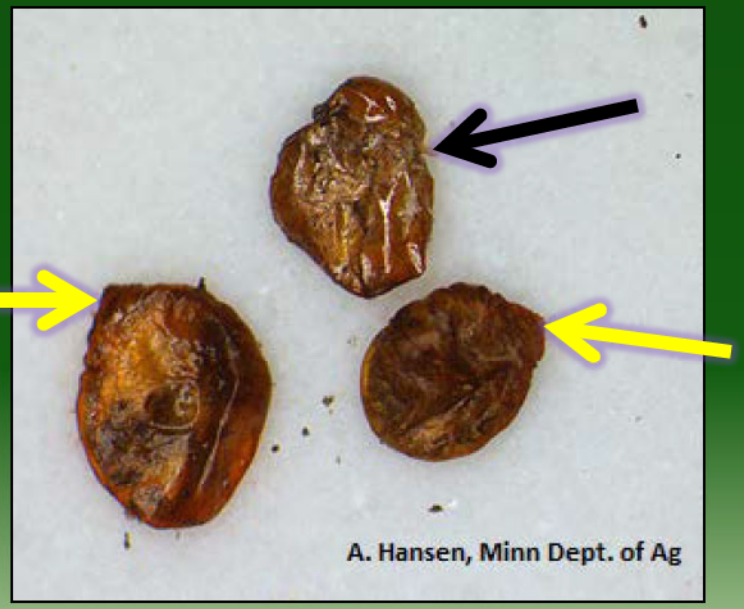
Scale vs. EAB Egg Revealed

Look for pointed end (yellow arrows) and other subtle differences to help distinguish scale from EAB eggs (black arrows)



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Misc.

- It is not unusual to find other eggs and arthropods in a debris sample. Collect what you find

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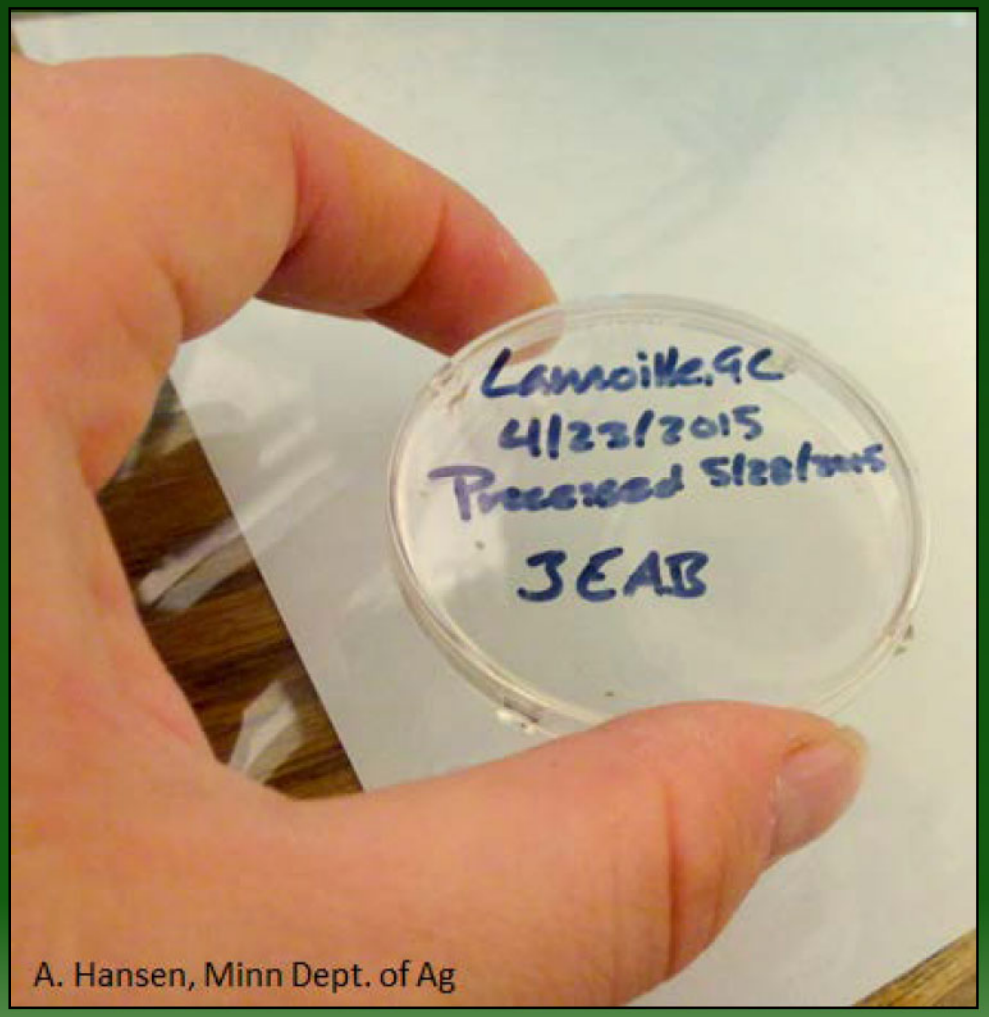
Wrapping Up

- Transfer collected eggs, fragments and arthropods into labeled vial or petri dish with friction fit lid
- Return sorted debris into container
- Store bark debris and petri dish in designated lab location



A. Hansen, Minn Dept. of Ag

Minnesota Department of Agriculture

Where Are Parasitoids Being Released?

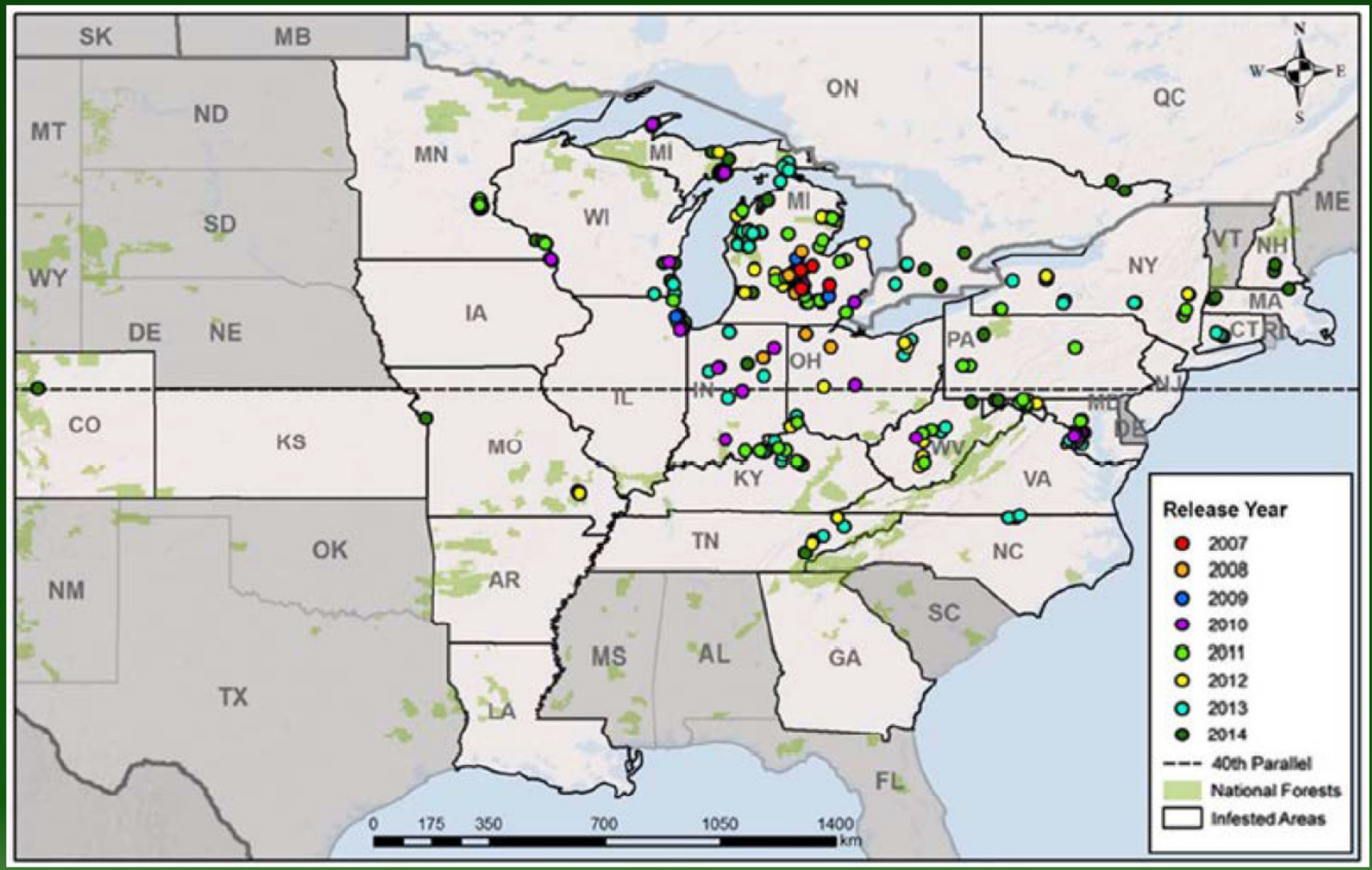


Fig. 1- Known distribution of emerald ash borer, *Agrilus planipennis , in North America as of February 2015 and the locations of EAB biocontrol agents.*. Map created by Applied Spatial Ecology and Technical Services, Department of Entomology, Michigan State University (East Lansing, Michigan, United States of America.

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Bauer et al., 2015

Acknowledgements

- Leah Bauer, USDA Forest Service
- Deborah Miller, USDA Forest Service
- Parasitoids were produced and supplied by the USDA EAB Parasitoid Rearing Facility in Brighton, MI

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- **Duan, J.J., L.S. Bauer, J.A. Hansen, K.J. Abell and R. van Driesche. 2012.** An improved method for monitoring parasitism and establishment of *Oobius agrili* (Hymenoptera: Encyrtidae), an egg parasitoid introduced for biological control of the emerald ash borer (Coleoptera: Buprestidae) in North America. Biological Control, 60: 255 -261. Duan et al. (www.nrs.fs.fed.us/pubs/40498)

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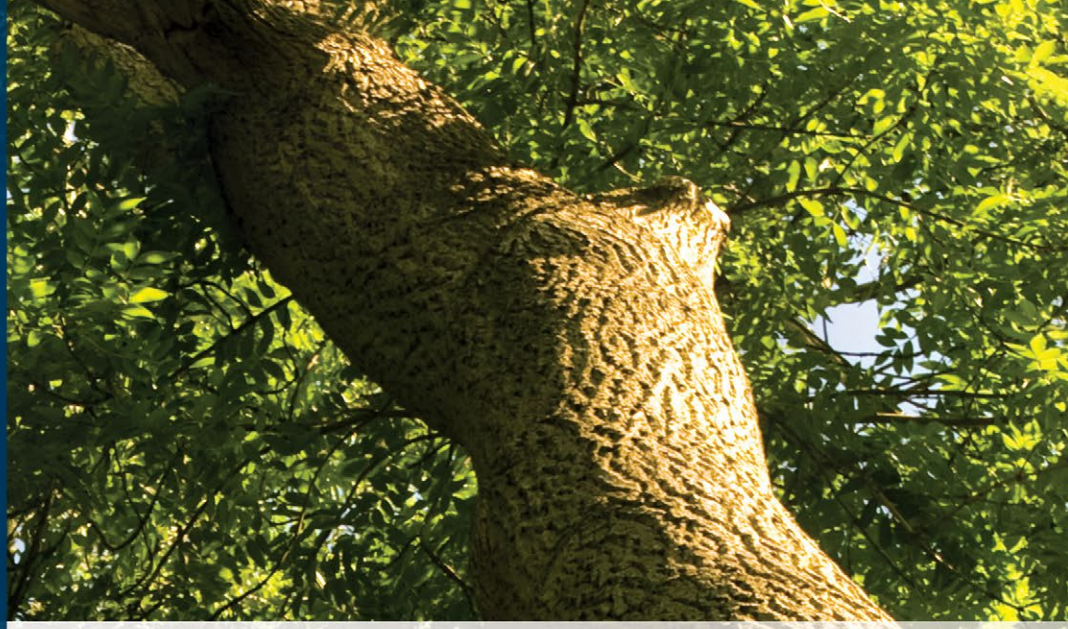
- **USDA APHIS, 2007.** The proposed release of three parasitoids for the biological control of the emerald ash borer (Agrilus planipennis) in the continental United States: environmental assessment. Federal Register 72, 28947–28948 (Docket No. APHIS-2007-0060). USDA APHIS (www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0060)

EMERALD ASH BORER

MANAGEMENT GUIDELINES

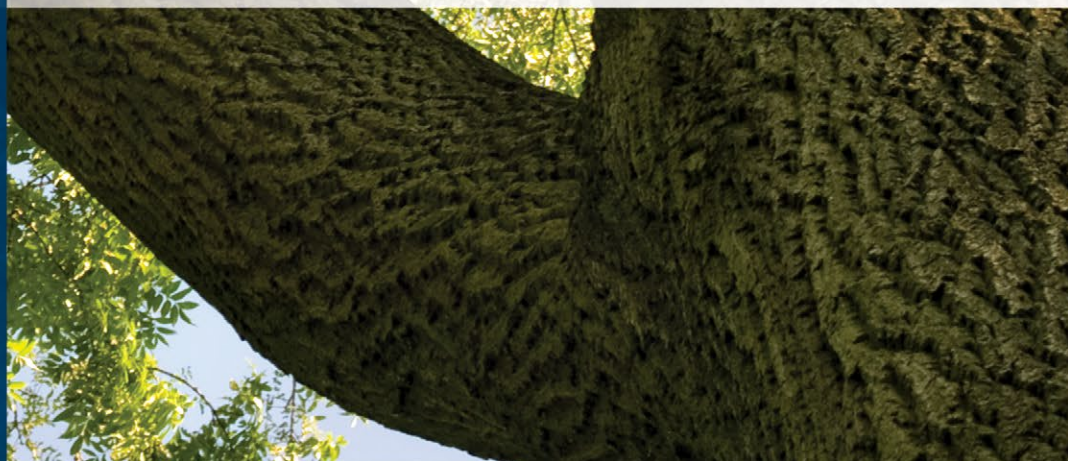


Background

Emerald ash borer (EAB), *Agrilus planipennis*, is an invasive wood-boring beetle first detected in the U.S. near Detroit, Michigan, in 2002. Since that time EAB has been responsible for killing millions of ash trees. All ash trees native to Minnesota are considered highly susceptible to EAB. Minnesota has about one billion ash trees in our forests and ash accounts for about 15 percent of trees in the average community (Natural Resources, 2010).

A single generation of EAB is completed in one to two years. Eggs are laid during the summer on trunks and branches of ash trees. Larvae hatch from the eggs and tunnel beneath the bark. Larvae make distinct “S”-shaped (serpentine) galleries and feed on the phloem of the tree. Larvae may spend the winter inside pupal chambers in the outer sapwood, bark, or in feeding galleries, and some larvae will feed for another summer before completing development. Adults emerge from ash trees through a distinct “D”-shaped exit hole during May through September. Upon emergence, adults will feed on ash leaves in the canopy before mating and laying eggs.

Trees are killed by continual insect larval feeding, and tree mortality accelerates as EAB populations increase in density. Although the beetle is capable of spreading to nearby areas through flight, the primary means of long distance EAB spread to new areas is through transport of firewood or other woody material from ash trees.



DEPARTMENT OF AGRICULTURE

CONTENTS

How to Confirm and Report EAB

To confirm that a tree is infested with EAB there must be at least one of these symptoms.

An "S"-shaped gallery visible underneath the bark of the suspect ash tree. There are many native insects that will make galleries under the bark of ash but none will be "S"-shaped.

EAB larva
Length up to ~1 inch

A larva pulled out from a suspect ash tree and identified as EAB. Emerald ash borer larvae look much like our other native flatheaded borers but they have a characteristic urogomphi, which look like small spine-like projection at the tail end of the insect.

EAB Adult
Length ~1/2 inch

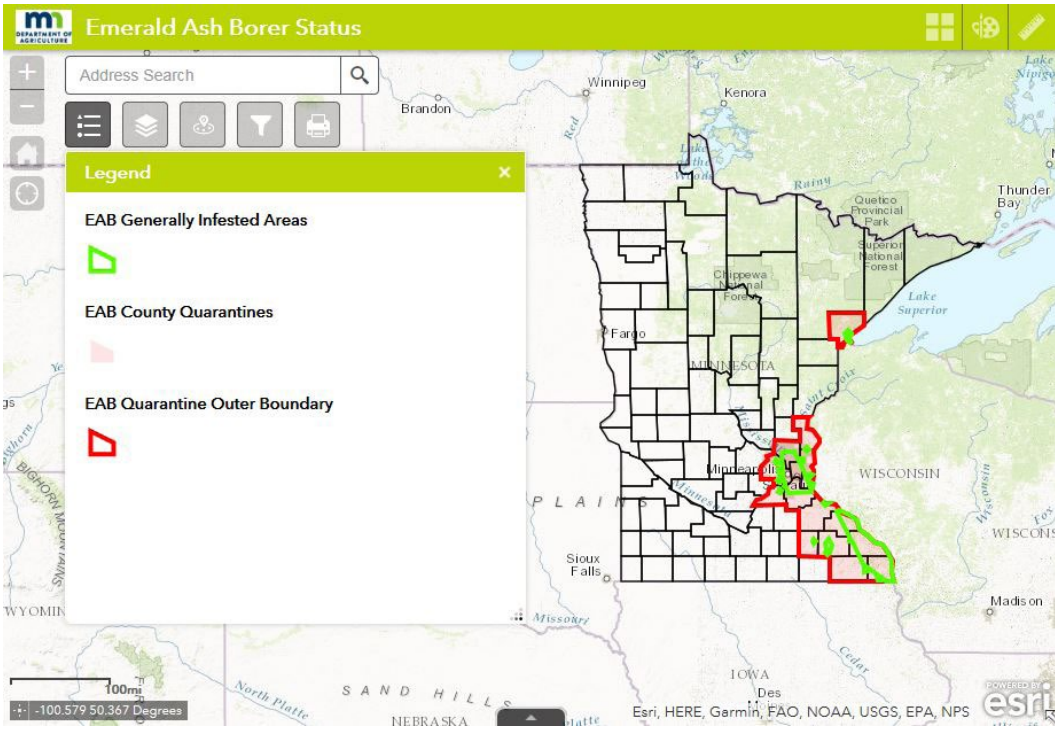
An adult EAB identified by the Minnesota Department of Agriculture (MDA) (see how to report EAB). This will be a very rare occurrence. Adult insects are not commonly seen except in areas of high insect pressure.

A "D"- shaped exit hole; however, if you think you have this, you should peel back the bark of the tree and make sure you can find the "S"-shaped gallery. "D"- shaped exit holes are easily misidentified. Only peel back bark when and if the tree is on your property or you have the permission to do so.

If EAB is suspected in a new area (town or city) of an already quarantined county, gallery photos and/ or samples of larvae, adult insects and/or photos may be submitted to the MDA for identification. This allows us to keep our online map updated and allows the public access to this information.

EAB does not need to be reported to or identified by the MDA in areas that are considered generally infested (these are areas where EAB is already known to occur). These generally infested areas are outlined in green on our online map.

Visit the MDA EAB webpage to **view a map of EAB finds in Minnesota.**



There are two main ways to report EAB to the MDA: Arrest the Pest and the Great Lakes Early Detection Network Application (GLEDN App) which is free for iOS and android smart phones and tablets.

GLEDN App: The GLEDN App is the easiest way to report EAB and other invasive species. It is designed so that all the necessary information can be taken from the field and sent to a verifier; the MDA in the case of EAB. The app allows you to take a GPS point of the location and take a picture of the insect or insect damage to send to the MDA. Your contact information is also sent so the MDA can follow up or make a confirmation quickly.

The GLEDN App also allows you to see locations of past reports of EAB while in the field. This is a helpful tool to track EAB infestations reported within your community, as well as monitor management activities such as chemical treatments and removals.

Photographing EAB

Pictures should focus on definitive symptoms of EAB. A picture of a standing ash tree will not give enough detail to identify EAB. Try to get a picture of an EAB insect gallery, EAB larva, adult beetle, or woodpecker damage (if taking pictures of woodpecker damage, try to get clear close-up pictures if possible)

**Reminder – If you think the symptoms of the tree you are reporting were caused by EAB and definitive symptoms are not present please make sure to look at other ash trees in the immediate area.*

If a clear, focused photo of symptoms is not possible, then detailed notes on the location and type of damage are very important.

Arrest the Pest: Go to **www.mda.state.mn.us/arrestthepest** for instructions. You can email at **Arrest.the.pest@state.mn.us** or call and leave a detailed message at 888-545-6684 and a specialist will get back to you. You can also submit a sample. Request a prepaid envelope from the MDA to mail in submissions. Information to submit to Arrest the Pest:

- **Pictures of suspect trees:** Pictures should be as detailed as possible and show individual symptoms rather than the whole tree. If possible, take pictures of individual woodpecks or a gallery.
- **Location of suspect trees:** Address or GPS coordinates. Either is acceptable. Also include details of location within property; including any landmarks or other features to help easily identify suspect pest location.
- **Contact information of reporter** so that the MDA can contact you if we need further clarification.

Planning for EAB

Preparing for EAB before it has been identified in your community or in close proximity is a key component of EAB management and maintaining overall tree canopy. If communities are prepared, the inevitable impact from EAB may be spread over many years as opposed to a relatively short amount of time.

Inventory

Having a tree inventory is essential to general planning and estimating the costs associated with EAB. At minimum an inventory should include species, location information, size class and condition of the tree. If a complete tree inventory is not available you should at least have an inventory of ash trees. With this information predictions can be made about how the community will be impacted by the loss of all ash trees. It is also important, if possible, to make note of the ash population on private property and in natural areas.

Detection

Early detection of EAB will allow for more management options rather than just widespread tree removal and also results in more time to manage the trees and spread the cost over a longer period of time.

Costs to consider

Removal – EAB will eventually kill most ash trees and these trees will have to be removed. Removal costs will vary depending on the size of the tree. Delaying removal of infested trees will increase costs as dead ash trees become brittle and hazardous.

Disposal of material and utilization – Ash material will have to be taken to a disposal site. State quarantines prohibit the removal of ash material out of quarantined areas without a compliance agreement. Residents should be made aware of the restrictions of wood transportation and encouraged to dispose of wood near its origin.

Insecticide treatments – Treatments for EAB can be both therapeutic and preventative. Costs will vary depending on the size of the tree. There are many benefits to having large ash trees in the environments and preserving the forest canopy. Homeowners may also be interested in treating public boulevard trees. Managers should develop a method to track treated trees within the community. Treatments can also be used to delay the cost of removal.

Reforestation – Decline in ash tree populations will require planting new trees to restore the lost canopy. It would be best to use this as an opportunity to further diversify the urban forest and plant in a purposeful and strategic manner.

For more information regarding estimating future costs or EAB, Purdue University has developed a cost calculator. It can be found at: **http://int.entm.purdue.edu/ext/treecomputer/**

Private trees

Trees on private property will have to be a part of the overall EAB management. Private trees that are not treated will eventually succumb to EAB and will need to be removed if and when they become hazardous. Some communities already have a diseased tree ordinance in place for managing Dutch elm disease and oak wilt that can be amended for EAB management. It will be up to managers to decide if there are enough resources to take action when private trees are identified as infested.

Training/Outreach/Education

Having citizens and forestry staff who are informed about EAB and its symptoms will assist in identifying EAB populations within your community. Supplying education and outreach to residents will allow homeowners to start thinking about what to do with their own ash trees when EAB arrives and be aware of the management options available. Some residents may want to begin insecticide treatments or remove and replace trees in advance of EAB which can benefit the overall tree canopy.

Detection Methods

In order to effectively manage EAB, you will need to know where it is. Opportunities for management decrease over time as trees begin to die. It is beneficial to be proactive and detect EAB in the early stages of infestation. There are multiple methods to do this and each method requires different labor inputs and yields different information. The method chosen will depend on specific management goals.

VISUAL SURVEY

When trees are lightly infested with emerald ash borer, it's unlikely there will be any visible signs of infestation on the exterior of the tree. In contrast, trees that are heavily infested with emerald ash borer are likely to display many signs of infestation including canopy thinning, damage caused by woodpecker foraging, and loose, splitting bark.

Impacts to the canopy of a tree from EAB will not be apparent until the density of larvae within the tree is relatively high with many tunnels in the stem of the tree. At this point, it may be too late to save the tree with insecticide treatments. However, other visual symptoms such as woodpecker foraging and loose, splitting bark can often be found well before EAB levels are high enough to impact the canopy.

EAB infestations tend to begin in branches, and as more larvae infest branches they are more likely to be discovered as a food source by foraging woodpeckers. This provides an opportunity to spot the damage left when EAB levels in a tree are still relatively light and generally limited to branches and upper stems. Likewise, loose bark splits may also form during this time, providing another sign that a tree may be infested with EAB.

While neither of these symptoms is diagnostic for EAB, there are characteristics particular to each that may increase suspicion that the damage is related to EAB.

The MDA has a "How To" video on visual survey techniques available at: **https://youtu.be/Bq9mZKy-3Ao**

What to look for when conducting a visual survey:

**While these symptoms are present year round, it is best to conduct visual surveys in the late winter or early spring when leaves are absent from the trees. Woodpecker activity also increases in the early spring so there is likely to be more visual signs at this time of year.*

Woodpecker damage – When woodpeckers forage on ash trees they generally knock some of the outer bark off of the area they are pecking, thereby exposing the lighter colored inner bark. These areas of lighter bark are noticeable from the ground and indicate areas where closer inspection is needed. However, it is good to note that black and white ash trees tend to display less contrast for the lighter colored inner bark compared to green ash trees due to the differing bark texture. This can lead to woodpecker damage being less noticeable at earlier stages in black and white ash trees.

When woodpeckers forage on EAB, they peck a dime to quarter-sized hole through the bark and to the surface of the sapwood. If these holes are not present, it is unlikely that woodpeckers are foraging on EAB or other insects beneath the bark of the tree. Sometimes trees have areas of outer bark that appear to have been knocked away by woodpeckers but there are no holes through the bark. There are a number of possible reasons why this could happen including woodpeckers exploring trees for insects, squirrel activity, smooth bark pathogen, weather, or other unknown causes. The important point for EAB monitoring is that woodpecker foraging on EAB should leave behind light colored holes that go through the bark and to the surface of the wood.

Once it has been determined that woodpecker foraging with holes created through the bark is present, the only certain way to identify whether it is EAB is to view the tunneling left by the insect. This can be done by finding an area where enough bark has been removed already or removing some bark to enlarge the hole left by a woodpecker (see How to Confirm EAB for more information on insect tunneling in ash).

Some characteristics make it apparent that the woodpeckers were foraging on native insects and not EAB. Native insects typically infest trees that are in obvious decline, or they may infest discrete areas of trees in decline such as dead branches, areas around wounds or near large pruning cuts. The occurrence of one of these factors is an indicator that the insects being predated are native insects and not EAB. Another indicator is the appearance of the holes left behind by woodpeckers. Wood in areas where native insects have been active is often stained dark in color, either from the decline of the tree or from organisms introduced by the insects. As a result, the woodpecker holes over these galleries will also appear dark. In contrast, EAB can generally be found tunneling in healthy trees and in wood that is not stained dark. As a result, woodpecker holes over EAB galleries will often appear light in color with the white wood visible through the woodpecker hole. EAB does not tunnel deeply into the wood of a tree like some native insects do, so large, deep holes in the wood can be excluded as indicators of EAB.

Bark Cracks – Another early EAB visual symptom in the canopy of ash trees are bark cracks. As the tree is initially attacked, the tree tries to heal around the larval gallery area and keep growing. As the branch continues to grow it forms callus tissue around the gallery and the bark will begin to crack open. When the crack becomes large enough you may be able to see the gallery with a pair of binoculars.

***Note on removing bark**

Removing bark from a healthy area of a tree destroys food and possibly water conducting cells (if the outer wood is also damaged) in that area of the tree and also provides an entry point for pathogens. Areas in trees where insects have tunneled and woodpeckers have created holes through the bark have already sustained this injury and removing an additional small amount of bark will probably not add significant injury. However, bark missing from trees will attract the attention of other people who may not appreciate this argument and so you should never remove bark from a tree that you do not have authority or permission to sample in this way.

If an EAB gallery is present, bark should come off the tree relatively easy when pried up. This is due to how EAB feeds under the bark. If you are having to struggle to remove the bark, the damage is likely not caused by EAB

Note on Binoculars

While the light colored patches of inner bark are generally noticeable to the naked eye, determining whether or not woodpecker-created holes are present may require binoculars. Binoculars with greater magnifying power work better, but keep in mind that as viewing power increases the sensitivity of the view to movement also increases (it's hard to hold the binoculars steady enough). The MDA has had good success with binoculars offering 16 power (images magnified 16 times). The light gathering ability of binoculars is important as well, and generally the more light the better. Binoculars are generally labeled with both values, for instance, 10 x 20. This means that the binoculars will magnify images 10x and the diameter of the objective lens is 20 mm (wider lens = more light). The trade-off is that binoculars with greater power and light gathering ability will generally be bigger and heavier and more difficult to use.

There are characteristics associated with EAB in addition to woodpecker feeding damage and bark cracks, which can be seen while conducting a visual survey. While these things may in fact be present, they are not valuable indicators of EAB as they may be caused by many different things or are extremely difficult to see.

Canopy Thinning – Canopy thinning is typically a symptom that occurs after woodpecker damage and bark cracks can be seen, usually around the fourth year a tree is infested. The top canopy will have a general thinning to it, not a leafless branch.

Epicormic Sprouting – Epicormic sprouting is often seen on ash trees that are stressed in general. However, sprouting within the lower canopy of the tree is often seen with EAB infestations. This is the least reliable visual symptom for EAB.

Loose splitting bark

"D"-shaped Exit Holes – Unless you are working in the canopy of the trees, you will not see "D"-shaped holes until much later in the infestation. There are also many native insects attacking ash trees that make oval shaped holes of similar size. Looking for "D"-shaped exit holes is not a good use of your time when conducting visual survey.

How visual survey can be beneficial to managing urban environments:

Visual survey is an efficient way to detect EAB before impact to the canopy occurs. This is also the most economical method to find EAB. The MDA has observed that visual survey takes about 20 percent of the time it takes to branch sample a given area. The MDA has also noted that the difference of EAB detection between branch sampling and visual survey is rather small. Branch sampling can detect EAB at a lower density when no outward symptoms are present; however, in most cases trees infested with EAB will have some visual symptoms. It is also important to note that trees in an infested area will have varying degrees of EAB density, meaning that some trees are likely be at the level where woodpeckers have begun to forage and feed on EAB. Depending on the management goals, the value of knowing where EAB is may outweigh knowing exactly how many trees are infested in that area. For these reasons, if the goal is to detect EAB before canopy decline with the least amount of resources and time, visual survey is the best method to use.

How visual survey can be beneficial to managing woodlots and forested environments:

Management options are limited in woodlots and forest stands. Outside of biological control of EAB and cold mortality, there is no practical way to protect trees in these environments as EAB gradually spreads. As a result, the main goal for these areas will be to remove or harvest ash trees before they succumb to EAB and become hazardous. Visual survey will allow for the detection of EAB before this happens so that infested trees can be removed earlier and labor costs can be spread out over time.

BRANCH SAMPLING

Branch sampling is a technique that can be used to identify EAB infestations in trees that are free from external symptoms - making it the most sensitive method for EAB detection. This detection method involves removing two healthy limbs from ash trees and removing the bark to look for the presence of EAB larvae or feeding galleries. While branch sampling is sensitive and capable of early detection, it is very labor intensive and the results may not justify the added labor over other methods. Branch sampling can also be used to aid in estimating the density of an EAB infestation; however, this information may not be pertinent to managing the infestation.

How to process a branch sample:

Bark needs to be removed carefully down to the sapwood where EAB feeds. The best way to do this is by peeling the bark off in thin layers from the outer bark through the inner bark. The most common mistake when removing the bark from a branch sample with a draw knife is to not go deep enough. If the sample was recently cut this can be distinguished by a thin layer of moisture that is present when you reach the correct depth, as well as a change in texture.

A tree can be identified as positive when an EAB gallery or larva is uncovered. Depending on one's management goals, determining the density of EAB in a sample could be important. This is done by calculating the surface area of each sample and the amount of EAB galleries present. If the goal is to simply determine if a tree is infested, peeling can stop once one gallery is found. This can save time. It is important to note that other insects can leave feeding galleries, but the serpentine "s" gallery is unique to EAB in ash trees.

Things to consider before branch sampling:

- Is there enough staff time available for such work? Is there storage space available for the samples? Are there potential student worker/intern resources available?
- Keep in mind that sampling 50 trees will create 100 branches that will need to be peeled and documented for presence of EAB.
- Estimate of labor hours needed to sample 50 trees and peel 100 branches = 50 hours
- Intensity level of EAB Infestation in area (low, moderate or high)?
- If known, is it worthwhile in terms of potential management outcomes? If infestation levels are already moderate to high in the surrounding area, then the potential to positively impact management may be too late or the resources may be better used on future management rather than detection.
- Will results lead to targeted management?
- Are the results going to be used to influence the way a specific location is managed?
- Targeted removals or insecticide treatments? If no, then branch sampling may not be worth the time and resources as it won't impact forest management objectives.

Define area to be sampled:

To begin preparing your branch sampling plan, decide the following:

Define the geographic area being targeted for sampling:

- Entire city – EAB is not known to be in area or adjacent communities.
- High risk neighborhood(s) based on – proximity to nearby infestations, ash density, or types of businesses (areas with wood products, land clearing and firewood industry).
- High value areas – areas where ash is highly valuable to canopy coverage.
- County level – Parks, campgrounds, main travel corridors, high ash density, proximity to nearby infestations, etc.

Define the intensity of sampling:

Example: Grid based approach – create a grid using ArcGIS based on the intensity of sampling to be completed. (ex: place ½ mile x ½ mile grid over entire city) modify it until desired level of sampling is reached based on available staff resources.

Other Options:
Spot sample ash trees while performing other work such as trimming or removals. Have employees take a closer look while doing other work in the canopy of ash trees. This can be accomplished by peeling away bark if woodpecker damage or bark splits are noticed while pruning or removing a tree. Take a picture or collect a representative sample of the damage.

Recommended characteristics when selecting trees to sample:

- Open grown, semi-mature trees
- 8-20 inch DBH
- Two branches per tree from mid-crown (cut branch at the base)
- Branches are minimum of 2-3 inches diameter (4-5 inch diameter preferred)
- Branches have rough bark opposed to smooth bark
- Branches are taken from the south/southwest facing side of tree if possible (part of tree that receives the most sunlight)
- Branches are a minimum of 20 inches in length (30-40 inch lengths are best size for handling when peeling)

* Remember that the goal of branch sampling is to detect EAB, not to prune the ash tree. Take the best branches possible based on the criteria listed above and consider the tree being sampled as sacrificial to the goal.

Timing of branch sampling:

October 1 through April 1

*not recommended to fell, trim or sample ash trees during the summer due to risk of spreading EAB through movement of infested materials.

Tools/Equipment needed for this method:

- Bucket truck/pole saw/rope saw
- Chainsaw/ hand saw
- Drawknife
- Pocket knife
- Table vice/other with ability to hold branch in place

How branch sampling can be beneficial to urban environments

Branch sampling can be a valuable tool if finding EAB early will direct how the infestation is managed. For example, a management plan may involve insecticide treatments of healthy ash in an area once EAB is discovered. Branch sampling has the potential to detect EAB before the canopy is impacted resulting in a greater number of trees where treatments are viable.

** It is important to note that while branch sampling is the most sensitive tool available for detecting EAB, it is only 75% accurate. There is still a 25% chance that the sampling results will produce a false negative if the branches sampled happen to not contain EAB galleries even though the tree is infested*

How branch sampling can be beneficial to woodlots and forests

Due to the large labor costs compared to visual survey and the management goals associated with these

environments, branch sampling is not often the most practical method of detection. Resources would be better spent on planning for tree replacement and tree removal once EAB is detected with visual survey.

BIOSURVEILLANCE

Smoky winged beetle bandit wasp, Cerceris fumipennis, is a native, stingless wasp that preys on EAB and other similar beetles. The University of Minnesota Extension is working to use this wasp to detect EAB by monitoring wasp colonies and collecting beetle prey from the wasps. Beetles are intercepted from the wasps or found near nests by volunteers during the summer months.

For more information on this program visit: **www.myminnesotawoods.umn.edu/eab/waspwatchers/**

PURPLE TRAPS

Trapping for EAB involves placing prism traps in the canopies of ash trees during the EAB flight season. Traps contain a lure to attract EAB and are coated in a sticky substance. Adult EAB flying around the canopy get stuck to the outer surface of the trap. The US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) coordinates the placement of traps in counties that are not infested with EAB. These traps are useful on a state or county level but are not designed to detect EAB in a way that will help manage the insect and forest.

Minnesota municipalities on average have 20.3% ash in their urban forest, with percentages ranging from 0.2 to 59.6 based on a 2010 MN DNR Community Tree Survey. There is no stopping EAB from

Management Tactics for Municipalities

spreading to every municipality in Minnesota; however, actions can be taken to slow EAB's spread through a city and manage the ash resource. There are a variety of management options available which can be combined to cater to each individual municipality with or without EAB infestations. Management options include best management practices, surveys, removals, chemical treatments, outreach, and reforestation. The MDA encourages municipalities to manage EAB; however, it is not a requirement.

Best Management Practices (BMPs)

The MDA has prepared Best Management Practice (BMP) recommendations for when to perform work on ash trees. It is recommended that no work be completed on ash trees during the EAB Active Period: May 2 – September 30. This helps reduce the risk of EAB spreading during transportation, and will provide habitat for EAB adults to lay eggs that will be destroyed during the dormant period. Note that trees damaged in storms or hazardous trees can be removed at any time to prevent damage to property or persons.

If possible, perform maintenance on or remove ash trees during the EAB Dormant Period: October 1 – May 1.

For more information on EAB BMPs visit **www.mda.state.mn.us/eab**

Ordinances

The Shade Tree Pest Control Ordinance can be applied to EAB infested trees. Please remember that the MDA does not require municipalities to enforce any ordinance. More information on preparing a Shade Tree Pest Ordinance can be found on the League of Minnesota Cities website **www.lmc.org**.

Municipalities that enforce a Shade Tree Pest Ordinance will condemn trees that have a visible EAB gallery, an EAB larvae, or an EAB exit hole. Some municipalities allow private property owners to treat condemned trees if they are lightly infested and still have a healthy canopy.

Visual Survey

The MDA and the University of Minnesota (U of M) have determined through a three year study that visual survey is the most time and cost efficient way to find EAB infested trees at varying population densities is through visual survey in the late winter and early spring. The study compared three survey techniques used in the field; visual survey for woodpecker damage, purple prism traps, and branch sampling. They found that visual survey took 12-24 minutes to find a positive tree compared to 3.5-3.6 hours by branch sample and 4.3-5.4 hours by purple prism trap. With basic training, municipality staff

can easily identify EAB infested trees using a pair of binoculars to look for woodpecker damage. (See Detection Methods: Visual Survey for more information)

Removals

The MDA and the U of M also determined that removing trees with EAB woodpecker damage showed a larger decrease in the beetle production per removed tree in a four year study in the Twin Cities Metro. By removing ~ 63% of the total ash trees in the study area over four years, there was a ~54% reduction of the cumulative number of beetles produced. Only removing EAB woodpecked trees will allow fewer removals over a longer time period which can buy time for other management strategies to be implemented and place less strain on budgets.

Examples of removal options: poor quality ash trees, EAB woodpecked public ash trees, EAB woodpecked private ash trees, ash trees regardless of quality or EAB, hazardous/dead ash trees.

Insecticide Treatment

Insecticide treatments can be started before EAB is in the area, after an initial detection in the municipality or after a tree is lightly infested. When treatments are applied correctly they will protect the tree from EAB and they will need to be repeated. Trees that have 50% or more of the canopy in good health are candidates for chemical treatment. Any ash tree that is not treated can be infested by emerald ash borer and die.

There are many options available to chemically treat trees which are described in the Insecticide Options for Protecting Ash Trees from EAB produced by the North Central IPM Center. Note that certain chemicals require a Pesticide Applicator License from the MDA.
www.extension.umn.edu/garden/insects/find/emerald-ash-borer/docs/ncbipm_eab_insecticide_bulletin_2nd_ed_may_2014.pdf

A homeowner version of treatment options is available at **www.mda.state.mn.us/eab**.

Municipalities can perform insecticide treatments in–house or contract with a private company. Municipalities working with a contractor have the potential to offer private property owners the municipality's discounted rate. A free permit is typically issued by municipalities when private residents pay for the treatment of public ash trees on their property. In some cases, in-house treatment rates can be lower than contracted rates. One municipality was able to get their in-house treatment rate to $4.77 per diameter inch, which included licensing, wages, benefits and equipment costs. Contracted treatment rates vary but are typically around $6.00 per diameter inch.

Insecticide treatments can be used to maintain the current tree canopy while waiting for reforested tree species to grow or removals can be planned. This prevents widespread ash mortality that may overwhelm the municipality's available resources.

Examples of treatment options: public boulevard trees, public park trees not in forested areas, private treatment of public trees, private property trees at contracted rate.

Combinations

Many municipalities are combining management tactics by removing unhealthy (non-EAB infested) ash, removing EAB infested ash showing woodpecker damage, and chemically treating healthy mature trees. Below are examples of management activities at cities in Minnesota. Again, the MDA does not require municipalities to perform any management of EAB.

MANAGEMENT ACTIVITY EXAMPLES			
REMOVAL	City A	City B	City C
Poor quality public trees	Yes	Yes	Yes
Public woodpecked boulevard trees	Yes	Yes	Yes
Public woodpecked park landscape trees	Yes	Yes	Yes
Public woodpecked forestland trees	Only hazards	Only hazards	Only hazards
Private woodpecked trees (Shade Tree Pest Ordinance)	Within a specific distance of adjacent property		Yes
CHEMICAL TREATMENT	City A	City B	City C
Mature public boulevard trees	In-house		Contract, high-value
Mature public park landscape trees	In-house		Contract, high-value
Mature forestland trees			
Private mature trees			Contract rate
Privately funded public boulevard trees	Yes		Yes
Private mature trees lightly infested	Yes		Yes

Do Nothing

Municipalities do have the option to do nothing; however, dead ash trees become hazardous and will eventually require removal to ensure public safety.

Outreach Efforts

Educating citizens should be considered by every municipality even if they are not actively managing EAB to prevent spread. Movement of infested wood is a leading cause of EAB traveling long distances in short periods of time. EAB adult beetles do not travel a significant distance each year on their own, but a person can easily move infested firewood hundreds of miles in a day.

Examples of outreach efforts: tree signs/wraps, water bill inserts, postcard mailings, press releases, posters, educational tables at municipal functions, or presentations at public meetings.

Reforestation

Species diversity is essential in reforestation efforts to prevent widespread mortality from future pests. A guide to recommended trees for Minnesota by region can be found on the My Minnesota Woods website. **www.myminnesotawoods.umn.edu/2008/11/recommended-trees-for-minnesota-by-region/**

Tree sales are another way to reforest the urban canopy through private residents purchasing wholesale priced trees and shrubs. Tree sales are run by counties, cities, non-profits, gardening groups, soil and water conservation districts or other entities. The sales typically take place in the spring and can be comprised of bare root, container or air pot trees and shrubs. Trees purchased through the sales are typically planted on private property; however, some cities allow plantings in the public boulevards. Depending on the entity holding the sale, residents may also purchase trees and donate them to a municipal park.

Management Tactics for Woodlots and Forested Areas

Minnesota has a vast number of ash trees outside of urban environments located in woodlots and forested regions of the state. Biological control is one practical landscape-level management option. There is no way to stop EAB from spreading throughout the state or a way to protect all of these trees. Although it may take many years for EAB to spread, if you have ash trees on your property, it is time to start planning for a future with fewer ash trees. However, planning ahead and managing the ash resource before EAB arrives will help keep your forest healthy and resilient.

For more information on managing ash in a forested setting visit: **www.myminnesotawoods.umn.edu/2011/07/emerald-ash-borer-and-your-minnesota-woodlands/**

Biological Control

Biological control of EAB was initiated in Minnesota in 2010 and remains the most practical landscape-level management option. Three parasitoid wasp species are being released in Minnesota. Two species attacks the larval stage of EAB under the ash bark. The other species kills EAB eggs that are laid in bark crevices. These wasps are small like gnats and do not harm humans. They were selected by the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) and Forest Service and tested extensively to ensure that they will not negatively impact other species or the environment. APHIS rears these biological control agents at a specialized facility in Brighton, MI and provides them to states with EAB infestations. Program implementation includes EAB detection, site assessment, and parasitoid release and recovery.

Assessment of EAB Infestation

Not all sites fit the criteria for biological control. Once an EAB infestation is positively identified, several activities need to be completed to determine if biological control is viable:

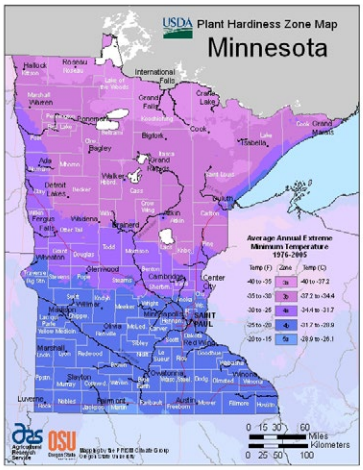
- Perform a delimit survey of the infestation to identify the perimeter of where symptoms are visible.
- Gauge the intensity or pest pressure in the area based on severity of EAB symptoms throughout the identified visibly infested area. Low to moderate EAB densities are recommended for potential sites. It is important that there are enough EAB for the parasitoids to feed on and there are enough living ash trees to sustain the populations over time.
- Identify forested areas on public or private land within the visibly infested area where removal and/or treatment of infested ash trees will not be feasible. Size and composition of forest should be at least 40 acres and at a minimum include 20% ash of varying size class. Ideally, the site would be greater than 25% ash and connected to other woodlots.

Coordination

After a viable biological control site is identified, coordination by the MDA with local natural resource managers, property owners and the USDA EAB Parasitoid Rearing Facility are necessary. At each site, one has to obtain permission, guarantee access and ensure other management objectives won't interfere with implementation. Special permits may be necessary depending on the ownership and designation of land. Long-term site access is important for follow-up monitoring of ash health and documenting parasitoid establishment.

EAB Cold Hardiness

Parasitoid Recovery



After parasitoids have been released, it is important to recover some to confirm that populations are overwintering and reproducing. There are multiple ways to recover parasitoids from release sites.

For more information on biological control of EAB in Minnesota; including parasitoids, release sites and recovery locations, visit MDA's biocontrol webpage:
www.mda.state.mn.us/plants/pestmanagement/eab/eabbiocontrol.aspx

The MDA, the US Forest Service, and the University of Minnesota partnered to study the winter hardiness of EAB larvae. Minnesota had a very cold "polar vortex" winter during the study period and an article was written regarding the effects on EAB titled "Cold snap is no snow day for emerald ash borer management" on January 31, 2014.

Article Summary

Emerald ash borer (EAB) causes problems when it becomes very abundant in an area. Populations grow slowly until they reach a "tipping point" after which they can grow very rapidly – killing many trees in a short time (1-3 years). We have found that some EAB larvae begin to freeze and die when temperatures within trees reach -20°F and that survival is very unlikely when temperatures reach below –30°F. In areas where the coldest winter temperature is generally warmer than -20°F, cold mortality is unlikely to have much or any impact on the population increase of EAB. In areas where the coldest winter temperature is generally between -20°F and -30°F, cold mortality may delay the increase of EAB to levels that kill trees, but EAB should still be expected to reach tree-killing levels. In areas where the coldest winter temperature is generally colder than -30°F, cold mortality may have a major impact on population increase of EAB – perhaps to the point of constraining populations below tree-killing levels. We cannot confirm this right now, but we are working to answer this question. Winter mortality should slow EAB population growth in these areas but it is probably not enough to justify changing management plans. EAB populations will likely recover and should still be expected to grow to tree-killing levels.

The entire article can be viewed at:
www.nrs.fs.fed.us/disturbance/invasive_species/eab/control_management/cold_hardiness/bp-EAB-and-extreme-cold.pdf

UNIVERSITY OF MINNESOTA EXTENSION

Wasp Watchers Program

In Partnership with: MINNESOTA DEPARTMENT OF AGRICULTURE With Support from: ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

WASP WATCHERS

2015 Field Report

By Jennifer Schultz, Wasp Watchers Coordinator

VOLUNTEERS

Volunteers are the heart and soul of any citizen science project and Wasp Watchers is no different. We couldn't do what we do without the passion, expertise, and commitment of volunteers. Thank you.

Students from Urban Roots helped conduct EAB biosurveillance in St. Paul.

VOLUNTEERING IN NUMBERS:

Over 50 Wasp Watchers volunteer worked on the project of EAB biosurveillance through Wasp Watchers this season. Some volunteers helped by scouting their communities for new Cerceris wasp nesting sites and some volunteers adopted known Cerceris sites to conduct biosurveillance and collect buprestid beetles from the wasps.

Over 160 volunteer hours were committed to EAB biosurveillance with the help of the *Cerceris fumipennis* wasp.

Volunteers were from 11 different counties: Aitkin, Anoka, Benton, Chisago, Crow Wing, Dakota, Goodhue, Hennepin, Olmstead, Ramsey, and Washington.

NEW CERCERIS SITES

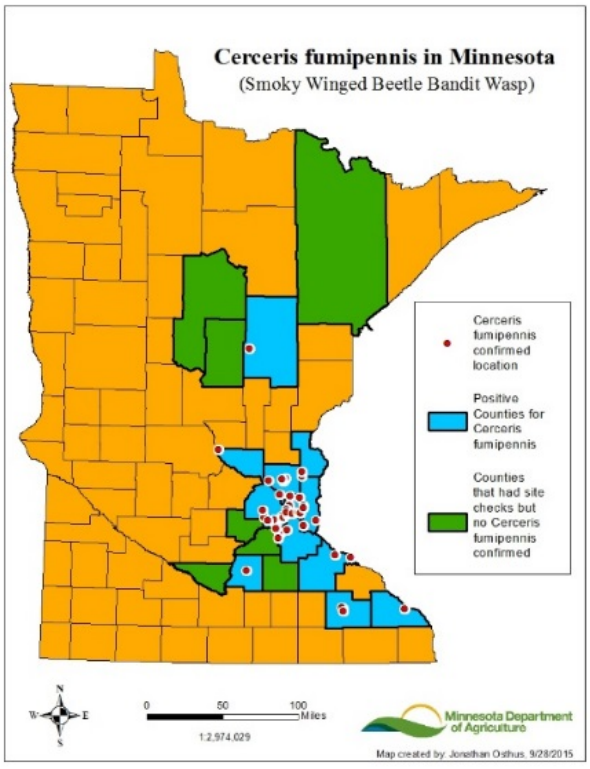
In the summer of 2015, 88 new sites were scouted in 27 different cities in 11 different counties around the state of Minnesota.

13 new or confirmed Cerceris sites were discovered in Lakeville, Eden Prairie, Wyoming, St. Paul, Afton, Frontenac, Red Wing, St. Cloud, Eagan, Wayzata, and Aitkin.

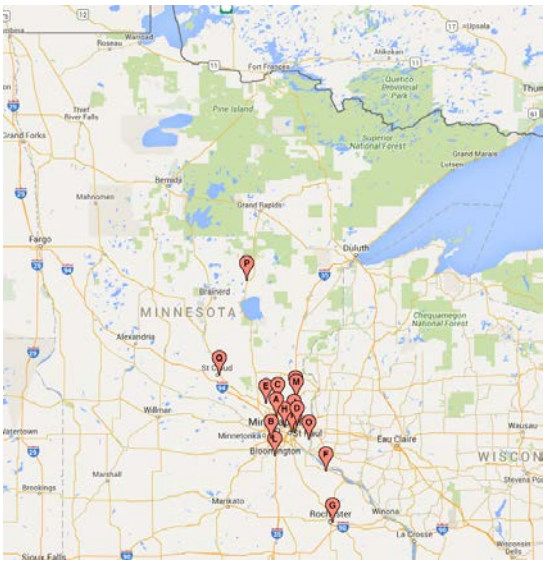
KNOWN CERCERIS SITES

Currently there are 31 known Cerceris sites, with 15 additional sites of interest (unconfirmed or past Cerceris sites).

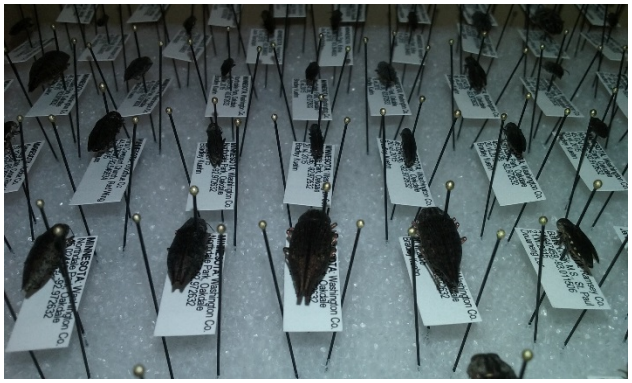
Currently, confirmed Cerceris sites are found in 11 counties: Aitkin, Anoka, Sherburne, Chisago, Dakota, Goodhue, Hennepin, Le Sueur, Olmstead, Ramsey, and Washington.



BIOSURVEILLANCE SITES:



Biosurveillance was conducted at 17 different sites in 9 counties. Volunteers captured 95 buprestid (metallic, wood-boring) beetles. None of these captured beetles were Emerald Ash Borer.



CERCERIS FIND IN AITKIN COUNTY

Prior to this summer, the northern-most Cerceris colony in Minnesota was found in Anoka County.

Wasp Watchers Allison Rian and Pam Brand (left) discovered a small Cerceris colony in Aitkin, MN. According to entomologist and Cerceris researcher Claire Rutledge, this is very far north, even nationwide, for Cerceris fumipennis to be found.

Allison Rian (right) and Pam Brand (left) found Cerceris fumipennis in Aitkin County, the northern-most Cerceris find in Minnesota.

MINNESOTA STATE FAIR

THE GREAT MINNESOTA GET-TOGETHER

Wasp Watchers had an opportunity to be a part of the Minnesota State Fair to help highlight the many wonderful Citizen Science projects occurring throughout Minnesota. Volunteers worked at the Citizen Science Exhibit hosted by the Minnesota Pollution Control Agency in the Eco-Experience Building. Look for more opportunities during the 2016 State Fair.

WHAT IS CITIZEN SCIENCE?

Citizen scientists are volunteer data collectors. They observe and record information about the natural world and contribute to a growing need for environmental data. In Minnesota, there are dozens of programs that train and support thousands of citizen scientists. Citizen-collected data are regularly used in decision making and conservation efforts.

Minnesota Citizen Science Links:

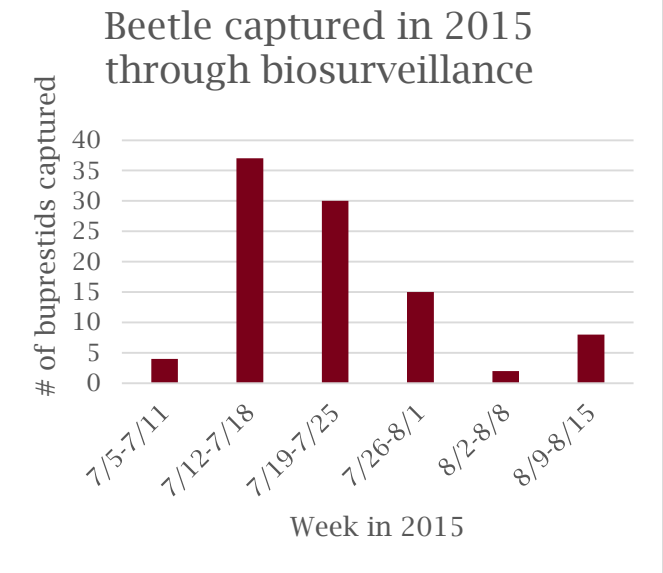
https://www.pca.state.mn.us/living-green/citizen-science

http://www.extension.umn.edu/environment/citizen-science/

JULY IS A BUSY MONTH

The majority of our biosurveillance sites are found in the twin cities area and July is our busiest Wasp Watching month. EAB flight season peaks around 900-1100 DD. This corresponds well with the Cerceris emergence and peak foraging period.

In northern areas of the state, EAB is active into August (due to a lag in accumulated degree days) so Cerceris is likely to be active well into August in Minnesota's northern areas.



IN THE MEDIA

On July 21, 2015 Wasp Watchers hosted a media event at a ballfield in Oakdale. This was our opportunity to introduce the smoky winged beetle bandit (*Cerceris fumipennis*) to Minnesotans.

Three television news agencies took video coverage and EAB biosurveillance was covered in the evening news. In addition, the Star Tribune and several local newspapers covered Wasp Watchers efforts to find EAB (Rochester Post Bulletin and Winona Daily News). To see or read the stories, please visit the media links on the Wasp Watchers website.

Jennifer Schultz doing an interview with the WCCO News Team.

GROWING DEGREE DAY DATA

Tracking growing degree days helps to predict the emergence of the smoky winged beetle bandit wasp (*Cerceris fumipennis)* at the beginning of the field season.

We track the emergence after the wasp overwintering using degree days. Degree days (dd or DD) are a measurement of the amount of heat that accumulates above a specified base temperature. In measuring degree days for insect development, base 50F is commonly used. Insect development occurs above 50F, stops when the temperature drops below this threshold and resumes when the temperature rises above 50F again.

Degree days help us track the emergence of insects as well as their peak and their end of season.

This is a great tool to use when monitoring for any turf or landscape pests. Emerald Ash Borer adults start emerging around 450-500 degree days (base 50) and peaks at 900-1100 degree days.

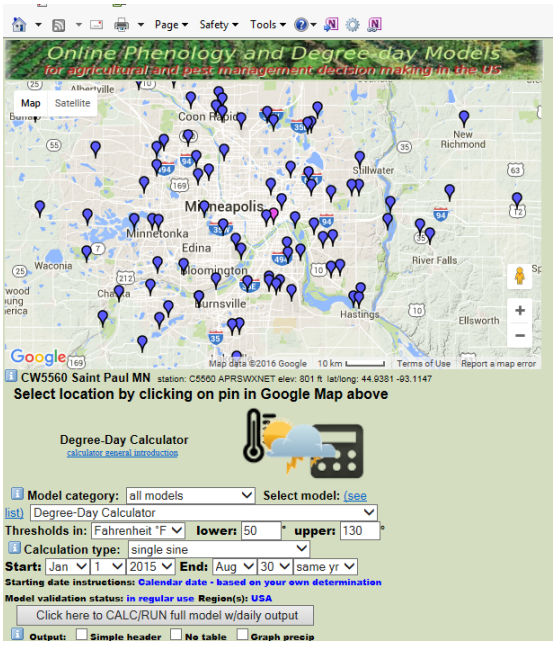
Emergence data had not been collected in Minnesota on the Cerceris wasp species before 2015. However, in Connecticut, reseachers placed emergence at around 865DD.

After analyzing the result of the degree day data that was gathered in the summer of 2015, it appears that in Minnesota, Cerceris fumipennis emerges closer **950-975** degree days. We will be tracking emergence again this summer to collect and verify previous data. If you are curious what the accumulated degree days are in your area, try the US Pest Degree Day model website:

http://uspest.org/cgi-bin/ddmodel.us

Find the weather station nearest to your home, enter January 1st and 50F for the lower threshold and click the CALC/Run button.

It will generate a list of data that will tell you the real time degree days and the projected future degree days.



WE NEED YOUR HELP IN 2016!

Please consider being a Wasp Watcher in the summer of 2016. Experienced or new volunteers, we need you all! We need help searching for new Cerceris wasp nesting sites as well as collecting beetles from known sites.

PERMIT TO COLLECT IN STATE PARKS

The Wasp Watchers Program has obtained a permit from the Minnesota DNR to collect beetles in Minnesota State Parks. We have a known site in Afton State Park already. If you are visiting any other state parks this summer, be on the lookout for Cerceris.

Thank you from the entire Wasp Watchers Team!

UNIVERSITY OF MINNESOTA EXTENSION

Wasp Watchers Program

WASP WATCHERS

2016 Field Report

In Partnership with: MINNESOTA DEPARTMENT OF AGRICULTURE With Support from: ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

By Jennifer Schultz, Wasp Watchers Coordinator

WASP WATCHERS PARTICIPANTS

Thank you, Wasp Watchers Volunteers. We are humbled by your knowledge, generosity, and commitment. Thank you for all the time and energy you devote to protecting and conserving the natural landscapes of Minnesota, including our ash trees!

Students from Urban Roots conducted EAB biosurveillance in St. Paul.

VOLUNTEER ACCOMPLISHMENTS:

There were 65 Wasp Watcher volunteers engaged in this project in 2016. There were **458 hours** spent scouting for and monitoring the smoky winged beetle bandit wasp (*Cerceris fumipennis).* Since the beetle bandit has a short lifespan, all of these volunteer hours were completed in a nine week period. Great work, everyone!

Volunteers were from thirteen different counties: Aitkin, Anoka, Chisago, Dakota, Hennepin, Houston, Olmstead, Ramsey, Rice, Sherburne, St. Louis, Todd, and Washington.

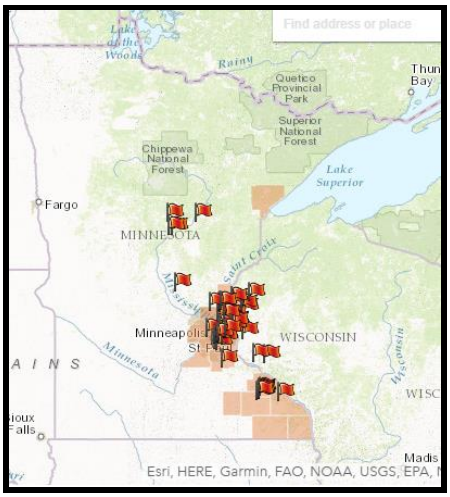
NEW BEETLE BANDIT WASP SITES

In the summer of 2016, there were 219 new sites scouted for the presence of the smoky winged beetle bandit wasp (*Cerceris fumipennis).* This is more than double the number of sites searched in the previous year. (87 sites were searched in 2015.)

There were 29 new or confirmed beetle bandit wasp sites discovered from mid-June to mid-August in 2016. (13 were found in 2015.)

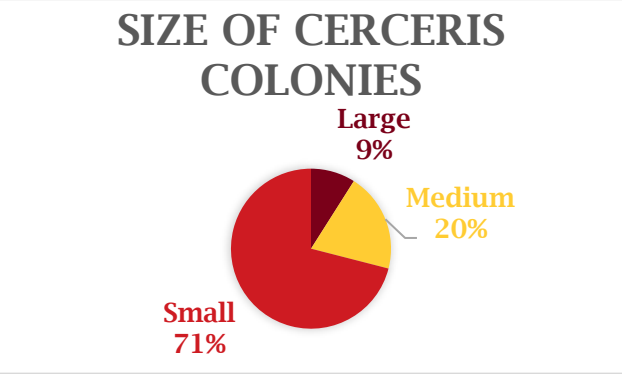
KNOWN BEETLE BANDIT WASP SITES

Currently there are 56 known smoky winged beetle bandit wasp sites around the state of Minnesota, with 53 additional sites of interest (unconfirmed or past sites). Confirmed sites are found in 13 counties: Aitkin, Anoka, Benton, Chisago, Crow Wing, Dakota, Goodhue, Hennepin, Olmstead, Ramsey, Rice, Washington, and Winona.

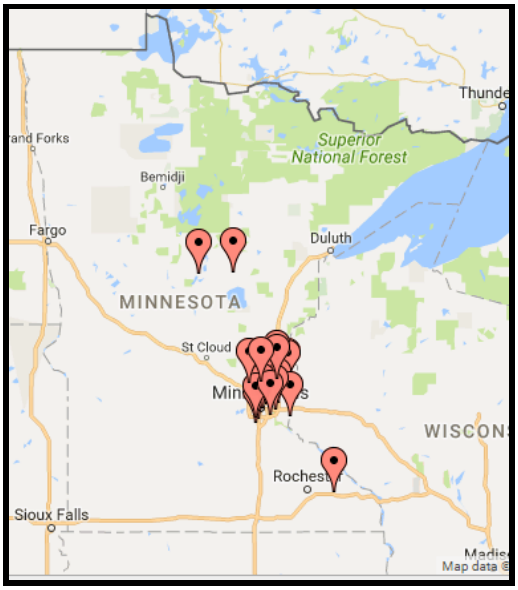


COLONY SIZE

Of the 56 known Cerceris sites, 71% of the colonies are small (1-9 nests), 20% are medium sized (10-29 nests), and 9% are large (30+ nests). Biosurveillance is most effective at medium or large colonies, but capturing buprestids at small colonies can be quite informative for collecting taxonomic and geographic data.



BIOSURVEILLANCE SITES:



Biosurveillance was conducted at 21 different sites. Volunteers captured 183 buprestid (metallic, wood-boring) beetles throughout 9 counties including; Aitkin, Anoka, Chisago, Crow Wing, Dakota, Hennepin, Ramsey, Washington, and Winona counties. Emerald Ash Borer specimens were captured at Riverside Park in Minneapolis.

Native buprestid specimens capturing during EAB biosurveillance. Photo credit: U of MN Extension

BIOSURVEILLANCE IS PRIZE WINNING!

Kaley, a 4H partipant from Wyoming, MN, completed an Entomology Project on biosurveillance for her county fair. She adopted 2 sites in Wyoming and collected over 60 buprestid beetles. Kaley received Reserve Grand Champion on her project at the Washington County Fair and earned a spot to take her project to the State Fair. At the Minnesota State Fair, she earned a purple ribbon on her project. We are so proud of Kaley's achievement and so appreciative of her work to highlight Wasp Watchers and the biosurveillance process. Thanks, Kaley!

SUMMER FIELD TRAININGS

We had several free Wasp Watchers field trainings in 2016 with widespread interest from city and county professionals as well as community members and dedicated volunteers. These biosurveillance events provided opportunities to practice identifying *Cerceris fumipennis* wasps and nests as well as to enjoy the biosurveillance process with others. There will be more trainings in July of 2017.

Volunteers examine netted beetle prey. Photo credit: University of Minnesota Extension

Wasp Watchers also partnered with the Minnesota Master Naturalist Program to offer a more intensive educational opportunity through an Advanced Training. This fee-based class is open to everyone and will happen again in July of 2017.

Participants in the Master Naturalist Advanced Training with Wasp Watchers. Photo: U of MN Extension

ANOTHER CERCERIS SPECIES?

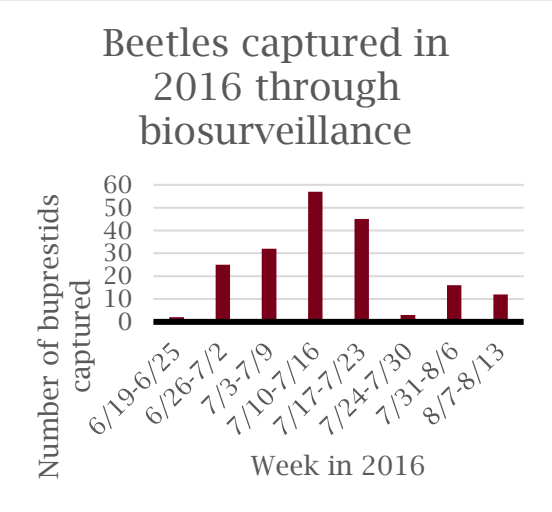
Wasp Watcher Walt Niemiec has been a committed volunteer for 2 years. In 2015, he covered dozens of miles searching for a beetle bandit colony in Afton State Park where he regularly hikes in the summer. After much searching, he found a small colony (10-15 nests) on a hiking trail leading to a backpacking campsite. In 2016, he collected over 30 buprestids at this colony—quite an accomplishment for such a small colony. He dedicated several days each week to spending numerous hours at his site monitoring *Cerceris fumipennis* nest holes. He also searched the park for additional colonies. His inquisitiveness and pursuit of knowledge led to an interesting discovery. He found ground nesting wasp that resembled *Cerceris fumipennis*: both in the wasp's appearance and in the nesting holes. After consulting a taxonomist at the University of Minnesota, this other wasp was identified as *Cerceris atramontensis*.

Cerceris atramontensis. Photo credit: Tom Murray, Bugguide.net

Cerceris atramontensis does not hunt buprestids, so cannot be utilized for EAB detection. Rather, *Cerceris atromentensis* hunt weevils, small, long snouted beetles in the Curculionidae family. *Cerceris atramontensis* has not been encountered at any other biosurveillance site in Minnesota, so Walt's find was an informative one. The specimen will be added to the University of Minnesota Insect Collection. Thanks, Walt!

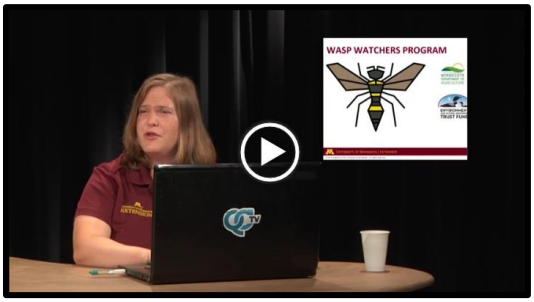
JULY REMAINS OUR MOST ACTIVE TIME

The smoky winged beetle bandits have consistently been most active in their beetle hunting in July throughout much of Minnesota. The majority of our biosurveillance sites are found in the Twin Cities metro area, and July is our busiest Wasp Watching month. In northern areas of the state, EAB is active into August (due to a lag in accumulated degree days), so beetle bandits are likely to be active well into August in Minnesota's northern areas.



IN THE MEDIA

One of the goals of the Wasp Watchers Program is to educate people around the state of Minnesota about Emerald Ash Borer and encourage citizens to be involved in the early detection of EAB in their own communities. During the fall, winter, and spring months, Jennifer Schultz, Wasp Watchers Coordinator, had the opportunity to travel around the state to talk with Minnesotans about this invasive beetle and what we can do about it. Last year, Wasp Watchers was featured in various local newspapers including *Kanabec County Times*, *Pine City Pioneer*, and *Alexandria Echo Press*. The Wasp Watchers Program was highlighted on the QCTV cable channel on the Master Gardener segment in August, 2016. To watch this one hour-long presentation on Wasp Watchers, go to this link: http://qctv.org/anoka-master-gardener/



HEAVY RAIN IMPACTS BEETLE BANDIT COLONIES?

According to NOAA, Minnesota saw +3 inches of rain from June 15-August 15 2016. This means that compared to average rainfall measures, 2016 saw a 3 inch increase in those critical 2 months of the biosurveillance field season. Many of the 2016 rain events were extremely heavy. While certainly, ground-nesting wasps are adapted to survive rain, it is unknown how much these extreme rain events impact their underground nests and the mortality of their eggs and larvae.

WE NEED YOUR HELP IN 2017!

Capturing a beetle bandit wasp during biosurveillance
Photo credit: U of MN Extension

Please consider being a Wasp Watcher in the summer of 2017. Experienced or new volunteers, we need you all! We need help searching for new beetle bandit nesting sites as well as collecting beetles from known sites.

Thank you from the entire Wasp Watchers Team!

PROMISING NEST SITES

- Hard packed sandy soil
- Areas of human disturbance (baseball fields, trail and road edges, informal parking lots, fire pits, etc.)
- Full sunshine
- Sparse vegetation (about 50% hard packed soil and 50% short vegetation
- Near a wooded area, about 200 yards (200 meters) or less.
- Currently, Wasp Watchers Minnesota is focused on searching baseball fields with encroaching vegetation.

Known Cerceris fumipennis nesting site
Kellogg Middle School, Rochester
Photo credit: Jennifer Schultz

Known Cerceris fumipennis nesting site
Mayo High School, Rochester
Photo credit: Jennifer Schultz

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University of Minnesota | Extension

Wasp Watchers Program
Department of Entomology
219 Hodson Hall, 1980 Folwell Ave.
St. Paul, MN 55108

Wasp Watchers

Find and monitor the wasp that hunts Emerald Ash Borer!

We are looking for colonies of these wasps throughout Minnesota and need your help.

This native wasp is not known to sting humans, even when handled.

Cerceris fumipennis
Photo credit: Jeffrey Hahn

Cerceris fumipennis is a solitary ground-nesting wasp. The female stocks her nest with Buprestid beetles as food for her offspring, including emerald ash borer (EAB) when present.

Emerald Ash Borer
Photo credit: Jeffrey Hahn

Biosurveillance for emerald ash borer can be done by observing colonies of harmless native wasps and collecting some of the prey they bring back to their nests.

Wasp Watchers Program

University of Minnesota
EXTENSION

WHAT IS EMERALD ASH BORER?

- Small metallic green beetle (1/2 inch long, 1/8 inch wide)
- An exotic beetle from Asia
- Larvae tunnel under the bark, eventually killing the tree
- Attacks all species of ash
- First found in Minnesota in 2009; now found in 6 counties
- Spreading VERY rapidly across the U.S.A. and Canada (primarily in transported firewood)
- Early detection is difficult. Together, this wasp and Wasp Watchers can help

Emerald Ash Borer (EAB)
Photo credit: Jeffrey Hahn

Emerald Ash Borer larva
Photo credit: Mark Abrahamson

EAB larval gallery
Photo credit: Monika Chandler

HOW TO IDENTIFY CERCERIS WASP NESTS

- Nest openings are round with diameter of a pencil
- Holes typically go straight down, not angled
- Nest opening is surrounded by a mound of excavated soil, much like an ant hill
- Often tucked beside or partially under a clump of grass
- There can be 5-100 nests in an area

Cerceris fumipennis ground nest openings
Photo credit: Jennifer Schultz

IDENTIFYING MARKINGS

- ½ -3/4 inch long
- Dark smoky brown wings
- One cream/yellow band on second segment of abdomen (near "waist")
- Female has three large cream/yellow spots on face

Adult *Cerceris fumipennis*
Photo credit: Philip Careless

Female adult *C. fumipennis* facial markings
Photo credit: Philip Careless

For More Information:

Visit these websites:
http://z.umn.edu/waspwatchers
www.cerceris.info
Contact: Jennifer Schultz, Wasp Watchers Coordinator
Email: schultzj@umn.edu Phone: 612-301-8310

BIOSURVEILLANCE INSTRUCTIONS

***Cerceris fumipennis* is active in Minnesota from late June-early September (most active in July and early August).**

- Visit your colony mid-day, 4-6 sunny days during peak activity in July and early August.
- Visit site during Cerceris peak flight time; between 11am to 4pm.
- Pick up all dropped/abandoned beetles lying on the ground around the nests.
- For 1-3 hours, watch as wasps return to nests. Wasps with prey can be netted using a lightweight mesh net. Take the beetle prey and release the wasp.
- Collect a total of 50 beetles over 4-6 visits. Rule of thumb: Steal the equivalent (or less) of one beetle per wasp hole per search day. Place all beetles in labeled vials (provided by U of MN Extension) and put into freezer until the end of the summer.
- At the end of the field season (September), mail the collected beetles to the U of MN for identification in a pre-paid mailing box.

Cerceris fumipennis with native beetle prey
Photo credit: Michael Bohne, U.S. Forest Service

In partnership with: MINNESOTA DEPARTMENT OF AGRICULTURE

With support from: ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

WASP WATCHERS PROGRAM

How Do We Detect Emerald Ash Borer Using This Native Wasp?

WHAT IS BIOSURVEILLANCE?

- Use of one species to monitor another species.
- The Smoky winged beetle bandit wasp (*Cerceris fumipennis*) hunts and captures metallic wood boring beetles (buprestids) including EAB and carries them back to provision their ground nests.
- Each wasp colony provides a site to monitor for the presence of Emerald Ash Borer (EAB).

Cerceris fumipennis with prey
© Floyd Conner

NESTS ARE MONITORED TO SEE WHAT TYPE OF BEETLE ARE BROUGHT BACK BY THE WASP.

- Beetles can be intercepted by netting the foraging wasp before their beetle prey are taken down into the nest.
- When netted, the wasp drops its beetle prey.
- Dropped or abandoned beetles are collected by volunteers and sent to the University of Minnesota for identification.

Non-EAB Buprestids ©MN Dept. of Ag

IDENTIFICATION OF THE SMOKY WINGED BEETLE BANDIT, CERCERIS FUMIPENNIS

Body markings of female *Cerceris fumipennis*
©Philip Careless

Face of female *Cerceris fumipennis*
© Philip Careless

Face of male *Cerceris fumipennis*
© Philip Careless

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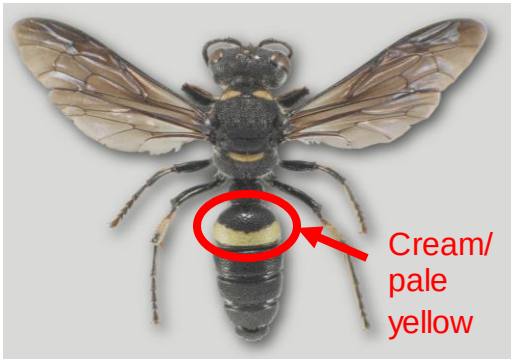
OTHER DIGGER WASPS COMMONLY FOUND NEAR CERCERIS NESTING SITES

Insects Commonly Mistaken for *Cerceris fumipennis*, the smoky winged beetle bandit

When searching for *Cerceris fumipennis* nesting sites, you often find other similar insects present. They are all taking advantage of similar soil and light conditions. All of the below wasp species are non-aggressive solitary, ground-nesting wasps that capture other insects, haul their prey back to their burrows and place them in nest cells as food for their young. The adults themselves feed on flower nectar.

THE REAL THING: CERCERIS FUMIPENNIS, THE SMOKY WINGED BEETLE BANDIT



©Elliote Rusty Harold © Philip Careless ©Philip Careless

Left photo: Male (top) and female Cerceris fumipennis wasps. The male has some yellow markings below the primary abdominal yellow band. The male is much smaller than the female. The males are typically found immediately following emergence in late June for a very short time.

BEE WOLF, PHILANTHUS SPECIES

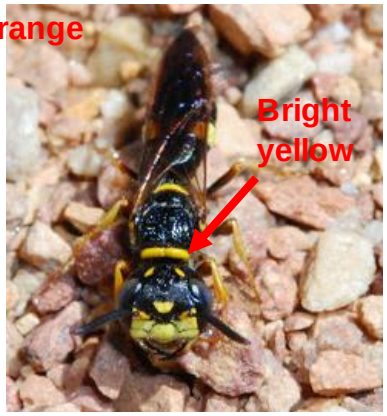


Photo credit: Jeff Hahn Photo credit: Jeff Hahn Photo credit: Jennifer Schultz

The bee wolf has more abdominal bands (bright yellow) and the wing color is rusty orange instead of brown.
The bee wolf excavates its nest much like a dog and the dirt outside the nest opening is spray off to one side.
The bee wolf captures and paralyzes small bees to deposit in their underground burrows as food for their offspring.

SAND WASP, BEMBIX SPECIES

Photo Credit: Sean McCann, 2008 Photo credit: Jennifer Schultz, University of Minnesota Extension

Bembix species (sand wasp family of Bembix). Right photo: Sand wasp looking out of its nest opening.

Note: Sand wasps often have red or green eyes while Cerceris wasp eyes are typically brown in color. Bembix wasps are often found nesting in loose sand (sand boxes). Preys on flies.

CICADA KILLER, *SPHECIUS SPECIOSUS*

Photo credits: University of Minnesota Extension, Jeffrey Hahn (middle and right photos), Jennifer Schultz (left)

The Cicada Killer, *Specius Speciosus*, is a large digger wasp (.6-2.0 inches long). Note the trail of excavated dirt in front of the nest on the left photo. Preys on cicadas.

GREAT GOLDEN DIGGER WASP AND GREAT BLACK WASP

Photo credit: U of MN Extension Photo credit: John Ascher

Great Golden Digger, *Sphex ichneumoneus* Great Black Wasp, *Sphex pensylvanius*

Both species can be found in yards and gardens and prey upon katydids and crickets.

HOPLISOIDES GENUS

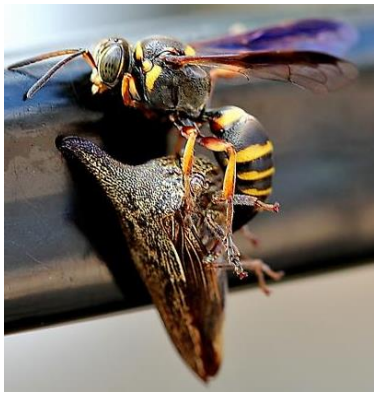



Photo credits: Ken Wolgemuth (left) and Anthony Rodgers (middle) and Lynn Burns (right): Hoplisoides species are also in the family Crabronidae (along with Cerceris and Philanthus). Hoplisoides wasps have tell-tale spots on their wings. They are also sand wasps, but prey on Homoptera, specifically treehoppers.

TIGER BEETLE


Photo credits: Jeff Hahn, University of Minnesota Extension. While not a wasp, tiger beetles are often found at ballfields. When you see one stationery on the ground, they do not look like a wasp. However, when they are flying, they can easily be mistaken for a Cerceris wasp.

JAPANESE BEETLE


Like tiger beetles, Japanese beetles are commonly found at ballfields. Again, while they look vastly different from a wasp when stationery, but they can be confused with Cerceris when they are flying.

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WASP WATCHERS PROGRAM

Where to find Smoky Winged Beetle Bandit wasp colonies

BALLFIELDS

Photo credit: U of MN Extension

Researchers have found that ballfields—especially partially overgrown or less maintained fields—are good habitat for smoky winged beetle bandit wasps, *Cerceris fumipennis*. Even on fields that are moderately maintained (groomed approximately once a week), *Cerceris fumipennis* can often be found on the periphery of the infield (where the sandy infield meets the grassy outfield).

OTHER HABITATS

- Ground should be hard-packed with relatively fine, sandy soil.
- NOT loose sand like beaches or sand boxes.
- Sparse vegetation (50% bare, hard-packed sand and 50% short herbaceous vegetation is best)
- Areas disturbed by humans
    - Informal parking spots
    - Infrequently used roads
    - Foot paths
    - Soil around fire pits or open campsites
- Full sun exposure
- Within 200-300 yards of a wooded area

Photo credit: U of MN Extension

WASP WATCHERS PROGRAM

Possible Nesting Sites for the Smoky Winged Beetle Bandit Wasp (*Cerceris fumipennis*)

PREFERRED HABITAT

- Hard packed sandy soil
- Areas of human disturbance
- Full exposure to sunshine
- Sparse vegetation
- Near a wooded area, 500 yards or less
- Dirt/sand trail or road
- Informal parking lots

Dirt road in a regional park. ©Philip Careless

- Campsites, often in clearings around fire rings
- Infrequently used, less maintained baseball or softball fields. Often nests are found along the line where the grass (outfield) meets the sand (infield).

Ballfield. Photo credit: University of Minnesota Extension

Exposed dirt/sand in grassy field in a park. ©Philip Careless

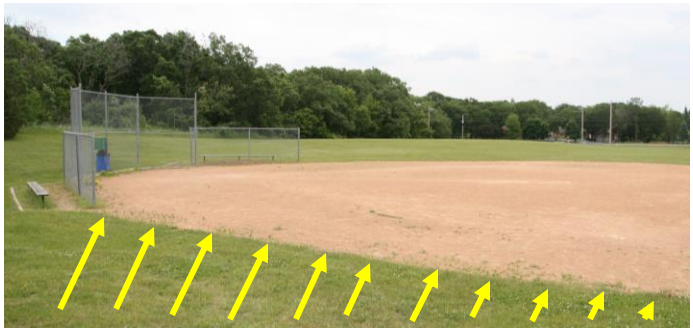
Exposed dirt/sand circling a fire pit in a park. ©Philip Careless

Farm road. ©Mike Bohne

WASP WATCHERS PROGRAM

How to search for the Smoky Winged Beetle Bandit wasp at a ballfield

SEARCHING FOR THE SMOKY WINGED BEETLE BANDIT (*CERCERIS FUMIPENNIS*) AT YOUR LOCAL BALLFIELD IS SIMPLE. FOLLOW THESE STEPS:



- Search your site between 11am-3pm. The beetle bandit wasp is most active around the middle of the day.
- Walk around the ballfield following the line where the grass (outfield) meets the sand (infield). Ballfields with encroaching vegetation tend to be better habitat for this wasp species. The beetle bandits prefer a small amount of plant cover for shade and nest orientation.
- There can be 5-100 nests in a ballfield.
- Nest openings are round with a diameter of a pencil.
- Holes typically go straight down, not angled.
- Nest openings are sometimes tucked beside or partially under a clump of grass or plant.
- Nest openings are usually surrounded by a mound of excavated soil, much like an anthill.
- Differing from anthills: the opening is larger and the beetle bandit wasp nests has a mound surrounding the opening with larger sand particles. The mound around an anthill is typically comprised of finer (smaller) pieces of sand.
- If you are uncertain, watch the nest opening for a few moments. Ant hills are typically busy with ants coming and going frequently.

Ant Hills

All photo credits: U of MN Extension

WASP WATCHERS

How to Carry Out Biosurveillance: Looking for Emerald Ash Borer with the Cerceris Wasp

Photo credit: Jeff Hahn, U of MN Extension, Smoky winged beetle bandit, *Cerceris fumipennis*

THE UNIVERSITY OF MINNESOTA WILL PROVIDE THE FOLLOWING EQUIPMENT:

- ✓ Insect Net (aerial mesh)
- ✓ Plastic vials for the collection and storage of beetles
- ✓ A sheet of adhesive vial labels
- ✓ A postage-paid box or envelope
- ✓ Wasp Watcher training binder

Aerial mesh insect net

1. VISIT YOUR SITE 2-3 TIMES A WEEK IN JULY AND EARLY AUGUST

1. Wasps hunt best on sunny days when the temperature is above 70 degrees F.
2. The peak flight time is 11am to 3pm, so visit your site during that time. The wasps are most actively hunting beetles between 12noon-2pm.
3. Wait a day after moderate/heavy rain. Wasps will dig out after rain events, but it make take a day for the soil to dry out and for the wasps to re-excavate their nest tunnels.

Photo credit: U of MN Extension, *Cerceris fumipennis* nest opening

2. COUNT NESTS

1. At your site, walk around and roughly count the number of nests.
2. Record this on your data sheet.
3. This information will let us know how the wasps are doing over time.

Photo credit: Philip Careless
Dropped beetle near nest opening

3. GATHER ABANDONED BEETLES

1. Pick up all abandoned beetles lying on the ground around the colony.
2. Look through the sand mounds surrounding the holes, too. Often discarded beetles are dropped near the nest and covered by the mound.
3. Abandoned beetles may be dry and brittle so handle carefully.
4. Place these in a vial and fill out the label, being sure to mark them as abandoned.

4. MONITOR NESTS FOR RETURNING WASPS

Photo credit: Mike Bohne, *Cerceris fumipennis* with native beetle prey

1. Observe as many nests as you can watch.
2. Watch for wasps coming in with prey. You will soon be able to recognize the bottom-heavy silhouette and slow, heavy flight of a wasp with prey.
3. Gently net the wasp returning with prey. Use a lightweight mesh net so you do not hurt the wasp. The shock of netting will usually cause the wasp to drop her prey.
4. If you see a beetle in the bottom of the net, open the net and let the wasp crawl out or fly away. If she has not released the beetle, set the net face down on the ground and walk away. Usually the wasp will drop her prey within 5 minutes.
5. Place the "net captured" beetles in a separate vial from the abandoned beetles and fill out the label.

5. BEETLES SHOULD BE PLACED IN VIALS AND LABELED

1. Affix label to vial and write down information when collecting. You can place multiple beetles together in the same vial as long as the date, site, and collecting method (captured vs. abandoned) are all the same.
2. Each day of collection, you can have two vials per site:
   - ✓ One vial for captured beetles (w/net)
   - ✓ One vial for abandoned beetles found on the ground.

Date: Weather:
Site: City:
Abandoned or Captured (circle one)
Collector's name:

6. FILL OUT DATA SHEET/ENTER DATA

1. Fill out a "Biosurveillance Beetle Collecting Data Sheet" (found at the back of the binder). Use this data form to help when entering you data online.
2. Enter your data at www.minnesotamasternaturalist.org
3. Use the Data Entry handout (Handout 8) to navigate the website and process.

7. PLACE THE LABELED VIALS OF BEETLES IN THE FREEZER UNTIL THE END OF SUMMER.

1. **VERY IMPORTANT**: Beetles will develop a fungus if not frozen on the collection day, a.s.a.p.
2. Use the postage paid box or envelope to send the collected beetles and data sheets to the University of Minnesota at the end of the summer. **Send to: Jennifer Schultz, 219 Hodson Hall, 1980 Folwell Ave. St. Paul, MN 55108**
3. **If you suspect that you have found EAB, contact the University immediately!**

For more information visit: http://z.umn.edu/waspwatchers
Contact: Jennifer Schultz, Wasp Watchers Coordinator
Email: schultzj@umn.edu OR Phone: 612-301-8310

WASP WATCHERS PROGRAM

Common Buprestids (Metallic Wood Boring Beetles)

COMMON BUPRESTIDS CAPTURED THROUGH BIOSURVEILLANCE IN MINNESOTA (2014-2016).

Buprestids captured in Minnesota through biosurveillance utilizing the hunting behavior of the smoky winged beetle bandit wasp (*Cerceris fumipennis*) fall into six genera: Actenodes, Agrilus, Buprestis, Chrysobothris, Dicerca, Poecilonota,

Actenodes

Acetonodes acornis
Copyright © 2011 Mike Quinn
(bugguide.net)

Actenodes simi
Copyright © 2016 Mike Quinn
(bugguide.net)

Buprestis

Buprestis consularis
Copyright © 2011 Jason Hansen
(bugguide.net)

Bupestis maculativentris
Copyright © 2011 Jason Hansen
(bugguide.net)

Agrilus

Two lined chestnut borer
Agrilus bilineatus
Copyright © 2011 Mike Quinn (bugguide.net)

Agrilus quadriguttatus
Copyright © 2008 Joshua Basham (bugguide.net)

Bronze birch borer
Agrilus anxius
Copyright © 2012 Tom Murray (bugguide.net)

Agrilus difficilis
Copyright © 2016 Jennifer Shaughney (bugguide.net)

Agrilus politus
Copyright © 2008 Tom Murray (bugguide.net)

Agrilus obsoletoguttatus
Copyright © 2017 Kim Fleming (bugguide.net)

Poecilonota

Poecilonota cyanipes
Copyright © 2014 Stuart Tingley (bugguide.net)

Chrysobothris

Flatheaded Appletree Borer
Chrysobothris femorata
Copyright © 2010 JC Jones
(bugguide.net)

Chrysobothris sexsignata
Copyright © 2014 Betsy Betros
(bugguide.net)

Chrysobothris rugosiceps
Copyright © 2011 Mike Quinn
(bugguide.net)

Dicerca

Flatheaded Hardwood Borer
Dicerca divaricate
Copyright © 2011 Tom Murray
(bugguide.net)

Flatheaded Conifer Borer
Dicerca tenebrosa
Copyright © 2011 Jason Hansen
(bugguide.net)

Flatheaded Poplar Borer
Dicerca tenebrica
Copyright © 2014 Dave McShaffrey
(bugguide.net)

WASP WATCHERS PROGRAM

Entering Your Data

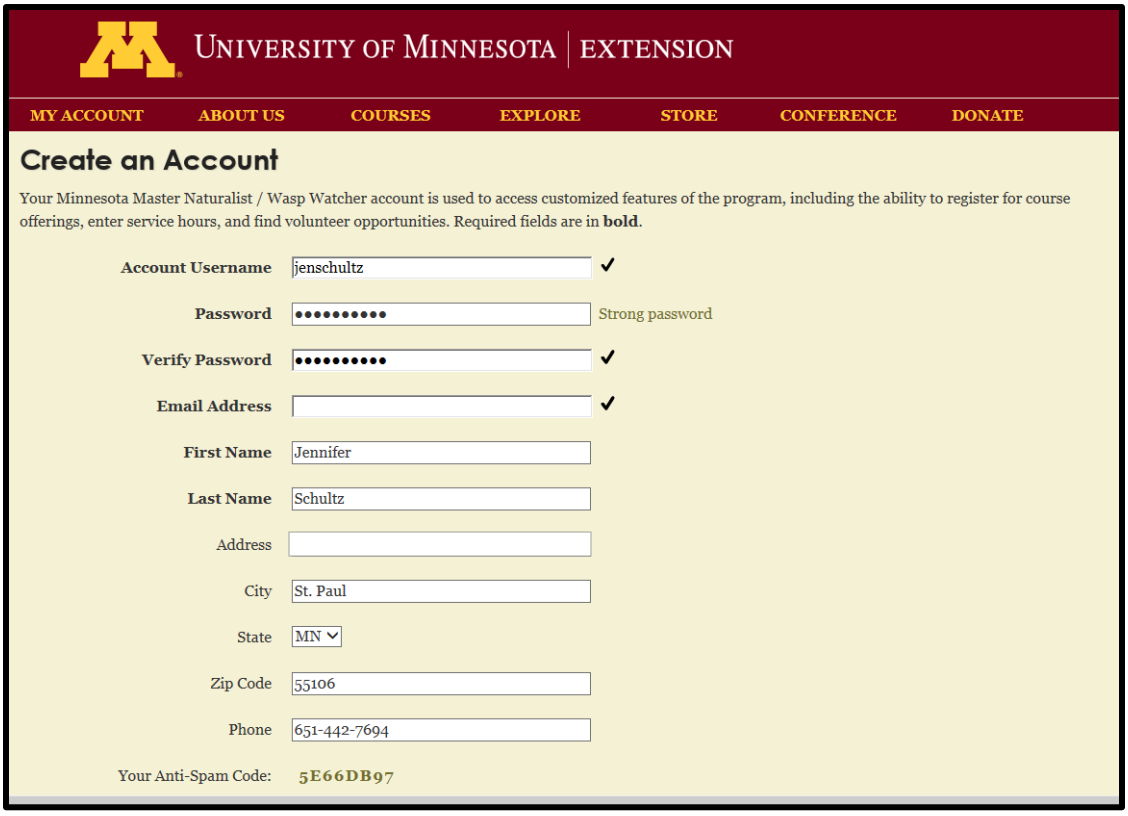
The Wasp Watchers database is embedded in the Minnesota Master Naturalists program. Go to: www.minnesotamasternaturalist.org

If you have a Minnesota Master Naturalists account already, you may use your current username and password. However, your account will need to be flagged by an administrator as a Wasp Watcher in order for you to have access to the Wasp Watcher Data Entry screens. Contact Jennifer Schultz, schultzj@umn.edu or 612-301-8310, if you cannot view the Wasp Watcher box at the bottom of your Master Naturalist Dashboard.

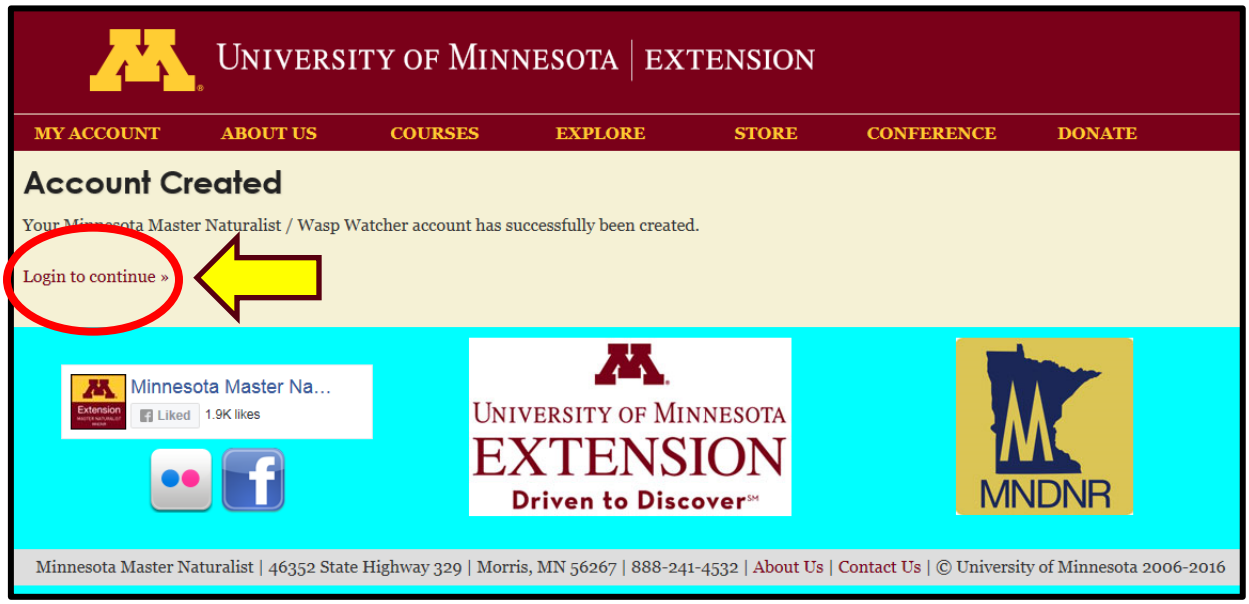
If you do not currently have an account with Minnesota Master Naturalists, you will need to create a new account. This takes about 2 minutes.

CREATE AN ACCOUNT:

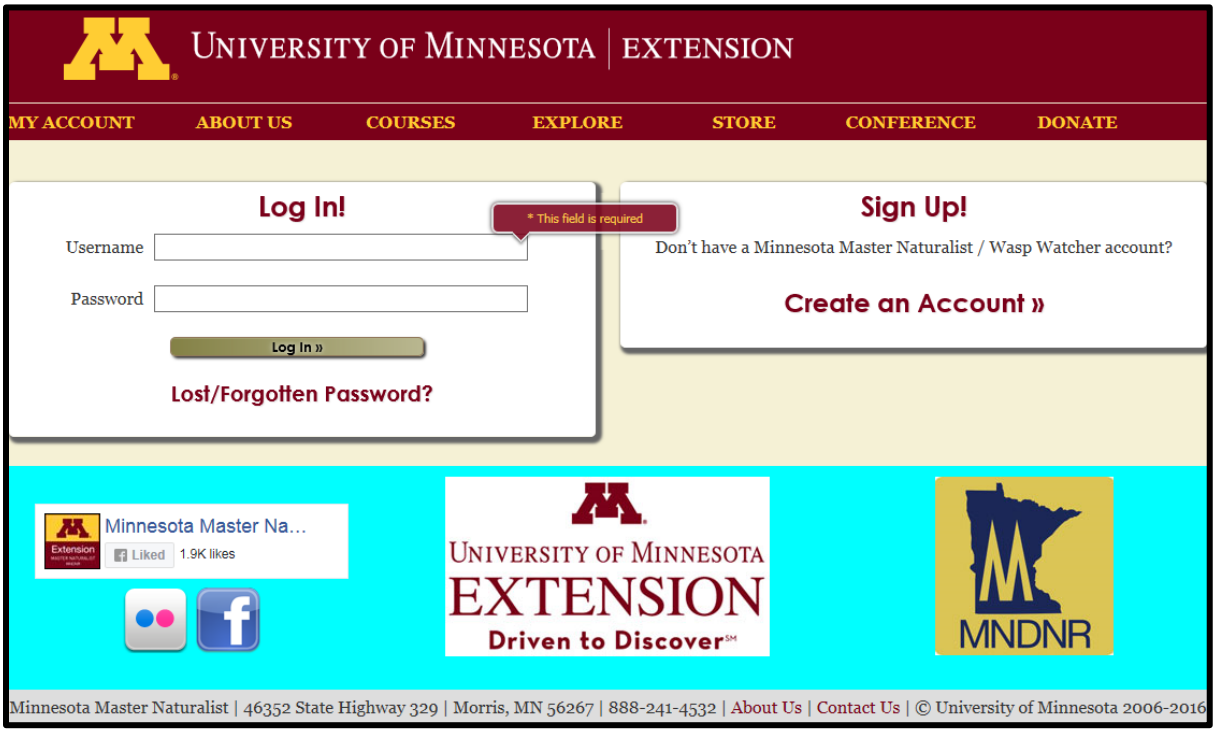
Create an account username and password and enter your information to create an account.



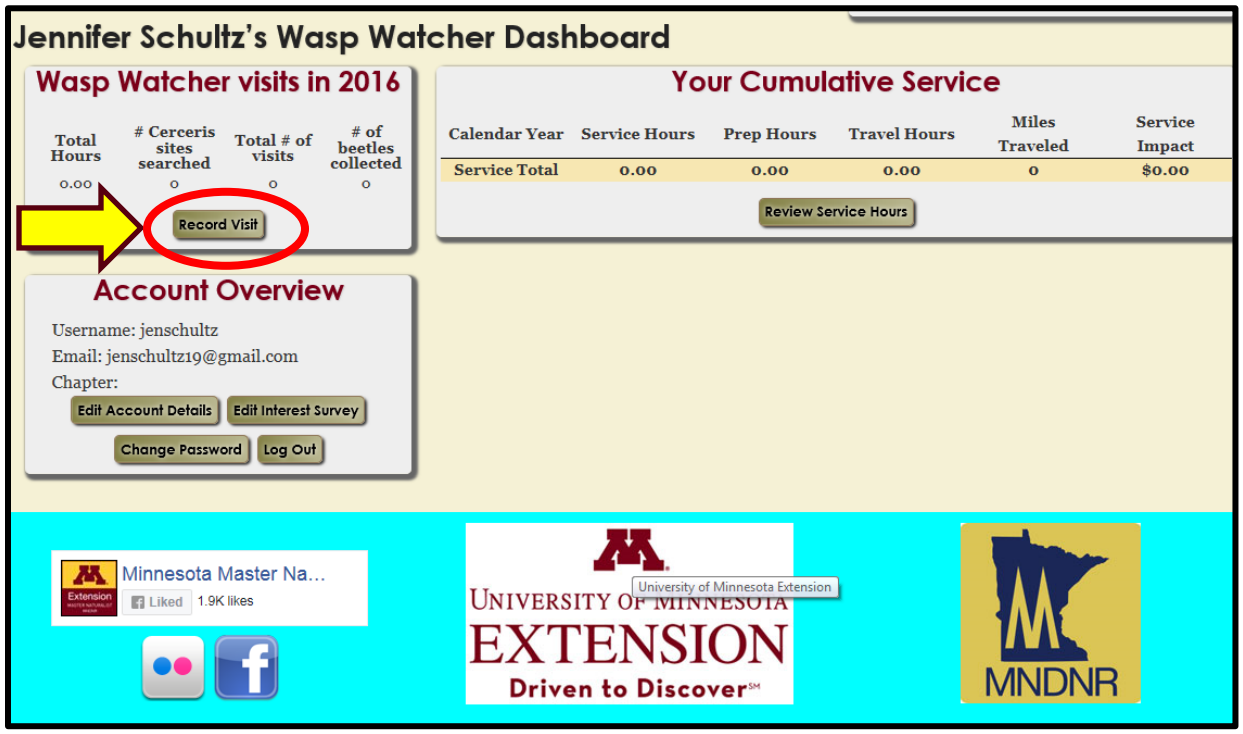
ACCOUNT CREATED SCREEN. CLICK LOGIN TO CONTINUE. THIS WILL BRING YOU TO THE LOG IN SCREEN



ENTER YOUR NEW USERNAME AND PASSWORD.



AFTER LOGGING IN YOU WILL BE AT YOUR DASHBOARD. SCROLL DOWN TO THE WASP WATCHER DASHBOARD. LOOK AT THE UPPER LEFT CORNER BOX LABELED: WASP WATCHER VISITS IN 2017. CLICK ON RECORD VISIT.



BOTH TYPES OF VISITS ARE RECORDED ON THE SAME DATA FORM:

- **CHECKING FOR THE PRESENCE OF CERCERIS FUMIPENNIS**
- **COLLECTING BEETLES (BIOSURVEILLANCE)**

IF YOU COLLECT BEETLES AT A NEW SITE, YOU WILL NEED TO ENTER THE SITE INFORMATION (SITE NAME, ADDRESS, ETC.) KNOWN SITES WILL AUTOFILL WITH THE ADDRESS. AFTER YOU'VE REPORTED A NEW SITE, ADMINISTRATORS WILL ADD THAT INFORMATION TO THE LIST. THEN IF YOU COLLECT BEETLES THERE AGAIN, YOU CAN SELECT THE SITE FROM THE DROP DOWN MENU.

Cerceris Wasp Presence/Absence Reporting Data Entry

THESE ARE THE INSTRUCTIONS FOR REPORTING A NEW SEARCH AT A SITE. THIS CAN INCLUDE SEARCHING ANY OF THE FOLLOWING:

- **PREVIOUSLY UNKNOWN AND UNSEARCHED SITE**
- **PAST CERCERIS SITE THAT HAS NOT BEEN ACTIVE FOR A YEAR OR MORE**
- **UNCONFIRMED SITE WHICH WAS REPORTED TO HAVE CERCERIS BUT HASN'T BE CONFIRMED**

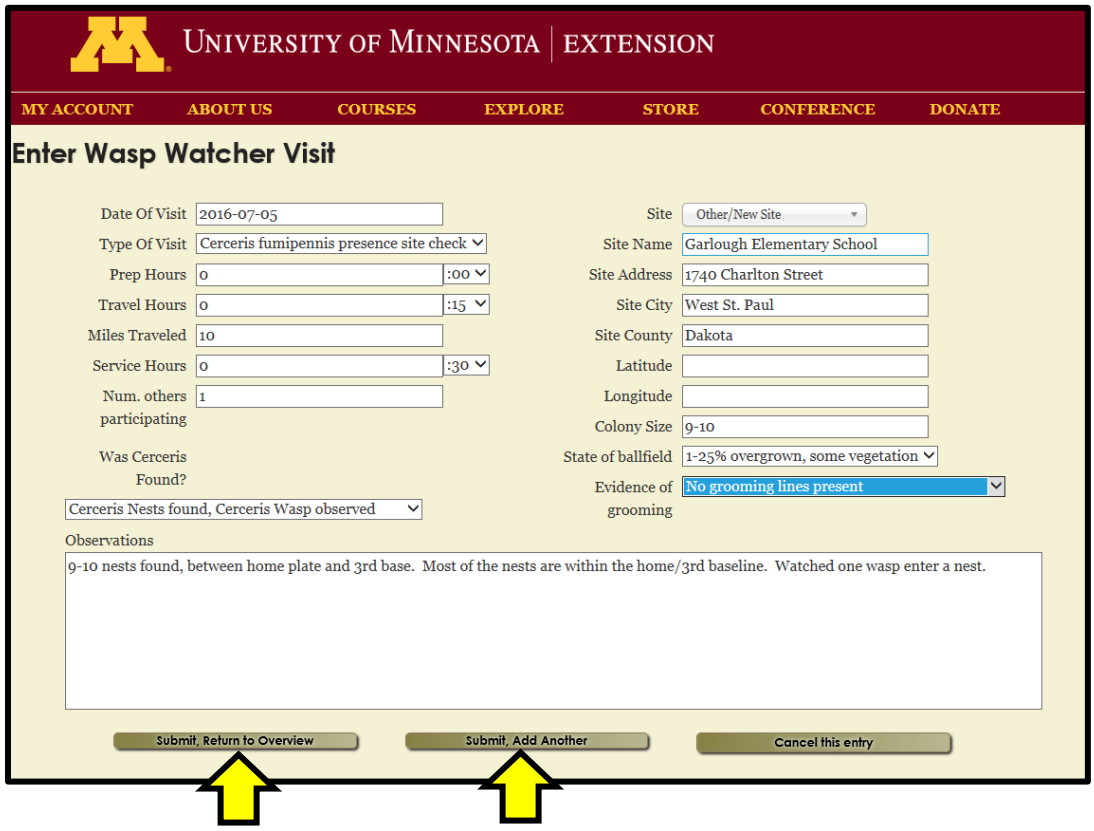
ON THE REVIEW WASP WATCHER VISITS PAGE, LOOK AT THE BOTTOM BOX LABELED WASP WATCHER RECORDS. CLICK ON ADD WASP WATCHER VISIT.

DATA ENTRY SCREEN:

UNDER "TYPE OF VISIT" SELECT CERCERIS FUMIPENNIS PRESENCE SITE CHECK. FOR THE QUESTION, WAS CERCERIS FOUND YOU HAVE SEVERAL OPTIONS IN THE DROP DOWN MENU:

- **CERCERIS NESTS FOUND, CERCERIS WASP OBSERVED**
- **CERCERIS NEST FOUND, NO CERCERIS WASPS OBSERVED**
- **NO CERCERIS NESTS FOUND, CERCERIS WASP OBSERVED**
- **NESTS AND WASPS FOUND, UNSURE IF CERCERIS**
- **NESTS FOUND, UNSURE IF CERCERIS NESTS**
- **WASPS FOUND, UNSURE IF CERCERIS WASPS**
- **NO WASPS OR NESTS FOUND**
- **OTHER: PLEASE WRITE IN OBSERVATION SECTION**

ENTER THE DATA FOR THE WASP WATCHER VISIT. FREE WRITE ANY QUESTIONS OR PERTINENT DATA OR INFORMATION IN THE OBSERVATION SECTION.



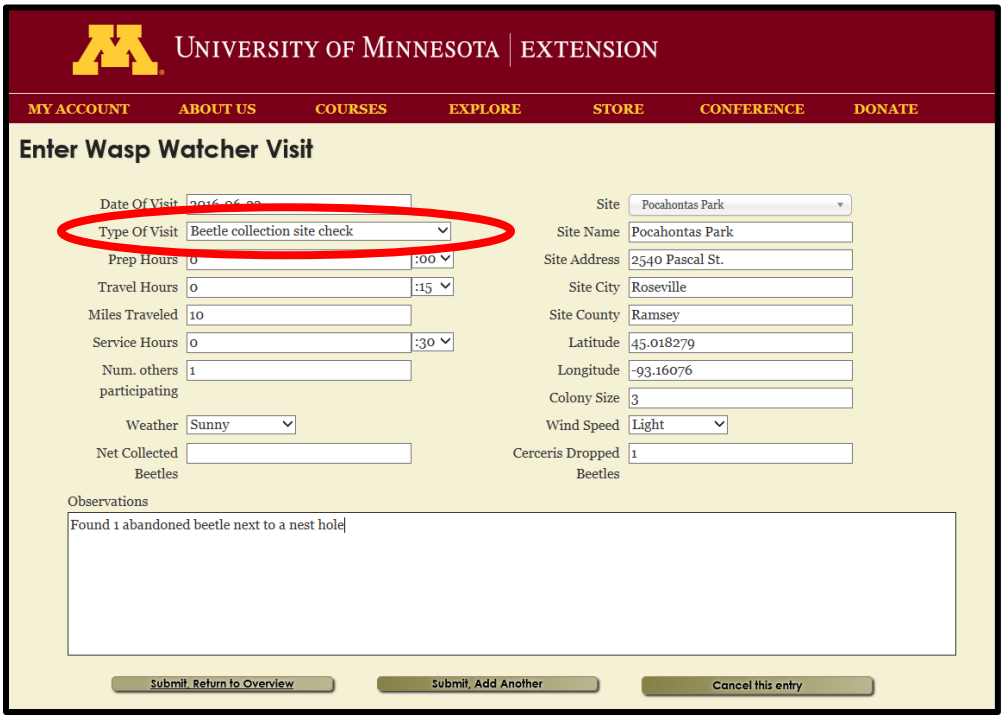
CLICK "SUBMIT, RETURN TO OVERVIEW" OR "SUBMIT, ADD ANOTHER"

WHEN YOU RETURN TO THE OVERVIEW, YOUR WASP WATCHER RECORDS SHOULD BE UPDATED WITH THE NEW ENTRY.

Beetle Collecting Data Entry

ON THE REVIEW WASP WATCHER VISITS PAGE, LOOK AT THE BOTTOM BOX LABELED WASP WATCHER RECORDS. CLICK ON ADD WASP WATCHER VISIT.

UNDER "TYPE OF VISIT" SELECT BEETLE COLLECTION SITE CHECK.
ENTER DATA, INCLUDING THE # OF BEETLES COLLECTED. "NET COLLECTED BEETLES ARE BEETLES YOU CAPTURED IN YOUR AERIAL NET. "CERCERIS DROPPED BEETLES" ARE ANY BEETLES YOU FIND ON THE GROUND ABANDONED BY THE WASP.
WHEN YOU SELECT A SITE, THE ADDRESS INFORMATION SHOULD AUTOFILL FOR YOU.



WHEN DONE, CLICK "SUBMIT, RETURN TO OVERVIEW" OR "SUBMIT, ADD ANOTHER" WHEN YOU RETURN TO THE OVERVIEW, YOUR WASP WATCHER RECORDS SHOULD BE UPDATED WITH THE NEW ENTRY.

UNIVERSITY OF MINNESOTA | EXTENSION

Cerceris fumipennis wasp
Presence/Absence Data Sheet

Please fill out a data sheet for each ballfield/site that you check for Cerceris fumipennis nests. Please either enter your data into the Wasp Watchers website (http://z.umn.edu/waspwatchers) or mail the data sheet to the University of Minnesota within a week of checking the site so we can update our online map. Thank you very much for your help.

Your name: **Your e-mail or phone #:**

Name of site: (park or school name, etc.)

Site Street Address:

Name of city: **Name of county:**

Latitude/Longitude (if known)

Date: **Time:**

Number of Minutes spent at site:

Cerceris fumipennis wasp found? (check one)

- ☐ Cerceris fumipennis nests found and wasp was observed.
- ☐ Cerceris fumipennis wasp observed, but no nests found.
- ☐ Nest found, but unsure if it is Cerceris fumipennis.
- ☐ No wasps or nests found at site.
- ☐ Other: _____

If Cerceris fumpennis is found, please give details about where the nests were located at site. (For example: on Northeast field between home plate and 3rd base.):

Other site visit notes (note status of fields—well groomed, encroaching vegetation, etc.):

Return to: Jennifer Schultz, Entomology
219 Hodson Hall, 1980 Folwell Ave.
University of Minnesota
St. Paul, MN 55108

UNIVERSITY OF MINNESOTA | EXTENSION

Emerald Ash Borer Biosurveillance Beetle Collecting Data Sheet

Please fill out a data sheet each day you collect beetles at your colony. Return the data sheets to us at the end of the season with your beetles. Thank you very much for your help!

Your name:

Name of site: (park or school name, etc.)

Name of city: Name of county:

Date: Time:

Temperature (if known):

Sunny / partly sunny / mostly cloudy / cloudy (circle one)

Wind speed: Light / moderate / strong (circle one)

Number of nests in your colony today:

Number of people carrying out biosurveillance today:

Time spent at site today:

Total Number of beetles collected today:

- Number of beetles collect by net:
- Number of abandoned/dropped beetles collected:

Comments/observations:

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