

Emerald Ash Borer
(*Agrilus planipennis*)

A Report to Congress

By

USDA Forest Service

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Executive Summary

The emerald ash borer (EAB) is a non-native pest that has killed tens of millions of ash trees in North America, and poses a serious threat to our nation's ash resources.

Ash trees are an important part of the rural and urban forests of the US, valued at more than \$282 billion. Ash trees are an important component in forests and riparian corridors, and are commonly planted in urban landscapes across the country. Since its introduction, EAB has had a significant impact on the ecology and economy of infested areas.

EAB was first found in the US in southeastern Michigan in 2002, although it was likely introduced into the area in the early 1990s. In the years prior to its detection, EAB-infested material was moved from Michigan to many areas around the US, and it is now found infesting portions of 13 states.

One of the greatest challenges is to detect EAB infestations early enough to manage them and prevent their spread.

Previous to its identification in North America, very little was known about the biology or control of EAB in its native Asia. Basic research into its life cycle, flight capabilities, host preferences and natural enemies was necessary. Studies were also necessary on methods to detect EAB and EAB-infested trees.

By 2009 much had been learned about EAB: It has become clear that the EAB infestation is much more widespread than first thought.

The management of EAB is the joint responsibility of several agencies in the US Department of Agriculture: the Animal and Plant Health Inspection Service (APHIS), Natural Resources and Conservation Service (NRCS), and the US Forest Service.

Whereas APHIS is the lead agency on regulatory actions against EAB and has supported research, the Forest Service (FS), through its delegated authorities, provides technical and financial assistance on EAB management to state, Tribal, private and federal land managers, local communities and other organizations, and conducts research on EAB.

In the beginning, APHIS concentrated its efforts on delimiting the EAB infestation, containing it, and attempting to eradicate. The FS provided technical support to these efforts as well as significant funding toward research on EAB biology and development of tools.

The FS and APHIS worked together with states and others to provide information to the public about the threat of EAB and how to recognize the beetle and its damage to trees, and providing cooperators with training kits and outreach materials.

Communities and woodland owners have been affected by the removal of EAB-damaged trees. The FS, using appropriated funds and funds from APHIS through the Commodity Credit Corporation, provided financial assistance for the replacement of trees removed

through eradication activities. As eradication efforts declined, FS support of these tree replacement projects decreased.

The FS initiated work on survey techniques, chemical and biological control and ash reduction-based control methods.

The FS developed a national EAB risk map to target survey and monitoring efforts, as well as conducted aerial photography of potentially infested areas.

Local eradication of infestations is expensive and often unattainable. There are 13 states with EAB infestations; even the most recent infestations found are estimated to be three to five-years-old.

As the EAB program has transitioned from an emergency response to a management program, FS has taken on a larger role.

Several of the tools developed during the past 5-6 years were integrated into a pilot project to SLow Ash Mortality (SLAM). Partners in this pilot project include APHIS, FS, and the Michigan Department of Agriculture.

Several FS, State & Private Forestry Redesign projects as well as American Recovery and Reinvestment Act (ARRA) projects have provided funds to conduct EAB survey, preparedness, management and restoration.

Through cooperation with universities, the FS is looking at innovative ways to provide education, outreach and training to professionals and the public. Live webinars and a comprehensive EAB website www.emeraldashborer.info are now available to help inform the public, communities and others about EAB identification and control.

The FS will continue to partner with APHIS and states, Federal land managers, tribes, communities, arborists, forest product businesses and others to develop and implement an integrated strategy to manage EAB in rural and urban forests.

The FS recognizes that firewood may provide a significant pathway for the inadvertent transport of EAB and has participated in broad public outreach campaigns to educate the public about the movement of EAB-infested ash firewood, which poses a significant threat to the health of forests nationwide. FS is working with APHIS, which has held public hearings and convened a National Firewood Task Force to explore options and approaches to dealing with this issue.

The FS will provide its partners with technical advice and financial support to prepare for an infestation and restore and rehabilitate impacted landscapes.

Through replanting activities, the FS will work with urban and community foresters to restore healthy and sustainable urban forests following EAB infestations. There will also be a focus on long-term objectives, such as ash germplasm conservation, identification of resistant ash strains, and silvicultural guidelines.

Background

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, is a devastating, wood boring beetle native to Asia. It was first found infesting trees in North America in southeastern Michigan and adjacent areas of Ontario, Canada, in 2002 (USDA Forest Service, 2008). Within the core infested area of Michigan, Indiana and Ohio, more than 50 million ash trees are estimated to be dead, dying or infested by EAB (Smith et al. 2009). Elsewhere, EAB already has killed tens of millions of ash trees, and continues to pose a serious threat to the ash resource of North America.

Although EAB was first found in the US in 2002, it is likely that EAB was introduced into the area around Detroit in the early 1990s (Kovacs et al. 2009). It is not known how EAB arrived in the US, but a likely pathway is solid wood packing material associated with cargo from Asia. Soon after EAB was recognized as a serious pest, five counties in Michigan were placed under quarantine; however, in the years prior to its detection, EAB-infested material, such as nursery stock, ash logs, and firewood, were most likely moved from Michigan to many areas around the US. Surveys in 2003 found EAB in 12 counties in Michigan, and three counties in northern Ohio. As of 2009, EAB infestations have been found in 13 states: Michigan, Ohio, Indiana, Illinois, Maryland, Pennsylvania, Missouri, Virginia, West Virginia, Wisconsin, Kentucky, Minnesota and New York (Fig. 1). In Canada, infestations are known to occur in several areas of Ontario and Quebec.

The broad distribution of EAB in the US and Canada is largely due to the inadvertent movement of infested ash nursery stock, unprocessed logs, firewood and other ash commodities. Once EAB is detected in a county, Federal and state quarantines restrict the movement of these materials (for details see Appendix A. Agency Authorities and Roles Appendix).

In its native range in Asia, EAB does not cause serious damage to ash trees. As a consequence, very little was known about the biology or control of EAB in Asia prior to its identification in North America. Basic information on its life cycle, flight capabilities, host preferences and natural enemies was necessary. Studies were also needed on methods to detect EAB and EAB-infested trees. One of the greatest challenges in managing EAB to this day is the limited ability to detect EAB infestations early enough to effectively manage them and prevent their spread.

Since its introduction, EAB has had a significant negative impact on the ecology and economy of infested areas. All 16 species of North American ash appear to be susceptible to EAB attack. Ash trees are an important part of the rural and urban forests of the US, valued at more than \$282 billion (Federal Register, 2003). White, green and black ash make up more than 7 percent of the hardwood forests in the northeastern US; however, in certain areas, such as western New York, Pennsylvania and the upper Midwest, ash may make up 20 to 40 percent of the forest. Ash wood is used for a number of applications including tool handles, baseball bats, furniture, cabinetry and paper. In the nation's urban forests, Green Ash is often the tree of choice for landscaping in new residential areas and commercial plantings, and is one of the most common species along streets, and in parks and yards. Annually, the nursery industry produced an

estimated 2 million ash trees, valued at approximately \$140 million. Ecologically, the 16 species of ash fill a number of niches, from riparian areas to upland forests.

Agency Authorities and Roles

EAB-related activities within USDA are coordinated among the Animal and Plant Health Inspection Service (APHIS), Forest Service (FS) and the Natural Resources Conservation Service (NRCS). The lead federal agency responsible for responding to EAB is APHIS, Plant Protection and Quarantine (PPQ). The corresponding entity at the state level is generally the state Department of Agriculture. APHIS works with states to survey, and to establish and implement the regulatory framework, as well as providing funds to states to support regulatory, response and outreach activities. The FS provides technical and financial assistance to support ongoing activities in:

- ash utilization
- biological investigations, communication and outreach
- detection, survey, and monitoring
- preparedness and prevention
- ecological, economic and social impact assessments
- resistance and restoration activities in impacted areas.

In addition FS conducts science-based research and develops the technology needed to conduct these activities.

The NRCS is cooperating with the FS, state forestry agencies, and other partners to distribute technical information and provide technical and financial assistance to rural forest landowners. Through its Environmental Quality Incentives Program (EQIP), NRCS assists forest landowners with tree planting, forest-stand improvement, and other conservation practices. The USDA implements these programs with the cooperation of state forestry agencies, state departments of agriculture, state and local governments, communities, and others (for more information on agency authorities and roles see Appendix A).

Other USDA agencies that work on EAB include the Agricultural Research Service (ARS), which has responsibility for knowledge development and application in agricultural production and in protecting crops from pests and disease; and the National Institute of Food and Agriculture (NIFA), formally known as the Cooperative State Research, Education, and Extension Service (CSREES), which does not directly perform research, education, and extension, but rather provides national partnership and funding for cooperative state and local research, education, and extension programs.

The Early Years (2002 to 2007)

With the discovery of EAB in the Detroit area in summer, 2002, a steady stream of visitors came to the site to view the new exotic pest and its damage, to assess its potential threat, and to participate in discussions on how to respond. Prior to 2002, most of our experience in responding to an exotic wood borer had been with the Asian Longhorned

beetle (ALB) in New York City (1995) and Chicago (1998). That experience became the “template” for coordinating the multi-agency response to EAB. Little did we know that EAB would pose a much bigger and more complex problem than ALB, one that would challenge science as well as professional opinion.

The FS and APHIS have a long and successful history of collaborating on pest problems. This excellent working relationship has been honed through the agencies’ collaborative work on gypsy moth, especially the Gypsy Moth “Slow the Spread” Program. Relationships of such caliber exist at the state level as well. Through these collaborative efforts, many of the people at the federal and state levels who would be responding to EAB knew each other personally and had worked together on other forest pest issues. This working environment set the tone for the commitment of people to the project and the near seamless coordination between the federal and state agencies. The agencies and their staffs “hit the ground running.”

The FS supports the evaluation and eradication of exotic forest pests and the management of new pests when they become established. Although not the lead federal agency in the response to EAB, the FS made a commitment to bring to bear forest entomology, research and forest health skills and added capacity to assist and support the effort. Ultimately, the FS and State Forestry agencies had a significant stake in this response because it was in their best interests to do all they could to help the plant-pest regulatory agencies succeed in their efforts to contain and eradicate EAB, so that we would not have to deal with this insect and its impacts in the hardwood forests and riparian areas of the U.S.

From the outset, it was clear we were mounting an “emergency response” against EAB. The objective of APHIS and the Michigan Department of Agriculture was to delimit or characterize the infestation, contain it, and then eradicate it. The first order of business was to determine the scope (delimit) of the infestation around Detroit. To that end, the FS detailed personnel to the project area to assist in the surveys. Concurrent with the field work, scientists in FS, APHIS, and universities scoured the published literature and contacted colleagues in China and elsewhere to find out as much as possible about this new pest.

The roles and responsibilities identified by FS for responding to new pest introductions had been previously developed and validated in the response to ALB in Illinois and New York, and were quickly adopted and implemented for EAB. In following that successful template for coordinating the multi-agency response to ALB during the Early Years, the FS focused on: technical and scientific support, early detection, and the restoration of areas impacted by EAB. In addition, communication and outreach activities were prioritized.

1. *Technical and scientific support*

The FS provided technical and scientific support to Federal and State plant-pest regulatory agencies in the delimitation, containment and eradication of EAB. In this role the FS committed on-site personnel for extended periods to assist with planning, delimitation surveys, communications and outreach, and help organize the initial response, at least until the lead agencies could marshal sufficient

permanent personnel to replace them. Because so little was known about EAB at the outset, data were urgently needed in a number of subject areas. During the Early Years, the FS committed significant funding, skills and research capacity to develop tools and technology in the following general areas:

- EAB biology, behavior, and ecology
- detection, survey and monitoring
- control tools
- natural enemies
- origin and epidemiology
- impact assessment
- landscape and forest-settings management

2. *Early detection*

The FS is responsible for monitoring the health of the nation's forests, which includes detecting and assessing insects and pathogens that threaten forest and tree health. To that end, the FS participated in detection and monitoring activities designed to locate and identify infestations outside areas known to be infested. The FS committed resources to develop survey tools and methods to conduct EAB surveys in high risk sites (campgrounds, lumber mills, other wood processing facilities, etc.), in states where EAB had not been detected. Early detection efforts included developing traps and attractants and the evaluation of remote sensing techniques.

In collaboration with APHIS, FS evaluated the relative attraction of EAB to healthy adult ash trees and seedlings, stressed trees and seedlings, and to trap logs. We determined that stress-induced ash seedlings attracted more EAB than did healthy seedlings. Purple prism traps baited with chemicals emitted by stressed seedlings were significantly more attractive to EAB than un-baited traps. These results have contributed to operational survey and detection programs implemented by APHIS, state regulatory agencies, and FS State and Private Forestry (S&PF).

3. *Restoration*

Affected communities and woodland owners needed advice and technical and financial assistance to deal with the loss of their trees. Communities are particularly hard pressed to deal with the cost of replacing dead and dying trees. The FS utilized Commodity Credit Corporation (CCC) funds (provided to FS from APHIS) to support the replacement of trees that had been ordered removed from public places (eradication programs). This was in line with the FS's objective to support successful eradication efforts: a lesson learned from the Asian longhorned beetle program was that the public would more readily support a plan to remove street and landscape trees if a restoration component was part of that plan. As fewer eradication projects were attempted, fewer resources were committed to replanting. During the Early Years, replanting initiatives were funded in follow-up to EAB eradication projects in Indiana, Maryland, Michigan, and Ohio.

4. *Communication and outreach*

Since 2002, considerable effort has gone toward the development of educational programs to inform the public about the threats posed by EAB and other invasive species, and how citizens can get involved in prevention, detection and mitigation efforts. Educating a larger community of cooperators who could assist with detecting and preventing the spread of EAB is critical to successfully preparing for the pest's arrival. Outreach efforts have been targeted toward key recipients including regional and national experts in tree care industries such as: nurseries and garden centers, arborists and other tree care professionals; universities; professional organizations; state and municipal governments including County extension master gardeners. In addition, to raise awareness public presentations have been given across the country to public and private campground managers, nonprofit organizations, garden clubs, school groups, and the general public. The FS continues to be committed to participate in the development, printing and distribution of a series of EAB information products to all cooperators. Publications, including the *EAB Pest Alert*, *EAB ID card*, *What is an EAB* brochure, *Don't Move Firewood* poster and *Identifying Ash Firewood*, became integral to the EAB Response Program. As well, the FS customized some printed products to better fit individual States' planned public outreach programs. To date, the FS has printed and distributed more than 4 million of these publications to EAB cooperators across the country, in Canada, and abroad. Other key communication and outreach items included:

- the EAB portal website established with Michigan State University to service the EAB program and provide links to other sites www.emeraldashborer.info/
- *Green Menace* DVD, a collaborative effort with APHIS and Detroit Public TV
- a regional EAB communications team, which works with federal and state agency communicators to help keep outreach programs "on message"
- EAB training kits
- FS, EAB liaison position in Brighton, MI, to facilitate communication and coordination between FS and APHIS. (This office also serves as a distribution point for EAB publications)
- FS communications specialist to represent FS on the regional EAB communications team.

Synopsis of 2002-2007

2002

The FS assisted in the delimitation of the EAB infestation in the Detroit area, including the completion of an aerial photographic mission of the quarantine area, to help detect and quantify the number of trees affected.

2003

Work focused on survey and monitoring activities in Michigan and Ohio. Spot infestations were discovered in Columbus and Hicksville, OH, Prince Georges County,

MD, and Arlington County, VA. A national EAB risk map for targeting survey and monitoring efforts was developed (Poland and McCullough 2006). Methods-development work and research geared up to begin answering critical questions on survey techniques, chemical and biological control, EAB survival in wood chips, and the development of markets for ash wood and fiber. EAB pest alert developed and printed. EAB Science Panel established and met for the first time.

2004

Forest Service detection activities expanded to include surveys on federal, public and private lands in 21 states. Trap trees (trees purposefully injured to attract EAB for sampling) were used in addition to visual surveys and destructive sampling. Containment cuts serving to suppress EAB outbreaks were made at six sites in four Michigan counties. The EAB Science Panel met at the end of 2004 and, based on the new EAB picture, considered a large-scale ash reduction effort in Michigan, Ohio and Indiana. Over 300,000 copies of the EAB *Pest Alert* and 1,200 EAB identification kits were distributed. Development began on the EAB portal website, www.emeraldashborer.info/.

Research efforts focusing on biology, rearing, impact, detection, surveying, monitoring, biological and chemical control, management in nursery, landscape and forest-settings continued.

2005

Early-detection surveys continued on federal, public and private lands. Spot infestations underwent attempted eradication efforts, and spread and dispersal capabilities of EAB were evaluated. In collaboration with APHIS, the FS began to identify the pathways for artificial movement of EAB for possible regulation. Financial assistance was made available to support infrastructures for the utilization of ash trees destined for landfills, in support of reclaiming the ash lumber for uses beyond firewood and biofuels, such as baseball bats, furniture, flooring, molding, paneling, park benches, etc. The expansion in research and methods development on biology, rearing, impact, detection, control, and management began to bear fruit with an increase in science-based knowledge and products such as identification of possible biological control, conventional, and microbial controls and better understanding of EAB selection and larval development on North American ash species.

2006

The EAB Program continued to extend its survey area and methods (trap trees), identify and regulate pathways for artificial movement of EAB, and develop compliance agreements with businesses. After a large increase in the number of spots needed to be treated in Indiana, Ohio and Michigan, making eradication an increasingly unrealistic goal, eradication efforts ceased or were scaled back. EAB infestations were confirmed for the first time in northern Illinois. By the end of 2006, the APHIS EAB quarantine area encompassed 136,000 square miles. Research efforts continued to focus on a variety of biology, ecology, impact, detection, and control projects such as improving detection methods and treatments, better understanding the insect and its spread, and developing silvicultural guidelines for managing affected forests. A microbial formulated with *Beauveria bassiana* strain GHA was found to be highly virulent against EAB and a conventional insecticide was proved useful for protecting landscape ash. Research also

determined that EAB is attracted to ash trees stressed by girdling and herbicide treatment, and mapped the diffusion of trunk-injected C¹⁴-labelled imidacloprid to determine optimal insecticide application techniques and timing. The FS also contributed to the scientific knowledge used to establish state and federal regulatory guidelines for removal and disposal of EAB-infested trees.

2007

New counties continued to be added to the list of EAB-positive counties in Illinois, Indiana, Michigan and Ohio. Pennsylvania and West Virginia reported their first infestations. FS activities included the evaluation of chemical controls and 3 EAB biocontrol parasitoids, EAB survival in wood chips and firewood, and gene-conservation work, and an agreement to develop an ash-gene conservation plan. In addition, the Great Plains Tree and Forest Invasives Initiative (GPI) was funded in Kansas, Nebraska, South Dakota and North Dakota focusing on prevention activities in case EAB spread to the West. Also, the development of an efficient laboratory rearing methodology for EAB was started, enabling production of larger number of parasites needed for evaluations and mass production.

The Transition Years (2008 to 2009)

Dramatic changes in the emerald ash borer (EAB) response program began in 2008. Eradication objectives proved to be unattainable given the pest's biology and the lack of tools and technology available for early detection and control (GAO 2006). Although trap trees were the most sensitive survey tool, they were very expensive and labor-intensive. In order to find EAB larvae, trap trees had to be selected and girdled before spring, cut down in the fall, and the trunks and branches had to be laboriously and painstakingly peeled. In contrast to Asian longhorned beetle, finding EAB larvae in very lightly infested trees is very difficult. As well, there were training and safety issues regarding the use of equipment to girdle, cut down and peel trees. Eradication treatments were limited to cutting down infested and often adjacent host trees (trees as small as 1 inch in diameter) and grinding them into wood chips. High cost aside, eradication was not effective. This had less to do with the treatment method than with the ability to accurately delimit the actual size of spot infestations. Furthermore, it appeared that every EAB spot infestation found during the Early Years actually had been there well before the EAB response program was initiated. Dendrochronological evidence at sites identified between 2002 and 2004 suggested that EAB had been established at these sites prior to 2002 (Kovacs et al. 2009), and before regulations were put in place to prevent the artificial movement of EAB-infested commodities. Program changes were needed.

Following the EAB Science Panel meeting in October, 2007, EAB program officials decided to: 1) adopt the purple prism traps baited with the Manuka oil lure as the primary detection tool; 2) implement a national EAB survey program; 3) expand and implement a "leading edge" survey to further delimit the EAB infested area. The response strategy was also revised by APHIS. The new policy modified the conditions under which eradication efforts would be supported by the program, curtailing all eradication treatments of the type that were pursued in the Early Years. Eradication treatments would be considered only if a spot infestation met these criteria:

- The EAB spot must be a single, clearly identifiable, regulatory incident, such as moving nursery stock, firewood, or other host material beyond a 150-mile buffer around the area generally considered to be infested.
- Using the dendrochronology tool and a delimiting survey, the EAB spot must be less than 2-years-old or have no more than one population release from the original host material.
- Using the most current technology, there must be a high probability of eradication success, i.e., the point of introduction and age of infestation must be known.
- The EAB Management Team may consider control cuts for EAB populations older than 2 years, providing circumstances are such that eradication in the outlier site may be achieved or strategically important for slowing the spread.

The only tree removal treatments that were still being supported in 2008 and 2009 were those in Prince Georges and Charles Counties, Maryland.

These and other decisions led to the transition of the EAB program from an emergency response to a management program. Such a management approach, similar to the USDA gypsy moth management program, would include management objectives and agency roles and responsibilities for “generally infested areas,” the “leading edge,” and uninfested areas. Regulatory activities, biocontrol, research and methods development, and survey and management would be prominent features of the new approach.

During these transition years, the FS and others came to realize that EAB had a much larger footprint across the landscape than was ever anticipated, and it was not going to be possible to eradicate EAB from North America. All the spot infestations that had been found prior to the detection in 2009 of the insect in Minneapolis, MN, were established before the EAB response program was put in place in 2002 or before regulatory efforts were in full swing. While ramping up, more and more discussions on EAB management were tending toward the gypsy moth model. However, whereas the gypsy moth model is convenient, we need to remember that the current gypsy moth management approach and tools have more than 100 years of research behind their development, and we have been acquainted with EAB for only 7 short years. Just as we are woefully short of tools and tactics for use against EAB, we are short of effective management recommendations and prescriptions. Nonetheless, the progress made in 7 years of focused research and development has been very significant. Since 2003, more than 200 scientific publications have been produced on EAB, greatly increasing our knowledge of EAB biology and control. (The list of publications is available upon request to the Forest Service.) Continuing at the same or higher level of commitment will be necessary if we are to implement something similar to the gypsy moth model.

One of the most significant changes in FS priorities during this period was the commitment to examine potential tools and tactics developed during the Early Years of the response program. This included managing or manipulating EAB spot infestations to prevent or slow their growth or spread across the landscape. This is most evident in the 2008 FS decision to implement the SLOWing Ash Mortality (SLAM) pilot project in two isolated EAB outlier sites in Michigan’s Upper Peninsula. As part of the SLAM pilot

project, ash inventories and EAB detection surveys were conducted in 2008; treatments begun in 2009 will be implemented annually during this long-term pilot study and efficacy will be evaluated using intensive sampling and dispersal models. In addition, an analysis was initiated in 2009 to examine the economics associated with implementing a SLAM strategy. Funding through the American Recovery and Reinvestment Act (ARRA) was secured in 2009 to expand the project to two more sites in the Upper Peninsula and to finance the work through 2011.

Other issues that will need more attention include technical assistance in EAB management programs and the issue of long-distance firewood movement. It is clear that, within the EAB quarantined areas, our state partners need technical and financial assistance to prepare for EAB, manage it when it arrives, and restore damaged areas. In addition, the “firewood issue” has gained traction with state foresters, FS and APHIS, and discussions could lead to some national action or campaign. Some jurisdictions are seeking a national standard regulating the movement of firewood. In 2009, a multi-agency, Federal and State National Firewood Task Force, was convened by APHIS to examine options and provide recommendations on preventing human assisted spread of EAB and other forest pest with firewood.

FS partners have weighed in with their recommendations, priorities and needs. The Great Plains Tree and Forest Invasives Initiative was selected as a State and Private Forestry (S&PF) “Redesign” pilot project in August 2007 for work to be done in 2008 and 2009. The purpose of the Great Plains Initiative was to develop a comprehensive 4-state multi-agency response plan to EAB and future harmful invasive species. In 2008 and 2009, nine proposals related to EAB survey, outreach, and management were submitted by state foresters through the State and Private Forestry (S&PF) “Redesign” process and funded by the FS. (Redesign is a mechanism used by S&PF to focus funds on high priority, landscape-level issues.) In 2009, Congress directed the FS to allocate \$2 million to reforest and replant areas heavily impacted by EAB in the Midwest. These funds went to the state foresters in Ohio and Michigan for critical work in the Toledo and Detroit areas. Also in 2009, ARRA funding was secured to restore and replant affected areas around Detroit and Toledo. In FY 2010, the FS is positioned to receive \$3 million from the Environmental Protection Agency Great Lakes Restoration Initiative to assist communities and landowners within the Great Lakes watershed area. The funds will be used to prepare for the arrival of EAB, remove infested and dying trees, and restore affected areas.

In 2009, the Northeastern Area (NA) of the FS completed a new EAB strategic plan to guide priorities and investments. The plan describes a movement away from the response objective of the Early Years, and toward a plan that helps communities, homeowners and landowners prepare for EAB and restore damaged ecosystems. A shift of FS priorities and investment began to take place during these transition years.

Synopsis of 2008-2009

2008

Approximately 40,000 purple prism traps and lures were systematically deployed (grid) along the 100-mile buffer (“leading edge”) by APHIS and their cooperators. Also, they

implemented a national survey deploying additional traps in high-risk sites in 48 states. In total, approximately 60,000 traps were deployed. The highly visible nature of the purple prism traps also drew considerable public attention to the EAB Program. New EAB spots were detected in Virginia and Missouri. At the end of 2008, EAB infestations were known in 10 states: Illinois, Indiana, Maryland, Michigan, Missouri, Ohio, Pennsylvania, Virginia, West Virginia, and Wisconsin. The EAB federal quarantine encompassed 189,711 square miles. FS activities of note in 2008 included:

- Partnering with APHIS, completion of the EAB Biological Control Rearing Facility in Brighton, MI
- provided parasitoids for starter colonies in the laboratory
- supported development work to fine tune rearing technology for the parasitoids
- planned and funded the SLOWing Ash Mortality (SLAM) pilot project in Michigan's Upper Peninsula
- funded five S&PF Redesign projects involving EAB survey, outreach and management
- drafted plans for ash-seed collection and ash-gene conservation
- partnered with APHIS to conduct a joint Request for Proposals to develop high-priority technology and methods
- partnered on communication and outreach activities
 - the national "Don't Move Firewood" campaign
 - "Symposium on Ash in North America," planned for March 2010
- investigated possible EAB-resistant ash strains
- supported ash seed collections
- supported street tree inventory and EAB impact assessments in key municipalities
- continued support of the Great Plains Initiative

2009

Again, approximately 40,000 purple prism traps and lures were systematically deployed along the "leading edge" in 2009 by APHIS and their partners. They also deployed traps in uninfested states as part of the national EAB survey initiative. New EAB records were confirmed in Minnesota, New York and Kentucky, bringing the total number of States with confirmed EAB infestations to 13. The APHIS EAB biological Control Laboratory began rearing EAB parasites in order to evaluate and fine tune the production techniques. Noteworthy FS activities supported in 2009 included:

- funded four S&PF Redesign projects related to EAB survey, outreach, preparedness and management
- funded \$2 million in earmarks to provide resources to remove and replace dead and dying ash trees in heavily impacted areas in and around Toledo and Detroit
- supported a second year of funding for the SLAM pilot project
- supported surveys and inventories of EAB spot infestations in Missouri and Indiana to determine if they are candidates for the SLAM pilot project
- secured \$3 million in Great Lakes Restoration Initiative funding to assist communities in the Great Lakes watershed prepare for the arrival of EAB, and deal with tree removal and replacement in EAB-affected areas

- secured American Recovery and Reinvestment Act (ARRA) funding for SLAM, including expansion of the project to two other areas in the Upper Peninsula
- secured ARRA funding for ecosystem restoration in heavily impacted areas in and around Detroit and Toledo
- conducted a second year of EAB biosurveillance activities to assess the potential of predator *Cerceris fumipennis* as an early EAB detection tool
- developed a pilot project, “EAB University,” to test the use of live webinars and related technologies to advance training and distribute information on a wide range of EAB subject areas
- delivered detailed insecticide recommendations for arborists, communities and homeowners
- standardized ash-seed collection protocols with NRCS and Agriculture Research Service (ARS) to ensure a consistent approach to seed collection
- completed a new economic analysis of EAB that projects more than \$10 billion in potential costs to remove and replace trees in communities over the next decade (Kovacs et al. 2009)
- initiated an EAB Citizen Monitoring project in northern Virginia that capitalizes on the skills of Master Gardeners and citizen volunteers
- conducted firewood surveys to evaluate firewood’s potential as a pathway for invasive insects.

The New Frontier: 2010 and Beyond

Since the first detection of emerald ash borer (EAB) in 2002, through the fall of 2009, there have been gains in understanding the biology and management of this non-native insect. The FS will continue to partner with APHIS, state departments of agriculture and forestry agencies, to implement a response strategy for managing EAB infestations. In addition, the FS will continue to work both internally and with the broader research community to develop and improve the tools needed to manage EAB populations and assist communities and landowners in preparing for the arrival of the insect and the impacts it causes.

It is clear that EAB cannot be eradicated from the North American landscape (GAO 2006). As it has done when other insects and pathogens affecting our nation’s forests have been discovered, the FS will develop and implement an integrated strategy to manage EAB in both rural and urban landscapes. FS funding to support these efforts are provided in Appendix B. The FS and APHIS are preparing an EAB Response Framework, which will provide states, communities, businesses, homeowners and forest land managers with guidelines to prevent EAB movement, prepare in advance of an infestation, respond to an infestation, and recover from an infestation. Specifically, the Response Framework will emphasize the following:

Prevention: APHIS and State Plant Regulatory Officials will continue to restrict the movement of ash products and conduct outreach campaigns in order to minimize the human assisted spread of EAB to non-infested areas. In collaboration with Customs and Border Protection, APHIS also will continue to enforce international trade regulations, including ISPM 15 requirements for wood packaging materials, and to pursue innovative

new approaches including the 2009 publication of an Advanced Notice of Proposed Rulemaking for wood packaging materials moving interstate and the National Firewood Task Force mentioned earlier. In cooperation with these partners, the FS will engage arborists, forest-product businesses, campers, communities, state parks, National Forests, federal land management agencies, Tribal governments and others concerning the risks associated with moving infested ash products. Forest Service scientists have identified potential interstate pathways and evaluated the risk for EAB movement. FS will collaborate with APHIS to conduct research on disrupting those pathways, the science needed to refine regulatory strategies, and treatments to kill EAB in infested products.

Preparedness: Preparing for EAB should take place years before an infestation is detected. The FS, through its various State and Private Forestry staffs (S&PF) can provide assistance to state and local governments, community organizations, homeowners, forest land managers, Federal partners and tribal governments. The assistance can help to develop guidelines to manage urban and rural forests in various stages of an infestation, utilize harvested ash products, and mitigate impacts to high-value and unique ecosystems. Research and technology development efforts will focus on improving our understanding of EAB biology, behavior and ecology, and the roles of climate variability on EAB movement. Such research can be used to develop not just more effective strategies for EAB early detection, and management, but also strategies that can be adapted to different landscape conditions in the US. As we refine our knowledge about EAB we will be able to provide better information to communities, landowners and others to help them deal with the ecological, economic, and social impacts of this insect.

Response: Detecting and delimiting EAB are important steps to determining its severity and implementing an appropriate management response. Whereas APHIS will conduct EAB-detection surveys in support of its regulatory and response efforts, FS detection activities will be used to support management actions. Once an EAB infestation is found, the FS will provide technical assistance and science-based support to neighboring communities, landowners and others so they can act to minimize the impacts. Tactics that are being evaluated in the Slow Ash Mortality (SLAM) pilot projects may become part of a strategy to slow the spread of EAB.

Despite the best efforts to eradicate and manage the pest, EAB has proven to be a perfect pest and an elusive target. In some areas, communities and land managers may need to identify the highest-value areas and most unique ecosystems they wish to protect. Forest Service Stewardship, Urban and Community Forestry and Forest Health Protection staffs will work with partners to evaluate and implement EAB management options in these areas. Regardless of the management option chosen, the removal of ash trees may provide a usable wood resource that can be turned into valuable products and help defray the cost of tree removal. To that end the FS will provide technical assistance and facilitate ash utilization and marketing in EAB-impacted areas. As well, the FS will continue its efforts through SLAM and develop other tools and management tactics on EAB infested lands. These efforts will capitalize on findings from research and technology development work and will focus resources on developing more effective techniques for detection, monitoring, and methods for biological, silvicultural, genetic, and insecticidal control of EAB. Current and potential biological controls of EAB will be

assessed for effectiveness, especially with respect to their rates of establishment and impact on the EAB population.

Recovery: Once it enters an area, EAB is likely to eliminate a large portion of the ash resource. The FS will provide technical assistance and information needed to rehabilitate and restore EAB-affected rural and urban landscapes. The FS will work with urban and community foresters to replant and restore healthy and sustainable urban forests following an EAB infestation. In addition, to mitigate the danger from hazardous trees the FS will provide assistance with the removal of EAB-infested trees. Recovery research will focus on restoring and rehabilitating EAB-impacted urban, riparian and forested landscapes. In urban ecosystems, the goal is to replace infested ash with resistant ash or other species of trees that maintain the urban social values. In riparian and forested areas the strategy is to preserve existing diversity and function. Ash conservation and genetic improvement are key components of both strategies. The FS, in partnership with others, is conserving ash germplasm and is making strides toward identifying EAB-resistant ash strains, especially in hybrid ash. Long-term silvicultural research may provide guidance for management strategies for ash regeneration and stand composition in forested and riparian landscapes.

An important component of the EAB Response Framework being developed by the FS and APHIS will be community outreach and education. Community organizations and the general public alike will be important partners in the early detection and subsequent treatments of EAB infestations. The FS is working closely with Cooperative Extension offices to develop training for Master Gardeners, who in turn will educate community groups to identify and report EAB. As well, through its program, Emerald Ash Borer University (www.emeraldashborer.info), the FS will continue to work with Cooperative Extension staffs and others to provide webinars on EAB identification and management, the utilization of ash-wood products, regulatory issues, reforestation, and community awareness. The FS will continue to invest in several EAB communication tools, such as, the [emeraldashborer.info](http://www.emeraldashborer.info) website, *EAB Pest Alerts* and other publications, and EAB information kits. The FS is also part of the joint agency National Firewood Task Force that will look at ways to disrupt this pathway for EAB movement.

FS and its partners will maintain EAB as a high-priority pest. We will continue to conduct research and provide technical and financial assistance to manage and restore forests and communities impacted by this devastating insect pest.

Citations

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Figures and Appendices

Figure 1. Cooperative Emerald Ash Borer Project: EAB locations

Appendix A. Agency Authorities and Roles

Appendix B. Forest Service EAB Funding, 2006-2010

Appendix C. Forest Service Partners in Emerald Ash Borer Response

Appendix A.

Agency Authorities and Roles

There has been a significant Federal and State response to EAB. By Executive Order 13112 (February 1999), all Federal agencies dealing with invasive pests are required to work in consultation with the National Invasive Species Council (NISC), coordinate and collaborate with one another, and cooperate and share information with stakeholders, international organizations, and foreign countries.

Three agencies within the US Department of Agriculture (USDA) deal extensively with EAB: the US Forest Service (FS), the Animal Plant Health Inspection Service (APHIS), and the Natural Resources and Conservation Service (NRCS). Pursuant to the Plant Protection Act (June 2000) and other public laws, APHIS is the primary agency responsible for regulating to protect against non-native invasive plant pests, such as EAB, as well as any biological control organisms that may be used against invasive pests. In its broader mission, to protect the health and value of American agriculture and natural resources, APHIS works closely with other federal agencies, state departments of agriculture and tribes to restrict or prohibit the movement of plants, plant products and pests, and implement emergency procedures and actions to contain, control or eradicate destructive plant pests. Such close cooperation has resulted in the discovery of numerous areas where EAB is present and the designation of multiple quarantine areas.

The Plant Protection and Quarantine (PPQ) program of APHIS also aims to insure a strong domestic agricultural-pest detection system. PPQ has implemented a national survey effort for EAB, much of which is accomplished through agreements with state departments of agriculture and universities. As well, PPQ conducts EAB-related research to identify, develop, refine, and transfer technology for pest survey, exclusion, control, and risk assessment.

In accordance with the Food, Conservation and Energy Act of 2008, the 2002 Farm Bill, and other public laws, NRCS has helped America's private landowners and managers to conserve their natural resources and combat EAB. NRCS has provided conservation programs and activities in the areas of:

- technical assistance
- environmental improvement
- stewardship
- easements (e.g., Healthy Forest Reserve Program)
- community assistance.

Many of these NRCS programs provide technical and/or financial assistance to rural landowners and farmers to establish, protect, enhance, and manage trees and forests. NRCS's Plant Materials Program has partnered with the FS and the National Center for Genetic Resources Preservation and created the Ash Tree Seed Collection Initiative, the ultimate goal of which is to preserve ash trees in all the ash regions of the U.S.

Under the authority of the Cooperative Forestry Assistance Act of 1978, Forest and Rangeland Renewable Resources Research Act of 1978, the Multiple-Use and Sustained-Yield Act of 1960, American Recovery and Reinvestment Act of 2009, and other laws,

the FS has provided technical and financial assistance for a myriad of EAB-related activities. All three Deputy Areas of the FS—State & Private Forestry (S&PF), Research & Development (R&D), and the National Forest System (NFS) —are addressing the EAB problem.

- S&PF assists state forestry and agriculture agencies and other partners to provide resource-protection and management assistance to state and private land managers, local communities, organizations, and citizens of urban and rural areas. In addition, through its Forest Health Protection (FHP) section, S&PF provides technical and financial assistance to the National Forests, other Federal lands, and Tribal lands to monitor and control insect and disease pests.
- R&D works closely with universities and other scientific institutions to share knowledge with, and transfer technologies to, private land owners and managers in the U.S and abroad. Also, R&D provides expertise in detecting, controlling, and managing invasive plant pests, such as EAB.
- NFS is responsible for managing the public’s National Forests across 44 States, Puerto Rico, and the Virgin Islands. The lands comprise 193 million acres, or 8.5 percent of the total land area in the US. The natural resources on these lands have major economic, environmental, and social significance for all Americans. To help protect against the inadvertent spread of EAB onto the National Forests, NFS has restricted or prohibited the movement of firewood.

Appendix B.

Forest Service EAB Budget Allocations, 2006-2010

	2006	2007	2008	2009	2010*
	(dollars in thousands)				
State & Private Forestry	\$1,950	\$1,700	\$ 995	\$2,495	\$ 4,995
Research & Development	\$1,249	\$1,264	\$1,417	\$1,428	\$ 1,428
Total	\$3,199	\$2,964	\$2,412	\$3,923	\$ 6,423

* - 2010 S&PF allocation includes \$1.5 million as part of Pest Revolving Loan Fund

Appendix C.

Forest Service Partners in Emerald Ash Borer Response

Partners and Collaborators

Auburn Enterprises, LLC.
Canadian Forest Service Research (Sault Ste. Marie ON, Fredericton NB)
Chinese Academy of Forestry
College of Menominee Nation
Connecticut Department of Agriculture
Dawes Arboretum OH
Dempsey Middle School (OH)
Detroit Public Broadcast Station (PBS)
DTE Energy
ESSI, Inc.
Holden Arboretum OH
Illinois Arborist Association
Illinois Conservation Foundation
Illinois Department of Agriculture
Illinois Morton Arboretum
Indiana Department of Natural Resources
Indiana Plant Pest Regulatory
Ingham Resource Conservation & Development (RC&D)
Iowa Department of Agriculture
Iowa State Forester
Iowa State University
ITT, Inc. (formerly of Kodak)
Liberty Science Center (Jersey City, NJ)
Louisiana State Forester
M7 Visual Intelligence, Inc.
Maine State Forester
Maryland Department of Natural Resources
Massachusetts State Forester
Maumee Valley RC&D District
Menominee Indian Reservation
Michigan Department of Agriculture
Michigan State University (MSU)
Michigan Tech University (MTU)
Minnesota Campground Managers
Minnesota Consumer and Trade Protection
Minnesota Department of Agriculture
Minnesota Department of Transportation
Minnesota Forest Protection Task Force
Minnesota Forest Resource Council

Minnesota Invasive Species Advisory Council
Minnesota Shade Tree Advisory Committee
Minnesota State Forester
Missouri Department of Agriculture
New Hampshire State Forester
New Jersey Department of Agriculture
New York State Forester
Notabaert Nature Museum (Illinois)
Ohio Department of Natural Resources
Ohio State University (OSU)
Pallet & Container Corporation of America
Pennsylvania State University (PSU)
Pennsylvania Horticultural Society
Pennsylvania State Forester
PhylloM LLC
Purdue University
Southeast Michigan Resource Conservation and Development Council (RC&D Council)
Southern Illinois University
Specim, Inc.
SpecTIR, Inc.
The National Center for Ecological Analysis
The Nature Conservancy
Toledo Metroparks
U.S. Geological Survey (USGS)
University of Georgia (UGA)
University of Illinois
University of Michigan
University of California, Santa Barbara
University of Massachusetts (UMASS)
University of Minnesota
University of Missouri
University of Nevada, Reno
University of Wisconsin Extension: Town and Country Resource Conservation
Vermont State Forester
Virginia Department of Forestry
Virginia Master Gardeners from 5 counties in Northern Virginia
Virginia Tech University, Department of Wood Science and Forest Products
West Virginia Department of Agriculture
West Virginia University (WVU)
Wisconsin Department of Agriculture
