United States Department of Agriculture

Emerald Ash Borer Biological Control Program

5-Year Implementation Strategy (FY2010-2014)

October 2009

PEST STATUS and PROGRAM BACKGROUND

The Emerald Ash Borer (EAB) *Agrilus planipennis* (Fairmaire) (Coleoptera: Buprestidae) is a non-native wood-boring pest of North American ash (*Fraxinus* spp.)[1]. This devastating pest was first found in 2002 in southeastern Michigan and adjacent areas of Windsor, Ontario, Canada. It is thought to have been introduced in the 1990's on solid wood packing material originating from Asia. As of September 2009, EAB has been discovered in 13 states (Indiana, Illinois, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Virginia, West Virginia and Wisconsin) and parts of Canada.

This destructive beetle represents an enormous threat to North America's ash resources and forested ecosystems. Unlike many other wood boring beetles, EAB aggressively kills healthy as well as stressed trees. Larvae bore through the bark and into the cambium where they feed on the phloem. As the larvae feed they create serpentine-like galleries that disrupt the flow of nutrients, usually causing tree death after four to five years of infestation. Currently, there are no effective natural enemies attacking EAB in North America. If no new management strategies are developed, it is estimated this pest will likely spread to 25 states in the next 10 years, resulting in an estimated 10.0 billion dollars of economic damage (Kovacs et al. 2009). The USDA's Animal and Plant Health Inspection Service (APHIS), Forest Service (FS), and Agricultural Research Service (ARS) are working together to implement an EAB biological control program.

A classical biological control effort was initiated by APHIS and FS scientists shortly after the beetle was first found in Michigan. Foreign exploration to identify candidate biological control agents initially focused in The People's Republic of China (P.R. China), which led to the discovery of three promising parasitoid species: a gregarious larval ectoparasitoid, *Spathius agrili* Yang (Hymenoptera: Braconidae) (Yang et al. 2005); a gregarious larval endoparasitoid, *Tetrastichus planipennisi* Yang (Hymenoptera:

Eulophidae) (Liu et al. 2003; Yang et al. 2006); and a solitary, parthenogenic, egg parasitoid, *Oobius agrili* Zhang and Huang (Hymenoptera: Encyrtidae) (Zhang et al. 2005). In P.R. China, EAB populations are patchily distributed and population densities are low in stands of native ash, due to a combination of factors including host plant resistance and natural enemies. Based on the rates of parasitism of EAB by these species in P.R. China, their introduction has significant potential to reduce EAB population densities in the United States (Liu et al. 2007). Following host range testing in P.R. China and the United States, an environmental assessment was prepared outlining the risks and benefits of releasing these three parasitoids. After a 60-day public comment period and a Finding-of-No-Significant-Impact[2], APHIS and the State of Michigan approved release of these parasitoids in July 2007.

The first small-scale releases of these three parasitoids (few hundred parasitoids per release site) were conducted in Michigan in the summer and fall of 2007. Limited releases also took place in 2008, with more substantial releases (few thousand parasitoids per release site) occurring in 2009 in Michigan, Ohio, Indiana, Illinois and Maryland. All releases thus far have been conducted by researchers from APHIS, FS and ARS to establish the parasitoids as well as to answer basic biological questions. These "research" release sites are being monitored to determine numbers of parasitoids and site conditions for establishment, dispersal rates, impacts on EAB populations and ash health, interactions among released and native natural enemies, and effects on non-target species.

S. agrili released in Michigan in the fall of 2007 was recovered at one site in 2008 and *O. agrili* released in 2007 was recovered at two sites. Thus, it does appear that these parasitoids can survive Michigan winters. In 2009, within season recoveries of both *O. agrili* and *T. planipennisi* occurred at several release sites. Moreover, *T. planipennisi* was recovered almost ½-mile from the original release points at two different sites, confirming parasitoid dispersal. Research continues at these sites to monitor long-term parasitoid establishment and impacts on EAB populations.

Foreign exploration for additional biological control agents is on-going. In 2008 and 2009, additional natural enemies were found in Korea and the Russian Far East, including the discovery of new species of *Spathius* and *Tetrastichus*. Efforts are underway to rear and evaluate these species both in the countries of origin and in quarantine in the United States. If new agents are approved for environmental release, they will be incorporated into on-going research and operational programs to determine how they can best be utilized to support EAB area-wide management efforts.

Native parasitoids and predators do not appear to be providing a significant level of control (generally <5%). However, a number of species have been found to be locally abundant on EAB. For example, a native parasitic wasp in the genus *Atanycolus* (Hymenoptera: Braconidae) has been found attacking EAB larvae at a number of sites in Michigan. This may be an indication of a native predator learning to attack EAB. This and other native entomophagous species found associated with EAB are being studied by FS and ARS scientists to determine their biology, distribution and phenology relative to their impact on EAB populations.

TIMELINE

A 5-year plan (FY2010-2014) has been formulated to facilitate the development and field testing of biological control technologies for area-wide-management of EAB. An EAB Biological Control Production Facility was established at Brighton, Michigan, (=Brighton Production Facility) to mass-rear the three approved exotic parasitoids and potentially other natural enemies as they become available in the future. Operational releases of the different species will start in 2010 as production levels permit and will be monitored for establishment and impacts on EAB. Parasitoid release sites will be established across a range of EAB densities, ash species, and environs to determine the conditions under which each species is most effective. Results at the different sites will help determine the locations for mass-releases in subsequent years and potentially for establishing locations for field insectaries.

GOAL

Develop and evaluate biological control of EAB as a long-term management strategy in the United States.

OBJECTIVES

1. **Develop and implement mass-rearing efforts** for approved and permitted biological control agents of EAB.

2. **Facilitate the release of permitted EAB biological control agents** in all states infested with EAB.

3. **Determine overwintering and establishment of released biological control agents and the impact** of these agents on EAB populations and ash survival.

4. **Continue methods development activities** aimed at improving the rearing, releasing and monitoring of EAB biological control agents.

ACTION STEPS

1. **Develop and Implement Mass-Rearing Efforts**

1.1. Maintain laboratory research colonies of *T. planipennis*, *S. agrili* and *O. agrili* at APHIS, FS and ARS research facilities in an effort to refine rearing technologies and continue research efforts into natural enemy biology and behavior. Colonies from these research facilities will be used as needed to establish and maintain colonies at the Brighton Production Facility. Insects from China will be collected

periodically and incorporated into the Brighton colonies to help minimize the selection of laboratory adapted insects

1.2. The primary mission of the Brighton Production Facility is to mass-rear parasitoids for field release. This includes the collection of adequate host life stages to support the parasitoid rearing as well as assisting in the field collection of host life stages for evaluation of parasitoid establishment and impacts. EAB and its natural enemies are difficult insects to mass-rear. As such, the challenges of rearing these natural enemies will limit their availability for releases. However, as rearing methods improve and production increases, the goal is to be able to provide natural enemies for releases in all infested states on a priority basis.

2. **Facilitate Releases**

2.1. Develop an EAB Biological Control Manual and other outreach materials that can be provided to state cooperators and the public to aid in understanding and conducting the release, monitoring and evaluation of parasitoids.

Criteria for choosing suitable release sites include the following:

- positive evidence of EAB infestation (emergence holes, crown decline, epicormic shoots, woodpecker feeding)
- relatively high percentage (>25%) of ash in the overstory
- predominance of ash trees that are $\leq$25cm in diameter
- accessibility
- land owners have granted permission to conduct parasitoid releases
- sites are not subject to disturbances (logging, development, etc.) for at least 3 years

Each release will consist of a specified number of female parasitoids previously exposed to male parasitoids. The number of parasitoids released will be determined based on discussions with researchers. The releases must occur when the appropriate EAB life stages (freshly laid eggs for *O. agrili* and late 3rd or 4th instar for *S. agrili* and *T. planipennisi*) are present in the field. Because of geographic climate differences, the release season and the timing of releases will be different for different locations. Also, the duration of EAB life cycles needs to be considered when developing release and monitoring protocols (e.g., low EAB densities on healthy ash often need two years to complete their life cycles whereas EAB on heavily infested ash usually have a one year life cycle).

2.2. Initiate operational releases of EAB parasitoids in 2010 at a limited number of sites. States and sites chosen to receive parasitoids will be determined based on discussions between State Plant Health Directors and State Plant Regulatory Officials from EAB infested states and the PPQ EAB National Program Manager. The criteria for selecting release sites will be determined and modified as needed based on data collected from “research” sites. New detection sites that have or will have active eradication programs will not receive parasitoids. Program staff and

APHIS/FS/ARS scientists will work with Program managers and cooperators to ensure proper site selection and release protocols are followed.

2.3. Obtain State release permits and land use permits in a timely manner. These are necessary before any releases can occur at an infested site. This process can take 2-3 months. Cooperators interested in receiving parasitoids need to fill out APHIS PPQ Form 526 "Application for permit to move live plant pests, biological control agents, or noxious weeds". The application process and permits are offered through an on-line web-based ePermits system. The URL for this site is: http://www.aphis.usda.gov/permits/ppq_epermits.shtml.

3. **Determine Establishment and Impacts**

3.1. Seek agreement from State cooperators to follow standardized release and monitoring protocols provided by the Brighton Production Facility. They also must agree to monitor release sites for parasitoid establishment for minimum three years following each release. This information will influence the location and timing of future releases and will be integrated into GIS and available on the internet.

3.2. Seek agreement from all research and state cooperators making releases with material provided by the Brighton Production Facility to submit their data into a centrally managed, online, searchable database. The database will store precisely where, when, what and how parasitoids are being released and recovered in the United States. Stand health and EAB population data will also be included.

4. **Continue Methods Development**

Commit to on-going methods development activities that improve Program delivery. The EAB Biological Control Program is still very much in the initial stages of development and implementation. For example, current parasitoid rearing systems have not been optimized for such factors as temperature, humidity, photoperiod and host density. Similarly in the field, the appropriate number and combination of each parasitoid species to release and the frequency of parasitoid releases to best ensure establishment are not known. As such, the Program will actively encourage and support research and development efforts that specifically focus on these and other Program priorities.

LITERATURE CITED

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[1] Link to APHIS Emerald Ash Borer Program Manual
http://www.aphis.usda.gov/import_export/plants/manuals/domestic/downloads/emerald_ash_borer_manual.pdf

[2] Link to Environmental Assessment
http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0060