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<http://www.dcnr.state.pa.us/forestry/foresthealth.aspx>

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*Emerald Ash Borer Adult (Top left)
White Ash Killed by Emerald Ash Borer (Right)
Photo by H. Liu, PA DCNR*

Program Summary

1. A total of 27,479 acres of forest land were damaged in 2012.
2. Tree mortality/decline was found in 13,787 acres.
3. Pest activities were observed for 16 species in 10 counties.
4. Emerald ash borer (EAB) was confirmed in 9 new counties in 2012.
5. Emamectin benzoate was effective against EAB through tree injection.
6. EAB parasitoids *Spathius agrili* and *Oobius agrili* were recovered one year after initial releases.
7. Emerald ash borer community management plan was developed and being adopted by two communities.
8. No new counties for hemlock woolly adelgid (HWA).
9. A total of 1,160 hemlocks were chemically treated to suppress HWA.
10. Gypsy moth population is on the rise in northwestern and North Central Pennsylvania.
11. A gypsy moth suppression program is planned in 2013.
12. No Asian longhorned beetle was found through survey.
13. Exotic bark beetle survey completed without detecting any species of concern.
14. Walnut twig beetles were captured near the initial infestation site in Bucks County.
15. Survey for sudden oak death & butternut canker continued.
16. Diagnostic service, training, cooperation, extension, and outreach activities continued.



1. Weather Conditions

Agricultural weather statistics for Pennsylvania are provided weekly by the USDA-National Agricultural Statistics Service based on 59 reporting stations across 9 regions.



Hurricane Sandy on October 29, 2012
Photo by NASA GOES Project

Early Warming Up

Late Spring Coldness

Hurricane Sandy

The weather pattern in 2012 can be characterized as an early warming in March, cold spring in late April and early May, drought conditions in July, and major hurricane activities in late October. As a result, early bud break and flower development were observed for sugar maple and red maple across northern tier counties from late March to early April, about one month earlier than usual. Cold temperatures in April and May not only caused frost damage to young tree leaves in the central part of the state, but also led to poor seed crops of maples, and extensive anthracnose disease on oaks, maples, and sycamores on ridge tops and high elevations in eastern and northern counties. Drought conditions were reported in most regions in July. Hurricane Sandy passed through the southern and central part of the state in late October, leaving light to moderate damage to trees for several communities.



Oak Anthracnose
Photo by J. O'Brien - Forestry Archive, Bugwood

2. Pest Conditions

Forest pest conditions in forested land across the state were monitored through aerial surveys, forest insect and disease reports, and special projects.

2.1. Forest Discoloration

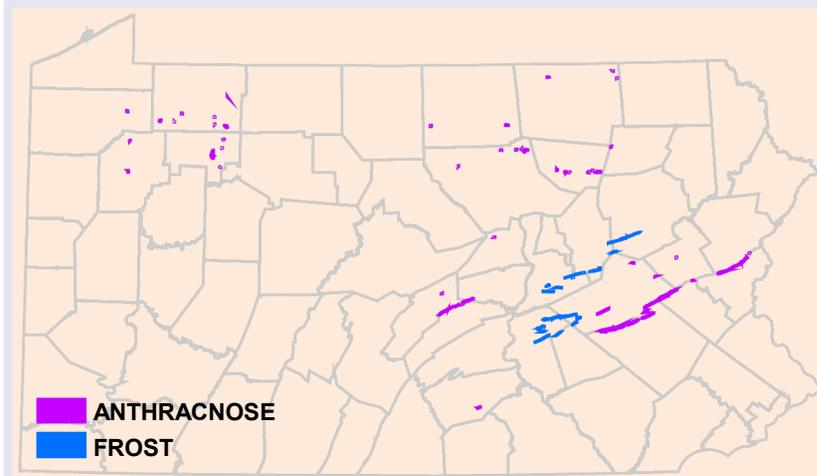
Forest discoloration was observed in 27,479 acres of forest land in 2012 (map below). Total discolored acreages is about the same as that of 2011. Major causal agents include anthracnose (*Apiognomonina quercina* for oaks and *Aureobasidium apocrytum* for maples), frost damage, and other incidentals.



Maple Anthracnose
Photo by P. Bachi - Forestry Archive, Bugwood



Frost Damage on American Beech
Photo by PA DCNR - Forestry Archive, Bugwood



by the numbers

- 29**
Counties affected
- 27,479**
Total acres discolored
- 6,678**
Acres in Schuylkill County
- 5,700**
Acres in Berks County
- 17,461**
Acres by anthracnose
- 6,975**
Acres by frost damage

2.2. Tree Mortality / Decline



Forest Tent Caterpillar Larva
Photo by H. Liu, PA DCNR

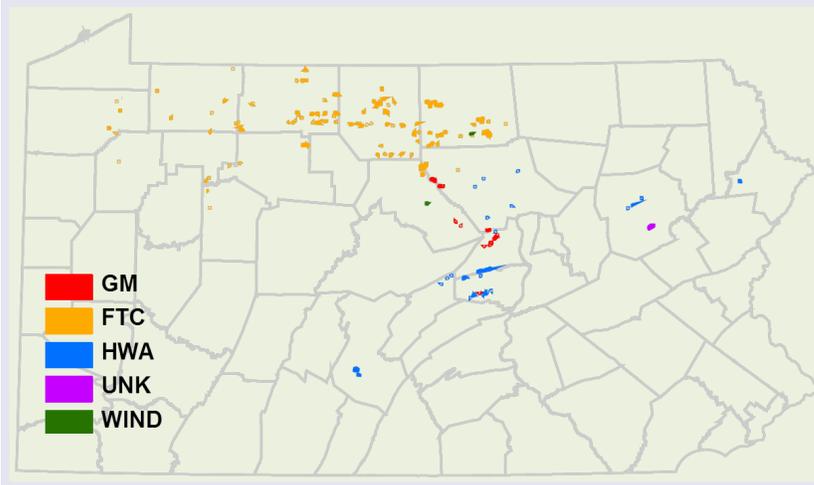


Hemlock Woolly Adelgid
Photo by D. Schmit, PA DCNR



Gypsy Moth Larva
Photo by H. Liu, PA DCNR

Tree mortality/decline was observed on oaks, hemlocks, and other species in 13,787 acres of forest land in northern and central PA in 2012 (map below). This represents a 40% decrease from 2011. Major mortality factors include forest tent caterpillar (FTC) (*Malacosoma disstria*), hemlock woolly adelgid (HWA) (*Adelges tsugae*), and gypsy moth (GM) (*Lymantria dispar*). Wind damage (WIND) was also observed. Repeated defoliations from previous outbreaks were responsible for observed tree mortality/decline.



by the numbers

- 14**
Counties affected
- 3,807**
Acres in Tioga County
- 2,238**
Acres in Potter County
- 9,505**
Acres by forest tent caterpillar
- 1,132**
Acres by gypsy moth
- 940**
Acres by hemlock woolly adelgid

2.3. Forest Insect and Disease (FI&D) Reports

Forest health in Pennsylvania was also monitored through the Forest Insect and Disease (FI&D) reporting system. Isolated infestations in various stages may not always be detectable via aerial surveys, whereas early detection of exotic invasive species relies on targeted surveys on specific hosts or in high risk areas. The occurrence and damage extent of specific pests were recorded and filed as point (< 1 acre) or polygon (>1 acre) reports. Negative reports were used to monitor certain pests such as Asian longhorned beetle (ALB) (*Anoplophora glabripennis*) and walnut twig beetle (WTB) (*Pityophthorus juglandis*) in un-infested areas.



Emerald Ash Borer Larva
Photo by H. Liu, PA DCNR

A total of 2,584 (915 positive, 1,669 negative) FI&D reports concerning 16 major pests were received in 2012. Positive pest activities were reported in 10 counties, including countywide prevalence of emerald ash borer (EAB) (*Agrilus planipennis*) in Bedford and Juniata counties, and variable oakleaf caterpillar (VOLC) (*Lachmaeus manteo*) in Lackawanna and Luzerne counties. In addition, 34 acres of pink-striped oakworm (PSOW) (*Anisota virginienensis*) was reported in Luzerne County, and 128 acres of *Fabrella* needle blight in Susquehanna County.



Variable Oakleaf Caterpillar
Photo by W. Cranshaw - Forestry Archive, Bugwood



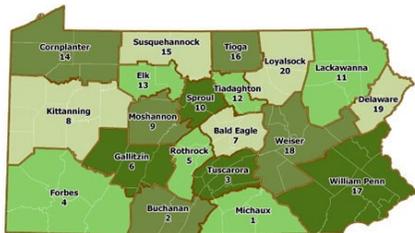
Pink-Striped Oakworm
Photo by L. Hyeche - Forestry Archive, Bugwood

by the numbers

Emerald Ash Borer
Countywide in Bedford & Juniata
325 Acres in Allegheny

Variable Oakleaf Caterpillar
Countywide in Lackawanna & Luzerne
20 Acres in Carbon, 30 Acres in Monroe

Pinkstriped Oakworm
34 Acres in Luzerne
Fabrella needle blight
128 Acres in Susquehanna



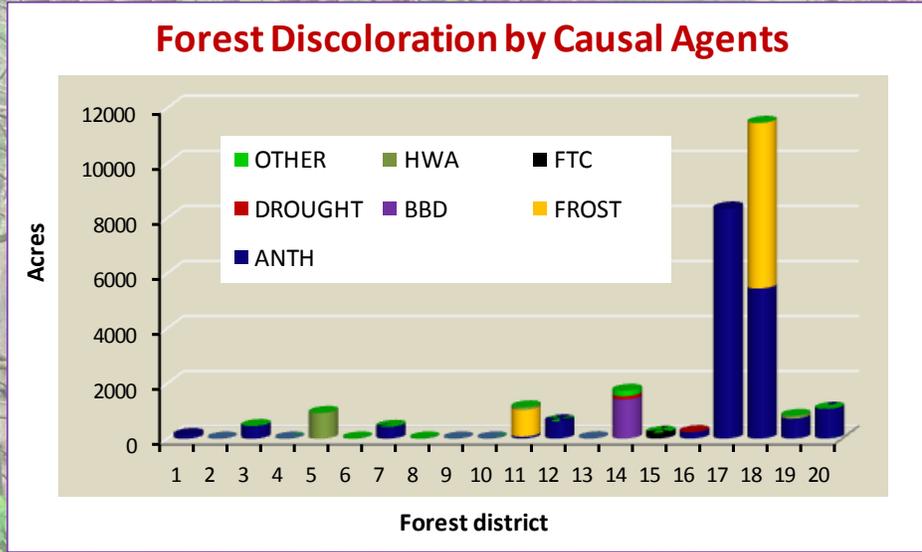
Pine Creek Gorge, Tioga Forest District
Photo by DCNR

Forest Districts Counties

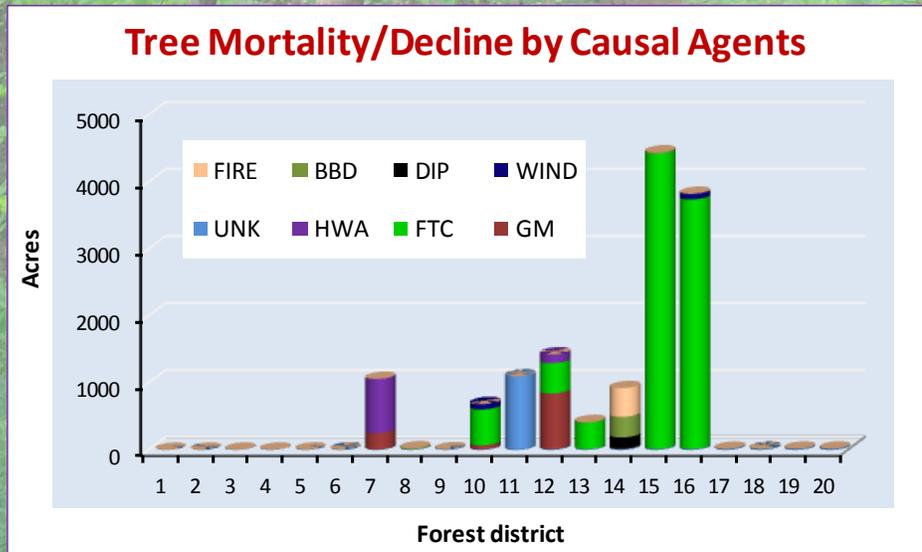
- #1 Michaux**
Adams, Cumberland, Franklin, York
- #2 Buchanan**
Bedford, Fulton
- #3 Tuscarora**
Juniata, Perry
- #4 Forbes**
*Allegheny, Fayette, Greene, Somerset
Washington, Westmoreland*
- #5 Rothrock**
Centre, Huntingdon
- #6 Gallitzin**
Blair, Cambria, Indiana
- #7 Bald Eagle**
Mifflin, Snyder, Union
- #8 Clear Creek**
*Armstrong, Beaver, Butler, Clarion,
Jefferson, Lawrence, Mercer*
- #9 Moshannon**
Clearfield
- #10 Sprout**
Clinton
- #11 Lackawanna**
*Lackawanna, Luzerne, Susquehanna,
Wayne, Wyoming*
- #12 Tiadaghton**
Lycoming
- #13 Elk**
Cameron, Elk
- #14 Cornplanter**
*Crawford, Erie, Forest,
Venango, Warren*
- #15 Susquehannock**
McKean, Potter
- #16 Tioga**
Tioga
- #17 William Penn**
*Berks, Bucks, Chester, Delaware,
Lancaster, Lehigh, Montgomery,
Northampton, Philadelphia*
- #18 Weiser**
*Carbon, Columbia, Dauphin,
Lebanon, Montour, Northumberland,
Schuylkill*
- #19 Delaware**
Monroe, Pike
- #20 Loyalsock**
Bradford, Sullivan

2.4. District Highlights

About 75% of the forest discoloration in 2012 was reported from Districts 17 and 18. Other noticeable damage was reported from Districts 5, 11, 14, 19 and 20. Scattered forest discoloration was also found in 1, 3, 7, 12, 15 and 16. No damage was reported from other districts (figure below).

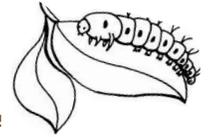


Tree mortality/decline was found concentrated in Districts 10, 12, 13, 15, 16 as the result of forest tent caterpillar damage from 2009-2011. Tree mortality/decline was also reported for hemlocks by HWA in Districts 7 and 12, and for oaks by GM in Districts 7, 10, and 12. Wind damage was reported in District 10 and 16 (figure below).



Jakey Hollow Natural Area
Weiser Forest District
Photo from wikipedia.org

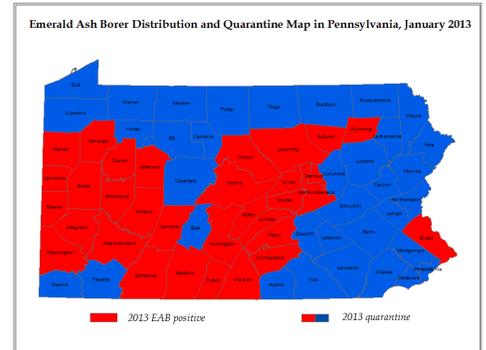
3. Entomology Projects



Entomology projects are supported by federal grants from The USDA Forest Service Cooperative Forest Health Program (CFHP) with matching funds from the state. Special projects are awarded yearly through a competitive application.

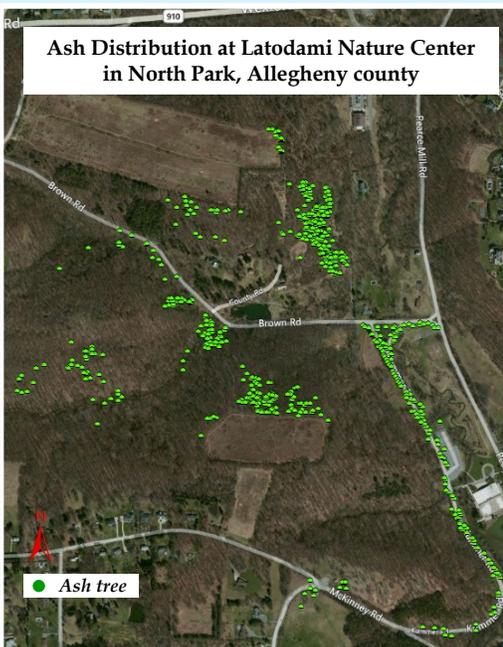
3.1. Emerald Ash Borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae)

EAB was first discovered in Pennsylvania in Cranberry Township, Butler County in 2007. Subsequently, neighboring counties such as Allegheny, Beaver, and Lawrence have also become infested. It has since been found in Mercer in 2008; Armstrong, Indiana, Juniata, Mifflin, Washington, and Westmoreland in 2009; Bedford, Centre, Clarion, Cumberland, Fulton, Somerset, and Union in 2010; Huntingdon, Lycoming, Sullivan, and Wyoming in 2011; Bucks, Clinton, Franklin, Jefferson, Montour, Northumberland, Perry, Snyder, and Venango in 2012; and Cambria in 2013. A total of 32 counties in Pennsylvania are currently infested with EAB, with the quarantine extended to the entire state (map above).



3.1.1. Integrated Pest Management (CFHP 2010-2012)

An EAB integrated management project consisting of tree removal, chemical treatment, and biological control was initiated at North Park, Allegheny County in 2010 (map left). Tree removal was carried out in 2010 and limited to a few hazardous trees along major roads, whereas high-value ash trees at the study site were treated with Tree-äge® (emamectin benzoate) through trunk injection in 2011. One egg parasitoid - *Oobius agrili* Zhang and Huang (Encyrtidae), and two larval parasitoids - *Tetrastichus planipennisi* Yang (Eulophidae) and *Spathius agrili* Yang (Braconidae) were released in 2011 and 2012 as part of the biological control effort. Tree-äge® treatment efficacy and parasitoid establishment was evaluated in 2012.



By the numbers

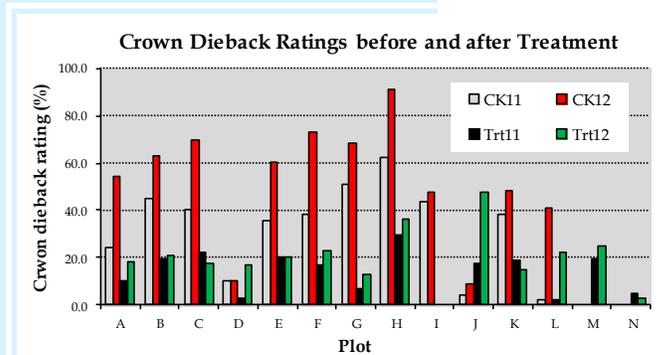
- 14
Plots in the study site
- 10.0 - 90.0 (ft²/acre)
Range of ash basal area
- 713
No. of ash trees included
- 0% - 100%
Crown dieback range
- 17
No. of trees removed
- 249
No. of trees treated
- 3,094
T. planipennisi released
- 1,458
S. agrili released
- 1,104
O. agrili released

Results of this evaluation

showed that crown dieback progressed at a slower pace in treated trees compared to that of untreated controls in all study plots except J (figure right). *S. agrili* adults (photo left) were recovered from EAB larvae



S. agrili adult
Photo by H. Liu, PA DCNR

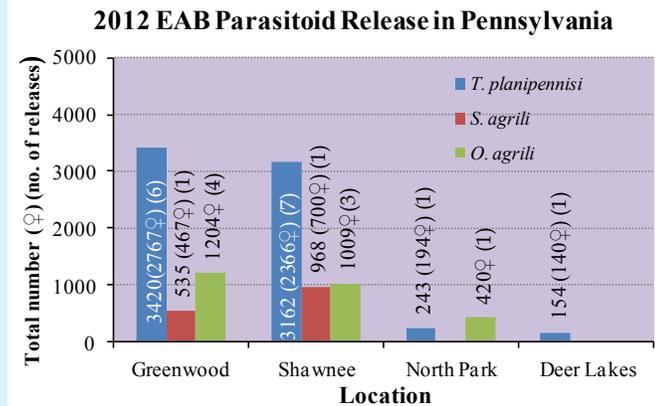


3.1.2. Parasitoids Release (CFHP 2010-2012)

EAB biological control was extended to two new sites in 2012, with 5,159 and 5,139 parasitoids released at Greenwood Furnace State Park in Huntingdon County and Shawnee State Park in Bedford County, respectively. Parasitoids were released weekly as adults for *T. planipennisi* and *S. agrili*, and adults or parasitized host eggs for *O. agrili* on 12 pre-selected ash trees from June to August whenever available. A



Release Site Evaluation
Photo by H. Liu, PA DCNR



total of 3,420 *T. planipennisi*, 535 *S. agrili*, and 1,204 *O. agrili* (620 as parasitized host eggs) were released at Greenwood Furnace; whereas 3,162 *T. planipennisi*, 968 *S. agrili*, and 1,009 *O. agrili* (420 as parasitized host eggs) were released at Shawnee (figure left). In addition, a few supplemental releases were carried out at



Parasitoids Shipped in Containers
Photo by P. Weiss, PA DCNR

two of the 2011 release sites, with 243 *T. planipennisi* and 420 *O. agrili* (all as parasitized host eggs) released at North Park in Allegheny County as reported in the previous section, and 154 *T. planipennisi* in Deer Lakes Park (Allegheny County) (figure above).



Parasitoids Field Release
Photo by H. Liu, PA DCNR



S. agrili Cocoons in EAB larval Gallery
Photo by H. Liu, PA DCNR

3.1.3. Parasitoids Recovery (CFHP 2010-2012)

Field recovery of EAB parasitoids released in 2011 was attempted in North Park and Deer Lakes Park between April - September 2012. Release trees were felled with a chain saw and the main trunk was separated into 100 cm sections for dissection. EAB eggs found on bark surface, between bark layers, and within cervices were collected and brought back to the lab in petri dishes for incubation. Normal EAB eggs are white (early) to dark brown (later) in color, whereas host eggs parasitized by *O. agrili* turned to black as parasitoids developed inside. Log sections were then examined for EAB larvae, prepupae, pupae, and enclosed adults within the bark, as well as in the cambial and outer sapwood region. Fresh adult exit holes were also recorded as they represent a portion of the current year population. All EAB stages were collected and brought back to the lab in petri dishes for incubation of larval parasitoids *T. planipennisi* and *S. agrili*. A total of 4 trees (74 log sections) from North Park and 3 trees (48 log sections) from Deer Lakes Park were dissected during the year. Overall, 408 fresh exit holes, 941 eggs, 811 larvae (3rd or 4th instars), 47 prepupae, 218 pupae, and 61 adults were recorded/collected. *S. agrili* was recovered in North Park when its cocoons were found from one EAB larva, whereas *O. agrili* adults were recovered from parasitized host eggs collected from Deer Lakes Park through tree dissection.



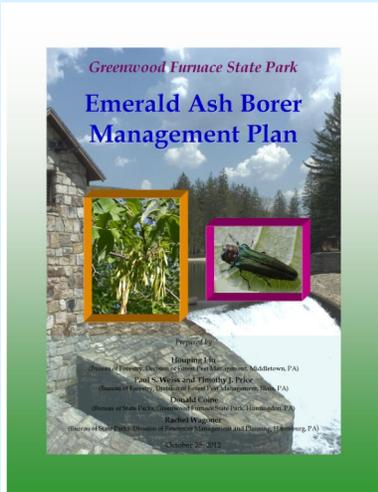
Log Dissection in Deer Lakes Park
Photo by H. Liu, PA DCNR



O. agrili Parasitized EAB Egg (black)
Photo by H. Liu, PA DCNR

3.1.4. Community Management Plan (DCNR 2012)

An EAB management plan was developed in early 2012 to help local communities (counties, cities, boroughs, and townships) preparing for the potential negative economic, social and environmental impact on urban forests. This document was drafted to address management options for current or anticipated EAB infestations in urban forests. It contains clear objectives and viable approaches in the management of EAB at the community level. When adopted, it becomes the official action plan for the community to use in its battle against EAB for the protection of its ash resources.



Communities can choose from four recommended management options (no action, selective management, preemptive management, and aggressive management) and adopt a combination of management tools that include tree removal, chemical

treatment, and biological control to meet their specific goals.

Greenwood Furnace State Park and The Borough of West Chester drafted plans in 2012 by completing ash inventories, conducting EAB population surveys, prioritizing treatments, determining wood utilization and material disposal methods, preparing replanting schedules, and cost/benefit analysis. Chemical and biological control measures were implemented in Greenwood Furnace according to the plan, with 15 white ash trees

treated and 5,159 parasitoids released (see section 3.1.2. for details). Chemical treatment is scheduled for 2013 in West Chester. Experience from both communities will be used in the promotion of EAB management across the state in the coming years.

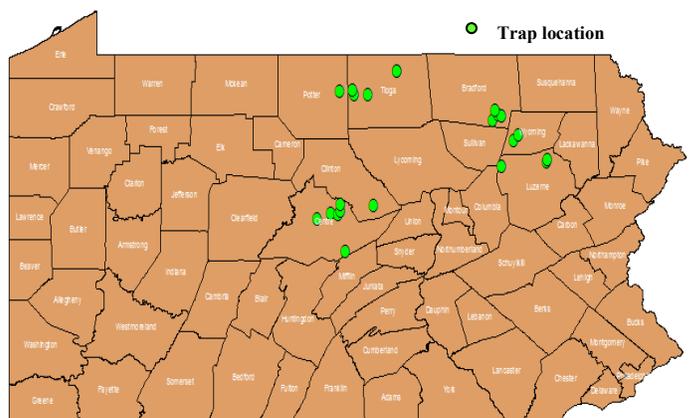


Left to right: White Ash trees, Tree Tag, Chemical Treatment with Tree IV System, Tree Removal, Release of Larval parasitoids, Release Apparatus for *O. agrili*

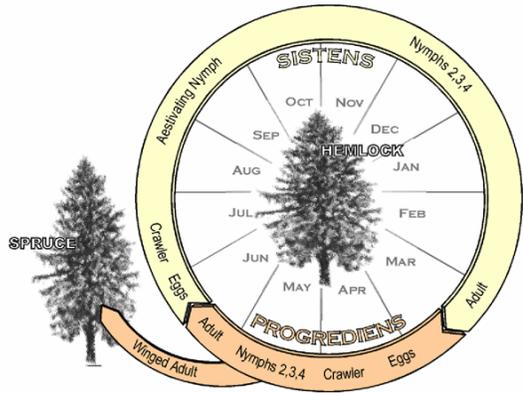
Photo by H. Liu, PA DCNR

3.1.5. Biological Control Site Selection (DCNR 2012)

Selection of potential biological control sites through visual survey and trapping continued. A total of 23 purple panel traps were deployed at 22 sites in 7 counties (map right). EAB adults were found on 6 traps in 3 counties, including 1 in Clinton County that lead to the discovery of new infestation in the county. Positive sites are being evaluated for parasitoids release in the future.



3.2. Hemlock Woolly Adelgid, *Adelges tsugae* Annand (Homoptera: Adelgidae)

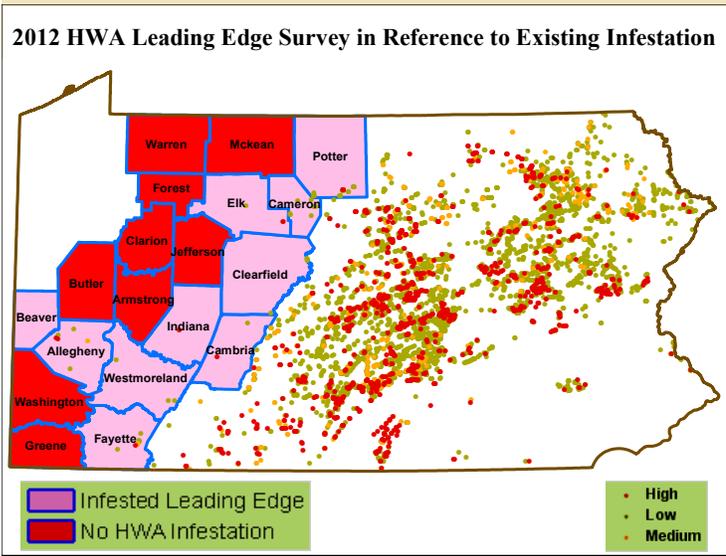


Left to right: Life Cycle, Infested Hemlock Branch, Crawlers at the Base of Needles, Adult and Eggs Inside the Ovisac

Photo by M. Montgomery - Forestry Archive, Bugwood

3.2.1. Multi-State Leading Edge Survey (CFHP 2012)

Surveys for HWA along the leading edge continued in 2012 in 17 western counties (Allegheny, Armstrong, Beaver, Butler, Cameron, Clarion, Clearfield, Elk, Fayette, Forest, Greene, Indiana, Jefferson, McKean, Potter, Washington, Westmoreland). As of December 2012, 195 sites in 13 of the 17 counties were surveyed. HWA infestation was found at 17 sites in five counties (Allegheny, Fayette, Cameron, Clearfield, and Potter) (map left). Survey activities will continue throughout the winter to include at least 10 geographically distinct sites in each county, with a total of 10 randomly selected branches from three to 10 hemlock trees examined.



Survey activities will continue throughout the winter to include at least 10 geographically distinct sites in each county, with a total of 10 randomly selected branches from three to 10 hemlock trees examined.



Chemical Preparation
Photo by T. Marasco, PA DCNR

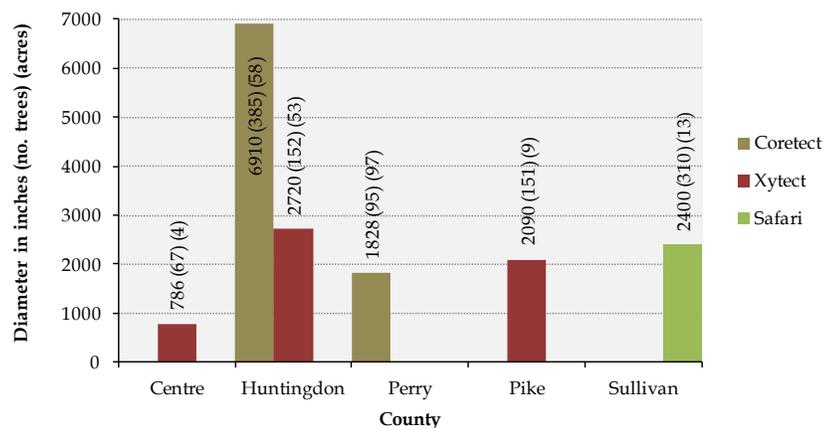


Soil Injection
Photo by T. Marasco, PA DCNR

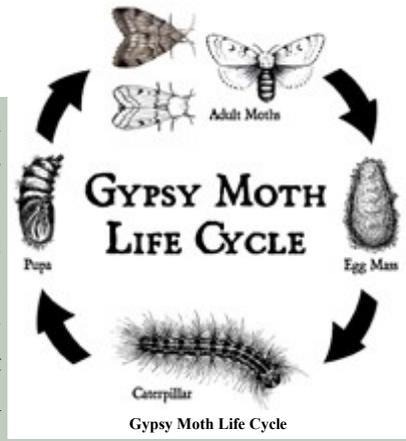
3.2.2. Population Suppression (CFHP 2012)

HWA population suppression through soil injection of imidacloprid (Xytect 75WSP and Coretect) and dinotefuran (Safari 20SG) continued on State Forest and State Park lands, with 7 treatment sites in five counties (Centre, Huntingdon, Perry, Pike, and Sullivan). A total of 1,160 hemlock trees (16,734 inches total DBH) were treated on 234 acres of high value lands (recreational, aesthetic, historic, watershed, wildlife habitat, biodiversity) (figure right). Designated evaluation sites will be visited for treatment efficacy next year after one growing cycle.

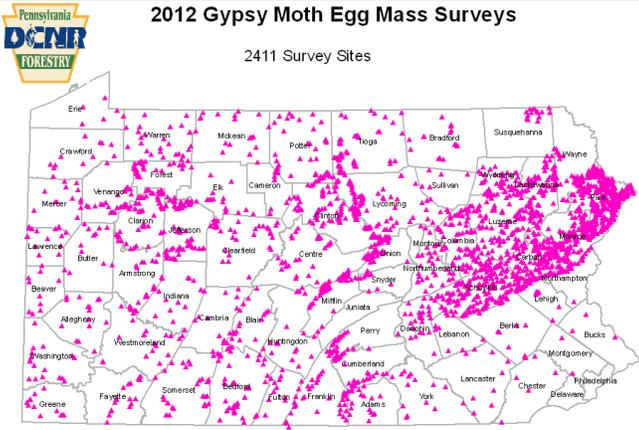
HWA treatment by county and insecticide in 2012



3.3. Gypsy Moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae)



Gypsy moth populations are monitored by surveying egg masses between September of the current year and March of the next year. About 2,000 semi-permanent sample sites (1/40 acre each) are selected across the state each year. The number of overwintering egg masses found at each site is recorded. An increase in egg mass size, frequency, and average number of egg masses per site from the previous year usually indicates an increasing population that may lead to suppression efforts.



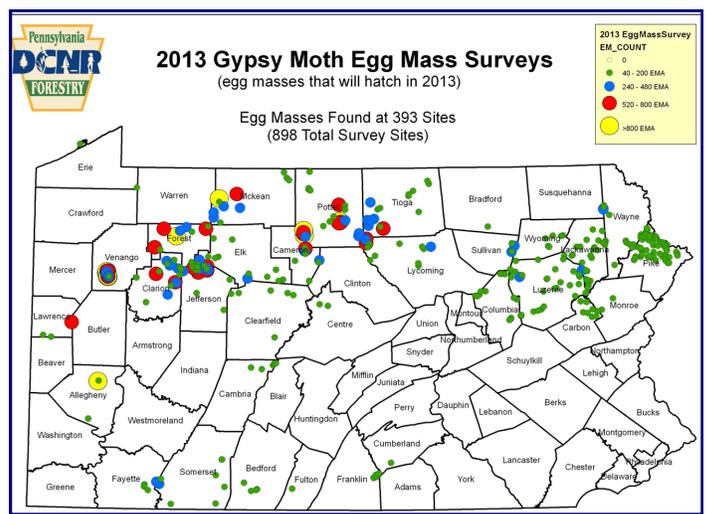
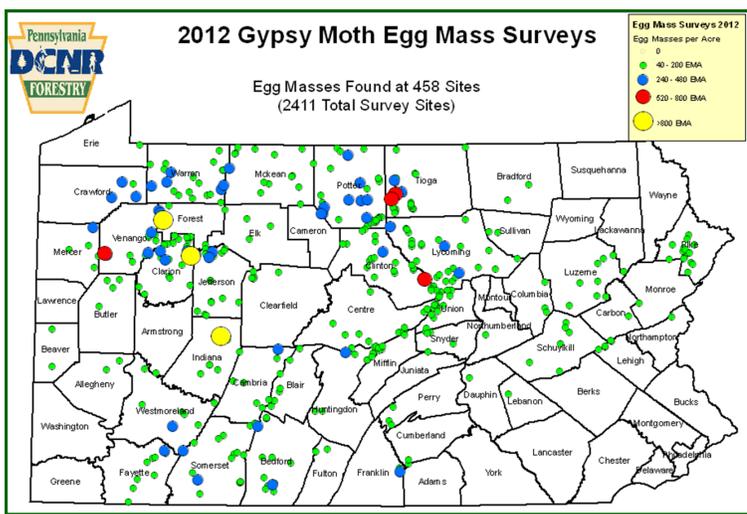
2012 Gypsy Moth Egg Mass Surveys
2411 Survey Sites



Egg-laying Females
Photo by D. Schmit, PA DCNR

3.3.1. Egg Mass Survey (DCNR 2012)

A total of 2,411 sites were surveyed for the 2012 season (September 2011-March 2012) (map above). New egg masses were observed in 458 sites, with the highest density (800-960 egg masses/acre) found in Clarion, Forest, and Indiana counties (map below left). Surveys for the 2013 season (September 2012-March 2013) is ongoing, with 898 sites visited as of December 2012. Preliminary results showed that 393 sites contains new egg masses, with high egg mass density found in Clarion, Forest, Jefferson, McKean, Potter, Tioga, and Venango counties (map below right).



Gypsy Moth Larva
Photo by J. Yachnick - Forestry Archive, Bugwood

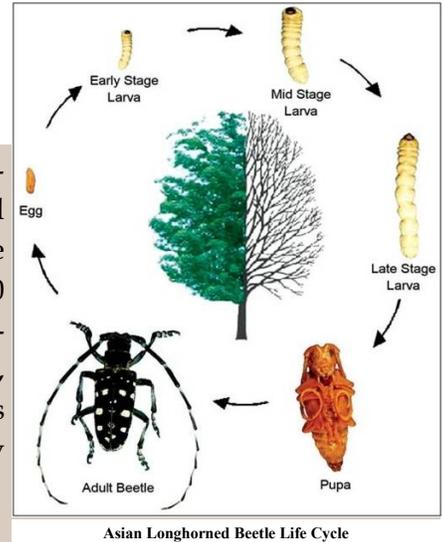
3.3.2. Suppression Program

A cooperative suppression program is planned for 2013 based on finished egg mass survey results. A total of 42,988 acres in 80 blocks are proposed by state forests, state parks, and other cooperators, along with 212 acres in 4 blocks of federal lands.



Aerial Spray for Population Suppression
Photo by J. H. Ghent - Forestry Archive, Bugwood

3.4. Asian Longhorned Beetle, *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae) (Survey - DCNR 2012)



ALB Trap
Photo by H. Liu, PA DCNR

ALB in North America

1996
New York, NY

1998
Chicago, IL

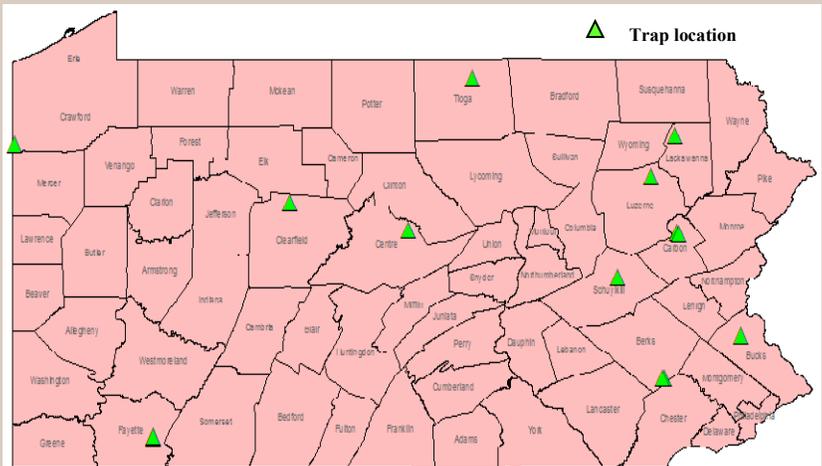
2002
Hudson, NJ

2003
Toronto, Canada

2004
Middlesex & Union, NJ

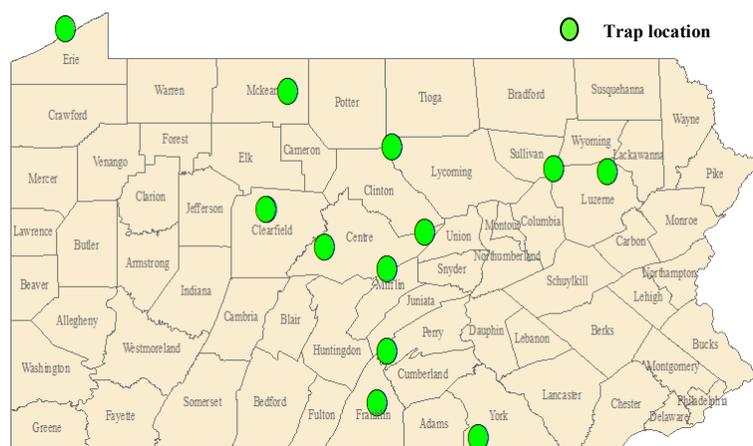
2008
Worcester, MA

2011
Bethel, OH



3.5. Exotic Bark Beetles (Coleoptera: Scolytinae) (EDRR - CFHP 2012)

An early detection and rapid response project was initiated in 2010 to detect, delimit, and monitor newly introduced exotic bark and ambrosia beetles at selected high-risk forest areas in Pennsylvania. Twelve sites in 10 counties were selected for this study (map left).



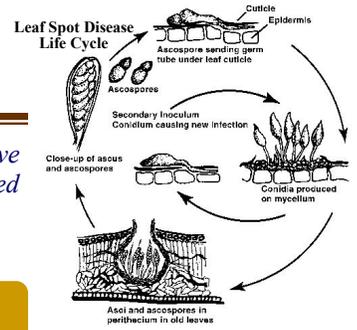
Bark Beetle Trap
Photo by USFS - Forestry Archive, Bugwood

Survey activities were repeated at those sites using the same methodologies in 2011 and 2012. A total of 2,552 beetles from 37 species were collected in 2012, a significant decrease from 2011. *Xylosandrus germanus* (Blanford) was again the most abundant species, making up 46% of the beetles collected. Other frequently encountered ambrosia beetles included *Gnathotrichus materiarius* (Fitch), *Euwallacea validus* (Eichhoff), and *Anisandrus sayi* (Hopkins). No major species of concern were recovered.

4. Pathology Projects

Pathology projects are supported by federal grants from The USDA Forest Service Cooperative Forest Health Program (CFHP) with matching funds from the state. Special projects are awarded yearly through a competitive application.

4.1. Thousand Cankers Disease, *Geosmithia morbida* Kolarik, Freeland, Utley & Tisserat (Hypocreales: Bionectriaceae) (Survey – CFHP 2012)



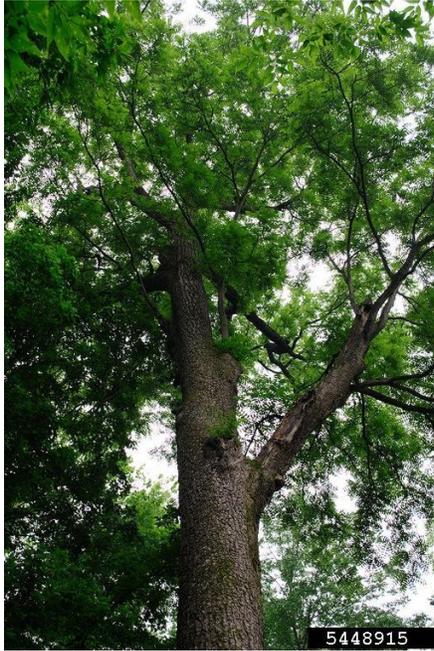
Thousand Cankers Disease (TCD) on walnut is caused by the aggressive feeding of the walnut twig beetle (WTB) (*Pityophthorus juglandis*) and subsequent canker development from the infection of *Geosmithia morbida* around beetle galleries. Widespread morbidity and mortality of black walnut, *Juglans nigra*, has been reported in the western United States for the past few decades.

Thousand Cankers Disease
G. morbida

The Pathogen

Conidiophores & asexual spores (right)
Photo by N. Tisserat
Forestry Archive, Bugwood

Asexual spores (left)
Photo by A. Windham
Forestry Archive, Bugwood



The Vector

Walnut Twig Beetle Adults
Photo by S. Valley - Forestry Archive, Bugwood

Symptoms on Twigs & Branches

Canker on small branch (below)
Photo by N. Tisserat
Forestry Archive, Bugwood

Canker on twig (above)
Photo by C. Utley
Forestry Archive, Bugwood

Symptoms on Trees

Infested Tree (below)
Photo by C. Utley - Forestry Archive, Bugwood

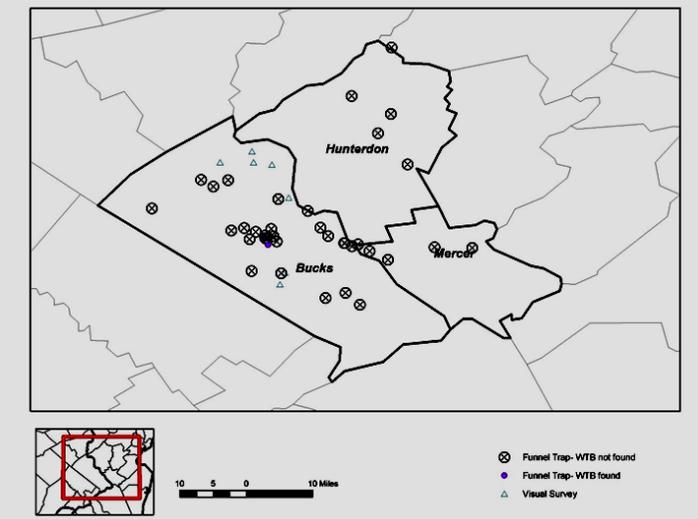
Infested Tree (above)
Photo by W. Cranshaw - Forestry Archive, Bugwood



Four-unit Funnel Trap
Photo by S. J. Seybold, USFS

In Pennsylvania, TCD was first discovered in Bucks County in 2011. An internal quarantine was established to restrict movement of black walnut materials out of the affected county while 50 susceptible black walnut trees from the site were destroyed. DCNR participated in the detection survey in 2012. A total of 43 trap locations were monitored. WTB adults were found at the initial site and three nearby locations (map right). However, *G. morbida* has not been detected since the eradication in February 2012.

Trap Locations in Bucks County, PA and Hunterdon and Mercer Counties, NJ in 2012
Map by R. Turcotte, USFS



4.2. Sudden Oak Death, *Phytophthora ramorum* Werres, de Cock & In't Veld (Oomycetes: Pythiaceae) (Survey – DCNR 2012)

Sudden oak death (SOD) is a disease of oaks and other trees caused by an oomycete pathogen, *Phytophthora ramorum*. It was first discovered in oak forests of coastal California in 1995. Symptoms include bleeding trunk cankers and foliage dieback, which could lead to the death of the tree. It has not been found anywhere else except one report in Curry County, Oregon across the northern border from California (map below left).

SOD Distribution as of April 2011



Leaf Lesion on Coast Live Oak
Photo by D. Eggen, PA DCNR



Infection of *P. ramorum* at a UK Site
Photo from DOI: 10.1371/journal.pbio.0020213.g004



Zone Lines on Tree Trunk
Photo by J. O'Brien - Forestry Archive, Bugwood

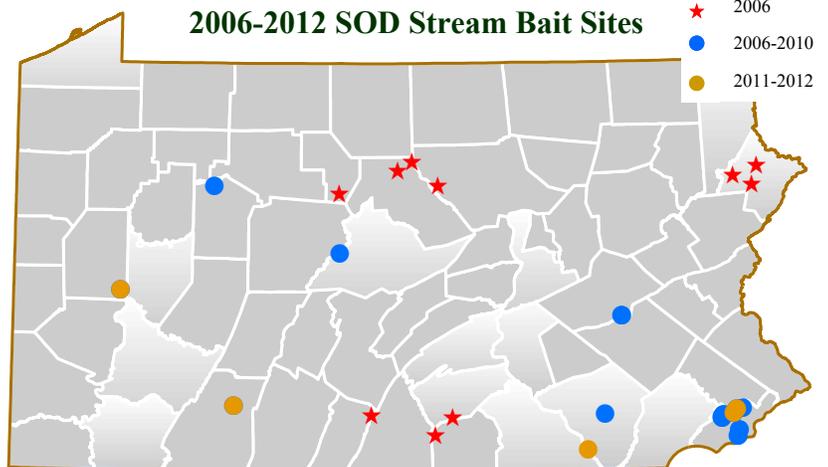


Bleeding Canker on Tree Trunk
Photo by J. O'Brien - Forestry Archive, Bugwood



Costal Live Oaks Plagued by *P. ramorum*
Photo by M. Gardelotto, UC Berkeley

Survey for SOD continued in 2012 with stream baiting extended to more counties. Four streams in Butler, Lancaster, Montgomery, and Somerset counties were monitored during the 6-week period when stream temperatures were conducive for pathogen detection (10 - 20 °C) (map right). Nylon mesh bags containing *Rhododendron* leaves were floated for 2 weeks to detect *P. ramorum* from the upstream watershed. No detection has been made in 26 streams surveyed since 2003.



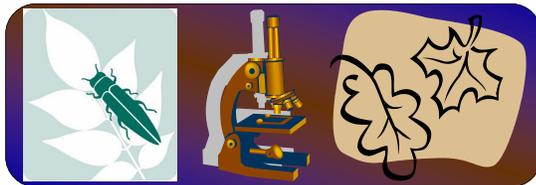
4.3. Butternut Canker, *Sirococcus clavigignenti-juglandacearum* N.B. Nair, Kostichka & Kuntz (Diaporthales: Incertae sedis) (Survey – DCNR 2012)

A multi-state project to conserve butternut was initiated in 2009. Efforts were directed to locate, verify, and propagate wild butternut families from different areas before they were screened against butternut canker disease. Genetic verification using a DNA test procedure has led to the selection of 35 potential pure butternut families for artificial propagation (grafting). Additional materials were received from the University of Missouri and the U.S. Forest Service, Oconto Seedling Nursery in 2012 for out-planting in a newly established seed orchard at the Greenwood Nursery. Grafted seedlings from various partners were made available for pathogenicity testing.



Scion Wood Collection
Photo by T. J. Hall, PA DCNR

5. Diagnostic Service



Diagnostic services were provided by staff of the Forest Pest Management Division (FPM) to forest professionals and the general public throughout the year.

Forest insect and disease samples submitted to the division's central office and field offices were examined for diagnosis in the order they were received. General requirements for sample collection and submission are listed below.

Forest Insect Samples

- Define symptoms to causal agents;
- Sample agents together with host materials;
- Place dead adults dry in air-tight bottles;
- Place immature stages (eggs, larvae, pupae) in 75% ethyl alcohol in air-tight bottles;
- Label sample with water proof pen/pencil;
- Include information on location, time, and collector;
- Mail or hand carry samples to service providers.



Cottony Maple Scale
Photo by S. Stitzer, PA DCNR



Pine Webworm
Photo by H. Liu, PA DCNR



Scallop Shell Moth
Photo by H. Liu, PA DCNR

Forest Disease Samples

- Define symptoms to causal agents;
- Sample infected host materials;
- Place host materials in zip-lock plastic bag;
- Place fruiting bodies in air-tight bottles;
- Label sample with water proof pen/pencil;
- Include information on location, time, and collector;
- Mail or hand carry samples to service providers.



6. Program Training

Program training is needed to ensure successful implementation of all federal and state projects. Trainings were provided to forest health specialists, assistant forest health specialists, FI&D coordinators, and project partners. Training topics include forest insect and disease survey, aerial survey, chemical control, biological control, disease resistance identification, and integrated pest management.

Beech Scale Resistance Training

Moshannon State Forest, July 2012

Procedures to challenge American beech trees with beech scale, *Cryptococcus fagisuga* Lindinger (Homoptera: Ericococcidae) (photo below), the vector of beech bark disease (*Nectria galligena* and *N. coccinea* var. *faginata*) through stem inoculation were demonstrated in the field. Individual trees with resistance upon later examinations will be used as scion material to establish seed orchards containing resistant clones.



Beech Scale Nymph
Photo by J. O'Brien - Forestry Archive, Bugwood

EAB Management Training

Greenwood Furnace State Park, May 2012

Information on EAB biology, infestation at Greenwood Furnace, resources at risk, survey and detection efforts in PA, management options, and general strategies were provided through indoor seminars. Guidelines and procedures for the drafting of EAB management in local communities were discussed.



Trunk Injection Demonstration
Photo by H. Liu, PA DCNR

Techniques on how to conduct tree inventory, damage assessment, and chemical treatment through trunk injection (photo left) were demonstrated in the field.

7. Interagency Cooperation



FPM has been cooperating with federal, state, and local agencies as well as research institutions on various projects in pest survey, detection, management, outreach, and public education throughout the year. Listed below are some of the notable partners and associated projects.

State Agencies

- DCNR State Forests & State Parks - HWA & EAB suppression
- DCNR Invasive Species Management Team - Representation
- PA Invasive Species Council - Representation
- PA Forest Pest Task Force - Representation
- PA Department of Agriculture - EAB, TCD & ALB survey
- Pennsylvania State University - ALB & SOD survey, training
- Pennsylvania Game Commission - EAB biological control
- PSU Extension - Forest health training



Stone Stack of Greenwood Iron Furnace
Photo from wikipedia.org



Town Center of West Chester
Photo from wikipedia.org

Federal Agencies

- USDA Forest Service
 - Aerial survey for leaf damage, defoliation & tree mortality
 - Aerial survey procedures & safety
 - EAB integrated pest management & biological control
 - HWA survey, biological control & suppression
 - Exotic bark beetle survey
 - Ash seed collection
 - TCD & SOD Survey
 - Butternut & beech conservation
 - Oak decline
- USDA APHIS
 - EAB biological control
 - Sirex* biological control
 - TCD survey

Local Agencies

- Allegheny County - EAB management & biological control
- City of Pittsburgh - Oak wilt & EAB management
- Borough of West Chester - EAB management
- Greenwood Furnace State Park - EAB management
- PA Association of Township Supervisors - EAB management
- City of Philadelphia - EAB action plan
- Borough of Laporte - EAB action plan
- Borough of Sewickley Heights - Invasive species management
- Lock Haven University - Forest health training
- Pennsylvania College of Technology - Forest health training
- West Chester University - EAB management
- Woodland Owners Assoc. of S Alleghenies - Forest health
- Northwest Forest Landowners Assoc. - Forest health training
- Clearfield Master Gardeners - Forest health training
- Clarion Forest Landowners Assoc. - FI&D update
- Township of Hatfield - EAB community action plan
- Borough of Kennett Square - EAB community action plan
- City of Lancaster - Woodboring beetle management
- Phipps Conservancy & Botanical Garden - EAB management

Across the Country

- NAASF Forest Health Committee - Representation
- Northeastern Forest Pest Council - Representation
- Continental Dialogue - Representation
- National Gypsy Moth Management Board - Representation
- University of Missouri - Butternut conservation
- New Jersey Department of Agriculture - HWA biocontrol
- Cornell University - *Sirex* biological control
- University of Notre Dame - Butternut genetics

8. Extension & Outreach



FPM has been actively involved in extension and outreach on forest health issues across the state by conducting trainings, demonstrations, seminars, trade shows, forest health updates, insect and disease diagnostics, interviews, and awareness campaigns on major invasive species; by providing important insect and disease materials; and by answering questions on a wide range of forest health topics. Examples of outreach audience include but not limited to resource management agencies, woodland owners associations, other professional associations and clubs, local communities (counties, cities, townships, boroughs, subdivisions, retirement communities, etc.), media (newspapers, magazines, radios, TVs, etc.), professional pesticide applicators, and private citizens.

8.1. Training Given

A total of 19 presentations were given by FPM staff during 2012, with 1,124 people trained (table right)



Indoor Seminar
Photo by H. Liu, PA DCNR



Field Training
Photo by H. Liu, PA DCNR

Training Given by FPM Staff in 2012

| LOCATION | TOPIC | INSTRUCTORS | ATTENDANCE |
|-------------------|----------------------|--------------|------------|
| Penn State - Erie | Forest Health | Frontz | 150 |
| DuBois | Forest health | Frontz | 15 |
| Laporte | EAB management | Register | 10 |
| Fryburg | FI&D | Frontz | 100 |
| Williamsport | Forest health | Marasco | 100 |
| Lancaster | Woodboring insects | Marasco | 66 |
| Pittsburgh | EAB management | Liu | 40 |
| Breezewood | Forest health | Hall, Liu | 51 |
| Nanticoke | Forest health update | Staff | 125 |
| St. Mary's | Forest health update | Staff | 250 |
| Sewickley Heights | Invasive species | Liu, Schmit | 18 |
| DuBois | Urban health | Frontz | 10 |
| Enola | EAB community plan | Liu, Eggen | 25 |
| West Chester | EAB management demo | Liu, Eggen | 15 |
| Huntingdon | EAB management demo | Staff | 30 |
| Penn Nursery | Aerial survey | Jia, Marasco | 4 |
| Hatfield Township | EAB action plan | Eggen | 40 |
| Kennett Square | EAB action plan | Eggen | 62 |
| Kennett Square | EAB action plan | Eggen | 13 |
| Total (19) | | | 1,124 |

8.2. Materials Distributed

A total of 32,381 copies of insect and disease materials were sent out to interested groups and individuals in 2012, including 5,123 pest alerts, 8,061 brochures, 452 posters, 1,500 booklets, 29 EAB ID kits, 3,639 ID wallet cards, 13,300 tattoos, 275 magnets, 1 DVD, and 1 book.



8.3. Media Contacts



Various interviews were given by FPM staff to different media outlets in the state in 2012, including *Yahoo Daily News*, *Centre Daily Times*, *Bradford Era*, *The Reporter (Lansdale)*, *The Philadelphia Inquirer*, *Post Gazette (Pittsburgh)*, *Williamsport Sun Gazette*, *The Derrick and The News-Herald (Oil City)*, *PA Borough News (Harrisburg)*, *HYY Public Radio (Philadelphia)*, *WJAC-TV (Johnstown)*.



8. Publications

Liu, H. 2012. Chapter 9. Microbial Control of Crop Pests Using Entomopathogenic Fungi, pp. 237-280. In D.P. Abrol and Shankar, U. (eds.), *Integrated Pest Management: Principles and Practice*. CABI Publishing, Wallingford, UK, 502 pp.

Liu, H. 2012. Emerald ash borer management plan for Pennsylvania communities. PA DCNR, 8 pp. http://www.dcnr.state.pa.us/ucmprd1/groups/public/documents/document/dcnr_010080.pdf

Schmit, D. A. 2012. A new enemy in Pennsylvania forests: thousand cankers disease. *Keystone Wild! Notes*, Spring 2012 Edition: 1.

Tobin, P. C., Bai, B. B., Eggen, D. A., and Leonard, D. S. 2012. The ecology, geopolitics, and economics of managing *Lymantria dispar* in the United States. *International Journal of Pest Management* 58(3): 195-210.

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