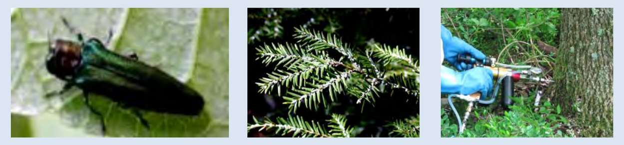
Invasive Species Management in the Forest: Theories and Practices



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Introduction

Invasive species are non-native species whose introduction do or are likely to cause economic or environmental harm, or harm to human health (Federal Executive Order 13112). Over 50,000 non-native species have been introduced to the U. S. intentionally or un-internationally. Only a small fraction of them became invasive. However, they pose a great threat to the environment, economy, and animal and human health. An estimated $137 billion has been lost to invasive species in agriculture, forestry and other economic segments annually (Pimentel et al. 2000). Potential negative ecological impacts include genetic hybridization and introgression, individual trait modification and fitness reduction, population competition and predation, community extinction and cascading effect, habitat alternation and species displacement, and landscape homogenization and loss of species diversity. Increasing globalization in the past few decades facilitates the spread of invasive species as international commerce develops new trade routes, markets, and products.

More than 450 nonindigenous insects and at least 16 pathogens have colonized forest and urban trees since European settlement, with an average of 2.5 species/year detected between 1860-2006. All the pathogens and at least 63 of the insect species have caused notable damage to trees (Aukema et al. 2010). Chestnut blight, gypsy moth, Dutch elm disease, Asian longhorned beetle, and emerald ash borer are just some of the examples.

Successful management of invasive species in the forest not only depends on the understanding of invasion biology for specific species, but also the adoption of appropriate management approaches at different stages during the invasion process. To demonstrate the application of those theories in field practices, we present here a few active programs in invasive species management in Pennsylvania.

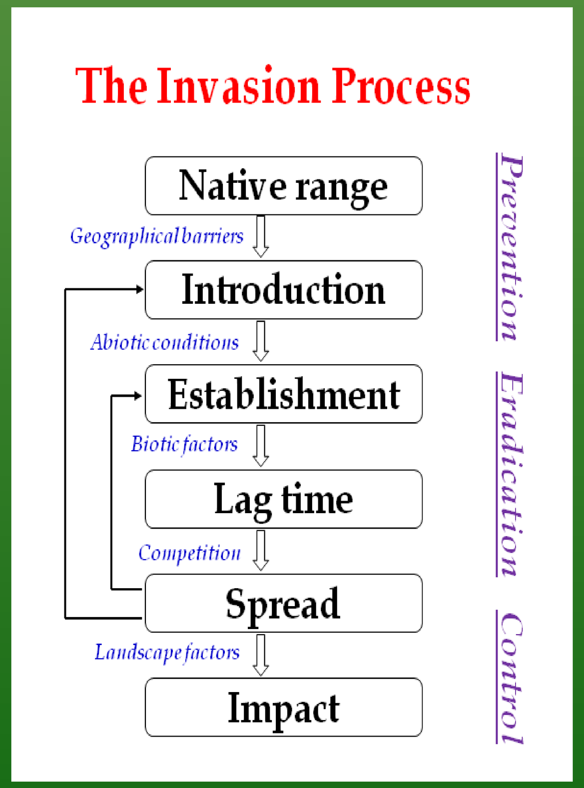
Invasion Mechanism and Process

Certain life history traits such as broad host range, wide geographic distribution, fast growth, rapid propagation, plastic genotypes, sexual or asexual reproduction, natural or human-assisted dispersal are predictive in invasion biology. However, the success of an invasive species is ultimately determined by its genetic and evolutionary processes, as well as the susceptibility of invaded communities.

Natural Enemy Release Hypothesis
- *The abundance and impact of some invasive species are related to the scarcity of natural enemies in the introduced range compared with the native range.*

Biotic Resistance Hypothesis
- *Species-rich communities are more resistance to invasion as resources are used more effectively and efficiently .*

Invasion Meltdown Theory
- *Invasion of an ecosystem occurs exponentially when disturbance from invasive species to the system reaches the threshold.*



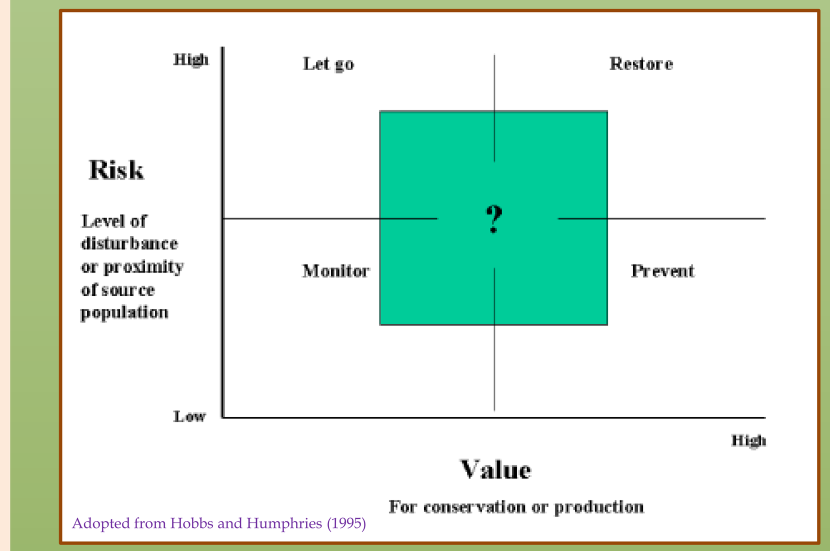
Management Options

Prevention
- Develop risk assessments for high priority species
- Develop screening systems for monitoring
- Identify major pathways to reduce movement
- Share information with cooperators and stakeholders

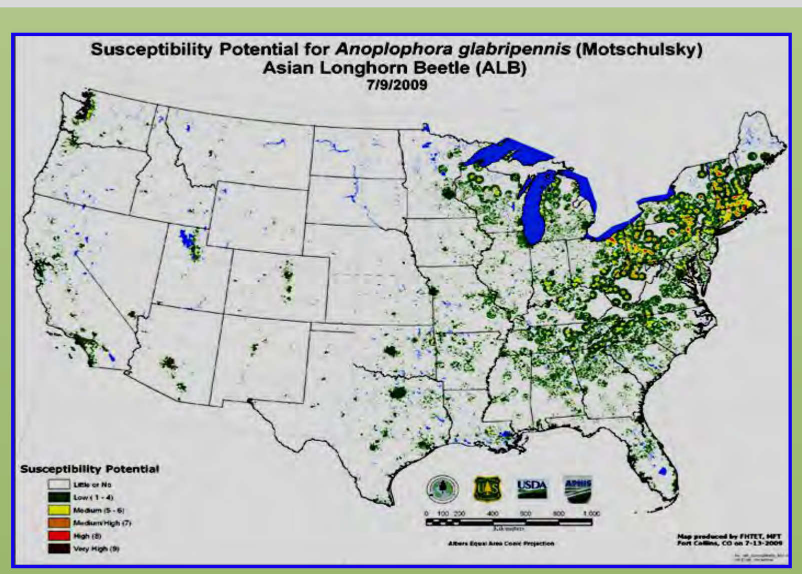
Monitoring
- Develop standard protocols for early detection
- Implement survey programs through cooperation
- Report results for analysis and decision-making
- Draft action plans to address rapid response needs

Control
- Enact quarantines to limit human-assisted spread
- Conduct eradication to destroy early populations
- Suppress populations by chemical & biological means
- Mitigate negative impacts through integrated projects

Restoration
- Address concerns over invasive species in planning
- Focus on high-value areas impacted by invasion
- Consider multi-scale rehabilitation and restoration
- Engage local communities and the public



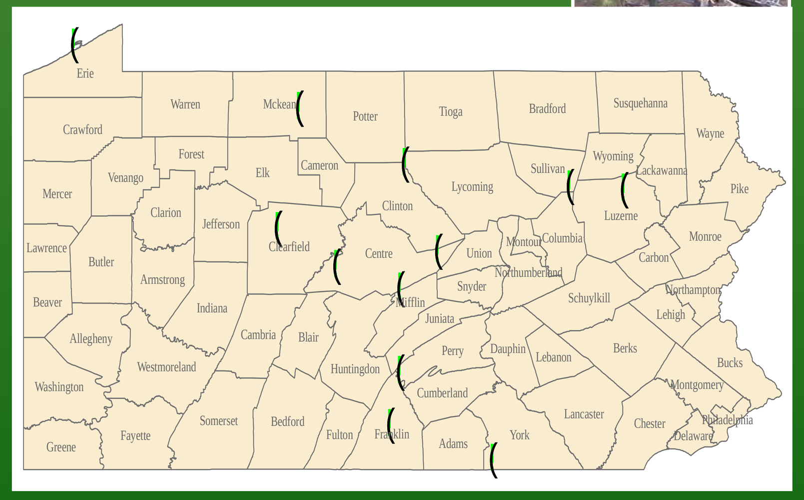
Adopted from Hobbs and Humphries (1995)



Case Study I *Asian Longhorned Beetle Prevention*

Anoplophora glabripennis (Motsch.) (Coleoptera: Cerambycidae) is an important exotic pest of maples (*Acer* spp.) and many other hardwood species. It was first discovered in the city of New York in 1996. Infestations were also found in Chicago, New Jersey, Massachusetts, and most recently Ohio. It attacks both healthy and stressed trees of all sizes.

A firewood quarantine was enacted in Pennsylvania to prevent it from spreading to the state. In addition, a zip-code based visual survey was conducted in 2010 and 2011 to examine campgrounds visited by campers from infested areas. Host trees surrounding the campsites within those campgrounds were inspected for signs and symptoms of infestations. A total of 548 host trees (mostly maple) from 84 campsites in 29 State Parks were visually inspected. No *A. glabripennis* infestation was detected.



Case Study II *Exotic Bark Beetle Monitoring*

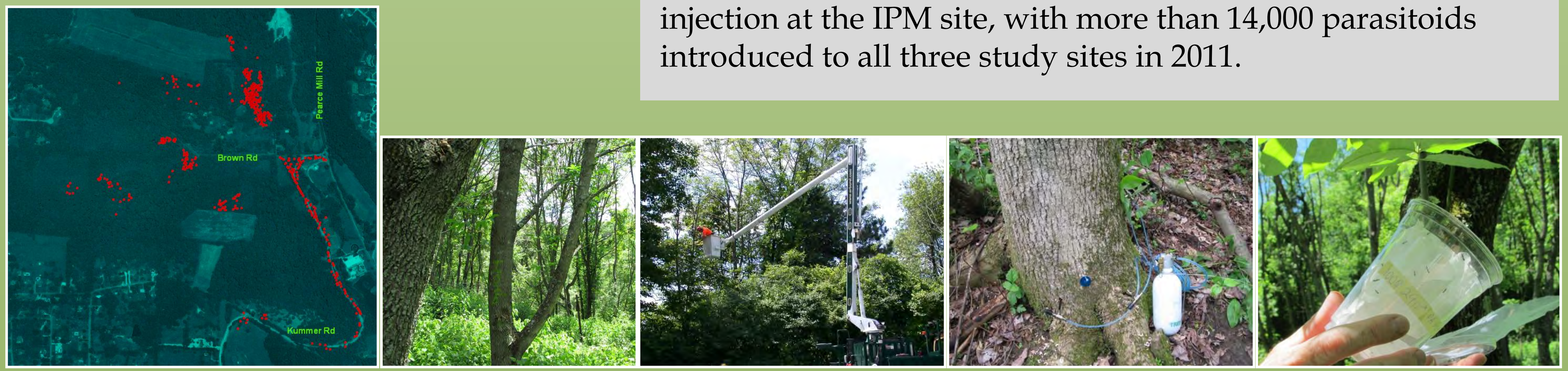
Non-native bark and ambrosia beetles (Scolytinae) are a serious threat to our nation's urban and rural forests. Early detection is the key to the management of these pests.

We participated the multi-state Early Detection and Rapid Response (EDRR) project from 2010-2011. A total of 12 sites were selected from wooded areas for the 12 wk trapping period each year. Three 12-unit funnel traps were used at each site with traps baited with one of the three types of lures. Over 22,000 beetles were collected in two years, with *Xylosandrus germanus* Blandford and *Anisandrus sayi* Hopkins the dominate species. No significant exotic species were found.

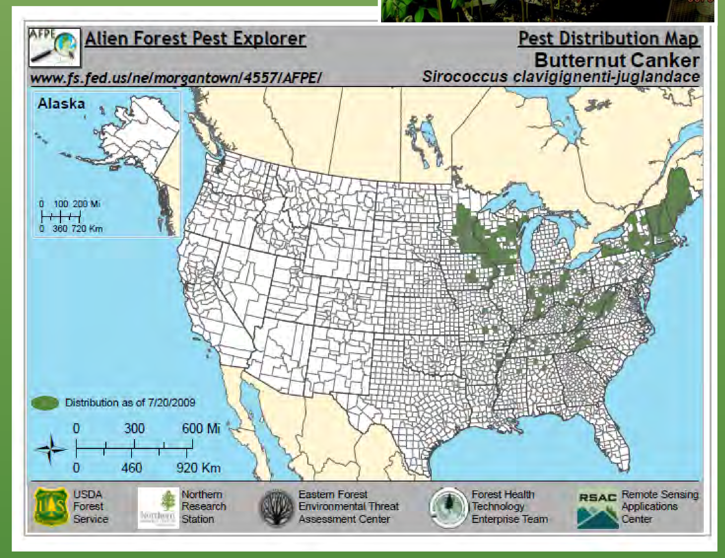
Case Study III *Emerald Ash Borer Control*

Agrilus planipennis Fairmaire (Coleoptera: Buprestidae) is an exotic pest of ash trees in North America. It was first discovered in southeastern Michigan in 2002. Since then it has been found in 15 states in the U.S. and 2 provinces in Canada. Larval feeding under the bark eventually leads to death of the tree. Millions of ash trees have been killed throughout the years.

EAB is currently found in 22 counties in Pennsylvania. An integrated pest management (IPM) project was implemented in a selected site with the adoption of limited tree removal, chemical control with Tree-äge, and biological control with three hymenopteran parasitoids, *Tetrastichus planipennisi* Yang (Eulophidae), *Spathius agrili* Yang (Braconidae), and *Oobius agrili* Zhang & Huang (Encyrtidae). Parasitoids were also released in two additional sites. Overall, 17 infested ash trees were removed and 249 trees chemically treated through trunk injection at the IPM site, with more than 14,000 parasitoids introduced to all three study sites in 2011.



Case Study IV *Butternut Conservation*



Butternut canker is a fungal disease caused by *Sirococcus claviginenti-juglandacearum*. Perennial stem cankers created by the infection of this fungus eventually girdles and kill s the infected trees.

A multi-state project was initiated in 2009 to locate canker–resistant butternut specimens for butternut conservation. A total of 196 trees have been located throughout the state. Dormant twigs or leaf samples were collected and tested for species identity. Positive identification led to grafted seedlings from 27 pure butternut families. Seedlings are being used for pathogenicity testing.

Conclusions

1. Nonindigenous invasive insects and diseases are a major threat to forest resources;
2. Knowledge of invasion mechanism and process is the key to successful monitoring and prevention;
3. An integrated approach must be adopted for invasive species management in the forest;
4. Damage mitigation and habitat restoration can be achieved through multi-level cooperation and public outreach.

References

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