Ecosystem Health and Sustainable Agriculture

Ecology and Animal Health

Editors: Leif Norrgren and Jeffrey M. Levengood
Introduction

Invasive species have threatened the Great Lakes region since the area was first settled by the English in the 1800’s. As stated by the Great Lakes Commission (1999), more than 140 exotic, aquatic invaders have become established in this area. Nevertheless, terrestrial invasive species have had a tremendous impact on the Great Lakes region, especially in the last decade.

According to the National Invasive Species Council (2001) an “invasive species” can be defined as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Immigration was the only mode of arrival by organisms into new areas until several thousand years ago. Today, while immigration (or range extension) still occurs, many introductions of non-native species are facilitated by human activities (Hallman and Schwalbe, 2002). The means to which an invasive species is introduced to an environment is called a “pathway”. There are several different types of pathways in which invasive species can be introduced into new environments (Hallman and Schwalbe, 2002; Mack et al., 2002).

Some organisms are imported for various reasons, but end up causing environmental problems rather than correcting them. For instance, kudzu (Pueraria lobata) was imported to help combat soil erosion. Now this fast growing vine is taking over large areas of the southeastern United States (Stein and Flack, 1996). Increased globalization that has accompanied the trade of goods and services has provided another outstanding means of transportation for these unwanted pests. Travel and trade between the United States and foreign countries has increased considerably. Direct airline routes have increased, thus increasing the speed at which cargo can be moved around the globe. Invasive plant pests can be transported into the United States from almost any point in the world within twenty-four to thirty-six hours (Mack et al., 2002). This timeframe is well within the survival time of many species. Hitchhikers can accompany commodities such as produce, nursery stock, or livestock and stowaways hide in solid wood packing materials or a ship’s ballast water. The use of seaborne shipping containers continues to rise as well. Unfortunately, it is impossible to inspect every shipping container that enters a port. With the increased use of shipping containers, concerns lie with the possibility of new infestations in not only port areas, but inland where containers may be opened for the first time when reaching their final destinations (Hallman and Schwalbe, 2002).

Not only will a potential invasive pest affect the economy – Pimentel et al. (2005) estimates the economic damages associated with alien invasive species effects
and their control amount to approximately $120 billion/year. Invasive species may also affect the beauty of our landscape, the diversity of our environment, and lead to the destruction of natural habitats. The Great Lakes area has suffered the consequences of many invasive species that have become established there (Great Lakes Council, 1999). This area continues to be on the lookout for the introduction of new invasive species and the movement of others currently found here (Table 4.1).

The Asian longhorn beetle was discovered in Chicago in 1998. Following intense survey, public awareness and regulatory activities, the Asian longhorn beetle was declared eradicated from the previously infested neighborhoods in Chicago in 2008. Later that year, a single Asian longhorned beetle adult was found in the Deerfield mall parking lot. At the time this chapter was printed, delimiting surveys and inspections were still underway to find out more about this occurrence. Ironically, many of the trees infested in the neighborhoods that were under attack by the Asian longhorn beetle were planted to replace ones killed by Dutch elm disease nearly 50 years before. Dutch elm disease is one of the most familiar tree diseases in North America. It has continued to affect native and urban elm populations since 1930. While both of the Asian longhorn beetle and Dutch elm disease have had a serious impact in the Great Lakes area, let’s look at two more invasive pests in greater detail.

**Emerald Ash Borer**

**Historical Background**
The emerald ash borer (*Agrilus planipennis*) was first discovered in North America in southeastern Michigan near Detroit during the summer of 2002. It is thought to have been accidentally introduced into the United States in packing material made from ash wood in the 1990’s. The native range of the emerald ash borer is eastern Russia, northern China, Japan, and Korea where it occurs on several species of ash. Since its introduction, the emerald ash borer has been found in nine other states and Canada (Figure 4.1). This beetle is responsible for killing millions of ash trees and threatens to kill millions more throughout North America.

**Biology**
The emerald ash borer generally has one generation per year. However, studies suggest that development may sometimes take longer in newly infested, healthy trees. In late May through August, beetles begin to emerge from infested ash trees; peak emergence occurs in mid- to late June. Trees display a small (0.3 cm) D-shaped hole in trunks and branches from where adults have emerged. For three to six weeks, adults with feed on ash leaves, mate, and lay eggs. Females will lay about 50-60 eggs individually on the bark surface or within bark cracks and crevices. Larvae hatch and tunnel into the tree. They feed on the phloem, creating S-shaped galleries just under the bark. Over the course of several years, the formation of these serpentine galleries disrupts the flow of nutrients and water, causing thinning of the canopy, branch dieback, and ultimately, tree death. Larvae feed

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<tr>
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<td>Emerald Ash Borer (<em>Agrilus planipennis</em>)</td>
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<td>European woodwasp (<em>Sirex noctilio</em>)</td>
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<td>Hemlock woolly adelgid (<em>Adelges tsugae</em>)</td>
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<td>Viburnum leaf beetle (<em>Pyrrhalta viburni</em>)</td>
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<td>Pathogens</td>
<td>Bacterial Leaf Scorch (<em>Xylella fastidiosa</em>)</td>
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<td>Beech bark disease (<em>Nectria coccinea var. faginate</em>)</td>
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<td>Chestnut blight (<em>Cryptonectria parasitica</em>)</td>
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<td>Chrysanthemum white rust (<em>Puccinia horianna</em>)</td>
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<td>Sudden oak death (<em>Phytophthora ramorum</em>)</td>
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<td>Potato golden cyst nematoide (<em>Globodera rostochiensis</em>)</td>
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<td>Plants</td>
<td>Garlic mustard (<em>Alliaria petiolata</em>)</td>
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<td>Giant hogweed (<em>Heracleum mantegazzianum</em>)</td>
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<td>Japanese hops (<em>Humulus japonicas</em>)</td>
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<td>Leafy spurge (<em>Euphorbia esula</em>)</td>
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<td>Multiflora rose (<em>Rosa multiflora</em>)</td>
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<td>Oriental bittersweet (<em>Celastrus orbiculatus</em>)</td>
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<td>Purple loosestrife (<em>Lythrum salicaria</em>)</td>
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<td>Spotted knapweed (<em>Centaurea biebersteinii</em>)</td>
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<td>Teasel (<em>Dipsacus syvestris</em>)</td>
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Table 4.1. A selected listing of terrestrial invasive specie threats to the Great Lakes Region. Source: Author.
throughout the summer and early fall before overwintering in the outer bark. In mid- to late spring, pupation occurs and adult emerge soon thereafter (McCullogh and Katovich, 2008).

Environmental and Economical Impacts
There is potential for the emerald ash borer to destroy all native ashes in infested areas because these native ashes lack an evolutionary history with the beetle. In an Ohio study, all native ashes (Fraxinus americana, F. nigra, F. pennsylvanica, and F. quadrangulata) have been shown to be sensitive to emerald ash borer. Ash species are dominant in eastern North American forests and well as being important nursery and landscape trees. Some losses are very straightforward and easy to put a financial value on, including the cost of tree removal (including stumps), and the cost of replacement trees. On the other hand, other losses associated with emerald ash borer infestations can be very difficult to assess. The loss in landscape value can include a multitude of aspects – reduced aesthetic value, increased heating and cooling costs, reduced property values, increased storm water runoff, and reduced wildlife habitat.

Control
Management options for emerald ash borer are still being widely researched. First and foremost, attempts should be made to limit the artificial movement of emerald ash borer, such as the movement of infested logs and firewood to prevent the spread of this insect to non-infested areas. In areas where emerald ash borer is present, large scale efforts including quarantines, infestation surveys, tree removal and outreach education to manage the emerald ash borer are primarily conducted by federal and state agencies. Ash trees can be preventatively treated for emerald ash borer, but this is not recommended unless infestations are within 24 km of tree and these treatments can be very costly as they required annual applications. Treatments are more effective when overall tree health is maintained. Imidacloprid and emamectin benzoate can be applied as trunk injections, and imidacloprid can also be used as a soil drench (Nixon, 2008). The efficacy of these treatments is currently being researched. It is also important to know that these insecticides may not be recommended or labeled yet in certain areas; please follow all label instructions. Insecticidal management options are continuing to be researched as well as biological
control options. In 2007, three parasitoids, *Oobius agrili*, *Tetrastichus planipennisi*, and *Spathius agrili*, were released in Michigan and will be evaluated over the next five years.

**Garlic Mustard**

**Historical Background**
Native to western Eurasia, garlic mustard (*Alliaria petiolata*) is thought to have been introduced to North America is the early 1800’s by European settlers who valued it as a food and medicinal plant. In 1968, garlic mustard was first reported as growing in native communities in Long Island, New York (Kaufman and Kaufman, 2007; Nuzzo, 1993).

**Biology**
This biennial plant can be found growing along forest edges, riverbanks, and roadsides as well as deep within forest ecosystems. Widely spread throughout the Great Lakes region, garlic mustard can be found from southern Ontario and Quebec south to Virginia and west to Wisconsin (Nuzzo, 1993). However, it occurs as far south as Georgia, west to Oregon and Washington, and even in southern Alaska (Figure 4.2). During its first year, garlic mustard forms a rosette of leaves and in mid-spring the second year, sends up weak single stems, 30-40 cm high with small clusters of white flowers. Known for its high seed production, this invasive plant can take over an area in a matter of years. (Kaufman and Kaufman, 2007)

**Environmental and Ecological Impacts**
Garlic mustard is considered by some as the most serious plant invader of forested area. Its ability to overwhelm natural habitats and dominate the understory of forested areas is a cause for great concern. Traits such as shade tolerance and the fact it does not require a disturbance to become established or to proliferate, allow it spread at an alarming rate. Additionally, it may inhibit the growth of micorrhizal fungi that is needed by many native plants that use the fungi to obtain nutrients from the soil. Garlic mustard populations threaten spring-blooming wildflowers and forest ecosystems, affect tree growth and ultimately animals that depend on natural growth.

Little direct economic damage has been described or documented, nor has its ability to cause changes in for-
est productivity (Kaufman and Kaufman, 2007; Nuzzo, 1993).

**Control**
The key to garlic mustard control is to attack it early, before it becomes established. Once garlic mustard becomes widespread, eradication is very difficult. Hand pulling second year plants is effective when dealing with small infestations. The optimum time to pull plants is just after they have started flowering; the entire plant should be removed, including the roots. Larger infestations are best controlled with herbicides. Glyphosate, a safe and widely used herbicide, can be used early in the spring when garlic mustard plant growth begins (and before native flowering plants begin). First year plants can also be sprayed in late fall, after native plants have been hit with frost. Garlic mustard control is a multiple year process; seed in the seed bank can continue to emerge for several years. Researchers are currently investigating potential biological control agents to aid in the management of garlic mustard (Kaufman and Kaufman, 2007).

**Conclusion**
The Great Lakes region has dealt with the arrival of many unwanted, invasive plant pests and will continue to do so well into the future. Each has the potential to significantly impact the urban and natural landscapes of the region. Preventing the arrival of these pests is the best and most economical form of protection against invasive species. This is easier said than done. Thus we must rely on early detection followed by eradication or if the introduced pests are already established, contain their spread and attempt to minimize their affects on the environment.
References

Chapter 3


Chapter 4


Chapter 5

Alien Species in Swedish seas and coastal areas. http://www.framman.dearter.se/0/2english/species_Sv.html?reload_coolmenus

Chapter 7