

How Invasive Species Affect Ecosystems

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Quick Facts

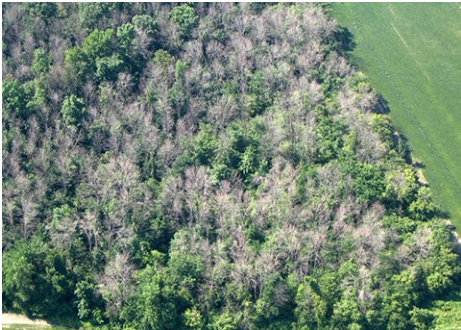


Fig. 1. Ash trees damaged by emerald ash borer in Canada. Troy Kimoto, Canadian Food Inspection Agency, bugwood.org.

- Invasive species disrupt ecosystems by outcompeting or preying on native species.
- Lack of natural predators allows invasive species to reproduce rapidly and dominate ecosystems.
- Invasive species impose massive economic costs on agriculture, forestry, infrastructure, and ecosystem restoration.
- Public awareness and conservation efforts are key to reducing the spread and impact of invasive species.

Invasive species can have profound impacts on ecosystems worldwide. In the absence of their natural enemies, invasive species thrive and reproduce quickly. In many cases, they outcompete or prey on native species, leading to changes in habitat structure (Fig. 1) and disrupting essential ecosystem services.

As native species decline, ecosystem resilience is reduced, leaving ecological gaps that invasive species can exploit. This disruption in habitat structure and resource availability provides opportunities for other non-native species to establish as well. Additionally, invasive species often alter soil, water, and nutrient dynamics, creating environments that favor additional invasions, thus accelerating the cycle of ecosystem degradation.

Impact on Biodiversity

Invasive species are a threat to biodiversity through mechanisms such as competition, predation, and vectors for disease. Studies have shown that invasive species are one of the leading threats to threatened and endangered species, behind habitat loss and overexploitation (Dueñas et al., 2021).



Fig. 2. Variations of the multicolored Asian lady beetle. Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

Competition

When invasive species are introduced into new ecosystems, they may outcompete native species for resources like food, space, and light. This competitive advantage is frequently due to their ability to grow faster, reproduce more quickly, or tolerate environmental conditions that native species cannot. The invasive spotted lanternfly (SLF) has a diverse diet and feeds on over 70 plant species in the U.S. In addition to its wide range of hosts, a female SLF can lay up to 100 eggs during her one-year lifespan. As a result, SLF consumes more resources each year away from native insects (Acosta, 2023).

Predation

Introduced invasive predators are often allowed to increase their populations unchecked. Native species that evolved without these predators are unable to adapt quickly enough, leading to a decrease in their populations. The multicolored Asian lady beetle (Fig. 2) was intentionally introduced to the U.S. in the early 1900s to control aphids in agriculture. It is now one of the most common lady beetles encountered and has, in fact, become an invasive pest in some regions. It not only competes with native lady beetles for habitat and food sources, but it also consumes them along with other beneficial native insects. Native lady beetle species populations have declined throughout North America, causing an imbalance in biodiversity (Brown et al., 2011).

Disease

Invasives also include pathogens (fungi, bacteria, etc.) or insect vectors for plant diseases that native species have not evolved defenses against. One prominent example of this is Dutch elm disease (DED), brought to the U.S. through imported elm logs from Europe. Since then, DED has spread throughout the country, including in Utah, causing widespread death of ornamental and native American elm trees (Fig. 3). Native and invasive elm bark beetles carry the fungal pathogen that causes the infection, and both transmit the disease. Once the fungus infects an elm tree, it blocks the flow of water and nutrients, leading to the tree's death. The ongoing spread of this disease highlights the vulnerability of native species to introduced pathogens (Bainbridge, 2023).



Fig. 3. Winged elm dying due to Dutch elm disease. GR. Scott Cameron, Advanced Forest Protection, Inc., bugwood.org

Altering Nutrient Cycles

Soil Health

Invasive trees, shrubs, perennials, and annuals have been shown to significantly alter soil microbial communities, with studies indicating these changes can occur in as little as three months following the introduction of a non-native plant (Kourtev et al., 2003). These shifts in microbial composition can have cascading effects on soil characteristics, leading to increased nitrification rates and a rise in soil pH. Such alterations to soil microbiota can change the nutrient cycling process and increase nitrogen availability in the soil. However, overabundant nitrates can have negative consequences, including contaminating groundwater through leaching, which can degrade water quality (Kourtev et al., 2003). This reduction in structural integrity can make plants more susceptible to damage from environmental stressors and herbivory.

Invasive plant species can significantly influence the carbon content of soil, presumably due to the distinct differences in leaf litter traits between native and invasive plants (Vujanovi# et al., 2022). This increase in carbon can, in turn, promote the growth of nitrogen-fixing bacteria

populations, which leads to higher concentrations of nitrates in the soil. These changes can disrupt the natural nutrient balance, further impacting ecosystem dynamics.

Water Quality

The introduction of zebra mussels into the Great Lakes region has had significant and lasting impacts on water quality and ecosystem dynamics. Research shows that zebra mussels have caused a 50% to 60% reduction in chlorophyll and phosphorus concentrations in the Lakes, as well as an increase in Secchi disk transparency, a measure used to assess the clarity of a body of water (Fahnenstiel et al., 1995). These changes have profound consequences for the aquatic ecosystem, as phosphorus and chlorophyll are critical nutrients for aquatic plant growth. Without sufficient phosphorus, these plants struggle to thrive, ultimately reducing food availability for a variety of native aquatic herbivores, such as invertebrates, fish, and mammals, including beavers (Fahnenstiel et al., 1995). These food shortages can lead to shifts in population dynamics, disrupt the balance of the aquatic food web, and reduce the abundance and biodiversity of native species.

Economic Consequences

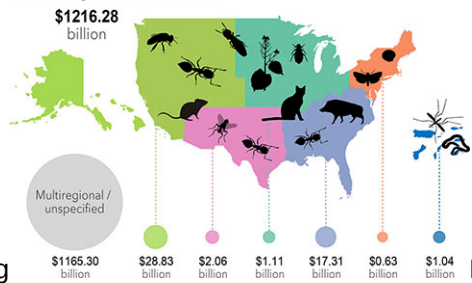
Invasive species not only have a major impact on ecosystems, but they also have a significant economic impact. Agriculture is often one of the most affected sectors, as invasive species like Japanese beetle can damage crops (Fig. 4), reduce yields, and increase the need for costly pest control. Other invasive pests like emerald ash borer have caused extensive damage to timber industries by killing millions of ash trees in forests. In aquatic systems, zebra mussels clog water intake pipes and damage infrastructure, costing millions of dollars in maintenance and repairs. In North America, the economic cost of invasive species has been estimated at \$1.288 trillion over the last 50 years (Zenni et al., 2021), with \$1.21 trillion of that cost being in the United States alone (Crystal-Ornelas et al., 2021) (Fig. 5). This cost also includes the conservation of habitat damaged by invasive species. Restoring damaged habitats can be a costly and complex process. Efforts often require extensive resources for removal, monitoring, and rehabilitation of native ecosystems, as well as long-term management to prevent re-invasion. These restoration projects can range from hundreds of thousands to millions of dollars, depending on the scale and location of the damage (Bainbridge, 2023).

Fig.

4. Japanese beetle feeding damage on

geraniums. Whitney Cranshaw, Colorado State University,

Cost of biological invasions in the USA



bugwood.org

Fig. 5. Costs of invasive species in each region of the United States from 1960 to 2020. Fantle-Lepczyk et al., 2022

What Can We Do?

There are several preventive actions everyone can take to help stop the spread of invasive species and reduce their impact on native ecosystems and biodiversity, such as:

- **Cleaning** boats, fishing gear, and hiking boots before moving them between habitats.
- **Choosing** native plants for gardens.
- **Avoiding** the release of non-native species into the wild.
- **Raising** awareness to neighbors and friends.
- **Reporting** invasive species to local authorities to help control their spread.
- **Participating** in local conservation efforts, such as invasive species removal programs.

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