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# Invasive Species

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## Introduction

An invasive species is defined legally in the USA as "An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health…'Alien species' means, with respect to a particular ecosystem, any species…that is not native to that ecosystem."

Non-native species can be added to a community either by natural range extensions or because they are introduced as a result of human activity. Most non-native species have harmful ecological effects; these are referred to as invasive species. Virtually all ecosystems are at risk from the harmful effects of introduced invasive species (also see exotic species, marine invasive species, and aquatic invasive species).

Invasive species are a major threat to our environment because they (1) can change habitats and alter ecosystem function and ecosystem services, (2) crowd out or replace native species, and (3) damage human activities, costing the economy millions of dollars. For example, costs to agriculture, forestry, fisheries, and other human activities by introduced species are estimated at $137 billion per year to the U.S. economy alone.

## Threats to Biodiversity

Invasive species rank second only to habitat destruction, such as deforestation, as a threat to biodiversity. Almost half of the species in the United States that are at risk of extinction are endangered because of the effects introduced species alone or because of their impacts combined with other processes. In fact, introduced species are considered a greater threat to native biodiversity than pollution, harvest, and disease combined. Invasive species threaten biodiversity by (1) causing disease, (2) acting as predators or parasites, (3) acting as competitors, (4) altering habitat, or (5) hybridizing with local species.

### Disease

Accidental introduction of the Asian chestnut blight fungus via the nursery trade virtually eliminated American chestnut from over 180 million acres of eastern United States forests in the first half of the 20th century. This extinction caused a whole scale transformation of the Eastern deciduous forest ecosystem, which was dominated by American chestnut. The loss of chestnuts was a disaster for many animals that were highly adapted to live in forests dominated by this tree species. For example, ten moth species that could live only on chestnut trees became extinct.

### Predators

Invasive predators can severely reduce the population sizes of native species, or even drive them extinct, because native prey species may not have evolved defenses against the novel predators:

- The predatory brown tree snake was introduced to Guam in cargo from the Admiralty Islands. Predation by brown tree snakes eliminated ten of the eleven native bird species endemic to the forests of Guam.
- The Nile perch, a voracious predator, was introduced to Lake Victoria in Africa as a food fish. Predation from the Nile perch has eliminated over one hundred species of the spectacular native cichlid fishes of Lake Victoria.
- Invasive herbivores can cause great damage. For example, goats were introduced by sailors to many remote oceanic islands during the age of European seafaring exploration, to provide a source of food when the islands were revisited. Goats introduced to the island of St. Helena in the 16th century eliminated over half the endemic plant species.
- North American gray squirrels are driving native red squirrels to extinction in Great Britain and Italy. The introduced squirrels forage for nuts more efficiently than the native species, potentially leading to the loss of a native species.
- Zebra mussels were accidentally brought to the United States from Russia in the ballast of ships. Zebra mussels alter aquatic habitats by filtering large amounts of water, thus reducing densities of planktonic organisms and settling in dense masses over vast areas. At least thirty freshwater mussel species are threatened with extinction by competition from the zebra mussel.

### Hybridization

Hybridization occurs when members of two different species mate with one another and produce viable offspring that carry genes from both parents. When an invasive species is much more abundant than a native relative, they may hybridize so often that the invaders genes "flood" the native species, such that no individuals contain the entire genotype of the native species, thus effectively driving the native species to extinction. It is possible that hybridization is common in such cases because the native species has not

experienced selection for reproductive isolating mechanisms to prevent hybridization with the invader. Of the 26 known animal species in the USA that have gone extinct since being listed under the Endangered Species Act, at least three were wholly or partly lost because of hybridization with invaders. For example, hybridization between Introduced mallards and the native Hawaiian duck and between the rarest European duck (the white-headed duck) and the invasive North American ruddy duck may result in the extinction of the native species.

**Invasion Meltdown**

Often invading species interact with one another to generate a problem where either species alone would be harmless, a concept known as invasion meltdown. Ornamental fig trees planted in Miami did not spread because they were sterile because they lacked the wasp species required for pollination. However, in the early 1990s a wasp species capable of fertilizing the figs independently invaded the region, so now the figs are capable of reproducing and spreading.

**Controlling Invasive Species**

Strategies used to control invasive species include (1) keeping potential invaders out, (2) eradicating potential invaders soon after invasion, (3) biological control, (4) chemical control, and (5) mechanical control.

*Keeping potential invaders out*

Keeping potentially damaging invaders out in the first place is the most cost-effective way to deal with introduced species. The ability of new species to invade can be reduced by monitoring the common invasion pathways such as ship ballast water, wooden packing material, and horticultural plants.

*Eradicating after invasion*

It is easier to eradicate invasive species if they are discovered quickly and population levels remain low. Even if it proves impossible to totally eliminate an invader, early intervention can keep the population sizes of invaders at acceptably low levels. For example, Giant African Snails were effectively eliminated from Florida. Currently researchers in California are attempting to eradicate the marine green alga Caulerpa which has recently invaded that region.

*Biological control*

Biological control involves introducing an enemy of an invasive plant (i.e., a disease, parasite, predator, or competitor) in an attempt to lower the population size of the invader. Sometimes introducing a natural enemy from the native range of the introduced pest can be effective. For example, prickly pear cactus that invaded Australia from the Americas has been effectively controlled by introducing a moth from South America whose caterpillar feeds on the cactus. In other cases the most effective control comes from finding an enemy from a different area (a novel association) because the invader may not have evolved any defenses to such species with which they have never been in contact. For example, a virus from South America has been used to control European Rabbits in Australia. A disadvantage of biological control is that some agents attack nontarget species, becoming noxious invaders themselves, and it is very difficult to remove a troublesome introduced natural enemy once it is established.

*Chemical control*

Chemical control involves using chemical pesticides to kill invaders. Although chemicals can effectively control some species (for example, water hyacinth in Florida), chemical control has some problems. For example pesticides may affect non target species. Chemical control can be expensive and may only be effective for a limited amount of time because pests can evolve resistance to the pesticides.

*Mechanical control*

Mechanical control involves using machinery or human effort to remove invaders. Mechanical control has been an effective control strategy for invasive Tamarix in the Southwestern US (Tamarix control). Volunteer convict labor has been used in Florida to cut paperbark trees and in Kentucky to rip out Eurasian musk thistle.

The newest technology for managing invaders is ecosystem management, in which the entire ecosystem is subject to a regular treatment (such as a simulated natural fire regime) that tends to favor adapted native species over most exotic invaders. Because it is so new, the specific ways in which ecosystem management can be employed must be determined in each type of habitat.




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