

Introduced Species: The Threat to Biodiversity & What Can Be Done Daniel

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The Cuban Tree Frog is an invasive species in southeast USA, competing with smaller native species. Photo: Oksana Hlodan

There are many ways in which the introduction of non-native or exotic species negatively affects our environment and the diversity of life on our planet. The statistics are startling and more attention must be paid to the problem and devising a solution before the cost is more than we can bear.

Invasive species cause more damage than some pollutants. Almost half of the native species in America are endangered because of invasive species.

- Compared to other threats to biodiversity, invasive introduced species rank second only to habitat destruction, such as forest clearing.
- Of all 1,880 imperiled species in the United States, 49% are endangered because of introduced species alone or because of their impact combined with other forces.
- In fact, introduced species are a greater threat to native biodiversity than pollution, harvest, and disease combined.
- Further, through damage to agriculture, forestry, fisheries, and other human enterprises, introduced species inflict an enormous economic cost, estimated at \$137 billion per year to the U.S. economy alone.
- Of course, some introduced species (such as most of our food crops and pets) are beneficial. However, others are very damaging.

Introduced species are not good guests

The greatest impact is caused by introduced species that change an entire habitat, because many native species thrive only in a particular habitat.

Florida's fires are fueled by a tree imported from Australia.

- When the Asian chestnut blight fungus virtually eliminated American chestnut from over 180 million acres of eastern United States forests in the first half of the 20th century, it 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.
- Similarly, the Australian paperbark tree has replaced native plants, such as sawgrass, over 400,000 acres of south Florida, because it has a combination of traits (for example, spongy outer bark and flammable leaves and litter) that increase fire frequency and intensity. Many birds and mammals adapted to the native plant community declined in abundance as paperbark spread.

The invasive zebra mussel is depleting the food of marine natives.

- In similar fashion, aquatic plants such as South American water hyacinth in Texas and Louisiana and marine algae such as Australian Caulerpa in the Mediterranean Sea change vast expanses of habitat by replacing

formerly dominant native plants.

- The zebra mussel, accidentally brought to the United States from southern Russia, transforms aquatic habitats by filtering prodigious amounts of water (thereby lowering densities of planktonic organisms) and settling in dense masses over vast areas. At least thirty freshwater mussel species are threatened with extinction by the zebra mussel.

Other invaders, though they do not change a habitat, endanger single species or even entire groups of them in various ways:

Trout fishing is almost nonexistent in some American states because of a foreign parasite.

- The predatory brown tree snake, introduced in cargo from the Admiralty Islands, has eliminated ten of the eleven native bird species from the forests of Guam.
- The Nile perch, a voracious predator introduced to Lake Victoria as a food fish, has already extinguished over one hundred species of native cichlid fish there.
- A parasite can be similarly devastating. The sea lamprey reached the Great Lakes through a series of canals and, in combination with overfishing, led to the extinction of three endemic fishes.
- The European parasite that causes whirling disease in fishes, introduced to rainbow trout in a hatchery in Pennsylvania, has now spread to many states and devastated the rainbow trout sport fishery in Montana and Colorado.
- Herbivores can wreak great damage. The first sailors to land on the remote Atlantic island of St. Helena in the 16th century introduced goats, which quickly extinguished over half the endemic plant species.

Some impacts of invaders are subtle but nonetheless destructive to native species:

Some alien species eliminate native species by breeding with them, altering the gene pool.

- North American gray squirrels are driving native red squirrels to extinction in Great Britain and Italy by foraging for nuts more efficiently than the native species. Such competition for resources is not easy to observe, but the end result is the loss of a native species.
- Hybridization, or cross-breeding, of introduced species with natives is an even subtler impact (no lineage goes extinct), but it is insidious because it leads gradually to the extinction of many native species, as their gene pools inevitably evolve to become those of the invader. Introduced mallards, for instance, are driving the native Hawaiian duck to a sort of genetic extinction by breeding with them.
- Of 26 animal species 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. One was a fish native to Texas, eliminated by hybridization with introduced mosquito fish.
- Rainbow trout introduced widely in the United States as game fish are hybridizing with five species listed under the Endangered Species Act, such as the Gila trout and Apache trout.
- The endangered, endemic Hawaiian duck is being lost to hybridization with North American mallards introduced for hunting.
- The rarest European duck (the white-headed duck) is threatened by hybridization with the North American ruddy duck, which was originally kept as an amenity in a British game park. The ruddy duck escaped, crossed the English Channel, and spread to Spain, the last stronghold of the white-headed duck.

Invasion meltdown: when an invasive species triggers destructive traits in another species.

Often invaders interact with one another to generate a problem where either species alone would be harmless. For example, ornamental fig trees in the Miami area for over a century stayed where planted, in people's yards, because they were sterile. Each fig species requires a particular wasp to pollinate it, and the wasps were absent. About fifteen years ago, the pollinating wasps for three fig species arrived independently in the region, and now these fig species are reproducing. At least one has become invasive, with seedlings and saplings being found many miles from any planted figs. More cases of this phenomenon, termed "invasion meltdown," are likely to arise as more species are introduced and have the opportunity to interact with each other.

Warding off the intruder

Ballast water, packing material, and gardening plants: transportation for invasives.

Keeping potentially damaging invaders out is the most cost-effective way to deal with introduced species. Targeting common pathways by which invaders reach our shores can slow or stop their entry. Ship ballast water, wooden packing material, and horticultural plants are three prominent pathways for invasion that could all be monitored or treated more rigorously. A species that is introduced despite precautions can sometimes be eradicated, especially if discovered quickly. In the United States, a Giant African snail population was eliminated by a long campaign in Florida, and a federal-state cooperative effort is currently underway in California to attempt to eradicate the recently discovered *Caulerpa* alga invasion. Even if eradication fails, several technologies often can control invasive species at acceptably low levels. No method is a magic bullet, each can have drawbacks if misused, and each has failed when used against certain invaders, but each also has successes to its credit.

Biological, chemical, and mechanical control of invasives have had limited success.

- Biological control entails introducing a natural enemy usually from the native range of the introduced pest. For example, prickly pear cactus from the Americas is well controlled on hundreds of thousands of square miles of Australian rangeland by caterpillars of a moth introduced from South America. A disadvantage of biological control is that some agents attack nontarget species, and it is very difficult to remove a troublesome introduced natural enemy once it is established.
- Chemical control involves using a pesticide, such as an herbicide or insecticide. Although chemicals can effectively control some species (such as water hyacinth in Florida), they may have nontarget impacts, they are often expensive, and pests can evolve resistance to them.
- In mechanical control, hand pulling or various kinds of machinery are employed. For example, volunteer convict labor is used in Florida to cut paperbark trees and in Kentucky to rip out Eurasian musk thistle. However, some invaders cannot be easily found for mechanical removal or occupy a habitat (for example, the marine benthos) that is not readily accessible.
- 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.

Addressing the problem

International cooperation and management is the best solution.

The numbers of introduced species are growing in the United States and elsewhere because of increased trade and travel, but the situation is not hopeless.

- Internationally, the Rio Convention of Biological Diversity (1992) recognized the threat and called for action to limit it.

- A Global Invasive Species Program, formed by the United Nations and other international organizations, is beginning to answer this call with a series of programs designed to deal with particular sorts of introduced species.

In the United States, a Presidential Executive Order in 1999 called for the formation of a Federal Invasive Species Council to render the federal response to introduced species more effective, and to foster cooperation among federal agencies, state agencies, and other stakeholders such as conservation organizations and private landowners. The Council has formulated a Management Plan that includes many activities to slow the influx of invasive introduced species and to deal with them more effectively once they are present.

If all these policies (or global measures) and weapons are used in the battle against invaders, there is every reason to think that most native species and ecosystems can be protected against this threat. If our interest or support falters, the current wave of invaders will surely become a flood, leading to massive habitat change and extinction as much of the earth undergoes a massive biotic homogenization.

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