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# Invasive Species: A Look at their Disastrous Effects on Ecosystems, Health, and Stability of Native Species

## **Abstract**

Invasive predators, competitors, and disease-causing pathogens are the cause of immense and often irreversible harm to the environment, presenting a serious threat to biodiversity. The problem of invasive species dates back to ancient times, when people started using different methods of transport such as horses, canoes, and camels to travel quickly, bringing with them lice, rats, microbes, cows, cats, dogs, goats, pigs, and other creatures. The actions of other species, most notably humans, play an increasing role in species invasions, as *Homo sapiens* have colonized almost all of the ecosystems on Earth and tend to transform natural environments into agricultural or urban landscapes. Invasive organisms can have negative effects on ecosystems and disastrous effects on native flora and fauna, and the most effective way to thwart further invasions and protect biodiversity is to prevent these new species introductions. The instillation of protocols such as the closer inspection of pallets in international trade and travel, effective education programs, and aggressive monitoring and eradication programs is necessary to reduce the deleterious effects of invasive species.

## **Keywords**

Environment, Species, Biology, Invasive Species, Biodiversity, Sustainability

## ***Invasive Species: A Look at their Disastrous Effects on Ecosystems, Health, and Stability of Native Species***

Vanessa Nikolovska

Invasive predators, competitors, and disease-causing pathogens are the cause of immense and often irreversible harm to the environment, presenting a serious threat to biodiversity. Approximately 42% of threatened or endangered species today are at risk primarily due to invasive species (National Wildlife Federation 2015). The problem of invasive species dates back to ancient times, when people started using different methods of transport such as horses, canoes, and camels to travel quickly, bringing with them lice, rats, microbes, cows, cats, dogs, goats, pigs, and other creatures. The actions of other species, most notably humans, play an increasing role in species invasions, as *Homo sapiens* have colonized almost all of the ecosystems on Earth and tend to transform natural environments into agricultural or urban landscapes. Invasive organisms can have negative effects on ecosystems and disastrous effects on native flora and fauna, and the most effective way to thwart further invasions and protect biodiversity is to prevent these new species introductions. The instillation of protocols such as the closer inspection of pallets in international trade and travel, effective education programs, and aggressive monitoring and eradication programs are necessary to reduce the deleterious effects of invasive species.

According to the New York City Department of Environmental Protection, in the United States alone, the cost of the damage to property, agriculture, forestry, and fisheries caused by invasive species exceeds \$120 billion annually. In addition to this monetary loss, invasive species also are capable of causing immense harm to the

environment and human health in both the short and long-term. The question then becomes, why would anyone intentionally want to introduce invasive species into their environment? Ironically enough, these species are usually introduced into an environment as a means toward financial or economic growth, since exotic species are charming as they hold a kind of newness and uniqueness to them (Madigan 2014).

In addition to introducing invasive species into an environment for financial growth, invasive species have also caused disastrous consequences in history, with Europeans colonizing new territories over the past 400 years, and deliberately introducing plants and animals to their new homes in an effort to reconstruct their familiar surroundings. Perhaps it was not understood at that time, but this would have incredibly detrimental effects on the new ecosystems. For instance, before the arrival of Europeans, no mosquitos existed anywhere in the Hawaiian Islands. The first mosquito species was found there in 1827, and then at the start of the 20th century the microbial pathogen that causes avian malaria arrived from the importation of caged birds. Since mosquitos are vectors of the disease, today nearly all endemic bird species living on the Hawaiian Islands below 1,500 meters elevation, the current upper limit of the range of the mosquito vectors, have been eliminated by avian malaria (Sadava 2011).

Humans have been extremely conducive to moving species to regions outside their original range, both deliberately and inadvertently. For example, in Australia, the introduction of European rabbits and foxes for sport and hunting, and of dogs and cats

as pets, led to the extermination of nearly half of the small to medium sized native marsupials on the continent over the last 100 years. This was due to a combination of competition with rabbits and predation by foxes, dogs, and cats. Interestingly, some species deliberately introduced to control other invasive species have themselves become invasive and caused further problems. The U.S. Congress passed the Endangered Species Act in 1973, and in February 2000, Blackburn's sphinx moth, *Manduca blackburni*, became the first Hawaiian insect species to be protected under the act. This moth is endangered perhaps partly due to mortality caused by a parasitoid wasp imported to Hawaii to control the tobacco hornworm, *M. sexta* (Sadava 2011). The pattern of species introduction into areas outside their original range evidently has long-lasting effects and the potential to do much harm, despite initial intentions.

Introduced species do not possess the evolutionary adaptations to adjust to the challenges posed by their new surroundings. As a result, most introduced species do not survive extended periods of time in their new habitats. Introduced species may become invasive when they possess a natural competitive advantage over indigenous species in invaded areas. Under these conditions, new arrivals can establish breeding populations and thrive, especially if the ecosystem lacks natural predators capable of keeping them in check. The ecological disruption that tends to follow such invasions often reduces the ecosystem's biodiversity and causes economic detriment to people who depend on the ecosystem's biological resources. Invasive predators may be so adept at capturing prey that the prey populations decline over time and become eliminated from the ecosystem (Rafferty 2014). Another way an invasive species can have

such a competitive advantage is by preventing native species from obtaining food, living space, or other resources. Over time, invading species can effectively replace native ones, often forcing the localized extinction of many native species.

An important point to keep in mind regarding invasive species is that invasive plants may also have negative effects on ecosystems. In the same manner as animals, invasive plants serve as disease vectors that spread parasites and pathogens, disrupting invaded areas. Native plants must devote considerable energy and resources to defend themselves against native herbivores, while invasive plants are less prone to attack, as their natural enemies have been left behind in their home range (Sadava 2011). According to the United States Department of Agriculture, invasive plants are successful because many species produce large quantities of seed and thrive on disturbed soil. Their seeds are often distributed by birds, wind, or unaware humans, moving them great distances. Some invasive plant species have aggressive root systems that spread long distances from a single plant—these often grow so densely that they smother the root systems of surrounding vegetation. Other species also produce chemicals in their leaves or root systems, which inhibit the growth of other plants around them. Invasive plant species may decrease overall plant diversity, can result in poor quality agriculture lands, decrease recreation opportunities, and increase soil erosion.

Kudzu is one of the more famous non-native, invasive species. Its prolific ability to spread has led to landscapes where Kudzu has spread over all other plants, and even human structures. It is native to Japan and southeast China, but grows better in the southern United States than it does in its native lands as its natural insect enemies

were not brought to the U.S. with it. Kudzu was first introduced to the United States during the Philadelphia Centennial Exposition in 1876 where attendees marveled at the sweet-smelling blooms, large leaves and sturdy vines of what was thought to be a great forage plant and ornamental for the backyard. Then, in the 1930s through the 1950s, the Soil Conservation Service promoted it as an inexpensive, drought-resistant forage crop and as a great tool for soil erosion control. This let it to be planted in abundance throughout the south. The plant looks innocent enough, and little did they know that Kudzu is quite a killer, overtaking and growing over anything in its path. This semi-woody vine grows out of control quickly, spreading through runners (stems that root at the tip when in contact with moist soil), rhizomes, and by vines that root at the nodes to form new plants. Once established, kudzu grows at a rate of one foot per day with mature vines as long as 100 feet (The Nature Conservancy 2015). Kudzu can easily overtake trees, abandoned homes, cars and telephone poles. Since the prolific plant is here, and free, why not put it to some practical use? Basket makers have found that the rubber-like vines are excellent for decorative and functional creations. Ground kudzu root is also a common ingredient in foods and medications in Japan and China, as it contains a number of useful anti-inflammatory and antimicrobial compounds (The Nature Conservancy 2015). It has even shown value in treating migraine and cluster headaches. However, aggressive plant species like kudzu can quickly replace a diverse ecosystem with a monoculture of only kudzu, illustrating a key point that the decrease in biodiversity caused by invasive species alters the abundance and diversity of species that are important habitat for native wildlife.

Biological invasion is truly an ancient process, and invasive species are spread in a multitude of different ways, including through ships carrying aquatic organisms, wood products (insects getting into wood, shipping palettes and crates shipped around the world), ornamental plants, and pet trade. Ships carry up to 10,000 species with them in their ballast tanks (to balance the ship), carrying biodiverse creatures throughout parts of the world. Marine organisms in the ballast tanks are taken on at the port of departure and discharged at the destination port along with its surviving animals and plants. Through the sea travel route, the potential exists for any species from any port on Earth to be introduced into the many new regions. Over the past 200 years, 200 or more invasive species have established themselves in the Great Lakes, replacing native species and causing economic and ecological problems (American Museum of Natural History). For example, ecologists that search for native crayfish find only invasive species. To manage the invasive species of crayfish, ecologists study predatory fish as a strategy to keep the population of the invasive species low enough to prevent further ecological destruction. Researchers use a non-lethal method to examine the stomach contents of the fish to identify which fish species, and what sizes of fish species, are eating different sizes of crayfish. With this information, researchers are able to pinpoint which fish community will be most effective at controlling invasive crayfish populations.

The notorious zebra mussel, *Dreissena polymorpha*, arrived in North American waters when ballast water from European ships was pumped into Lake Erie. The mussels became established, and rapidly spread via rivers through eastern North America, with the range of zebra mussels increasing exponentially between 1989 and 2005 (Sadava 2011). In recent years, the

invasive pest has also begun to appear in lakes and streams of the American West, as humans can unintentionally transport zebra mussel larvae from one body of water to the next in their watercraft. Zebra mussels can attach to almost any hard surface, clogging water intake and discharging pipes. They can also attach themselves to boat hulls and docks, and they even attach to native mussels and crayfish. Since they are very good water filterers, they remove substantial quantities of suspended particulate matter and phyto-plankton from the water, reducing the food supply for other marine organisms. Cleaning and removing mussels from water intakes and other structures costs hundreds of millions of dollars each year (Grijalva 2013). The total impact of mussel infestations has been estimated at over \$3.1 billion! Zebra mussels, an example of an aquatic invasive organism, illustrate how invasive species can change food webs.

The brown tree snake, *Boiga irregularis*, arrived on Guam in air cargo shortly after World War II. The snake is actually native to Australia and Indonesia. Until the brown tree snakes were introduced to Guam after WWII, the only snake in the country was one tiny, insect-eating species. They arrived in Guam as accidental stowaways in lumber shipments from New Guinea as islanders rebuilt from the devastating effects of World War II. Since its accidental introduction to these islands in the 1950s, the brown tree snake has caused the extinction of 15 species of land birds, including 3 found only on Guam, as well as reptiles and amphibians, and 2 of the 3 native bat species in Guam (Sadava 2011). The brown tree snake also caused extensive damage to the island's electrical grid. Although the snakes remained rare for the first 20 years following their introduction, in the 1960s they began to multiply and today can be found at densities as high as 5,000 individuals per square kilometer! The key

point this example illustrates is that invasive species can be accidentally introduced into the environment, often as an undetected passenger on a ship, plane, or vehicle. The brown tree snake was introduced to Guam this way, and as a result, wiped out most of the native bird life on the island.

Invasive species aren't just species — they can also be pathogens. The West Nile Virus (WNV) is a prime example of this. The virus originates from Africa, and first arrived in the United States in 1999 inside another invasive species, the Asian tiger mosquito. Now, it has been detected throughout most of the continental United States. The main route of human infection is through the bite of an infected mosquito, and, for people who are exposed, one in 150 infected with WNV will develop severe illness. Interestingly, 80% of infections are subclinical — meaning they yield no symptoms. In others, the virus causes mild flu-like symptoms. The severe symptoms can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis, and even death. The West Nile Virus has reduced wildlife populations throughout the United States. The virus can lead to encephalitis, inflammation of the brain, and meningitis, inflammation of the meninges, the lining of the brain and spinal cord. There were more than 5,500 cases of West Nile Virus in the U.S. in 2012, and 286 deaths (Walsh 2014), illustrating the disastrous effects invasive species can have on human health and the health of native wildlife.

Invasive species are a symptom of modernity. David Quammen lists invasive species as the fifth of the five factors contributing to our current experiment in mass extinction in his article “Planet of Weeds.” Around 1950, Charles Elton, a British ecologist, prophetically warned that

“we are living in a period of the world’s history when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature” (Quammen 65). Indeed, species are relocated from place to place and the resulting ecosystems are thrown into disorder. There is a larger pattern to these invasions; invasive species, such as zebra mussels, water hyacinths, kudzu, Asian gypsy moths, and others, are weedy species; they reproduce quickly, disperse widely, tolerate a broad range, succeed in disturbed ecosystems, and resist eradication once they’re established.

Modern humans have played an increasing role in species invasions, as *Homo sapiens* have colonized almost all of the ecosystems on Earth and tend to transform natural environments into agricultural or urban landscapes. Human beings are “the most successful invasive species” (Rafferty). The Norway rat, *Rattus norvegicus*, is another example of an invasive species. This rodent was accidentally introduced to many Pacific islands during voyages of exploration between the 18th and 19th centuries, and since the rat’s accidental introduction, populations have established themselves on numerous islands, including Hawaii and New Zealand, where they prey on many native birds, small reptiles, and amphibians. Invasive species are a factor that threaten species persistence, and can have catastrophic effects by eliminating native species and threatening biodiversity.

Feral pigs exemplify the disastrous effects invasive species can have by eliminating native species and threatening biodiversity. They were brought to the United States as domestic pigs from Europe and Asia, damage native plants and crops, and compete with native species (National Wildlife Federation). Feral pigs will eat almost anything, including native birds.

They compete with native wildlife for food sources such as acorns. Feral swine also can transmit diseases and parasites, such as pseudorabies, brucellosis, and tuberculosis, to livestock and people. Another example of their ability to transmit disease is that the *E. coli* from their feces was implicated in the *E. coli* contamination of baby spinach in 2006, killing three people and sickening around 200 (NBC News). They dig constantly, eroding the earth, disrupting soil ecosystems, and, since they are omnivores, will cause extinction of native species if left alone (Madigan 2014). Feral swine are aggressive animals that can be extremely destructive to fields, fences, and facilities. Their wallows can affect ponds and wetlands, muddying the water and destroying aquatic vegetation. They can even strip a field of crops in one night and pose a threat to ground-nesting birds and some endangered species!

There is significance and a pattern to the conclusions one can make regarding invasive species. Direct threats of invasive species lead to their more indirect threats that compromise the stability of native species. Some direct threats seen include that nonnative species prey on native species (Brown tree snake, feral pigs), out-compete native species for food or other resources (zebra mussels, an aquatic invasive organism that threatens many species in the Great Lakes), cause or carry disease (West Nile Virus, Feral Pigs), and also prevent native species from reproducing or kill their young. These lead to the indirect threats of invasive species: the alteration of food webs, reducing biodiversity, and altering ecosystem conditions. Invasive species can change the food web in an ecosystem by destroying or replacing native food sources, providing little to no food value for wildlife. An example of this is zebra mussels, which consume incredible amounts of microscopic plants and animals from the water, depriving

native species of food. Invasive species can alter the abundance or diversity of species that are important habitat for native wildlife, such as the aggressive plant species kudzu. Some invasive species are capable of changing the conditions in an ecosystem, such as changing soil chemistry or the intensity of wildfires. Examples of invasive species that can alter ecosystem conditions include certain types of invasive grasses, the paperbark tree in Australia and Florida, and certain types of canes growing in soils.

Researchers completed a very interesting study looking at invasive alien plant species in Romania. A key finding was that invasion risk increased with landscape heterogeneity (man-made changes to natural landscapes); roads and agricultural areas were most prone to invasion, whereas forests were least at risk. During the summer of 2013, the group of researchers mapped the presence of 8 prominent alien plant species across the study area of southern Transylvania, and derived invasion risk maps for each species. The results show that the eight invaders have great potential to further expand their distribution, and echoing Quammen's points in "Planet of Weeds," the researchers found that like many invasive species, the ones in this study were adapted to disturbance through their short life cycles, rapid germination, persistent seed banks, and vegetative reproduction.

Truthfully, human beings have been introducing non-native plants and animals to new environments for thousands of years, and most of the time, there have been positive outcomes. Taking the United States as an example, non-native species include those species not present prior to the colonization of the New World, such as horses, dogs, cats, as well as many grains and other staple food crops on which Americans have come to depend. Even though these organisms were transplanted to

the North American habitat, they do not constitute invasive species because they remain firmly under human control (Ballaro 2015).

Invasive species and global warming have been found to be interrelated. Climate change is enhancing the ability for invasive species to proliferate and spread. Higher average temperatures and changes in rain and snow patterns caused by global warming will enable some invasive plant species—such as garlic mustard, kudzu and purple loosestrife—to move into new areas. Insect pest infestations will be more severe as pests, such as the mountain pine beetle, are able to take advantage of drought-weakened plants. Higher temperatures and lower precipitation will generally lead to more cases of West Nile, as well as the spread of the virus to northern territories that haven't yet been affected by it (Walsh 2014).

It is worthwhile to study invasive organisms in efforts to maintain biodiversity, as 42% of threatened or endangered species today are at risk primarily due to invasive species. Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play. For example, a larger number of plant species means a greater variety of crops. Greater species diversity ensures natural sustainability for all life forms (Shah 2014). It is possible to both prevent the introduction of invasive species and to reduce the negative effects of already established invasive species, contributing to the protection of biodiversity. Some solutions include the instillation of protocols such as the closer inspection of pallets in international trade and travel, effective education programs, and aggressive monitoring and eradication programs to reduce the deleterious effects of invasive species. Another solution is biocontrol, using a predator of the invasive species as a strategy to reduce their numbers

and negative effects. Using a predator of the invasive species to reduce their numbers is currently being investigated with invasive crayfish in the Great Lakes, but in any case this strategy requires close monitoring to ensure the introduced predator does not, in turn, also become invasive.

There are also ways the average person can help curb the spread of invasive species. For instance, plant native plants and remove any invasive plants in your garden—there are many good native plant alternatives to common exotic ornamental plants! Also, learn to identify invasive species in your area, learn more about invasive species in your state, and report any sightings to your

county extension agent or local land manager. Regularly cleaning your boots, gear, boat, tires and any outdoor equipment is also a good idea to remove insects and plant parts that may spread invasive species to new places. When camping, buy firewood within 30 miles of your campsite instead of bringing your own from home, and leave any extra there for the next campers. Invertebrates and plants can easily hitch a ride on firewood you haul to or from a campsite, and this could inadvertently introduce an invasive organism to a new area (National Wildlife Federation). We should remember that weeds are everyone's problem, and to spread the word, not the weeds!

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