

# AMERICA'S LEAST WANTED



Alien Species  
Invasions of U.S.  
Ecosystems



A NatureServe™ Publication

# America's Least Wanted:

## Alien Species Invasions of U.S. Ecosystems

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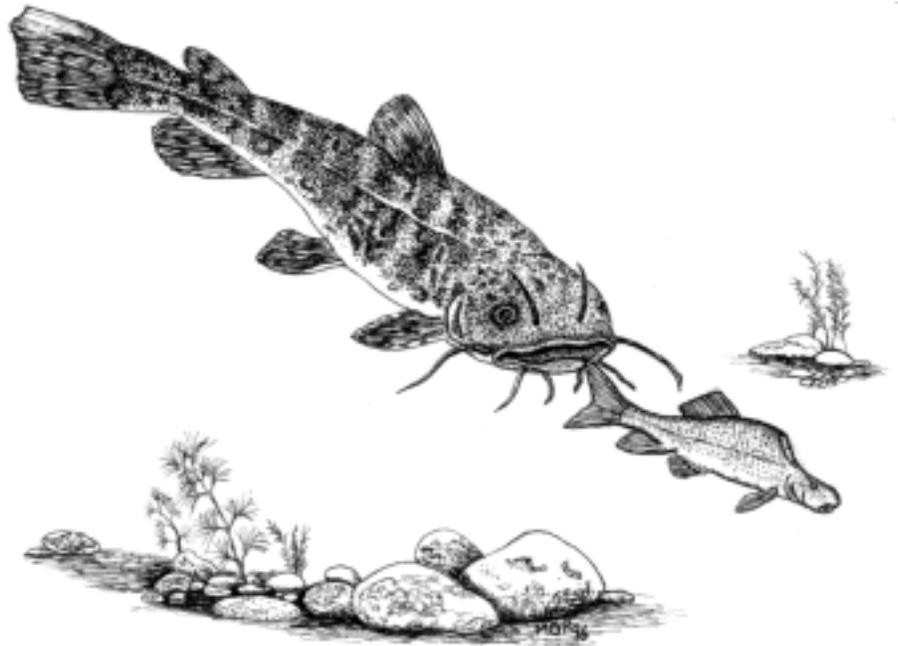
*Front cover illustration: Miconia calvescens, an alien invader threatening Hawaii's remaining rain forests.*



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*Flathead catfish, one of the "Dirty Dozen" profiled in this report.*

## SUMMARY

An invasion is under way that is undermining our nation's economy and endangering our most precious natural treasures. The intruders are alien species—non-native plants and animals introduced into this country either intentionally or by accident. Attention to the problem of alien, or exotic, species often centers on their costs to agriculture, ranching, forestry, and industry. The price they exact on the nation's forests, grasslands, and waterways, however, is at least as great.

**The Problem.** Alien species now are one of the leading threats to U.S. species and ecosystems. Of the approximately 4,000 exotic plant species and 2,300 non-native animal species in the United States, most cause few problems. Unfortunately, some alien species are proliferating unfettered, causing severe environmental or economic damage; just 79 of them have cost the U.S. economy *\$97 billion*. Infestations of introduced pest species also are changing the very fabric of our natural ecosystems and pushing endangered species even further toward the brink of extinction. Indeed, exotics have contributed to the decline of 42 percent of U.S. threatened and endangered species.

**The Dirty Dozen.** This rogues' gallery represents some of America's least wanted intruders. These 12 plants and animals exemplify the range of problems caused by exotic species. Some, such as tamarisk and Chinese tallow, degrade ecosystems by altering their physical or chemical properties. Others, including the rosy wolfsnail and brown tree snake, deplete native wildlife by preying on them. Yet others, such as the zebra mussel or balsam wooly adelgid, set off cascading biological changes in the natural systems they invade.

**What Can Be Done?** Containing the onslaught of exotic species will not be easy or quick, but it is not impossible. This effort requires work on four fronts:

- ▶ *Prevention of additional introductions;*
- ▶ *Early detection and eradication of new pests;*
- ▶ *Control and management of established problem species; and*
- ▶ *Protection and recovery of native species and ecosystems.*

Our nation's native plant and animal species, and the ecosystems on which they—and we—depend, are too important to sacrifice to alien invaders. This is an issue of both ecological *and* economic survival. Containing these invasions requires shared commitment and action. And although the problem may be expensive to address now, the cost will be far higher if we delay—both in dollars and diversity. With prompt attention and action, though, we still have time to safeguard our nation's unique natural heritage.

▼  
*Alien species  
are now one of  
the leading threats  
to the ecological  
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forests, grasslands,  
and waterways.*  
▲



*Tamarisk, a water-guzzling Eurasian invader, threatens fragile desert ecosystems.*

## ALIEN INVADERS

An invasion is under way that is undermining our nation's economy and endangering our most precious natural treasures. The incursion comes not from foreign armies, political terrorists, or extraterrestrials. Instead, the stealthy invaders are alien species. Also known as exotic, non-native, introduced, or non-indigenous species, these are plants and animals that have been introduced—either intentionally or by accident—into areas outside their natural ranges. Yet despite the vast ecological and economic damage done by these aliens, most Americans are unaware of their presence.

The deteriorating health of our nation's ecosystems is gaining increased public concern. Water and air pollution, excessive harvesting and extraction of natural resources, and habitat destruction from poorly planned development all imperil our remaining native ecosystems. But these highly visible threats to the environment are only part of the problem. Biological pollution, in the form of exotic species, is now one of the leading threats to the ecological integrity of our forests, grasslands, and waterways. Surprisingly, these aliens often strike at the heart of those natural lands and waters that we most cherish—our national parks and nature preserves. They also are pushing many of our rarest plants and animals even further toward the brink of extinction.

The number of exotic species residing in the United States is not precisely known. About 4,000 species of non-indigenous plants occur outside cultivation, according to North Carolina Botanical Garden's Biota of North America Program. And at least 2,300 species of non-native animals inhabit the United States, reports the Congressional Office of Technology Assessment (OTA).

These alien species arrive here in many ways. Some are the product of misguided efforts to correct other environmental problems. For instance, kudzu (*Pueraria lobata*), a fast-growing vine that now blankets large areas of the Southeast, originally was imported and promoted to combat soil erosion. Others, including many non-native fish species, were introduced for sport or recreation. Many more, however, end up here as accidental stowaways, having hitched a ride in mail, cargo, ballast water, or even by slithering into aircraft landing gear. With expanding global travel and trade, opportunities for such unwanted guests are only increasing.

Clearly, not all non-native species are undesirable; much of our economy and food supply relies on cultivating crops and raising livestock that originally came from elsewhere. We quickly would tire of eating only the handful of crops, such as cranberries, sunflowers, and jerusalem artichokes, that originated in the United States. But although we depend on certain introduced species to

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enhance our well-being, and others have little discernable negative impact, the OTA found that about 15 percent of non-native species do cause severe harm to our economy or ecology. This report, *America's Least Wanted*, focuses on those intruders that threaten our nation's rich natural heritage.

## ▶ Gambling with Our Inheritance

Moving species from one place to another is like playing biological roulette. Within their natural range, most plants and animals are kept in check by the powerful forces of competition, predation, and disease. If moved to new regions, however, species may be freed from their normal biological and physical constraints and spread unfettered. For most relocated plants and animals, their new environs usually have limitations that restrain the introduced species and prevent them from winning at this roulette game. But those species that have invasive tendencies and find themselves free from natural controls can win big, wreaking havoc on the local economy and ecology.

Although the biological reasons for the success of some alien species may seem esoteric, the economic consequences are very understandable. And they directly affect the vitality of U.S. agriculture, forestry, ranching, fisheries, and tourism. A scant 79 harmful alien species caused \$97 billion in direct economic losses in the United States from 1906 to 1991, according to the OTA. One-half of all agricultural weeds are foreign to the United States, as are almost 40 percent of agricultural and forestry insect pests.

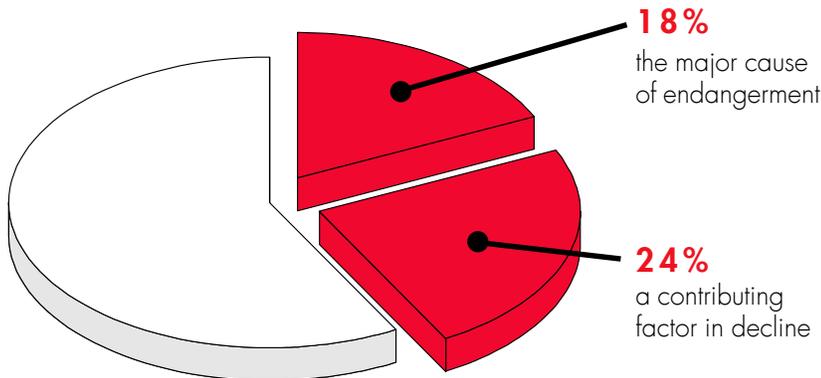
Efforts to control alien pests cost the U.S. economy several billion dollars annually. In one year alone the European gypsy moth (*Lymantria dispar*), an introduced forest pest, caused an estimated \$764 million in losses, according to the U.S. Department of Agriculture. The zebra mussel (*Dreissena polymorpha*), a relatively recent invader, may cause more than \$5 billion in damages by the year 2002. Harmful alien species also threaten human health, as shown by the recent accidental introduction of the Asian tiger mosquito (*Aedes albopictus*). This insect is a vector for such serious diseases as dengue fever and several forms of encephalitis.

## ▶ Depleting Life's Diversity

Even if we aren't always able to place precise dollar values on the damage, the impact of non-native species on our natural ecosystems is at least as costly as it is to our economy. The nation's biodiversity—comprising wild genes, species, and ecosystems—already is under siege, struggling against a wide range of insults. The continuing destruction and degradation of natural habitats cause more species to become endangered. They also reduce our ecosystems' ability to provide basic ecological services, such as flood control and crop pollination, on which humans

▼  
*A scant 79 harmful alien species caused \$97 billion in direct economic losses in the United States during the period of 1906 to 1991.*  
▲

## Impact of Aliens on Threatened and Endangered Species



Non-indigenous species have been implicated in the decline of 42 percent of 958 U.S. species federally listed as threatened or endangered. For 18 percent of listed species, exotics represent *the* major factor leading to their endangerment. (Data sources: for species listed June 1991-September 1996—*Nature Conservancy analysis of Federal Register notices*; prior to June 1991—*Environmental Defense Fund analysis for OTA*.)

depend. Against this backdrop of ecological deterioration, exotic species are emerging as one of the leading threats to our native species and ecosystems.

Introduced species may compete directly with natives for food or space, may compete indirectly by changing the food web or physical environment, or may prey on or hybridize with native species. Those natives whose natural range and population size already are limited, or have declined for other reasons, are particularly vulnerable to aggressive exotics. This is especially acute in island environments such as Hawaii, where most species evolved in isolation—without continental competitors, predators, and pathogens—and lack defenses against these invaders (*see box, page 7*).

The impact of aliens on most native species is unknown, reflecting the overall lack of knowledge about the basic biology and ecology of most species, even our most imperiled. Exotic species, however, have been implicated in the decline of 42 percent of those species listed as threatened or endangered by the U.S. Fish and Wildlife Service (*see figure above*). Of 40 North American freshwater fishes that have become extinct over the past century, the American Fisheries Society has documented that introduced species were a contributing factor in 68 percent of these extinctions.

A team of Nature Conservancy scientists has just conducted an assessment of the leading threats to imperiled freshwater aquatic animals, which, as a group, are among the most endangered organisms in the continental United States. Their analysis suggests that interference from exotic species is one of three leading threats, and that “the combined effects of competition, predation, and hybridization appear to be widespread and increasing among the species

sampled.” These researchers found exotic species currently are limiting the recovery of 37 percent of imperiled fish species and 22 percent of imperiled mussel species.

## ► Changing the Rules of the Game

Entire ecosystems, too, can be transformed by certain alien species. Invasive exotics can change the rules by which other species must live through modifying an ecosystem’s natural water or fire regime, or by altering the soil’s physical or chemical composition. These changes in the nature of the system may have cascading effects. Tamarisk (*Tamarix* spp.), one of the “Dirty Dozen” profiled in this report, is so effective at sucking water out of desert sands that it can lower water tables and literally dry up the springs on which some rare desert fishes completely depend. The soil and topography of Florida’s fragile Everglades are being transformed by an Australian import, *Melaleuca quinquenervia* (see box below). Not only does this tree fill in wetlands, but it also is highly flammable. Following fires melaleuca spreads vigorously—at the expense of the Everglades’ native vegetation.

Large mammals, such as feral pigs and goats, can have particularly devastating impacts when introduced into fragile ecosystems. Notoriously effective and indiscriminate grazers, goats will eat anything in their path—



*Melaleuca*, an aggressive Australian import, is transforming the Florida Everglades’ fragile ecosystem.

### HARD-HIT ECOSYSTEMS:

## The Endangered Everglades

Hydrological manipulation, agricultural runoff, and invasive exotic species have eroded the ecological integrity and natural diversity of Florida’s “River of Grass.” Alien species, whose rampant spread has been hastened by changes to the Everglades’ natural water flows, threaten both native species and the wetlands’ natural plant communities. Two species are particularly problematic: Brazilian pepper (*Schinus terebinthifolius*), a shrub that has colonized more than 100,000 acres of Everglades lands, and *Melaleuca quinquenervia*, an Australian species that the OTA calls “the most serious threat to the integrity of all south Florida’s natural systems.”

Melaleuca was introduced in 1906 to dry up wetlands and provide a new

source of timber. But because its wood turned out to be too hard for use as lumber, the tree was instead promoted as an ornamental. Melaleuca forms dense monospecific stands, reducing species diversity in marshlands by 60 to 80 percent. Despite efforts to control it, the tree has infested more than 450,000 acres in south Florida. It spreads at an estimated rate of 50 acres per day. In addition, melaleuca is difficult to eradicate since each tree produces millions of seeds that are released when it is stressed following fire or damage by herbicides.

Melaleuca seeds cannot take root in soils submerged under six or more inches of water. Consequently, efforts to restore natural hydrological flows in the Everglades should help contain its spread.

## HARD-HIT ECOSYSTEMS:



### Hawaii's Silent Invasion

Hawaii's remote, oceanic location and distinctive volcanic geography have produced an extraordinary array of species unlike any other found on Earth. Unfortunately, the state also has the distinction of being the world's "extinction capital." More than one-third of U.S. plant and animal species officially listed as threatened or endangered occur in the Hawaiian Islands. And the primary threats to virtually all of them are aliens: diseases, predators, or competing species introduced from abroad.

Hawaii's role as the commercial hub of the Pacific makes the archipelago especially vulnerable to invasions by alien pests. Control efforts notwithstanding, non-native species now are entering the

islands at a rate that is about two million times greater than the natural rate of colonization. Today, more than half of Hawaii's wild species are non-native.

The invasion of non-native pest species is "the single greatest threat to Hawaii's economy and environment, and to the health and lifestyle of Hawaii's people." This sobering assessment appears in a new report, *The Silent Invasion*, issued jointly by 14 state, federal, and private organizations in Hawaii, including The Nature Conservancy. In addition, the report provides a 10-point "call to action" to halt the influx of new pests and to close the gaps in Hawaii's current pest prevention and control system.

from old shoes to endangered plants—leaving once-vegetated lands exposed to erosion. Feral goats on southern California's channel islands browsed to extinction at least two plant species. Similarly, feral pigs are serious problems in the southeastern United States, California, and Hawaii. There they act as living Rototillers, capable of converting a healthy landscape into a barren moonscape. In Hawaii, an insidious by-product of this soil disturbance is the creation of ideal breeding habitat for introduced mosquitos that spread lethal, non-native diseases to the islands' endangered native bird life.

The demise of the American chestnut (*Castanea dentata*) illustrates how an entire ecosystem can be fundamentally altered. For most of our country's history, the chestnut was one of the most abundant hardwoods of the eastern deciduous forests, in some areas accounting for as much as 25 percent of all trees. It was also among the most economically important trees in the eastern United States. Its wood was highly valued for furniture and construction, and the tree's nuts were both a cash crop and a staple for wildlife. In the early 1900s, a fungal chestnut blight (*Cryphonectria parasitica*) from China was introduced accidentally, killing as many as one billion trees over 91 million acres. Although the American chestnut still survives as a species, it is ecologically extinct—no longer a functional part of the ecosystem. Its loss has permanently changed the ecology of our eastern deciduous forests.



*The once-abundant American chestnut has been eliminated from eastern forests by a fungal blight, which arrived from Asia in a shipment of infected logs.*

## ► Of Pests and Preserves

Protected wildlands offer one of the greatest opportunities for preserving functional native ecosystems. Since the designation of Yellowstone National Park in 1872, the United States has been a world leader in establishing and managing natural areas. For more than 45 years, The Nature Conservancy itself has been working to preserve imperiled plants and wildlife and protect representative ecosystems by establishing a system of private nature preserves. The task is far from complete. But the combination of federally and state-protected natural areas and such privately held lands as those maintained by the Conservancy provides some of the last, best hope for the survival of many species and natural communities.

Nonetheless, even though national parks and private preserves protect their inhabitants from many threats, their boundaries are permeable to alien species. Because many protected areas were established specifically to shelter our most endangered flora and fauna, exotic species invasions of these areas can have particularly serious consequences. In a 1996 poll of U.S. National Park supervisors, 61 percent indicated that non-native plant invasions were moderate or major problems in their parks. Similarly, 60 percent of land stewards for The Nature Conservancy's more than 1,500 preserves reported in a recent survey that exotic plants are among their top management dilemmas; 12 percent indicated that they are their single most severe problem. These land managers reported that at least 237 plant pests are infesting Conservancy preserves and are threatening their ecological integrity.

### HARD-HIT ECOSYSTEMS:

#### A Beleaguered Bay

"San Francisco Bay is the most invaded aquatic ecosystem in the world," says University of California marine biologist Andrew Cohen. At least 230 introduced species have taken up residence in the bay and delta estuary, and they make up 90 percent of the system's plant and animal life by weight in all but the deepest parts. On average, a new alien species invades the bay once every 12 weeks.

A comprehensive 1995 study of non-indigenous aquatic species in San Francisco Bay by Cohen and James Carlton of Williams College found that introductions have led to the regional loss

of species. Non-native species have also contributed to the extinction of a California freshwater fish and to the further demise of endangered marsh birds and other animals.

The primary way in which alien species enter the bay is through ballast water released by ships. Government controls for releasing this water exist only in Alaska, the Great Lakes, and the Hudson River. Exchanging foreign ballast water in mid-ocean—a cheap and easy approach that could be implemented immediately—would greatly reduce the number of such alien species invasions.

## THE DIRTY DOZEN

The “Dirty Dozen” is a rogues’ gallery representing some of America’s least wanted alien species. Although these 12 intruders differ from each other in many ways, all share a common trait: they spell trouble for our native species and ecosystems.

The following portfolio of pests was chosen to illustrate the breadth of problems that our native biodiversity and natural lands face from the onslaught of introduced species. Many others could have been selected—species that also are despoiling our ecosystems and imperiling our native plants and animals. The “Dirty Dozen” were chosen for this dubious distinction because they exemplify the worst of a bad lot. The species profiled here depict an array of different organisms (plants and animals), a variety of ecological systems (terrestrial, freshwater, and marine), and a wide geographical range—from Hawaii to Florida, and Maine to California.



Purple Loosestrife

Flathead Catfish



Green Crab

Brown Tree Snake

Rosy Wolfsnail



Miconia

Tamarisk

Balsam Woolly Adelgid



Chinese Tallow



Leafy Spurge

Zebra Mussel

Hydrilla

# Zebra Mussel

*Dreissena polymorpha*

Imagine an animal with the power to shut down electrical utilities by clogging water intake pipes; an animal that the U.S. Fish and Wildlife Service expects to cause \$5 billion in damages by the year 2002. This very real creature is causing large-scale ecosystem changes and hastening the decline of our native freshwater mussels, the nation's most threatened animal group. The culprit? A mere thumbnail-sized mollusk—the zebra mussel (*Dreissena polymorpha*).

Native to the Caspian and Black Seas, the tiny striped-shelled mussel was discovered in North America in 1988. Marine biologists believe it arrived by transatlantic ship—an undetected stowaway in ballast water that was discharged, mussel larvae and all, into Lake St. Clair, between Lakes Huron and Erie. Since then, the prolific creature has spread rapidly throughout lakes and waterways of the eastern United States and Canada, from the Great Lakes through the Mississippi River drainage. It remains unchecked by predators or parasites.

Because they cement themselves to any and all submerged hard surfaces, zebra mussels exact a heavy economic and ecological toll. They gorge on phytoplankton, outcompeting zooplankton for this essential food and disrupting natural food webs. They also adhere to the shells of our freshwater



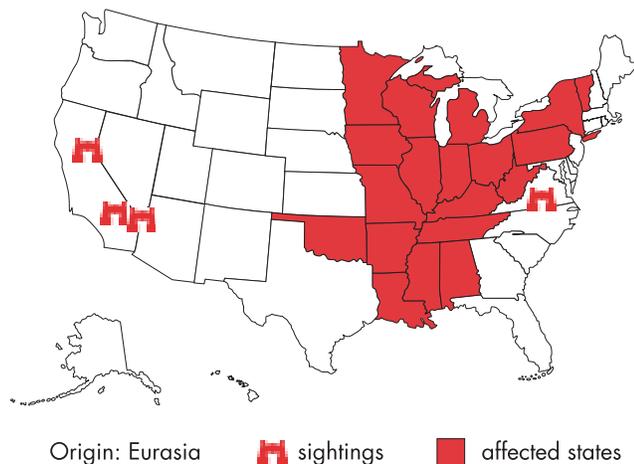
*A recent invader, the zebra mussel is overwhelming aquatic systems throughout the Great Lakes and Mississippi basins, and could lead to a massive extinction of native freshwater mussels.*

mussels—sometimes in numbers exceeding 10,000 zebra mussels to a single native mussel—thereby interfering with the natives' feeding, growth, movement, respiration, and reproduction. Native mollusk populations tend to crash within four years of zebra mussel colonization.

Researchers predict that zebra mussel invasions of the Mississippi River basin will reduce its native mussel species by as much as 50 percent within a decade. Because native mussels play an important role in nutrient cycling and sediment mixing, this could seriously affect the ecology of the Mississippi River system. The basin contains more endemic species of freshwater mussels than any other river system in the world. Consequently, the loss of its native mussel life on a scale similar to that already seen in the Great Lakes could result in the extinction of up to 140 species. With luck, some native mussels may persist in the small, upstream branches of the Mississippi River system.

Since the zebra mussel's arrival, a number of institutions—including the Great Lakes Sea Grant Network and the National Biological Service—have developed public education and mussel monitoring efforts. These partners recommend a number of precautions individuals can take to prevent new zebra mussel introductions: remove attached vegetation and wash boats or trailers before moving them to new lakes or rivers; flush engine cooling systems, bilging areas, and live wells with tap water; leave unused bait and bait bucket water behind; and inspect boat hulls for signs of zebra mussels before relocating the vessels.

## U.S. Zebra Mussel Distribution



# Purple Loosestrife

*Lythrum salicaria*

A hardy European native graced with stunning spikes of purple flowers, purple loosestrife (*Lythrum salicaria*) was first brought to New England in the early 1800s, most likely as an ornamental. After its introduction, the plant moved rapidly north into Canada, south into Virginia, and west through the Great Lakes, earning it the nickname the “purple plague.” This alien now exists throughout much of the United States; it is an especially serious threat to wetlands in the Northeast and upper Midwest.

Purple loosestrife’s swift growth and enormous reproductive capacity allow it to spread rapidly and outcompete native plants, including some species of endangered orchids. Mature loosestrife propagates vegetatively by root or stem segments. Also, each plant can produce millions of tiny seeds that are carried along by wind and water to establish new populations. As a result, many wetlands once inhabited by a rich diversity of native plants are now overrun by dense stands of purple loosestrife—stands that can grow to thousands of acres in size, eliminating open water habitat. The loss of native species and habitat diversity is a significant threat to wildlife, including several rare amphibians and butterflies, that depends on wetlands for food and shelter.

Purple loosestrife is still sold commercially, despite its devastating and well-documented effect on natural



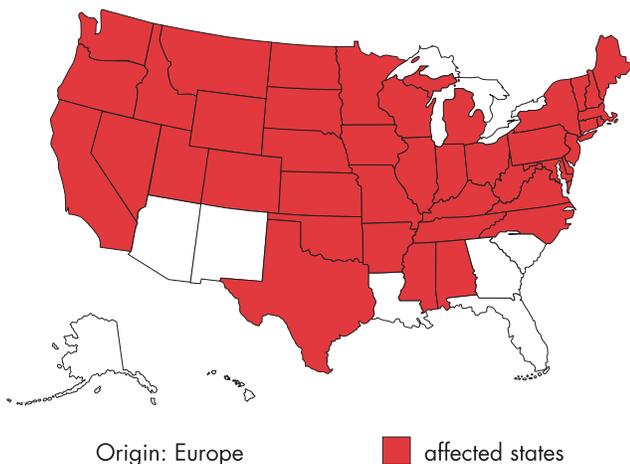
*Purple loosestrife chokes wetlands, rendering them inhospitable to native plants and wildlife. Known as the “purple plague,” this invasive plant unfortunately is still sold for landscaping.*

communities. It is promoted by horticulturalists for its beauty as a landscape plant and by beekeepers as a nectar plant. Some U.S. plant nurseries sell cultivated varieties of purple loosestrife that are reportedly infertile. But studies have shown that the plants are fertile and can cross with wild strains of loosestrife. Currently, about two dozen states have listed purple loosestrife as a noxious weed and prohibit its importation and distribution. In many other states, native plant societies are raising public awareness of this aggressive invader and urging that its sale be banned.

Purple loosestrife’s rapid spread across North America has been aided by the absence of its natural predators: herbivorous beetles that keep the plant in check by feeding on its roots and leaves. Like loosestrife, the beetles are native to Europe. Although herbicides and hand removal may be helpful in controlling individual plants or small populations of purple loosestrife, carefully selected biological controls—such as natural diseases or predators that are specific to the invasive pest species—are considered to be a potential long-term management strategy.

Because purple loosestrife is extremely difficult to control once established, the best defenses against the weed are detecting it early and preventing its spread. Resource managers must focus on keeping natural wetlands free from human disturbance; even minor disruptions can make them highly vulnerable to the “purple plague’s” invasion. Informing the public about the dangers of purple loosestrife and discouraging its use in landscaping are other keys to deterrence.

## U.S. Purple Loosestrife Distribution



# Flathead Catfish

*Pylodictis olivaris*

Not all destructive alien species come from distant lands. The flathead catfish (*Pylodictis olivaris*) poses no threat within its native range of the lower Great Lakes, Mississippi River basin, and parts of the Gulf slope drainage. But when introduced to new waters as a sportfish, it's a different story. Now found in the rivers and reservoirs of 18 states where it was previously unknown, this catfish is depleting native fish populations.

The flathead has earned a reputation as an outstanding sportfish. It lives for 20 years or more and reaches a length of four feet and a weight of 50 pounds. Its attractiveness to fishermen has encouraged its introduction into other drainages in the West and Southeast. Good sportfish or not, its appearance in these river systems had unforeseen and disastrous effects on native fishes.

Unlike other catfishes, the flathead is not a scavenger; as an adult, it feeds chiefly on other fish. A voracious predator, it has sped to the top of the food chain in aquatic communities where it has been introduced. In 1966, 11 adult flatheads were released in North Carolina's Cape Fear River. From a single point introduction they proliferated along a 150-mile stretch of river. Within 15 years, flatheads became the dominant predator there, feasting on bullheads (*Ictalurus* spp.). And after these were wiped out, they shifted to



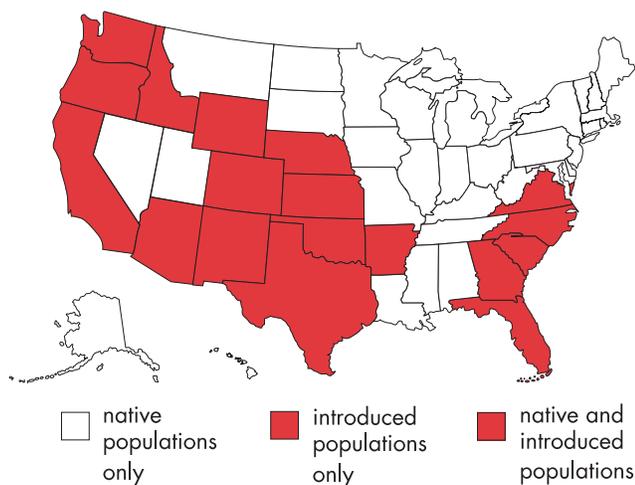
The flathead catfish, a voracious predator, has decimated native fishes where it has been introduced outside its natural range. The catfish jeopardizes recovery of endangered fish such as the razorback sucker, pictured above.

commercially valuable American shad (*Alosa sapidissima*). Today, flathead catfishes constitute more than 10 percent of the river system's fish by number, and 65 percent by weight. Similarly, the flathead is seriously affecting the fish fauna of the Apalachicola River in Florida, where it consumes the young of the federally listed threatened Gulf sturgeon (*Acipenser oxyrhynchus desotoi*).

Introduced into Arizona's Salt River in 1967, the flathead reproduced rapidly within the first decade, while populations of native fishes plummeted. Here, the foreigner defeated repeated attempts to reintroduce both the endangered razorback sucker (*Xyrauchen texanus*) and the endangered Colorado squawfish (*Ptychocheilus lucius*). It preys on the imperiled species' young.

Because of the catfish's threat to the recovery of the Colorado squawfish and other endangered fishes, a new federal/state agreement prohibits introduction of the species in the upper Colorado River basin. This agreement, which the Conservancy helped negotiate, also bans the introduction of eight other non-native fishes. Although the agreement is sensitive to traditional sportfishing management by state agencies, it provides for careful review of continued stocking of several non-native fishes whose release is not prohibited altogether. And, as part of a comprehensive recovery program for the system's endangered native fish species, a number of cooperative federal/state actions will focus on removing or controlling non-native fishes already present in the upper Colorado River basin.

U.S. Flathead Catfish Distribution



# Tamarisk

*Tamarix* species

In the arid Southwest, where water is the lifeblood of the region's economy and ecology, the alien tamarisk tree (*Tamarix* spp.) guzzles five million acre-feet of water a year. Its roots can reach water tables deep below the desert floor, sucking desert springs dry and altering natural hydrological regimes. And when rain does fall, the tree promotes flooding by blocking water channels with its dense growth. There's more: as its alternate name, saltcedar, suggests, tamarisk exudes salt from glands in its leaves, making the soil around it inhospitable to native vegetation.

Originally introduced by western settlers in the 1800s as a source of wood, shade, and erosion control, tamarisk now infests approximately one million acres in the United States. The name tamarisk actually refers to several different species in the genus *Tamarix*, all of which originated in Eurasia. In this country, tamarisk is found primarily in the Southwest, but has spread as far north as Montana.

Tamarisk is a major threat to riparian woodlands, which support the greatest levels of biodiversity within fragile desert ecosystems. Through its devastating effects on soils and hydrology, this alien may alter or eliminate the habitat of such rare species as desert pupfish, salamanders, butterflies, elf owls, and yellow-billed cuckoos. Recent studies have shown that the number and diversity of birds, small mammals, and



*Sucking dry already arid lands, tamarisk threatens the fragile water balance that sustains desert life.*

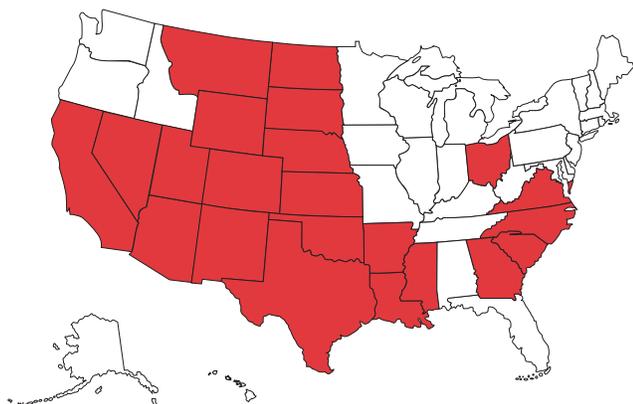
invertebrates is significantly reduced when the exotic tree replaces native woodland communities.

Like many other invasive alien plants, tamarisk is successful largely because of the lack of natural predators or disease to keep its populations in check. This superior competitor's reproductive ability is also impressive. Each plant produces up to a half million seeds per year. Seedlings can grow as much as 10 feet each year and can survive virtually anywhere they can reach water.

Human activities, such as dam building and cattle raising, also promote tamarisk's proliferation. Because grazing cattle prefer native cottonwood and willow trees to tamarisk, the ungrazed weed gains an advantage in the intensely competitive desert environment. Dams that alter natural flooding regimes also appear to give tamarisk an edge over native vegetation.

There have been some successful attempts to control tamarisk on specific sites. In The Nature Conservancy's Hassayampa River Preserve in central Arizona's Sonoran Desert, native species slowly have been replacing tamarisk since grazing was halted within the sanctuary. And in Death Valley National Park, the U.S. National Park Service is successfully restoring desert pools through an intensive program of tamarisk removal. Only with more efforts such as these, in addition to developing an effective biological control agent, will we be able to win back the West from this aggressive invader.

## U.S. Tamarisk Distribution



Origin: Eurasia

■ affected states

# Rosy Wolfsnail

*Euglandina rosea*

The future of Hawaii's rich suite of native snail species is not so rosy, thanks to *Euglandina rosea*—the rosy wolfsnail. This carnivorous native of Latin America and the southeastern United States first was introduced to Hawaii in 1955 to combat an exotic agricultural pest, the African tree snail (*Achatina fulica*). The rosy wolfsnail has since become an out-of-control biocontrol agent; it has forsaken the prey it was intended to control and prefers to eat the islands' native snail species instead, driving many native snails to extinction.

The Hawaiian Islands are a remarkable evolutionary showcase. Because of the archipelago's isolation and its highly dissected topography, nearly 800 nonmarine snail species have developed there—a textbook case of evolutionary diversification. But depredation from *Euglandina rosea*, rats, and human shell collectors, along with large-scale loss of forest habitat from logging, farming, urbanization, and feral animal disturbance, already has eliminated 50 to 75 percent of this remarkable group of native land snails.

A voracious predator, the rosy wolfsnail ravages native snail populations. It consumes its prey, sometimes shell and all, which has earned it the moniker in Hawaii “cannibal snail.” Because Hawaii's indigenous snail species evolved with few



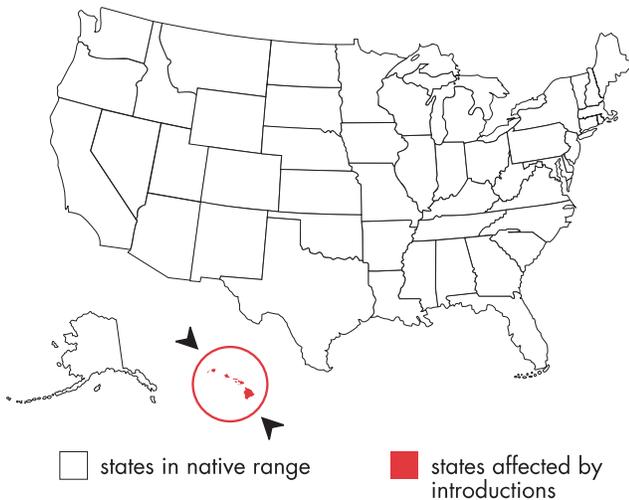
*Rosy wolfsnail was introduced in Hawaii to control another pest. Instead, it developed a taste for the islands' native snail species, becoming a pest itself.*

predators, they lack physical or behavioral defenses against this aggressive non-native. On the Hawaiian island of Oahu, the alien snail is responsible for the loss of most of the 15 to 20 endemic species of *Achatinella* snails that have vanished over the past four decades. This decimation catapulted the entire genus *Achatinella* onto the U.S. endangered species list. Similarly, some 50 percent of the species in the closely related genus *Partulina*—found on Molokai, Maui, Oahu, Lanai, and the Big Island of Hawaii—also have been devastated.

Human activities have now taken the rosy wolfsnail to more than 20 other island groups in the Pacific and Indian Oceans. What is known about the impact of these introductions is further cause for alarm. In the Indian Ocean island nation of Mauritius, 24 of the 106 endemic snail species have become extinct. And on the island of Moorea in French Polynesia, *Euglandina* was a major contributor to the extinction of seven endemic snails in the genus *Partulina*.

*Euglandina* is not the sole cause of native snail species' declines in Hawaii, yet it is a critical factor that is helping to seal their fate. To protect remaining native snail populations, conservationists are working to prevent the further spread of rosy wolfsnails into uninfested areas. They also have developed a toxic bait for the invader using the bodies of another pest snail, *Pomacea*. These activities are complemented by efforts to protect undisturbed, intact forests that serve as snail havens and by the establishment of captive breeding colonies of endangered Hawaiian snail species.

## U.S. Rosy Wolfsnail Distribution



# Leafy Spurge

*Euphorbia esula*

Both ranchers and conservationists would love to rid their lands of leafy spurge (*Euphorbia esula*). Ranchers hate the weed because it reduces the productivity of grazing land by 50 to 75 percent. Conservationists dislike it because it crowds out native grasses, reducing species diversity and habitat for wildlife.

This perennial, narrow-leafed Eurasian herb first was recorded in the United States in 1827, introduced either by accident in a mix of agricultural seed stock, or by design for its attractive yellow flowers. In the ensuing 80 years, the fast-spreading weed blazed west from Massachusetts to North Dakota, crowding out native grasses in its path. It was probably also introduced to the northern Plains states in contaminated seed from Europe brought in by new settlers.

Today, leafy spurge plagues approximately three million acres of rangeland. Montana, the Dakotas, Nebraska, and Wyoming are particularly affected. Conservancy preserve managers in 11 states who report it as a threat have good reason to be concerned: left unchecked, a leafy spurge infestation can completely displace native grasses and forbs in just a few years.

*Euphorbia esula* spreads rapidly and is difficult to eradicate owing to its deep root system and extraordinary seed dispersal abilities. The plant can expel its seeds to distances of 15 feet.



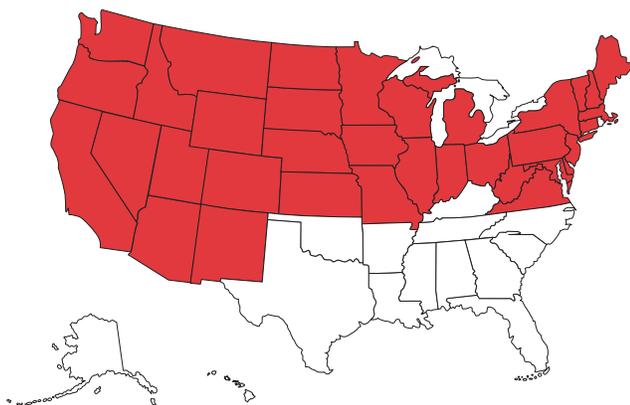
*Already infesting three million acres of rangeland, leafy spurge is an aggressive weed that displaces native vegetation and degrades grazing lands.*

Seeds also are carried across the landscape by birds and other animals. In untilled pasture, rangeland, and natural habitats, the spurge can outcompete other vegetation by shading competitors and usurping available moisture and nutrients. It is most aggressive in dry areas where competition from native plants is less intense.

Researchers, ranchers, and conservationists have experimented with many different methods to control leafy spurge, including mowing, burning, plowing, chemical herbicides, and carefully tested insect biocontrols. These last are organisms, such as several species of flea beetles, that selectively feed on leafy spurge. In the past few years, insect biocontrol agents have been successful on some sites. Other tools being used to fight the spurge are grazing goats and sheep. Unlike cattle, sheep and goats will eat large quantities of leafy spurge. Used as part of an integrated weed management program, these grazers can be effective allies in controlling the pest.

At the Conservancy's Pine Butte Swamp Preserve in Montana, half the field season is spent fighting exotic weeds, including leafy spurge. Preserve manager Dave Carr says, "In areas such as ours, we realize that eradication of exotic species is impossible. Through our control efforts, we're trying to get leafy spurge to be a component of natural communities—not a dominator of them."

## U.S. Leafy Spurge Distribution



Origin: Eurasia

■ affected states

# Green Crab

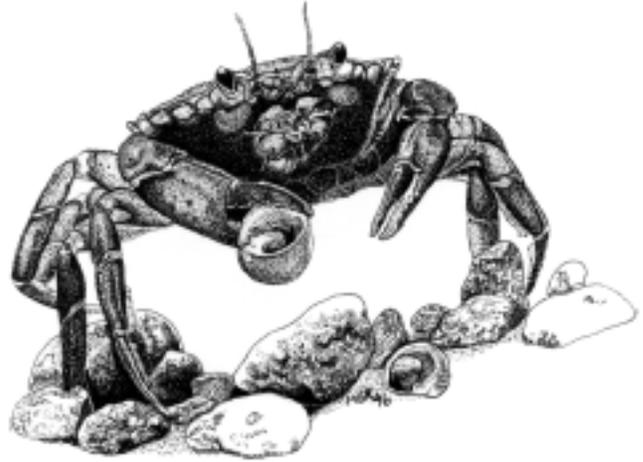
*Carcinus maenas*

In coastal marine environments, it is sometimes difficult to determine which species are native and which are exotic. Scientists call these questionable species “cryptogenic,” meaning of hidden or mysterious origin. There is little doubt, however, about the origins of the green crab (*Carcinus maenas*).

This native of the European North Atlantic coast first made its way to North America in the early 1800s, where it successfully established itself along the eastern seaboard, from New Jersey to Nova Scotia. And now it has turned up in California. If the crab becomes as abundant in its new home on the West Coast as it has elsewhere, it may alter native food webs and disrupt multimillion-dollar shellfish industries.

The green crab is one more insult to the already beleaguered San Francisco Bay (see box, page 8). Marine biologists first documented the crustacean's West Coast debut at San Francisco Bay in 1989. Although scientists know the crab's origins, they are not sure exactly how it arrived there. They suspect it was introduced among the algae used to package lobster or live bait imported from the East.

Highly prolific, green crabs pose serious ecological and economic threats. “This crab has an appetite, and it eats virtually anything,” cautions University of California biologist Andrew Cohen, who has been studying the crustacean since



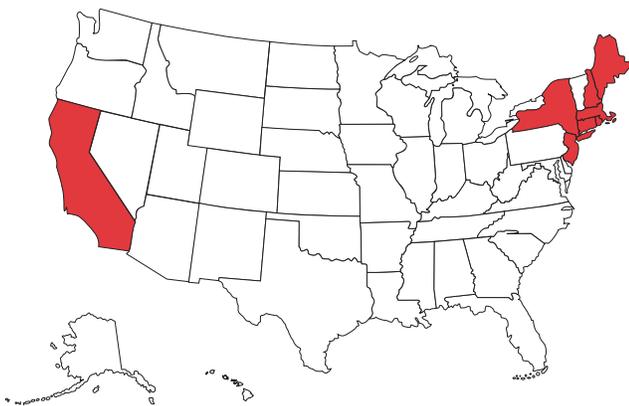
*The green crab, a new arrival on the West Coast, threatens to disrupt coastal food webs and damage multimillion-dollar shellfish industries.*

he first spotted it in 1989. As the crab spreads to more bays along the Pacific Coast, wherever it becomes abundant it could reduce populations of clams, oysters, or crabs by eating them, and harm certain crab, bird, or fish populations by eating their food. It could also damage California's valuable oyster culture and Dungeness crab industries.

Since it was first sighted in San Francisco Bay, *Carcinus maenas* has spread; it now inhabits several bays over a 300-mile stretch of the California coast. Its potential range runs from Baja California to southern Alaska. With an expanding distribution, the green crab may soon threaten fisheries in the Pacific Northwest, including Puget Sound's \$20-million annual shellfish harvest.

Control efforts such as fencing, trapping, and poisoning have had little success on the East Coast. As is the case with terrestrial alien invaders, our best bet with alien aquatics is to prevent invasions before they happen.

## U.S. Green Crab Distribution



Origin: Europe

■ affected states

# Hydrilla

*Hydrilla verticillata*

Hydra, the mythological nine-headed serpent, sprouted two heads for each one Hercules severed with his sword. Its namesake, hydrilla (*Hydrilla verticillata*), is a real-world monster that is taking over our waterways. Native to Asia, Africa, and Australia, this aquatic plant was introduced into Florida waters in the early 1950s, where it was being cultured for the aquarium industry. It expanded rapidly in the eastern United States and continued to be introduced in other U.S. waters. By 1995, hydrilla was choking lakes and rivers as far west as California and Washington. Because it tolerates many different environments, hydrilla could easily spread throughout most of the United States and north into Canada, with serious consequences for aquatic systems, native biodiversity, recreation, and agriculture.

Hydrilla forms green carpets thick enough for ducks to walk on, and clogs waterways so thoroughly that they are inaccessible to swimmers and boaters. Despite control efforts, hydrilla infests nearly half of Florida's public waters. Boats aid its dispersal along waterways by catching small fragments of the plant and pulling them into new waters where they regenerate. Also, agricultural and urban runoff cause artificially high nutrient levels in many waters, which promote hydrilla proliferation.

And proliferate it does. Hydrilla can grow as much as 10



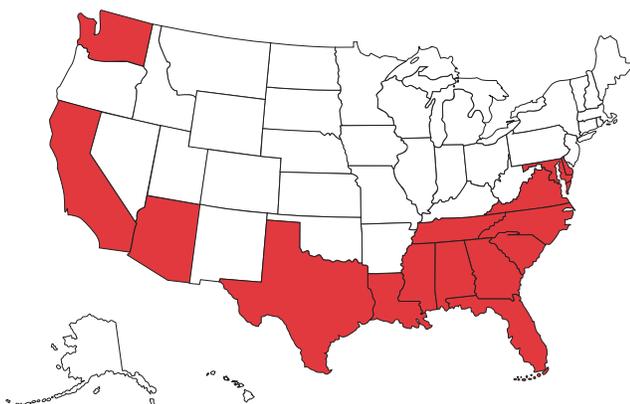
*Forming thick green mats, hydrilla clogs waterways, which dramatically reduces their value to native wildlife and makes them inaccessible for recreational use.*

inches a day, develop from a small fragment into a large mass in a few weeks, and spread from a few acres to several thousand acres in only a few years. Although it is rooted in the soil, 70 percent of hydrilla's biomass floats on the water's surface. It is able to reproduce vegetatively from buds that can germinate year-round in warm climates.

Hydrilla alters water chemistry and can outcompete native vegetation by photosynthesizing under low light levels and producing a dense canopy on the water's surface that shades out most of the vegetation below it. Once it invades a site, the diversity of other submersed aquatic vegetation plunges; so does the diversity of fish and other aquatic life. Hydrilla infestations also can eliminate open-water feeding areas for birds and spawning sites for fish.

Once established, hydrilla is nearly impossible to eradicate. Mechanical harvesting and herbicide spraying are the most common control methods. Both are costly—Florida spent more than \$50 million on hydrilla management between 1980 and 1991—and are only somewhat effective against large infestations. The best way to protect our waterways and aquatic biodiversity is to prevent the weed from spreading and invading new areas. In Florida, for example, many freshwater rivers and lakes are inspected annually for hydrilla and other exotic pests so that control efforts can begin before the alien invaders become more widespread.

## U.S. Hydrilla Distribution



Origin: Asia, Africa, Australia

■ affected states

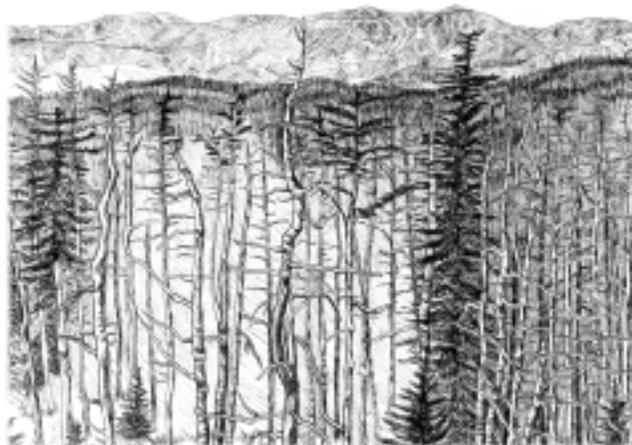
# Balsam Woolly Adelgid

*Adelges piceae*

Cool, dark, damp forests of Fraser fir (*Abies fraseri*) once cloaked the high mountain peaks of western North Carolina, eastern Tennessee, and southern Virginia. By the early 1970s, however, patches of dead firs blemished the lush green mountainsides. Twenty years later, dense tangles of brush and deciduous tree saplings arose beneath the dead fir forests. The culprit responsible for this destruction is the balsam woolly adelgid (*Adelges piceae*), a tiny European sucking insect related to aphids that drains the firs' sap, killing the trees over several years.

Although tiny, the insect exerts a huge influence on this unique ecosystem. It has killed virtually all the adult firs in Great Smoky Mountains National Park, thereby eliminating almost three-quarters of the spruce-fir forests in the southern United States. As this dominant canopy tree disappears, the forests become warmer and drier. The subsequent change in temperature jeopardizes the survival of several northern species that have persisted as Ice Age relics in these cool, high-elevation Appalachian forests. Some of these plants and animals may adapt to the new conditions, but for some their southern populations will probably disappear.

The elimination of Fraser fir also has cascading effects on many other species. A number of them are localized endemics—such as Weller's salamander—that are found only in these Appalachian forests. A few species, including larvae of the moth *Semiothisa fraserata*, appear to depend exclusively



The balsam woolly adelgid, a tiny aphid-like insect, has destroyed three-quarters of the spruce-fir forests in the southern United States.

on Fraser fir for food. In addition, the tree's bark provides substrate for eight species of rare mosses and liverworts. Most native insect species that directly use Fraser fir can turn to red spruce, but the spruce is not as abundant as the fir once was. And though a few of these insects can also use hemlocks at lower elevations, hemlocks, too, are being damaged by a related pest—the hemlock woolly adelgid.

The spiral continues. Many more species are probably being harmed, not by the loss of Fraser fir as a food source, but by adelgid-induced changes in vegetation structure and microclimate. Three species—the rock gnome lichen, spruce-fir moss spider, and Carolina northern flying squirrel—landed on the federal endangered species list largely because of this habitat damage. Other affected animal species include populations of hermit thrush and northern saw-whet owl that are separate from the species' main breeding populations.

It is unlikely that natural processes alone will ever restore the Fraser fir forests. Chemical control of adelgids over large areas is impractical, notwithstanding possible negative impacts to native species. According to Conservancy zoologist Dale Schweitzer, "The only apparent hope for recovery of these forests seems to be a combination of one or more successful biocontrols and a few centuries of healing time." He cautions, however, that recovery can never be complete if their original inhabitants become extinct.

## U.S. Balsam Woolly Adelgid Distribution



# Miconia

*Miconia calvenscens*

It looks innocent enough, this attractive ornamental plant with large, velvety leaves. But Tahitians aptly call it the “green cancer.” A Latin American native, miconia (*Miconia calvenscens*) strayed from three Tahitian garden plantings in 1937; today, it covers 70 percent of Tahiti’s forests and threatens one-fourth of the island’s indigenous wildlife. Although it resembles a bush as a young plant, a mature miconia tree can grow as high as 50 feet, casting dense shade that kills native plants. Scientists are increasingly recognizing it as the most invasive and damaging alien plant invader of many Pacific island rain forests.

The potential impacts of miconia on Hawaii’s native plants, animals, watersheds, and farmlands are enormous. Where a miconia invasion begins, almost all other plant life ends. The tree forms dense thickets that stop sunlight from reaching the forest floor; few plants below can survive. Not only does miconia’s deep shade eliminate ground cover, but its shallow roots also cannot hold the forest floor’s exposed soil. The soil erodes into the ocean, choking ecologically fragile and biologically rich coral reefs.

Miconia was introduced to Hawaii in 1960 as an ornamental. Since then, it has been found in 36 locations covering more than 11,000 acres on Oahu, Kauai, Maui, and



*Miconia is considered the greatest single threat to Hawaii’s remaining wet forest. Volunteer mobilization, however, provides hope for eradicating this pest on most of Hawaii’s islands.*

the Big Island of Hawaii. It spreads quickly to all moist habitats, including farms, pastures, roadsides, and forests. After only a few years’ growth, a single plant can produce millions of seeds a year—seeds that can be dispersed widely by birds or by people who inadvertently carry them to new areas on their muddy boots or vehicles.

The state of Hawaii recently launched “Operation Miconia,” which teams federal, state, and county agencies, businesses, and nonprofit organizations in the largest mobilization effort in state history to eradicate an invasive alien weed. Authorities hope to prevent miconia from reaching the islands of Molokai and Lanai, and they expect to eliminate it completely on Oahu and Kauai. The outlook on Maui is also good: volunteers have removed more than 60,000 miconia plants from the most infested areas. But the Big Island is severely threatened. Here, nearly 10,000 acres are already infested and the majority of the state’s native rain forests and abandoned sugar lands are open to invasion.

If miconia is not stopped in Hawaii now, future massive control projects will place a heavy, long-term financial burden on the state. Investigators from Hawaii and Tahiti have gone to Latin America to seek out natural enemies of *Miconia calvenscens* that could be safely introduced in the Pacific. It is an urgent situation—one that reminds us how important it is to prevent destructive alien pests from becoming established in the first place.

## U.S. Miconia Distribution



# Chinese Tallow

*Sapium sebiferum*

It's easy to see why Chinese tallow (*Sapium sebiferum*) was introduced to the United States. The fast-growing tree reaches heights of 30 to 40 feet, sports lovely leaves that turn from green to yellow to red in autumn, and produces seeds with an oil that was useful to industry. Native to eastern Asia, where it has been cultivated for 14 centuries as an oilseed crop, Chinese tallow first was introduced to South Carolina in the late 1700s. In the early 1900s, the Foreign Plant Introduction Division of the U.S. Department of Agriculture promoted tallow planting in Gulf Coast states to establish a local soap industry. But Chinese tallow is yet another example of a species brought intentionally to North America with unforeseen—and unwelcome—consequences.

Chinese tallow has flourished in its new home, spreading from South Carolina to Florida and Texas. Capable of flowering and fruiting at only three years of age and three feet in height, the plant produces an abundant seed crop that is dispersed by birds and moving waters. It has been described as the “happy invader” for its ability to become established in a wide range of environments; it can thrive not only in developed and degraded areas near human habitation, but also in more natural wet prairies and bottomland forests. Able to grow in both full sunlight and shade, the tree is also more



*Chinese tallow does more than just invade natural habitats in the Southeast: it releases toxins that alter soil chemistry and prevent re-establishment of native plants.*

tolerant of salinity than many native competitors. The final blow? Chinese tallow wields a hidden weapon against competitors: the leaves it sheds contain toxins that alter soil chemistry and make it difficult for native vegetation to become established.

This jack-of-all-trades of the plant kingdom has displaced native species and changed natural community structures in the lands it has invaded. Formerly natural coastal habitats are becoming infested with stands of Chinese tallow. Large parts of the Texas Gulf coastal prairie have been transformed from native grassland or abandoned cropland into Chinese tallow woodland. Although the plant is a serious and growing threat to the native plants and habitats of the Southeast, it is still in demand from nurseries there, many of which continue to stock it as an ornamental. Educating both plant consumers and nursery owners could help control the spread of such invasive exotics as Chinese tallow, which should no longer be used for landscaping.

## U.S. Chinese Tallow Distribution



Origin: Asia

■ affected states

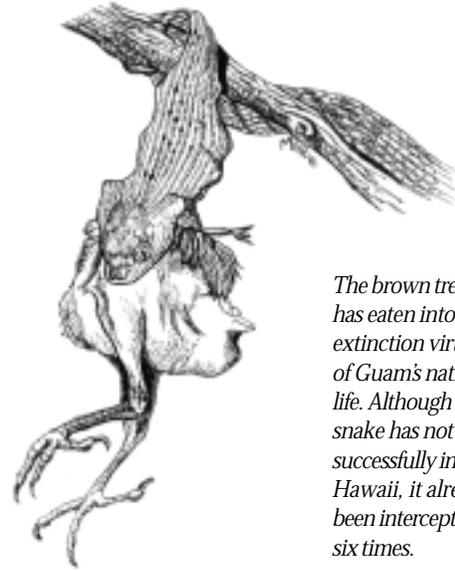
# Brown Tree Snake

*Boiga irregularis*

On the Pacific island of Guam, the forests are strangely silent, devoid of bird song. There are no bird songs because there are few birds. They have been wiped out by the brown tree snake (*Boiga irregularis*). A native of the Solomon Islands, Papua New Guinea, and northern Australia, the reptile was accidentally introduced to Guam in the 1940s. It probably arrived via military transports after World War II. Since then, the snake has spread throughout the island, reaching numbers of 12,000 per square mile in some forested areas.

Greenish-brown in color, with bulging eyes, the brown tree snake can reach 10 feet in length. It is a nocturnal creature noted for its stealth and adaptability. Although it usually resides in trees and shrubs, it often invades homes, commercial buildings, and other urban habitats in search of food and hiding places. This snake will eat anything—from lizards to garbage to hamburgers—but it prefers birds. Already, it has eliminated nine of Guam's 11 native land bird species and most of the non-native birds as well.

Crawling along electrical lines, *Boiga irregularis* causes, on average, one power outage every four days on Guam—a huge economic burden to the island's citizens. More than 200 people have been treated for bites from this aggressive,



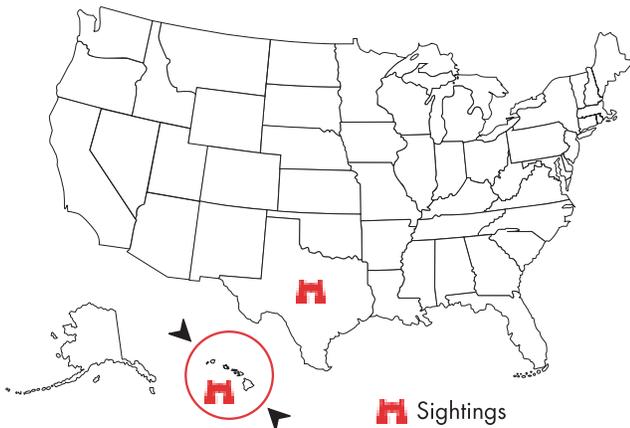
*The brown tree snake has eaten into extinction virtually all of Guam's native bird life. Although the snake has not yet successfully invaded Hawaii, it already has been intercepted there six times.*

venomous snake. Most (84 percent) were bitten at night while asleep in bed. On more than one occasion, parents checking on a crying baby have been horrified to find an eight-foot snake coiled around the child, the baby's hands punctured and swollen from repeated bites.

The brown tree snake poses an imminent threat to the Hawaiian Islands. It already has made its way to Hawaii on six occasions, on or somehow associated with aircraft from Guam. Fortunately, vigilant inspectors discovered these individuals before they escaped into the wild. Even one pregnant female snake slipping through could begin an invasion that would devastate Hawaii's environment and tourism-dependent economy. Experts predict that the reptile could also thrive in southern California, Florida, and other warm-climate states with potentially damaging effects. One brown tree snake was even found in cargo in Texas, so the threat to the continental United States is real.

Federal, state, and Guam authorities have prepared a coordinated plan for preventing brown tree snake invasion of other lands. Part of this plan is already in place, including inspecting aircraft that leave Guam. But research on improved control methods, inspection of shipped cargo, and other parts of the strategy still require funding. Experts say that without major improvements in prevention systems, it is only a matter of time before the brown tree snake establishes itself in Hawaii. If that happens, Hawaii's forests, like Guam's, may one day echo with the sounds of silence.

## U.S. Brown Tree Snake Sightings



Origin: Solomon Islands, Papua New Guinea, northern Australia

## CONTAINING THE INVASION

The future of our biodiversity and natural lands need not be bleak, despite the ecological and economic devastation unleashed by the “Dirty Dozen” and others of their kind. As a nation, we still have the power to choose a future in which most of our country’s species and ecosystems remain intact and continue to provide those values and services upon which we depend. Containing the onslaught of alien species will not be easy or quick, but it is not impossible. Indeed, the economic and ecological consequences of surrendering our shores to these foreign invaders make controlling them a national imperative.

What can be done? Safeguarding the United States’ natural heritage from harmful alien species requires work on four fronts:

**Prevention of Additional Introductions.** The best and most cost-effective solution is to prevent the arrival of new alien pests in the first place. Once exotic species gain a foothold in a new area, they often are capable of spreading with breathtaking speed, making eradication and control efforts difficult or impossible—and almost always costly.

**Early Detection and Eradication of New Pests.** Finding new outbreaks early, together with aggressive eradication campaigns, is the next best solution. Attacking the problem while it is still small and limited in range offers the prospect of total elimination, saving both money and natural resources.

**Control and Management of Established Problem Species.** If the invaders cannot be eradicated, or already are established, containing their spread and controlling their numbers can help minimize their effects on natural systems and biological diversity. Control efforts can vary enormously, relying on mechanical, chemical, or biological means, or employing environmental management strategies. Fighting exotic species within natural areas or around endangered species, however, presents special challenges to ensure that the control measures do not inadvertently cause further harm to these sensitive species or systems.

**Protection and Recovery of Native Species and Ecosystems.** Controlling problem species is not enough; the affected native species and ecosystems also must be restored and protected. Simply removing alien species without working to repair or restore the ecosystem conditions often leaves

natural areas susceptible to re-invasion by the same or other pests. Of particular importance is reinstating the natural ecosystem processes, such as flooding or fire, that sustain the natural communities and native plant and animal species.

## ▶ Shared Responsibilities

To contain the impact of exotic species on our native biodiversity and natural lands, individuals, private organizations, and governments must work together. We must all share commitments and responsibilities.

Although the overall problem may seem vast, some of the most important steps in controlling alien species come down to the choices and decisions we each make. What should we plant in our gardens, send through the mail, or bring back from our vacations? People can also contribute by volunteering to help land managers rid a nearby nature preserve or park of problem species. And individual citizens can influence the priorities of the governments that serve them. Raising public awareness and concern about the problem of non-native plants and animals helps motivate our elected officials and state and federal agencies to deal effectively with the issue. Specific actions that you as an individual can take to help stem the invasion of alien species are listed on page 24.

Much of the responsibility for containing these invasions and dealing with their aftermath rests squarely with public agencies. A complex patchwork of federal legislation exists that addresses many exotic species issues. But even though a legal framework is in place, significant legislative gaps remain. The laws that do exist often aren't effective even where they apply, and funds for enforcement are lacking.

Complicating matters further, more than two dozen federal, state, and local agencies have major responsibilities relating to alien species introductions or controls. Unfortunately, the various laws and agencies often have conflicting mandates. Coordination among agencies often is lacking, although promising efforts do exist, such as the new Federal Interagency Committee for the Management of Noxious and Exotic Weeds. At best, lack of coordination and conflicts in approaches slow response time in dealing aggressively with problems; at worst, agencies still contribute to the problem through intentional introductions of species that may have value for some purpose, but that are harmful to native biodiversity.

## ▶ The Nature Conservancy's Commitment

The Nature Conservancy is deeply concerned about the threat of alien species to native species and ecosystems, and is committed to combating the problem.

## WHAT YOU CAN DO TO HELP

- ▶ Know your own backyard—learn to identify your region’s most threatening pests. Find out whom to contact to report new invasions, or to receive guidance on controlling pests on your property.
- ▶ Landscape with native species or non-invasive ornamental plants appropriate to your region.
- ▶ Don’t release pets or aquarium plants and fish into the environment.
- ▶ Avoid disturbing natural areas—it increases their vulnerability to alien species invasions.
- ▶ Be careful not to send or receive potentially harmful plants or animals through the mail—use mail-order services wisely.
- ▶ Don’t bring plants, fruits, soil, or animals into the country from abroad—or to Hawaii from the mainland—without having them inspected by quarantine officials; fill out agricultural declaration forms completely and honestly.
- ▶ Clean boats and boating equipment before transporting them from one water body to another to avoid spreading aquatic pests such as zebra mussels or hydrilla. Leave behind unused bait and bucket water.
- ▶ Clean your boots and camping gear before setting out for other regions or countries, and again before returning home. On horse-packing trips, make sure that feed is certified weed-free.
- ▶ Spread the word—educate yourself and others about the problem of alien species.
- ▶ Get involved—join volunteer efforts to remove invasive species in natural areas, such as local Conservancy preserves and state or national parks.

In the United States, the Conservancy owns and manages more than 1,500 preserves encompassing about 1.4 million acres. Accomplishing our ambitious mission—protecting the full diversity of plants, animals, and natural communities—requires that we eliminate or reduce threats to these preserves from harmful non-native species. We also must work with others to thwart this menace on non-Conservancy lands. In keeping with the Conservancy's overall conservation approach, our attack on alien species relies on sound science to guide our activities, emphasizes on-the-ground conservation action, and depends on close partnerships with other public and private entities.

**Sound Science.** The Conservancy strives to base its conservation decisions on the best available scientific information. Together with state natural heritage data centers, we are working to identify those species and ecosystems at greatest risk from exotic species. To help set priorities in controlling and managing non-native plants, our scientists are developing a computerized database that ranks the threat of various plant pests to natural areas. Conservancy land stewards and scientists also are documenting effective control and management strategies for specific pests and distributing this information on the Internet.

**On-the-Ground Action.** On-the-ground conservation action lies at the heart of the Conservancy's efforts to protect the Earth's diversity of life. Our stewardship staff uses an array of tools to combat existing alien species problems in biologically important natural areas. The Conservancy's innovative Wildland Weed Management and Research Program helps land managers select and use plant pest control and management measures that are appropriate for a given natural area and its species. Our stewardship efforts also emphasize using water, fire, and grazing to sustain or restore those ecological processes that are needed to keep natural areas healthy and free of pests. And ambitious ecosystem restoration projects, such as the re-creation of native Illinois prairies, rely extensively on local volunteer help.

**Partnerships.** We cannot succeed alone. The Conservancy works in close partnership with a wide variety of groups, both government and private, to help prevent new pest invasions and to fight established problem species. In Hawaii, for example, we are actively involved with the Coordinating Group on Alien Species, a 14-agency effort that is implementing a strategy for effective prevention of and response to exotic species introductions in that state. At the national level, a new collaboration between the Natural Resources Conservation

Service (formerly the Soil Conservation Service) and the Conservancy will provide input from a biodiversity conservation perspective on plants being developed and introduced by this federal agency.

## ▶ Safeguarding Our Heritage

Our nation's native plant and animal species, and the ecosystems on which they—and we—depend, are too important to sacrifice to alien invaders. This is a critical issue of both ecological *and* economic survival. But despite formidable challenges, opportunities for success do exist. And although the problem may be expensive to address now, the cost will be far higher if we delay—both in dollars and diversity. With prompt attention and action, though, we still have time to safeguard our nation's unique natural heritage.

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## ADDITIONAL RESOURCES

For more information on the management of exotic plants and animals and on what you can do to help minimize the impact of non-native species on biodiversity and natural areas in your region, contact your state cooperative extension service or university. These institutions can provide information about management and control of non-native plants and animals in your area. Local nurseries, botanical gardens, arboreta, or native plant societies can help suggest regionally appropriate plants to use in gardening and landscaping. The Nature Conservancy's state field offices offer volunteer work opportunities to remove exotic species on preserves owned by the Conservancy.

### ▶ Selected National Organizations

**Animal and Plant Health Inspection Service:** an agency of the U.S. Department of Agriculture charged with preventing the importation of noxious weeds and designated foreign pests into the United States.

**Exotic Pest Plant Councils:** nonprofit organizations operating in Florida, Tennessee, California, and the Pacific Northwest, which are dedicated to building public awareness about the invasive plant problem and developing support for the control and management of exotic plants.

**Federal Interagency Committee for the Management of Noxious and Exotic Weeds:** 17 federal land management agencies working to coordinate the government's approach to managing exotic weeds on federal lands.

**Federal Native Plant Conservation Committee's Exotic Plant Working Group:** a partnership of federal agencies and other public and private groups working to promote awareness of invasive exotic plant management issues.

**The Nature Conservancy's Wildland Weed Management and Research Program:** a program promoting sound management of pest plants on Nature Conservancy managed lands and other lands with significant biological diversity.

**Non-indigenous Aquatic Nuisance Species Task Force:** a federal interagency task force helping to implement a program to control and reduce the risk of further introductions of aquatic nuisance species, such as the zebra mussel.

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