

Alien Invaders Affecting Our Nation's Waters

Invasive species. They sound menacing, and for many ecosystems, invasive species have been just that. These species include aquatic and terrestrial plants, animals, and microorganisms, and are found at the tops of mountains, in the oceans, and everywhere in between. Invasive species are infamous for negatively impacting natural communities—either through unchecked colonization of an ecosystem or by spreading disease. Aquatic invasive species can drastically alter a water ecosystem and can interfere with recreational use. Even when not directly colonized by invasive species, water resources can suffer indirect consequences from terrestrial invasive species. For example, altering a watershed's upland ecosystem can lead to changes in water tables, runoff dynamics, and other attributes that influence the watershed drainage system. As the widespread negative impacts of invasive species have become apparent, agencies and organizations across the U.S. and the world have launched programs to monitor invasive species populations and to try to prevent or prepare for further spread.

Native, Exotic, or Invasive?

The media often use terms such as native, exotic, and invasive to describe different plants and animals. What is the difference? A native or indigenous species is one that evolved in a particular place. Climate, geology, soils, hydrology, biological interactions, and natural dispersal govern that species' evolution and its development within a balanced ecosystem. Species native to North America are generally recognized as those occurring on the continent prior to European settlement.

An organism is considered non-native, or exotic, when it has been introduced by humans to a location outside its natural range. Many non-native species co-exist with native plants and cause no apparent ecosystem disruption. In fact, our nation's agricultural industry is largely based on non-native species, including oats, rice, soy, wheat, cattle, and poultry. However, sometimes the exotic species find a niche where they have no predators or other natural controls, and are able to aggressively colonize a region. Once the spread of an exotic species causes harm to human health, the environment, or the economy, the National Invasive Species Council then considers it an "invasive species."

Invasive species typically enjoy robust growth, high reproductive rates, and longevity. While some native species display invasive tendencies under certain ecosystem conditions, eventually the ecosystem's natural checks and balances will bring the native population back under control. By contrast, invasive species often lack natural controls and can overwhelm and severely disrupt an ecosystem, thereby altering watershed characteristics in the process.

Recent Study Offers Grim News

A recent Cornell University study (Pimentel et al., 2005) reports that invasive species in the United States cause major environmental damages and losses adding up to almost \$120 billion per year. The study estimates that the U.S. is home to 50,000 invasive species—and the number continues to increase. Moreover, approximately 42 percent of native species on the threatened or endangered species lists are thought to be at risk primarily because of competition with, or predation by, invasive species. The study was described in an article printed in the February 2005 issue of *Ecological Economics* (52:273-288). An "in-press" version of this article is available online at

http://ipm.ifas.ufl.edu/applying/invasive-species/EconomicCosts_invasives.pdf. An earlier version of the article, released by Cornell University, is available at www.news.cornell.edu/releases/Jan99/species_costs.html.

How Do Invasive Species Impact Water Resources?

The effects of invasive species on water resources can be direct, as in the case of many aquatic invasive plant and animal species, or indirect, as in terrestrial species that change water table levels, watershed cover, speed and frequency of runoff, fire frequency, and other watershed attributes that in turn can alter the condition of water resources. Moreover, people can poison water resources when they misapply pesticides and herbicides to control invasive species. The chemicals can find their way into waterbodies by accidental direct application, wind drift, and nonpoint source runoff.

Aliens on Our Shores

The problem of invasive species has likely been around as long as human trading routes have existed—long before Hannibal and Marco Polo. However, in modern times, the increase of global trade and transport has significantly increased the pace of invasive plant, animal, and microorganism species introduction around the globe. Invasive species are constantly on the move; sometimes they escape from aquariums or the live food industry and sometimes they are intentionally released. Often, they hitch a ride in ballast water (water added to the empty cargo holds of ships to provide stability), on boat hulls, on diving gear, on vehicles, on boots, in transported firewood, in packing material, in nursery plants, or in countless other instances involving transport. For more on the pathways of invasive species introduction, see www.epa.gov/owow/invasive_species/pathways.html.

America's Least Wanted

Some examples of the invasive species and their widespread water quality impacts include:

- Cheatgrass (*Bromus tectorum*) is a winter annual grass that originated in Europe and Asia and came to the Inter-mountain West in contaminated seed in the 1890s. By 1920, cheatgrass had invaded native semi-arid grasslands and open pinyon-juniper woodlands of the Colorado Plateau. Despite its early growth and rich color, cheatgrass is unpalatable to sheep and other livestock, which tend to overgraze native plants when cheatgrass begins to prevail. Cheatgrass now covers millions of acres, where it increases the frequency and intensity of wildfires. This increases the number of heavily-burned watersheds and increases fire-related impacts on water resources. Cheatgrass is also a heavy user of early season moisture, which reduces much-needed spring runoff in western watersheds.
- The hemlock woolly adelgid (*Adelges tsugae*), a small, aphid-like insect, was imported from Asia and first appeared in 1951 near Richmond, Virginia. By 2005, it was established in portions of 16 States from Maine to Georgia, where infestations covered about half of the range of eastern and Carolina hemlock in the eastern United States. In the Appalachians, hemlock woolly adelgid infestations have been 100 percent fatal for Eastern Hemlock trees, a key native species providing riparian forest cover and bank stability for headwaters streams. Deforested streams are at risk for developing temperature and sediment problems and losing their coldwater aquatic communities.

- Nutria (*Myocastor coypus*) are large rodents imported from South America in 1899 for fur production. Some nutria escaped, while others were released into southern coastal marshes in the 1940s after the nutria fur market collapsed. Nutria destroy marsh vegetation by digging underneath and overturning the plants to feed on the root mat. The destruction of these wetlands increases the vulnerability of adjacent upland sites to erosion and flooding during storms. Nutria are found in coastal areas from Texas to Delaware.



Nutria- a large member of the rodent family, which destroys wetlands.

- Purple loosestrife (*Lythrum salicaria*), a plant with purple flowers, was introduced from Eurasia to the northeastern United States and Canada in the 1800s for ornamental and medicinal uses. According to the U.S. Fish and Wildlife Service, purple loosestrife now occurs in every state except Florida. Purple loosestrife is capable of invading many wetlands, including wet freshwater meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs, and ditches. Under favorable conditions, loosestrife is able to rapidly establish and replace native vegetation with a dense, homogeneous stand that changes the biogeochemistry of the wetland, reduces local biodiversity, endangers rare species, and provides little value to wildlife. Some areas experience economic losses resulting from reductions in waterfowl viewing and hunting opportunities.



Purple Loosestrife growing along the shores of Lake Huron. It is very plentiful and crowds out other plants.

- Saltcedar (*Tamarix ramosissima*), a deciduous shrub/small tree native to Eurasia and Africa, was released in 1837 as an ornamental shrub and to help control wind and water erosion. Saltcedar is extremely invasive in the western U.S.—infesting more than one million acres. It spreads rapidly along streams, out-competing beneficial native vegetation such as willows and cottonwoods and displacing animals and insects. Saltcedar has a very high evapotranspiration rate, and depletes ground water and surface water that would otherwise be used by native vegetation or by farmers to irrigate fields. Reduced water levels change

stream morphology and increase the risk of wildfire. The U.S. Department of Agriculture reports that saltcedar alone causes economic losses in the millions of dollars per year.

- Water hyacinth (*Eichhornia crassipes*), a floating flowering aquatic plant native to South America, was released into Florida's St. John's River in the 1880s. It spread rapidly, and is now abundant in the southeast U.S, the U.S. gulf coast, California, and Hawaii, as well as other sub-tropical areas worldwide. Water hyacinth can form dense, impenetrable mats of floating vegetation that interfere with navigation, recreation, irrigation, and power generation. Water hyacinths reproduce extremely rapidly by seed and rhizomes and quickly out-compete native submersed and floating-leaved plants. The water hyacinths cover the water's surface, which prevents photosynthesis from occurring in the water column and leads to low oxygen conditions. Decaying plant mats further reduce oxygen levels. Water hyacinth quickly spreads to new water bodies when plant fragments or seeds hitch a ride on boats, trailers, or other recreational equipment.



water hyacinths grows along the edge of a lake. It has a large root mass and can crowd out other plants.

- The zebra mussel (*Dreissena polymorpha*) is a mollusk that is native to the Caspian Sea and was accidentally introduced to the Great Lakes in the ballast water of ships. It was first found in Lake St. Clair in 1988 and has spread to each of the Great Lakes. Zebra mussels are estimated to have caused more than \$3.1 billion in economic damages during the past 10 years alone. Zebra mussels clog engines, municipal water intakes, and cooling systems. Each mussel filters up to a quart of water each day, reducing available phytoplankton and altering food chains, which reduces fish populations. Zebra mussels damage spawning areas, smother native mussel beds, and cause taste and odor problems in water.

What is Being Done?

In 1999, President Clinton signed Executive Order 13112, which outlined the federal government's invasive species-related duties and established the National Invasive Species Council (Council). The Council is an inter-departmental body that helps to coordinate and ensure complementary, cost-effective federal activities regarding invasive species. Together with other stakeholders, concerned members of the public, and member departments, the Council formulated a national action plan—the National

Invasive Species Management Plan. Completed in early 2001, the Plan provides an overall blueprint for federal action. The Plan recommends specific action items to improve coordination, prevention, control, and management of invasive species by the federal agency members of the Council. Bi-annual reports chart the Council's progress as it implements the Plan. These reports, along with the original Plan, are available for download at www.invasivespeciesinfo.gov/council/nmp.shtml.

One of the Council's most important tools to assist and enhance the quality and accessibility of information about invasive species is the Council's Web site, www.invasivespeciesinfo.gov. Launched and maintained by the National Agricultural Library's National Invasive Species Information Center, the site provides a convenient Web gateway to more than 13,000 science-backed information resources from both the private and public sectors. Users can browse for information by invasive species type, such as aquatic species, plants, animals and microbes, or by other topics, such as economic impacts, laws and regulations, management, or news, and events. The site provides profiles for nearly a hundred species, and offers links to images, fact sheets, management plans, and an extensive list of state, federal, and local government agencies and other private and public organizations with interest in preventing, controlling, or eradicating invasive species.

The Web site offers links to documents and guidebooks prepared by organizations specializing in different areas of invasive species control. For example, the Web site lists a new aquatic invasive species management document developed by The U.S. Environmental Protection Agency (EPA) Office of Water, in response to Executive Order 13112, which required "each Federal agency whose actions may affect the status of invasive species ... to identify such actions [and] use relevant programs and authorities to detect and respond rapidly to and control populations in a cost-effective and environmentally sound manner."

- EPA's new document, *Overview of EPA Authorities for Natural Resource Managers Developing Aquatic Invasive Species Rapid Response and Management Plans* (Dec 2005), was created to help states and localities respond quickly and appropriately to invasions of aquatic invasive species. The document, available at www.epa.gov/owow/invasive_species, provides an overview of EPA authorities that
- might apply to state or local aquatic invasive species rapid response and control actions, such as the Clean Water Act (CWA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The document also describes case studies in which state and local natural resource managers successfully obtained FIFRA emergency exemptions and special local need registrations for aquatic invasive species eradication or control actions. Like other federal organizations, EPA also maintains its own Web site about invasive species at www.epa.gov/owow/invasive_species. EPA's Watershed Academy Web, an online training resource, offers an invasive species training module at www.epa.gov/watertrain/invasive.html
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