USGS
science for a changing world

Microbes to Mammals

Invasive Species Program

U.S. Department of the Interior
U.S. Geological Survey

Invasive Species

What is an invasive species?

Any species that is not native to an ecosystem and whose introduction does (or is likely to) cause harm to the economy, environment, or human health. Invasive species comprise "biological pollution," which (unlike chemical pollution) multiplies on its own, often explosively, with far-reaching consequences. Invasive species research is a top priority for the U.S. Geological Survey and the Department of the Interior, nationally and internationally.

How do they get here?

Increased global travel and trade provides pathways for both intentional and unintentional introductions of invasive species. Many species introduced for beneficial purposes are now harmful, like kudzu (*Pueraria lobata*), which was first planted in the U.S. for erosion control. Over 80% of tree and shrub invaders in the U.S. arrived as landscape plants. Accidental introductions often hitchhike across our borders where they are not expected. Zebra mussels (*Dreissena polymorpha*) traveled to the Great Lakes unnoticed in ballast water from Europe. The chestnut blight fungus (*Cryphonectria parasitica*) arrived with imported ornamental trees from Asia and destroyed the beloved American chestnut during the early 20th century.

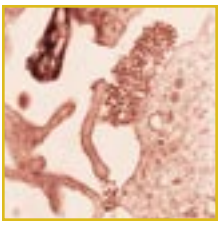
from left to right: kudzu-covered landscape, zebra mussel, and chestnut blight fungus

How do invasive species affect us?

Biological invasion is rapidly becoming one of the greatest threats to the natural environment of the United States. The impacts of invasive species are many and widespread, and include: elimination or reduction of native plant and animal species, forest degradation, water depletion, crop decimation, clogging of waterworks, transmission of disease, and reduced property values. Invasive species can dramatically modify ecosystem processes. For example, in some western states, wildfires are twenty times more likely to recur where invasive cheatgrass (*Bromus tectorum*) has invaded. The problem is not a new one (cheatgrass arrived in the 1880s), but its impacts are rapidly increasing.

Invasive species adversely affect every ecosystem in the U.S., from Alaska to Florida and from urban centers to wilderness. According to one estimate, invasive species already cause more than $137 billion in damage each year to the United States economy.*

Invasive species cause a combination of health, environmental, and economic threats. For example, West Nile virus was first reported in the United States in 1999 in captive birds at a New York zoo. Mosquitoes spread the virus from captive birds to native wildlife and humans and the disease is now a threat to both nationwide. The red imported fire ant (*Solenopsis invicta*), known for its painful stings, negatively impacts both human and animal health and quality of life across the South, disrupts native ecosystems, and continues to spread unabated. The sea lamprey (*Petromyzon marinus*) devastated the trout fishery in the Great Lakes before it was controlled by continuing annual applications of chemical lampricide and other methods. The trout fishing industry has partially recovered, but sea lampreys are not totally eliminated.



from top to bottom: West Nile virus, cheatgrass-fueled fire, and red imported fire ants

*Pimentel, D. et al. (2000). *Bioscience,* Vol. 50, No. 1, pp. 53-65. (January).

Why USGS?

The U.S. Geological Survey is the primary research arm of the Department of the Interior, which manages nearly one-fifth of all land in the United States. The Department of the Interior co-chairs the National Invasive Species Council, and USGS plays a significant role in implementing the National Invasive Species Management Plan, called for in the Presidential Executive Order on Invasive Species. To meet the goals of the Plan, the USGS Invasive Species Program provides management-oriented research and delivers information needed to prevent, detect, control, and eradicate invasive species, and to restore impaired ecosystems. USGS research includes all major taxonomic groups of invasive organisms – truly "Microbes to Mammals."

from top to bottom: USGS virologist Douglas Docherty looking for evidence of the West Nile virus; USGS scientists test a crow for West Nile virus; and USGS scientists, National Park Service staff, and university researchers measure optical characteristics of leafy spurge that are used to map infestations.

Future Direction

The National Institute for Invasive Species Science

The Institute is a quickly growing consortium of partnerships between government and non-government organizations that is administratively housed in the U.S. Geological Survey's Fort Collins Science Center in Colorado. USGS researchers are leading or cooperating in efforts to integrate the capabilities of USGS and partners, which include Federal and State resource agencies and other customers, to help provide the information, methods, technologies, and technical assistance needed for effective responses to terrestrial and aquatic invaders threatening U.S. ecosystems and native species. An important focus is on developing models for predicting the probable spread and impacts of invaders in cooperation with NASA Goddard Space Flight Center, the USGS EROS Data Center, the NBII Program, and others.

http://www.nrel.colostate.edu/projects/niiss/niiss.html

Prevention

Defense is the best offense. Preventing invasive species now saves time, effort, and money later – but prevention is easier said than done. USGS scientists are striving to become increasingly involved in facilitating prevention efforts, which are an essential part of a comprehensive program for providing a lasting solution.

Hawaii's unique native species evolved in isolation and are extremely vulnerable to invasive species. The brown tree snake (*Boiga irregularis*) has already decimated the native bird population of Guam, and Hawaii and other Pacific islands must be spared a similar fate. USGS researchers designed an extremely effective snake-proof concrete barrier for placement around ports, to be used at the Guam International Airport to prevent hitchhiking snakes from stowing away on aircraft. Also, applied researchers have developed a training method to teach cargo-sniffing dogs on islands receiving shipments from Guam to identify brown tree snakes. The dogs learn by sniffing sterilized male snakes that smell hormonally normal, but are incapable of reproducing, should they escape or be released accidentally.

Ballast water – which contains a veritable soup of live organisms – is used to stabilize large ships as they travel and is discharged in U.S. ports at an average of 40,000 gallons per minute around the clock, dumping foreign pathogens and nuisance aquatic species such as the zebra mussel. The USGS Western Fisheries Research Center initiated cooperative research to help Federal, State, and local agencies and industry prevent introductions of invasive aquatic species through ballast water. The program includes testing the effectiveness of ballast water treatments, such as ultraviolet light irradiation, for sterilizing ballast water and its potential use by the shipping industry.

Early Detection & Rapid Response

Given that prevention efforts worldwide are far from being comprehensive and effective, early detection of invaders and quick, coordinated responses help eradicate invasive species before they become a problem.

USGS scientists on Maui, Hawaii, are exploring ways of detecting the presence of the most threatening invasive plant species while

there is still an opportunity for cooperative efforts to eradicate them. The largely pristine rainforests of Haleakala National Park are already under siege by the invasive tree *Miconia calvescens,* which forms dense stands and shades out native plants. Containment efforts for miconia now cost more than $1 million annually. Miconia, known for its spectacular damage to the South Pacific island of Tahiti, was unfortunately detected a decade too late in Hawaii. Thus the concept of "stopping the next Miconia" understandably appeals to county, State, and Federal partners.

Specialized biological containment facilities at the USGS National Wildlife Health Center in Madison, Wisconsin, allow scientists to provide diagnostic support and critical information to all levels of government and the public, enabling them to use patterns of wild bird mortality as an indicator of the spread and activity level of West Nile virus. This information has allowed public health officials to estimate risk to human populations and enact control and prevention activities.

Monitoring & Prediction

If an invasive species becomes established, monitoring is essential to track and predict its spread and to inform management decisions.

Leafy spurge (*Euphorbia esula*) is a plant that is poisonous to cattle. It outcompetes other prairie and pasture plants, dominates landscapes, and crowds out natural grasses and habitats. It now infests more than 2.7 million acres in southern Canada and the Northern Great Plains and is rapidly spreading toward much larger susceptible habitats. USGS is using a variety of technologies to detect and map leafy spurge infestations at Theodore Roosevelt National Park in North Dakota, partnering with the National Aeronautic and Space Administration, the National Park Service, and the USDA Agricultural Research Service.

Research on Invasive Species and Their Effects

Providing management-oriented research is a primary mission of USGS. Our scientists help tackle the problem of invasive species through research on their spread and impacts.

When the non-native, air-breathing northern snakehead fish (*Channa argus*) was discovered reproducing in a Maryland pond,

USGS researchers were on the scene to identify the fish, provide information on its biology and potential ecological effects, and suggest control methods. This valuable input led to a successful rapid response to a highly destructive aquatic species that poses a severe threat to native fish and wildlife and the economic sectors that depend on them.

Control

Once an invasive species becomes established, it is necessary to find effective and inexpensive ways to control it. The USGS emphasizes the development and application of genetic, biological, and ecological methods that reduce impacts of invasive species at local to national scales, and that help restore ecosystem processes and populations of native species.

The USGS worked with the Great Lakes Fisheries Commission to produce a successful integrated pest management approach to control the parasitic sea lamprey, a fish that was decimating the economically important lake trout fishery in the Great Lakes. USGS scientists developed technologies to block spawning migrations in Great Lakes tributaries. A lampricide is used at low concentrations to control lamprey populations in small tributaries, while sterile males are released to achieve reduction in large river systems. Adult lake trout populations are stable or rising as a result of these controls.

The nutria (*Myocastor coypus*), an invasive rodent from South America, destroys thousands of acres of fragile wetlands from Maryland to Louisiana by feeding on the roots of wetland plants. USGS researchers are developing controls to reduce nutria populations while minimizing the effects on native species.

Restoration

Once invasive species are eradicated or controlled, ecosystems can often be restored to promote natural processes and function, increase populations of native species in ways that restore ecosystems to their full value, and lower the risk of future invasion.

USGS researchers in Oregon, Idaho, Utah, and Nevada are evaluating management techniques for reducing the dominance of cheatgrass and other weeds, which burn increasingly frequently and

intensely, destroying the sagebrush steppe ecosystem and the habitat of native plants and animals, such as sage grouse and golden eagles. Re-establishing native plant communities will help to bring back ecosystem structure and function, inhibit destructive fires, and reduce the cost of fire fighting and additional restoration.

Information Systems

By sharing information on invasive species, we can better learn about all aspects of invasive species management, from taxonomy to control methods. The National Biological Information Infrastructure (NBII) <http://www.nbii.gov> – a Web-based system coordinated by the USGS that provides information on the nation's biological resources – is taking the lead in acquiring and supplying information to help researchers and planners predict, prevent, and manage the influx of invasive plants, animals, and diseases. Invasive species information from the USGS as well as NBII partners around the nation and the globe is available through the NBII Invasive Species Information Node <http://invasivespecies.nbii.gov>. This new information hub is developing standards, analytical tools, predictive models, and technologies that will be applicable to a broad range of invasive species issues being addressed by the USGS and its partners worldwide.

International Work

Invasive species in the United States come from other countries, and the United States has "donated" invasive species to foreign lands as well. Because of this, the Invasive Species Program participates actively in international entities like the Global Invasive Species Programme. Some international efforts focus on countries like China and Russia, which are large trading partners with the United States and have similar climates and ecosystems and shared invasive threats (most of which flow toward the U.S.). Others focus on Pacific island nations and territories which stand to suffer immensely from commerce that introduces invasives from the U.S., such as the red imported fire ant and West Nile virus.

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http://biology.usgs.gov/invasive/index.htm

Photos courtesy of the following:
Front cover: West Nile virus, Paul Slota, USGS; nutria, Dixie L. Bounds, USGS

In the order in which they appear: kudzu, FICMNEW Invasive Plants Factbook; zebra mussel, Amy J. Benson, USGS; chestnut blight, Scott E. Schlarbaum, University of Tennessee, Knoxville; West Nile virus, Paul Slota, USGS; cheatgrass, Troy Wirth, USGS; red imported fire ants, Bastiaan M. Drees, Texas A&M University; scientist at microscope, Paul Slota, USGS; scientists with crow, F. Joshua Dein, USGS; scientists and researchers/leafy spurge, Ralph Root, USGS; brown tree snake, Gordon Rodda, USGS; ballast water, L. David Smith, Smith College; miconia, Michael Walker, University of Hawaii; northern snakehead fish, Buck Albert, USGS; sea lamprey, Great Lakes Fishery Commission