USGS
science for a changing world

Invasive Species Research
Science for Detection, Containment, and Control

Invasive species research within the U.S. Geological Survey's (USGS) Ecosystems Mission Area (EMA) focuses on invasive organisms throughout the United States. USGS scientists work with partners in the Department of the Interior (DOI), other Federal, State and Territorial agencies, Tribes, industry, and agriculture to provide the information needed to help solve problems posed by these invaders. Key components of USGS invasive species science include the development of novel prevention, prediction, early detection, containment, and control tools.

Invasive Species Facts

- Invasive species are alien species whose introduction does or is likely to cause economic or environmental harm, or harm to human health.

- Invasive species adversely affect every State, Territory, and Tribe in the Nation, including urban centers and wilderness areas.

- Increased global travel and trade provide pathways for both intentional and unintentional introductions of invasive species.

- Every year, harm caused by invasive species costs governments, industries, and private citizens substantial economic losses potentially reaching into the billions of dollars.

- The costs of battling invasive species impact farmers, ranchers, businesses, and all levels of government to control the economic, health, and environmental threats these invaders pose.

- Invasive species decrease agricultural production, compete with and predate on native plants and wildlife, impair critical water infrastructure, transmit disease to wildlife and humans, threaten commercial and native fisheries, and reduce hunting, fishing, and other recreational opportunities such as boating and swimming.
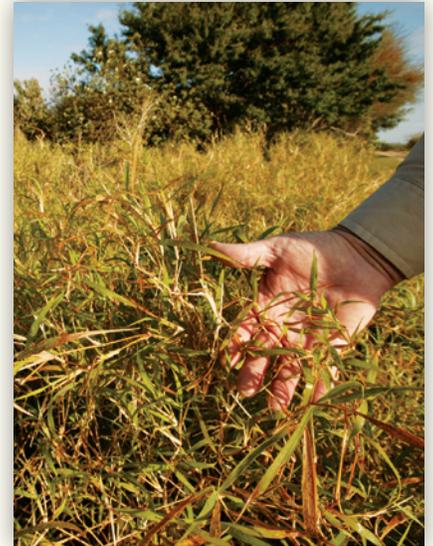
USGS EMA Areas of Emphasis

- Preventing establishment and further spread of Asian carps in the Great Lakes, Upper Mississippi, and Ohio River Basins

- Control of sea lamprey (*Petromyzon marinus*) in the Great Lakes

- Support for brown treesnake (BTS, *Boiga irregularis*) control on Guam and regional Pacific Island biosecurity

- Developing tools to address Rapid 'Ohi'a Death (ROD, *Ceratocystis lukuohia* and *huliohia*) in Hawaii (an introduced chytrid fungus infecting 'Ohi'a, a native Hawaiian tree species)

- Development of control and monitoring techniques for Burmese python (*Python bivittatus*), black and white tegu (*Tupinambis merianae*), and other pests in the Everglades and southern Florida

- Supporting management efforts related to invasive weeds such as salt cedar (*Tamarix* spp.), cheatgrass (*Bromus tectorum*), Russian olive (*Elaeagnus angustifolia*), leafy spurge (*Euphorbia esula*), brome (*Bromus* spp.), and buffelgrass (*Cenchrus ciliaris*)

- Assisting Federal, State and Tribal partners with response to zebra and quagga mussels (*Dreissena polymorpha* and *D. bugensis*) in the continental United States

- Providing nationwide reporting, monitoring, and tracking of all freshwater aquatic invasive species as part of a national early detection system

In Hawai'i, USGS scientists have developed a successful eDNA field method to detect the fungus that causes Rapid Ohi'a Death (ROD) in mature Ohi'a trees in collaboration with partners.
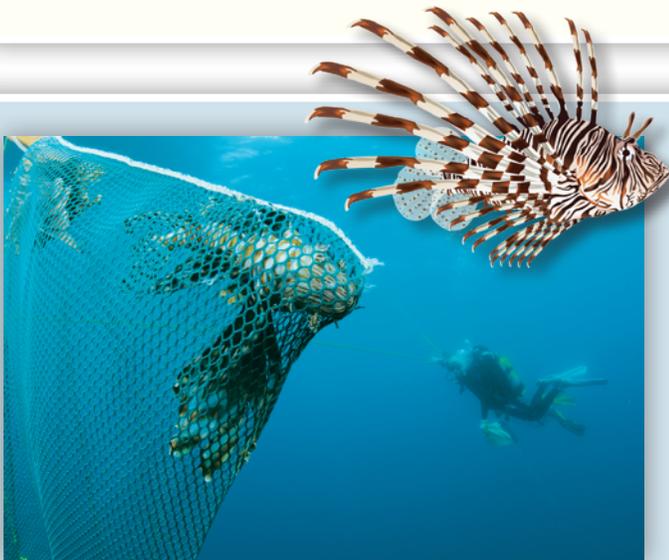
Genetics and Invasive Species Detection—Environmental deoxyribonucleic acid (eDNA), genetic material shed by organisms into the waters in which they live, has recently emerged as a powerful genetic tool for detecting invasive species and rare aquatic animals in lake or river water. USGS research has led to refinements of methods to improve detection sensitivity, understand how eDNA changes over time, and decrease time between sampling and results. For example, scientists have developed a portable eDNA detection kit for detecting bighead and silver carps that provides results in less than an hour and could be used to detect other species. The USGS also used eDNA sampling to detect invasive northern pike (_Esox lucius_) in several south-central Alaska lakes following eradication efforts, and to monitor potential range expansion of pythons and snakeheads in southern Florida.

Early Detection and Rapid Response (EDRR) Tool Development—While invasive species prevention is the first line of defense, even the best prevention efforts will not stop all invaders. EDRR is a coordinated set of actions to detect and eradicate potential invasive species in a specific location before they spread and cause harm. In one example, the USGS provides scientific support to resource managers to aid in implementation of EDRR efforts, make informed management actions, and lead multiagency and partner rapid response efforts such as training relative to brown treesnake (BTS) rapid response. For this effort, the USGS developed a model for determining the amount of search and (or) trap effort required when responding to BTS rapid response efforts to meet the desired degree of certainty by resource managers that a population is not present in the area.

Buffelgrass is a nonnative perennial grass that is rapidly spreading across National Park Service (NPS) and adjacent lands in the Sonoran Desert in Arizona and California and can carry fire quickly across the landscape. USGS is working with the NPS and others on EDRR tools to detect invasive buffelgrass such as sensors aboard Unmanned Aerial Systems and high-resolution satellite imagery.

USGS scientists developed tools to assist managers in predicting potential range expansions of invasive lionfish (_Pterois volitans_) following weather-related flooding such as hurricanes, and in producing maps indicating potential rapid response areas after a new location is invaded.

Nonindigenous Aquatic Species Database—The USGS Nonindigenous Aquatic Species (NAS) Program, created by Congress in 1990 to provide timely information to natural resource managers, maintains a database that helps managers monitor, record, and analyze sightings of nonindigenous aquatic plant and animal species throughout the United States. The NAS database is a clearinghouse of information for confirmed sightings of nonindigenous aquatic species throughout the Nation. The database assists managers by sending email risk alerts intended to support prompt early detection and rapid response efforts in the field when new species are detected in sites of concern. Flood and Storm Tracker (FaST) Maps, a new NAS database product, enable managers to predict potential spread of NAS associated with flooding and storm surge events. The database also provides species distribution maps, scientific publications, and other information products to support natural resource management.

Zebra and Quagga Mussels—Invasive zebra and quagga mussels (collectively called dreissenid mussels) affect industrial and municipal infrastructure, recreational water use, and they severely alter aquatic ecosystems as they spread across North America. The USGS has been conducting dreissenid mussel control and rapid response in the Great Lakes and Upper Mississippi River Basins for several years including developing genetic tools for detecting and evaluating the application of molluscicides and assessing effects on nontarget species. In 2016 the first detection of dreissenid mussel larvae was documented in Montana resulting in strengthened Federal government efforts, in coordination with States and Tribes, to address invasive mussels in the Northern Rocky Mountains and Columbia River Basin. In support of this effort, the USGS evaluated genetic markers for early detection of dreissenid mussels and is working to improve eDNA sampling and analysis protocols, and early-detection monitoring plans.

Invasive zebra mussels are now part of many of our Nation's lakes and rivers, and USGS science and technical assistance is assisting in the control and prevention of further spread of these and other damaging mollusks.

Asian Carps—High-density populations of Asian carps [bighead, black, grass, and silver carps (*Hypophthalmichthys nobilis, Mylopharyngodon piceus, Ctenopharyngodon idella* and *H. molitrix*)] have caused a range of negative impacts to the Nation's waterways. The USGS provides data, tools, and technologies to partners to keep these invasive fish out of the Great Lakes and other aquatic ecosystems, and to control them where they occur in the Ohio and Mississippi River Basins. Current field testing is being conducted on underwater sound technology and carbon dioxide levels in water as methods to deter Asian carps range expansion, and researchers are testing a specific toxicant to control populations in open-water systems.

USGS has extensive capabilities that have led to development of the risk assessment tool, Fluvial Egg Drift Simulator, for bighead, silver, and grass carps to predict where Asian carps are likely to spawn and where eggs and larvae will likely be located after spawning.

Brown Treesnakes and Pacific Islands Biosecurity Research—The BTS is a threat to the economy and unique ecosystems of Guam, specifically to the biodiversity, economy, and human health of the Pacific region and beyond. The BTS was accidentally introduced to Guam in the late 1940s and has caused global or island-wide extinction of 9 of 13 native forest birds. This invader frequently short circuits power lines, causing costly power outages and is a significant biosecurity risk. The USGS has played an essential role in developing control techniques such as traps and barriers to manage this pest and leads the regional BTS Rapid Response Team to ensure effective EDRR to BTS sightings in new locations on the Pacific Islands. Scientists have also been applying lessons learned from working on the BTS to inform other biosecurity efforts regionally.

A brown treesnake crawls on some frangipangi blossoms in Guam, where significant quarantine efforts are implemented to prevent the introduction and establishment of this invasive snake elsewhere.

Burmese Pythons—Burmese pythons are large invasive snakes, which can exceed 18 feet and 150 pounds. USGS research on Burmese pythons has focused on methods for detection and control, predicting potential range of the species in the United States, understanding thermal tolerances, and conducting risk assessments of pythons and other giant constrictors. The USGS continues to conduct research to aid in the management of Burmese pythons in Everglades National Park, Big Cypress National Preserve, and other DOI lands in southern Florida. Recently, USGS scientists and partners documented that Burmese pythons have devastated the mammal communities in Everglades National Park and are known to have consumed several endangered species including Wood Storks (*Mycteria americana*) and Key Largo woodrats (*Neotoma floridana smalli*).

USGS scientists conduct research on invasive Burmese pythons in Everglades National Park and other DOI lands in South Florida to aid in the management of these large, voracious constrictor snakes.

Cheatgrass—Cheatgrass and other invasive grasses continue to expand into sagebrush ecosystems in western United States where they colonize burned areas before native plants can become established, providing more fuel for wildland fire. USGS scientists are assessing strategies to restore native vegetation to fight cheatgrass invasion and increase postfire resilience. These strategies include modeling postfire recovery times and developing fire management protocols that include alternatives to chemical and mechanical cheatgrass control methods and linking patterns of wildfire across the Great Basin with changing sage-grouse populations and climate.

Invasive cheatgrass turning red in the Squirrel Creek burn area, Medicine Bow National Forest, Wyoming. The USGS developed a map of the percentage of cheatgrass cover by early June each year which can help land managers plan fire operations and protective measures for development and crucial wildlife habitats.

Salt Cedar (Tamarisk)—The USGS is a leader in understanding the distribution and impact of invasive salt cedar, known as tamarisk, on riparian ecosystems in the Southwest including effects on plant communities, water loss, erosion, wildlife use and human recreational resources. Scientists are studying the effectiveness of biological control to reduce salt cedar populations, in collaboration with multiple partners to provide valuable information for resource managers tasked with decisions related to restoration of native plant communities and associated wildlife, and assessments of changes in water yield.

In arid and semiarid regions of the western United States, much of the riparian vegetation is dominated by nonnative shrubs and trees such as salt cedar (tamarisk), which have replaced native vegetation in many areas over the past several decades. (Photograph from NPS)

Sea Lamprey—The parasitic sea lamprey invaded the Great Lakes in the mid-20th century, devastating valuable native fisheries and coastal economies. The USGS plays a central role in sea lamprey control research by working with the Great Lakes Fishery Commission, the U.S. Fish and Wildlife Service, other State, Federal, and Tribal agencies, and academic institutions to provide science on sea lamprey biology, ecology, and control technologies. Recently, the USGS developed a novel trap and electrical guidance array capable of removing 75 percent of invasive sea lamprey from a stream with minimal impacts to nontarget species and streamflow.

Sea lampreys feed on the blood and fluids of native fish, causing population declines in commercial and recreational species that are essential to the Great Lakes' multibillion dollar per year fishery. USGS scientists registered with the U.S. Environmental Protection Agency the first vertebrate pheromone, which when applied can increase sea lamprey trap catch by 35 percent.

Black and White Tegu—(hereafter referred to as tegu) are large omnivorous lizards native to South America and are common in international pet trade. There are at least three established populations of tegus in southern Florida, all likely resulting from escaped or released pets. Tegus eat a variety of plants and animals but specialized in consuming eggs from bird and reptile nests. USGS scientists recently demonstrated that conditions suitable for tegu survival may exist across the southern one-third of the continental United States. USGS research on tegus includes developing and testing methods for detection and control, determining thermal tolerances, and assessing risks to the greater Everglades ecosystem.

USGS is working on development of tools for the detection and capture of invasive reptiles in Florida such as black and white tegu lizards (*Salvator merianae*).

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