

Wildlife Services

Protecting People
Protecting Agriculture
Protecting Wildlife

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Managing Invasive Species Impacts to Agriculture, Natural Resources, and Human Health and Safety



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Groups Affected By These Problems:

- Commercial transportation industry
- Farmers/Homeowners
- Horticulture industry
- Natural resource managers
- Seed crop industry
- Tropical fruit and nut producers
- Wildlife and refuge managers

Major Cooperators:

- Guam
- Hawaii Agriculture Research Center
- Hawaii Department of Agriculture
- Hawaii Department of Land and Natural Resources
- Hawaii Macadamia Nut Growers Association
- Hawaiian Commercial and Sugar
- Hilo International Airport
- Kamehameha Schools (Bishop Estate)
- MacFarms of Hawaii
- Mauna Loa Mac Nut
- Monsanto Corporation
- Nature Conservancy
- Pioneer Hi-Bred Seed
- Syngenta Corporation
- Tropical Fruit Growers of Hawaii
- University of Hawaii
- U.S. Department of Defense
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey

National Wildlife Research Center Scientists Develop Methods to Reduce Damage Caused by Invasive Species

Wildlife Services' (WS) National Wildlife Research Center (NWRC) is the only Federal research facility devoted exclusively to resolving conflicts between people and wildlife through the development of effective, selective, and socially responsible methods, tools, and techniques. NWRC's field station in Hilo, HI, is ideally located to allow research biologists to develop methods needed to control invasive species damage to agricultural crops and native ecosystems on islands.

Oceanic islands, like the Hawaiian archipelago, are more susceptible to the impacts of invasive species than mainland areas because remote islands evolved in ecological isolation and have few predators or competitors, have a lot of air and sea traffic, and typically provide a favorable habitat and climate for many introduced species. Further, native species on the islands have evolved in the absence of many introduced threats and usually respond poorly to invasive animals or disease.

Invasive species are one of the greatest threats to Hawaii's agricultural economy, natural environment, and the health and lifestyle of Hawaii's people. Invasive vertebrate species cause millions of dollars' worth of crop losses, the extinction of native species, the destruction of native forests, the spread of disease, and threats to the health and safety of residents. Scientists at the NWRC Hilo, Hawaii, field station are investigating a variety of methods to reduce damage caused by invasive species such as rodents, Coqui frogs, brown treesnakes, invasive birds, mongooses, and feral ungulates in Hawaii, as well as islands throughout Pacific Rim which are linked to Hawaii through transport and trade.

Applying Science and Expertise to Wildlife Challenges

Recording Bait Station Visits. — Bait stations are often used to deliver toxic baits to invasive species, especially in environmentally sensitive areas where the risks to nontarget species may be high. The stations are designed to be very selective, attracting or allowing entry only to target species. Using passive integrated transponder (PIT) tags in conjunction with radio telemetry, NWRC researchers developed a monitoring system that automatically records bait-station visits and evaluates the attractiveness of bait in two separate field studies involving brown treesnakes in Guam and small Indian mongooses in Hawaii. Researchers found that although visitation rates by brown treesnakes to bait stations were low (32 percent), most adult snakes attracted to the stations did consume the bait. The delivery device was not attractive to juvenile snakes, suggesting that the device, its placement in the trees, and/or the bait itself (dead neonate mice) were ineffective for young snakes. On the other hand, mongooses were attracted to the new food baits, traveled up to 2,000 feet to baits, and displayed fidelity to food sources. The study suggested that perimeter trapping and increased trap spacing could be effective if used with preferred baits to attract resident mongooses. The automatic PIT tag monitoring system successfully allowed researchers to collect important information on the foraging behavior of target species and the attractiveness of selected baits and to document individual visits to bait delivery systems in a way other field techniques cannot. Researchers note the system can be adapted to monitor other small mammals, birds, reptiles, or amphibian species, as well as various activities of interest.

Aerosolized Chemicals To Flush Brown Treesnakes From Cargo. — Numerous local and Federal agencies are involved in efforts to reduce the invasive brown treesnake population on Guam and prevent the species' spread to other Pacific islands. Many of those efforts focus on Guam's seaports and airports, to ensure outbound cargo is snake-free. New repellents are needed to deter snakes from entering or encouraging their exit from cargo. To be practical, a snake repellent must be quick, economical, easily applied, and nearly 100 percent effective to avoid any delays of commercial and military transport. NWRC researchers evaluated the effectiveness of five chemical aerosols to flush snakes from hiding. Previous research showed that cinnamon and wintergreen oil aerosols drew strong responses in snakes. Movements and the percentage of snakes flushed from hiding were small in this study, which tested the effects of wintergreen (0 percent), cinnamon (18 percent), and eucalyptus oil (11 percent). In contrast, snakes moved when exposed to aerosols of chloroform (94 percent) and trichloroethylene (100 percent), but only chloroform succeeded in flushing them into the open (94 percent versus 6 percent.)



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Further testing of these agents using actual cargo will determine whether this technology can be made operational.

Rodent Control To Reduce Seed Predation of the Endangered Hawaiian Lobelia. — To assess whether a rodent control effort on Hawaii's Oahu Island helped to protect endangered Hawaiian lobelia plants (*Cyanea superba*), invasive black rat consumption of lobelia fruit was monitored at sites with and without rodent management. Over 47 percent of the fruit was eaten at the site without rodent control compared to only 4 percent at the managed site. To determine whether the rodents from the sites depredated or dispersed lobelia seeds, fruit was fed to captive black rats and house mice. Black rats consumed the entire fruit, killing all of the seeds, while mice did little damage to either the fruit or the seeds. Researchers conclude that large-scale rat trapping can benefit reproduction of endangered plants and that controlling black rats at restoration sites appears integral to successfully restoring lobelia plants.

Evaluating Toxicity of Citric Acid to Endangered Hawaiian Hoary Bats. — Spray applications of citric acid, a registered minimum-risk pesticide, are used in Hawaii to control invasive coqui frog populations. NWRC researchers investigated the potential impacts of citric acid applications on endangered Hawaiian hoary bats, using the more-common big brown bat as a surrogate species. Hoary bats are endemic to Hawaii and roost alone in foliage that may also be used by invasive coqui frogs. In field and laboratory studies using big brown bats, researchers determined (1) the toxicity of citric acid to bats, (2) the quantity of citric acid solution a bat might consume, (3) the effects of spraying citric acid solution on bats, (4) the amount of citric acid solution a bat's fur might retain, and (5) the amount of citric acid Hawaiian hoary bats might encounter during actual ground and aerial spray operations that use a 16-percent citric acid solution. Absorbent bat effigies exposed to ground and aerial spraying retained 1.54 grams and 0.02 grams of citric acid solution, respectively. The amount of citric acid toxic to big brown bats that ingested it was between 0.10 and 0.14 milliliters. Bats sprayed with 5 milliliters of citric acid solution showed no evidence of intoxication through grooming or absorption. In field situations, it is unlikely bats would be sprayed directly or ingest much citric acid retained in their fur or in water sources. Based on their observations, researchers believe Hawaiian hoary bats are at low risk from harmful exposure to citric acid during frog control operations.

Selected Publications:

Berentsen, A.R., W.C. Pitt, J.D. Eisemann, R.M. Engeman. 2014. Longevity of rodenticide bait pellets in a tropical environment following a rat eradication program. *Environmental Science and Pollution Research* 21:2283-2288. doi:10.1007 / s11356-013-2148-1.

Pender, R.J., A.B. Shiels, L. Bialic-Murphy, and S.M. Mosher. 2013. Large-scale rodent control reduces pre- and post-dispersal seed predation of the endangered Hawaiian lobeliad, *Cyanea superba* subsp. *superba* (Campanulaceae). *Biological Invasions* 15:213-223. doi: 10.1007 / s10530-012-0280-3.

Pitt, W.C., G.W. Witmer, S.M. Jojola, and H. Sin. 2014. Potential citric acid exposure and toxicity to Hawaiian hoary bats (*Lasiurus cinereus semotus*) associated with *Eleutherodactylus* frog control. *Ecotoxicology* 23(3):429-436. doi:10.1007 / s10646-014-1208-8.

Shiels, A.B., C.A. Flores, A. Khamsing, P.D. Krushelnycky, S.M. Mosher, and D.R. Drake. 2013. Dietary niche differentiation among three species of invasive rodents (*Rattus rattus*, *R. exulans*, *Mus musculus*). *Biological Invasions* 15:1037-1048. doi: 10.1007 / s10530-012-0348-0.

Shiels, A.B., W.C. Pitt, R.T. Sugihara, and G.W. Witmer. 2014. Biology and impacts of Pacific Island invasive species. 11. The Black Rat, *Rattus rattus* (Rodentia: Muridae). *Pacific Science* 68(2):145-184. doi:10.2984 / 68.2.1.

Major Research Accomplishments:

- WS developed a monitoring system for recording bait-station visits and evaluating bait attractiveness for invasive brown treesnakes and Indian mongooses.
- WS research evaluated the use of five chemical aerosols to flush snakes from hiding places showed chloroform to be the most effective.
- WS research showed large-scale rat trapping benefits the reproduction of endangered lobelia plants.
- Using the more-common big brown bat as a surrogate species, WS research determined the potential impacts of citric acid applications for invasive frog management to endangered Hawaiian hoary bats are low.