

Wildlife Services

Protecting People
Protecting Agriculture
Protecting Wildlife

National Wildlife Research Center

FY 2010

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



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Major Cooperators

- Hawaii Agriculture Research Center
- US Fish and Wildlife Service
- US Department of Defense
- Hawaii Department of Land and Natural Resources
- Hawaii Department of Agriculture
- University of Hawaii
- Kamehameha Schools (Bishop Estate)
- Nature Conservancy
- Tropical Fruit Growers of Hawaii
- Monsanto Corporation
- Syngenta Corporation
- Pioneers Seed
- MacFarms of Hawaii
- Mauna Loa Mac Nut
- Hawaii Macadamia Nut Growers Association
- Hawaiian Commercial and Sugar
- Island of Guam
- Hilo International Airport

Groups Affected By These Problems

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

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 the single greatest threat 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. NWRC scientists at the Hilo, HI, 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 throughout Pacific islands linked to Hawaii through transport and trade.

Applying Science and Expertise to Wildlife Challenges

Rodent Management and Eradication— To better manage rodent damage to Hawaii's agricultural resources, NWRC scientists are identifying and evaluating various rodenticide baits. As part of this process, NWRC scientists compiled the necessary data to obtain federal registration for these baits. Field tests were conducted on roof rats, a species that decimates native ecosystems as well as agricultural crops throughout the Pacific region. Results indicate that only certain rodenticides are effective on Hawaiian mice and rats. To date, two products have been registered by the Hawaii Department of Agriculture for use in tropical fruits and seed crops in Hawaii. Prior to this, no rodenticides were registered for use in these Hawaiian crops. In addition, several projects were completed which resulted in the registration of three products for the aerial broadcast of rodenticides. Much of the supporting documentation and many of the studies for these labels were completed at the Hilo, Hawaii field station. Collaborative studies will continue to evaluate aerial broadcast application of rodenticides in conservation areas throughout the Pacific region to protect native fauna and flora with emphasis on reducing the potential for exposure to non-target animals such as feral swine, native raptors, and land crabs.

Introduced Invasive Species— The negative impacts of introduced species on island ecosystems are severe. In Guam, brown treesnakes continue to impact the local economy, power grids, native plants and animals and military operations. NWRC scientists are attempting to reduce the opportunity for snakes to spread to new areas, such as Hawaii, and to reduce the impact of snakes on Guam. Alternative baits, such as beef treated with extracts of dead mice, also have been evaluated to help reduce the cost of operational baiting programs and improve baiting effectiveness. For wide area suppression of snake populations in remote areas, scientists are evaluating helicopter aerial delivery of mouse bait attached to paper streamers. The bait lands in the canopy where it is accessible to brown tree snakes, but inaccessible to non-target species. To help prevent snakes from stowing away in outbound cargo from Guam, NWRC scientists are evaluating repellencies of formulations containing essential oils, natural compounds, and other chemicals, with



United States Department of Agriculture
Animal and Plant Health Inspection Service

the goal of providing a safe, ready-for-use product for military, commercial and private users. Furthermore, a major study was initiated in the beginning of this year to evaluate the risk of introducing invasive vertebrates throughout the Pacific as a result of the planned restructuring of military forces in the Pacific, specifically the introduction and spread of the brown tree snake. A risk analysis and biosecurity plan of the move has been prepared to assist in the development of an Environmental Impact Statement.

In Hawaii, a species of tree frog (coqui frog) was introduced from the Caribbean. In addition to its propensity for reproducing quickly and its piercing loud nighttime call, the species eats the insects and snails that many native forest birds rely on for survival and may have significant effects on forest dynamics. During the last five years, the development and evaluation of frog toxicants has been supported by several key cooperators. NWRRC scientists have identified several effective frog toxicants (citric acid, hydrated lime, endosulfan sodium bicarbonate, potassium bicarbonate) for registration and evaluated the potential environmental effects of frog toxicants (citric acid, caffeine, hydrated lime, and sodium bicarbonate). Although, citric acid is, currently, the only frog toxicant that is being used, NWRRC scientists are generating data for the registration of bicarbonate products for the state of Hawaii.

There is a serious concern about the introduction of Indian mongooses to new locations in the Pacific area that have so far remained free of this alien pest. NWRRC scientists are identifying candidate bait substrates, lures, and/or attractants that elicit a strong attraction response from mongooses in the field. Preliminary results show that food-based baits are more effective than animal or food scents, and that fish-based food baits are the most effective. Findings could aid in optimizing current detection and capture strategies for mongooses and facilitate the development of toxicant baits specific for mongooses. More recently, NWRRC scientists completed an intensive field study that explored mongoose behavior and evaluated the effectiveness of baits in attracting mongooses. Overall, it was found that mongooses cover much larger areas than previously reported with some home ranges exceeding 124 acres (50 hectares). Fish, coconut, and eggs were all effective baits in attracting mongooses to stations but distance traveled by mongooses were highest for fish baits.

Introduced predators such as cats can cause significant reductions in native bird species in Hawaii. Due to high food availability and their mobility, feral cats are often extremely difficult to manage in tropical climates. NWRRC scientists completed an initial field evaluation of non-food based lures and scents for use as feral cat attractants. Food based lures, such as fish, are effective at times for cats but they are also effective on non-target animals, such as mongooses. Thus, trapping programs may be saturated with non-target captures and few cat captures. Non-food based lures that are effective for cats and not as effective for non-target animals will be assessed further for application onto feral cat trapping.

Lastly, NWRRC scientists have initiated a new study to evaluate the diet of non-native feral sheep on Mauna Kea and assess the impacts of browsing by these sheep on the endangered native mamane tree. Mamane seeds are critical for the survival of the endangered honeycreeper, palila. NWRRC scientists are investigating the relative preference of sheep based on rumen contents. Rumen analysis is continuing and future plans include conducting vegetation surveys in the locations where ungulate samples were collected to compare stomach contents with availability of the various herbaceous foods consumed.

Seed Crop Protection— Growing plants for seeds has emerged as one of Hawaii's biggest industries. Hawaii's climate enables three to four growing seasons per year, which allows companies to produce up to four generations of seed crops per year, enabling crops to move more quickly to market.

With this new industry comes a new interest in protecting seeds from foraging birds. Approximately 40 percent of the bird species in Hawaii are invasive. In addition to the damage they cause to native birds through disease and competition, invasive bird species cause millions of dollars in crop losses annually. For example, pigeons, doves, francolins, turkeys and skylarks feast on a variety of seeds and sprouting crops.

NWRRC scientists are developing methods to minimize the damage caused by invasive birds. Scientists developed an integrated management plan to alter farm operations and reduce invasive bird populations on one farm. Birds were killing more than 76 percent of planted soybeans. Nine months after the program was initiated, bird damage was absent. During the past two years, NWRRC has partnered with the Hawaii WS operational program to develop a bird management program for seed corn and soybeans. NWRRC scientists evaluated the extent of the bird problem and developed an operational program; they, periodically, returned to evaluate the effectiveness of the operational program. The program continues to be successful in reducing the threat of seed predation and in reducing the threat from avian diseases. NWRRC has also partnered with the Hawaii Department of Land and Natural Resources to evaluate crop depredation threats from feral parrots and to provide a management strategy to minimize the potential effects (e.g., fruit crop depredation) of these birds. The state partnered with the operational program to manage the feral parrot population, particularly the large population on Kauai.

Rodent-Proof Nest Boxes for Endangered Birds in Hawaii— The puaiohi, or small Kauai thrush, is an endangered bird endemic to the island of Kauai, HI. The sole population of about 500 birds is currently restricted to remote, higher elevation areas of the Alakai Plateau. Puaiohi nest primarily on steep stream-side cliffs, and their distribution and abundance are limited partly by the availability of suitable nest sites. Invasive black rats cause nest failure and mortality of nesting females, and ground-based rodent control has not been effective at reducing nest predation. NWRRC researchers investigated whether artificial nest structures might be a viable alternative to rodent control by testing nest box designs to find one that is resistant to rats. In laboratory trials, the researchers evaluated three designs that were currently being deployed as artificial nest boxes for puaiohi and found that these structures are not rat resistant. From these initial results, researchers developed and tested an improved nest box design, producing a rodent-proof nest box for endangered birds and a bait station that protects non-target animals from accessing the baits.

Human Health and Safety— Due to the threat to human safety by bird strikes at airports, a program has been developed to evaluate the operational management of bird hazards at airports. The number of bird aircraft collisions continues to be high at Hawaii's airports. WS and NWRRC personnel are evaluating the effects of current hazing techniques on one native species, the Pacific golden plover, at the Hilo International Airport. These hazing techniques include vehicular and pyrotechnic harassment by WS personnel, as well as harass-

ment by trained canines. The efficacy of the two methods will be compared by assessing the value of the introduction of a canine unit in the second year of the study. Additionally, the deployment of decoys to assist relocating territorial plovers to alternative habitats will be considered.

Selected Publications:

BEARD, K. H., E. A. PRICE, AND W. C. PITT. 2009. Biology and impacts of Pacific Island invasive species: *Eleutherodactylus coqui*, the Coqui frog (Anura: Leptodactylidae). *Pacific Science* 63:297-316.

TUTTLE, N. C., K. H. BEARD, AND W. C. PITT. 2009. Invasive litter, not an invasive insectivore, determines invertebrate communities in Hawaiian forests. *Biological Invasions* 11:845-855.

MATHIES, T., J. A. CRUZ, V. A. LANCE, AND J. A. SAVIDGE. 2010. Reproductive biology of the male brown treesnakes (*Boiga irregularis*) on Guam. *Journal of Herpetology* 44:209-221.

MATHIES, T., SCARPINO, R., LEVINE, B. A., CLARK, C., and SAVIDGE, J. A. 2011. Excluding Nontarget Species from Brown Tree Snake, *Boiga irregularis* (Reptilia: Colubridae), Bait Stations: Experimental Tests of Station Design and Placement. *Pacific Science* 65:41-57.

MATHIES, T. 2010. Reproductive cycles of tropical snakes. Book chapter in: *Reproductive Biology and Phylogeny of Snakes*. Eds: D.M. Sever and R.D. Aldridge.

PITT, W. C., L. C. DRISCOLL, AND R. T. SUGIHARA. 2010. Efficacy of rodenticide baits for the control of black rats, Polynesian rats, and mice. *Archives of Environmental Contamination and Toxicology*.

PITT, W. C., L. C. DRISCOLL, AND E. A. VANDERWERF. 2010. A rat-resistant artificial nest box for cavity-nesting birds. *Human Wildlife Interactions*.

PITT, W. C. R. STAHL, AND C. YODER. 2010. Emerging Challenges of Managing Island Invasive Species: Potential invasive species unintentionally spread from military restructuring. *Vertebrate Pest Conference*.

EISEMANN, J.D. K. SWIFT, PETER DUNLEVY, W. C. PITT AND G. WITMER. 2010. Regulatory and Policy Issues Around Non-Target Mortality and Environmental Fate of Rodenticides – Panel Discussion. *Vertebrate Pest Conference*.

Major Research Accomplishments:

- WS supports rodenticide registrations for use in island conservation and the protection of seed crops and tropical fruits.
- WS research is evaluating the effectiveness of sex pheromones as attractants for invasive brown treesnakes on Guam.
- WS continued to develop tools to manage invasive tree frogs. Research efforts have led to collection of registration data for the use of sodium and potassium bicarbonate to reduce invasive tree frog populations.
- WS investigated ways to reduce rodent and bird damage to valuable seed crops.
- WS designed a rodent-proof nest box to help protect the endangered small Kauai thrush from predation by invasive rats.
- WS evaluates aerial delivery of acetaminophen-treated dead neonatal mice for wide area population suppression of brown tree snakes.
- WS evaluated lures, baits, and baiting strategies, and continues collaborations with local, national and international cooperators on impacts and control strategies for invasive mesopredators (mongooses, feral cats).
- WS is conducting rumen dietary examinations of non-native feral sheep to determine the browse preference of a native tree/shrub (mamane), the seeds and pods of which are critical for the survival of the endangered Hawaiian honeycreeper, palila.
- WS is evaluating the effects of current hazing techniques on native and non-native avian species that pose bird-aircraft collision hazards at the Hilo International Airport.
- WS and Hawaii natural resources agencies are assessing the ecological and economical threat from feral parrots, whose populations have dramatically increased in the wild.