Wildlife Services

Protecting People
Protecting Agriculture
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National Wildlife Research Center

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

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Major Cooperators
- Guam
- Hawaii Agriculture Research Center
- Hawaii Department of Land and Natural Resources
- Hawaii Department of Agriculture
- Hawaiian Commercial and Sugar
- Hawaii Macadamia Nut Growers Association
- 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. Fish and Wildlife Service
- U.S. Department of Defense

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

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, Hawaii, 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 throughout Pacific islands linked to Hawaii through transport and trade.

Applying Science and Expertise to Wildlife Challenges

Ensuring Safe Rodent Eradication Efforts—Rodenticides are used to eradicate invasive rodents from islands throughout the world. In 2011, the Palmyra Atoll Rainforest Restoration Project (composed of the U.S. Fish and Wildlife Service, The Nature Conservancy of Hawaii, and Island Conservation) attempted to eradicate rats from Palmyra Atoll (a remote island in the Pacific Ocean, approximately 1,000 miles south of Hawaii) in an effort to enhance the biodiversity of seabirds, native plants and terrestrial invertebrates. The eradication was implemented by applying Brodifacoum 25W Conservation, a rodenticide bait containing the second generation anticoagulant rodenticide brodifacoum, by air and ground application. Because the eradication effort used an APHIS pesticide label and implementation of the control operation required a label variance, the coalition contracted with NWRC to monitor the eradication's environmental effects. NWRC scientists measured the application rate and bait distribution on the ground following aerial application and documented the fate of bait, collected potential nontarget mortalities, and systematically collected soil, water, insects, geckos, fish, and crabs to determine environmental residue levels. NWRC's goal was to help evaluate any secondary hazards associated with the eradication effort.

Researchers found the overall rodenticide application rate to be within the limits specified by the Environmental Protection Agency's approved supplemental label. However, they also documented bait in the aquatic environment and considerable variation in the amount applied over small localized areas. Bait may have ended up in the aquatic environment due to shoreline configuration, island topography, overhanging vegetation, bird activity affecting baiting aircraft flight lines, wind strength and direction, pilot experience, and weather conditions at the time of the bait drop.

NWRC researchers found rodenticide residues in ants, cockroaches, geckoes, hermit crabs, fiddler crabs, and black-spot sergeant fish that were collected alive as part of scheduled environmental sampling activities during and after bait application. Fifty-one animal samples representing 15 species of birds, fish, reptiles, and invertebrates were

found dead and collected for residue analysis during systematic searches or collected opportunistically as potential nontarget mortalities during regular activities throughout the atoll. NWRC researchers detected rodenticide residues in 12 of 15 birds that were found dead on or around the atoll after the broadcast application. Affected avian species included bristle-thighed curlews, Pacific golden plovers, ruddy turnstones, and wandering tattlers. Affected non-avian species included mullet fish and Cardisoma spp. land crabs. Nontarget exposure to the rodenticide likely was a result of direct consumption of bait and secondary exposure through scavenging of poisoned rat carcasses.

More than one live rat was detected in July 2011, necessitating a third broadcast application of rodenticide bait over part of the Atoll. Rats have not been detected after the final broadcast. Monitoring for the presence of rats will continue through the summer of 2013 to determine whether rat eradication has been achieved. This type of collaboration, evaluation, and monitoring is critical to the success of the current project as well as future eradication projects.

Bait Delivery for Brown Treesnakes—The invasive brown treesnake has caused extensive economic and ecological damage to the Island of Guam. WS operational and research experts work on a variety of fronts to reduce damage caused by these snakes. In cooperation with Applied Design Corporation, a private engineering firm, NWRC scientists designed an automated aerial bait delivery system for use in brown treesnake control efforts. The first phase of the system's development is complete and consists of the bait delivery device. Additional components that remain to be developed include the design of bait package manufacturing equipment, integrated helicopter electronics, and integrated software systems. Once completed, this aerial delivery system will allow for the economical delivery of toxic brown treesnake bait to large, remote, and rugged areas of Guam.

Sources of Island Rats—Rodent control on islands to protect nesting seabirds and other threatened wildlife is an important conservation activity. When rats reappear after an eradication effort, it is important to know whether eradication was incomplete or whether the island was recolonized. Using genetic analyses, NWRC researchers showed that in the case of Lehua Island, Hawaii, the reemergence of rats was due to an incomplete eradication effort and not new colonizations. This finding has led to reevaluations of rat eradication strategies and efforts.

Diphacinone Residue in Feral Swine—NWRC researchers examined feral swine tissues to determine whether the potential hazard of consuming meat from swine previously exposed to diphacinone rodenticide baits was reduced by cooking. Cooking had little effect on residual diphacinone concentrations, the highest concentration of which was found in the liver tissue. Accordingly, NWRC researchers caution that the consumption of swine meat obtained from areas with active rodent control programs should be avoided.

Biosecurity Assessment for U.S. Military Operations in the Pacific—In 2006, the U.S. Department of Defense (DoD) proposed to restructure military assets in the Pacific, including relocating 8,600 Marines plus their dependents from Okinawa, Japan, to Guam. In addition to this translocation, the military also proposed to construct both inland and port facilities to support the move and future training, as well as additional offices, homes, and other facilities on Guam. Both the short term and long term increase of military activity over the next 10 years will result in an increase in the movement of cargo and people into Micronesia from Asia, the United States, and other parts of the world. With this increase in movement, the potential for the introduction of invasive species and wildlife-borne diseases also increases.

In an unprecedented effort, WS, along with other APHIS programs, the U.S. Geological Survey, and the Smithsonian Institute, assisted the DoD in the development of a risk assessment and biosecurity plan for Guam and the rest of Micronesia. WS' part of the assessment identified and quantified potential routes of introduction and the risks of introduction of 1) wildlife-related pathogens, such as rabies, avian malaria, West Nile virus, and H5N1 avian influenza virus, and 2) invasive species, such as brown treesnakes, Indian mynah, Asian beauty snakes, coqui frogs, and small Indian mongoose. More importantly, WS made numerous specific recommendations for eliminating or minimizing these threats with five key issues pertaining to all recommendations: funding, coordination and communication, education and training, control methods development, and enforcement.

Ecology of Invasive Rose-Ringed Parakeets—Feral populations of rose-ringed parakeets have significantly increased on the island of Kauai. Parakeet damage to kernels of corn cobs just prior to the harvest stage is especially serious. NWRC researchers completed a cooperative field study with Pioneer Hi-Bred International Inc., to determine the rose-ringed parakeet population size, home range and dispersal patterns, roost locations, habitat use, food preferences, daily movements and associated crop damage. Parakeet exposure to diseases such as avian influenza, Newcastle's disease, and avian psittacosis was also evaluated. NWRC researchers estimated the parakeet population to include more than 2,000 birds that ranged widely across the island to reach specific fields with seed farms. No diseases were detected in the birds sampled. NWRC researchers recommend damage management actions focus on specific agricultural fields and the birds' potential nesting areas.

Selected Publications:

BEARD, K. H. and W. C. PITT. 2012. Chapter 26: Caribbean tree frog (Eleutherodactylus coqui). Pp. 311-319. In: Handbook of Global Freshwater Invasive Species. Earthscan, London. Ed. Robert A. Francis (Invited Submission).

ENGEMAN R. M., W. C. PITT, A. R. BERENTSEN, and J. D. EISEMANN. 2012. Assessing spatial variation and overall density of aerially broadcast toxic bait during a rat eradication on Palmyra Atoll. Environmental Science and Pollution Research. DOI: 10.1007/s11356-012-1050-6.

MATHIES, T., W. C. PITT, and J. A. RABON. 2012. Boiga irregularis (Brown Treesnake) Diet. Herpetological Review. 43(1) 143-144.

OLSON, C., K. H. BEARD, and W. C. PITT. Biology and Impacts of Pacific Island Invasive Species: Eleutherodactylus planirostris, the greenhouse frog (Anura: Eleutherodactylidae). Pacific Science. 66:255-270.

PITT, W. C., L. C. DRISCOLL, and R. T. SUGIHARA. 2011. Efficacy of rodenticide baits for the control of three invasive rodent species in Hawaii. Archives of Environmental Contamination and Toxicology 60(3): 533-542.

PITT, W. C., L. C. DRISCOLL, and E. A. VANDERWERF. 2011. A rat-resistant artificial nest box for cavity-nesting birds. Human-Wildlife Interactions. 5:100-105.

Pitt, W. C., R. T. Sugihara, L. C. Driscoll, and D. S. Vice. 2011. Physical and behavioral abilities of commensal rodents related to design of selective rodenticide bait stations. International Journal of Pest Management 57:189-193.

PITT, W. C., M. HIGASHI, and T. M. PRIMUS. 2011. The effect of cooking on diphacinone residues in feral pig tissues. Journal of Food and Chemical Toxicology. 49:2030-2034.

PITT, W. C., K. H. BEARD, R. DORATT. 2012. Management of invasive coqui frog populations in Hawaii. Outlooks on Pest Management. 23(4): 166-169.

PITT, W. C., D. VICE, D. LUJAN, D. VICE, and G. WITMER. 2012. Freeing islands from rodents: broadcast rodenticides help native species recover. Wildlife Professional 6: 33-34.

SHIELS, A.B. 2011. Frugivory by introduced black rats (Rattus rattus) promotes dispersal of invasive plant seeds. Biological Invasions 13: 781-792.

WALKER, L. R., and A. B. SHIELS. 2012. Landslide Ecology. Cambridge University Press, Cambridge, U.K.

Major Research Accomplishments:

- WS was an integral part of the largest environmental monitoring effort conducted in conjunction with a U.S. rodent eradication effort on Palmyra Atoll (a remote island in the Pacific Ocean, approximately 1,000 miles south of Hawaii).
- WS and a private engineering firm designed an automated aerial bait delivery system for use with the invasive brown treesnake.
- WS determined cooking had little effect on residual rodenticide concentrations in feral swine tissues from pigs exposed to rodenticide bait. Experts caution that the consumption of swine meat obtained from areas with active rodent control programs should be avoided.
- WS developed a risk assessment and biosecurity plan for U.S. military operations in the Pacific. The assessment identified possible routes of introductions for wildlife-related pathogens and invasive species.
- WS conducted a comprehensive study of invasive rose-ringed parakeet ecology and damage to agricultural crops in Hawaii.