Wildlife Services

Protecting People
Protecting Agriculture
Protecting Wildlife

National Wildlife Research Center

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Chemical and Metabolic Approaches for Minimizing Human-Wildlife Conflicts

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Major Cooperators

- APHIS Veterinary Services
- British Columbia Ministry of Forests and Range
- California Department of Food and Agriculture
- Case Western Reserve University
- Colorado State University
- Drexel University
- Island Conservation
- Karolinska Institutet (Sweden)
- Landcare Research (New Zealand)
- Monell Chemical Senses Center
- U.S. Department of Defense
- U.S. Department of the Interior Office of Insular Affairs
- U.S. Fish and Wildlife Service
- U.S. Geological Survey Patuxent Wildlife Research Center
- VetAgro Sup (France)

Groups Affected By These Problems

- Agricultural producers
- Consumers of agricultural products
- Industry groups
- State wildlife and natural resource managers

National Wildlife Research Center Scientists Use Chemistry to Resolve Wildlife Damage

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.

To help meet the increasing need for new, Federally-approved chemical tools for use in wildlife damage management, NWRC scientists design and test methodologies to identify, analyze, and develop new drugs, repellents, toxicants, and other chemically-based wildlife damage management tools. These methodologies are used to support U.S. Environmental Protection Agency (EPA) and U.S. Food and Drug Administration (FDA) registration requirements. NWRC scientists are experienced in a variety of scientific disciplines, including pharmacology, environmental fate, chemical synthesis, toxicology, chemical ecology, computer modeling and formulation chemistry.

Applying Science and Expertise to Wildlife Challenges

Biomarkers for Monitoring Wildlife Populations—One focus of NWRC research is the development of diagnostic methods in support of risk assessments and the management of wildlife diseases that may impact domestic animal and/or human health. Identifying the point of origin of contaminants and disease agents (e.g., wildlife) is a critical first step in developing management practices to ensure the safety of the food supply and protect animal health. For example, NWRC researchers discovered mallards infected with avian influenza (AV) produced feces with higher concentrations of acetoin (3-hydroxy-2-butanone) than non-infected mallards. Building on this finding, researchers trained biosensor mice to discriminate between healthy and AV-infected ducks on the basis of fecal odors. These results suggest that chemical and/or biosensor-based field monitoring of waterfowl population health could potentially be achieved.

In another study, breath samples collected from tuberculosis-infected and non-infected cattle were analyzed by gas chromatography/mass spectroscopy to determine chemical profiles. These profiles led to the development of diagnostic methods for identifying infected animals. These same data are being used to develop Linear Discriminant Analysis models for classifying infection status of cattle. Preliminary evaluation of an alternative breath analysis instrument called the NA-NOSE suggests that this commercially available technology is a promising tool for routine diagnosis.

Investigating Wildlife Chemical Ecology—NWRC responds to emerging pests and diseases by developing novel methods to reduce damage caused by herbivory. For example, to determine how black-tailed deer respond to the flavor, color, texture, and smell of plants while browsing, NWRC researchers offered captive and free-ranging deer rooted cuttings and seedlings of western redcedar with varying monoterpene content. Monoterpenes are chemicals found in conifer plants that have a repellent effect on foraging mammals. Experiments demonstrated that browse preference for individual western redcedar plants was a function of the amount of monoterpene in the leaves of the plants. Researchers note that sense of smell may play a significant role in both fine- and coarse-scale browse behaviors of deer as they employ a risk-averse foraging strategy. This information may prove useful for developing "browse-resistant" seedlings for reforestation efforts.

Evaluating Chemical Agents to Improve Toxicant Efficacy and Minimize Secondary Hazards—In response to a need for safer toxicants, NWRC researchers are exploring chemical, biochemical, toxicological, and molecular biological techniques for evaluating existing and novel chemical agents. These agents may aid in the development of

novel toxicants or improve existing toxicants while also reducing environmental hazards. NWRC researchers are also investigating ways to lower pesticide concentrations in rodenticides and other baits in order to reduce the amount of these compounds in the environment.

Voles cause significant damage to agricultural crops in California—Both chlorophacinone and zinc phosphide are registered as rodenticides to help control vole populations in California. NWRC studies include efforts to increase the effectiveness of these rodenticides while also lowering pesticide concentrations. Recently, NWRC researchers micro-encapsulated zinc phosphide to prevent oral detection and bait shyness of the rodenticide by voles. This enabled researchers to also reduce the concentration of zinc phosphide in baits from 2 to 0.5 percent. Significant vole mortality was still achieved at this lower concentration.

In certain areas, voles have become resistant to chlorophacinone bait. NWRC researchers are working to improve the bait's effectiveness by investigating natural products and inert ingredients as possible inhibitors of chlorophacinone metabolism in voles. Five compounds ranged in their ability to inhibit the metabolism of chlorophacinone from 2.5 to 36 percent. Of these, two were selected for further testing and were found to be more effective in female than male voles at all concentration ranges tested. Future studies will focus on combining the inhibitors with chlorophacinone baits to increase bait effectiveness.

Providing Analytical Support to Wildlife Services—NWRC's Analytical Chemistry Laboratory provides support for all research projects being conducted at the Center's headquarters in Fort Collins, Colorado, the Center's field stations located throughout the United States, and WS operational programs. This chemistry assistance supports a variety of research topics, including avian infertility; bovine tuberculosis; rabies; wildlife hazards to aviation; wildlife damage to forest resources; bird damage to rice, sunflowers, and aquaculture; and waterfowl disease.

Selected Publications:

HOMAN, H. J., R. S. STAHL, and G. M. LINZ. 2011. Comparing a bioenergetics model with feeding rates of caged European starlings. J. Wildl. Manage. 75:126-131.

HUSSEY, A. M., B. A. KIMBALL, and J. M. FRIEDMAN. 2011. Assessment of tannin variation in tamarisk foliage across a latitudinal gradient. Open Environ. Biol. Monitor. J. 4:32-35.

KIMBALL, B. A., J. H. RUSSELL, and P. K. OTT. 2012. Phytochemical variation within a single plant species Influences Foraging Behavior of Deer. Oikos. 121:743-751.

KIMBALL, B. A., F. PFUND, M. GOURLEY, D. L. GRIFFIN, and J. H. RUSSELL. 2011. Silvicultural attempts to induce browse resistance in conifer seedlings. Int. J. For. Res. Article ID 108529.

RATTNER, B. A., K. E. HORAK, S. E. WARNER, D. D. DAY, C. U. METEYER, S. V. VOLKER, J. D. EISEMAN, and J. J. JOHNSTON. 2011. Acute toxicity, histopathology, and coagulopathy in American kestrels (Falco sparverius) following administration of the rodenticide diphacinone. Environ. Toxicol. Chem. 30(5):1213-1222.

RATTNER, B. A., K. E. HORAK, R. S. LAZARUS, K. M. EISENREICH, C. U. METEYER, S. F. VOLKER, C. M. CAMPTON, J. D. EISEMANN, and J. J. JOHNSTON. 2012. Assessment of toxicity and potential risk of the anticoagulant rodenticide diphacinone using Eastern screech-owls (*Megascops asio*). Ecotoxicology. 21(3):832-46.

Major Research Accomplishments:

- WS developed a physiologically-based pharmacokinetic model for anticoagulant rodenticides. The model will aid in the development of new rodenticides that minimize tissue residue levels in target animals, thus minimizing risks to non-target species.
- WS research found that encapsulated zinc phosphide resulted in 80-percent vole mortality when formulated at 0.5 percent, a significantly lower concentration than the 2 percent that is currently being used.
- WS experiments demonstrated that deer browse preference for individual western redcedar plants was a function of the amount of monoterpene in the leaves of the plants. Seedlings bred for elevated monoterpene content are currently being tested in field studies.
- WS research led to the development of a field monitoring method for detecting low pathogenic avian influenza in waterfowl.
- WS developed a method for collecting and analyzing volatile organic compounds associated with tuberculosis infection in the exhaled breath of infected cattle.
- WS developed a method for aging double-crested cormorants by determining the concentrations of pentosidine and hydroxyproline in skin samples.
- WS research identified two compounds that show promise in improving the efficacy of rodenticide bait for use with voles.

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