National Wildlife Research Center Scientists Develop New Methods, Strategies to Reduce Rabies Transmission from Infected Wildlife to Humans, Domestic Animals, and Wildlife

Wildlife Services' (WS) National Wildlife Research Center (NWRC) is the only Federal research organization devoted exclusively to resolving conflicts between people and wildlife through the development of effective, selective, and socially responsible methods, tools, and techniques.

Increased urbanization, greater acceptance of and desire for living closer to free-ranging wildlife, and burgeoning wildlife numbers have led to increased conflict between people and wildlife. Such conflict can take many forms, including disease transmission among wildlife, livestock, and people.

Rabies is an acute, fatal viral disease, most often transmitted through the bite of a rabid mammal, which can infect people as well as domestic pets, livestock and wildlife. Impacts to society from this and other wildlife diseases can be great. For instance, the cost of detection, prevention, and control of rabies in the United States exceeds $300 million annually. In 2000, the Secretary of Agriculture enacted a Declaration of Emergency for raccoons, citing threats to livestock and to public health and safety. In 2001, NWRC initiated research to help reduce the spread of rabies.

In the United States and its territories, terrestrial rabies can be found in many wild animals, including raccoons, skunks, gray foxes, arctic foxes, and mongooses. In an effort to halt the spread and eventually eliminate terrestrial rabies in the United States, NWRC scientists are studying the behavior, ecology, movement, and populations of raccoons and other wildlife hosts.

Applying Science & Expertise to Wildlife Challenges

Oral Rabies Vaccine Bait Flavors for Skunks. Wildlife are the leading cause of rabies infections in animals and people in the United States. While the U.S. number of human deaths due to rabies is low, one study has estimated that over 20,000 people are exposed to this disease and receive post-exposure vaccination for it each year. To eliminate the rabies virus and keep it from circulating in wild carnivores, the WS' National Rabies Management Program distributes millions of oral raccoon vaccine baits each year. Most of these baits target raccoons, but skunks are another important spillover source of raccoon rabies—so wildlife managers need effective oral rabies vaccine products for them, too. In a recent study, NWRC researchers tested skunks' preference for six different flavors of placebo Ontario Rabies Vaccine Bait (ONRAB), a product permitted in Canada for use with skunks. The researchers also tested the dose of vaccine needed to protect the skunks from rabies infection; this information helps evaluate if it’s possible to reduce vaccine volume and dose without compromising efficacy. Results showed that skunks preferred chicken, cheese, and egg flavors over the plain flavor, but they did not show strong flavor preferences. Also, a relatively high dose of vaccine was needed to protect skunks against rabies. These findings aid in further refining ONRAB baits for delivery to skunks in the United States.

Efficacy of Ontario Rabies Vaccine Bait (ONRAB) for Raccoons. The RABORAL V-RG product is the only rabies vaccine permitted for use in free-ranging raccoons and coyotes in the United States. However, another product—ONRAB—has shown promise for controlling raccoons in raccoon and striped skunk in Canada. NWRC researchers evaluated the efficacy of ONRAB for use on raccoons in the United States. Across two experiments, fifty captive raccoons were given either sham or live vaccine baits and then challenged with a lethal dose of rabies virus and monitored for 90 days. Seventy-three percent of raccoons in the first experiment and 91 percent in the second experiment were protected from rabies infection. All sham-vaccinated raccoons succumbed to rabies. The efficacy results of the second experiment were within recommended standards for animal rabies vaccines in the United States. The results complement recent field data showing the potential of ONRAB to control and prevent raccoons in free-ranging raccoon populations. From 2012 to 2014, NWRC researchers and the WS National Rabies Management Program distributed ONRAB baits in areas of New York, Vermont, and New Hampshire. Prevalence of the rabies virus-neutralizing
antibodies in blood-sampled raccoons was 27 percent before the trial and 68 percent after baiting (averaged over 3 years). NWRC shared the captive trial and field data with the USDA Center for Veterinary Biologics (CVB). This information will aid decisions as CVB is considering a request from Artemis Technologies (ONRAB's manufacturer) to permit the product for broader use in the United States.

Biomarkers for Use with Mongoose Oral Rabies Vaccine. The small Indian mongoose (Herpestes auropunctatus) is a reservoir of rabies virus in Puerto Rico and comprises over 70 percent of animal rabies cases reported annually. Oral rabies vaccination (ORV) is the primary strategy used to control rabies in wildlife reservoirs, but currently no wildlife ORV program exists in Puerto Rico. Research into oral rabies vaccines and optimal bait types for mongooses has been done in Puerto Rico with promising results. To help evaluate ORV strategies targeting free-ranging mongooses in Puerto Rico, NWRC researchers tested the effectiveness of two biomarkers (ethyl-iophenoxic acid and methyl-iophenoxic acid) incorporated into placebo ORV baits to estimate bait uptake by captive mongooses. A biomarker is a measurable substance in an animal that can indicate that it has at least partially eaten a bait. Researchers fed biomarker-treated baits to mongooses and collected blood samples from mongooses prior to treatment, one day post-treatment, and then weekly up to 8 weeks post-treatment. Results showed mongooses that ate greater than or equal to 25 percent of the marked baits had robust short and long-term (4 to 8 weeks) levels of iophenoxic acid biomarker in their blood, which will be useful in evaluating future ORV programs for mongooses on Puerto Rico.

Evaluating Rabies Surveillance Strategies and Determining Rabies Elimination. In support of WS’ National Rabies Management Program (NRMP), NWRC researchers collaborated with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model and with NRMP experts to determine when raccoon rabies is eliminated from an area using a dynamic occupancy model. This collaborative approach helped inform ORV zone placement in Ohio, West Virginia, and Pennsylvania. It also contributed to FY19 management decisions in New York, Vermont, and New Hampshire to move the ORV zone 20 miles south of the Quebec border as part of efforts to eliminate raccoon rabies in northeastern U.S. and Canada.

Innovative Problem Solving in Raccoons. Animals that exhibit innovative problem solving are more likely to adapt to living in novel or rapidly changing environments, such as urban areas. Raccoons are an abundant, generalist species frequently found in urban habitats. NWRC and University of Wyoming researchers gave 20 captive raccoons a multi-access puzzle box to evaluate the animals’ abilities to innovate, learn from previous experiences, and to inhibit behaviors that were previously successful, but are no longer useful for solving new problems. Twelve of the raccoons tested were not only capable of innovative problem solving, but also of repeated innovations during a novel foraging task. The majority of the raccoons in the study found two or three solutions to the multi-access puzzle box. Researchers also found that an individual animal’s level of persistence, unique exploratory behaviors, and neophobia associated with the puzzle box impacted its innovative behavior and the degree to which it exhibited repeated innovations. These findings may aid in the development of future oral rabies vaccine baiting strategies for raccoons.

Selected Publications:

Major Research Accomplishments:
- WS research on the use of ONRAB baits for striped skunks showed that skunks preferred chicken-, cheese-, and egg-flavored baits over the plain-flavored baits, but they did not show strong flavor preferences. Also, a relatively high dose of vaccine was needed to protect skunks against rabies.
- WS researchers evaluated the efficacy of ONRAB for use on raccoons in the United States through a field trial and found the prevalence of the rabies virus-neutralizing antibodies in blood-sampled raccoons was 27 percent before the trial and 68 percent after baiting (averaged over 3 years).
- WS research demonstrated the feasibility of including a iophenoxic acid biomarker in oral rabies vaccination baits for invasive mongooses.
- WS modelling supports the National Rabies Management Program's efforts to determine if/when raccoon rabies is eliminated from an area, helping to ensure the efficient allocation of baiting and surveillance resources.
- WS and university behavioral studies with captive raccoons demonstrate the species' ability to innovate and learn from previous experiences.