Wildlife Services

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National Wildlife Research Center

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Ecology, Control, and Prevention of Terrestrial Rabies in Free-ranging Wildlife

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- **Major Cooperators**
- Artemis Technologies
- Centers for Disease Control and Prevention
- Cleveland Metroparks
- FoodSource
- Global Alliance for Rabies Control
- Kansas State University
- Lyssa, LLC
- MERIAL, Inc.
- New Mexico State University
- Purdue University
- Texas A&M University
- Texas State Department of Health Services
- University of Georgia
- University of Tennessee
- Wildlife Services Operations

- **Groups Affected By These Problems**
- Consumers
- Health officials
- Livestock producers and farmers
- Sporting organizations
- Veterinarians
- Wildlife and natural resource managers

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 the transmission of diseases among wildlife, livestock, and humans. Indeed, many of the pathogens that cause animal disease also are capable of causing disease in humans. Appropriately, there is a great need to understand the processes mediating disease transmission among wildlife, livestock, and humans.

Rabies is an acute, fatal viral disease, most often transmitted through the bite of a rabid mammal, which can infect people as well as animals. 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 rabies, citing threats to livestock and to public health and safety. In 2001, NWRC initiated research to help reduce the transmission of this disease.

In the United States terrestrial rabies can be found in many wild animals, including raccoons, skunks, gray foxes, arctic foxes, bobcats, and coyotes. In an effort to halt the spread and eventually eliminate terrestrial rabies in the United States, NWRC scientists are researching the behavior, ecology, movement, and population structure of raccoons and other wildlife hosts. They also are evaluating methods and techniques used to vaccinate wildlife against rabies to decrease the risk of transmission and maintenance of the disease in the wild.

Applying Science & Expertise to Wildlife Challenges

Safety and Efficacy of ONRAB® in Target and Nontarget Species—NWRC researchers are exploring a new oral rabies vaccine (ORV) called ONRAB for use on raccoons and skunks in the United States. In an initial field trial in West Virginia, ONRAB resulted in the highest seroconversion rate in raccoons ever observed for an ORV bait used in the United States with 49.4 percent of raccoons showing seroconversion post-ORV versus 9.6 percent pre-ORV. Unfortunately, the skunk sample size was too low to adequately assess the effects of the vaccine on skunks. In addition to conducting field trials with the target species, researchers also investigated the effects of the vaccine on nontarget species including wood rats, eastern cottontail rabbits, opossums, eastern wild turkey, and fox squirrels. These are all species whose habitats overlap with ORV target species. Evaluations of non-target species were conducted with captive animals and NWRC researchers tested fecal and oral swabs from animals dosed with the ONRAB vaccine at 10 times the rate that they could be exposed to in the wild. Viral ribonucleic acid (RNA) was detected in turkey feces up to 3 days post inoculation (dpi), opossum feces up to 6 dpi, cottontail feces up to 5 dpi, and fox squirrel feces through 7 dpi. Although over 40 percent of fox squirrels were still shedding viral RNA on 7 dpi, some showed signs of co-infections with Leptospira spp. This co-infection may have made them more susceptible to the vaccine or may have interfered with the test, resulting in false-positives. Minimal

shedding was observed via oral routes (and opossum nasal swabs), demonstrating that ONRAB has very minimal and temporary impacts on these nontarget species even when exposed to 10 times the expected dose. Results from these studies will aid in efforts to license ONRAB for use in the United States through the USDA-APHIS Center for Veterinary Biologics.

Role of Water Availability in Rabies Transmission—Since rabies can infect multiple species and has a high potential for cross-species transmission, an understanding of the role water availability may play in facilitating disease transmission could lead to better disease prevention strategies. NWRC researchers collected data on interactions among coyotes, bobcats, and gray foxes at 31 artificial water features in Texas. Results indicated that gray foxes behaved as subordinate competitors for these water sources, having both the shortest time intervals at the sites and using them almost exclusively (greater than 97 percent of visits) at night. In contrast, only 41 percent of coyote and 61 percent of bobcat visits to water sources occurred at night. Bobcats also spent more time at the sites, on average, than coyotes or gray foxes. The use of water sources by both coyotes and bobcats was directly related to the days since the last rainfall, with animals using artificial water sources more frequently as the time since last rainfall increased. Gray fox use of artificial water sources, on the other hand, was positively related to the availability of rugged escape terrain and inversely related to activity of the larger carnivores. These data suggest that while artificial water in arid environments of the southwestern United States may result in increased interactions and potential disease transmission among coyotes and bobcats, this may not be the case for gray foxes. Researchers also observed that 60 percent of the interspecies interactions recorded were between carnivores and cattle. These data indicate that the incidence of encounters at water features may be higher between carnivores and cattle than between carnivores and other carnivores, which suggests that these sites can lead to a higher probability of rabies virus transmission from wildlife to livestock.

Use of Infrared Thermography to Detect Rabies in Bats—The use of modern technology, including infrared thermography, in disease surveillance provides opportunities for insights into pathogen emergence, prevention, and control. This technology should have the capacity to identify diseased individuals within a population that are potentially manifesting clinical signs. NWRC researchers conducted a study that evaluated the use of infrared thermography to detect thermal changes associated with experimental rabies virus infection in big brown bats in a captive colony. Results indicated that when bats began to show clinical signs of rabies, 54 percent had detectable facial temperature decreases, compared to pre-inoculation temperatures. As a result, researchers believe that infrared thermography may be a useful noninvasive tool for use in rabies surveillance in bats.

Selected Publications:

ATWOOD, T. C., T. L. FRY, and B. R. LELAND. 2011. Partitioning of a limited resource by sympatric carnivores in the Chihuahuan Desert and the implications for disease transmission. Journal of Wildlife Management 75: 1609-1615.

BEASLEY, J., W. BEATTY, T. C. ATWOOD, S. JOHNSON, and O. E. RHODES. 2012. A comparison of methods for estimating raccoon abundance: implications for disease vaccination programs. Journal of Wildlife Management 76(6):1290-1297.

FRY, T. L., T. C. ATWOOD, and M. R. DUNBAR. 2010. Evaluation of rhodamine B as a biomarker in raccoons. Human-Wildlife Interactions 4:275-282.

FRY, T., K. VANDALEN, J. HURLEY, and P. NASH. 2012. Mucosal adjuvants to improve wildlife rabies vaccination. Journal of Wildlife Diseases 48:1042-6. DOI: 10.7589/2011-11-331.

SLATE, D., R. CHIPMAN, K. NELSON, C. CROSON, S. MILLS, C. RUPPRECHT, and K. VERCAUTEREN. Safety and immunogenicity of ONRAB in raccoons and skunks in West Virginia: 2011 field trial report. USDA/APHIS/WS/National Rabies Management Program. Report to USDA/VS/Center for Veterinary Biologics.

VERCAUTEREN, K., T. DELIBERTO, S. SHWIFF, C. ELLIS, R. CHIPMAN, and D. SLATE. 2012. Rabies in North America: need and call for a One Health Approach. In: Frey, S.N., editor. Proceedings of the 14th Wildlife Damage Management Conference, April 18-21, 2011, Nebraska City, NE; The Wildlife Damage Management Working Group of the Wildlife Society: 56-63.

Major Research Accomplishments:

- WS evaluated the efficacy of the ONRAB® vaccine for use in oral rabies vaccination programs. In an initial field trial in West Virginia, ONRAB resulted in the highest seroconversion rate in raccoons ever observed for an ORV bait used in the United States, with 49.4 percent of raccoons showing seroconversion post-ORV versus 9.6 percent pre-ORV. Data collected from this and non-target studies will aid in the registration of the vaccine for use in the United States.
- WS studies on the availability of water and rabies transmission among carnivores indicated that the incidence of encounters between carnivores and cattle at water features suggest these locations may lead to a higher probability of rabies virus transmission from wildlife to livestock.
- WS determined that infrared thermography may be a useful noninvasive tool for use in rabies surveillance in bats.