Wildlife Services

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National Wildlife Research Center

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

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Major Cooperators
- Auburn University
- Centers for Disease Control and Prevention
- Colorado State University
- FoodSource (private bait company)
- MERIAL, Inc. (private vaccine development company)
- Ohio Department of Health Services
- Pennsylvania State University
- State Departments of Public Health
- Texas A&M University
- Texas State Health Services Department
- The Ohio State University
- The University of Maryland
- University of Alaska, Fairbanks
- USDA/APHIS/Wildlife Services Operations

Groups Affected By These Problems
- U.S. citizens
- Wildlife and natural resource managers
- Livestock producers and farmers
- Sporting organizations
- Consumers

NWRC 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 acceptable methods, tools, and techniques.

Increased urbanization, greater acceptance and desire of living closer to free-ranging wildlife, and increasing wildlife numbers have led to increased conflicts between people and wildlife. Such conflicts can take many forms, both direct and indirect. Recently, the potential for the transmission of diseases among wildlife, livestock, and humans has received greater attention.

Rabies is an acute, fatal viral disease most often transmitted through the bite of a rabid mammal. It 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 is exceeding $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 that could help reduce the transmission of this disease.

In the United States, terrestrial rabies can be found in many wild animals, including raccoons, skunks, gray fox, arctic fox, and coyotes. In an effort to halt the spread and eventually eliminate terrestrial rabies in the United States, NWRC scientists are conducting research on the behavior, ecology, movements and population structures of raccoons and gray fox. They are also evaluating methods and techniques used to vaccinate free-roaming wildlife against rabies that could help decrease the risks of transmission and maintenance of the disease in the wild.

Applying Science & Expertise to Wildlife Challenges

Ecological and Genetic Studies on Raccoons in Urban Areas—NWRC scientists are learning more about raccoon ecology and genetics in northern Ohio. The information gathered will help improve the effectiveness of the WS oral rabies vaccination (ORV) program in the state and help prevent the westward spread of rabies in raccoons.

By combining radio telemetry, global positioning systems (GPS) collars, geographic information systems (GIS) habitat layers and population genetics data, scientists hope to answer questions regarding how rabies could be spread across northern Ohio, especially the Cleveland metropolitan area. Scientists want to know if factors such as urban area, suburban area, major highways, or greenbelts in the city, or even rural farming areas east of the city may prevent or encourage the spread of rabies in raccoons.

Since the fall of 2006, WS scientists and field specialists have been live-trapping and radio-collaring raccoons in and around the Cleveland area. Approximately 60 raccoons have been trapped for the telemetry study and nearly 200 DNA samples have been collected from raccoons for the genetic analysis. Documented raccoon movements have shown that a small percentage of raccoons move great distances (> 2 km) and may breach ORV zones and facilitate the spread of rabies. Preliminary genetic analysis appears to show that the greater Cleveland area is a barrier to the spread of rabies. These data provide the WS National Rabies Management Program a basis for reliable strategies that facilitate the control of rabies in and near metropolitan urban and suburban areas.

United States Department of Agriculture
Animal and Plant Health Inspection Service

Rabies Vaccine Efficacy—In captive animal studies, NWRC scientists and collaborators showed the Raboral-VRG® vaccine to effectively prevent rabies in raccoons at least 18 months after a single or double dose of the vaccine. This knowledge aids in the development of risk assessments and possible modifications of WS baiting strategies designed to eradicate raccoon rabies in the United States.

Effects of Natural Orthopoxviruses on Vaccination with V-RG—The search for reasons of low rabies vaccination rates in raccoons has been at the forefront of the ORV program. Post ORV surveys have shown antibody prevalence to be as low as 30% in targeted raccoons. One reason for the low prevalence may be naturally occurring orthopoxviruses in raccoon. NWRC studies have shown that orthopoxviruses in raccoons prevent the production of antibodies in response to other pox viruses including the pox virus, vaccinia, which is used in the rabies V-RG vaccine. Results indicate that a new non-vaccinia vectored vaccine may be needed in order to increase antibody prevalence rates in vaccinated raccoons.

Rhodamine B as a Biomarker for Raccoons—NWRC researchers investigated the use of rhodamine B as an alternative biomarker to tetracycline in raccoons. Rhodamine B is a chemical dye that, when ingested, stains the oral cavity and is absorbed systemically in growing tissues such as hair and whiskers producing fluorescent orange bands under ultraviolet (UV) light.

In studies, rhodamine B marked all raccoons that consumed at least 100 mg of the dye. An average of 55% of whiskers sampled from each individual exhibited fluorescence for up to 13 weeks. Researchers used two methods to evaluate whiskers: a UV microscope and hand-held UV lights. Both methods were effective for detecting the fluorescence produced by rhodamine B dye and could aid in the field evaluation of whiskers. By including rhodamine B in vaccine-laden baits, WS can estimate the percentage of raccoons that consume baits. Armed with this knowledge, WS can better evaluate the overall effectiveness of the ORV program and make informed decisions concerning changes in baiting and vaccination strategies aimed at controlling the spread of rabies in raccoons.

Barrier to Prevent the Western Spread of Rabies—Current efforts to prevent the spread of rabies in the United States involves the distribution of ORV baits which target specific wildlife host species, principally raccoons and gray foxes. Understanding the spatial spread of rabies and of the host species is necessary for designing control strategies. The ORV program uses natural barriers such as mountains and large bodies of water to help delineate ORV zones and slow the westward movement of raccoon rabies.

In Alabama, NWRC scientists collaborated with researchers from Auburn University to determine if gene flow occurred between raccoon populations across the Alabama River and thus determine whether this river served as a barrier to movement. The scientists employed 11 raccoon-specific microsatellite markers to obtain individual genotypes of 70 individuals. The scientists examined if population differentiation among microsatellites was due primarily to distances between localities and found that gene flow occurred across the river, and thus both dispersal of animals across the river and possible subsequent rabies transmission can occur. The spread of rabies across Alabama has been hindered, but this research indicates that the river is not the sole hindrance to the spread of rabies and that other landscape features still need to be investigated.

Selected Publications:

Dunbar, M. R., R. T. Sterner, and S. R. Johnson. 2007 Impacts of wildlife disease (including rabies) in urban environments. Proceedings of the 12th Wildlife Damage Management Conference. D. Nolte, W. M. Arjo, D. H. Stalman, Eds. Pp 253-264.

Fry, T. L. and M. R. Dunbar. A review of biomarkers used for wildlife damage and disease management. 2007. Proceedings of the 12th Wildlife Damage Management Conference. D. Nolte, W. M. Arjo, and D. H. Stalman, Eds. Pp 217-222.

Root, J. J., R. G. McLean, D. Slate, K. A. MacCarthy and J. E. Osorio. 2008. Potential effect of prior raccoonpox virus infection in raccoons on vaccinia-based rabies immunization. BMC Immunology. http://www.biomedcentral.com/1471-2172/9/57.

Compton, J. A., G. J. San Julian, and R. H. Yahner. 2006. A final report on the zoogeography of common raccoon (Procyon lotor) in Western Pennsylvania as related to an Oral Rabies Vaccination Program. School of Forest Resources, The Pennsylvania State University publication, 66 pp.

Mesenbrink, B. T., B. Leland, M. R. Dunbar, G. Moore, R. DeYoung, A. Zamorano, R. G. Mclean, and J. J. Root. 2006. Gray fox research to support oral rabies vaccination programs in Texas: An overview. R. M. Timm and J. M. O'Brien, eds. Proceedings of the 22nd Vertebrate Pest Conference 22:354-355.

Dunbar, M. R. and K. A. MacCarthy. 2006. Use of infrared thermography to detect signs of rabies infection in raccoons (Procyon lotor). Journal of Zoo and Wildlife Medicine 37 (4): 518-523

Major Assistance Activities:

- WS investigated raccoon ecology and genetics in urban and suburban areas to better understand the spread of rabies in these environments.
- WS studies showed the Raboral-VRG® vaccine effectively prevented rabies for at least 18 months in captive raccoons.
- WS discovered naturally occurring orthopoxviruses in raccoons prevent the production of antibodies in response to other pox viruses including the pox virus, vaccinia, which is used in the rabies V-RG vaccine.
- WS determined rhodamine B is an effective biomarker for use in ORV baits.
- WS field studies identified natural barriers to help delineate ORV zones and slow the westward movement of raccoon rabies.