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NWRC Research Areas: Rabies

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Our scientists are developing methods and strategies to control and eliminate wildlife rabies.

Rabies, one of the oldest known diseases affecting humans, is an acute, fatal viral zoonosis most often transmitted through the bite of a rabid mammal. This vaccine-preventable disease is 100% fatal once symptoms appear. In the United States,

rabies is maintained in distinct variants associated with bat, raccoon, striped skunk, gray fox, arctic fox and mongoose populations. The globally recognized modern approach to controlling wild carnivore rabies is by a strategy called oral rabies vaccination.

Although human rabies deaths are now rare in the United States and are mostly acquired during travel abroad to areas affected by canine rabies or domestically from native bat species, there are significant impacts associated with the disease in the United States. Among all wildlife rabies reservoirs described in the United States, including various bats, raccoon rabies has the highest rate of spillover infections to domestic animals and wildlife and consequently is associated with the greatest burden of human exposures which may require post-exposure treatment. Current data estimate that approximately 55,000 persons seek post-exposure treatment in the United States each year, with cumulative costs in excess of $200 million. If rabies variants such as those transmitted by raccoons are not prevented from spreading to new areas of the United States, the health threats and costs associated with rabies could increase substantially as broader geographic areas are affected.

The United States also enjoys a canine-rabies free status since 2007 following the elimination of the dog-coyote rabies variant in Texas by oral rabies vaccine baiting. This status is maintained by an oral rabies vaccine barrier along the United States-Mexico border to prevent the re-introduction of the dog-coyote rabies variant into the United States coyote population.

A single vaccine is licensed for use with coyotes and raccoons in the US, which is a vaccinia rabies virus recombinant vaccine (RABORAL V-RG®). Since 2011, the NWRC and National Rabies Management Program (NRMP) have collaborated with WS state programs and industry to evaluate a new Canadian vaccine product in the field, and those experimental trials are near complete. The NRMP has also outlined strategies for elimination of raccoon rabies by 2053 and one key ongoing NWRC activity focuses on raccoon rabies elimination modeling based on public health and enhanced rabies surveillance data. Other ongoing studies include novel oral rabies vaccine bait development targeting skunks and raccoons; development and testing of oral rabies vaccination products and strategies for mongooses in Puerto Rico; using advanced genetic tools to understand the movements and ecology of raccoons, gray foxes and mongooses; and refinements to systems and strategies for vaccine delivery to free-ranging meso-carnivores in developed landscapes.

Project Goal and Objectives

Goal: To conduct applied research that enhances the prevention and control of rabies virus, to mitigate and reduce risk(s) to human health, agriculture and natural resources in the United States and Territories.

Objectives:

1. Enhancing field diagnostic tools to support wildlife rabies management.

2. Further refinement and evaluation of novel wildlife rabies vaccines, baits, and biomarkers.

3. Target and nontarget ecology, behavior, and population biology to improve wildlife rabies management planning and operations.

4. Host population and landscape genetics to define population connectivity across areas of importance for wildlife rabies management.

5. Collaborative field trials to evaluate new oral rabies vaccination products or strategies targeting free-ranging wildlife populations.

6. Development and evaluation of practical mechanically engineered tools and/or technology to improve logistics and efficiency off the operational baiting program delivery

7. Proof of concept testing and evaluation of field methods and products for wildlife rabies management.

8. Modeling and risk assessment to improve the prevention, control, and elimination of wildlife rabies

9. Risk assessment and surveillance for bat rabies viruses in the Americas

Project Accomplishments

Expand All

Managing Raccoon Rabies in Urban Areas

Raccoon rabies is managed in the eastern US and Canada using oral rabies vaccination (ORV) in both urban and rural areas. Understanding how ORV bait distribution impacts raccoon rabies antibody prevalence in urban areas is critical for estimating local elimination and refining vaccination strategies. Using raccoon capture data from the greater Burlington, Vermont, management area, WS' National Rabies Management Program (NRMP) experts and NWRC researchers worked with the University of Vermont to 1) estimate raccoon abundance, rabies antibody prevalence, and capture rates across the urban gradient, 2) understand what factors may explain the low rabies antibody prevalence among raccoon populations in urban areas, and 3) make recommendations for improving ORV baiting strategies for raccoons in urban areas. Results from statistical models showed that raccoon abundance in Burlington varied. The highly developed urban center had more raccoons compared to areas that were more suburban and had more open space. Also, raccoon rabies antibody prevalence increased when spatial ORV bait coverage increased. However, increases in bait density did not always correspond to increases in rabies antibody prevalence. In less developed areas, raccoon rabies antibody prevalence decreased as the number of opossum captures increased, suggesting that opossums may be eating ORV baits meant for raccoons in these areas. Rabies managers should further consider the spatial pattern of bait distribution in addition to bait density, especially in developed areas.

Bait Uptake Modeling for Oral Rabies Vaccination

The NRMP partnered with NWRC researchers, WS Operations, and Colorado State University to develop a simulation model of raccoon population movement, ORV bait

uptake, and rabies antibody prevalence in greater Burlington, Vermont. The model estimated rabies antibody prevalence levels based on current NRMP baiting compared to strategies based on raccoon habitat selection informed by GPS telemetry data. Results showed that current NRMP hand-baiting strategies may be constrained in the Burlington ORV zone because raccoon-preferred habitats are highly clustered and not very accessible by roads. Further refinements to the NRMP baiting strategies in developed areas may increase raccoon population rabies antibody prevalence (where practical) based on raccoon ecology and the landscape composition and accessibility of preferred habitats. This simulation approach provides a flexible framework to test alternative or prospective baiting strategies for raccoons or other wildlife across complex landscapes.

Regional Cross-Border Raccoon Rabies Elimination

Wildlife rabies is intensively managed in the northeastern US and several southeastern Canadian provinces to control the spread of and locally eliminate raccoon rabies virus. Researchers studied and modeled the occurrence of raccoon rabies across the northeastern US and southeastern Canada from surveillance data during 2008 to 2018. They examined the probability of raccoon rabies occurrence on the landscape and relationships with management activities (e.g., ORV and trap-vaccinate-release), habitat types and other factors. They also compared raccoon rabies detection probabilities between different surveillance samples (e.g., strange acting animals, road-kills, public health surveillance). Results showed that ORV management was the greatest driver in reducing raccoon rabies occurrence on the landscape. Additionally, raccoon rabies occupancy declined with increasing duration of ORV baiting programs across years. Raccoon rabies detection probabilities varied, with samples from strange acting animals and public health surveillance having the highest detection rates. These results support the movement of the ORV zone south within the US due to high elimination probabilities along the shared border with Québec. However, enhanced rabies surveillance is still needed to ensure elimination is maintained.

Vampire Bat Surveillance in the United States

The common vampire bat (*Desmodus rotundus*) feeds on the blood of livestock, other domestic animals, and wildlife in Latin America. These bats also sometimes feed on human blood and are an important reservoir and vector of rabies virus to cattle and people in Latin America. Recently, vampire bats have been documented within 35 miles of the Texas border. This and ecological habitat modeling have led to speculation about their potential movement to areas within the US due in part to rising global temperatures. Some of the concerns associated with vampire bats include injuries from bites and the fear of rabies virus transmission, economic impacts, and biodiversity losses from non-target hazards to other bat species. Research and development using modern technologies are needed to deliver specific, effective, and practical interventions for vampire bat rabies control. NWRC researchers, WS Operations, and partners are using a multidisciplinary approach that includes enhanced surveillance, targeted risk assessments, habitat modification, and renewed research and collaborations, as well as greater public and professional awareness, education, and outreach. In Texas, Arizona, New Mexico, and Florida, WS biologists are monitoring livestock at centralized locations for evidence of vampire bat bites, which may serve as an early warning indicator of vampire bat establishment in the U.S. WS has found no evidence of vampire bat bites during these surveys. In 2020, the NRMP and NWRC hosted an expert Blue-Ribbon Panel to discuss risk assessment and best practices related to vampire bat rabies virus surveillance and monitoring. The panel included 34 experts representing 20 agencies and organizations. Outcomes from the event included a report summarizing the experts' opinions on a range of issues, including: the likelihood that vampire bats will expand to the US soon, the main risks posed by vampire bats, the surveillance methods most likely to detect vampire bats and the vampire bat rabies virus variant, and potential vampire bat management methods. Collaborative research also generated recommendations to improve species identification among all bat submissions to the public health surveillance system, as well as routine virus characterization of rabid animals, particularly along the shared border with Mexico, to enhance early detection of vampire bat rabies in the US.

Related Links

Rabies (Publications)

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