

Review

# Status of oral rabies vaccination in wild carnivores in the United States

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## Abstract

Persistence of multiple variants of rabies virus in wild *Chiroptera* and *Carnivora* presents a continuing challenge to medical, veterinary and wildlife management professionals. Oral rabies vaccination (ORV) targeting specific *Carnivora* species has emerged as an integral adjunct to conventional rabies control strategies to protect humans and domestic animals. ORV has been applied with progress toward eliminating rabies in red foxes (*Vulpes vulpes*) in western Europe and southern Ontario, Canada. More recently since 1995, coordinated ORV was implemented among eastern states in the U.S.A. to prevent spread of raccoon (*Procyon lotor*) rabies and to contain and eliminate variants of rabies virus in the gray fox (*Urocyon cinereoargenteus*) and coyote (*Canis latrans*) in Texas. In this paper, we describe the current cooperative ORV program in the U.S.A. and discuss the importance of coordination of surveillance and rabies control programs in Canada, Mexico and the U.S.A. Specifically, several priorities have been identified for these programs to succeed, which include additional oral vaccines, improved baits to reach target species, optimized ORV strategies, effective communication and legal strategies to limit translocation across ORV barriers, and access to sufficient long-term funding. These key priorities must be addressed to ensure that ORV has the optimal chance of achieving long range programmatic goals of eliminating specific variants of rabies virus in North American terrestrial carnivores.

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## Contents

1. Introduction	69
2. Recent history and current status of ORV in the United States	69
3. Programmatic challenges and initiatives	70
3.1. Need for additional oral rabies vaccines	70
3.2. Current bait options and future needs	72
3.3. Strategy considerations for ORV targeting terrestrial carnivores	72
3.4. Potential for rabies translocation	72
3.5. Bat rabies—a potential confounding rabies control factor	73
3.6. Economic basis for rabies funding	73
4. Collaboration and cooperation among Canada, Mexico and the United States	74
5. Conclusions	74
References	75

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## 1. Introduction

In countries where the control of canine rabies has been achieved, wildlife serves as a dominant reservoir. Modern prevention and control techniques for wildlife rabies may serve as a model for intervention with other zoonotic diseases. Oral rabies vaccination (ORV) was proven feasible in captive red foxes in the U.S. in 1969 (Baer et al., 1971). Thereafter, ORV targeting rabies in red foxes began in Europe in 1977 (Steck et al., 1982), and continues in several European countries with the goal of disease elimination (Aubert et al., 1994; Stohr and Meslin, 1996; Wandeler, 2000; Zanoni et al., 2000). ORV was initiated in Ontario, Canada in 1989 (MacInnes et al., 2001) and continues with the goal of eliminating an arctic fox (*Alopex lagopus*) variant of rabies virus in red foxes (MacInnes and LeBer, 2000).

Experimental ORV programs began in the U.S.A. in the mid-1990s (Bigler, 1997; Robbins et al., 1998; Fearneyhough et al., 1998; Smith et al., 1999; Olson et al., 2000; USDA, 2003) after field safety and efficacy trials were successfully completed on Parramore Island, Virginia in 1990 (Hanlon et al., 1998) and near Williamsport, Pennsylvania in 1991 (Hanlon and Rupprecht, 1998) and Cape May, New Jersey from 1992 and 1993 (Roscoe et al., 1998). Federal support for coordinated ORV has provided the impetus to establish cooperative programs in 15 eastern states to prevent the spread of raccoon rabies and to create programs in Texas to prevent rabies in coyotes and a unique variant of rabies in gray foxes. While these programs show promise, several challenges need to be addressed to better ensure that the long-term programmatic goal of rabies elimination in terrestrial wildlife may be achieved. In this paper, we discuss the current status of ORV in the U.S.A., initiatives to address challenges facing ORV, and the role of international cooperation and coordination with Canada and Mexico in meeting North American rabies management goals.

## 2. Recent history and current status of ORV in the United States

In 1998, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS) received its first federal appropriation to cooperate in existing ORV projects, expand ORV to states of strategic importance in preventing the spread of specific terrestrial variants of the rabies virus, and to assist in coordinating cooperative interstate ORV projects. The first initiative taken to meet these objectives was to form a National Rabies Management Team, composed of diverse expertise from State agencies responsible for public health, agriculture, and wildlife, Centers for Disease Control and Prevention (CDC) and other Federal agencies and universities to strategically plan, establish program priorities and goals, and evaluate program progress. This National Rabies Manage-

Table 1

Ten interdisciplinary teams within the National Rabies Management Team charged with evaluating critical ORV subject areas and providing recommendations for cooperative rabies control planning

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Baiting support: air and ground
Baiting strategies/GIS planning
Communications planning
Contingency action planning
Economic analysis
NEPA compliance
ORV evaluation
Research prioritization
Surveillance/laboratory support
Vaccine/bait/biomarker

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ment Team is composed of 10 focus teams charged with providing guidance and recommendations for topics integral to national ORV, ranging from National Environmental Policy Act (NEPA [NEPA, 1969]) compliance to research prioritization (Table 1).

Between 1998 and 2003, ORV expanded from New York, Ohio, Texas and Vermont (smaller programs were also in place in Florida, Maryland, and Massachusetts) to include 16 states (Figs. 1 and 2). Vaccination zones were integrated with natural geographic features such as large lakes, rivers and poorer raccoon habitats at high elevations where practical to bolster vaccination barriers and reduce the overall cost of rabies control. By 2003, increased federal support had facilitated nearly full implementation of the containment barrier for raccoon rabies in the eastern U.S. In addition, approximately 96 km of western Pennsylvania had been treated where raccoon rabies has been enzootic for over a decade. This extension is designed to explore strategies to eliminate the raccoon variant of rabies virus. ORV was implemented to eliminate canine rabies (spread predominantly by coyotes) from south Texas. This goal was achieved in 2000, but a 65 km wide maintenance vaccination barrier has been created along the Rio Grande to prevent re-infection from Mexico. This barrier was challenged in 2001 and 2004, underscoring its importance especially in the absence of more comprehensive rabies surveillance in the region. The containment barrier for gray fox rabies that was created solely with state funding in 1996 in west-central Texas was also restored with federal support to make up for decreased state funding. In 2003, approximately 180,000 km<sup>2</sup> were treated with over 10 million vaccine-laden baits in 16 states to target variants of rabies virus unique to the raccoon and gray fox, as well as the canine strain in coyotes along Texas–Mexico border (Figs. 1 and 2; Table 2).

The vision for the National ORV Program is to eliminate rabies in terrestrial carnivores. The immediate goals are to prevent specific variants of rabies virus in the raccoon and gray fox (strain unique to Texas) from spreading to new, uninfected areas (Slate et al., 2002). The long-range goal is to eliminate these variants from the U.S.A. as has been accomplished with rabies in the coyote in south Texas. Elimination

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