

# **COOPERATIVE RABIES MANAGEMENT PROGRAM NATIONAL SUMMARY REPORT 2008**

**United States Department of Agriculture  
Animal and Plant Health Inspection Service**



Protecting People | Protecting Agriculture | Protecting Wildlife

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Operational oral rabies vaccination (ORV) programs in the United States began in the early 1990s in New Jersey and Massachusetts with the goal of preventing the raccoon (*Procyon lotor*) variant of rabies from spreading to populated vacation areas of Cape May and Cape Cod, respectively. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) program's initial involvement in cooperative ORV was in 1995 in south Texas to prevent canine rabies in coyotes (*Canis latrans*) from gaining a larger foot-hold in the U.S. One year later, an ORV program began in west-central Texas to prevent rabies in gray foxes (*Urocyon cinereoargenteus*). In April and May 1997, WS began involvement in cooperative ORV projects in Ohio and Vermont to prevent the spread of raccoon rabies. Wildlife Services' National Rabies Management Program (NRMP) continued to grow over the next 8 years and in 2008 included ORV programs targeting raccoon rabies in 16 eastern states and canine and gray fox rabies in Texas. Overall in 2008, WS participated in coordinated ORV programs that distributed more than 11.5 million baits over 224,763 km<sup>2</sup>, an area about the size of Minnesota (Table 1).

Table 1. Operational oral rabies vaccination (ORV) bait distribution and area baited by Wildlife Services and their cooperators in the United States, 2008.

State	Target species	ORV baits distributed	Area baited (km <sup>2</sup> )	Bait distribution methods
Alabama	Raccoon	612,999	9,337	Fixed-wing, ground
Florida <sup>a</sup>	Raccoon	626,760	8,185	Ground, helicopter, bait station, boat
Georgia	Raccoon	141,689	2,538	Fixed-wing, ground
Maine	Raccoon	51,120	690	Fixed-wing, ground
Maryland	Raccoon	85,680	1,086	Ground, helicopter
Massachusetts	Raccoon	127,394	988	Ground, helicopter, bait station
New Hampshire	Raccoon	21,660	299	Fixed-wing, ground
New Jersey	Raccoon	40,000	480	Ground, helicopter
New York	Raccoon	1,284,217	20,003	Fixed-wing, ground, helicopter
North Carolina	Raccoon	180,588	2,955	Fixed-wing, ground
Ohio	Raccoon	1,352,422	13,913	Fixed-wing, ground, helicopter
Pennsylvania	Raccoon	1,028,405	12,637	Fixed-wing, ground
Tennessee	Raccoon	671,236	10,481	Fixed-wing, ground
Texas	Coyote	413,764	18,490	Fixed-wing, ground, helicopter
Texas	Gray fox	2,713,305	89,110	Fixed-wing, ground
Vermont	Raccoon	555,433	7,255	Fixed-wing, ground
Virginia	Raccoon	327,561	5,048	Fixed-wing, ground
West Virginia	Raccoon	1,330,739	21,268	Fixed-wing, ground, helicopter
Total		11,564,972	224,763	

<sup>a</sup> Includes baits distributed by county officials in Broward County.

In the Northeast, WS continued cooperation with Cornell University, state agencies and international partners in New Brunswick, Quebec, and Ontario, Canada to try to prevent the northern and western spread of raccoon rabies. These ORV zones extended along a portion of the New Brunswick border with Maine, the Quebec border with New Hampshire, Vermont and New York, and the Ontario border in northern and western New York (Figure 1). As a continued response to the first ever case of raccoon rabies being confirmed in Quebec in 2006, and to help maintain raccoon rabies free status in Ontario, Vermont and New York WS implemented trap-vaccinate-release (TVR) efforts along the international border. As a result of these border efforts, 3,612 animals were hand vaccinated and released in Vermont (1,461) and northern New York (2,151).

As a component of the greater Appalachian Ridge (AR) ORV zone, Ohio continued biannual baiting of the Contingency Action (CA) ORV zone (east of Cleveland) in the spring and fall of 2008. Wildlife Services integrated TVR into the rabies control campaign within the CA zone to prevent the spread of raccoon rabies that was first detected in 2004 west of the established ORV zone. As a result of this effort, 4,385 animals were hand vaccinated and released in northeastern Ohio. The number of rabid animals with raccoon variant in this CA zone decreased to 7 cases in 2008 with enhanced surveillance in place (from a high of 46 cases in 2004).

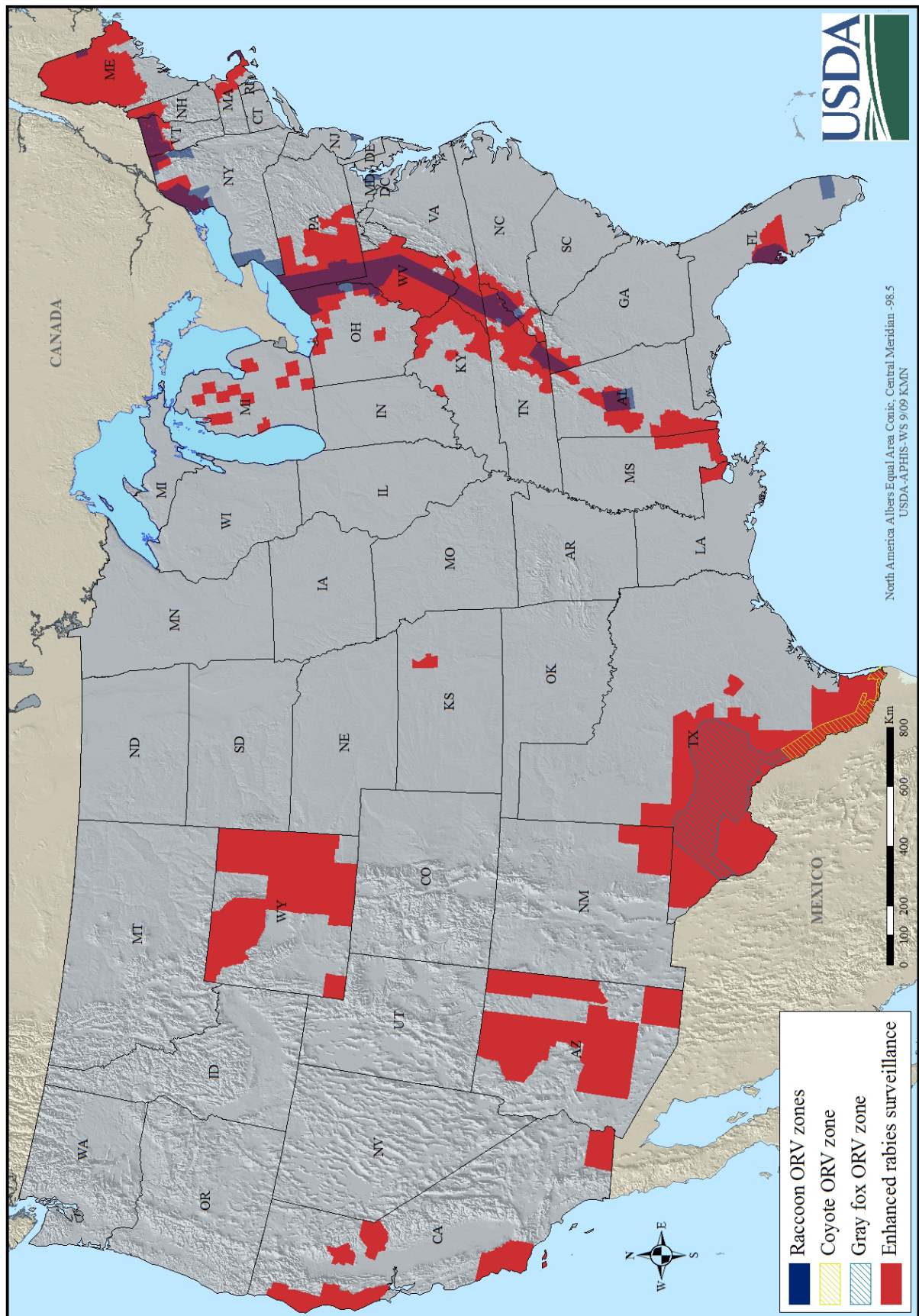


Figure 1. Species-specific cooperative oral rabies vaccination (ORV) zones and Wildlife Services enhanced rabies surveillance counties in the United States, 2008.



The greater AR ORV zone extended from Lake Erie in Ohio and Pennsylvania, south through West Virginia and western Virginia, to northeastern Tennessee and North Carolina in 2008 (Figure 1). While baiting this zone, the NRMP conducted a study in southeast Ohio along the West Virginia border to evaluate a new baiting strategy that involved distributing baits in groups ("pulse baiting") rather than a single bait delivery system. Pulse baiting targeted family groups of raccoons traveling together by dropping a pulse of 8 baits every 13.6 seconds instead of the traditional strategy of dropping 1 bait every 1.7 seconds. Results from this effort will be analyzed and published in the 2009 summary report. The remaining AR zone, along with the Georgia-Alabama-Tennessee (GAT) ORV zone, baiting operations near Birmingham, Alabama, and natural barriers made up control programs targeting raccoons that reached from Lake Erie to the Gulf of Mexico.

In 2008, WS continued to participate in cooperative ORV projects in Massachusetts, New Jersey, eastern Maryland, and Florida (Figure 1). These projects provided information on ORV and surveillance strategies. Future contingency actions are planned to integrate TVR with ORV to attempt to restore Cape Cod to raccoon rabies free status. The current strategy is to systematically conduct control from the eastern part of the Cape back toward the Canal, with the objective of ultimately reestablishing an ORV zone west of the canal that is sufficient to prevent raccoon rabies reemergence on Cape Cod. Cape May, New Jersey is the longest running operational ORV project in the U.S. and WS' role continues to be limited post-ORV evaluation. The Maryland project is designed to investigate if ORV can be used to eliminate raccoon rabies from peninsular habitat. The Florida ORV program is an extension of the long-standing Pinellas County project, with a near-term goal of determining if raccoon rabies-free areas can be created and maintained, with the initial attention to Pinellas County. All of these projects have peninsular geography in common, which is more favorable for evaluating rabies status and control effects than mainland areas where raccoon movements are generally not restricted.

Wildlife Services assumes an important cooperative role with the Texas Department of State Health Services (TDSHS) and several other agencies and organizations in ORV efforts that began in Texas in 1995. The canine rabies control program in coyotes is a combination of surveillance, with reliance on maintaining a 64-kilometer (40-mile) wide ORV zone along the Rio Grande River (Figure 1), to prevent this rabies variant from re-emerging in Texas from feral dogs (*Canis lupus familiaris*) in Mexico. Single cases were confirmed near Laredo in 2001 and 2004 within 1.6 km (1 mi) of the U.S.-Mexico border. No additional cases have been reported since 2004 and the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) declared the United States free of canine rabies in 2007 (Velasco-Villa et al. 2008).

Wildlife Services is also an important funding and operational partner with the TDSHS in conducting ORV efforts to contain and eliminate a unique gray fox rabies variant in west-central Texas (Figure 1). In 2008, WS and the TDSHS continued enhanced surveillance and baiting in response to the fox variant rabies cases confirmed west of the 2007 ORV zone beginning in February 2007. In 2008, WS contributed over 2.7 million baits and assisted with bait distribution over more than 89,000 km<sup>2</sup> (34,000 mi<sup>2</sup>) to contain gray fox rabies in Texas. Wildlife Services also provides field expertise, infrastructure, and equipment to help obtain samples for continued monitoring and evaluating of ORV status targeting coyotes and gray foxes in Texas.

A pilot ORV study was conducted in Flagstaff, Arizona in 2005 and 2006 in response to the reemergence of rabies in the striped skunk (*Mephitis mephitis*) population that originated as a result of a rabies virus host shift from big brown bats (*Eptesicus fuscus*). These studies represented the first operational attempts to field test the performance of Raboral V-RG<sup>®</sup> vaccine (Merial Limited, Athens, Georgia, USA) specifically targeting skunks. Baiting was done by hand (ground operations) at approximately 75 baits/km<sup>2</sup>. Over the 2-year study, only 8 of 66 skunks (12.1%) demonstrated a detectable rabies antibody response ( $\geq 0.05$  IU/ml) and 7 of the 8 positives had a record of recent hand vaccination with Rabdomun<sup>®</sup> (Schering-Plough Animal Health Corporation, Summit, New Jersey, USA). In the eastern U.S., where raccoon variant rabies frequently spills over into striped skunks, there has been virtually no detectable antibody response in skunks related to large scale, multi-year ORV projects targeting raccoons at 75 baits/km<sup>2</sup>. From 2001-2008, 11 of 506 skunks (2.2%) sampled during raccoon post-ORV programs had rabies antibodies ( $\geq 0.05$  IU/ml). Due to these findings, the pilot ORV study in Flagstaff was not continued in 2007 or 2008, but WS did continue its TVR campaign in skunks (through February 2008) in an effort to restore Flagstaff to terrestrial rabies-free status. In February 2008, WS concluded the TVR effort because no terrestrial rabies cases had been reported in the Flagstaff area for over 2 years. One skunk was vaccinated in 2008 prior to the February termination date. Over the multi-year TVR effort (2001 and 2004-2008), 496 animals were trapped, vaccinated, and released: 454 striped skunks, 37 raccoons, 3 gray foxes, and 2 Western hog-nosed skunks (*Conepatus mesoleucus*). The significance of spillover of other rabies virus variants in skunks is not well understood, but the apparent inability to orally vaccinate them with the currently licensed oral rabies vaccine and bait could potentially confound progress toward effective raccoon rabies control in the eastern U.S. The Arizona

program remains critical to better understanding the role skunks play in rabies outbreaks and the nationwide efforts to reduce and eventually eliminate terrestrial rabies from the U.S.

An ORV pilot program conducted from 2005 through 2007 in the vicinity of Chinle, Arizona on the Navajo Nation to field test Raboral V-RG<sup>®</sup> vaccine and determine rabies antibody levels in feral dogs that may have been exposed to the vaccine was postponed in 2008 in lieu of more research on new baits/vaccines and the immunocontraceptive GonaCon<sup>™</sup>. In April 2008, WS coordinated with Merial Limited, the CDC, and the Navajo Nation to evaluate the acceptance of an experimental enrobed sachet (ES) bait matrix with feral and free-ranging dogs. This study followed an ORV placebo bait study conducted in 2003 and 2004 that determined the coated sachet (CS) was the preferred bait of dogs, when compared to fishmeal polymer (FMP) and dog food polymer (DFP) baits. One limitation with the CS is the absence of an incorporated biomarker. In addition, the fishmeal crumbles coating the bait exterior frequently fall off during shipment and hand distribution, potentially affecting the overall attractiveness of the bait to target species. An experimental bait matrix using an enrobing process to coat the plastic sachet could potentially alleviate these drawbacks. The 2008 study compared bait acceptance of the experimental ES to the CS. Only 31% of dogs offered the ES handled the bait in such a way that would facilitate delivery of a vaccine to the oral cavity, while 62% of those dogs offered the CS would have received a dose of oral vaccine. It is beneficial to continue evaluating new vaccine/bait delivery systems for feral and free-ranging dogs on the Navajo Nation. The efforts represent potential for technology transfer to Mexico and other countries where dog rabies remains a problem and where a segment of the dog population cannot not be effectively captured and vaccinated parenterally..

A GonaCon<sup>™</sup> trial in captive dogs was initiated on the Navajo Nation in 2008. This initiative was taken under the North American Rabies Management Plan (NARMP). GonaCon<sup>™</sup>, developed by WS' National Wildlife Research Center (NWRC), stimulates the production of antibodies that bind to the gonadotropin-releasing-hormone (GnRH). By binding to the GnRH, the antibodies reduce GnRH's ability to stimulate the release of sex hormones, inhibiting sexual activity. GonaCon<sup>™</sup> has shown to result in an immune response that contracepts both males and females for upwards of two or more years. This vaccine, with a simultaneous injection of rabies vaccine, could provide a combined vaccine to address rabies and population control in dogs. Eighteen female free-roaming dogs (approximately 1-3 years old) were included in the study. Dogs were divided into 3 groups of 6 individuals: Group 1 received only a GonaCon<sup>™</sup> injection, Group 2 received only a rabies vaccine injection, and Group 3 was injected with both vaccines simultaneously. Thirteen of the 18 study dogs were euthanized and tissue samples were collected for injection site examinations and the remaining dogs are being held in captivity for long-term evaluations. All dogs received daily routine animal care and were under veterinary supervision through the duration of the study. Each group developed the expected antibodies and there was no statistically significant difference in mean rabies virus neutralizing antibody titers between Groups 2 and 3, indicating no evidence of interference from the immunocontraceptive on the development of rabies antibodies after injection. Injection site reactions were the impetus to explore improved vaccine formulations for future testing. The results of this study were published in the journal Vaccine (Bender et al. 2009).

Wildlife Services and cooperators implemented contingency actions in New York, Ohio, Texas, and Vermont in 2008. Contingency actions often include an integration of ORV, TVR, and increased enhanced rabies surveillance. Enhanced surveillance is designed to complement public health surveillance and provide greater intensity and scope in suspect animal testing to delineate the leading edge of rabies distribution, allowing for sound ORV decisions while maximizing the effective use of resources. Enhanced surveillance includes obtaining samples from: animals exhibiting behaviors suggestive of rabies but not implicated in human or domestic animal exposures, road kills, other animals found dead, animals with wounds or lesions suggestive of rabies, and animals removed near locations where rabies has recently been confirmed. In 2008, WS continued to enhance rabies surveillance in most of the states conducting ORV for raccoons, as well as emphasizing surveillance in adjacent states west of the raccoon ORV zone including Michigan, Kentucky, Mississippi and Louisiana (Figure 1). Texas and New Mexico collected 1,474 and 190 animals, respectively, in support of coyote and gray fox ORV programs. Arizona collected 232 animals (6 positive skunks in Cochise County) in support of feral dog and skunk research. In addition, California, Kansas, and Wyoming collected and submitted animals for testing to enhance surveillance of skunk variants of rabies. During enhanced surveillance efforts in 2008, WS' cooperation led to the collection and submission of 11,004 samples for rabies testing that otherwise would not likely have been tested through the public health surveillance system (Table 2) as they did not involve human or pet exposures; 211 of these tested positive for rabies.

Since 2005, 46 WS personnel have attended direct rapid immunohistochemistry test (dRIT) training at the CDC in Atlanta, Georgia. The dRIT is an unlicensed procedure designed for consideration as a potential confirmatory measure of the direct fluorescent antibody (dFA) test (the test most frequently used to diagnose

rabies). In addition, the dRIT may be used to enhance field surveillance among suspect wildlife, particularly in support of ORV programs. The dRIT may be used in remote locations to improve sample turnaround and not overburden rabies laboratories, but it is not to be used for public health surveillance in the U.S. Animals involved in potential or actual rabies exposures with humans or domestic animals are evaluated through standard procedures by public health experts at established local, state, or federal laboratories. From 2005-2008, WS implemented the dRIT in 16 states. In 2008, WS (and the TDSHS) tested 8,790 (79.9%) of the enhanced surveillance collected animals using the dRIT; 142 tested positive for rabies (Table 2).

Table 2. Wildlife Services enhanced rabies surveillance and use of the direct rapid immunohistochemistry test as part of rabies management programs in the United States, 2008.

State	Enhanced surveillance animals	WS tested by dRIT	Rabid by dRIT
Alabama	208	208 (100%)	0
Arizona	232	229 (98.7%)	6
California <sup>a</sup>	30	0	
Florida	470	462 (98.3%)	7
Georgia	120	119 (99.2%)	2
Kansas <sup>a</sup>	n/a <sup>b</sup>		
Kentucky <sup>a</sup>	141	140 (99.3%)	0
Louisiana <sup>a</sup>	18	18 (100%)	0
Maine	123	121 (98.4%)	2
Maryland	0		
Massachusetts	346	0	
Michigan <sup>a</sup>	14	14 (100%)	0
Mississippi <sup>a</sup>	17	17 (100%)	0
New Hampshire	1	0	
New Jersey	0		
New Mexico <sup>a</sup>	190	190 (100%)	0
New York	231	0	
North Carolina	125	125 (100%)	29
Ohio	752	751 (99.9%)	6
Pennsylvania	3,719	3,586 (96.4%)	53
Tennessee	761	754 (99.1%)	19
Texas	1,474	384 <sup>c</sup> (26.1%)	1
Vermont	183	0	
Virginia	401	401 (100%)	6
West Virginia	1,283	1,271 (99.1%)	11
Wyoming <sup>a</sup>	165	0	
Total	11,004	8,790 (79.9%)	142

<sup>a</sup> ORV not applied in this state.

<sup>b</sup> Wildlife Services removed skunks from Fort Riley Military Installation during routine wildlife damage management activities; the number submitted for rabies testing was not recorded.

<sup>c</sup> Includes samples tested by the Texas Department of State Health Services using the dRIT.

In all states conducting ORV, WS continues to take the lead on post-ORV monitoring to evaluate program effectiveness by collecting blood and tooth samples for determining rabies virus neutralizing antibody (RVNA) levels and bait uptake (when biomarker is available) in raccoons, skunks, coyotes, foxes, and bobcats. Density indexing is also used to characterize raccoon and skunk populations and to provide post-ORV serum samples for analysis. Typically, WS presents ORV program evaluation data (serology, tetracycline, and age results) from the previous year's monitoring to provide time for laboratory analyses. At the time of this report, however, all states had received 2008 serology results so they are included in this report. In addition, we have included the 2007 serology results for each state because some results were unavailable at the time the 2007 annual report was printed and we also had some samples retested due to higher than expected seroconversion levels.

All animals captured by WS in 2008 were trapped in accordance with federal, state, and local laws and handled according to the American Society of Mammalogists, Animal Care and Use Committee guidelines. All animals that had to be euthanized by WS in 2008 were done so in accordance with the American Veterinary Medical Association's Panel on Euthanasia recommendations.

In 2007, a mean positive antibody response of  $30 \pm 12\%$  ( $\geq 0.05$  IU/ml) was observed for 5,537 raccoon serum samples collected post-ORV (Table 3); 91 of the positive samples had a previous record of hand vaccination. Post-ORV sera were also collected from 176 skunks, 5 feral cats, 5 gray foxes, 4 fishers (*Martes pennanti*), 4 red foxes (*Vulpes vulpes*), and 1 opossum (*Didelphis virginiana*) during raccoon rabies management programs. Four skunks (2%), 4 gray foxes (80%), 1 feral cat (20%) and 1 red fox (25%) had a detectable RVNA response; none of these responses had a previous record of hand vaccination. Texas collected sera from 120 coyotes and 139 gray foxes to evaluate ORV efficacy targeting those species in south and west-central Texas, respectively; 59 (49%) coyotes and 102 (73%) gray foxes had RVNA (Table 3). Texas also collected post-ORV sera from 116 coyotes, 10 skunks, 4 bobcats (*Lynx rufus*), 2 raccoons, and 1 ringtail (*Bassariscus astutus*) during evaluation of the gray fox ORV program; 42 coyotes (36%) and 3 skunks (30%) had detectable rabies antibodies. Arizona collected serum samples from 63 dogs within the ORV pilot study area of Chinle (Table 3). Seventeen dogs (27%) had a positive RVNA response.

Table 3. Wildlife Services post-oral rabies vaccination (ORV) sampling efforts as part of rabies management programs in the United States, 2007.

State	All post-ORV serum samples	Positive rabies antibody response ( $\geq 0.05$ IU)	4-12 <sup>a</sup> weeks post-ORV samples	Positive rabies antibody response ( $\geq 0.05$ IU)
Raccoon <sup>b</sup>				
Alabama	384	121 (31.5%)	383	121 (31.6%)
Florida	190	56 (29.5%)	190	56 (29.5%)
Georgia	130	35 (26.9%)	130	35 (26.9%)
Maine	125	37 (29.6%)	117	34 (29.1%)
Maryland	258	118 (45.7%) <sup>c</sup>	258	118 (45.7%)
Massachusetts	39	21 (53.8%) <sup>c</sup>	26	17 (65.4%)
New Hampshire	10	1 (10.0%)	10	1 (10.0%)
New Jersey	0		0	
New York	310	53 (17.1%) <sup>c</sup>	259	48 (18.5%)
North Carolina	202	38 (18.8%)	120	28 (23.3%)
Ohio	1,463	322 (22.0%) <sup>c</sup>	432	97 (22.5%)
Pennsylvania	470	118 (25.1%) <sup>c</sup>	204	47 (23.0%)
Tennessee	352	123 (34.9%)	296	110 (37.2%)
Vermont	993	280 (28.2%) <sup>c</sup>	215	52 (24.2%)
Virginia	367	118 (32.2%)	210	82 (39.0%)
West Virginia	244	117 (48.0%)	85	40 (47.1%)
Total	5,537	1,558 (28.1%)	2,935	886 (30.2%)
Mean $\pm$ St. Dev.		$30 \pm 12\%$		$32 \pm 14\%$
Arizona (feral dog)	63	17 (27.0%)	27	7 (25.9%)
Texas (coyote)	120	59 (49.2%)	120	59 (49.2%)
Texas (gray fox)	139	102 (73.4%)	139	102 (73.4%)

<sup>a</sup> Samples taken during optimal evaluation period of 4-12 weeks post-ORV bait distribution.

<sup>b</sup> Non-raccoon samples collected during raccoon rabies management programs are not represented in this table.

<sup>c</sup> In these states, some raccoons with a positive rabies antibody response had a record of previous hand vaccination by Wildlife Services (MD=30, MA=2, NY=8, OH=28, PA=6, VT=17) either through a coordinated trap-vaccinate-release effort (as in NY, OH and VT) or in urban/suburban areas where ORV baiting is supplemented by hand vaccination (as in Anne Arundel Co., MD; Cape Cod, MA and Allegheny Co., PA).

Premolar teeth collected from live-captured animals during post-ORV monitoring and canine teeth from animals found dead or euthanized during enhanced surveillance activities were submitted to Matson's Laboratory

LLC (Milltown, Montana, USA) and Johnston's Biotech (Sarnia, Ontario, CAN) for tetracycline biomarker analysis and aging. Tetracycline biomarker results for the raccoon rabies management program are not presented because 64% of the 9.3 million ORV baits distributed for raccoons in 2007 were coated sachets, which did not contain tetracycline biomarker. In Texas, fishmeal polymer and dog food polymer baits were distributed (both contain biomarker). In the south Texas ORV zone, 112 of 120 coyote teeth tested (93%) showed a presence of tetracycline. In the west-central Texas zone, 84 of 139 gray fox teeth (60%); 21 of 68 coyote teeth (31%) (teeth not collected from 48 coyotes); 5 of 10 skunk teeth (50%); and 1 of 2 raccoon teeth (50%) tested showed a presence of tetracycline. None of the 4 bobcats or 1 ringtail had biomarker. Age results for target species sampled during raccoon, coyote and gray fox rabies management programs were typical except that the largest raccoon age class was 1 year olds (Figure 2). This is in part due to increased sampling conducted during TVR efforts in April-July in multiple states; trapping in these months leads to large numbers of adults ( $\geq 1$  y.o.) being sampled. Typically, the majority of sampling is conducted in August-November when juvenile young of the year raccoons are available for capture. Overall in 2007, median raccoon age was 2 years and ranged from  $<1$  to 15 years. Thirty-eight raccoons were aged at  $\geq 10$  y.o.: 12 at 10 y.o., 10 at 11 y.o., 4 at 12 y.o., 8 at 13 y.o., 1 at 14 y.o., and 3 at 15 y.o. Median coyote age was 3 years and ranged from 1 to 11 years. Seven coyotes were aged at  $\geq 10$  y.o.: 5 at 10 y.o., and 2 at 11 y.o. Median gray fox age was 2 years and ranged from 1 to 10 years. One gray fox was aged at 10 y.o.

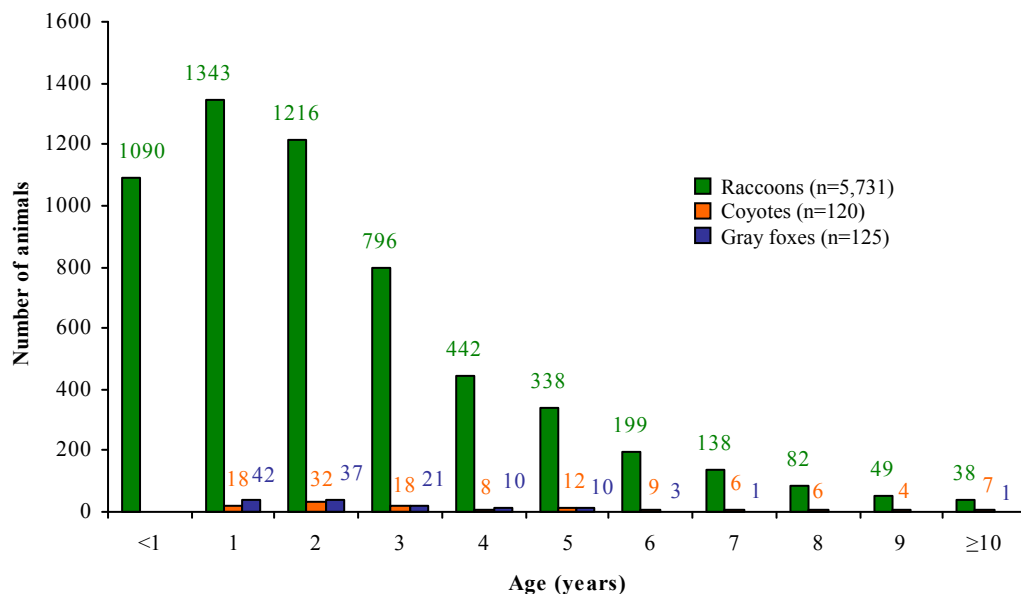


Figure 2. Age class distribution of 5,731 raccoon, 120 coyote, and 125 gray fox tooth samples collected by Wildlife Services during cooperative rabies management programs in the eastern United States (raccoons) and Texas (coyotes and gray foxes), 2007.

In addition, during raccoon rabies management programs in 2007, WS collected teeth for aging from: 282 striped skunks (median age: 1 year, range:  $<1$ -7 years); 21 coyotes (median age: 1 year, range:  $<1$ -12 years); 21 red foxes (median age: 1 year, range:  $<1$ -6 years); 14 gray foxes (median age: 1 year, range:  $<1$ -4 years); 4 feral cats (median age: 2.5 years, range:  $<1$ -9 years); 3 fishers (median age: 1 year, range: 1-4 years); and 2 opossums (median age: 2.5 years, range:  $<1$ -5 years).

In 2008, a mean positive antibody response of  $38 \pm 10\%$  was observed for 4,195 raccoon serum samples collected post-ORV (Table 4); 130 of the positive samples had a previous record of hand vaccination. Post-ORV sera were also collected from 107 striped skunks, 17 feral cats, 3 gray foxes, 2 fishers, and 1 bobcat during raccoon rabies management programs. Six skunks (6%) and 1 gray fox (33%) had a detectable RVNA response; none of these responses had a previous record of hand vaccination. Texas collected sera from 82 coyotes and 131 gray foxes to evaluate ORV efficacy targeting those species in south and west-central Texas, respectively; 34 (42%) coyotes and 101 (78%) gray foxes had RVNA (Table 4). Texas also collected post-ORV sera from 82 coyotes, 3 bobcats,



and 1 raccoon during evaluation of the gray fox ORV program; 61 coyotes (74%) had detectable rabies antibodies. Arizona did not conduct ORV distribution activities for feral dogs or skunks in 2008.

Table 4. Wildlife Services post-oral rabies vaccination (ORV) sampling efforts as part of rabies management programs in the United States, 2008.

State	All post-ORV serum samples	Positive rabies antibody response ( $\geq 0.05$ IU)	4-12 <sup>a</sup> weeks post-ORV samples	Positive rabies antibody response ( $\geq 0.05$ IU)
Raccoon <sup>b</sup>				
Alabama	251	126 (50.2%)	251	126 (50.2%)
Florida	542	116 (21.4%)	315	76 (24.1%)
Georgia	124	60 (48.4%)	124	60 (48.4%)
Maine	125	48 (38.4%)	121	47 (38.8%)
Maryland	265	111 (41.9%)	114	49 (43.0%)
Massachusetts	41	19 (46.3%)	40	19 (47.5%)
New Hampshire	0			
New Jersey	0			
New York	354	137 (38.7%)	234	95 (40.6%)
North Carolina	124	49 (39.5%)	124	49 (39.5%)
Ohio	727	175 (24.1%)	382	154 (40.3%)
Pennsylvania	544	190 (34.9%)	232	87 (37.5%)
Tennessee	336	133 (39.6%)	334	132 (39.5%)
Vermont	186	104 (55.9%)	64	40 (62.5%)
Virginia	238	66 (27.7%)	147	47 (32.0%)
West Virginia	338	93 (67.4%)	136	25 (18.4%)
Total	4,195	1,427 (34.0%)	2,618	1,006 (38.4%)
Mean $\pm$ St. Dev.		38 $\pm$ 10%		40 $\pm$ 11%
Texas (coyote)	82	34 (41.5%)	82	34 (41.5%)
Texas (gray fox)	131	101 (77.7%)	131	101 (77.7%)

<sup>a</sup> Samples taken during optimal evaluation period of 4-12 weeks post-ORV bait distribution.

<sup>b</sup> Non-raccoon samples collected during raccoon rabies management programs are not represented in this table.

<sup>c</sup> In these states, some raccoons with a positive rabies antibody response had a record of previous hand vaccination by Wildlife Services (MD=13, MA=5, NY=2, OH=14, PA=53, VT=43) either through a coordinated trap-vaccinate-release effort (as in NY, OH and VT) or in urban/suburban areas where ORV baiting is supplemented by hand vaccination (as in Anne Arundel Co., MD; Cape Cod, MA and Allegheny Co., PA).

Teeth were again submitted to Matson's Laboratory and Johnston's Biotech in 2008 for tetracycline biomarker analysis and aging. Tetracycline biomarker results for the raccoon rabies management program are not presented because 74% of the 8.4 million ORV baits distributed for raccoons in 2008 were coated sachets. Texas continued to distribute polymer baits containing biomarker. In the south Texas ORV zone, 67 of 83 coyote teeth tested (81%) showed a presence of tetracycline. In the west-central Texas zone, 95 of 134 gray fox teeth (71%), 61 of 85 coyote teeth (72%); and the 1 raccoon tooth (100%) tested showed a presence of tetracycline. None of the 3 bobcat teeth had biomarker. Age results for target species sampled during raccoon, coyote and gray fox rabies management programs were typical (Figure 3). Median raccoon age was 1 year and ranged from <1 to 19 years (a female from Maryland). Twenty-seven raccoons were aged at  $\geq 10$  y.o.: 10 at 10 y.o., 5 at 11 y.o., 8 at 12 y.o., 1 at 13 y.o., 1 at 14 y.o., 1 at 15 y.o. and 1 at 19 y.o. Median coyote age was 2 years and ranged from 1 to 14 years. Four coyotes were aged at  $\geq 10$  y.o.: 1 at 10 y.o., 2 at 11 y.o. and 1 at 14 y.o. Median gray fox age was 2 years and ranged from 1 to 7 years.

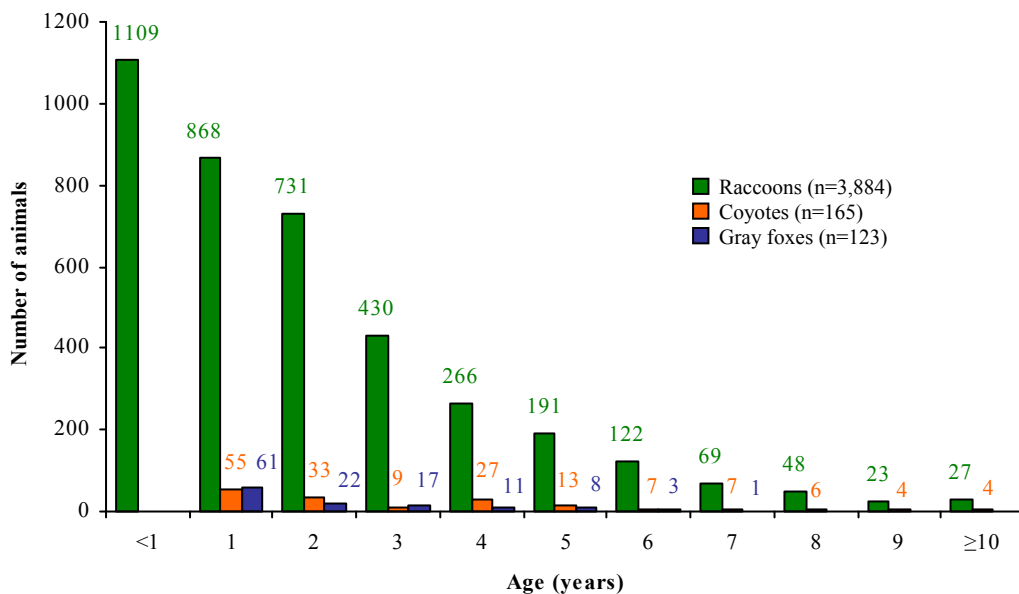


Figure 3. Age class distribution of 3,884 raccoon, 165 coyote and 123 gray fox tooth samples collected by Wildlife Services during cooperative rabies management programs in the eastern United States (raccoons) and Texas (coyotes and gray foxes), 2008.

In addition, during raccoon rabies management programs in 2008, WS collected teeth for aging from: 167 striped skunks (median age: 1 year, range: 0-8 years); 16 red foxes (median age: <1 year, range: 0-4 years); 15 coyotes (median age: <1 year, range: 0-3 years); 12 feral cats (median age: 2.5 years, range: 0-10 years); 7 gray foxes (median age: 1 year, range: 0-1 year); 4 opossums (median age: 4.5 years, range: 2-8 years); and 2 fishers (both 1 y.o.).

The need for a bait-vaccine combination producing higher levels of RVNA in meso-carnivore species serving as rabies reservoirs remains the highest research priority and requires continued systematic research. In 2008, research at Thomas Jefferson University in Philadelphia, Pennsylvania and at the CDC continued to focus on the development of new, safe, and effective oral rabies vaccines with canine adenovirus as a prospective vector for expression of the rabies glycoprotein.

In August 2008, a collaborative field study along the Maine-New Brunswick border was conducted to compare Merial's Raboral V-RG<sup>®</sup>, a vaccinia-rabies glycoprotein recombinant ORV delivered in fishmeal coated sachet baits to ONRAB<sup>®</sup> (Artemis Technologies Inc., Guelph, Ontario, Canada), a human adenovirus5-rabies glycoprotein recombinant ORV delivered in Ultralite baits. Collaborators included the Ontario Ministry of Natural Resources, the Canadian Food Inspection Agency, the New York State Department of Health Wadsworth Center, the New Brunswick Health Ministry, and Maine WS. Baits were distributed by fixed-wing aircraft at 75 baits/km<sup>2</sup> (1 km flight line spacing) on the same day along the international border with Maine receiving Raboral V-RG<sup>®</sup> and New Brunswick receiving ONRAB<sup>®</sup>. The border areas of Maine and New Brunswick involved in this study had similar habitats and raccoon densities, reducing the effects of covariates. Post-ORV monitoring occurred 5-7 weeks after baiting with an emphasis on raccoon and skunk sample collection. There was no significant difference between ONRAB<sup>®</sup> and Raboral V-RG<sup>®</sup> in the proportion of seropositive skunks sampled post-ORV, but there was a highly significant difference in raccoons: 74% seropositive vs. 30% seropositive (Fehlner-Gardiner *in press*). These findings suggest that the ONRAB<sup>®</sup>/Ultralite vaccine-bait combination appears more effective in producing seroconversions and likely more effective in raccoon rabies control, but follow up studies are warranted to determine if similar results can be replicated.

Several pen, laboratory, and field studies were continued or initiated through WS' National Wildlife Research Center (NWRC) in Fort Collins, Colorado. Pen and laboratory studies were conducted at the NWRC and Colorado State University, while field studies were conducted in Alabama, Ohio, Pennsylvania, and Texas. Studies involved research on: raccoon genetics as it relates to corridors and barriers to movement over landscapes; evaluation of bait attractants to enhance delivery of Raboral V-RG<sup>®</sup> to raccoons; ecology of raccoons in urban areas;

increased rabies vaccine stability; development of better biomarkers to evaluate vaccine uptake by target and non-target wildlife; testing of immune system enhancers to increase rabies vaccine antibody titers in raccoons; evaluation of immunocontraception in raccoons to reduce raccoon fecundity in urban areas; testing efficacy of Raboral V-RG® in arctic fox (*Alopex lagopus*); and evaluation of geographic barriers for wildlife dispersal that may affect the spread of rabies.

Throughout 2008, WS continued to participate in formal meetings with counterparts from Canada, Mexico, and the Navajo Nation on the completion of a North American Rabies Management Plan (NARMP) that identifies information exchange, enhanced surveillance, rabies control, and research as key needs toward meeting continental goals for rabies management. The NARMP was formally recognized by Canada, Mexico, the U.S. and Navajo Nation at a signing ceremony during the XIX International Conference on Rabies in the Americas held at the CDC in Atlanta, Georgia in September 2008.

In 2009, WS and cooperators will continue to focus on implementing adequate enhanced rabies surveillance in conjunction with ORV to determine areas at risk of rabies spread and to monitor program success. Adjustment to ORV zones may occur as a result of improved surveillance information. Contingency actions are expected to continue in New York, Ohio, Vermont, and Texas. Commitments will continue toward improvements to the existing bait-vaccine and development of new bait-vaccines that perform better and are efficacious in all carnivore reservoirs.

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