

Rabies Epidemiology in North Carolina 2008 Surveillance Report

Introduction /Background

History – Canine Variant Rabies

In 2007 the Centers for Disease Control declared the United States free of indigenous canine variant rabies.¹ However, dogs, cats, cattle, horses and other domestic animals are still at risk in the United States and may become infected with rabies wildlife rabies variants through interactions with wildlife rabies vectors and feral animals. This spillover of virus can continue and humans can become infected when they are bitten or otherwise exposed to infected animals. Human rabies cases are now rare in the United States; the few cases that are acquired in the U.S. are due to bat-variant rabies. This was not always the case. During the period 1946 through 1949 human cases averaged twenty four per year in the US and were caused predominantly (90%) by dog bite transmission of canine-variant rabies. Aggressive canine rabies vaccination campaigns subsequently have resulted in immune protection of domestic dogs that are currently vaccinated and decreases in incident US human cases to about 1.5 per year from 1962 through 1965 (67% canine variant), and 3.3 human cases per year from 1970 to 1989 (45% canine variant).² The last human case among 25 total cases of human rabies reported to North Carolina Division of Public Health through 31 DEC 2008 occurred in 1955 when a woman succumbed to canine variant rabies after she was bitten by her pet dog. As the threat of canine variant rabies declined in the United States, primarily due to successful veterinary vaccination prevention programs and animal control efforts, other important wildlife reservoirs of rabies emerged to the forefront.

The Current Situation in North Carolina Raccoon Variant Rabies Epidemiology

Raccoons (*Procyon lotor*) are the terrestrial (land) reservoir for rabies in North Carolina and transmit the raccoon variant of rabies to other mammals, principally wild carnivores and large rodents (skunks, red and gray foxes, bobcats, coyotes, beaver, and groundhogs), and domestic animals (pets and livestock). These non-reservoir species become infected through “spillover,” when they have interactions with rabid raccoons in a shared ecological environment. A rabies reservoir species, due to species-specific adaptation by the virus, is capable of maintaining the virus through efficient intra-species transmission. Raccoon variant rabies is responsible for the majority of rabies cases in animals (both domestic and wild) throughout North Carolina and all of the eastern coastal states, as well as Alabama, Tennessee, West Virginia, Ohio, Pennsylvania, and Vermont.³

Rabies is present in wildlife throughout the state of North Carolina; virtually every county is enzootic with raccoon variant rabies.

Raccoons are native to North America, have a wide geographic distribution, and are uniquely adapted to suburban living with humans. North Carolina raccoons were naïve (not exposed or infected) to the raccoon variant rabies virus prior to the 1990s. The raccoon variant was first identified in Florida raccoons in the 1940s and remained in the Southeast until a suspected translocation of rabid raccoons from Florida to the mid-Atlantic region occurred in the 1970s. In time the epizootic of raccoon rabies spread when the two separate rabies foci, the southeastern and mid-Atlantic fronts, met in North Carolina around 1995. As a result of this epizootic spread, raccoon variant rabies is present in raccoon and other wildlife populations from Florida up through Ontario, Canada.⁴

Bat Variant Rabies Epidemiology

Insectivorous bats are the other principal reservoir for rabies in North Carolina; there are several species and variants. Bats are flying mammals that are highly mobile and migrate widely into different geographic areas. Because of this, it is difficult to map a geographic range for the multiple bat variants and all areas of the continental United States are considered enzootic for bat rabies, including every US state except Hawaii.³

Human Rabies Cases in the United States

In the last couple of decades bat variant rabies has been recognized as the most common variant for rabies transmission in humans. Any exposure or potential exposure to a bat should be taken seriously and requires careful evaluation. If possible, the bat(s) involved should be collected safely and submitted for testing. The potential for rabies transmission exists even with seemingly minor exposures to bats because some variants of the virus are capable of infection after superficial epidermal inoculation. Therefore, if a person or pet is exposed to a bat, or a bat is found in close proximity or in a living space, the local health department or health care provider should be contacted immediately for careful rabies risk assessment for postexposure prophylaxis. Of 28 cases of human bat variant rabies acquired naturally within the United States from 1995 to 2006, the CDC reports that 61% (17/28) of the cases had an unknown or unrecognized bite exposure history. Once infected with rabies virus, regardless of variant, the disease is 100% fatal without appropriate postexposure prophylaxis. All of the human cases documented in the United States died except one person that was left with severe neurological complications.⁵

An exposure is any bite, scratch or other situation in which saliva or central nervous system (CNS) tissue of a potentially rabid animal enters an open wound, fresh wound, or comes in contact with a mucous membrane by entering the eye, mouth or nose.

Other situations that might qualify as exposures include finding a bat in the same room as a person who might be unaware that a bite or direct contact had occurred (e.g., a deeply sleeping person awakens to find a bat in the room or an adult witnesses a bat in the room with a previously unattended child, mentally disabled person, or intoxicated person).

Laboratory Submission Criteria

Animals are accepted for submission and rabies testing to the SLPH if certain criteria are met. Animal control authorities in each jurisdiction are responsible for enforcing state rabies laws and local rabies ordinances, and for submitting rabies specimens for testing. When a person or unvaccinated domestic animal is bitten or otherwise exposed to an animal suspected of transmitting rabies and the animal is available for testing, animal control is engaged to capture, prepare and submit the animal for testing. Timely consultations between health care providers, veterinarians, animal control authorities, and local health departments are critical to performance of risk assessments for potential rabies transmission and determination of the need to capture of the animal for observation or testing. High risk wildlife species are considered rabid unless tested negative for rabies and should be submitted for testing. High risk animals include raccoons, skunks, foxes, coyotes, wolves, bobcats, beavers, groundhogs (woodchucks), and bats. Small rodents (squirrels, mice, rats, etc.), rabbits and opossums are considered low risk species for rabies transmission. Low risk species may be submitted by animal control services on a case by case basis *only* with prior approval by one of the public health veterinarians. Important factors to consider prior to request for animal submission include the species of animal, animal behavior and health status, and the circumstances of exposure (provoked or unprovoked). Only animals that have exposed a person or an unvaccinated domestic animal and are reasonably suspected of transmitting rabies are to be tested by SLPH.

The State Laboratory Public Health specimen acceptance policy is:

Testing resources are reserved for situations where the testing outcome will influence patient management decisions. Terrestrial animal submissions are limited to significant rabies vector species that expose humans, livestock or unvaccinated pets. Significant rabies vector terrestrial species include raccoons, skunks, foxes, most other carnivores, and woodchucks. Domestic animals exhibiting signs of rabies and wild animals that have potentially exposed a person, unvaccinated pet, or livestock to rabies should be submitted for testing without delay.

Public health veterinarians at North Carolina Division of Health and Human Services are available to assist with animal exposure assessments during business hours at 919.733.3410 and after hours in emergency situations for health care providers, local health departments, animal control officers and veterinarians at 919.733.3419.

Rabies Surveillance in North Carolina, 2008

In 2008 the North Carolina State Laboratory of Public Health (SLPH) received 3,924 animal specimens for rabies testing, submitted throughout every month of the year (Table 1 and Figure 1). All 100 North Carolina counties submitted specimens for testing and an aggregate of 452 positive cases were reported by the SLPH from 73 counties. Included in the analysis are ten animals designated “out of state,” two of these animals were rabies positive. These animals were included in NC data because they either resided or were captured in North Carolina but were submitted by a veterinarian or other entity from an adjacent state. The total number of specimens tested (3877) was less than number of specimens submitted because tests were not performed (TNP) on brains that were deteriorated, desiccated or otherwise unsuitable for testing.

Table 1. RABIES, Animals Submitted, Tested and % Positivity by Month, North Carolina, 2008

<u>Month</u>	<u>Submitted</u>	<u>Tested</u>	<u>Positive</u>	<u>% Positive</u>
JAN	258	258	27	10.5
FEB	207	207	35	16.9
MAR	254	254	44	17.3
APR	266	266	44	16.5
MAY	333	332	49	14.8
JUN	556	545	40	7.3
JUL	522	502	49	9.8
AUG	469	457	36	7.9
SEP	295	295	41	13.9
OCT	267	266	38	14.3
NOV	229	228	26	11.4
DEC	268	267	23	8.6
TOTAL	3924	3877	452	11.7

Figure 1. shows that animals were submitted and tested positive throughout every month of 2008. The number of specimens submitted for testing clearly began to increase in May and peaked in the summer months, June through August, corresponding most probably to increased outdoor activity and associated exposures to people and their pets. Wildlife activity also increases during the spring and summer months; wildlife emerge from hibernation or become more active as daylight increases, feeding and mating. Bats migrate back to roosting and nursery areas often in areas that are in close proximity to people, like attics.

Figure 1. RABIES, Frequency of Animals Submitted, Tested and Rabies Positives by Month, North Carolina, 2008 (N=3924)

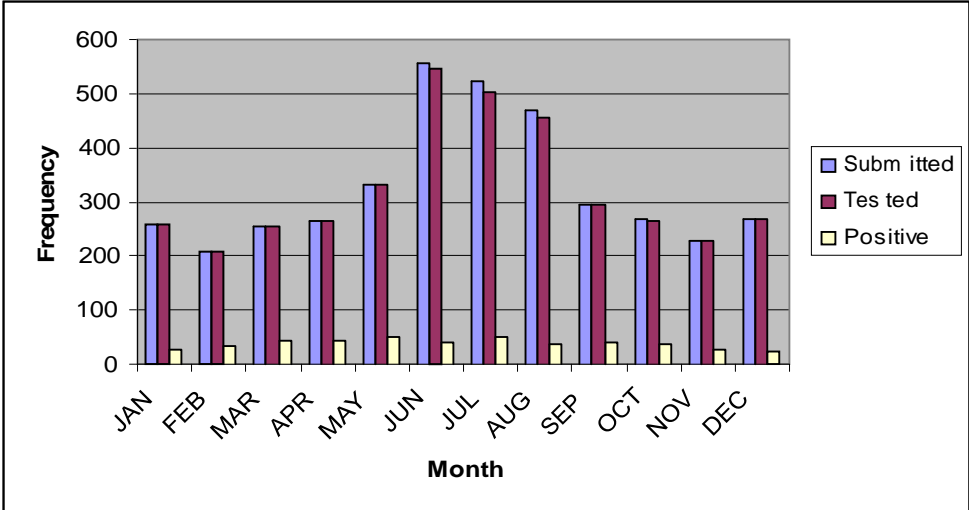
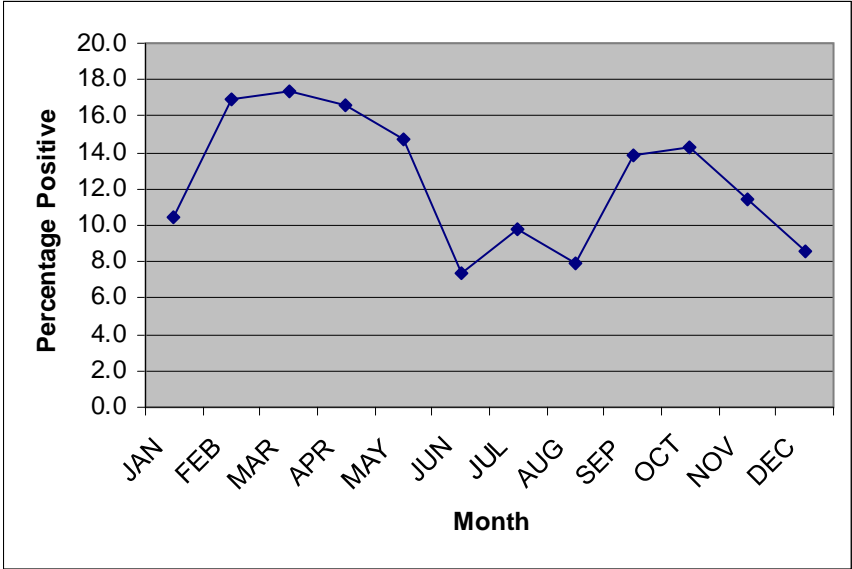


Figure 2. displays the percent rabies positive among all animals tested at NC SLPH by month. Bimodal peaks occur from February to May and September to November indicating increases in the percent of animals testing positive. The lowest percentage positive of animals tested occurred in the summer months June 7.3% (40/545), July 9.8% (49/502) and August 7.9% (36/457). However it is important to note that the greatest number of animals were submitted and tested during these months (Figure 1.). The highest percentage positive among animals tested occurred in March, 17.3% (44/254).

Figure 2. RABIES, Percent Positivity by Month among All Animals Tested, North Carolina 2008 (N=3877)



High Risk Wildlife

Among wildlife species that pose a high risk for rabies transmission in North Carolina (Table 2 and Figure 3), the SLPH received 1,145 bats, 552 raccoons, 117 foxes, 108 skunks, 6 groundhogs, 5 coyotes, and 3 beavers for testing. Of 549 raccoons tested, 45.7% (251) were positive. This represents a high risk of potential rabies transmission given an exposure to a raccoon. It is important to remember that the SLPH tests only those animals that have exposed a human or an unvaccinated domestic animal. This subset of surveillance data represents a small fraction of the entire population of a particular wildlife species in North Carolina; almost half of the raccoons tested positive. Other high risk wildlife species, that are presumed rabid unless tested negative, had the following positivity: skunks 86.1% (93/108), foxes 48.7% (57/117), bats 1.6% (18/1104), 3 of 5 coyotes, 3 of 3 bobcats, and 1 of 3 beavers.

Table 2. RABIES, Percent Positive among High Risk Wildlife Species Tested, North Carolina 2008

<u>High Risk - Wildlife</u>	<u>Tested</u>	<u>Positive</u>	<u>% Positive</u>
Bats	1104	18	1.6
Beaver	3	1	33.3
Bobcat	3	3	100.0
Coyote	5	3	60.0
Fox	117	57	48.7
Groundhog	38	0	0.0
Raccoon	549	251	45.7
Skunk	108	93	86.1
Total	1927	426	22.1

Figure 3. RABIES, Frequency of Tests and Positives among Selected High Risk Wildlife Species, North Carolina, 2008 (N=1878)

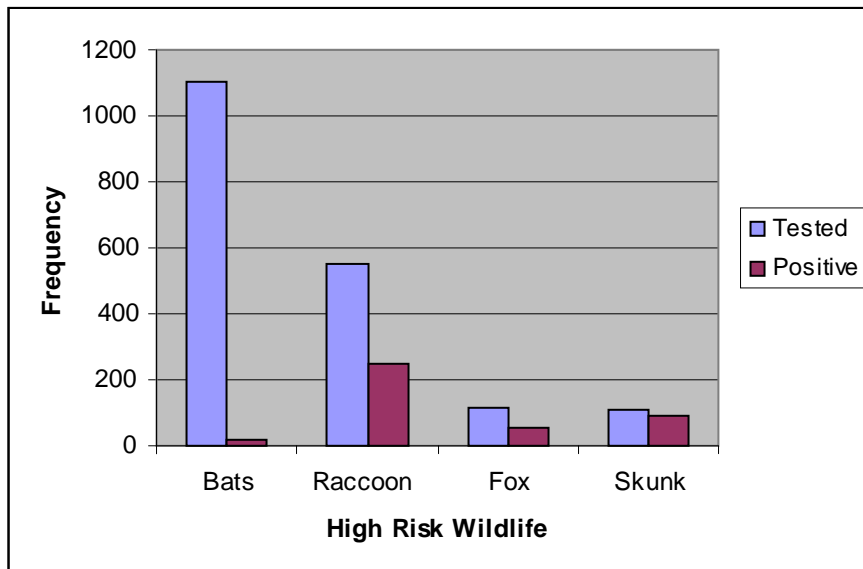
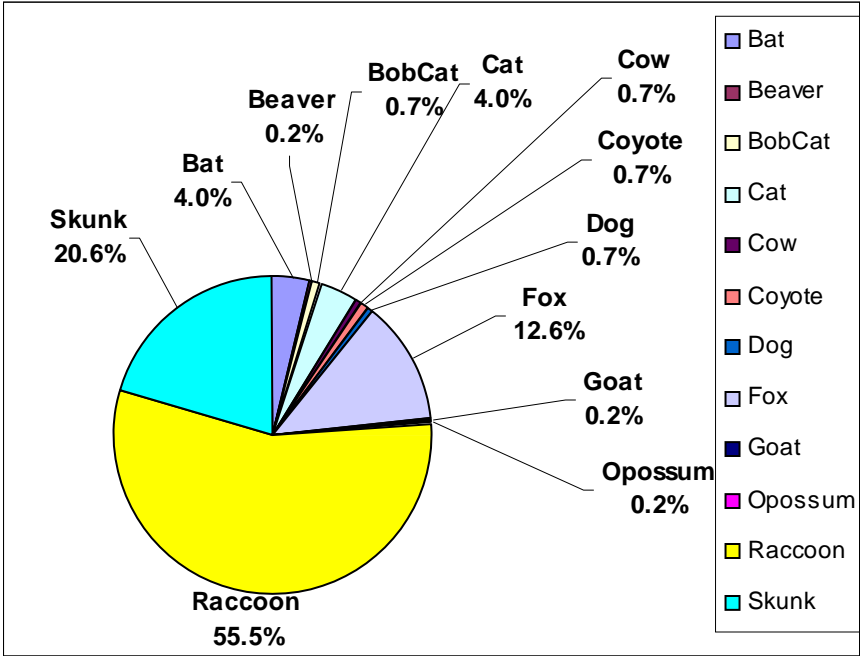


Figure 4 displays the relative percent rabies positivity among all animal species tested in North Carolina during 2008. Of 452 positive animals, 251 Raccoons (55.5%) presented the greatest burden in 2008 of all rabies vectors submitted and tested in North Carolina, followed by 93 skunks (20.6%) and 57 foxes (12.6%). Bats and cats (mostly stray or feral) each represented about 4% of the 2008 positive animals that created a rabies exposure burden.

Figure 4. RABIES, Percentage Positive among All Species Testing Positive, North Carolina 2008 (N=452)



Raccoons

Figure 5. RABIES, Frequency of Raccoons Submitted and Testing Positive by Month, North Carolina, 2008 (N=552)

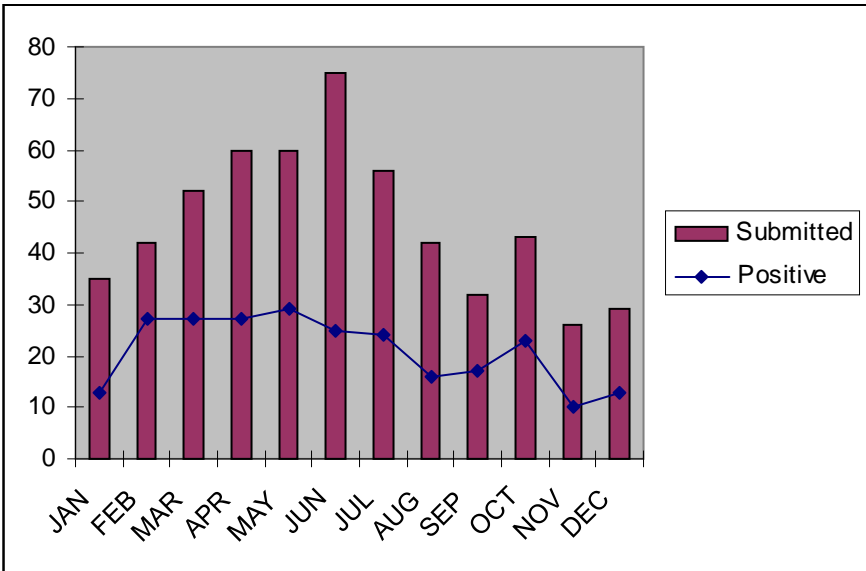


Table 3. RABIES, Number of Raccoons Submitted and Percent Positive by County, North Carolina, 2008

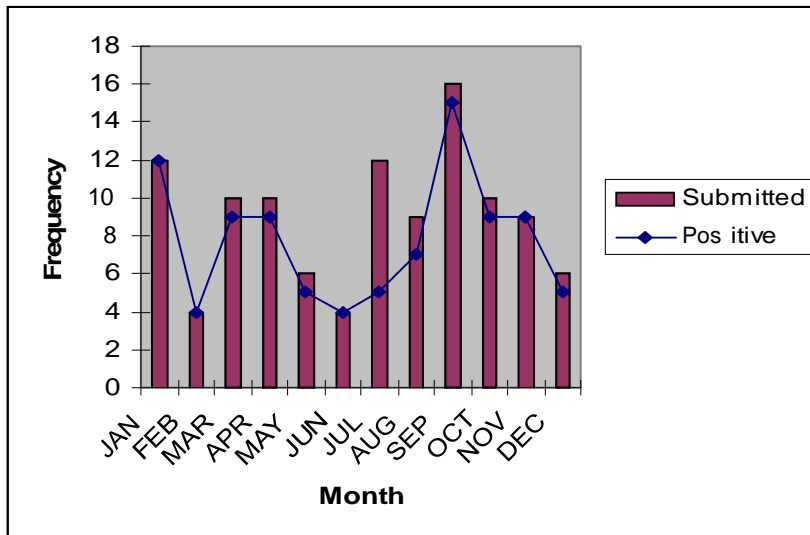
County*	Total		Percentage Positive
	Raccoons Submitted	Positive	
Mecklenburg	52	16	30.8
Forsyth	31	11	35.5
Orange	29	14	48.3
Cherokee	26	13	50.0
Wake	22	11	50.0
Wilkes	22	8	36.4
Buncombe	18	10	55.6
Guilford	16	10	62.5
Mitchell	15	10	66.7

*Counties submitting 15 or more raccoons

Skunks

Skunks were submitted for testing and tested positive throughout every month of 2008. Peak skunk submissions and positives both occurred in January and October, 2008.

Figure 6. RABIES, Frequency of Skunks Submitted and Testing Positive by Month, North Carolina, 2008 (N=108)



Among the 33 counties that submitted 108 skunks for testing in 2008, thirty two (97%) reported at least one rabid skunk. Overall the majority of skunks submitted to the SLPH in 2008 for testing were positive, 86% (93/108). Table 4 shows counties that submitted at least 2 skunks for testing to the SLPH and the number testing positive.

Table 4. RABIES, Number of Skunks Submitted and Percent Positive by County, North Carolina, 2008

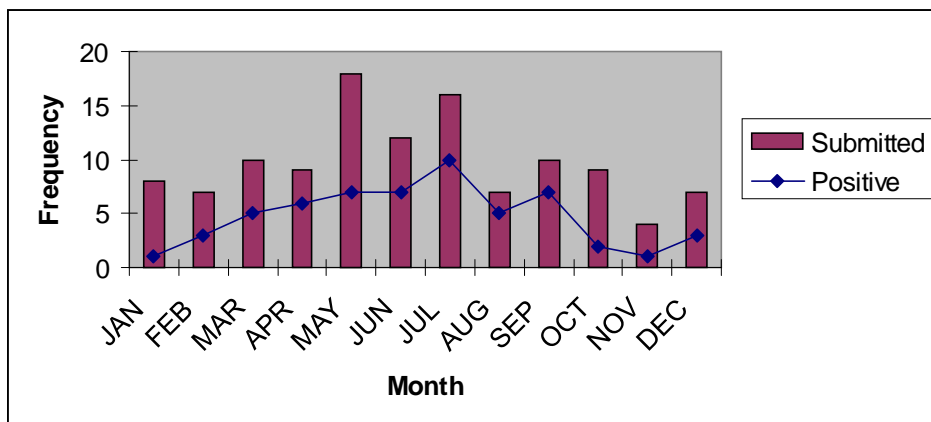
<u>County</u>	<u>Submitted</u>	<u>Positive</u>
Wilkes	25	18
Yadkin	9	9
Cleveland	7	6
Rowan	7	7
Forsyth	6	6
Iredell	6	6
Surry	5	5
Rockingham	4	4
Catawba	3	2
Guilford	3	2
Orange	3	2
Rutherford	3	2
Ashe	2	1
Cherokee	2	2
Clay	2	2
Montgomery	2	2
Stanly	2	1
Union	2	2

*Counties submitting at least 2 skunks for testing.

Foxes

Peak fox submissions and positives occurred in the summer months, May through August (Figure 5).

Figure 5. RABIES, Frequency of Foxes Submitted and Testing Positive by Month, North Carolina, 2008 (N=117)



Among 46 counties submitting 117 foxes for testing in 2008, 30 counties received positive results; 65.2% of the foxes submitted (57/117) were positive. Table 4. displays counties that submitted at least 2 foxes for testing and the relative number of foxes that tested positive. Forsyth, Guilford, Randolph and Wake counties each had 4 or more rabid foxes in 2008.

Table 4. RABIES, Foxes Submitted and Testing Positive by County, North Carolina, 2008

*County	Total Foxes	
	Submitted	Positive
Wake	16	4
Forsyth	10	8
Guilford	7	7
Mecklenburg	7	1
Randolph	6	4
Surry	6	2
Rowan	5	2
Orange	4	1
Carteret	3	2
Catawba	3	1
Cherokee	3	3
Sampson	3	1
Cabarrus	2	1
Cleveland	2	0
Davidson	2	2
Halifax	2	0
Mitchell	2	1
Montgomery	2	2
Rockingham	2	2

*Counties submitting at least 2 foxes for testing

Bats

A large number (1145) of bats, were submitted to the SLPH for rabies testing in 2008. Of 1104 bats tested, 18 bats (1.6%) tested positive for rabies: 8 Big Brown Bats (*Eptesicus fuscus*), 8 Eastern Red Bats (*Lasiurus Borealis*), 1 Mexican Free Tailed Bat (*Tadarida brasiliensis*), and one bat was an unspiciated juvenile (Table 5.).

Table 5. RABIES, Frequency and Percent Positive by Species among Bats Tested by Species, North Carolina 2008

Bat Species	Tested	Positive	Percentage Positive by Species
<i>Eptesicus fuscus</i>	834	8	1.0
<i>Lasionycteris noctivagans</i>	29	0	0.0
<i>Lasiurus borealis</i>	62	8	11.6
<i>Lasiurus seminolus</i>	4	0	0.0
<i>Myotis sp</i>	4	0	0.0
<i>Nysticeius humeralis</i>	24	0	0.0
<i>Pipistrellus subflavus</i>	3	0	0.0
<i>Tadarida brasiliensis</i>	42	1	2.4
Juvenile	74	1	1.4
Unidentified	28	0	0.0
Total	1104	18	

Figure 6. illustrates that the majority of bats were submitted for testing in the summer months (June through September) and bats tested positive predominantly May through August. Most bats migrate and hibernate when temperatures drop in the fall. Beginning in April through August (depending on warming temperatures) many female bats form maternity colonies and nurture their young in attics or other spaces in buildings that may be inhabited by people resulting in many accidental exposures to people.

Figure 6. RABIES, Number of Bats Submitted (N=1145) and Testing Positive (N=18) by Month, North Carolina, 2008

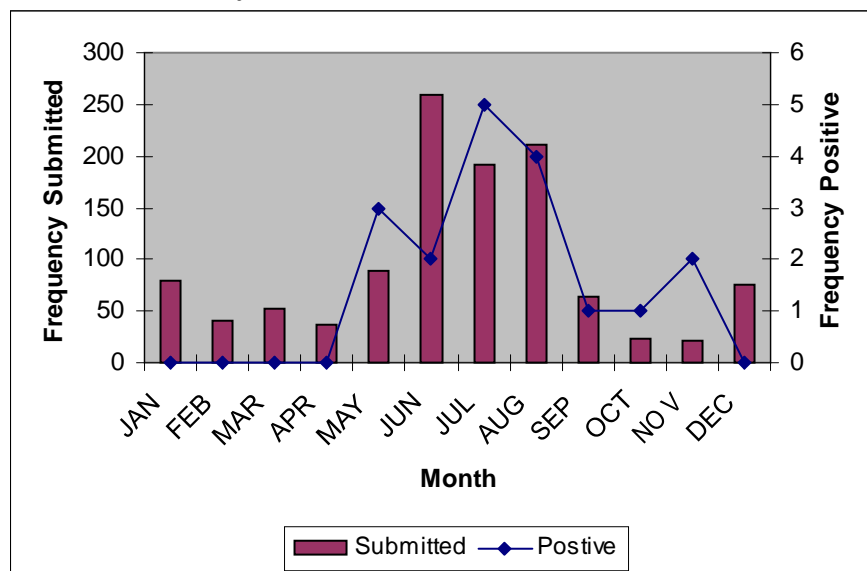


Table 5. RABIES, Number of Bats Submitted and Percent Positive by County, North Carolina, 2008

<u>County*</u>	<u>Total Bats Submitted</u>	<u>Positive</u>	<u>% Positive</u>
Mecklenburg	179	3	1.7
Wake	153	2	1.3
Guilford	121	1	0.8
Forsyth	87	0	0.0
Orange	80	1	1.3
Durham	71	0	0.0
Rowan	40	2	5.0
Alamance	36	0	0.0
Moore	30	1	3.3
Randolph	29	0	0.0
Buncombe	26	0	0.0
Cumberland	24	0	0.0
Henderson	20	0	0.0
Cleveland	17	0	0.0

*Counties submitting over 15 bats

Domestic Animals and Low Risk Wildlife

Companion Animals

Domestic pets or companion animals (dogs, cats, and ferrets) have close and frequent contact with people in and around the home environment, at pet stores, and often when people approach and feed stray or feral cats and dogs. In 2008, 3 dogs and 18 cats tested positive for rabies in North Carolina. Domestic dogs, cats, and ferrets are likely to acquire rabies after a bite exposure to a high risk wildlife species if they are not currently vaccinated against rabies and if they are allowed outdoors unsupervised. Beginning October 1, 2009 North Carolina General Statute. 130A-185 required owned ferrets (in addition to the current requirement for cats and dogs) to be currently vaccinated against rabies by four months of age. Among nationally reported rabies cases in domestic animals in 2008, cats represented four times the number of reported cases in dogs and five times the reported cases in cattle. Most of the cases reported in cats (82.3%) of 294 were from states with enzootic raccoon variant rabies.⁷

Livestock

North Carolina statute does not require that domestic livestock be vaccinated against rabies. In 2008, 3 of 48 cattle and 1 of 31 goats tested positive for rabies. The Compendium of Animal Rabies Prevention and Control, 2008 published by the National Association of Public Health Veterinarians recommends vaccination of livestock that may have close contact with people (petting zoos, fairs, or public exhibitions), valuable livestock, and horses traveling interstate. Currently there are USDA licensed vaccines for horses, cattle and sheep marketed in the United States. The North Carolina Department of Agriculture and Consumer Services requires vaccination of livestock at animal contact exhibits, if a USDA licensed approved vaccine exists for that species, per .02 NCAC 52K .0601, Section .0600 – Animal Keeping, Certification and Exhibition. More specific information on USDA licensed vaccines by species can be accessed at <http://www.nasphv.org/Documents/RabiesCompendium.pdf>

Low Risk Wildlife

Low risk wildlife species include small rodents (squirrels, mice, rats, chipmunks, etc.), lagomorphs (rabbits), marsupials (opossums), voles, moles and others. Although any warm blooded mammal can become infected with rabies, carnivores and large rodents are the animals most likely to be exposed to high risk vectors because of shared ecological niches. Larger body size also favors survival from attacks by rabid carnivores. Among low risk animals tested at the NC SLPH from 1990 to present a total of 6 were confirmed with rabies: 3 rabbits (1996, 1997, and 2001) and 3 opossums (2005, 2008, and 2009).

Overview

Since 2004 the percentage of animals submitted to the SLPH that test positive has decreased to less than 12% (Figure 7.). Table 7 displays the frequency of all rabid animals by species reported by the SLPH over the past 5 years.

Figure 7. RABIES, Percentage Positive among Total Submissions by Year, North Carolina, 2004 -2008 (N=20,504)

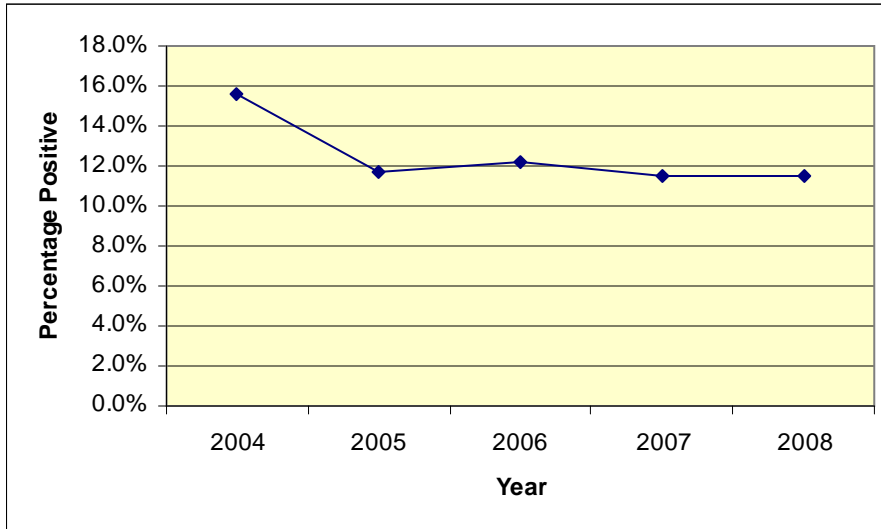


Table 7. RABIES, Positives by Species, North Carolina 2004 - 2008

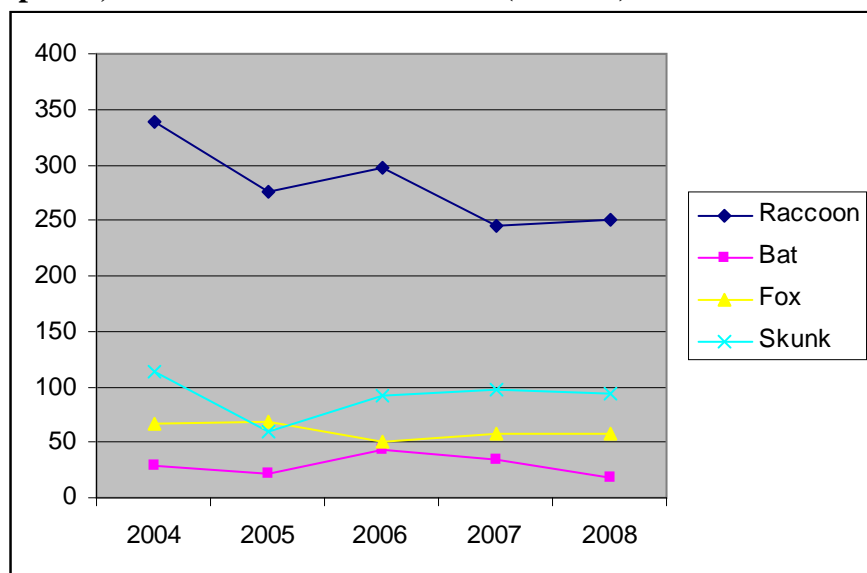
<u>Species</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>
Bat	28	22	43	34	18
Beaver	0	1	0	0	1
Bobcat	1	2	5	0	3
Canine	7	4	8	4	3
Cat	22	16	19	21	18
Bovine	4	3	2	5	3
Coyote	1	3	2	3	3
Equine	1	3	0	4	0
Ferret	0	0	1	0	0
Fox	66	68	50	58	57
Goat	0	0	0	2	1
Groundhog	0	1	3	0	0
Raccoon	338	276	297	245	251
Skunk	114	60	91	98	93
<u>Opossum</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>
Total	582	458	521	474	452

Table 6 and Figure 8 below show that the relative and absolute frequency of rabies positives reported over the last five years has, in general, decreased for the four most frequently submitted wildlife species.

Table 6. RABIES, Five-Year Frequencies by High Risk Species, 2004 - 2008

SPECIES	2004	2005	2006	2007	2008	Totals
Raccoon	338	276	297	245	251	1407
Bat	28	22	43	34	18	145
Fox	66	68	50	58	57	299
Skunk	114	60	91	98	93	456
Totals	546	426	481	435	419	2307

Figure 8. RABIES, Five Year Trend in Frequency for High Risk Species, North Carolina 2004 – 2008 (N=2307)



Factors Confounding Submission and Rabies Numbers Reported

The animal surveillance data presented here is a select, biased subset and by no means represents the entire population of animals and the totality of rabies positives for each species in North Carolina. In North Carolina submission and testing of animals for rabies at the SLPH, for the most part, occurs as a result of a bite or other exposure to a human or unvaccinated domestic animal. Variations to this policy do occur, and the public health veterinarians are consulted regularly to make testing decisions on a case-by case basis when exceptions to the submission policy are requested.

Several factors may affect the number of submissions by year, by county, and by species and may result in systematic differences in the denominator (submission numbers) and also percent positive by species in North Carolina from year to year. Local animal control services are relied upon to enforce the rabies laws and in doing so respond to requests from multiple sources including local health departments, health care providers, private citizens, and veterinarians to capture animals and submit animal specimens for testing. The exposure details involved in risk assessment may not be accurately recounted or assessed due to factors associated with timeliness of reporting, age of person exposed, emotions aroused with potential

rabies exposures and knowledge of animal risk assessment. Animal risk assessment includes knowledge of high risk rabies wildlife vectors, normal animal health and behavior, and circumstances of exposure (provoked or unprovoked bite).

References

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