J Am Vet Med Assoc. Author manuscript; available in PMC 2016 November 23.

Published in final edited form as:

J Am Vet Med Assoc. 2012 September 15; 241(6): 712–722. doi:10.2460/javma.241.6.712.

Rabies surveillance in the United States during 2011

Jesse D. Blanton, MPH, **Jessie Dyer, MSPH**, **Jesse McBrayer, DVM**, and **Charles E. Rupprecht, VMD, PHD**

Poxvirus and Rabies Branch, Division of High-Consequence Pathogens and Pathology, National Center for Emerging and Zoonotic Infectious Disease, CDC, 1600 Clifton Rd NE, Atlanta, GA 30333.

Summary

During 2011, 49 states and Puerto Rico reported 6,031 rabid animals and 6 human rabies cases to the CDC, representing a 1.9% decrease from the 6,153 rabid animals and 2 human cases reported in 2010. Approximately 92% of reported rabid animals were wildlife. Relative contributions by the major animal groups were as follows: 1,981 raccoons (32.8%), 1,627 skunks (270%), 1,380 bats (22.9%), 427 foxes (71%), 303 cats (5.0%), 65 cattle (1.1%), and 70 dogs (1.2%). Compared with 2010, there was a substantial increase in the number of rabid skunks reported. Six cases of rabies involving humans were reported from California, Massachusetts, New Jersey, New York, and South Carolina. Three cases reported from Massachusetts, New Jersey, and New York were determined to be a result of canine rabies virus variants acquired outside the United States.

The present report provides an update on rabies epidemiology and events in the United States during 2011.

Rabies is a zoonotic disease caused by viruses in the genus *Lyssavirus* and has the highest case fatality ratio of any infectious disease if PEP is not promptly initiated. In the United States, PEP consists of wound care (at a minimum, washing of the wound with soap and water), infiltration with rabies immune globulin, and administration of a series of 4 doses of rabies vaccine over 14 days.[1,2]

In many areas around the world, historical accounts of diseases that most likely represented rabies have been discovered. Although it is suspected that rabies may have been present in the New World before European colonization, the primary sources of rabies during the 20th century (ie, canine rabies virus variants) were likely introduced during colonization.[3,4] Canine rabies was successfully controlled in the United States during the late 1970s, but since that time, rabies has been maintained in multiple mesocarnivore and bat species.

Wildlife have accounted for > 90% of rabid animals reported in the United States since 1980. The primary reservoir species responsible for maintaining rabies are raccoons, bats, skunks, foxes, and mongooses (in Puerto Rico). Transmission of distinct rabies virus variants associated with mesocarnivores occurs in geographically definable regions, where transmission is primarily between members of the same species (Figure 1). The spatial

Address correspondence to Mr. Blanton (asi5@cdc.gov).

boundaries of these rabies virus variants change over time because of virus transmission and animal population interactions.[5] Many natural and anthropomorphic factors impact population dynamics and act as barriers to or corridors for the spread of rabies.[6] In addition, human-mediated translocation of rabid animals into naïve areas remains a threat to control programs.[7–10]

Spillover infection of distinct variants to nonmaintenance species occurs, but does not usually result in sustained transmission.[11] However, host switching of rabies virus variants occurs, and once established, those variants can become enzootic in new reservoir species and perpetuate regionally over time as a novel rabies virus variant.[4,12–14] Phylogenetic analysis of circulating variants suggests that canine rabies virus variants were the probable origins of several circulating wildlife variants of foxes (Alaska, Arizona, and Texas), skunks (California and north central United States), and mongooses (Puerto Rico). The remaining rabies virus variants in the United States (ie, raccoon and south central skunk rabies virus variants) are related ancestrally to bat rabies virus variants.[4] Potential host shifting of bat rabies virus variants to gray foxes in southern Oregon and northern Arizona has been identified on the basis of passive and active surveillance and phylogenetic analysis. Ongoing surveillance is necessary to monitor the circulation of rabies virus variants in the local carnivore populations in these areas to determine whether a new rabies virus variant is emerging and whether initiating or continuing more proactive interventions, such as oral rabies vaccination, is warranted.

In addition to these rabies virus variants in mesocarnivores, there are multiple variants associated with several species of bats. More than 30 species of bats have been reported with rabies in the United States, from which > 8 rabies virus lineages have been identified.[15,16] The greater mobility of bats precludes definitive determination of the distribution of bat rabies virus variants other than the geographic ranges of the implicated host bat species. Furthermore, higher rates of cross-species transmission of rabies virus variants occur, particularly among more phylogenetically related bat species, which share common biological barriers and social structures.[17]

In the United States, the burden of rabies in humans has been dramatically reduced since the 1970s because of diligent public health activities, including vaccination of wildlife and companion animals, education of the public and health professionals, and application of PEP, highlighting the successful application of a one health approach. Despite these advances, human rabies cases, primarily associated with bat exposures, continue to occur. Investigations of human rabies cases are frequently limited by recall bias (with exposures typically occurring several months before the patient becomes ill). Although there is often a history of observing bats, there is not always a report of a known bite, so the risk of contracting rabies from bats may be underappreciated. The Advisory Committee on Immunization Practices recommends evaluation of persons with direct contact with a bat and of persons who may have had unacknowledged contact with a bat (eg, a deeply sleeping, unattended child, mentally disabled person, or intoxicated person finding a bat in a room).[1] If the person is reasonably certain a bite, scratch, or mucous membrane contact did not occur or if the bat was submitted for testing and rabies was excluded, then administration of PEP is not necessary. Rabies control in bats by conventional methods is not currently feasible, and prevention of human rabies infection with bat rabies virus variants will continue to rely on health education to avoid exposure, careful exposure assessment in the event of potential contact (including laboratory testing of animals to exclude rabies), and judicial administration of PEP.

Reporting and Analysis

Human and animal rabies are nationally notifiable conditions in the United States.[18,19] Animal rabies surveillance is laboratory based, comprising 126 state health, agriculture, and university pathology laboratories performing the standard direct fluorescent antibody test for rabies diagnosis.[20] In addition, targeted enhanced surveillance with the direct rapid immunohistochemical test is conducted by more than 25 wildlife biologists engaged by the USDA Wildlife Services in oral rabies vaccination programs.[21]

During 2011, 10 states (Arkansas, Georgia, Idaho, Massachusetts, Michigan, North Dakota, Ohio, South Dakota, Vermont, and West Virginia) transmitted laboratory data for rabies diagnostic activity primarily through the Public Health Laboratory Information System. Other states and USDA Wildlife Services submitted animal rabies data on a monthly or annual basis directly to the CDC Poxvirus and Rabies Branch. A total of 102,193 samples were submitted to a laboratory for rabies testing, of which 99,890 were considered adequate for testing. This represents a 4.5% decrease in the number of animals tested for rabies, compared with the number tested during 2010. A total of 7,283 animals were submitted by USDA Wildlife Services personnel for testing with the direct rapid immunohistochemical test, accounting for 7.3% of all animals tested in 2011.

The CDC rabies program requests detailed information on animals submitted for rabies testing, as described.[22] All states provided data on species, county, and date of testing or collection for all animals submitted for rabies testing, with the exception of Oklahoma, which provided only aggregate numbers by species for nonrabid animals. All states are encouraged to identify bats that are submitted for rabies testing and to characterize the rabies virus variant isolated from rabid animals either through antigenic typing with monoclonal antibodies or by means of genetic sequencing.[23,24]

For the present report, calculations of percentages of rabid animals are based on total numbers of animals submitted for rabies testing. Because most animals submitted for testing are selected on the basis of abnormal behavior or signs of illness, proportions presented in this report are not representative of the incidence of rabies in the general population. In addition, comparisons of percentages of rabid animals between species or states should take into account the underlying bias associated with differences in submission rates and the fact that submission protocols may have differed between species or states. Geographic areas for displayed reservoirs in the United States were produced by aggregating data from 2007 through 2011, and all maps were produced as described.[22] Areas designated with potential host shift events signify regions where new rabies virus variants may be emerging because of spillover of a bat rabies virus variant with perpetuation in a mesocarnivore species. Designation of an area as the location of a potential host shift event is based on reports of a bat rabies virus variant (determined by means of antigenic or phylogenetic characterization) circulating in a species of the order Carnivora for at least 2 years at levels above that normally associated with incidental spillover. Once designated, regions will be listed until either there is enough evidence to support that a novel rabies virus variant has been established or until no rabid animals with the associated rabies virus variant have been reported for 3 years.

Calculations of submission rates in the present report were based on 2010 population data available from the US Census Bureau. Animal rabies data for Canada during 2011 were provided by the Centre of Expertise for Rabies—Ottawa Laboratory Fallowfield and the Terrestrial Animal Health Division, Canadian Food Inspection Agency. Data for Mexico were obtained from the Pan American Health Organization Epidemiological Information System.[a]

Rabies in Wild Animals

Wild animals accounted for 5,535 (91.8%) of the rabid animals reported in 2011, representing a 2.3% decrease in the number of rabid wild animals reported, compared with 2010 (Figure 2). Raccoons continued to be the most frequently reported rabid wildlife species (32.8% of all rabid animals during 2011), followed by skunks (27.0%), bats (22.9%), foxes (7.1%), and other wild animals including rodents and lagomorphs (2.0%). Seasonal trends for wildlife species were similar to trends for previous years, with peaks in numbers of rabid raccoons and skunks reported in March to May and a second peak around September. Number of rabid foxes had a moderate peak around June to July, and number of rabid bats peaked sharply in August.

Raccoons

The 1,981 rabid raccoons reported in 2011 represented an 11.8% decrease, compared with the number reported in 2010, continuing a declining trend that began in 2006 (Table 1). Percentage of raccoons submitted for rabies testing that were found to be rabid decreased to 14.5%, but this was not significantly different from the previous 5-year average of 15.6% (95% CI, 13.2% to 18.1%). Fewer rabid raccoons were reported by 12 of the 20 eastern states and the District of Columbia, where raccoon rabies is enzootic, with decreases of ≥ 50% reported by 4 localities (New York City, 93.5% decrease; Alabama, 84.1%; Delaware, 75.0%; and District of Columbia, 51.9%). States in the northeast and mid-Atlantic in which raccoon rabies is enzootic accounted for 70.3% (1,393 cases; 14.0% decrease) of all rabid raccoons reported in 2011 (Figure 3). The southeastern states of Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee, where raccoon rabies is enzootic, reported 27.7% (549 cases; 9.4% decrease) of all rabid raccoons. Rabid raccoons reported by South Dakota (2; causative rabies virus variant uncharacterized) and Texas (37; south central skunk rabies virus variant) accounted for the remaining cases reported in 2011.

Excluding Tennessee and Ohio, where raccoon rabies represents a small proportion of reported rabid animals, states in which raccoon rabies is enzootic reported 62.3%

[a]SIEPI Epidemiological information System [database online], Washington, DC: Pan American Health Organization, Pan American Center for Foot-and-Mouth Disease, 2009. Available at: www.paho.org/common/Display.asp?Lang=E&RecID=9260.

(3,758/6,031) of the national total of rabid animals and 73.1% (3,401/4,651) of all rabid animals excluding bats. Overall, states in which raccoon rabies is enzootic submitted 38.1 animals/100,000 persons for rabies testing during 2011, down from 41.0 animals/100,000 persons during 2010.

Bats

The 1,380 rabid bats reported during 2011 represented a 3.5% decrease, compared with the number reported in 2010. Percentage of bats submitted for rabies testing that were found to be rabid (5.9%) was lower than the average for the previous 5 years (6.1%; 95% CI, 5.8% to 6.3%), but not significantly so. Rabid bats were reported from all 48 contiguous states with the exception of Delaware (Figure 4). Five states (Idaho, Indiana, Mississippi, Utah, and Washington) reported rabies in bats only. A ≥ 50% decrease in the number of rabid bats was reported by 4 states (Alabama, Illinois, Missouri, and South Carolina). Over 40% (9,757/23,370) of the bats submitted for rabies testing were identified beyond the taxonomic level of order (Table 2). Overall, states where bats are the only recognized reservoir for rabies submitted 10.6 animals/100,000 persons during 2011, down from 11.0 animals/100,000 persons during 2010.

Skunks

The 1,627 rabid skunks reported during 2011 represented a 12.4% increase, compared with the number reported in 2010. Percentage of skunks submitted for rabies testing that were found to be rabid (29.4%) increased significantly from the previous 5-year average (26.5%; 95% CI, 25.1% to 27.9%). Six of the 22 states where skunk rabies virus variants are enzootic reported a ≥ 50% increase in the number of rabid skunks during 2011 (Arkansas, Montana, New Mexico, North Dakota, Texas, and Wisconsin). No rabid skunks have been reported from Illinois since 2005 or from Indiana since 2007.

Overall, 47.2% of the rabid skunks identified during 2011 were from states where the south central skunk rabies virus variant is enzootic (24.3% increase from 2010), 8.8% were from states where the north central skunk rabies virus variant is enzootic (13.8% decrease), 0.7% were from California (47.8% decrease), and 43.2% were from states where the raccoon rabies virus variant is enzootic (9.8% increase; Figure 5). For the third consecutive year, Ohio reported more rabid skunks than rabid raccoons in the counties where the raccoon rabies virus variant is enzootic. Overall, states where skunks are the primary reservoir for rabies submitted 30.7 animals/100,000 persons for rabies testing during 2011, down from 32.2 animals/100,000 persons in 2010. When stratified by the various skunk rabies virus variants, similar decreases in submission rates were observed for the south central, north central, and California skunk rabies virus variants (36.8, 35.0, and 15.8 animals/100,000 persons, respectively).

Foxes

The 427 rabid foxes reported during 2011 represented a 0.5% decrease, compared with the number reported in 2010. Percentage of foxes submitted for rabies testing that were found to be rabid (19.2%) was significantly lower than the average for the 5 previous years (25.9%; 95% CI, 24.6% to 27.2%). Most of the rabid foxes (370; [86.6%]) were reported from states where raccoon rabies is enzootic (Figure 6). Besides rabid foxes attributable to spillover from rabid raccoons, 33 (7.7%) rabid foxes were attributable to spillover from rabid skunks, 12 (2.8%) were attributable to the arctic fox rabies virus variant, and 4 (1.4%) were attributable to the Arizona gray fox rabies virus variant. Nine (2.0%) rabid foxes were characterized with a bat rabies virus variant, including 5 rabid foxes in southern Oregon, where a similar cluster occurred in 2010, and 2 rabid foxes reported from Coconino County, Ariz, with the same *Eptesicus fuscus* rabies virus variant associated with a 2009 epizootic in the same area. No rabid foxes associated with the Texas gray fox rabies virus variant were reported during 2011.

Other wild animals

Puerto Rico reported 35 rabid mongooses during 2011, a 40% increase from the 25 cases reported in 2010. Other reported rabid wildlife included 45 groundhogs (*Marmota monax*), 19 bobcats (*Lynx rufus*), 8 coyotes (*Canis latrans*), 5 deer (presumably *Odocoileus virginianus*), 3 beavers (*Castor canadensis*), 2 otters (presumably *Lontra canadensis*), 2 javelinas (*Pecari tajacu*), and 1 wolf hybrid. With the exception of 1 groundhog from Michigan, all rodents were reported from states where raccoon rabies is enzootic.

Rabies virus variants infecting 3 of the 8 rabid coyotes were characterized; these 3 coyotes were infected with the raccoon rabies virus variant (Virginia), south central skunk rabies virus variant (Texas), and a bat rabies virus variant (Oregon). Variant information was not reported for rabid coyotes in Connecticut (1), Massachusetts (1), North Carolina (2), and Pennsylvania (1).

Rabies in Domestic Animals

Domestic animals accounted for 8.2% of all rabid animals reported in 2011, an increase of 1.8%, compared with the number reported in 2010. Number of reported cases of rabies either remained equal or increased for all domestic species, with the exception of cattle. Five states together reported more than half of the rabid domestic animals in 2011: Texas (76), Pennsylvania (61), New York (46), Virginia (46), and Georgia (38).

Cats and dogs

Rabid cats continued to represent the majority (61.1%) of reported rabid domestic animals. Most (81.5%) of the 303 rabid cats were reported from states where raccoon rabies is enzootic, with 3 states (New York, Pennsylvania, and Virginia) accounting for nearly half of the rabid cats reported in 2011 (Figure 7). The percentage of cats submitted for testing that were found to be rabid (1.2%) was significantly higher than the average for the 5 previous years (1.0%; 95% CI, 0.9% to 1.1%). Twenty-three states, the District of Columbia, and New York City did not report any rabid cats. Results of viral typing were provided for 124 (40.9%) of the rabid cats reported in 2011. Of those, 83 (66.9%) were infected with a raccoon rabies virus variant, 35 (28.2%) were infected with a south central skunk rabies virus variant, and 4 (3.2%) were infected with a north central skunk rabies virus variant, corresponding to the primary carnivore rabies virus variant in the state from which the cat was reported. Viral typing of 2 cats (Iowa and Texas) identified a bat rabies virus variant.

During 2011, 70 rabid dogs were reported, a 1.4% increase, compared with the number reported in 2010. The percentage of dogs submitted for rabies testing that were found to be rabid (0.3%) was not significantly different from the average for the previous 5 years (0.3%; 95% CI, 0.2% to 0.3%). Georgia (12), Oklahoma (10), and Texas (9) reported the largest numbers of rabid dogs. No other states reported > 4 rabid dogs in 2011. Thirty states, the District of Columbia, and New York City did not report any rabid dogs during 2011.

After dogs from Puerto Rico, which presumably were infected with a canine-mongoose rabies virus variant, were excluded, information on rabies virus variant was available for 42 of the 66 (63.6%) rabid dogs reported during 2011. Variant information was not reported for dogs from Connecticut (1 rabid dog), Florida (1), Georgia (9), Maryland (1), North Carolina (1), North Dakota (2), Ohio (1), Oklahoma (1), Pennsylvania (2), South Dakota (3), and Virginia (2). Among rabid dogs for which rabies virus variant was reported, 19 were infected with the south central skunk variant, 12 were infected with a raccoon variant, 9 were infected with the north central skunk variant, and 2 were infected with Arctic fox rabies virus variants. Vaccination status was reported for 19 of the 70 (27%) rabid dogs. Of these, 3 had a history of rabies vaccination; however, none of the 3 dogs were considered current on their rabies vaccine status as defined by the compendium of animal rabies control.[25]

Other domestic animals

The number of rabid cattle decreased 8.4%, from 71 in 2010 to 65 in 2011. Texas (10 rabid cattle), Virginia (10), New York (6), Pennsylvania (6), and Minnesota (5) reported the largest numbers of rabid cattle. No other states reported > 4 rabid cattle during 2011. The 44 rabid horses and mules in 2011 represented an 18.9% increase, compared with the number reported during 2010. Number of rabid goats and sheep increased 100%. A rabid bison was reported from Minnesota, and a rabid alpaca was reported from Texas.

Rabies in Humans

During 2011, samples from 41 humans from 24 states were submitted to the CDC for rabies testing, representing a 2.5% increase from 2010. Six cases of human rabies were confirmed. Excluding 2004, when 4 of 8 cases were associated with organ transplantation, this represented the most cases of human rabies reported in a single year since 1994. Thirty-three human rabies cases have been reported in the United States since 2002 (Table 3). Of the 24 human patients with domestically acquired rabies (including Puerto Rico), 17 (71%) were male; median age was 35 years. Phylogenetic analysis or epidemiological investigations implicated a bat in 21 of the 24 (87.5%) patients with domestically acquired rabies. Only 3 human rabies cases since 2002 were not associated with exposure to bats, including patients from Virginia (2003; infecting variant was typed as a raccoon rabies virus variant), Puerto Rico (2003; infecting variant was typed as a mongoose rabies virus variant), and California (2011; causative source was not identified). Excluding the 4 human rabies cases associated with organ transplantation, 13 of 20 (65%) patients with domestically acquired rabies reported a bite or direct contact with the animals involved in the exposure.

In May 2011, an 8-year-old girl was brought to an emergency department in a rural county in California with a history of sore throat, difficulty swallowing, and weakness.[26] After presentation, she developed flaccid paralysis and encephalitis. Samples were submitted to the California Encephalitis Project at the California Department of Public Health, where rabies testing was performed on the basis of compatible clinical signs and negative results for other routine tests. The California Department of Public Health detected rabies virus–specific IgM and IgG in a serum sample from the patient. Additional samples were submitted to the CDC, where rabies virus–specific antibodies were also detected in CSE. No rabies virus antigen or nucleic acid was detected in a nuchal skin biopsy specimen or saliva sample. A rabies diagnosis was made on the basis of identification of specific antibodies in serum and CSF in conjunction with compatible clinical signs and a lack of alternative etiologies despite comprehensive testing. Because of this presumptive diagnosis of rabies, the patient was started on an experimental rabies treatment protocol. On the 8th day of hospitalization, the patient began to move her head spontaneously, and she was extubated on the 16th day of hospitalization. Approximately 2 months after hospitalization, following some rehabilitation services, she showed no signs of cognitive impairment. Although no definitive animal exposure was identified, the patient did confirm that she had been scratched by 2 cats in a feral colony at her school 4 to 9 weeks before the onset of symptoms. One of the 2 cats was identified and was still healthy, but the other cat was lost to follow-up.

In June 2011, a 73-year-old woman developed right shoulder pain, chest pain, headaches, and hypertension.[27] She was admitted to an emergency department on July 2 after her symptoms continued to progress and she developed a fever and became increasingly combative. After other etiologies of encephalitis were ruled out, samples were submitted to the CDC for rabies testing on July 15. Rabies was confirmed by antigen detection in a nuchal skin biopsy specimen and detection of rabies virus RNA in a saliva sample. Sequencing of viral amplicons identified a canine rabies virus variant associated with rabid dogs from Haiti. The patient's condition worsened, and she was declared dead on July 20. Following interviews with the patient's family, a history of a dog bite while the patient was visiting family in Haiti in April was identified. The patient had not considered the bite serious at the time and did not seek medical attention.

In August 2011, a 24-year-old male Army soldier was admitted to a hospital in New York.[28] He had recently returned to New York to begin a new military assignment after having been stationed in Germany from May to August following deployment in Afghanistan. The patient presented with difficulty swallowing, neck tendinitis, and dehydration. He was lucid at admission and provided a history of receiving a dog bite on the right hand in January while in Afghanistan. Samples were submitted for rabies testing to the New York State Department of Health Wadsworth Center and the CDC, where rabies was confirmed on August 20. Sequencing of viral amplicons identified a canine rabies virus variant associated with dogs in Afghanistan. The patient was started on an experimental treatment protocol, but his condition worsened, and he died on August 31.

In September 2011, a 40-year-old man presented to an emergency department in Massachusetts with leg pain and intermittent fever. After admission, he experienced progressive confusion, ataxia, and loss of CNS function. After other etiologies for encephalitis were ruled out, samples were submitted in early October to the CDC, where rabies virus–specific antibodies were identified in the patient's serum and CSF. The patient died shortly after the diagnosis, 31 days after initial hospitalization. Postmortem examination of brain material identified rabies virus antigens and RNA. Sequence analysis of viral amplicons identified a canine rabies virus variant associated with dogs in Brazil. After the diagnosis was established, interviews with family members indicated a history of contact with a "rabid-acting" dog while living in Brazil, approximately 8 years prior to becoming ill. An investigation of the patient's travel history did not identify any intermittent travel to Brazil since that time. Results of additional phylogenetic analysis and consultation with the Brazilian Ministry of Health were also consistent with the time frame of this long incubation period.

In December 2011, a 46-year-old woman presented to an emergency department in South Carolina with a history of shortness of breath, sweating, numbness in the hands, and dizziness. Shortly after she was admitted, the patient's family provided a history of bats entering the living area of the patient's home, and samples were sent for rabies testing to the CDC, where rabies was confirmed. Sequencing of viral amplicons from a saliva sample from the patient identified a rabies virus variant associated with free-tailed bats (*Tadarida brasiliensis*). The patient's condition did not improve, and she died 16 days following hospitalization. Further interviews with the patient's family identified multiple instances in which bats were observed in the patient's home from July to August, including an incident of waking to find a bat in her bedroom. The patient's family reported no known bites.

In December 2011, a 63-year-old man presented to an emergency department in Massachusetts with a history of elbow pain and decreased appetite. Upon admission, his condition progressed rapidly and included onset of hydrophobia. The patient provided a history of waking to find a bat in his bedroom approximately 2 to 3 months prior to the onset of symptoms. Rabies was suspected, and samples were sent for rabies testing to the CDC, where rabies was confirmed. Sequencing of viral amplicons from a saliva sample from the patient identified a rabies virus variant associated with bats in the *Myotis* genus. The patient was started on an experimental treatment protocol, but his condition did not improve, and he died in January 2012, 28 days after hospitalization.

Rabies in Canada and Mexico

Canada reported 115 laboratory-confirmed rabid animals during 2011, a 6.5% decrease from the number reported during 2010. A decrease in total numbers of rabid animals has been reported 9 of the past 10 years. Ninety-two percent (n = 106) were rabid wildlife, 2.6% (3) were rabid livestock, and 5.2% (6) were rabid cats and dogs. The overall number of animals submitted for diagnostic testing to the Canadian Food Inspection Agency rabies laboratories declined 6.3%, from 4,898 in 2010 to 4,589 in 2011. In addition to Canadian Food Inspection Agency submissions, several provincial ministries undertook active wildlife rabies surveillance testing during 2011, and no rabid animals were identified. No rabid raccoons have been reported in Canada since 2008. One rabid wolf was reported in Canada in 2011, compared with zero in 2010. Numbers of rabid skunks, bats, and dogs that were reported decreased by 30.0% (60 to 42), 2.1% (48 to 47), and 33.3% (3 to 2), respectively. Increases were reported in the numbers of equids (100%; 1 to 2) and foxes (166%; 6 to 16).

Numbers of rabid cattle and cats reported remained the same as in 2010. No human cases of rabies were reported in Canada during 2011.

Mexico reported 148 rabid animals during 2011, a 58.5% decrease from the number reported during 2010. Nearly 82% (121/148) of reported rabid animals were cattle. Twenty rabid dogs (no change from 2010) were reported, with evidence of limited circulation of canine rabies virus variants in some localities. Other rabid animals reported during 2011 included 3 rabid horses and 4 rabid wild animals. Three human rabies cases were reported from Mexico during 2011; 2 cases were associated with vampire bat exposures, and 1 was associated with a skunk.

Discussion

The CDC has requested information on all animals submitted for rabies testing since 2006. The number of animals submitted for rabies testing peaked in 2008 at 121,728 animals. However, a substantial decline in the number of animals tested was reported in 2010 (12.5% decrease from 2009), and this trend continued into 2011, marking the first time fewer than 100,000 animals were tested for rabies since 2006. Over the past 5 years, US laboratories have tested an average of 112,837 (95% CI, 105,119 to 120,554) animals each year.

Laboratory testing of animals involved in a human or domestic animal exposure remains a critical public health function. Laboratory testing provides information that often directly affects whether a person receives PEP. Each year, rabies is ruled out in more than 99,000 of the animals submitted for testing. A previous study[29] suggested that the average cost of collecting and testing an animal for rabies virus infection was approximately $400. This would place the national costs for laboratory-based rabies surveillance at approximately $45 million annually. This cost is approximately equal to the cost of providing PEP to an additional 15,000 persons. It seems likely that without laboratory-based rabies surveillance, the number of additional individuals who would receive PEP would greatly exceed this number. Nevertheless, even though the cost savings associated with a decrease in the number of individuals requiring PEP is high, additional research into the current epidemiology of human rabies exposure and PEP, including cost estimates for testing of animals and administration of PEP, is needed. Improved surveillance for PEP should allow for development of best practices and greater efficiencies in rabies risk assessment and prophylaxis.

Ongoing analysis of the genetic sequence of viruses involved in the apparent host shift of a big brown bat rabies virus variant into skunks and foxes in the Flagstaff, Ariz, area has suggested that at least 3 separate introductions occurred from 2001 through 2009,[12,14] given the identification of 2 distinct lineages associated with skunks in 2001 and a lineage associated with an epizootic in gray foxes in 2009. That these host shifts into skunk and fox populations remained transient may be due in part to control efforts, but it remains unknown whether the viruses would have continued to perpetuate had no control efforts taken place. Although passive surveillance has not identified continued perpetuation in local skunk populations, the identification of 2 foxes during 2011 in the Grand Canyon National Park, just north of Flagstaff, infected with an *E fuscus* rabies virus variant may suggest the 2009 host shift to gray foxes has perpetuated and expanded or, alternatively, that increased contact rates between bats and foxes continue in the region. In addition, a cluster of rabid gray foxes has been reported in Josephine County in southern Oregon since 2010. These cases may also represent either the beginning suggestion of a potential host shift or environmental changes that are facilitating increased contact between foxes and bats. Active surveillance, including extensive sequencing of any viruses isolated from carnivores in these regions, is needed to monitor this ongoing event. In addition, accurate species identification of bats submitted for rabies testing and sequencing of bat rabies virus variants will be needed to improve our understanding of the emergence of rabies virus variants.[14,17] Identifying a potential host shift early in its evolution may allow for a more comprehensive intervention with a higher likelihood of controlling and eliminating it.

Following the elimination of canine rabies virus variants in the United States, oral rabies vaccination of free-ranging wildlife has become a critical management practice. Over the past 40 years, oral rabies vaccination has been responsible for the successful elimination of rabies in red foxes in several European countries and a canine rabies virus variant in coyotes in Texas.[4,30] In addition, efforts are ongoing to eliminate a gray fox rabies virus variant in Texas and prevent the westward spread of the raccoon rabies virus variant.[21] To date, oral rabies vaccination in the United States has used the recombinant vaccinia-rabies glycoprotein vaccine for all baiting programs. Recently, a new recombinant human adenovirus-rabies glycoprotein vaccine has been developed and used in Canada.[31] To continue evaluation of this vaccine in the United States, a field trial was conducted in West Virginia during September 2011. Approximately 80,000 baits containing this vaccine were distributed over 1,400 km^2. Analysis of postbaiting serologic test results is ongoing, but preliminary results suggested a higher conversion rate was achieved with the adenovirus-rabies glycoprotein vaccine, compared with that achieved with the vaccinia-rabies glycoprotein vaccine. This finding is compatible with prior field studies[32] in Canada. Continued development of oral rabies vaccination, in addition to new baits and new distribution strategies, will be important for improving field performance and the success of such programs in the United States.

Efforts on a global scale continue to focus on reducing the burden of disease through the elimination of canine rabies. Preliminary work to reevaluate the global burden of rabies suggests that the annual human mortality rate is considerably higher than the 55,000 deaths estimated in 2005.[33] Successful efforts toward canine rabies elimination have been demonstrated. Canine rabies has been eliminated from western Europe and is approaching elimination throughout the Americas. The continued burden of canine and human rabies remains distributed throughout Africa and Asia. Even in these regions, successful community-driven prevention and control efforts have shown recent success at establishing sustainable rabies programs.[34] Recognizing that the elimination of canine rabies and the subsequent reduction in human deaths are a global public good, development of global efforts to eliminate canine rabies is needed. Canine rabies elimination is distinguishable from some other high-burden diseases through the availability of highly effective biologics and documented strategies that permit cost-effective intervention. Rabies is often considered a classic example of one health medicine in practice. Modern tools exist to make the elimination of canine rabies a successful and global one health legacy in the future.[35]

International recognition of the burden of rabies and the capacity to eliminate canine rabies is needed to commit resources toward this effort.

2012 Rabies Update

No human cases of rabies were reported in the United States during the first half of 2012. Additional evaluations of the AdRG1.3 recombinant oral rabies vaccine are planned by the USDA Wildlife Services during oral rabies vaccination baiting campaigns targeting raccoons during the fall of 2012. These evaluations include an expansion of the West Virginia site, where this vaccine was used in 2011, as well as additional sites in Ohio and New York. May 2012 marked 3 years since the last case of an animal with the Texas gray fox rabies virus variant was reported in the United States. Enhanced surveillance activities are ongoing to determine whether oral vaccination efforts have been successful in eliminating this variant.

Acknowledgments

Use of trade names and commercial sources is for identification only and does not imply endorsement by the US Department of Health and Human Services. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the CDC.

The authors thank the state and territorial health and agriculture departments and laboratories for their contributions of rabies surveillance data and human case investigations, especially C. Glaser, California Department of Public Health; E Sorhage, New Jersey Department of Health and Senior Services; Bryan Cherry, New York State Department of Health; Catherine Brown, Massachusetts Department of Public Health; and Stephanie Cox, South Carolina Department of Health and Environmental Control. The authors also thank L. Orciari, P. Yager, A. Velasco-Villa, I. Kuzmin, and D. Hightower for assistance with diagnostic testing and viral typing.

Abbreviations

CI	Confidence interval
PEP	Postexposure prophylaxis

References

1. Manning SE, Rupprecht CE, Fishbein D, et al. Human rabies prevention—United States, 2008: recommendations of the Advisory Committee on Immunization Practices. MMWR Recomm Rep. 2008; 57:1–28.
2. Rupprecht CE, Briggs D, Brown CM, et al. Use of a reduced (4-dose) vaccine schedule for postexposure prophylaxis to prevent human rabies. MMWR Recomm Rep. 2010; 59:1–9.
3. Baer, GM. The history of rabies. In: Jackson, AC.; Wunner, WH., editors. Rabies. 2nd. London: Academic Press; 2007. p. 1-22.
4. Velasco-Villa A, Reeder SA, Orciari LA, et al. Enzootic rabies elimination from dogs and reemergence in wild terrestrial carnivores, United States. Emerg Infect Dis. 2008; 14:1849–1854. [PubMed: 19046506]
5. Childs JE, Curns AT, Dey ME, et al. Predicting the local dynamics of epizootic rabies among raccoons in the United States. Proc Natl Acad Sci U S A. 2000; 97:13666–13671. [PubMed: 11069300]
6. Recuenco S, Eidson M, Cherry B, et al. Factors associated with endemic raccoon (*Procyon lotor*) rabies in terrestrial mammals in New York State, USA. Prev Vet Med. 2008; 86:30–42. [PubMed: 18406482]
7. CDC. Extension of the raccoon rabies epizootic—United States, 1992. MMWR Morb Mortal Wkly Rep. 1992; 41:661–664. [PubMed: 1513301]

8. CDC. Translocation of coyote rabies—Florida, 1994. MMWR Morb Mortal Wkly Rep. 1995; 44:580–581. 587. [PubMed: 7623760]
9. CDC. Rabies in a dog imported from Iraq—New Jersey, June 2008. MMWR Morb Mortal Wkly Rep. 2008; 57:1076–1078. [PubMed: 18830211]
10. McQuiston JH, Wilson T, Harris S, et al. Importation of dogs into the United States: risks from rabies and other zoonotic diseases. Zoonoses Public Health. 2008; 55:421–426. [PubMed: 18833595]
11. Guerra MA, Curns AT, Rupprecht CE, et al. Skunk and raccoon rabies in the eastern United States: temporal and spatial analysis. Emerg Infect Dis. 2003; 9:1143–1150. [PubMed: 14519253]
12. Leslie MJ, Messenger SL, Rohde RE, et al. Bat-associated rabies virus in skunks. Emerg Infect Dis. 2006; 12:1274–1277. [PubMed: 16965714]
13. Arechiga-Ceballos N, Velasco-Villa A, Shi M, et al. New rabies virus variant found during an epizootic in white-nosed coatis from the Yucatan Peninsula. Epidemiol Infect. 2010; 138:1586–1589. [PubMed: 20392303]
14. Kuzmin IV, Shi M, Orciari LA, et al. Molecular inferences suggest multiple host shifts of rabies viruses from bats to mesocarnivores in Arizona during 2001–2009. PLoS Pathog [serial online]. 2012; 8:e1002786. [Accessed Jul 31, 2012] Available at: www.plospathogens.org/article/info%3Adoi%2F10.1371%2Fjournal.ppat.l002786.
15. Kuzmin, I.; Rupprecht, C. Bat rabies. In: Jackson, AC.; Wunner, WH., editors. Rabies. 2nd. London: Academic Press; 2007. p. 259-307.
16. Patyk K, Turmelle A, Blanton JD, et al. Trends in national surveillance data for bat rabies in the United States: 2001–2009. Vector Borne Zoonotic Dis. 2012; 12:666–673. [PubMed: 22607069]
17. Streicker DG, Turmelle AS, Vonhof MJ, et al. Host phylogeny constrains cross-species emergence and establishment of rabies virus in bats. Science. 2010; 329:676–679. [PubMed: 20689015]
18. Council of State and Territorial Epidemiologists. Public health reporting and national notification for animal rabies. 09-ID-12. Atlanta: Council of State and Territorial Epidemiologists; 2009. Available at: www.cste.org/ps2009/09-ID-12.pdf [Accessed Jul 31, 2012]
19. Council of State and Territorial Epidemiologists. National surveillance for human rabies. 09-ID-70. Atlanta: Council of State and Territorial Epidemiologists; 2009. Available at: www.cste.org/ps2009/09-ID-70.pdf [Accessed Jul 31, 2012]
20. CDC. Protocol for postmortem diagnosis of rabies in animals by direct fluorescent antibody testing. Atlanta: CDC; 2003. Available at: www.cdc.gov/rabies/docs/standard_dfa_protocol_rabies.pdf [Accessed jul 31, 2012]
21. Slate D, Algeo TP, Nelson KM, et al. Oral rabies vaccination in North America: opportunities, complexities, and challenges. PLoS Negl Trop Dis [serial online]. 2009; 3:e549. [Accessed Jul 31, 2012] Available at: www.ploscollections.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0000549;jsessionid=5B04B8B50E07D48A447FDA4AECF1C2DC.
22. Blanton JD, Palmer D, Dyer J, et al. Rabies surveillance in the United States during 2010. J Am Vet Med Assoc. 2011; 239:773–783. [PubMed: 21916759]
23. Smith JS. Rabies virus epitopic variation: use in ecologic studies. Adv Virus Res. 1989; 36:215–253. [PubMed: 2472046]
24. Velasco-Villa A, Orciari LA, Juarez-Islas V, et al. Molecular diversity of rabies viruses associated with bats in Mexico and other countries of the Americas. J Clin Microbiol. 2006; 44:1697–1710. [PubMed: 16672396]
25. National Association of State Public Health Veterinarians. Compendium of animal rabies prevention and control, 2011. MMWR Recomm Rep. 2011; 60:1–17.
26. CDC. Recovery of a patient from clinical rabies—California, 2011. MMWR Morb Mortal Wkly Rep. 2012; 61:61–65. [PubMed: 22298301]
27. CDC. Imported human rabies—New Jersey, 2011. MMWR Morb Mortal Wkly Rep. 2012; 60:1734–1736. [PubMed: 22217622]
28. CDC. Imported human rabies in a US Army soldier—New York, 2011. MMWR Morb Mortal Wkly Rep. 2012; 61:302–305. [PubMed: 22552206]
29. Shwiff SA, Sterner RT, Jay MT, et al. Direct and indirect costs of rabies exposure: a retrospective study in Southern California (1998–2002). J Wildl Dis. 2007; 43:251–257. [PubMed: 17495309]

30. Blancou J. The control of rabies in Eurasia: overview, history and background. Dev Biol (Basel). 2008; 131:3–15. [PubMed: 18634461]

31. Knowles MK, Nadin-Davis SA, Sheen M, et al. Safety studies on an adenovirus recombinant vaccine for rabies (AdRG1.3-ONR-AB®) in target and non-target species. Vaccine. 2009; 27:6619–6626. [PubMed: 19698811]

32. Fehlner-Gardiner C, Rudd R, Donovan D, et al. Comparing On-rab® and Raboral V-Rg® oral rabies vaccine field performance in raccoons and striped skunks, New Brunswick, Canada, and Maine, USA. J Wildl Dis. 2012; 48:157–167. [PubMed: 22247384]

33. Knobel DL, Cleaveland S, Coleman PG, et al. Re-evaluating the burden of rabies in Africa and Asia. Bull World Health Organ. 2005; 83:360–368. [PubMed: 15976877]

34. Elliott, J. [Accessed jul 31, 2012] Case Studies for Global Health website. The Bohol Rabies Project: a model for a sustainable rabies prevention and elimination program. 2012 May 3. Available at: casestudies-forglobalhealth.org/post.cfm/the-bohol-rabies-project-a-model-for-a-sustainable-rabies-prevention-and-elimination-program

35. Lembo T. The blueprint for rabies prevention and control: a novel operational toolkit for rabies elimination. PLoS Negl Prop Dis [serial online]. 2012; 6:e1388. [Accessed jul 31, 2012] Available at: www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001388.

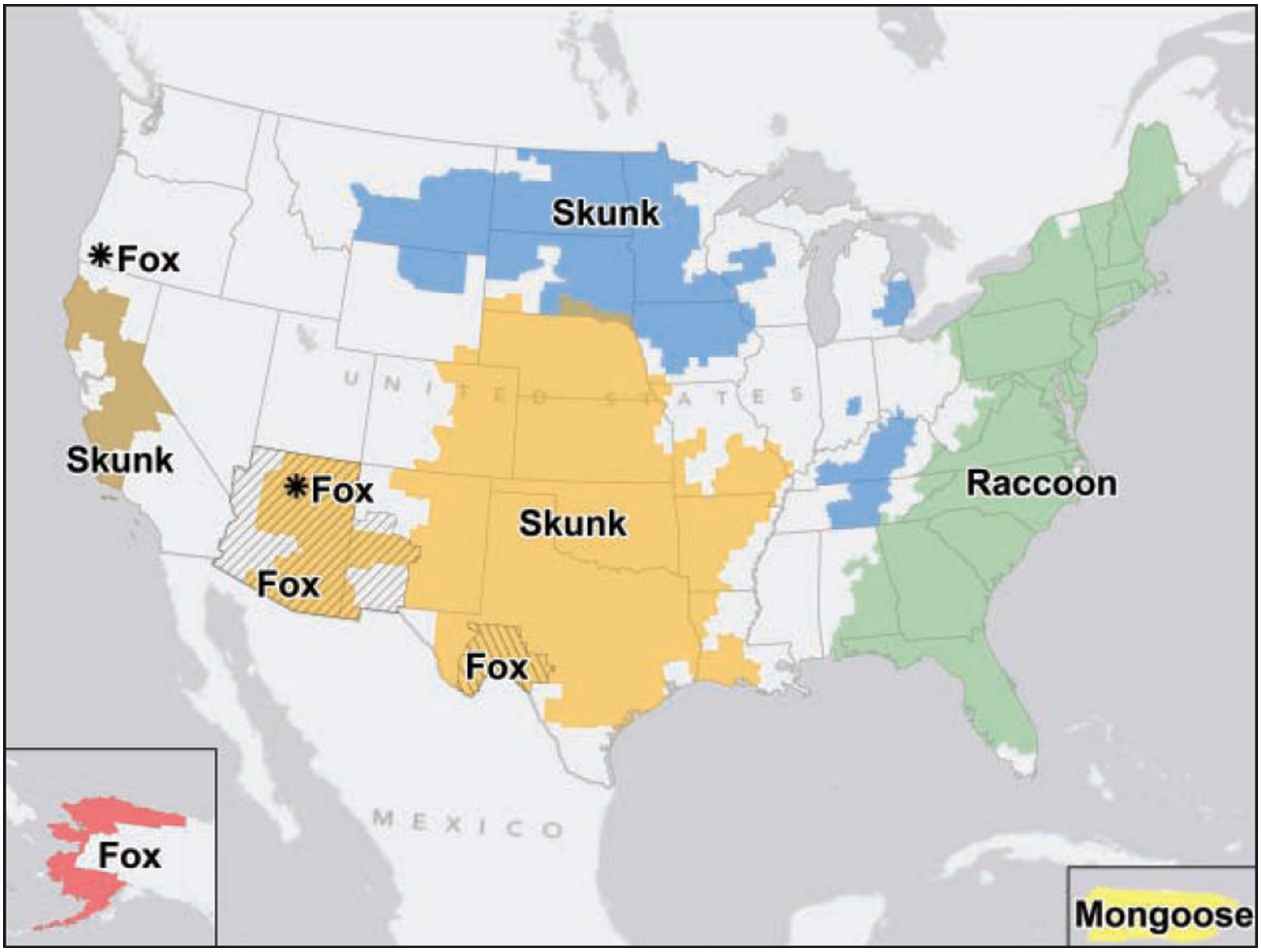

Figure 1.

Distribution of major rabies virus variants among mesocarnivore reservoirs in the United States and Puerto Rico, 2007 to 2011. *Potential host shift event.

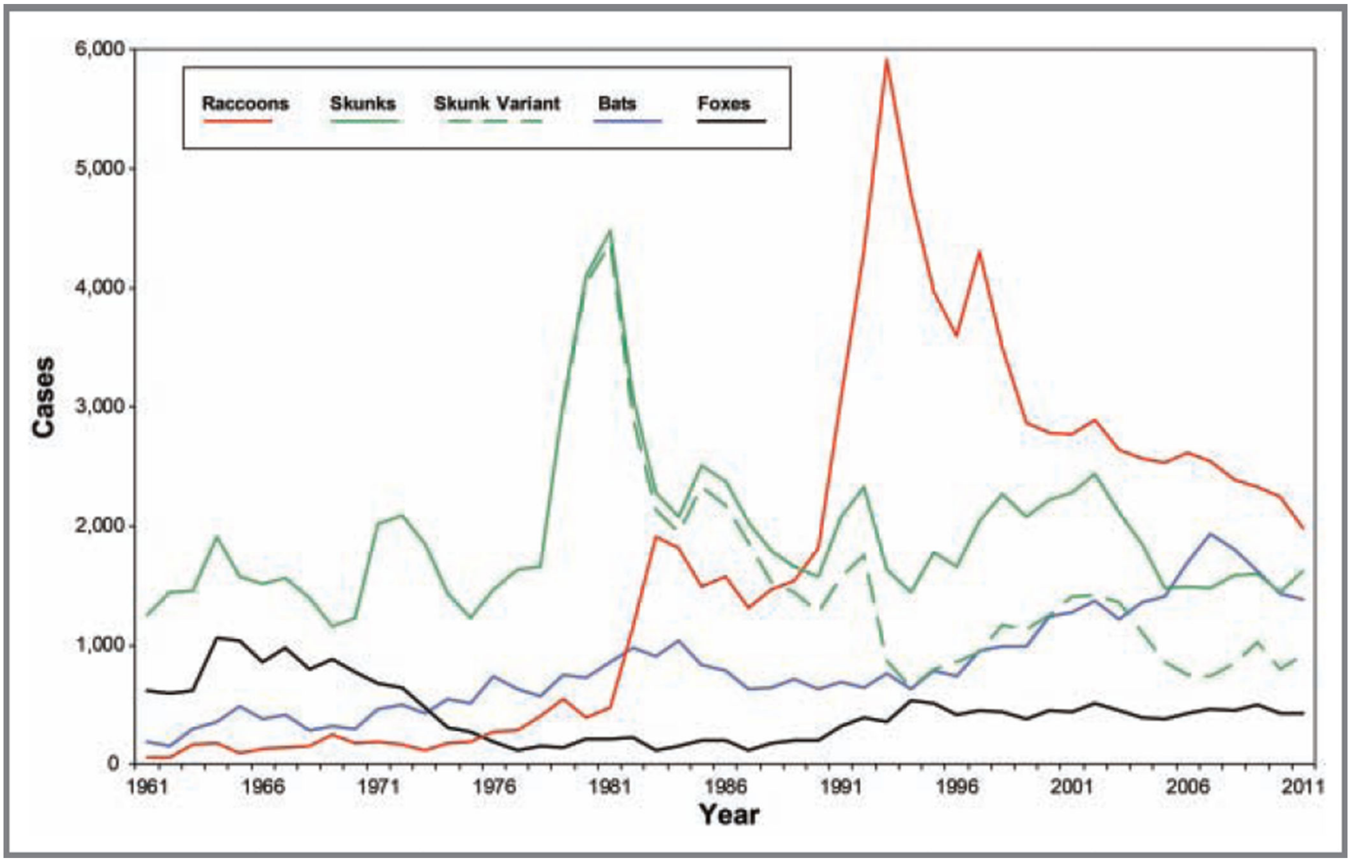

Figure 2.

Cases of rabies among wildlife in the United States, by year and species, 1961 to 2011.

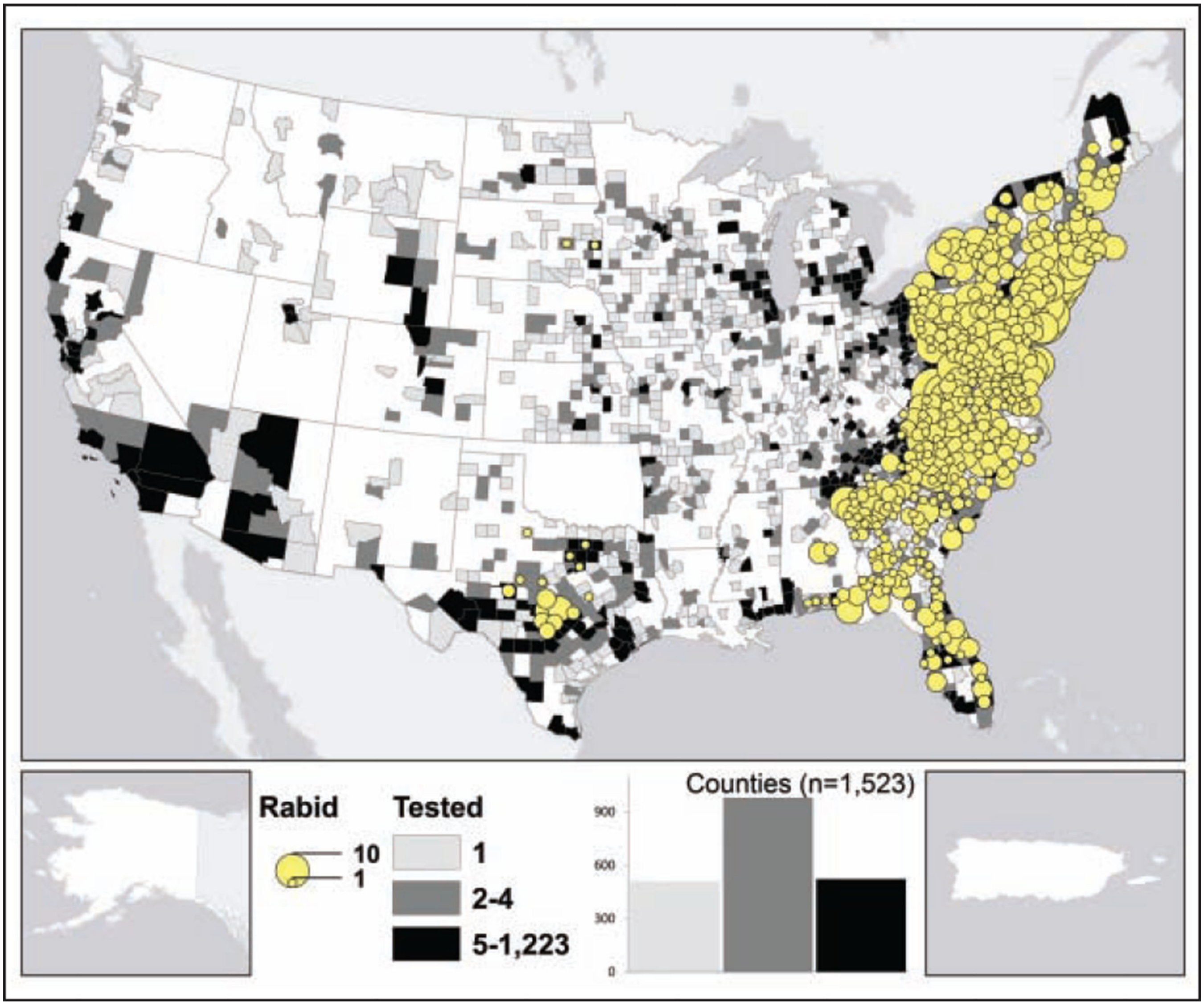

Figure 3.
Reported cases of rabies involving raccoons, by county, 2011. Histogram represents number of counties in each category for total number of raccoons submitted for testing (information on number of raccoons submitted for testing by county was not provided for Oklahoma).

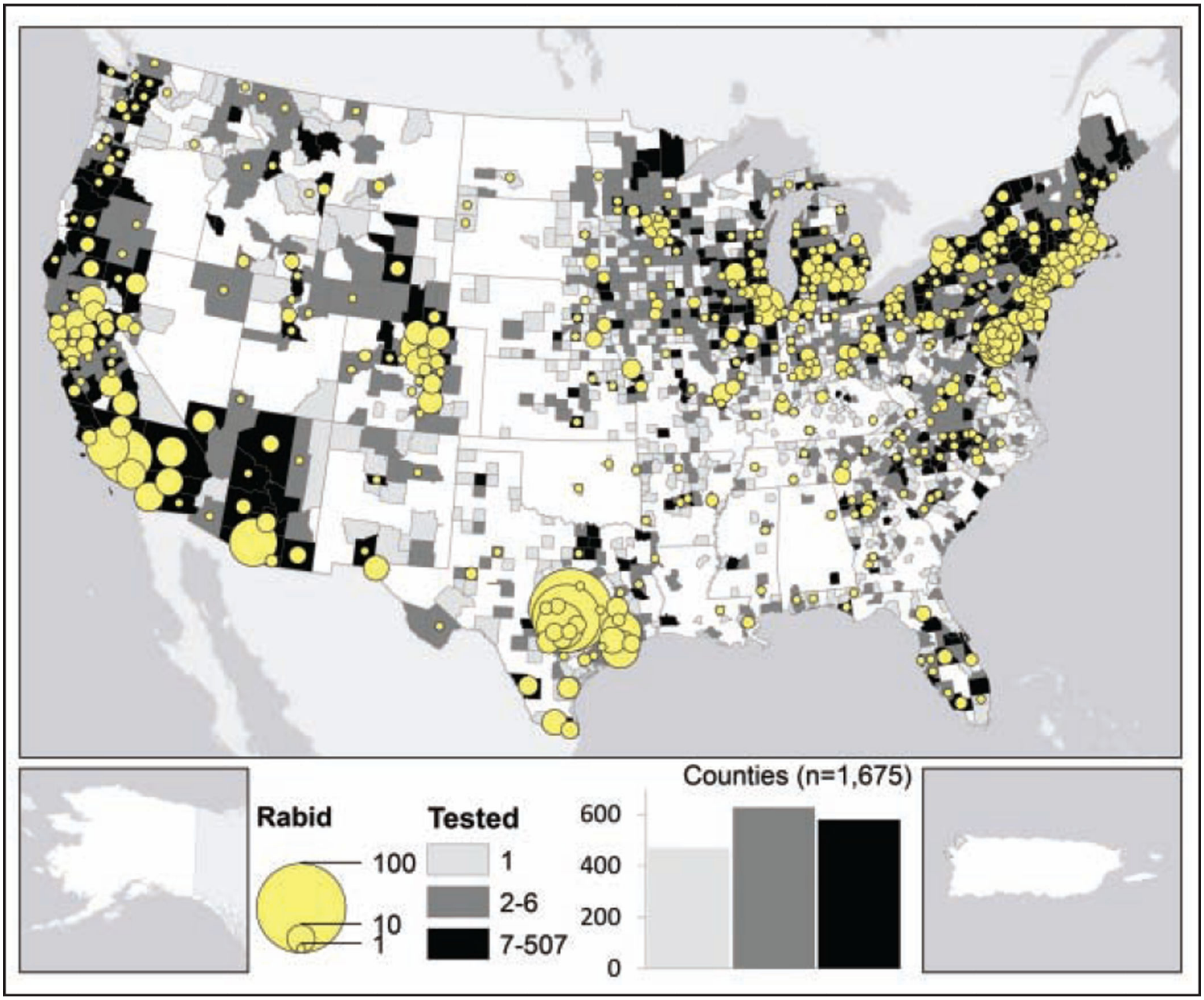

Figure 4.

Reported cases of rabies involving bats, by county, 2011. Histogram represents number of counties in each category for total number of bats submitted for testing (information on number of bats submitted for testing by county was not provided for Oklahoma).

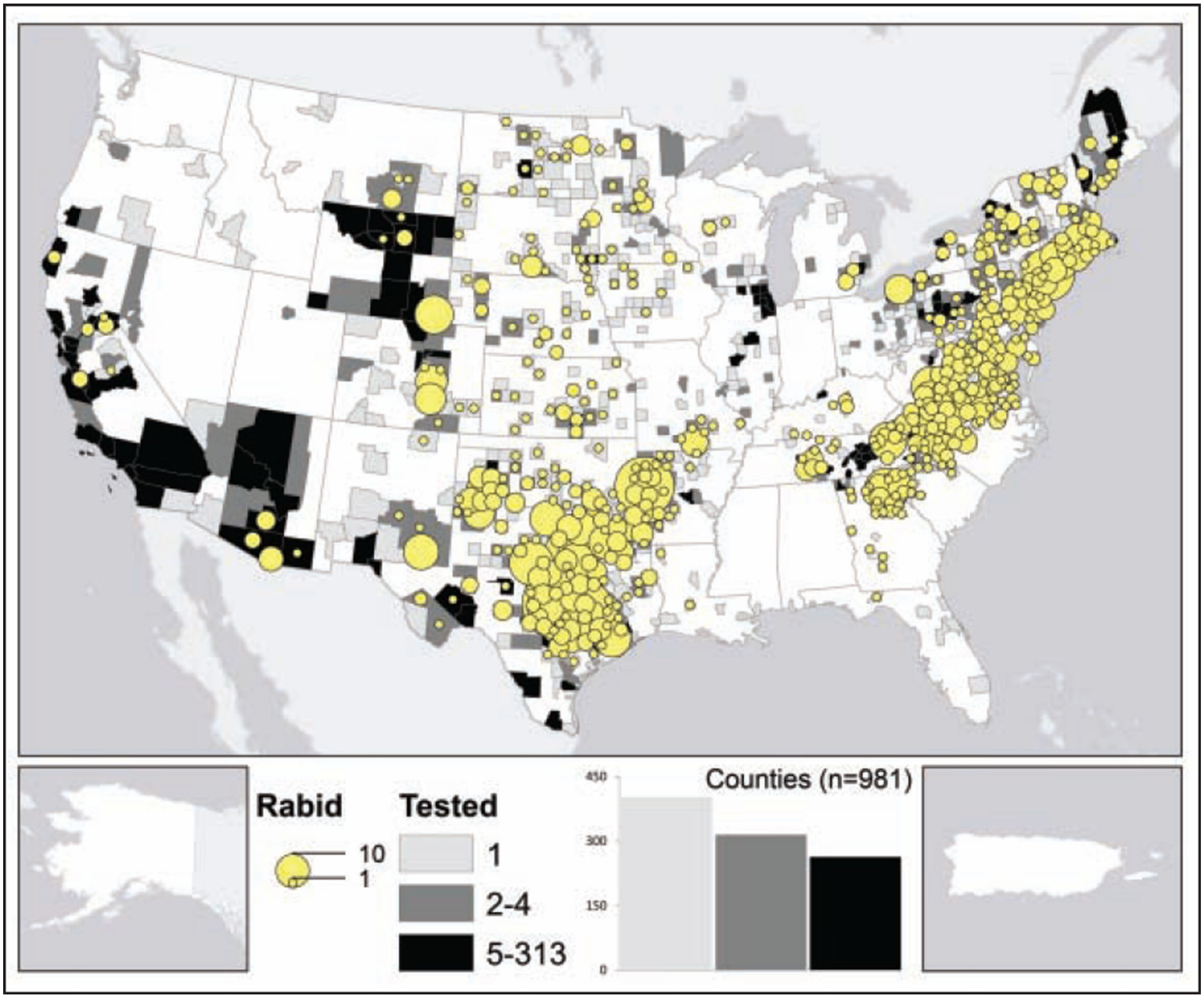

Figure 5.
Reported cases of rabies involving skunks, by county, 2011. Histogram represents number of counties in each category for total number of skunks submitted for testing (information on number of skunks submitted for testing by county was not provided for Oklahoma).

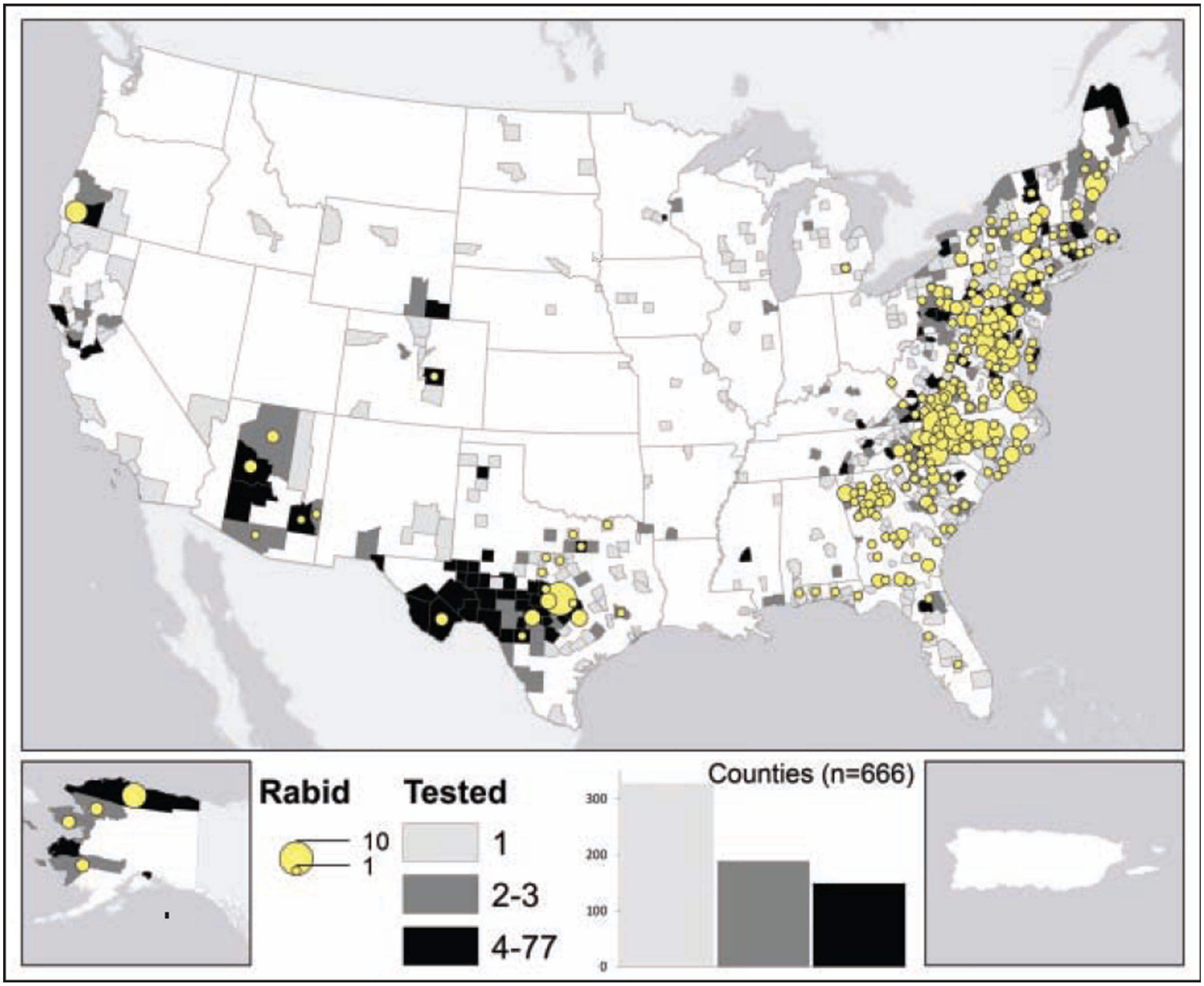

Figure 6.

Reported cases of rabies involving foxes, by county, 2011. Histogram represents number of counties in each category for total number of foxes submitted for testing (information on number of foxes submitted for testing by county was not provided for Oklahoma).

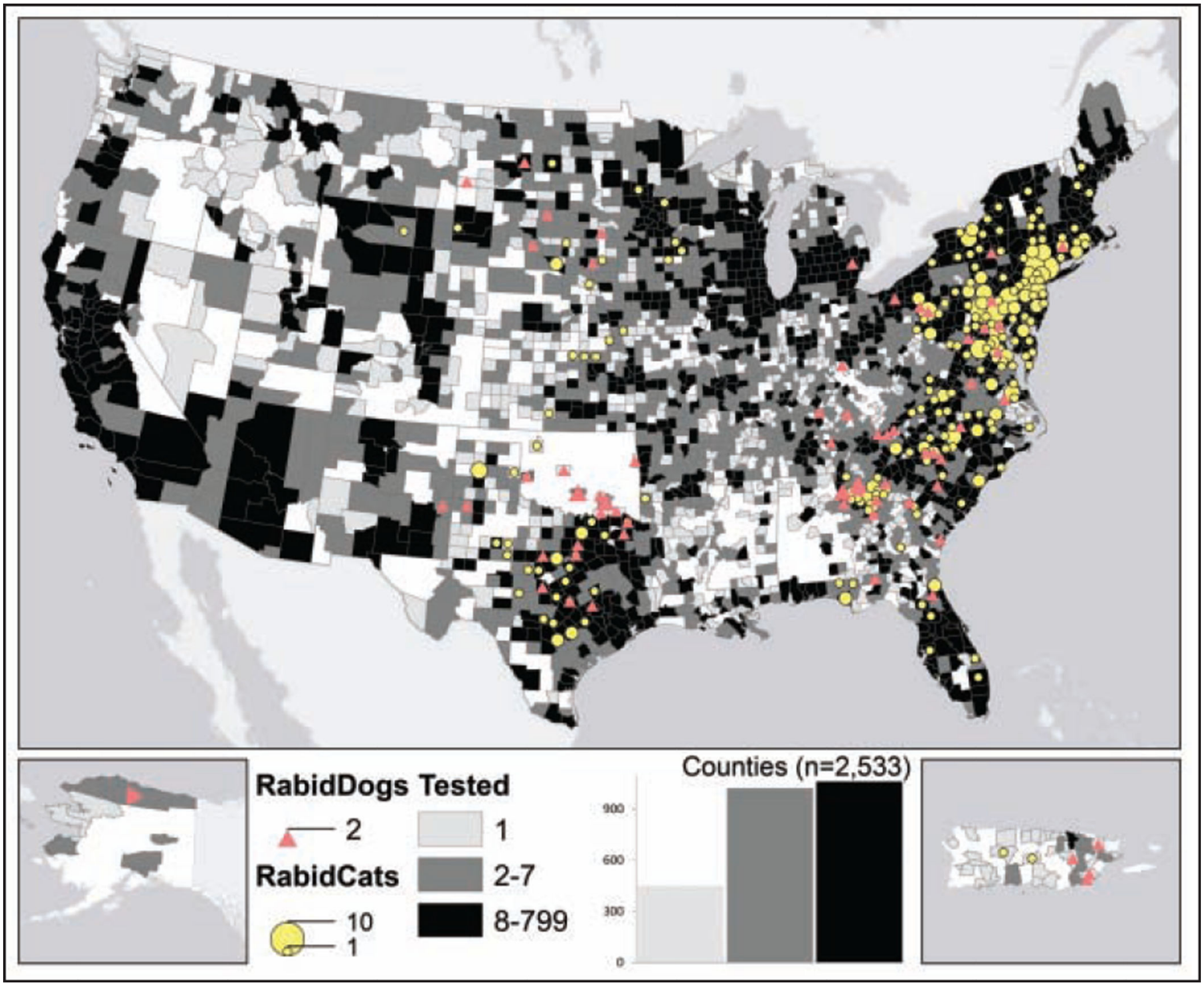

Figure 7.

Reported cases of rabies involving cats and dogs, by county and municipio, 2011. Histogram represents number of counties in each category for total number of cats and dogs submitted for testing (information on number of cats and dogs submitted for testing by county was not provided for Oklahoma).

Table 1

Cases of rabies in the United States, by location, during 2011.

				Domestic animals						Wild animals									
Location	Total cases	Domestic	Wild	Cats	Cattle	Dogs	Horses/ mules	Goats/sheep	Other domestic*	Raccoons	Bats	Skunks	Foxes	Other wild†	Rodents and lagomorphs‡	Humans	% Pos 2011	2010 cases	Change (%)
AK	14	2	12	0	0	2	0	0	0	0	0	0	12	0	0	0	14.3	13	7.69
AL	10	0	10	0	0	0	0	0	0	7	2	0	1	0	0	0	2.2	71	−85.92
AR	60	1	59	1	0	0	0	0	0	0	6	53	0	0	0	0	7.2	34	76.47
AZ	74	0	74	0	0	0	0	0	0	0	50	14	7	3[c]	0	0	7.0	111	−33.33
CA	224	0	223	0	0	0	0	0	0	0	211	12	0	0	0	1	3.8	175	28.00
CO	104	0	104	0	0	0	0	0	0	0	80	23	1	0	0	0	9.5	136	−23.53
CT	196	8	188	7	0	1	0	0	0	104	30	48	3	1[d]	2[s]	0	9.4	145	35.17
DC	28	0	28	0	0	0	0	0	0	13	15	0	0	0	0	0	8.3	38	−26.32
DE	6	3	3	3	0	0	0	0	0	1	0	1	1	0	0	0	3.5	11	−45.45
FL	122	13	109	11	0	1	1	0	0	82	18	1	6	2[e]	0	0	4.8	132	−7.58
GA	370	38	332	22	2	12	1	1	0	189	10	86	45	2[f]	0	0	14.7	375	−1.33
HI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0.00
IA	25	6	19	3	3	0	0	0	0	0	12	7	0	0	0	0	1.8	27	−7.41
ID	8	0	8	0	0	0	0	0	0	0	8	0	0	0	0	0	2.3	11	−27.27
IL	51	1	50	0	1	0	0	0	0	0	50	0	0	0	0	0	1.1	118	−56.78
IN	33	0	33	0	0	0	0	0	0	0	33	0	0	0	0	0	3.4	26	26.92
KS	31	4	27	4	0	0	0	0	0	0	3	24	0	0	0	0	2.8	58	−46.55
KY	17	4	13	0	0	3	1	0	0	0	6	7	0	0	0	0	1.8	21	−19.05
LA	6	0	6	0	0	0	0	0	0	0	4	2	0	0	0	0	1.0	11	−45.45
MA	118	3	113	2	0	0	0	1	0	59	20	25	6	1[g]	2[t]	2	4.7	144	−18.06
MD	311	23	288	17	3	3	0	0	0	172	59	24	27	0	6[u]	0	8.3	362	−14.09
ME	66	5	61	2	0	0	1	2	0	32	5	12	11	1[h]	0	0	9.8	62	6.45
MI	65	1	64	0	0	1	0	0	0	0	57	5	1	0	1[v]	0	2.0	73	−10.96
MN	55	11	44	4	5	1	0	0	1[a]	0	28	16	0	0	0	0	2.5	59	−6.78
MO	29	0	29	0	0	0	0	0	0	0	16	13	0	0	0	0	1.6	64	−54.69

Location	Total cases	Domestic	Wild	Domestic animals: Cats	Cattle	Dogs	Horses/ mules	Goats/sheep	Other domestic*	Wild animals: Raccoons	Bats	Skunks	Foxes	Other wild†	Rodents and lagomorphs‡	Humans	% Pos 2011	2010 cases	Change (%)
MS	2	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0.5	0	−
MT	17	2	15	0	2	0	0	0	0	0	9	6	0	0	0	0	4.3	17	0.00
NC	431	37	394	26	4	4	3	0	0	212	16	71	89	6[i]	0	0	11.3	411	4.87
ND	24	5	19	1	2	2	0	0	0	0	1	18	0	0	0	0	5.8	22	9.09
NE	35	8	27	2	2	0	4	0	0	0	10	17	0	0	0	0	3.2	52	−32.69
NH	25	1	24	1	0	0	0	0	0	10	6	5	3	0	0	0	5.7	17	47.06
NJ	294	23	270	22	0	0	1	0	0	184	36	32	7	0	11[w]	1	9.7	282	4.26
NM	18	1	17	0	0	1	0	0	0	0	3	14	0	0	0	0	4.3	14	28.57
NV	20	0	20	0	0	0	0	0	0	0	20	0	0	0	0	0	7.4	9	122.22
NY	369	46	322	38	6	1	0	1	0	162	63	62	26	2[j]	7[x]	1	6.0	496	−25.60
NYC	12	0	12	0	0	0	0	0	0	9	3	0	0	0	0	0	3.6	145	−91.72
OH	50	1	49	0	0	1	0	0	0	5	36	8	0	0	0	0	1.3	47	6.38
OK	60	15	45	3	1	10	1	0	0	0	3	41	0	1[k]	0	0	6.4	62	−3.23
OR	17	0	17	0	0	0	0	0	0	0	11	0	5	1[l]	0	0	4.7	17	0.00
PA	453	61	392	50	6	3	0	2	0	246	35	55	44	4[m]	8[y]	0	5.4	394	14.97
PR	47	12	35	3	1	4	4	0	0	0	0	0	0	35[n]	0	0	37.9	41	14.63
RI	28	3	25	3	0	0	0	0	0	9	9	6	1	0	0	0	5.8	29	−3.45
SC	109	6	102	5	0	1	0	0	0	58	4	20	20	0	0	1	6.0	106	2.83
SD	40	12	28	4	4	3	1	0	0	2	6	20	0	0	0	0	5.6	35	14.29
TN	64	6	58	0	0	4	2	0	0	1	12	44	0	1[o]	0	0	2.7	79	−18.99
TX	1,019	76	943	30	10	9	22	4	1[b]	37	304	567	31	4[p]	0	0	7.7	774	31.65
UT	7	0	7	0	0	0	0	0	0	0	7	0	0	0	0	0	1.4	10	−30.00
VA	649	46	603	30	10	3	2	1	0	300	20	197	74	5[q]	7[z]	0	14.7	591	9.81
VT	28	0	28	0	0	0	0	0	0	14	2	9	0	0	3[aa]	0	9.3	54	−48.15
WA	11	0	11	0	0	0	0	0	0	0	11	0	0	0	0	0	3.2	14	−21.43
WI	21	0	21	0	0	0	0	0	0	0	18	3	0	0	0	0	1.0	29	−27.59
WV	138	10	128	8	2	0	0	0	0	73	4	41	6	3[r]	1[bb]	0	8.7	97	42.27

				Domestic animals						Wild animals									
Location	Total cases	Domestic	Wild	Cats	Cattle	Dogs	Horses/ mules	Goats/sheep	Other domestic*	Raccoons	Bats	Skunks	Foxes	Other wild†	Rodents and lagomorphs‡	Humans	% Pos 2011	2010 cases	Change (%)
WY	26	2	24	1	1	0	0	0	0	0	6	18	0	0	0	0	4.3	34	−23.53
Total	**6,037**	**496**	**5,535**	**303**	**65**	**70**	**44**	**12**	**2**	**1,981**	**1,380**	**1,627**	**427**	**72**	**48**	**6**	—	**6,155**	**−1.92**
% 2011	100.00	8.22	91.68	5.02	1.08	1.16	0.73	0.20	0.03	32.81	22.86	26.95	7.07	1.19	0.80	0.10			
% Pos 2011	6.04	0.99	11.09	1.24	6.10	0.31	5.32	2.64	0.99	14.53	5.90	29.45	19.17	2.70	1.94	—			
Total 2010	6,155	487	5,666	303	71	69	37	6	1	2,246	1,430	1,448	429	80	33	2			
% Change	−1.92	1.85	−2.31	0.00	−8.45	1.45	18.92	100.00	100.00	−11.80	−3.50	12.36	−0.47	−10.00	45.45	200.00			

*Other domestic includes

[a] 1 bison;

[b] 1 alpaca.

†Other wild includes

[c] 1 bobcat, 2 javelinas;

[d] 1 coyote;

[e] 2 bobcats;

[f] 2 bobcats;

[g] 1 coyote;

[h] 1 bobcat;

[i] 4 bobcats, 2 coyotes;

[j] 1 deer, 1 otter;

[k] 1 bobcat;

[l] 1 coyote;

[m] 1 bobcat, 1 coyote, 2 deer;

[n] 35 mongooses;

[o] 1 wolf hybrid;

[p] 1 bobcat, 1 coyote, 2 deer;

[q] 4 bobcats, 1 coyote;

[r] 2 bobcats, 1 otter.

[‡] Rodents and lagomorphs include

[s] 2 groundhogs;

[t] 2 groundhogs;

[u] 6 groundhogs;

[v] 1 groundhog;

[w] 11 groundhogs;

[x] 7 groundhogs;

[y] 2 beavers, 6 groundhogs;

[z] 7 groundhogs;

[aa] 3 groundhogs;

[bb] 1 beaver.

Table 2

Species of bats submitted for rabies testing in the United States during 2011.

Species (common name)	No. tested	No. positive	Percentage positive
Unspeciated	13,613	952	7.0
Eptesicus fuscus (big brown bat)	8,273	314	3.8
Myotis lucifigus (little brown bat)	697	23	3.3
Lasionycteris noctivagans (silver-haired bat)	145	10	6.9
Tadarida brasiliensis (Mexican free-tailed bat)	110	15	13.6
Lasiurus borealis (red bat)	93	15	16.1
Myotis spp (not further speciated)	91	14	15.4
Myotis californicus (California myotis)	66	1	1.5
Nycticeius humeralis (evening bat)	48	0	0.0
Parastrellus hesperus (canyon bat)	41	7	17.1
Lasiurus cinereus (hoary bat)	34	20	58.8
Myotis evotis (long-eared myotis)	27	4	14.8
Myotis septentrionalis (northern long-eared myotis)	20	1	5.0
Myotis keenii (Keen's myotis)	15	0	0.0
Myotis yumanensis (Yuma myotis)	13	0	0.0
Antrozous pallidus (desert pallid bat)	13	1	7.7
Perimyotis subflavus (tri-colored bat)	13	2	15.4
Lasiurus ega (southern yellow bat)	11	1	9.1
Myotis ciliolabrum (western small-footed bat)	11	0	0.0
Leptonycteris yerbabuenae (lesser long-nosed bat)	9	0	0.0
Rousettus aegyptiacus (Egyptian musette*)	6	0	0.0
Myotis volans (long-legged myotis)	5	0	0.0
Plecotus townsendii (Townsend's big-eared bat)	5	0	0.0
Lasiurus seminolus (Seminole bat)	3	0	0.0
Macrotus californicus (California leaf-nosed bat)	3	0	0.0
Lasiurus blossevillii (western red bat)	1	0	0.0
Lasiurus intermedius (northern yellow bat)	1	0	0.0
Myotis austroriparius (southeastern myotis)	1	0	0.0
Myotis grisescens (gray myotis)	1	0	0.0
Myotis thysanodes (fringed myotis)	1	0	0.0
Total	**23,370**	**1,380**	**5.9**

* Exotic species submitted by zoos.

Table 3

Cases of rabies in humans in the United States and Puerto Rico, 2002 through July 2012, by circumstances of exposure and rabies virus variant.

Date of onset	Date of death	Reporting state	Age (y)	Sex	Exposure	Rabies virus variant†
18 Mar 02	31 Mar 02	CA	28	M	Unknown	Bat, Tb
21 Aug 02	31 Aug 02	TN	13	M	Contact	Bat, Ps
14 Sep 02	28 Sep 02	IA	20	M	Unknown	Bat, Ln/Ps
10 Feb 03	10 Mar 03	VA	25	M	Unknown	Raccoon, eastern United States
28 May 03	5 Jun 03	PR	64	M	Bite-Puerto Rico	Dog/mongoose, Puerto Rico
23 Aug 03	14 Sep 03	CA	66	M	Bite	Bat, Ln
9 Feb 04	15 Feb 04	FL	41	M	Bite-Haiti	Dog, Haiti
27 Apr 04	3 May 04	AR	20	M	Bite (organ donor)	Bat, Tb
25 May 04	31 May 04	OK	53	M	Liver transplant	Bat, Tb
29 May 04	9 Jun 04	TX	50	F	Kidney transplant	Bat, Tb
2 Jun 04	10 Jun 04	TX	55	F	Arterial transplant	Bat, Tb
27 May 04	21 Jun 04	TX	18	M	Kidney transplant	Bat, Tb
12 Oct 04	Survived	WI	15	F	Bite	Bat, unknown
19 Oct 04	26 Oct 04	CA	22	M	Unknown-El Salvador	Dog, El Salvador
27 Sep 05	27 Sep 05	MS	10	M	Contact	Bat, unknown
4 May 06	12 May 06	TX	16	M	Contact	Bat, Tb
30 Sep 06	2 Nov 06	IN	10	F	Bite	Bat, Ln
15 Nov 06	14 Dec 06	CA	11	M	Bite-Philippines	Dog, Philippines
19 Sep 07	20 Oct 07	MN	46	M	Bite	Bat, unknown
16 Mar 08	18 Mar 08	CA	16	M	Bite-Mexico	Fox, Tb related
19 Nov 08	30 Nov 08	MO	55	M	Bite	Bat, Ln
25 Feb 09	Survived	TX	17	F	Contact	Bat, unknown
5 Oct 09	20 Oct 09	IN	43	M	Unknown	Bat, Ps
23 Oct 09	20 Nov 09	VA	42	M	Contact-India	Dog, India
20 Oct 09	11 Nov 09	MI	55	M	Contact	Bat, Ln
2 Aug 10	21 Aug 10	LA	19	M	Bite-Mexico	Bat, Dr

Date of onset	Date of death	Reporting state	Age (y)	Sex	Exposure	Rabies virus variant[†]
24 Dec 10	10 Jan 11	WI	70	M	Unknown	Bat, Ps
30 Apr 11	Survived	CA	8	F	Unknown	Unknown
30 Jun 11	20 Jul 11	NJ	73	F	Bite-Haiti	Dog, Haiti
14 Aug 11	21 Aug 11	NY	25	M	Contact-Afghanistan	Dog, Afghanistan
Sep 11	Oct 11	MA	40	M	Contact-Brazil	Dog, Brazil
3 Dec 11	19 Dec 11	SC	46	F	Unknown	Tb
Dec 11	Jan 12	MA	63	M	Contact	My sp

[*] Data for exposure history are reported when plausible information was reported directly by the patient (if lucid or credible) or when a reliable account of an incident consistent with rabies virus exposure (eg, dog bite) was reported by an independent witness (usually a family member). Exposure histories are categorized as bite, contact (eg, waking to find bat on exposed skin) but no known bite acknowledged, or unknown (ie, no known contact with an animal was elicited during case investigation).

[†] Variants of the rabies virus associated with terrestrial animals in the United States and Puerto Rico are identified with the names of the reservoir animal (eg, dog or raccoon), followed by the name of the most definitive geographic entity (usually the country) from which the variant has been identified. Variants of the rabies virus associated with bats are identified with the names of the species of bats in which they have been found to be circulating. Because information regarding the location of the exposure and the identity of the exposing animal is almost always retrospective and much information is frequently unavailable, the location of the exposure and the identity of the animal responsible for the infection are often limited to deduction.

Dr = *Desmodus rotundus*. Ln = *Lasionycteris noctivagans*. My sp = *Myotis* sp. Ps = *Perimyotis subflavus*. Tb = *Tadarida brasiliensis*.