



# Background Information

**W**ith few exceptions, rabies occurs worldwide. The World Health Organization estimates that up to 59,000 human deaths occur annually, mostly in rural areas of Africa and Asia. In the United States, the number of human deaths attributed to rabies has declined from 100 or more each year in the early 1900s to just one or two cases per year. Two programs have contributed to this substantial reduction. Animal control and vaccination programs started during the 1940s and more recent oral rabies vaccination programs have eliminated domestic dogs as reservoirs of rabies in the United States. Also, effective human rabies vaccines and immunoglobulins have been developed; modern day post-exposure prophylaxis (PEP) has proven nearly 100% successful. From 2009 to 2018, 25 cases of human rabies were recorded in the United States. On the basis of historic records at the Nebraska Department of Health and Human Services (NDHHS), the last reported human case of rabies in Nebraska likely occurred in the 1920s.

Wild mesocarnivores (e.g. raccoons, skunks, and foxes) are important rabies reservoir species among which skunks are most often found to be infected with the virus in Nebraska. In contrast to eastern US states, raccoons in Nebraska are rarely infected with rabies. Rabid bats are increasingly implicated as an important wildlife reservoir of rabies in Nebraska; transmission can occur from minor, underappreciated or unrecognized bites. Given ongoing presence of this disease in reservoir species, rabies remains a potentially serious threat to public health in Nebraska.

# Summary 2019



During 2019, a total of 1,545 animals in Nebraska were submitted for testing (**Table 1**); 21 (1.4%) were positive including 18 bats (85.7%) and 3 skunks (14.3%). These animals originated from 10 of Nebraska's 93 counties; **Figure 1** depicts the geographic distribution of 2019 cases by species. Among all positive cases in 2019, 23.8% (5/21) were associated with human contact necessitating PEP. A report listing the current year-to-date positive cases and a menu of links to data from previous years are available on the NDHHS website at the following URL: <http://dhhs.ne.gov/Pages/Rabies-Data.aspx>.

**TABLE 1:** Number of animals submitted for rabies testing and number positive by species, 2019.

Species	Total submitted n (%)	Positive n (% of species total)
<b>Bat</b>	1,088 (70.4)	18 (1.7)
<b>Cat</b>	170 (11.0)	0 (0.0)
<b>Dog</b>	121 (7.8)	0 (0.0)
<b>Cattle</b>	42 (2.7)	0 (0.0)
<b>Raccoon</b>	51 (3.3)	0 (0.0)
<b>Horse</b>	13 (0.8)	0 (0.0)
<b>Skunk</b>	12 (0.8)	3 (25.0)
<b>Other*</b>	48 (3.1)	0 (0.0)
<b>Total</b>	<b>1,545</b>	<b>21 (1.4)</b>

\*Other includes badger (1), caprine (5), cervid (1), fox (3), llama (1), opossum (4), ovine (2), rodent (7), squirrel (18), woodchuck (3), and three unknown.



The Nebraska Department of Health and Human Services issues a Rabies Approval (RA) number for testing of animals involved in potential human rabies exposures if criteria as specified by the state's Rabies Control Program are met. Examples include persons who were bitten, had saliva contact in open wounds or mucus membranes, or were in the same room with a bat and cannot be certain that they were not bitten (e.g., sleeping person, unattended child, intoxicated person or individual who has a mental disability).<sup>1,2</sup> Fees for tests which qualify for an RA number are paid by the Program. This targeted testing provides rapid evaluation of risk after human exposure to potentially rabid animals. On the basis of timely results, medical professionals and public health officials are then able to make well-informed decisions and provide recommendations for the exposed person(s) regarding need for post-exposure prophylaxis which is extremely effective at preventing human rabies when administered appropriately. When test results are negative, such findings allow exposed persons to avoid expensive and time-intensive PEP. During 2019, the Nebraska Rabies Control Program issued RA numbers for 909 tests which were associated with documented potential human exposure events. Of these, 5 (0.6%), 22 (2.4%), and one (0.1%) were positive, unsuitable, and indeterminate, respectively; PEP was required among exposed persons in all instances. The remaining 96.9% (881/909) of 2019 exposure events were associated with negative tests. Among these, PEP was avoided in a total of 1,279 exposed persons (median number of persons/event, 1; range [1-10]).





# Ten-year Report

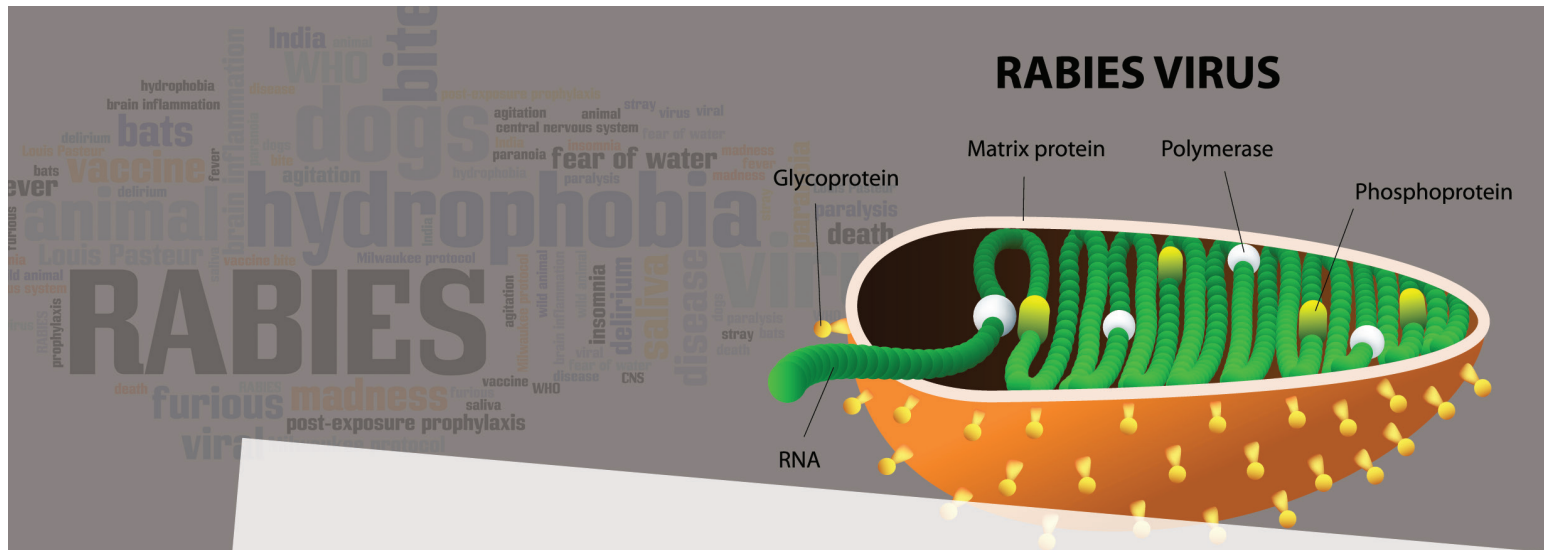
2010–2019

During 2010–2019, 11,859 animals from Nebraska were submitted for rabies testing of which 311 (2.6%) were positive (**Table 2**). Over this 10-year period, bats were the most commonly submitted animal. Of 7,563 bats submitted for testing, 127 (1.7%) tested positive. The majority of bats testing positive were from counties with larger urban population (**Figure 2**). Skunks represented the species with the highest proportion of positive tests. Of 198 submitted, 125 were positive (63.1%). Compared to bats, the locations of skunks and other animals that tested positive were more widely distributed throughout the state (**Figures 3 and 4**). Please refer to **Table 5** for total numbers of tests submitted and positive results, by species, for each year, from 2010 through 2019.

**TABLE 2:** Number of animals submitted for rabies tests and number positive by species, 2010-2019.

Species	Totals		Positive		
	N	median/year (range)	n	(%)	median/year (range)
<b>Skunk</b>	198	14.5 (9–63)	125	(63.1)	7.5 (2–53)
<b>Bat</b>	7,563	690.5 (478–1,088)	127	(1.7)	13 (6–18)
<b>Cat</b>	1,746	170.5 (146–216)	20	(1.1)	1.5 (0–9)
<b>Dog</b>	1,027	109.0 (100–142)	4	(0.4)	0 (0–1)
<b>Cattle</b>	379	40 (6–62)	24	(6.3)	2 (0–7)
<b>Raccoon</b>	444	40.5 (22–105)	1	(0.2)	0 (0–1)
<b>Horse</b>	113	9.0 (5–34)	7	(6.2)	0 (0–4)
<b>Other</b>	389	39 (29–48)	3*	(0.8)	0 (0–2)
<b>Total</b>	<b>11,859</b>	<b>1,134.5 (1,001–1,545)</b>	<b>311</b>	<b>(2.6)</b>	<b>25 (19–90)</b>

\*Other species testing positive include a sheep, fox, and llama in 2010, 2012, and 2013 respectively.



During 2010–2019, NDHHS issued a total of 5,264 Rabies Approval numbers (median/year, 475.5; range 371–909) (Table 3). Of these, 97 (1.84%) were positive (median/year, 11; range 5–13 [0.6–2.7%]), 107 (2.0%) were unsuitable (median/year, 8.5; range 5–23 [1.3–2.5%]), and 5,060 (96.1%) were negative (median/year, 458; range 354–881 [94.7–97.2%]). Among the exposure events with a corresponding negative test, all potentially exposed individuals were thus found not at risk for rabies. Therefore, each of the exposed persons could confidently avoid costly post-exposure prophylaxis as a direct result of State-funded rapid testing, corresponding timely reporting of the negative results, and evidence based public health recommendations.

**TABLE 3:** Count of Rabies Approval (RA) numbers and corresponding results by year. 2010-2019.

		Positive	Negative	Unsuitable
Year	N	n (%)	n (%)	n (%)
2010	371	12 (3.2)	354 (95.4)	5 (1.3)
2011	441	11 (2.5)	420 (95.2)	10 (2.3)
2012	474	13 (2.7)	455 (96.0)	6 (1.3)
2013	438	10 (2.3)	420 (95.9)	8 (1.8)
2014	466	8 (1.7)	449 (96.4)	9 (1.9)
2015	477	9 (1.9)	461 (96.6)	7 (1.5)
2016	530	12 (2.3)	510 (96.2)	8* (1.5)
2017	533	6 (1.1)	518 (97.2)	9 (1.7)
2018	625	11 (1.8)	592 (94.7)	22* (3.5)
2019	909	5 (0.6)	881 (96.9)	23* (2.5)
<b>TOTAL</b>	<b>5,264</b>	<b>97 (1.9)</b>	<b>5,060 (96.1)</b>	<b>107* (2.0)</b>

\*Total "Not testable" represents 104 that were unsuitable specimens and three with indeterminate results (1 each in 2016, 2018, and 2019)

# Human Exposure and Treatment

2012–2019

Beginning in 2012, NDHHS began collecting detailed records in advance of animal rabies testing to document all potential human exposures when an RA number was issued. Regardless of test result, local health department staff are then asked to document the post-exposure treatment recommendations which are provided to the exposed person(s) in each event. During 2012–2019, an annual median of 503.5 RA numbers were assigned (range, 371–909). Of 222 total animals with positive results in this time period, 84 (37.8%) were associated with human exposure thus necessitating PEP. Of these, 66 had been reported in advance of the test results to the Nebraska Rabies Control Program and had been assigned RA numbers (**Table 4**). Overall, post-exposure prophylaxis was recommended to 177 persons on the basis of positive tests; median number of exposed persons requiring PEP per positive test was 1 (range, 1–9). Also, during 2012–2019, PEP recommendations were documented among an additional 127 persons exposed to 91 animals whose specimens were unsuitable for testing and 3 additional animals that were indeterminate and thus exposure could not be ruled out.

**TABLE 4:** Human exposure to animals testing positive with and without Rabies Approval (RA) numbers by year. 2010–2019.

Year	Events with PEP recommended			No. of persons		
	No RA n	RA n	Total N	No RA n	RA n	Total N (median per event, range)
2012	3	10	13	5	14	19 (1, 1–4)
2013	6	10	16	14	25	39 (2, 1–6)
2014	3	6	9	11	13	24 (2, 1–9)
2015	2	8	10	4	17	21 (1.5, 1–5)
2016	0	10	10	0	25	25 (1, 1–7)
2017	2	6	8	2	12	14 (1, 1–5)
2018	1	11	12	1	25	26 (1, 1–6)
2019	1	5	6	2	7	9 (1.5, 1–2)
<b>TOTAL</b>	<b>18</b>	<b>66</b>	<b>84</b>	<b>39</b>	<b>138</b>	<b>177</b>



# Wildlife



Skunks and bats remain the two primary wildlife reservoirs for the rabies virus in Nebraska. During 2019, three of 12 skunks tested (25%) were positive for rabies (**Table 1**). During 2010–2019, the median number of skunks testing positive was 7.5 per year (range, 2–53). Due to the high prevalence of the virus among the skunk population in Nebraska, all skunks should be considered a potential source of the virus. Any bite by a skunk or other wild carnivore or exposure to saliva from such animals should be considered a possible rabies exposure and reported to the regional local health department.

All wounds should be thoroughly cleaned with soap and water immediately. Exposed persons should also contact their physician for appropriate medical care. In such instances of exposure, the local health department can provide consultation regarding risk and, if indicated, the Nebraska Rabies Control Program should be contacted for an RA number to facilitate rabies testing if the exposing wild animal can be captured safely.

Transmission of rabies from bats can occur from seemingly minor or unrecognized bites. Bites, scratches, or mucus membrane exposures from bats should be considered potential rabies exposures. Any instance where a person is in the same room as a bat and cannot declare with certainty that they were not bitten should also be considered a potential exposure. Such instances include persons sleeping in a room with a bat in it or an adult witnessing a bat in the room with a child who was unattended, a person with a mental



# Wildlife



disability, or an intoxicated person.<sup>1,2</sup> During 2019, 18 of 1,088 bats submitted (1.7%) were positive for rabies (**Table 1**). During 2010–2019, the median number of bats testing positive per year was 13 (range, 6–18). Given their hibernation behavior, bats often enter homes in late summer and early fall. A correspondingly higher level of testing is generally observed during these time periods as are relatively higher numbers of rabid bats. Because capture of bats from homes drives testing, bats with positive test results were more frequently encountered in counties with urban populations (**Figure 2**).





# Domestic Animals



Thirty-six cattle and 18 other domestic animals tested positive for rabies in 2012-2019 (feline, 12; canine, 3; equine, 2; llama, 1). All but the llama was of a species in which a licensed vaccine is currently available. Of particular concern, these 15 cats and dogs and the two horses were either reported as not vaccinated or had unknown vaccination histories. Further, 16 of these rabid animals were associated with documented human exposure including ten events involving cats in which humans were reportedly bitten. As a result of exposure to these sixteen animals, potentially avoidable PEP was required among 30 exposed persons because irresponsible owners failed to vaccinate animals in their care.

*Vaccination of domestic animals is required by Nebraska statutes and continues to be a critical, safe, and cost-effective component of rabies control to safeguard both animal and public health from this fatal virus.*

In each of these exposure events involving domestic animals, appropriate vaccination would likely have prevented rabies, thus reducing or eliminating the associated human risk and corresponding necessity for PEP. Equally troubling are the numbers of domestic animals tested for rabies in Nebraska for which inadequate vaccination is reported. During 2015 to 2019, 90.6% (769/849) of cats

# Domestic Animals



and 65.6% (361/550) of dogs tested for rabies were reported as not current, unvaccinated, or had unknown vaccination status. Given that lack of vaccination among domestic animals involved in exposure events often necessitates testing, such high proportions are expected. However, adequate vaccination of such animals would simply preclude the need to even sacrifice them for testing in most situations. Further, vaccination of domestic animals is required by Nebraska statutes and continues to be a critical, safe, and cost-effective component of rabies control to safeguard both animal and public health from this fatal virus.<sup>3</sup> All persons keeping domestic animals should consult their veterinarian to establish and maintain an appropriate vaccination schedule to prevent rabies.

## Vaccination

### Vaccine-preventable Diseases

#### REFERENCES:

1. Nebraska Department of Health and Human Services. *Nebraska Rabies Investigation Guideline*. Available at: [http://dhhs.ne.gov/epi docs/Rabies Investigation Guidelines.pdf](http://dhhs.ne.gov/epi_docs/Rabies%20Investigation%20Guidelines.pdf). Accessed November 24, 2020
2. 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 (RR-3): 1-28.
3. National Association of State Public Health Veterinarians. *Compendium of Animal Rabies Prevention and Control, 2016*. JAVMA 2016; 248 (5): 505-517.



# Table 5:

## Number of animals submitted for rabies testing and number positive by species and year, 2010–2019

Species	2010		2011		2012		2013		2014	
	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)
<b>Skunk</b>	36	28* (77.8)	30	17* (56.7)	44	35* (79.5)	17	14* (82.4)	13	7* (53.8)
<b>Bat</b>	658	13* (2.0)	660	10* (1.5)	715	13 (1.8)	666	6 (0.9)	642	10 (1.6)
<b>Cat</b>	216	6 (2.8)	185	2 (1.1)	171	5* (2.4)	157	3 (1.9)	168	0 (0.0)
<b>Dog</b>	105	1 (1.0)	109	0 (0.0)	114	1 (0.9)	101	1 (1.0)	109	0 (0.0)
<b>Cattle</b>	38	4 (10.5)	42	8* (18.2)	40	3* (2.6)	40	7* (17.5)	62	4 (6.5)
<b>Horse</b>	12	1 (8.3)	10	4 (40.0)	8	0 (0.0)	5	1 (20.0)	6	0 (0.0)
<b>Other</b>	63	1** (1.6)	88	0 (0.0)	73	2** (2.7)	59	1** (1.7)	57	0 (0.0)
<b>Total</b>	<b>1,128</b>	<b>54 (4.8)</b>	<b>1,124</b>	<b>35 (3.1)</b>	<b>1,165</b>	<b>59 (5.1)</b>	<b>1,045</b>	<b>33 (3.2)</b>	<b>1,057</b>	<b>21 (2.0)</b>

Species	2015		2016		2017		2018		2019	
	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)	N	Positive n (%)
<b>Skunk</b>	16	8*** (50.0)	11	4 (36.4)	10	7 (70.0)	9	2 (22.2)	12	3 (25.0)
<b>Bat</b>	609	16 (2.6)	765	14 (1.8)	739	10 (1.4)	1,021	17 (1.7)	1,088	18 (1.7)
<b>Cat</b>	188	1 (0.5)	146	0 (0.0)	166	2 (1.2)	179	1 (0.6)	170	0 (0.0)
<b>Dog</b>	115	1 (0.9)	100	0 (0.0)	105	0 (0.0)	109	0 (0.0)	121	0 (0.0)
<b>Cattle</b>	36	2 (5.6)	40	1 (2.5)	44	0 (0.0)	33	1 (3.0)	42	0 (0.0)
<b>Horse</b>	6	0 (0.0)	8	0 (0.0)	6	0 (0.0)	11	1 (9.1)	13	0 (0.0)
<b>Other</b>	98	0 (0.0)	71	0 (0.0)	80	0 (0.0)	74	0 (0.0)	99	0 (0.0)
<b>Total</b>	<b>1,068</b>	<b>28 (2.6)</b>	<b>1,141</b>	<b>19 (1.7)</b>	<b>1,150</b>	<b>19 (1.7)</b>	<b>1,436</b>	<b>22 (1.5)</b>	<b>1,545</b>	<b>21 (1.4)</b>

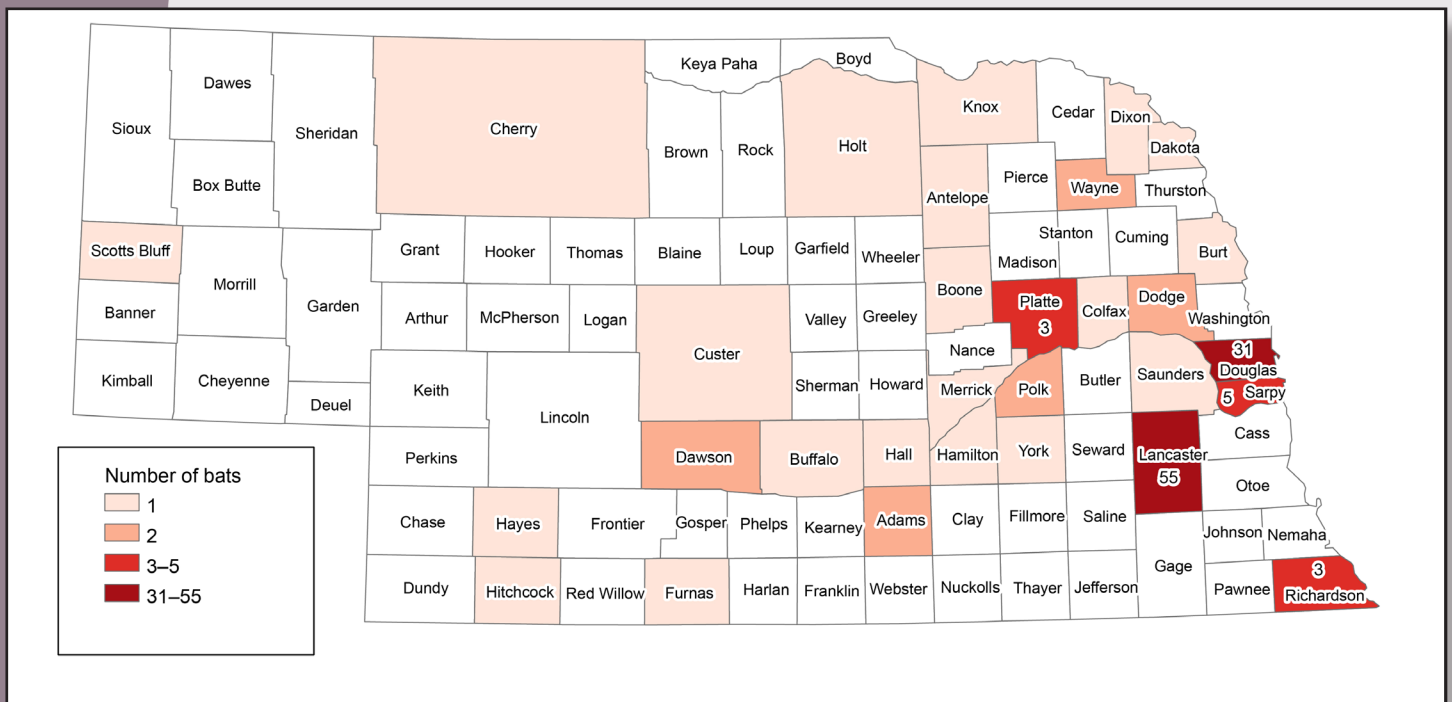
\*Rabies tests performed at laboratories other than Kansas State University Rabies Laboratory (KSU RL) or the University of Nebraska-Lincoln Veterinary Diagnostic Center (during 2015–2019) were only reported if positive as follows: 2010, 1 bat, 1 skunk; 2011, 1 bat, 1 skunk; 2012, 5 skunks, 1 cat, 1 bovine; 2013, 2 bovines, 4 skunks; 2014, 2 skunks.

\*\*Other species testing positive 1 sheep (2010); 1 fox (2012); 1 raccoon (2012); 1 llama (2013).

\*\*\*During 2015, in addition to KSU RL, University of Nebraska-Lincoln Veterinary Diagnostic Center began reporting both positive and negative rabies results for all animals tested including 2 skunks that tested positive.

# Figure 2:

Number of bats testing positive for rabies by county (N = 127),  
Nebraska, 2010–2019





# Figure 4:

Number of animals (other than skunks or bats) testing positive for rabies by species and county (N = 59), Nebraska, 2010–2019

