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## Developing a rabies prevention program based on rabies exposure data in Nebraska

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Capstone Research

*Developing a rabies prevention program based on rabies exposure data in Nebraska*

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## **Abstract**

Eighty-nine percent of Nebraska's towns are considered rural, with populations of less than 3,000 people and with many towns having less than 1,000 residents. Rural areas consist of crop ground, livestock facilities and regions inhabited by wildlife. Nebraska has two large urban cities, Lincoln and Omaha. Animal and human health in these communities can be greatly impacted by infectious diseases that are transmitted between animals and humans, known as zoonotic diseases. One zoonotic disease of great concern is rabies. Zoonotic diseases not only impact the health of animals and humans, but the social well-being of communities and result in increased costs to control and eliminate outbreaks. The risk of transmission of rabies from animal to animal and animal to human is a Public Health concern. Rabies left untreated in humans is fatal. To reduce the risk of human exposure between animals, the public needs to be made aware of the problem and prevention measures that can be taken. This project proposed to the Nebraska Department of Health and Human Services to analyze rabies data to create summary data tables that will be made publicly available. These summaries describe what type that had been collected between 2010 – 2019, and to use these data to create materials that will be used to improve community awareness regarding the extent of the rabies problem and methods of prevention.

## **Introduction**

Population growth around the world has led to animals and humans being forced into closer contact with one another, both in rural settings such as in animal confinement feeding operations, and in large cities as urban sprawl takes away wildlife habitat. New pathogens can affect the wildlife population and with closer proximity and increased contact between humans and animals, pathogens can readily spread through the population (Hasler et al., 2012). As wild animals have more contact with humans and domesticated animals there is a greater risk for the spread of animal to human transmission of disease, known as zoonotic disease. Zoonotic diseases are very common, both in the United States and around the world. Scientists estimate that more than 6 out of every 10 known infectious diseases in people can be spread from animals, and 3 out of every 4 new or emerging infectious diseases in people come from animals (CDC- Zoonotic Diseases, 2017). High zoonotic infection rates and the threat of emerging zoonotic diseases, such as the COVID-19 virus, necessitates increased zoonotic disease surveillance, emergency response, disease control for known and emerging diseases and education of the public regarding zoonotic risks.

## **Rabies**

Rabies is a viral disease and is transmitted through the bite or saliva of a rabid animal. This virus affects the central nervous system of mammals which causes the disease to infect the brain and death follows. Most rabies cases occur in wildlife in species such as bats, skunks, raccoons, and foxes, even though any mammal can get rabies, including humans. Human rabies cases are in the United States, with only 1 to 3 cases reported each year. However, around 59,000 Americans get post-exposure prophylaxis each year to prevent rabies infection after being exposed to an infected or suspected rabid animal. The leading cause of human rabies deaths are

exposures to infected bats. Rabies is preventable using vaccines, pre-exposure prophylaxis, and post-exposure prophylaxis. Pets and livestock can be vaccinated for rabies but nearly all pets and livestock that get rabies, do not have a current vaccination, or have no history of ever receiving a rabies vaccination. In the United States, there is a law requiring all dogs to be vaccinated for rabies. Dogs only make up 1% of rabid animals reported each year in the United States. (Rabies - World Health Organization).

### Rabies Prevention

Rabies prevention strategies include making sure pets stay up to date on their rabies vaccinations, keeping pets away from wild animals, spaying or neutering pets to reduce the number of unwanted animals, and calling animal control to remove stray animals from the community.

The rabies virus negatively impacts the health of livestock and their human handlers, as well as impacting the economic well-being of rural communities by the significant expense of controlling disease outbreaks (Mörner et al., 2002). The estimated public health expenditures on rabies disease diagnostics, prevention and control in the United States is \$245 to \$510 million annually (CDC - Rabies in the U.S.).

It may be difficult to tell if an animal has rabies and laboratory testing is needed to confirm diagnosis. Rabid animals may become very aggressive, try to bite people or another animal, or excessively drool. However, some animals with rabies may act more docile, move slower or show signs of paralysis (Rabies, CDC).

Wildlife act as a reservoir and transfer the virus to domestic animals such as dogs, cats, cattle, and horses which contact and expose humans. Due to the habitat of domestic livestock and wildlife overlapping, the different species may directly or indirectly encounter one another. They

can encounter one another since they share resources such as forage, cover, water, and mineral sources (Heinrich & Peck, 2014).

Wildlife Services has created an Oral Rabies Vaccination Program to prevent the spread of raccoon rabies in the eastern United States and coyote rabies in Texas. This program has been successful in decreasing rabies in wildlife. One method of distribution is baiting an area with plastic packets containing the oral vaccine. The second method is distributing the oral vaccine by air (Wildlife Services, 2011). Nebraska currently does not have an oral vaccine program or any interventions to reduce the spread of rabies in the wildlife population.

### Occupational Exposure

Veterinarians are at very high risk of contracting rabies due to their work-related contact with animals. Bites and scratches from animals are very common (MN Dept of Health). Even though veterinarians undergo pre-exposure rabies prophylaxis at some point in their career, some do not get their rabies titer checked on a regular basis. This puts them at risk for contracting rabies if exposed to a positive animal (Epp & Waldner, 2012). Pre-exposure rabies prophylaxis is a vaccine regimen given to individuals who are at high risk or have regular contact with potentially rabid animals. This vaccine series protects against unrecognized exposures and is more affordable than the post-exposure prophylaxis treatment (MN Dept of Health).

Another occupation at high risk for exposure to rabies are animal control officers (Rock et al., 2017). Like veterinarians, they have high work-related contact with animals and undergo pre-exposure rabies vaccination regimen. (Mann, 1984). Most animals they handle have an unknown vaccination record. If the animals are presumed to have rabies, animal control officers euthanize the animal and submit the specimen for testing. There are potentially many

occupations that encounter animals purposefully or by accident. More research is needed to identify at-risk occupations to reduce the risk of an occupational rabies exposure.

#### Nebraska Department of Health and Human Services Rabies Program

Nebraska Department of Health and Human Services issues a Rabies Approval (RA) number for animals involved in a potential human rabies exposure if specific criteria are met by the state's Rabies Control Program. Examples of criteria include whether a person was bitten, had saliva contact in open wounds or mucous membranes, or were in the same room as a bat and cannot be certain they were bitten. Proximity exposures to bats include if a person was sleeping, intoxicated, or has a mental disability or an unattended child. If a situation qualifies for an RA number, fees for a diagnostic rabies test are paid for by the state. Testing provides rapid evaluation of risk after human exposure to potentially rabid animals. As a result, medical professionals and public health officials can make well-informed decisions and provide recommendations for the exposed person(s) regarding the need for post-exposure prophylaxis (PEP). If the test results of the animal are negative, this allows the person(s) exposed to avoid the costly expense of PEP, which is estimated to total \$3,000 (Shwiff et al., 2018). PEP consists of a dose of human rabies immunoglobulin (HRIG). These recommendations are based on a case-to-case basis, the HRIG vaccine regimen can be given on the day of the exposure or delayed until the results of the animal testing are known. If PEP is recommended or the animal tests positive for rabies, HRIG is given and followed by a dose at 3, 7, and 14 days. It is very effective at preventing human rabies when administered appropriately. (Nebraska Rabies Investigation Guideline, 2017).

#### Rationale for Research

Eighty-nine percent of Nebraska's towns are considered rural. These rural populations have less than 3,000 people and many towns have less than 1,000 residents (Nebraska Population, 2020). The rural areas consist of diversified farm ground and animals including wildlife, domestic livestock, and companion animals are in contact leading to increased opportunity for zoonotic exposures, including rabies. Not only do rural areas have exposure to rabies, but urban populations have their own unique rabies encounters as well. Brown bats are commonly found in houses and building structures in urban areas and cause proximity exposure to humans (Bredthauer & Smith, 2004). During late summer and early fall bats exhibit hibernation behavior and enter homes. As a result, more bats are being captured in homes and tested for rabies.

In Nebraska, the primary animal species to have rabies are skunks and bats (Nebraska Rabies Investigation Guideline, 2017). Skunks are highly susceptible to rabies and can harbor the virus for extended periods of time. Dogs, cats, cattle, and horses have been infected with rabies by various wildlife species.

In 2012, NDHHS started collecting detailed data records of animal rabies testing to document all potential human exposures when an RA number was given. Local health departments were asked to document all post-exposure treatment recommendations, regardless of test result. This form and questions are shown in Appendix B.

The risk of transmission of rabies from animal to animal and animal to human in Nebraska is a Public Health concern. To reduce the risk of human exposure and exposure between animals the public needs to be made aware of the scope of the problem and prevention measures that can be taken.



The specific aims of this project are to 1) analyze rabies data collected between 2010-2019 by the NDHHS to create summary data tables that will be made publicly available. These summaries describe what type of animals were tested for rabies, geographic location of the animal(s) being tested, how many tested positive and negative, and how many cases were associated with human contact needing post-exposure prophylaxis (PEP) and 2) using Nebraska rabies data and a literature search, develop enduring materials for NDHHS that will be available as educational materials for Nebraskans at risk for exposure to rabies.

## **Methods**

### Aim 1

#### Database

Training was provided to the author on how to navigate the Nebraska Department of Health and Human Services (NDHHS) rabies database.

Prior to transferring the data to the author, NDHHS de-identified data that were not needed for analysis in this project. The variables that were de-identified and not needed by DHHS regarding this project are listed below.

<u>Variables Removed to De-Identify</u>	<u>Variables Removed - not needed</u>
PATIENT_FIRST_NAME	RA_NBR_EPI
PATIENT_MIDDLE_NAME	RA_NBR_MORB
PATIENT_LAST_NAME	EVENT_DATE_TYPE
PATIENT_DOB	INV_CREATED_BY_UID
PATIENT_ADDRESS	INV_LAST_UPDATED_BY_UID
PATIENT_PHONE_HOME	INVESTIGATION_STATUS
PATIENT_PHONE_WORK	INVESTIGATOR_NAME
PATIENT_PHONE_CELL	INVESTIGATOR_PHONE
INV_CASE_STATUS	INVESTIGATOR_ASSIGNED_DT
NOTIFICATION_STATUS	RA_NBR_INV
NOTIFICATION_SUBMITTED_BY_NAME	NOTIFICATION_COMMENTS
NOTIFICATION_SUBMITTED_BY_UID	INV_COMMENTS
NOTIFICATION_CREATED_DT	Patients_Sex
NOTIFICATION_SENT_DT	
Patients_DOB	
EPI_DiscriptionOfIncident	
EPI_OwnerPhoneNumber	
EPI_AnimalOwnerAddress	
EPI_AdditionalNameInfo	
ADM_IncidentReporterName	
ADM_IncidentReporterPhone	
ADM_AddContactName	
ADM_AddContactPhone	
EPI_human_exp_comments	
patient_general_comments	
MORB_RPT_COMMENTS	

A database was created in Microsoft Excel to organize and analyze the NDHHS rabies data that had been collected from 2010-2019. The database was modeled after a previous database used to collect NDHHS data. All formulas were checked by the author and the staff at DHHS to ensure accuracy.

#### Data Analysis.

Data were analyzed in Excel for the following variables:

- Animal to animal exposure
  - Species Involved
- Human to animal exposure

- Species of animal
- Type of injury
- Geographic location of exposure
- Numbers of animals/humans exposed
  - Test results
  - Condition of specimen
  - PEP recommendations

Variables were quantified in Excel and a summary document was created that will be placed on the NDHHS website for use by the public.

#### Analysis of Rabies Positive Cases.

Each human exposure was investigated further by the species of animal involved. Data were organized into the following categories:

- Human information
  - Age
  - Age units
  - Gender
  - City
  - County
  - State
  - Zip code
- Event information
  - Investigation jurisdiction
  - Jurisdiction name

- Event data
- Record added by NDHHS
- Report Data
- Year
- Positive, negative, untestable, or unknown test results
- Town of incident
- Animal information
  - If animal was captured
  - If animal was euthanized
  - Ownership status
  - If animal was quarantined
  - If animal was retrievable
  - Exposing animal type
  - Rabies vaccine status
- Human to animal exposure
  - Species Involved
  - Wound location
  - Wound type
- Numbers of animals/humans exposed
  - How many were recommended for PEP
  - If the person(s) were immune suppressed

Creation of Rabies Maps.

Maps were created by a DHHS staff member using information from the new database.

These maps were revised multiple times to ensure accuracy and legibility.

## Aim 2

The author conducted a thorough literature search on the pathology and prevention of rabies. Using the quantified data from Aim 1, and peer reviewed resources, education materials were created on the pathology of the rabies virus, exposure routes, and prevention measures that should be followed.

## **Results**

### Aim 1

Analysis of the NDHHS rabies data from 2010 to 2019 found that 11,859 animals were submitted for rabies testing with 311 (2.6%) testing positive (Table 1).

Table 1: Number of animals submitted for rabies tests per year and number positive by species, 2010-2019.

Totals			Positive		
Species	N	Median/year (range)	N	(%)	Median/ year (range)
Skunk	198	14.5 (9--63)	125	63.1%	7.5 (2-53)
Bat	7563	690.5 (478-1088)	127	1.7%	13 (6-18)
Cat	1746	170.5 (146-216)	20	1.1%	1.5 (0-9)
Dog	1027	109.0 (100-142)	4	0.4%	- (0-1)
Cattle	379	40 (6-62)	24	6.3%	2 (0-7)
Raccoon	444	40.5 (22-105)	1	0.2%	- (0-1)
Horse	113	9.0 (5-34)	7	6.2%	- (0-4)
Other	389*	39 (29-48)	3**	0.8%	- (0-2)
Total	11,859	1,134.5 (1001-1545)	311	2.6%	25 (19-90)

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

Over the ten-year period, bats were the most commonly submitted animal (n= 7,563; 127 (1.7%) positive). Most bats submitted for testing were from counties with large urban



Figure 2: Number of skunks testing positive for rabies by county (N=125), Nebraska, 2010 – 2019.

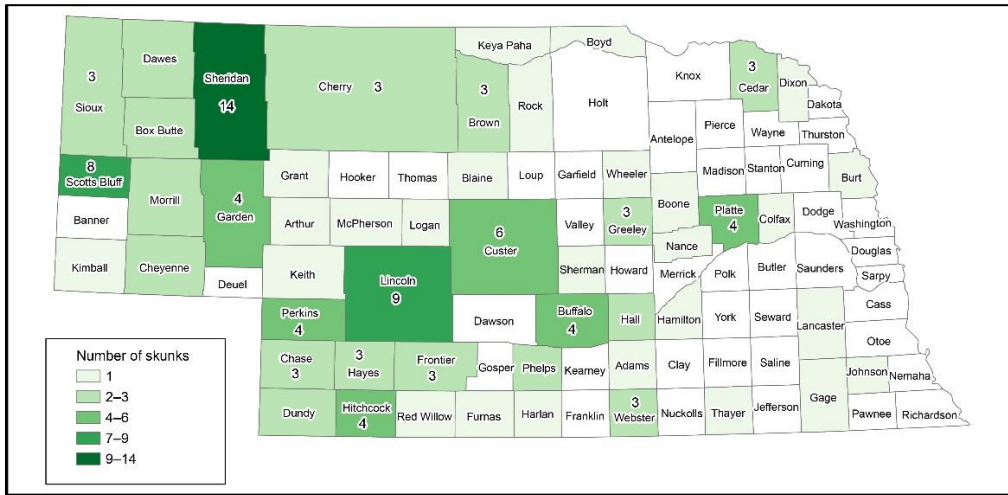
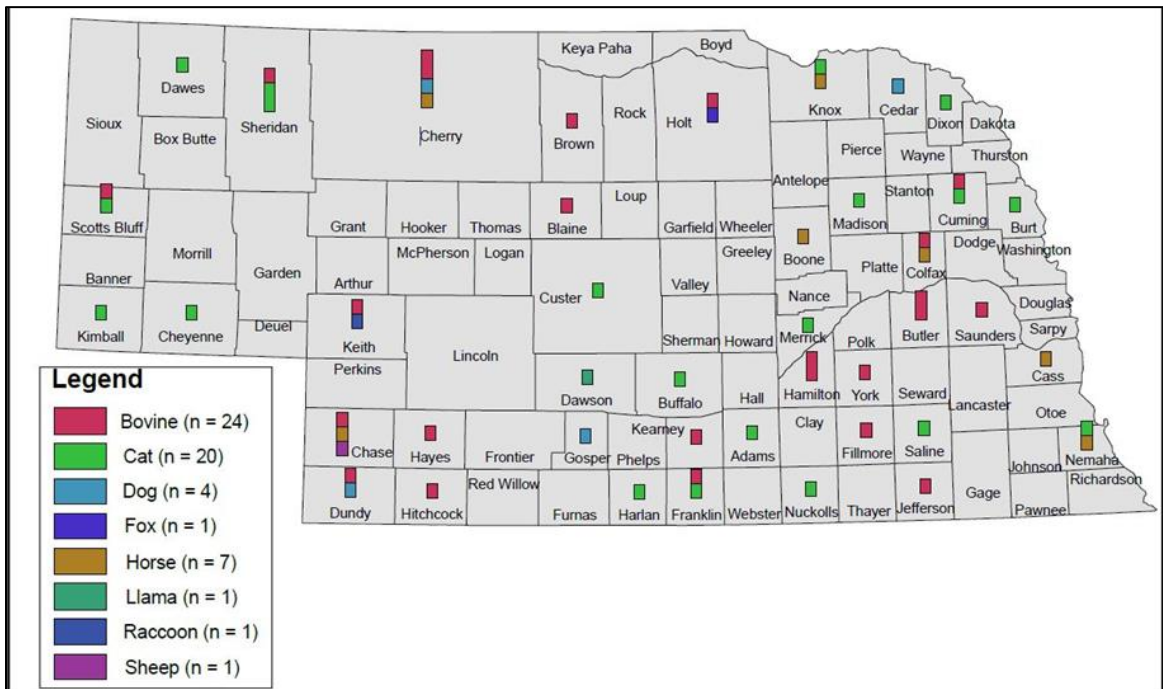


Figure 3: Number of animals (other than skunks or bats) testing positive by species and county (N=59), Nebraska, 2010 – 2019



From 2010-2019, 5,264 Rabies Approval numbers were given. Of these, 97 (1.84%) tested positive, 107 (2.03%) were untestable and 5,060 were negative. The potentially exposed individuals corresponding with a negative test were not found at risk for rabies.

Additionally, data were analyzed to determine rabies exposures and recommendations for PEP. This data did not include the year 2010 to 2011. The species submitted for testing include skunks, bats, cats, dogs, cattle, raccoons, horses, llamas, and many more that are represented in Table 4 below. Out of 222 positive animals tested during this time (Table 4), 84 (37.8%) were associated with human exposure which recommended PEP (Table 3). An additional 127 people were recommended PEP by being exposed to 94 animals whose specimens were not testable (Table 2).

Table 2: Count of Rabies Approval (RA) numbers and corresponding animal testing results by year. 2010-2019.

		Positive	Negative	Not testable
Year	N	N (%)	N (%)	N (%)
2010	371	12 (3.2)	354 (95.4)	5 (1.35)
2011	441	11 (2.5)	420 (95.2)	10 (2.3)
2012	474	13 (2.7)	455 (96.0)	6 (1.27)
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)
Total	5264	97 (1.9)	5,060 (96.1)	107* (2.0)

\*Total “Not testable” represents 104 that were unsuitable specimens and three with indeterminate results (1 each in 2016, 2017, and 2019).



Table 3: Human exposure to animals testing positive with and without Rabies Approval (RA) numbers by year. 2010-2019.

Events with PEP recommended			No. of persons			
Year	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)
Total	18	66	84	39	138	177

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

Species	2015		2016		2017		2018		2019	
	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)
Skunk	16	8** (50.0)	11	4 (36.4)	10	7 (70.0)	9	2 (22.2)	12	3 (25.0)
Bat	609	16 (2.6)	765	14 (1.8)	739	10 (1.4)	1021	17 (1.7)	1088	18 (1.7)
Cat	188	1 (0.5)	146	0 (0.0)	166	2 (1.2)	179	1 (0.6)	170	0 (0.0)
Dog	115	1 (0.9)	100	0 (0.0)	105	0 (0.0)	109	0 (0.0)	121	0 (0.0)
Cattle	36	2 (5.6)	40	1 (2.5)	44	0 (0.0)	33	1 (3.0)	42	0 (0.0)
Horse	6	0 (0.0)	8	0 (0.0)	6	0 (0.0)	11	1 (9.1)	13	0 (0.0)
Other	98	0 (0.0)	71	0 (0.0)	80	0 (0.0)	74	0 (0.0)	99	0 (0.0)
Total	1,068	28 (2.6)	1,141	19 (1.7)	1150	19 (1.7)	1436	22 (1.5)	1,545	21 (1.4)

\*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: 11 skunks; 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).

### Results – Analysis of PEP Data

Additionally, data were analyzed to determine recommendations for PEP. This data did not include the year 2010 and 2011. The species submitted for testing includes skunks, bats, cats, dogs, cattle, raccoons, horses, llamas, and many more. Vaccination status of eligible animals are shown and option of quarantine of suspected animal are given. A summary of the results is shown below.

#### Bats

- 4,943 cases
  - 350 bites
    - 36 on the hand
    - 7 below the ankle
    - 5 in the trunk
    - 3 head
    - 298 not recorded or unknown
  - 6 abrasions
  - 4,460 Proximity

#### Cats

- 1,247 cases
  - 388 were owned
    - 183 euthanized
    - 129 quarantined, 257 were not quarantined
    - 335 involved the person getting bit
  - 760 were unknown or strays
    - 542 were euthanized
    - 115 were not captured
    - 166 were quarantined, 673 were not
  - 1,155 had an unknown or not UTD rabies vaccination
    - 82 cases had PEP recommendations

- 49 were UTD on rabies vaccination
  - 0 cases had PEP recommendations

#### Dogs

- 1,275 cases
  - 965 were owned
    - 385 were quarantined, 591 were not quarantined
    - 312 were UTD on rabies vax
    - 631 had unknown or not UTD rabies vaccination
      - 10 tested positive, 6 were unsuitable
  - 305 were unknown or strays
    - 24 were quarantined, 278 were not quarantined
    - 274 had an unknown or not UTD rabies vaccination, 4 were UTD
    - 37 cases had PEP recommendations

#### Cattle

- 260 cases
  - 253 involve saliva as the wound type
    - 14 of those had hand as the wound location
    - 36 were positive
    - 6 unsuitable

#### Horses

- 55 cases
  - 6 positives
    - 5 animals were owned
    - None were quarantined
    - All had saliva as the wound type
  - 3 unsuitable
    - All animal owned
    - None were quarantined
    - All had saliva as the wound type
    -
  - 45 negatives
    - 3 had unknown ownership
    - 2 were quarantined
    - 43 had saliva as the wound type, 1 was a bite
  - All positive and unsuitable cases were recommended PEP

#### Skunk

- 11 cases
  - 6 were positive, 1 unsuitable
    - 6 saliva exposures, 1 Scratch/bite
    - 4 cases PEP was recommended

## Raccoon

- 137 cases
  - 122 negatives, 3 unsuitable
    - 31 had saliva as the wound type
    - 75 involved bite wounds
  - 22 unknown test result
  - 3 animals were owned

## Squirrel

- 45 cases
  - 31 negative, 1 unsuitable
    - 32 involved bite wounds
      - 23 bite wounds on hand/arm/finger
    - All had low to no risk exposure and PEP was not recommended

## Goat

- 21 cases
  - All negative, all owned
    - 1 animal was quarantined
    - 19 had saliva as the wound location

## Opossum

- 18 cases
  - 9 negatives
  - 8 were not retrievable
- 15 recorded bites, 1 abrasion
  - 6 bites were location on the hand

All the species listed below had 10 or fewer cases.

## Woodchuck

- 6 cases
  - None were quarantined.
  - 3 tested negative
  - 3 animals were not retrievable
    - 1 case recommended PEP

## Coyote

- 4 cases
  - All negative
  - All involved bite wounds

## Mouse

- 3 cases
  - All negative
  - All involved bite wounds

## Rat

- 9 cases
  - 7 negatives, 2 unknowns
  - All involved bite wounds
    - 8 wound locations were on the hand/finger
    - 5 in Lincoln, NE

## Prairie Dog

- 2 cases
- Animals were not retrievable
  - 1 case recommended PEP

## Vole

- 4 cases
  - All negative
  - All bite wounds
    - 3 located on the hand
    - 2 from Lincoln, NE

## Fox

- 4 cases
  - All negative
  - All bite wound on the hand or arm

## Ferret

- 2 cases
  - 1 negative
  - 1 quarantined
- Both animals were owned

## Llama

- 2 cases
  - 1 animal tested positive
  - Both were owned
  - Both PEP was recommended
  - Both involved saliva exposure

## Rabbit

- 3 cases
  - None were tested for rabies, just recorded in the system
  - All owned
  - 2 were quarantined
  - No PEP was recommended

## Hamster

- 1 case

- Animal was owned, not euthanized, and not quarantined
- Bite wound on the hand

## Aim 2

Educational materials were created to help NDHHS inform the public about the rabies virus. Infographics and News Releases were developed, reviewed, and approved by NDHHS. Topics include rabies prevention, recognition of clinical signs, and protection measures for humans and animals from rabies. Infographic 2 and News Release 1 focus on bats. Bats were found as the most prevalent positive species in urban counties, although there are positive bats found throughout the state. News Release 2 focuses on rabid skunk awareness since this species has the highest proportion of positive tests.

Infographics and images were created using the software program Canva. Each News Release is one page of information for the purpose of being released to the public. Resources used to make the products are stated in the correlated infographic, image, and news release. All products were created by the author and revised by NDHHS staff and the committee members of this project.

A complete project report was prepared and submitted to NDHHS (see Appendix A). The infographics, images and news releases created for this project cover a variety of topics related to the rabies virus and prevention methods.

Infographic 1

**NEBRASKA**  
Good Life. Great Mission.

## HOW TO PREVENT RABIES

Rabies is a fatal but preventable viral disease that affects only mammals. In the United States, 90% of rabies cases occur in wildlife. Wildlife that commonly carry rabies are skunks, bats, raccoons, and foxes. Contact with infected bats is the leading cause of rabies deaths in the United States. 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.

Source: [www.cdc.gov/rabies/animals.com](http://www.cdc.gov/rabies/animals.com)

<b>Do NOT pet stray dogs or cats</b>	
	<b>Never feed or approach a wild animal</b>
<b>Make sure your pets get regular rabies vaccinations</b>	
	<b>Be aware of any bats inside your home</b>

You can't tell if an animal has rabies just by looking at it. If you suspect an animal has rabies, please contact your local animal control and report it. If you've been in contact with any wildlife or unfamiliar animals and have been bitten or scratched, you should talk with a healthcare or public health professional and determine your risk for rabies or other illnesses. Decisions should not be delayed.

For more information: <http://dhhs.ne.gov/Pages/Rabies.aspx>

Infographic 1 focuses on how to prevent rabies and gives basic information on rabies.

Infographic 2

## HOW TO BAT-PROOF YOUR HOME

It is best to contact an animal-control or wildlife conservation agency for assistance with "bat-proofing" your home. If you do the "bat-proofing" yourself, here are some suggestions.

- 

### 1 BEST TIME TO BAT-PROOF

Avoid doing these activities May through August. There may be young bats in your attic who cannot fly. Keeping the adults out will trap them and they will die or try to come into your home. Most bats will leave your home in the fall or winter to hibernate. So, these are the best times to "bat-proof" your home.
- 

### 2 EXAMINE YOUR HOME

Carefully examine your home for holes that might allow bats into your living quarters. Use caulk for openings larger than quarter-inch by half inch. Use window screens, chimney caps and draft-guards between doors to attics. Fill electrical and plumbing holes and ensure all outside doors close tightly.
- 

### 3 COVER ENTRY POINTS

Prevent bats from roosting in attics or in buildings by covering outside entry points. Observe where they exit at dusk and keep them from coming back by hanging clear plastic sheeting or bird netting over these areas. Bats can leave but cannot re-enter. When all bats are gone, permanently seal openings.
- 

### 4 BATS AND RABIES

Most bats don't have rabies. But you can't tell if a bat has rabies by looking at it. If you suspect a bat has had any contact with humans, call animal control and have it tested for rabies. Wash any wound from an animal thoroughly with soap and water and seek medical attention immediately.
- 

### 5 IMPORTANCE OF BATS

Bats are a crucial part of our environment. Insects are their main food source so, they help control the insect population. Bats pollinate and disperse seeds to maintain plants and forests. Consider building a bat house to help keep them out of your home and provide cover for them. For more information about building a bat house, look up How to Build a Bat House from the National Wildlife Federation.

**NEBRASKA**  
Good Life. Great Mission.

Resource: CDC - Bats and Rabies. <https://www.cdc.gov/rabies/bats/management/index.html>

Infographic 2 focuses on methods to keep bats out of your home.

Image 1

**SIGNS OF RABIES**

- General sickness
- Problems swallowing
- Excess drool or saliva
- Aggression and biting

**An animal with rabies may NOT show any of these signs!**

- Appears tamer than you would expect
- Having trouble moving or may be paralyzed
- Bat that is on the ground

**NEBRASKA**  
Good Life. Great Mission.  
Source: CDC - Rabies

Image 2

**Are your pets protected against Rabies?**

**NEBRASKA**  
Good Life. Great Mission.

**All domestic animals must be vaccinated against rabies.**

**Cats  
Dogs  
Ferrets**

Contact your veterinarian for the vaccination status of your animal(s) and to schedule a vaccination appointment.

SOURCE: NEBRASKA REVISED STATUTE 71-4402

Image 1 describes the clinical signs of rabies in wildlife, livestock, and companion animals.

Image 2 relates to the Nebraska Statute stating all domestic animals must be vaccinated for rabies. The household pets required for rabies vaccination under this law are stated in the image and information on how your animal can receive a vaccination for rabies.



Image 3



Image 4



Image 3 is about protecting your pet from rabies. These steps are crucial to stop the spread of rabies in animal species but also prevent potential exposure to humans.

Lastly, Image 4 gives methods on how to protect people from rabies.

News Release 1 focuses on bats since they were found as the most prevalent positive species in urban counties, although there are positive bats found throughout the state. The best time, as stated in the header of the release, would be in the late summer or early fall when bats start coming into homes. This would inform the public of the increased risk of a potential exposure to rabies since bats are exhibiting hibernating behaviors.

## News Release 1– Bats

### **Uninvited guests roosting in your home?**

Bats often enter homes in late summer and early fall due to their hibernation behavior. This is a problem for urban and metro-areas since some species of bats live in buildings. There is no reason to evict them if there is little chance for them to have contact with people. If there is a risk for human contact, bats must be relocated because they can carry rabies.

Rabies is a fatal virus that affects the central nervous system and is transferred by the saliva of an infected animal through a bite, scratch, existing wounds or contact with mucous membranes. Bats are the leading cause of human rabies. Since bat's teeth are so tiny and sharp, it is hard to identify a bite unless witnessed. It is important to get these bats tested if there is potential, they have encountered humans or pets. Contact your medical professional or public health official if you have been in contact with a bat for immediate testing.

Rabies in humans is rare in the United States, with only one or two human cases per year. This is due to people successfully being protected from developing rabies by being vaccinated after exposure to a positive animal. During 2019, in Nebraska, 18 of 1,088 bats submitted (1.7%) were positive for rabies. In the ten-year period of 2010 to 2019, 127 bats tested positive for rabies. Douglas and Lancaster county had the largest total of positive bats, 86 out of 127 (67.7%).

You can find out more information about rabies in Nebraska by visiting their website <http://dhhs.ne.gov/Pages/Rabies-Data.aspx>.

More information on how to keep bats out of your home  
<https://www.cdc.gov/rabies/bats/management/index.html>

Steps to capture a bat in your house for release or to have rabies testing performed  
<https://www.cdc.gov/rabies/bats/contact/capture.html>

Rabies is more common in other countries including areas of Africa, Asia, and Central and South America. Talk to your doctor about your travel plans. More information is available at <https://wwwnc.cdc.gov/travel/diseases/rabies>

News Release 2 focuses on rabid skunk awareness since this species has the highest proportion of positive tests. Formatting and structure for these News Release's was based on information about writing press releases from the Huff Post (Cutler, 2013).

## News Release 2– Skunks

\*For release in the spring when skunks have young and come out from hibernation.

### **Skunks are on the move**

Skunks are mainly active at night but, this time of year they are out during the day with their offspring and looking for food. To prevent unnecessary encounters with skunks, remove attractants around your home. This includes securing trash, covering window wells, and feeding pets indoors. If pets are fed outdoors, remove food immediately after they are done eating. Skunks like convenient denning sites such as wood and rock piles, elevated sheds, openings under concrete slabs and porches and crawl spaces. Skunks are one of the primary carriers of rabies and have been known to also carry leptospirosis. Do not be concerned if you see an adult skunk during the day, unless they are showing these abnormal behaviors:

- Limb paralysis
- Circling
- Boldness or unprovoked aggression
- Disorientation, staggering
- Uncharacteristic tameness

Do not approach the skunk yourself. Call your local animal control officer, wildlife rehabilitator, health department, or police department for assistance.

According to the Nebraska Department of Health and Human Services, skunks represent the species with the highest proportion of positive tests. Of 198 submitted, 125 were positive (63.1%) from 2010 to 2019. 123 out of the 125 positive skunks were from non-metro, rural counties in Nebraska. The largest number of these positive skunk cases occurred in Sheridan county, followed by Lincoln and Scotts Bluff counties.

You can find out more information about rabies in Nebraska by visiting their website <http://dhhs.ne.gov/Pages/Rabies-Data.aspx>.

Resources for this article were provided by the Humane Society of the United States and data collected from the Nebraska Department of Health and Human Services.

## **Discussion**

Because a large portion of Nebraska consists of rural communities with farm ground and animals including wildlife, domestic livestock, and companion animals, zoonotic diseases are an ever-present risk. However, as shown in the research urban communities have their own risk for rabies exposure due to bat behaviors. Animal and human health are greatly impacted by zoonotic diseases with one of the greatest risks to health being the rabies virus. This study validated that most positive Nebraska rabies cases occur in the wildlife species bats and skunks. Skunks are highly susceptible to rabies and can harbor the virus for extended periods of time. In Nebraska, skunks have the highest proportion of positive tests. Even though there's only a few human exposure cases related to skunks, education is needed to identify signs and methods to prevent the spread of the virus.

This study demonstrated that the largest number of bats submitted for testing were in the States two largest cities Lincoln and Omaha. Brown bats are commonly found in houses and building structures in these urban areas and cause proximity exposure to humans. Rabid bats are a reservoir of rabies and transmission can occur from minor or unrecognizable bites. The leading cause of human rabies deaths are exposures to infected bats. Rabies is preventable by using vaccines, pre-exposure prophylaxis, and post-exposure prophylaxis.

Skunks were the species with the highest proportion of positive tests in Nebraska. Of the skunks submitted for testing 123 of the 125 were from non-metro, rural counties in Nebraska. The largest number of positive skunk cases occurred in Sheridan county, followed by Lincoln and Scotts Bluff counties. Compared to bats, skunks and the other animal species submitted, were widely distributed throughout the state.

One method of controlling rabies is proper vaccination of domestic animals and quarantining animals suspected of rabies (Woldehiwet, 2002). Quarantining involves isolating an animal for 10 days and observing for any signs of rabies. By doing this, it would save a negative animals life. Based on the results of the exposure data, 1,155 cats and 905 dogs would still be alive if the animal had an up-to-date rabies vaccination.

Enduring materials were created for NDHHS on rabies prevention, bat proofing, signs of rabies, and protection of pets and humans from rabies exposure. These flyers, press releases and data sets will all serve to educate and ultimately protect Nebraskans from rabies exposures.

Additionally, NDHHS received a complete report on the findings of this research as shown in Appendix A. To address the need for public education on the risks association with bats, press releases were created for use by NDHHS.

### **Limitations**

Limitations of this project include having to work remotely due to COVID-19 restrictions. I did not have access to a state issued computer so, all data had to be de-identified before I could analyze it. By de-identifying the data, I was restricted to only using the quantitative data through the form shown in Appendix B.

Another limitation is the lack of research about occupational exposures, other than veterinarians. A limited number studies briefly mentioned the exposures of animal control officers, but other occupations were not mentioned.

### **Recommendations**

The rabies exposure form for Nebraska does not include a question regarding the occupation or industry of the person exposed. Adding a question about occupation would find

any occupational exposures and supply more information about how people are encountering potentially rabid animals.

Currently Nebraska does not have an oral vaccination program to help control the spread of rabies in wildlife. Adopting a program like this from Wildlife Services could benefit the state by decreasing the spread of rabies.

### **Conclusion**

This study validated that most positive Nebraska rabies cases occur in the wildlife species bats and skunks. The risk of transmission of rabies from animal to animal and animal to human in Nebraska is a Public Health concern. To reduce the risk of human exposure and exposure between animals the public needs to be made aware of the scope of the problem and prevention measures that can be taken. Enduring materials were created for NHHS on rabies prevention, bat proofing, signs of rabies, and protection of pets and humans from rabies exposure. These flyers, press releases and data sets will all serve to educate and ultimately protect Nebraskans from rabies exposures.

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## Appendix A

Nebraska Department of Health and Human Services Report Updated by Jill Oatman

### **Rabies in Nebraska, 2010 – 2019**

#### **Background Information**

With 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 (1.7%), and 3 skunks (25.0%). 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>.

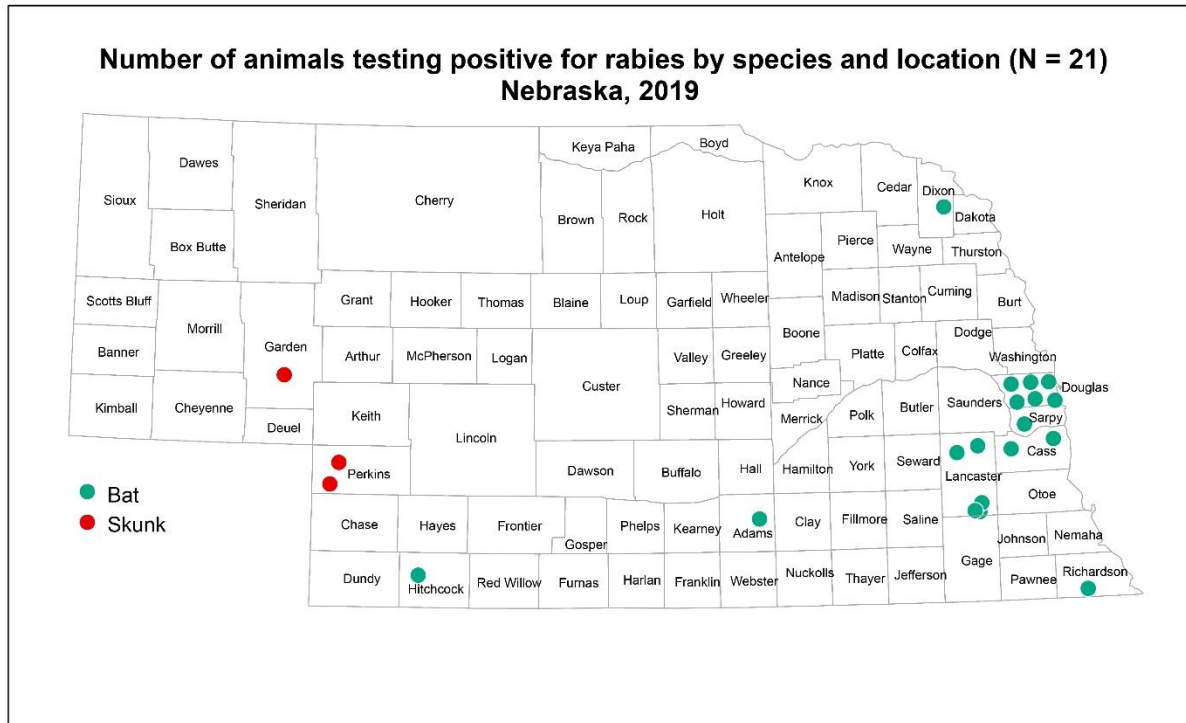
Table 1: Number of animals submitted for rabies testing and number positive by species, 2019.

Species	Total submitted n (%)	Positive n (% of species total)
Bat	1088	18
Cat	170	0
Dog	121	0
Cattle	42	0
Raccoon	51	0
Horse	13	0
Skunk	12	3
Other*	48	0
<b>Total</b>	<b>1545</b>	<b>21</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 903 exposed persons (median number of persons/event, 1; range [1–10]).

Figure 1:



### 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.

Totals			Positive		
Species	N	Median/year (range)	N	(%)	Median/ year (range)
Skunk	198	14.5 (9--63)	125	63.1%	7.5 (2-53)
Bat	7563	690.5 (478-1088)	127	1.7%	13 (6-18)
Cat	1746	170.5 (146-216)	20	1.1%	1.5 (0-9)
Dog	1027	109.0 (100-142)	4	0.4%	- (0-1)
Cattle	379	40 (6-62)	24	6.3%	2 (0-7)
Raccoon	444	40.5 (22-105)	1	0.2%	- (0-1)
Horse	113	9.0 (5-34)	7	6.2%	- (0-4)
Other	389*	39 (29-48)	3**	0.8%	- (0-2)
Total	11,859	1,134.5 (1001-1545)	311	2.6%	25 (19-90)

\*\*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 [0.55–2.7%]), 107 (2.03%) 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 animal testing results by year. 2010-2019.

		Positive	Negative	Not testable
Year	N	N (%)	N (%)	N (%)
2010	371	12 (3.2)	354 (95.4)	5 (1.35)
2011	441	11 (2.5)	420 (95.2)	10 (2.3)
2012	474	13 (2.7)	455 (96.0)	6 (1.27)
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)
Total	5264	97 (1.9)	5,060 (96.1)	107* (2.0)

\*Total “Not testable” represents 104 that were unsuitable specimens and three with indeterminate results (1 each in 2016, 2017, 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.

Events with PEP recommended			No. of persons			
Year	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)
Total	18	66	84	39	138	177

## 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 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 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 tested animals 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.

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

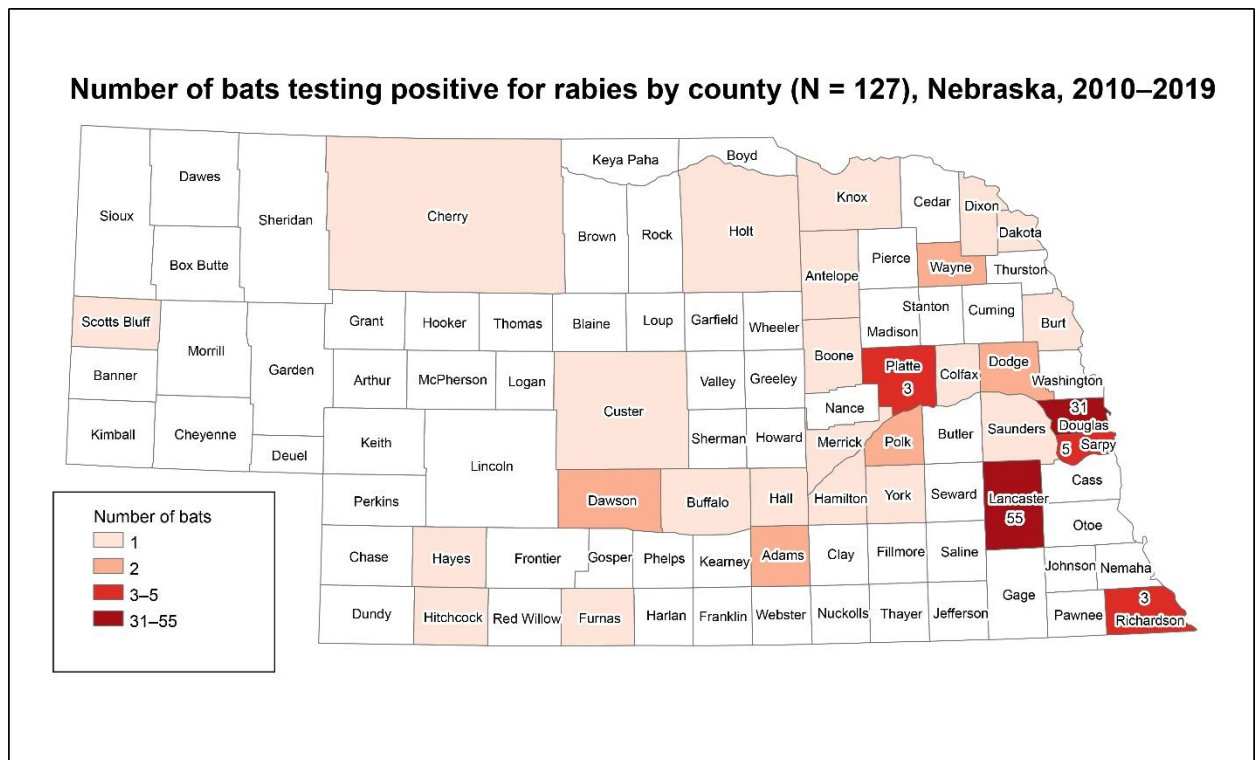


Species	2015		2016		2017		2018		2019	
	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)	N	Positive N (%)
Skunk	16	8** (50.0)	11	4 (36.4)	10	7 (70.0)	9	2 (22.2)	12	3 (25.0)
Bat	609	16 (2.6)	765	14 (1.8)	739	10 (1.4)	1021	17 (1.7)	1088	18 (1.7)
Cat	188	1 (0.5)	146	0 (0.0)	166	2 (1.2)	179	1 (0.6)	170	0 (0.0)
Dog	115	1 (0.9)	100	0 (0.0)	105	0 (0.0)	109	0 (0.0)	121	0 (0.0)
Cattle	36	2 (5.6)	40	1 (2.5)	44	0 (0.0)	33	1 (3.0)	42	0 (0.0)
Horse	6	0 (0.0)	8	0 (0.0)	6	0 (0.0)	11	1 (9.1)	13	0 (0.0)
Other	98	0 (0.0)	71	0 (0.0)	80	0 (0.0)	74	0 (0.0)	99	0 (0.0)
Total	1,068	28 (2.6)	1141	19 (1.7)	1150	19 (1.7)	1436	22 (1.5)	1545	21 (1.4)

\*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: 11 skunks; 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).

Figure 2:





Appendix B  
 Animal Exposure Rabies Form. Attached as an example of information collected for Aim 2 of  
 the Capstone project.

View Investigation: Animal Exposure (bite or nonbite)

RabiesTest RabiesTest   Male   —		Patient ID: 6345878
Investigation ID: CAS15612034NED1	Created: 11/04/2016	By: Bryan DHHS Buss 402.471.2937
Investigation Status: Closed	Last Updated: 11/18/2019	By: Bryan DHHS Buss 402.471.2937
Investigator: Bryan Buss	Case Status: Confirmed	Notification Status:

\* Indicates a Required Field

**[-] Patient Information**

General Information

\* General Information As Of Date: 11/04/2016  
 Comments:

Name Information

Name Information As Of Date: 11/04/2016  
 \* First Name: RabiesTest  
 Middle Name:  
 \* Last Name: RabiesTest  
 Suffix:

Other Personal Details

Other Personal Details As Of Date: 11/04/2016  
 Date of Birth:  
 Current Sex: Male  
 Is the patient pregnant?:  
 Mortality information As Of Date:  
 Is the patient deceased?:  
 Deceased Date:

Reporting Address for Case Counting

Address Information As Of Date: 11/04/2016  
 Street Address 1: 123 Any Street  
 Street Address 2:  
 \* City: Lincoln  
 \* State: Nebraska  
 Zip: 68516  
 County: Lancaster County  
 Country: UNITED STATES

Telephone Information

Telephone Information As Of Date: 11/04/2016  
 Home Phone: 402-471-2937  
 Work Phone:  
 Ext.:  
 Cell Phone: 402-450-6284  
 Email: test456@gmail.com

Alternate Contact Information

Name Of Additional Contact:  
 Phone Number Of Additional Contact:

Ethnicity and Race Information

Ethnicity information As Of Date:  
 Ethnicity:  
 Race information As Of Date:  
 Race:

**[-] Investigation Information**

Investigation Details

\* Jurisdiction: Alpha DHD (for Training Only)  
 \* Program Area: Vet/Epi  
 \* Investigation Start Date: 11/04/2016  
 \* Investigation Status: Closed  
 Investigator: Bryan Buss, DVM  
 301 Centennial Mall South

[Investigation Details](#)

PO Box 95026  
Lincoln, Nebraska 68509  
Date Assigned to Investigation: 11/04/2016  
\* Case Status: Confirmed  
Use Incident Date to calculate MMWR Week and Year  
\* MMWR Week: 44  
\* MMWR Year: 2016

**Reporting Information**[Key Report Dates and Information](#)

\* Incident Date: 10/02/2014  
Age at Onset:  
Age at Onset Units:  
City/Town of Incident: Other  
Other City/Town of Incident: Lincoln, NE

[Reporting Source](#)

\* Date of Report: 10/02/2014  
\* Reported By (Name): NE DHHS, Cole Vanicek, cole.vanicek@nebraska.gov  
Reported By (Phone): 402-441-7900  
\* Description Of Incident: Testing bat exposure questions  
Nebraska RA Number (if applicable): 2014-293

[Human Exposure Information](#)

\* Have other people been exposed to this animal?: No  
Number Of Additional Exposed Persons:  
Number Of Additional Persons Recommended for PEP:  
Additional Human Exposure Comments: Test Investigation.

**Exposing Animal Information**[Animal Status and Type](#)

\* Exposing Animal Species: Bat  
Other Exposing Animal Species:  
\* Was The Animal Captured?: Yes  
\* Was The Animal Retrievable?: Yes  
\* Was The Animal Quarantined?: No  
Animal Quarantine Location:  
Other Animal Quarantine Location:  
\* Was The Animal Euthanized?: No  
\* Was The Animal Tested?: Yes  
\* Ownership Status of the Animal: Unknown  
\* Rabies Vaccination Status: Does Not Apply

[Animal Owner Information](#)

Name Of The Animal Owner (if not victim?):  
Address Of Animal Owner:  
Animal Owner Phone Number:

**Wound Information**[Type and Location](#)

\* Type Of Exposure: Proximity (Bats)  
Location Of Wound (if applicable): Other (specify)  
Other Location Of Wound (if applicable): proximity only, no wounds

[Bat Exposure Questions](#)

Was the bat found in a room with a human who cannot state with certainty that they were not bitten?: Yes  
Did the person step on the bat barefoot?: No  
Did the bat directly contact the person's exposed skin?: Yes

**Clinical**[Recommendation for Post Exposure Prophylaxis](#)

[Recommendation for Post Exposure Prophylaxis](#)

Is patient immunosuppressed?: Yes  
 Type Of Immunosuppression:  
 Immunosuppressed Type Comments:  
 Recommendations/Treatment: No Risk Exposure (zero risk): No Vaccine Recommended  
 Off Schedule Or Other Vaccine Recommendation Comments:

**Lab Exam**

[Laboratory Results](#)

Date Of Laboratory Result: 11/04/2016  
 Laboratory Test NED88 Animal-Patient Last Name: NEGATIVE-22Jul2015K8RAB51  
 Laboratory Test Result: Negative

**Contact Records**

[Contacts Named By Patient](#)

The following contacts were named within RabiesTest RabiesTest's investigation:

Date Named	Contact Record ID	Name	Priority	Disposition	Investigation ID
08/14/2020	CON10342012NE01	NEG-26Aug2014K8RAB642, bat			

[Patient Named By Contacts](#)

The following contacts named RabiesTest RabiesTest within their investigation and have been associated to RabiesTest RabiesTest's investigation:

Date Named	Contact Record ID	Named By	Priority	Disposition	Investigation ID
Nothing found to display.					

**Associations**

[Associated Lab Reports](#)

Date Received	Reporting Facility/Provider	Date Collected	Test Results	Program Area	Event ID
Nothing found to display.					

[Associated Morbidity Reports](#)

Date Received	Condition	Report Date	Type	Observation ID
Nothing found to display.				

[Associated Treatments](#)

Date	Treatment	Treatment ID
Nothing found to display.		

[Associated Vaccinations](#)

Date Administered	Vaccine Administered	Vaccination ID
Nothing found to display.		

[Associated Documents](#)

Date Received	Type	Purpose	Description	Document ID
10/06/2014	Case Report	SHARE_NOTF	Animal Exposure (bite or nonbite)	DOC10000004NE01

**Notes And Attachments**

[Notes](#)

Date Added	Added By	Note	Private
Nothing found to display.			

[Attachments](#)

Date Added	Added By	File Name	Description
Nothing found to display.			



**History**

Investigation History

Change Date	User	Jurisdiction	Case Status	Version
11/18/2019	Bryan DHHS Buss 402.471.2937	Alpha DHD (for Training Only)	Confirmed	7

Notification History

Status Change Date	Date Sent	Jurisdiction	Case Status	Status	Type	Recipient
Nothing found to display.						