

Rabies: A Global and National Perspective

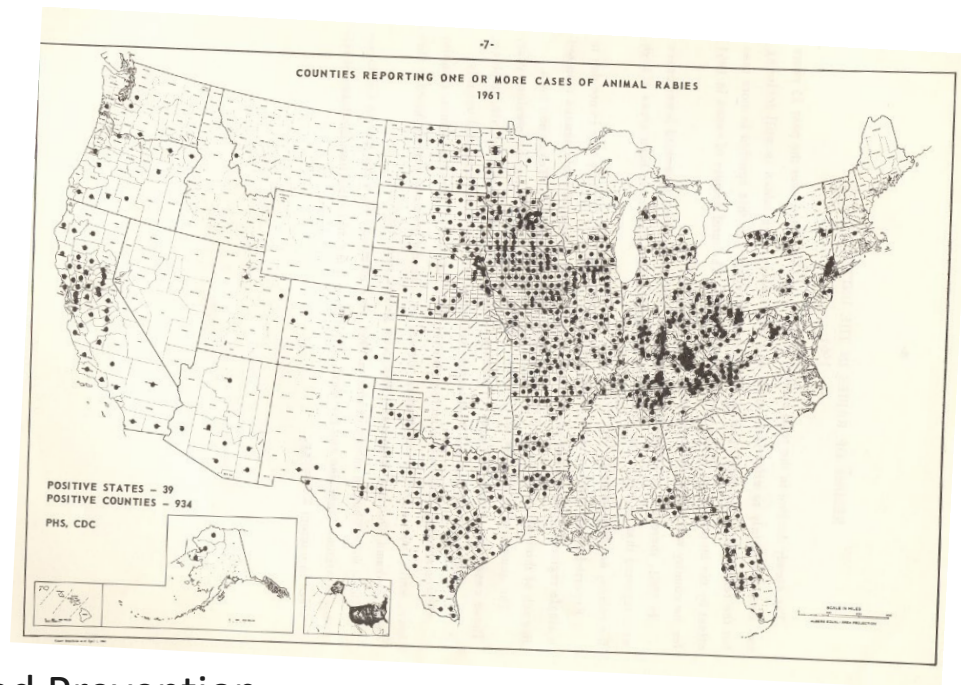
AJ Beron, PhD, MPH

February 14, 2024

Epidemic Intelligence Service

Poxvirus and Rabies Branch

US Centers for Disease Control and Prevention



CDC Rabies Program

Poxvirus and Rabies Branch

**WHO Collaborating
Center**

**WOAH Reference
Laboratory**

**Global Health
Securities**

**International
Rabies Task Force**



**National Rabies
Surveillance System**

**National Rabies
Reference Laboratory**

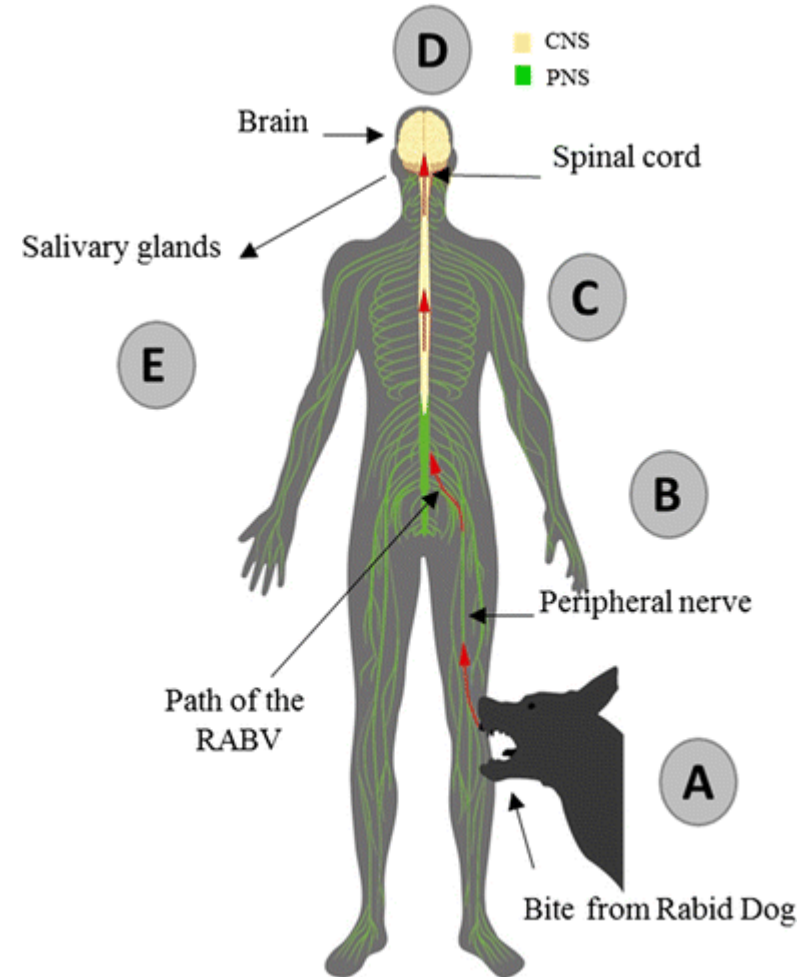
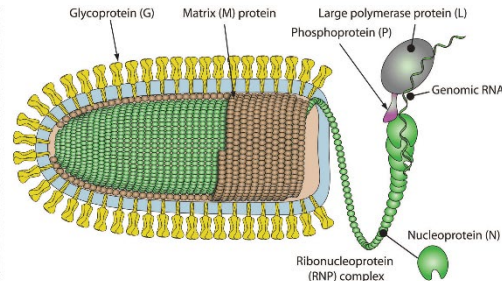
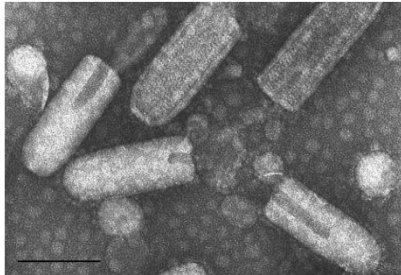
**National Rabies
TeleHealth Service**

**National Wildlife
Rabies Management
Plan**

What is rabies?

Rabies disease

- Rabies virus (RABV)
- Lyssaviruses
- Only mammals
- Encephalitis
- Almost always fatal



Where did rabies come from?

Rhabdoviruses emerged long ago



Long ago

Emergence of Lyssaviruses



Long ago



>30,000 BC



Emergence of canine rabies



Long ago



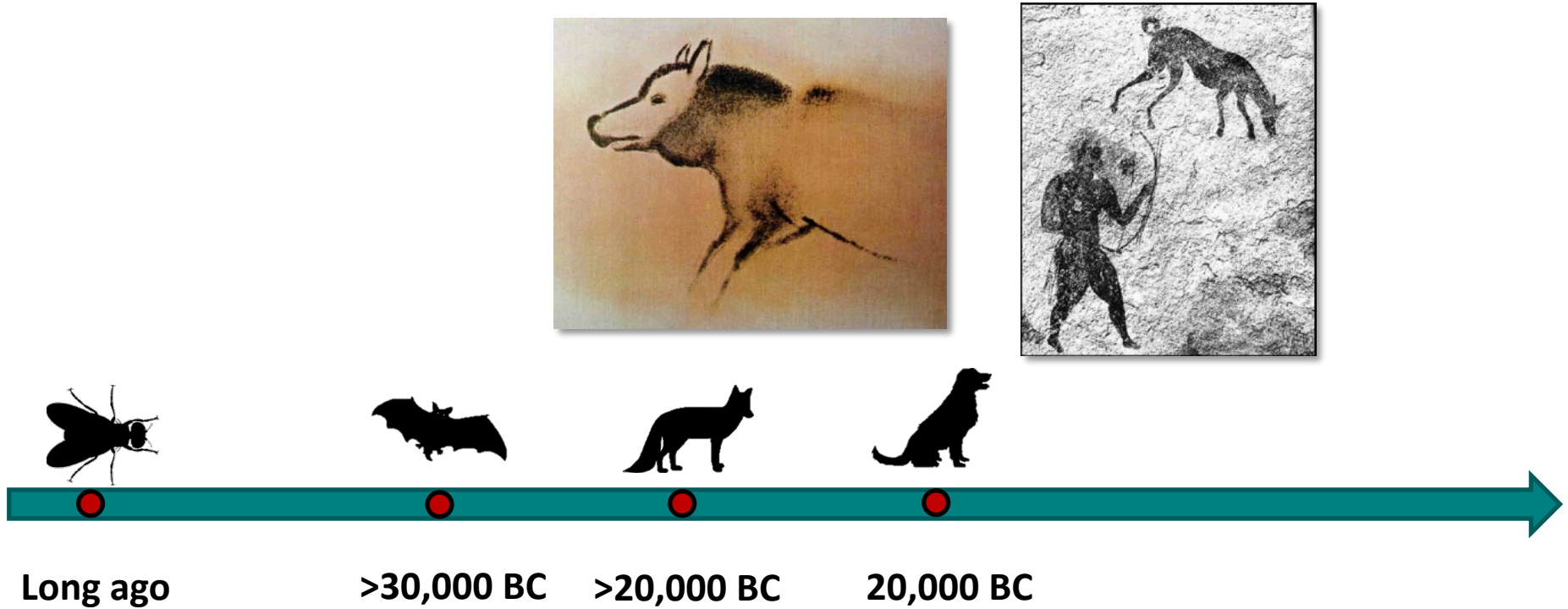
>30,000 BC



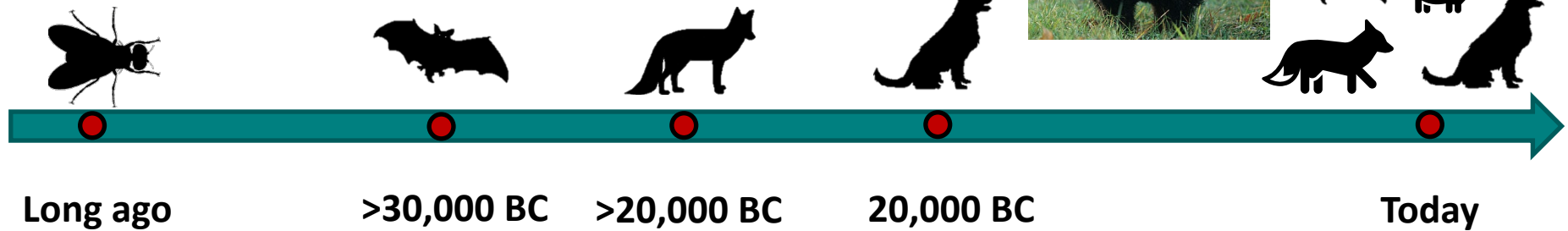
>20,000 BC



Domestication of animals



20 known terrestrial animal reservoirs for rabies





Rabies: A Domestic Perspective

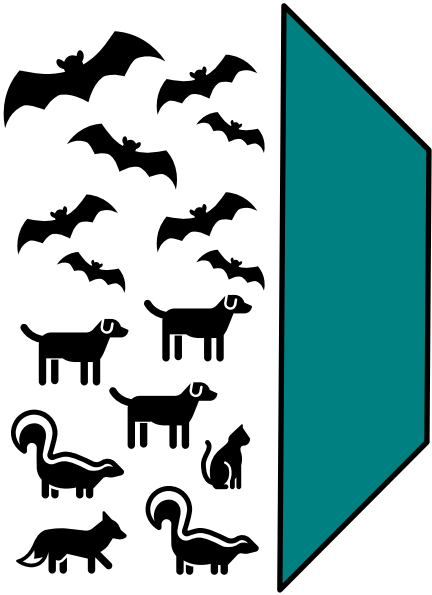
Eliminating Canine Rabies in the US

- **1938 – Rabies becomes reportable disease in the U.S.**
- **In the 1940's, mass dog vaccination campaigns were implemented in the U.S.**
- **Significant decline in dog and human rabies cases**
- **By late 1970's, canine rabies virus variant transmission eliminated**



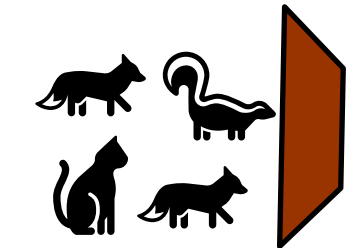


Rabies Surveillance in the United States



Public Health Surveillance

134
laboratories
100,000
samples

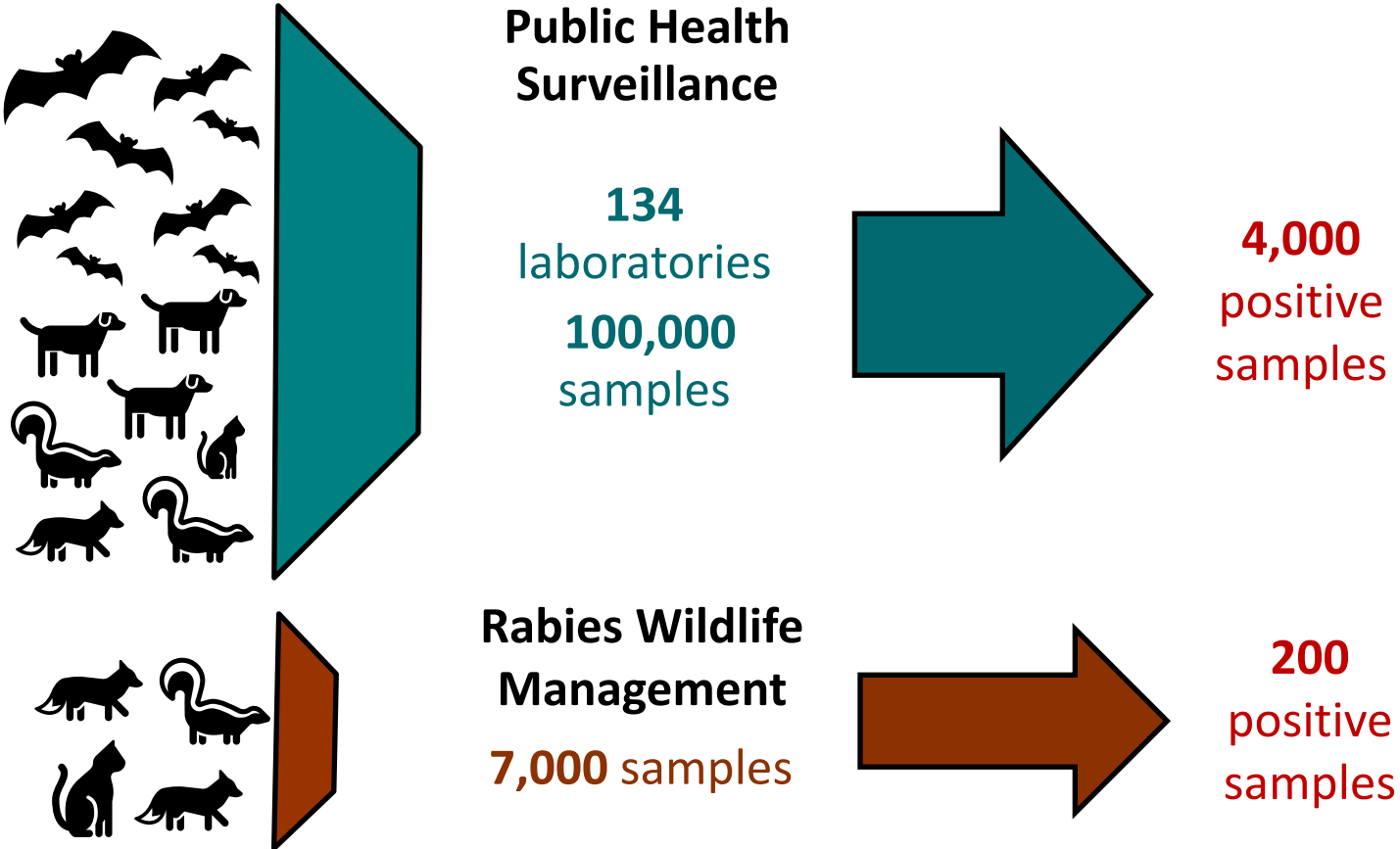


Rabies Wildlife Management

7,000 samples

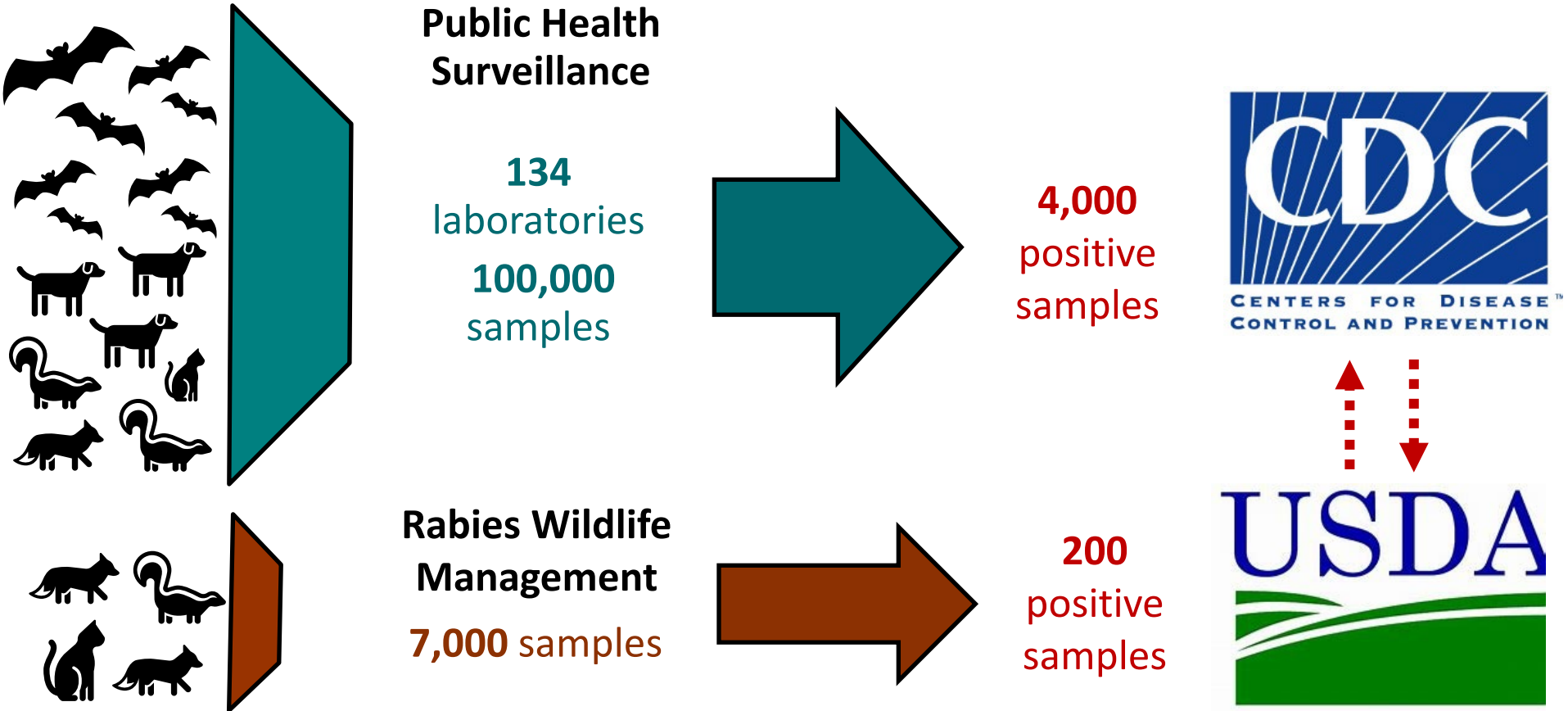


Rabies Surveillance in the United States





Rabies Surveillance in the United States





Rabies presents a major public health and financial burden to Americans



**4 million
annual
exposures**



Rabies presents a major public health and financial burden to Americans



**4 million
annual
exposures**



**800,000
seek care**



Rabies presents a major public health and financial burden to Americans



**4 million
annual
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**800,000
seek care**



**60,000
receive PEP**



Rabies presents a major public health and financial burden to Americans



**4 million
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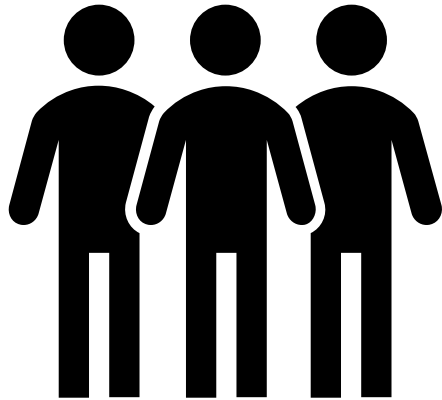
**60,000
receive PEP**



**\$356 million
in medical care**



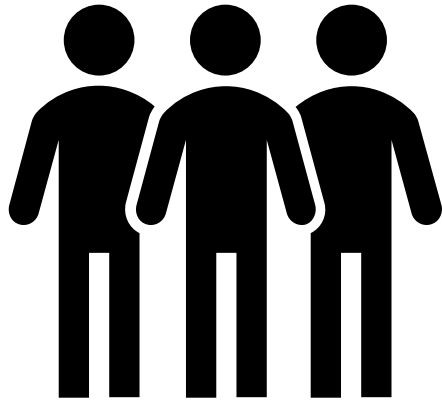
Rabies still kills Americans



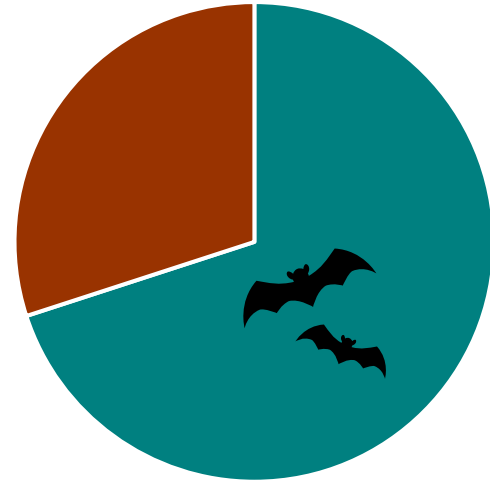
1-3 Deaths



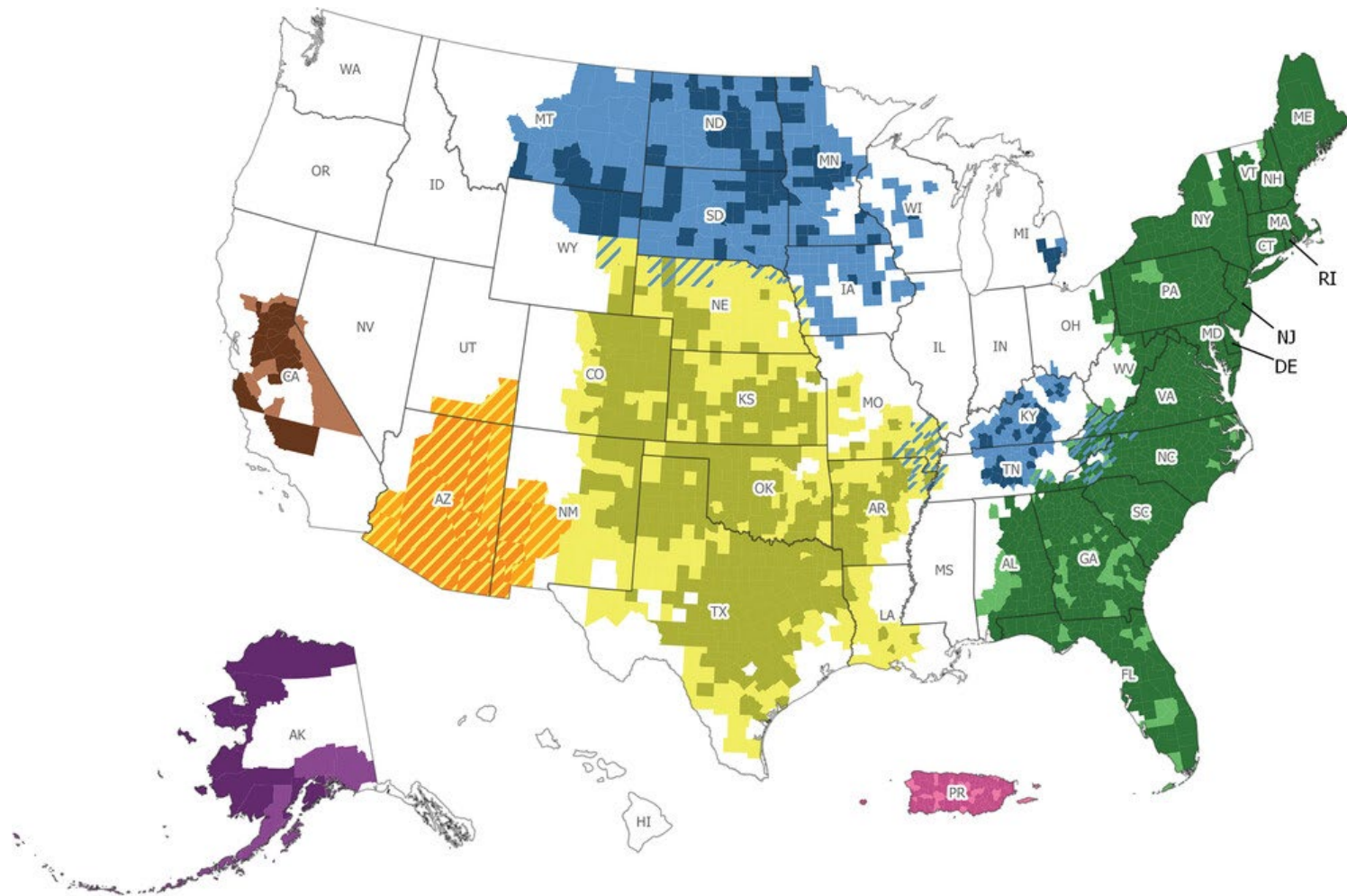
Rabies still kills Americans

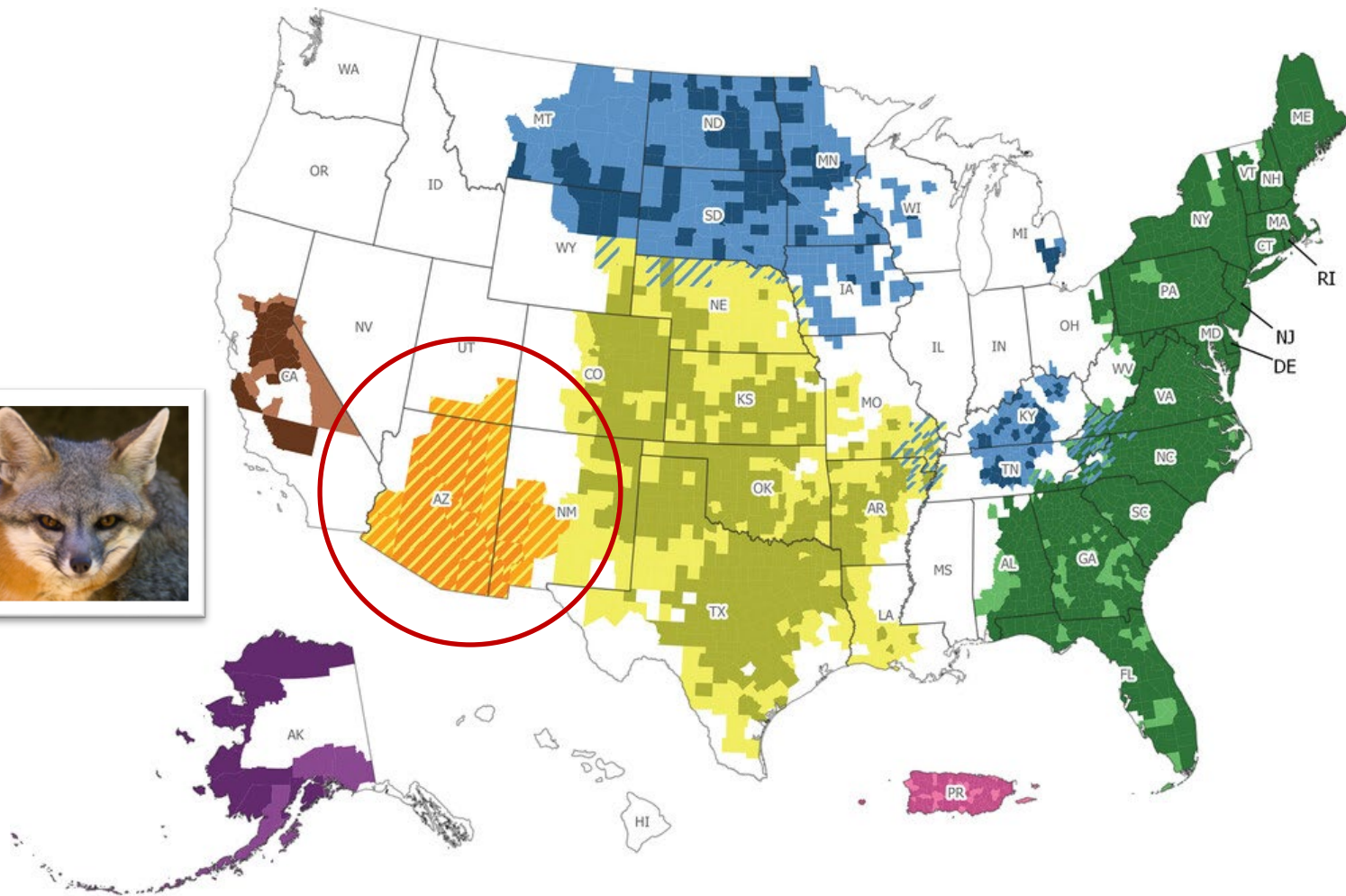
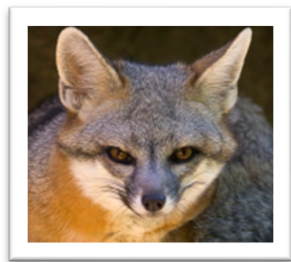


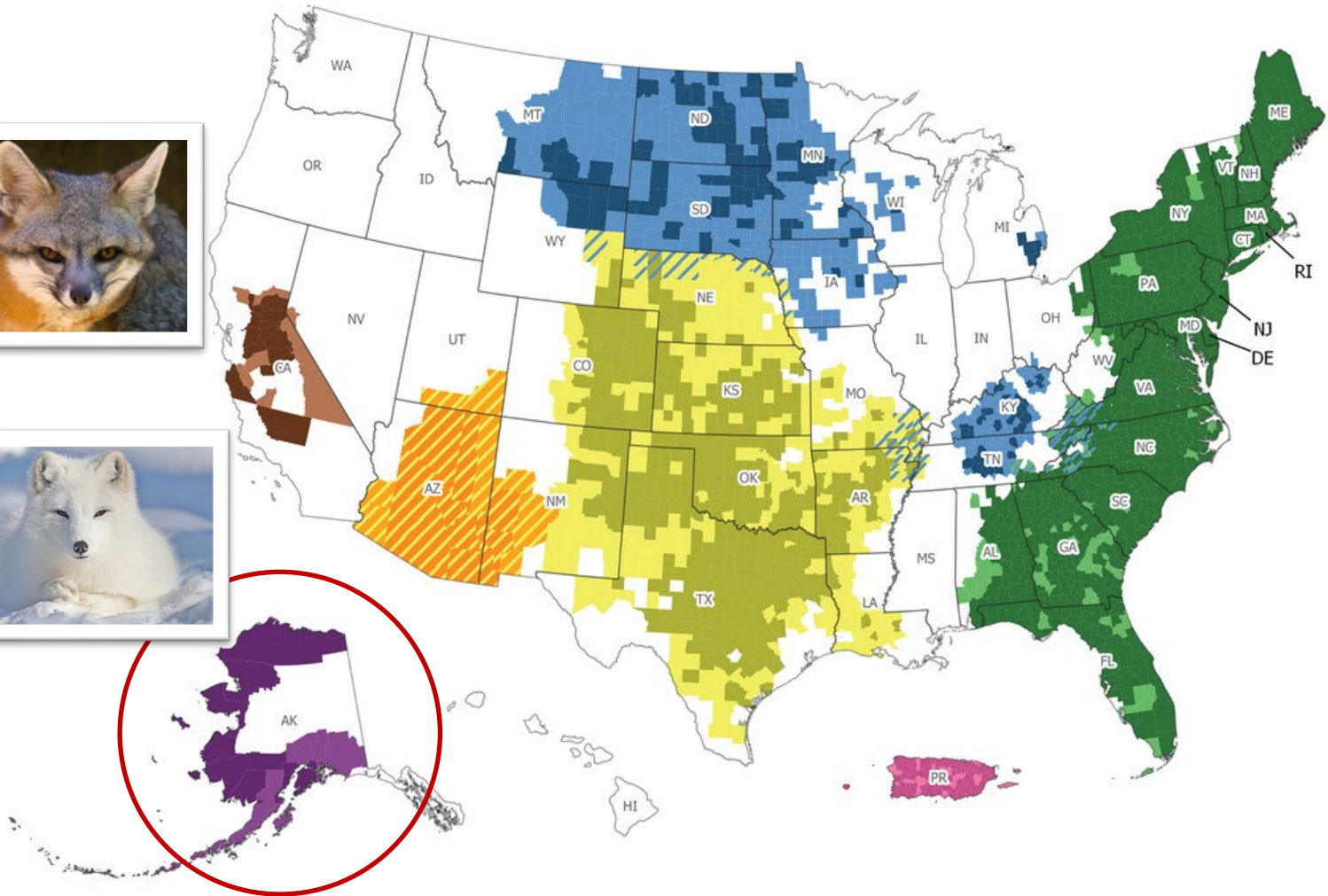
1-3 Deaths

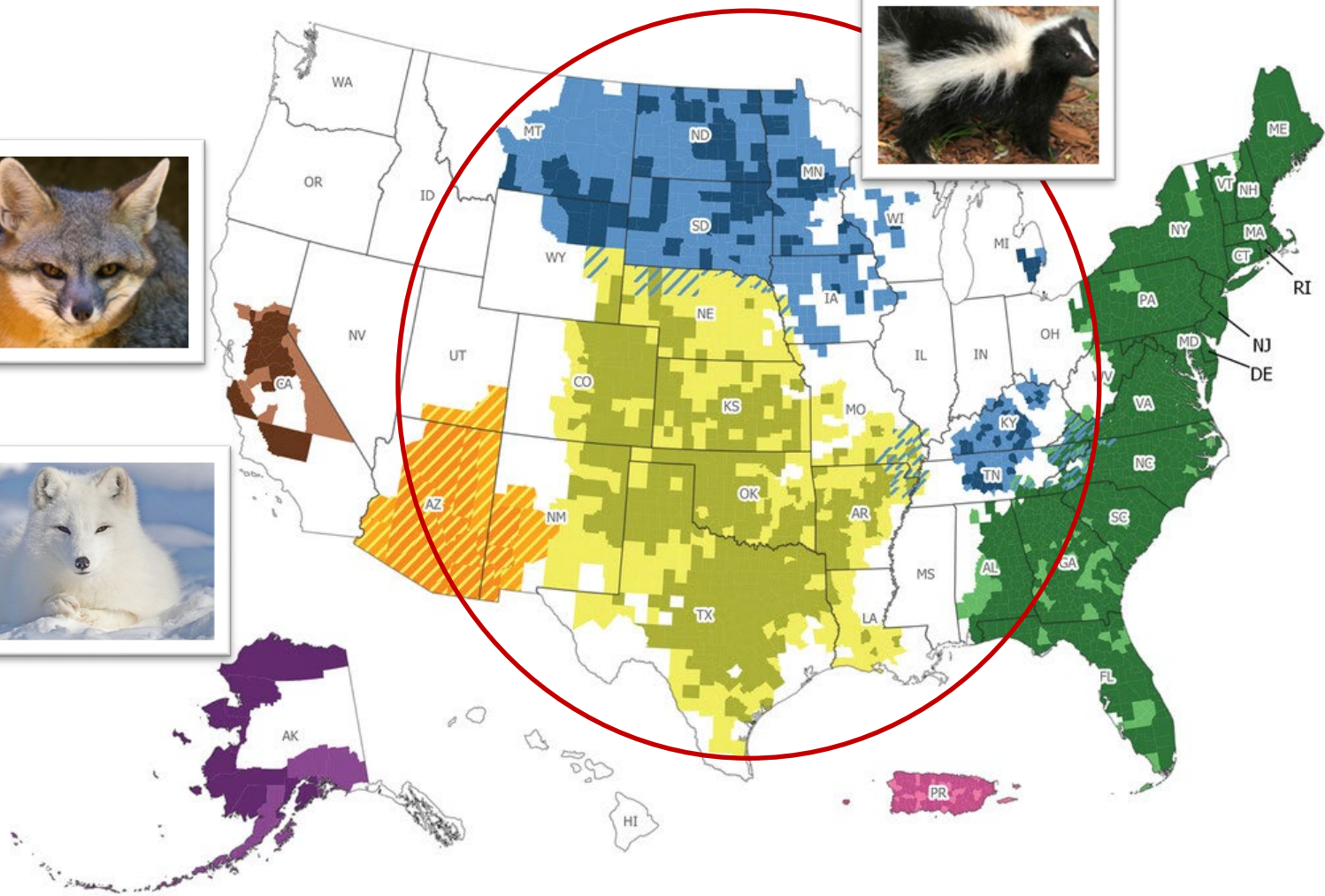
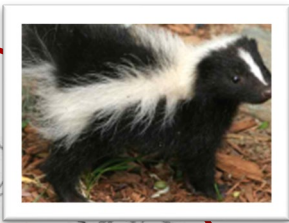


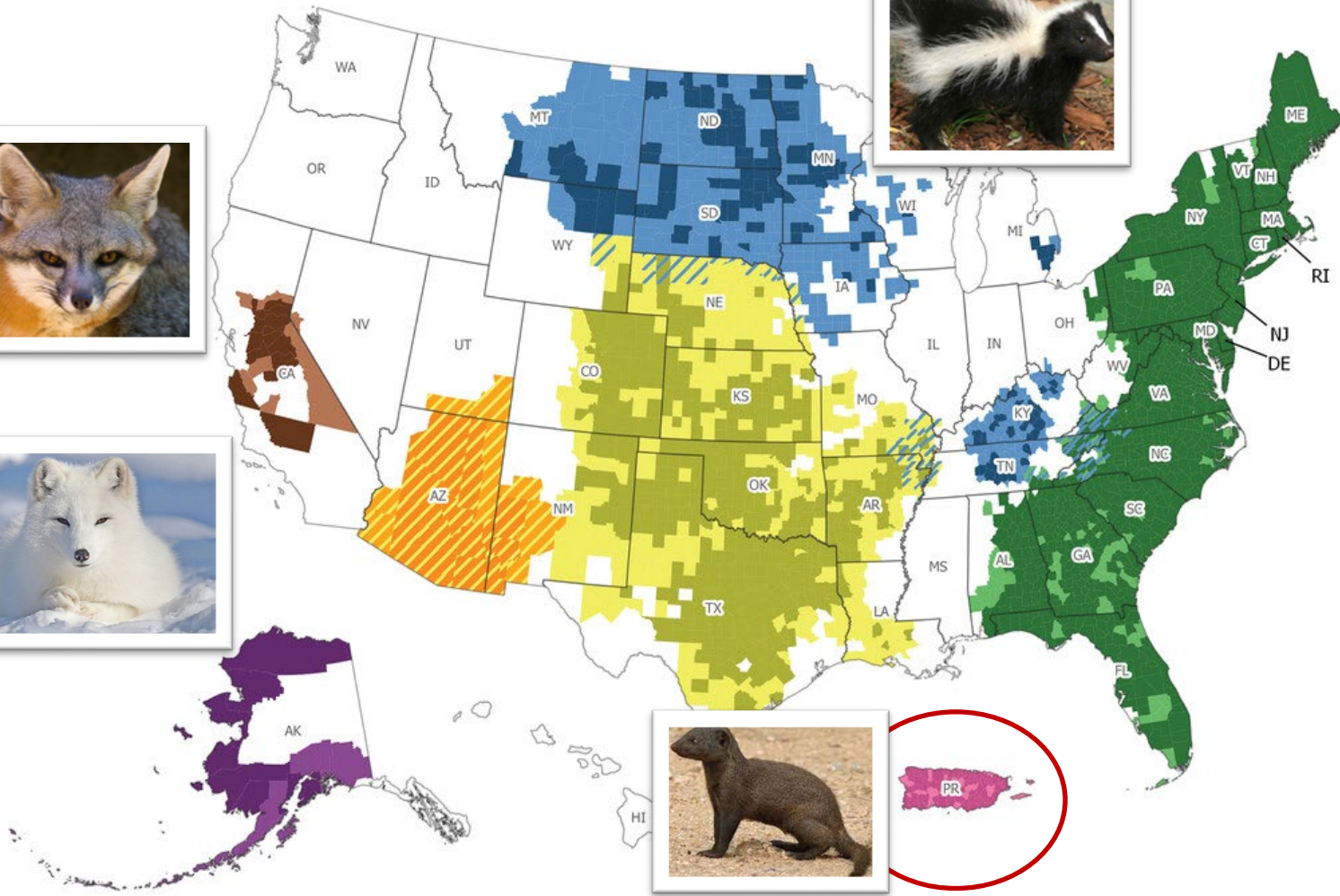
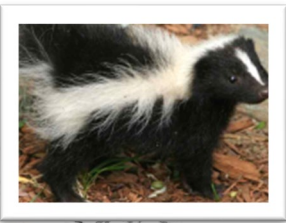
70%

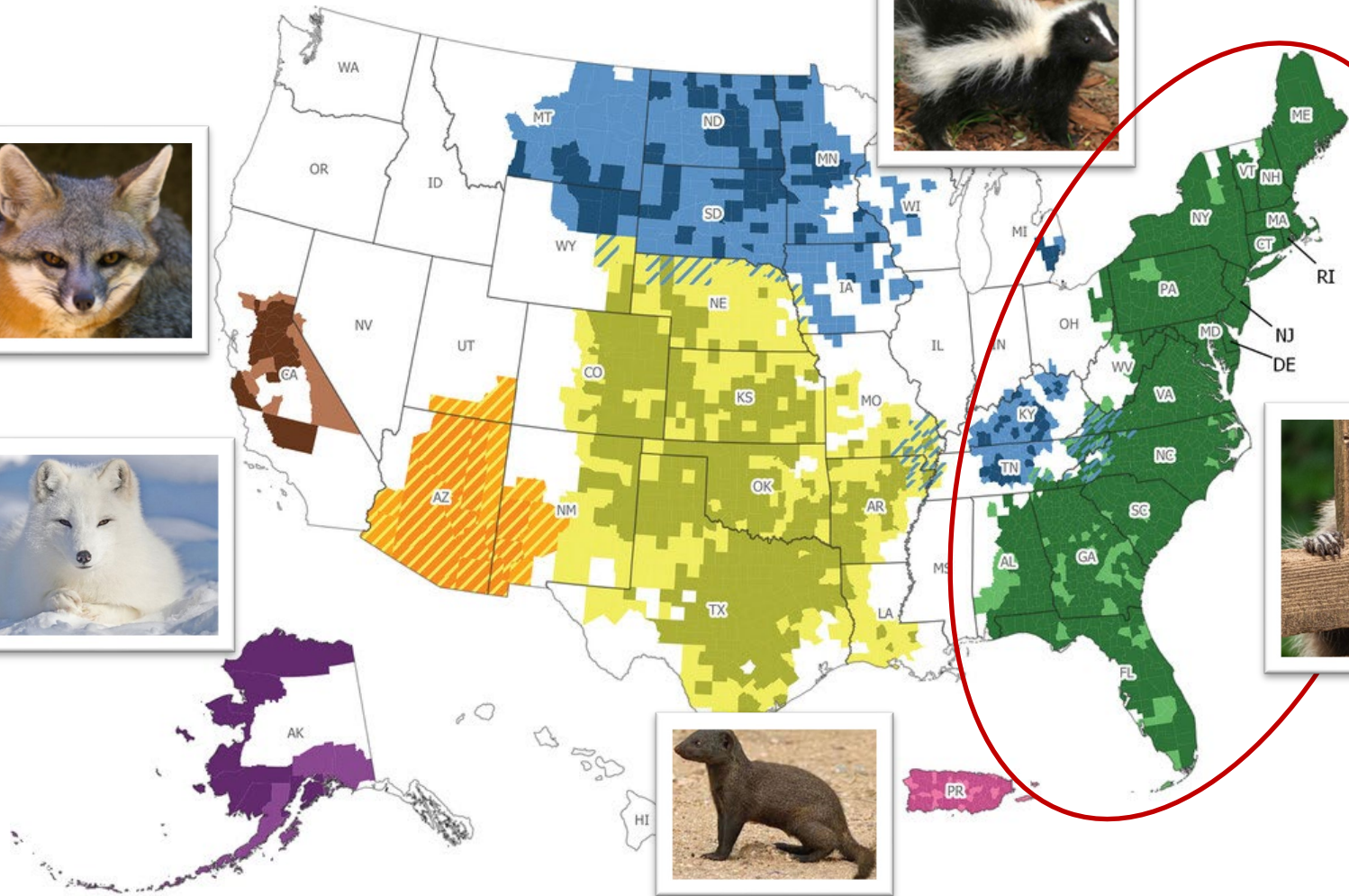
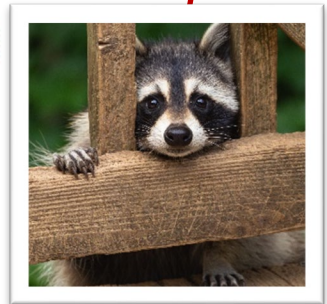
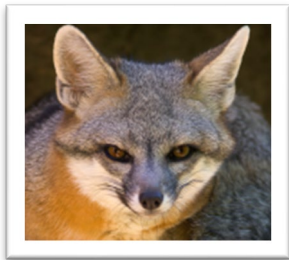








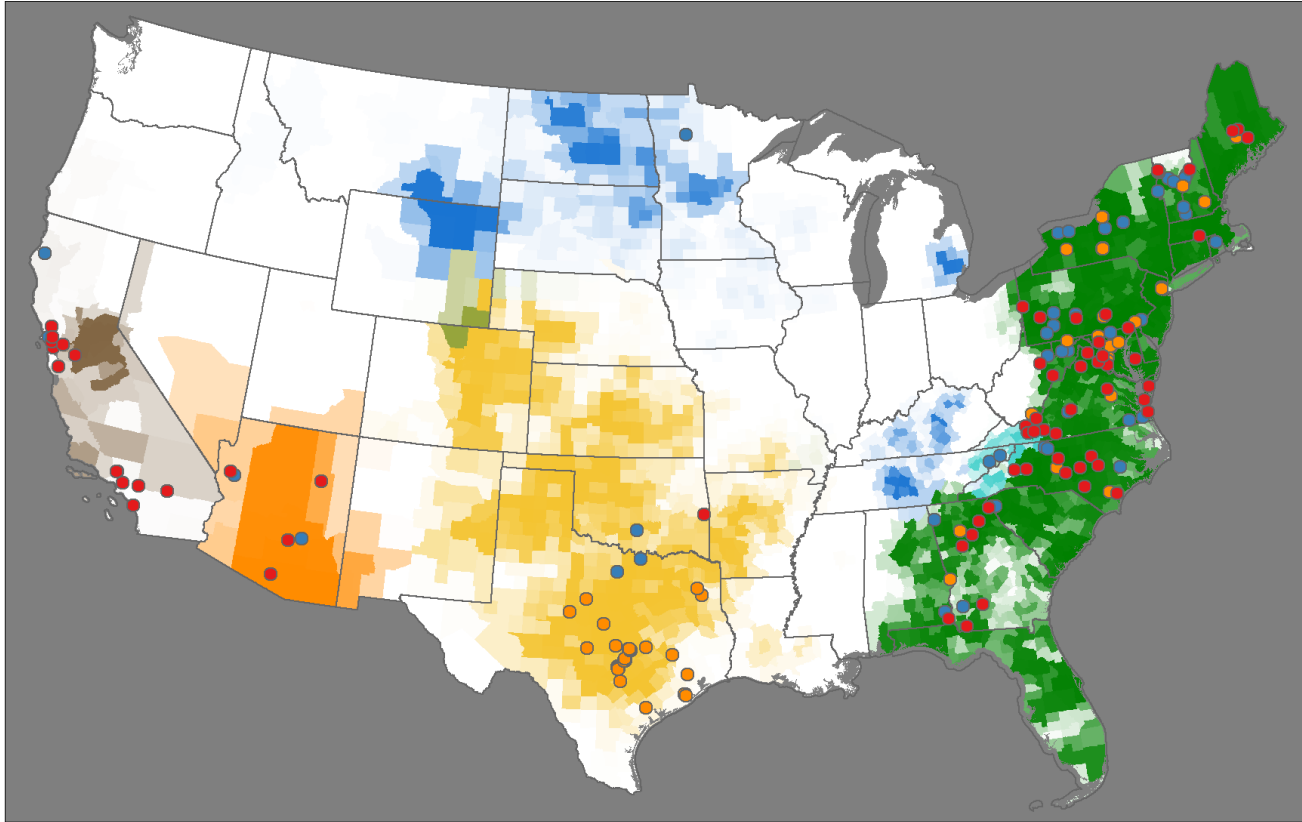




Monitoring for changes in the US rabies landscape - Samples of Epidemiologic Importance (SEIs)

- Antigenic and molecular testing methods can be used to identify major events or shifts in enzootic activity
 - Introduction of novel rabies virus variant (RVV)
 - Translocation of rabies virus variants into new geographic areas
 - Host-shift events
 - Introduction of RVV among nonindigenous bat species
- Other important events to monitor
 - Unusual rabies-related events
 - Early detection of a host-shift event in bats

Monthly reporting helps CDC identify SEIs sooner





Rabid Kitten Sparks Multiagency Response to Stop Spread of Raccoon Rabies in Omaha, Nebraska

October 2023

Sep 22: Stray kitten arrives on doorstep



Sep 22: Stray kitten arrives on doorstep

Sep 24: Kitten develops clinical signs



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Sep 25: Taken to vet and treated for toxoplasmosis



Sep 22: Stray kitten arrives on doorstep

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Sep 25: Taken to vet and treated for toxoplasmosis

Sep 26: Clinical signs worsen



Sep 22: Stray kitten arrives on doorstep

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Sep 26: Clinical signs worsen

Sep 27: Kitten dies, submitted for rabies testing



Sep 22: Stray kitten arrives on doorstep

Sep 24: Kitten develops clinical signs

Sep 25: Taken to vet and treated for toxoplasmosis

Sep 26: Clinical signs worsen

Sep 27: Kitten dies, submitted for rabies testing

Sep 28: Positive rabies result



Sep 22: Stray kitten arrives on doorstep

Sep 24: Kitten develops clinical signs

Sep 25: Taken to vet and treated for toxoplasmosis

Sep 26: Clinical signs worsen

Sep 27: Kitten dies, submitted for rabies testing

Sep 28: Positive rabies result

Oct 6: CDC confirms RRVV



Sep 22: Stray kitten arrives on doorstep

Sep 24: Kitten develops clinical signs

Sep 25: Taken to vet and treated for toxoplasmosis

Sep 26: Clinical signs worsen

Sep 27: Kitten dies, submitted for rabies testing

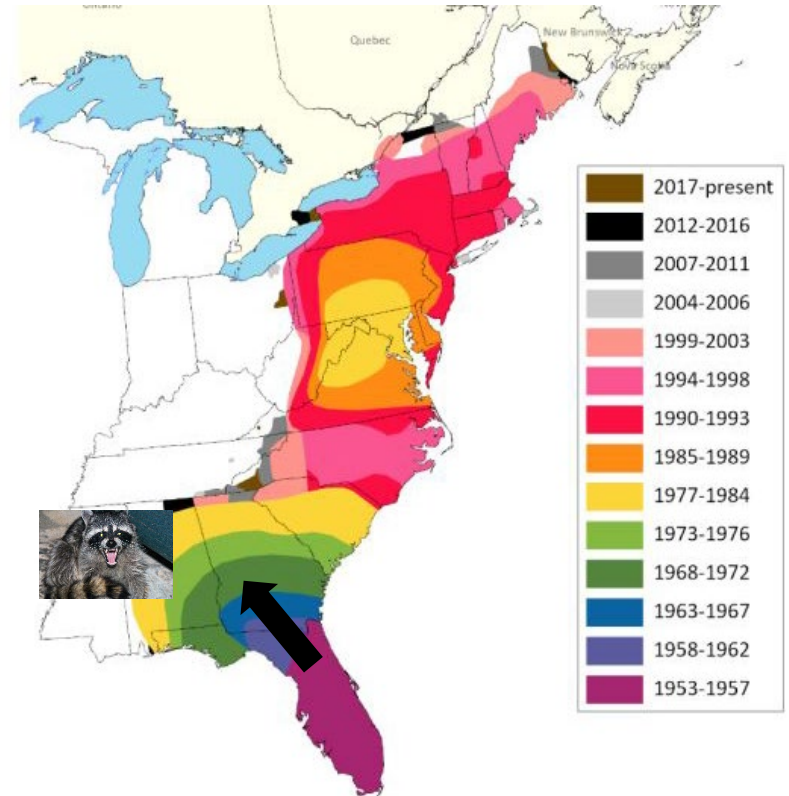
Sep 28: Positive rabies result

Oct 6: CDC confirms RRVV

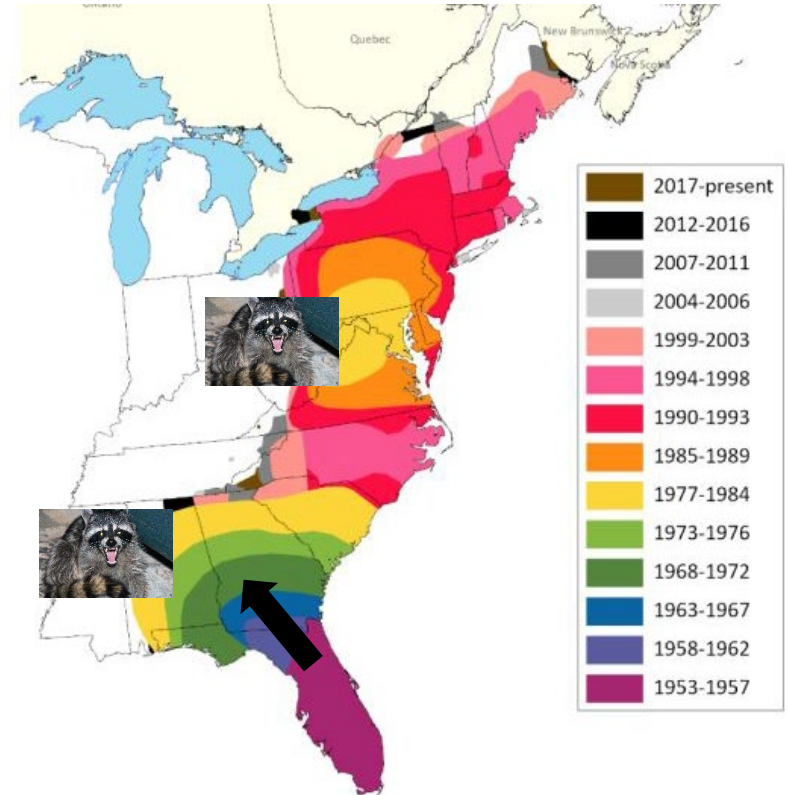
Oct 7: Multiagency call to plan response



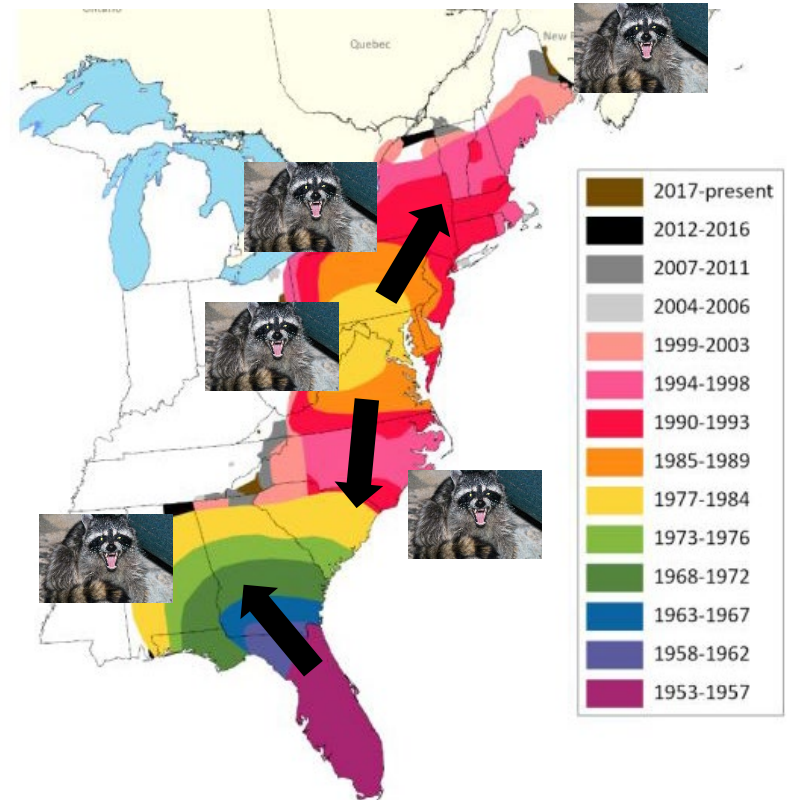
Translocation of RRVV in 1977



Translocation of RRVV in 1977

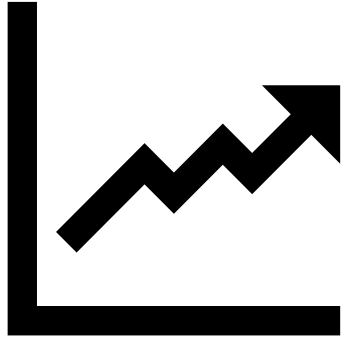


Translocation of RRVV in 1977





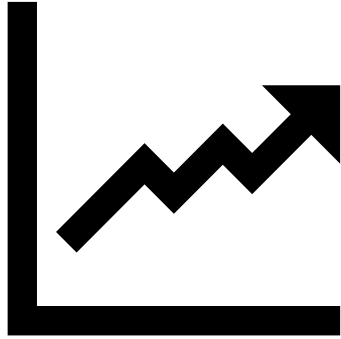
RRVV poses a major public health burden



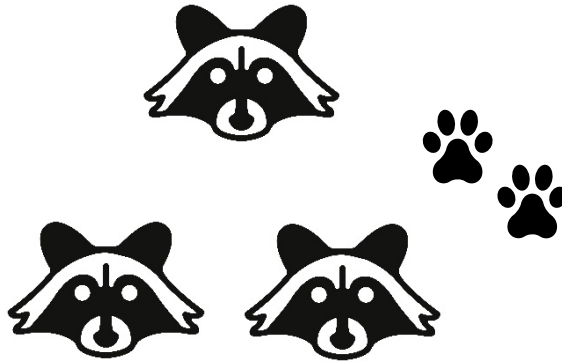
600%



RRVV poses a major public health burden



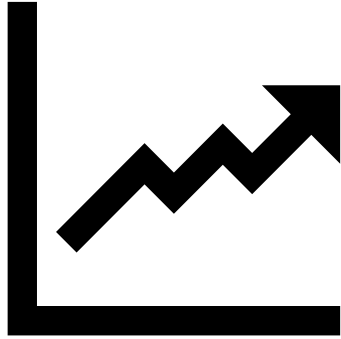
600%



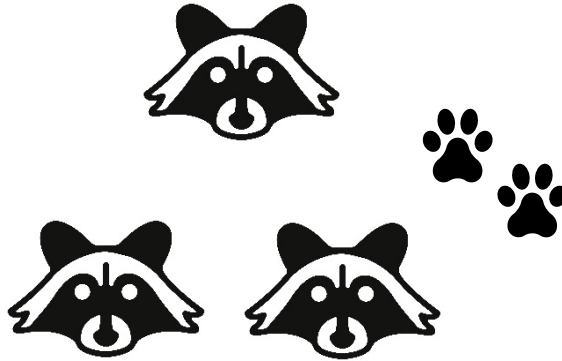
75%



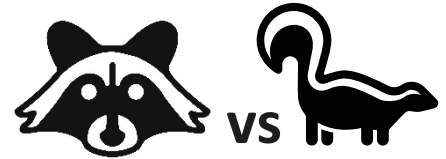
RRVV poses a major public health burden



600%

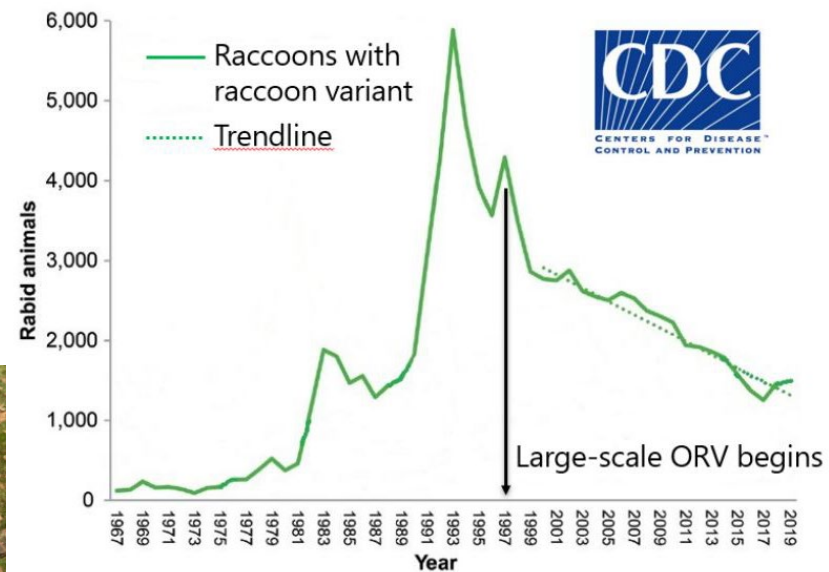
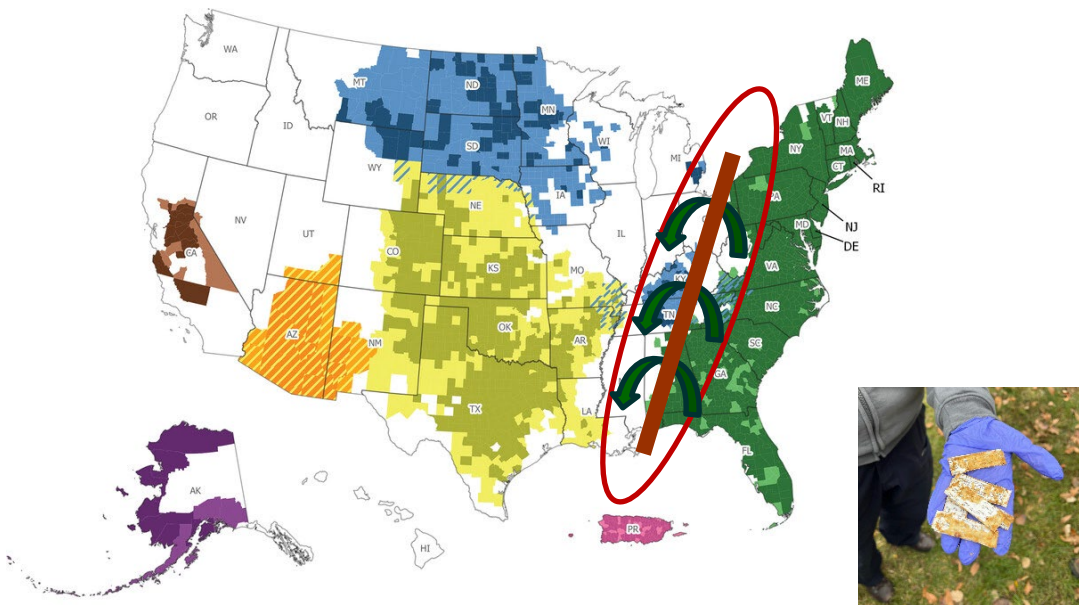


75%



1.68

Preventing westward expansion

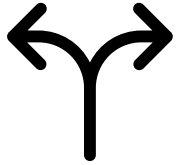




What would happen if RRVV emerged in Omaha wildlife?



After 5 years, RRVV would expand into 5 other states!



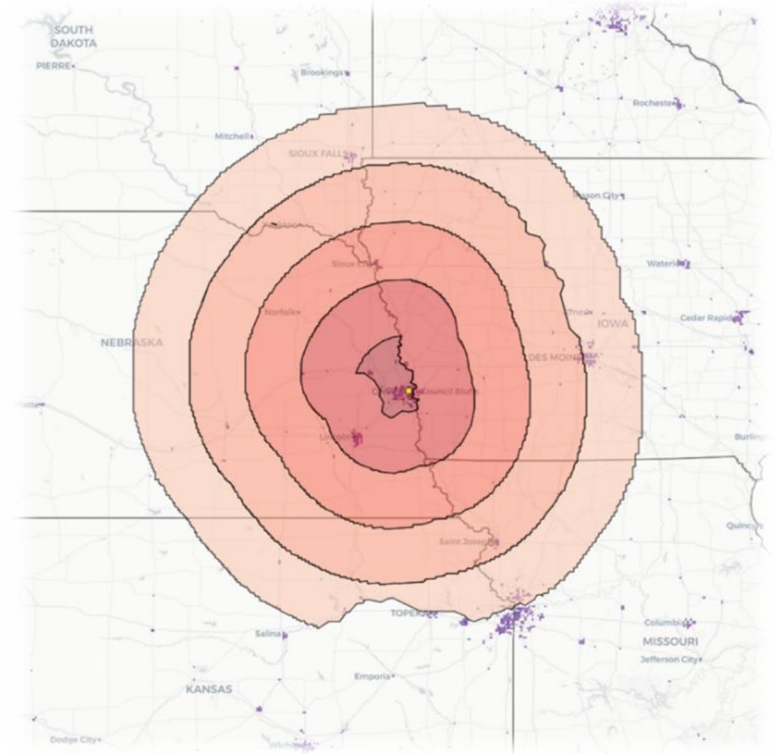
60 km/year expansion



2,000 – 12,000 human exposures



\$16-93 million in PEP costs



Unable to determine where this kitten came from or how it got RRVV



Multi-agency response initiated



Established enhanced rabies surveillance system



Identify additional RRVV cases



Vaccinate wildlife



Quick identification and decisive action may have prevented introduction of RRVV into Midwest wildlife

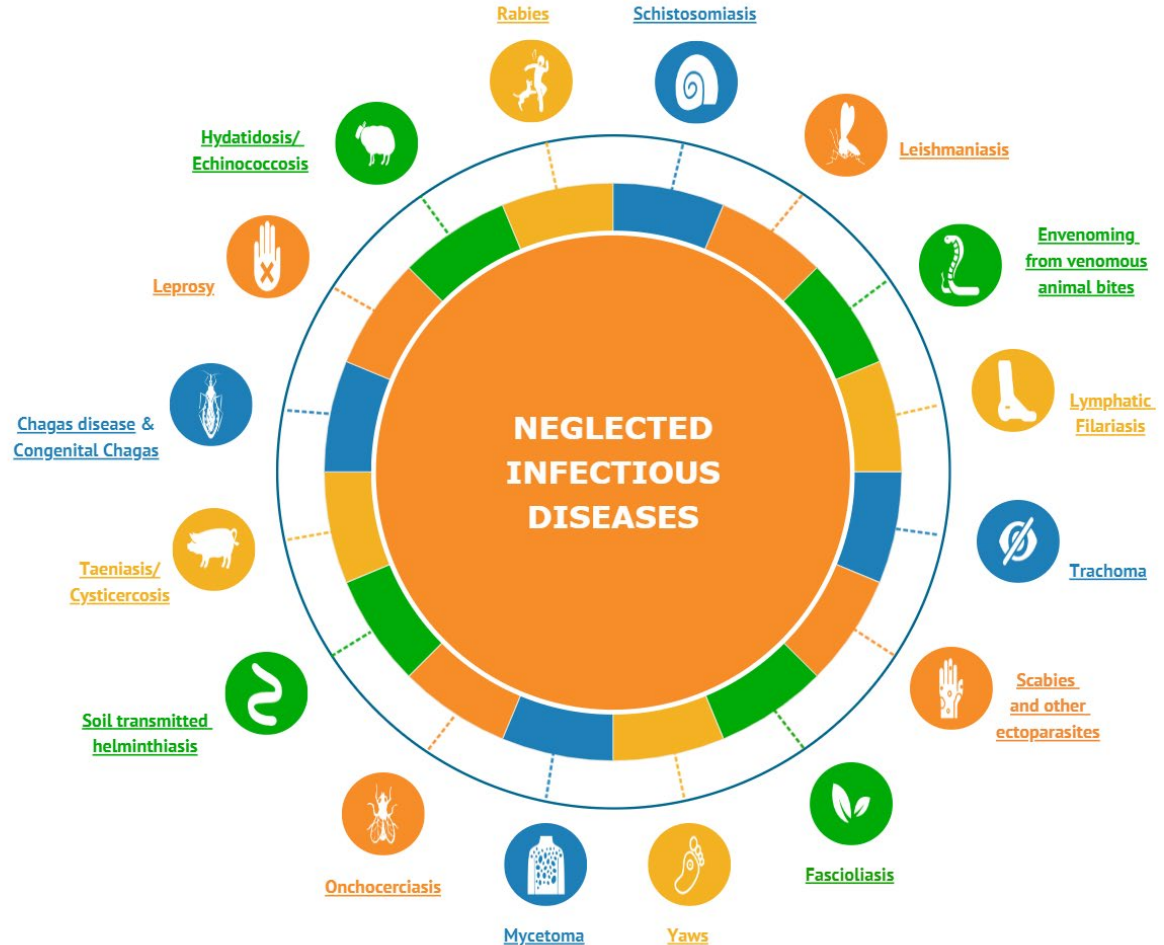
- Translocation of domestic animals can spread non-enzootic rabies variants
- Existing public health relationships allowed for a rapid, comprehensive, and collaborative multiagency response
- No additional evidence of RRVV in Nebraska
- Due to long rabies incubation periods, ERS will continue into mid-2024





Rabies: A Global Perspective

Rabies is a Neglected Tropical Disease



Neglected does NOT mean rare



70,000
deaths
annually



99%
deaths from
dog bites

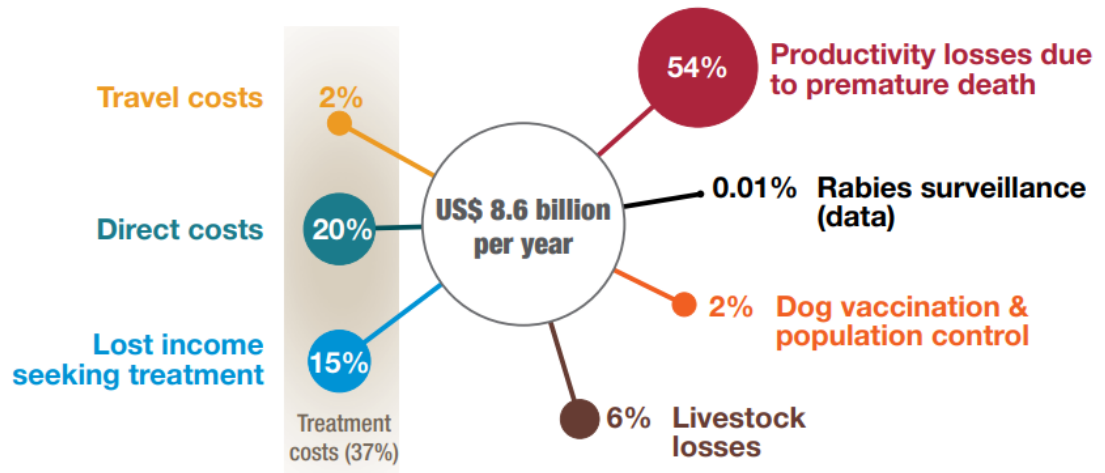


40%
deaths among
children

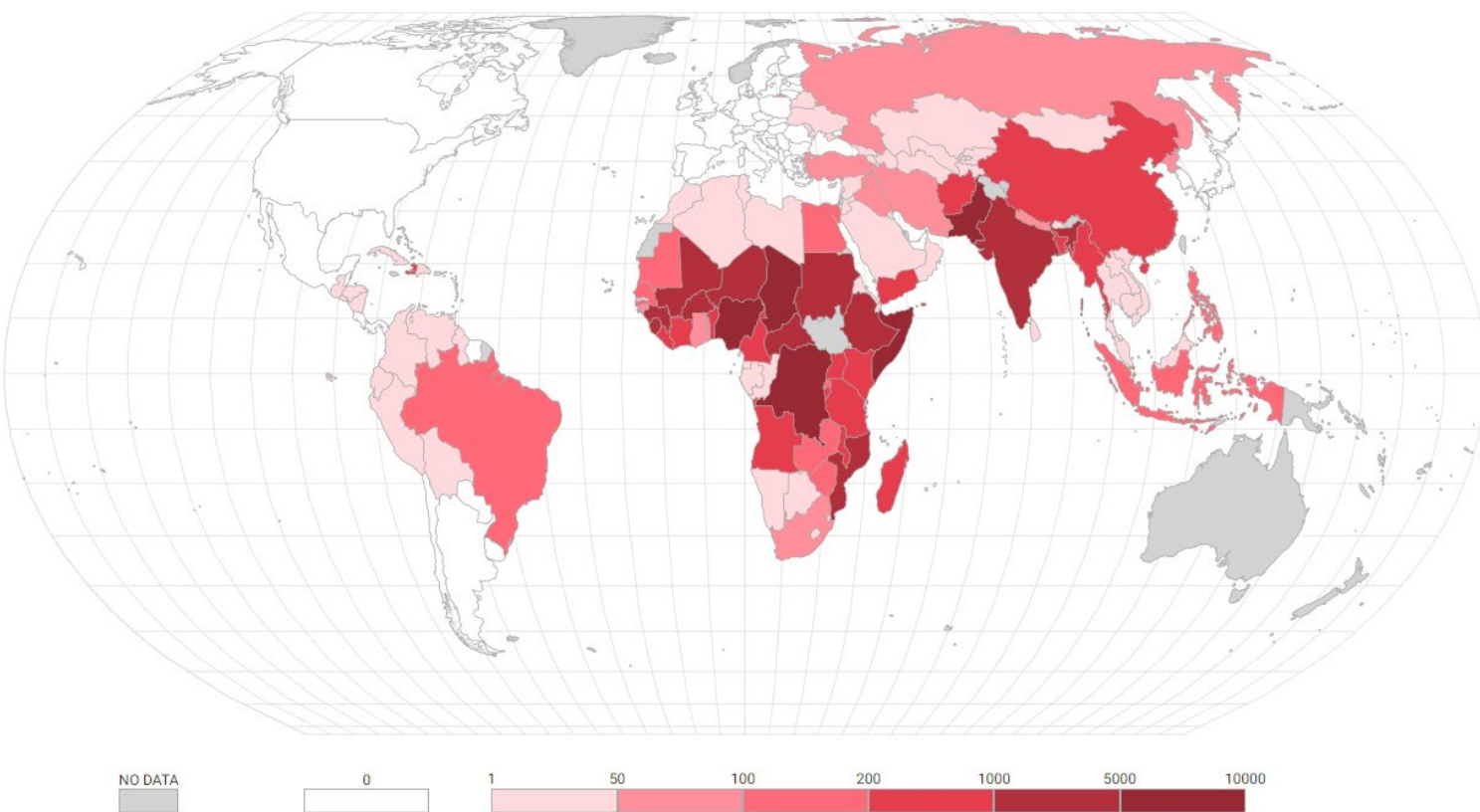
Rabies poses a heavy public health and economic burden

People continue to die from rabies because:

- 🔊 Limited awareness
- 🐕 Uncontrolled in dogs
- 💉 Limited access to medical care and PEP



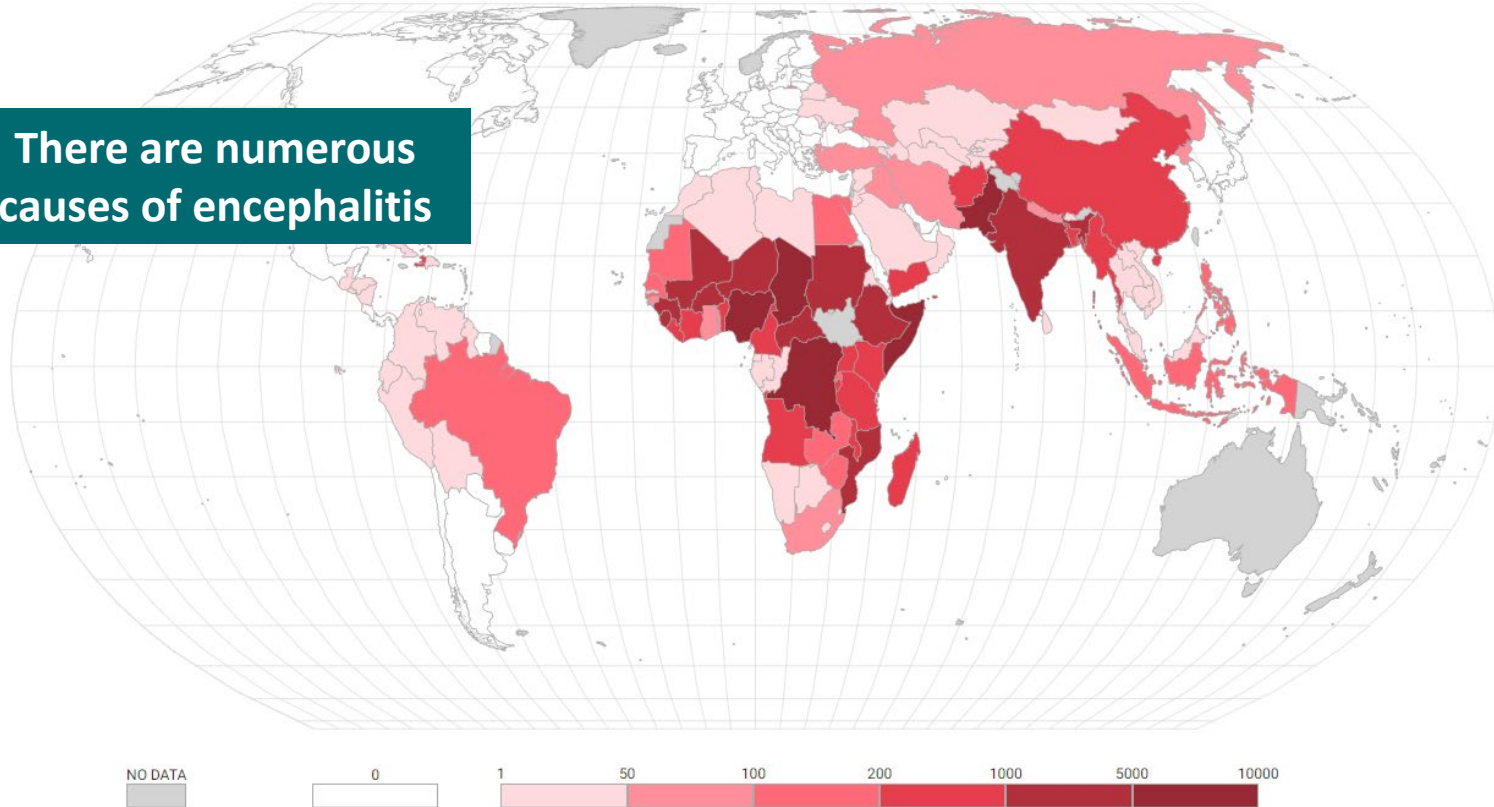
Estimated global rabies deaths by country in 2021



Estimated global rabies deaths by country in 2021

There are numerous causes of encephalitis

i

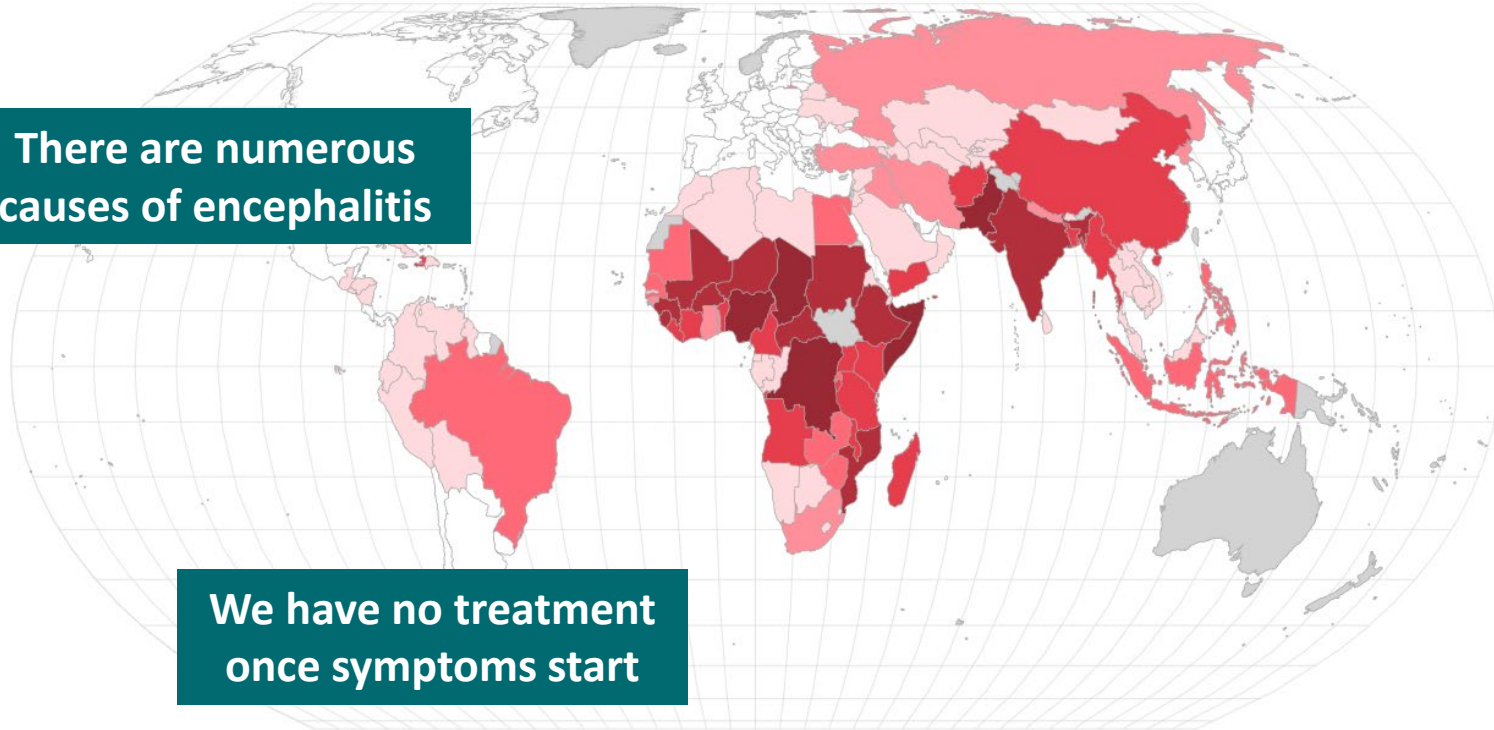


Estimated global rabies deaths by country in 2021

i

There are numerous causes of encephalitis

We have no treatment once symptoms start



NO DATA

0

1

50

100

200

1000

5000

10000

Estimated global rabies deaths by country in 2021

i

There are numerous causes of encephalitis

Diagnostics are costly and expensive

We have no treatment once symptoms start

NO DATA

0

1

50

100

200

1000

5000

10000



Estimated global rabies deaths by country in 2021

i

There are numerous causes of encephalitis

2017 WHO Global Health Observatory:
1,543 reported deaths

Diagnostics are costly and expensive

We have no treatment once symptoms start

NO DATA

0

1

50

100

200

1000

5000

10000

Conflicting rabies death estimates

2005 Global
Burden Study



2015 Global
Burden Study



2022 Global
Burden Study



RESEARCH ARTICLE

Estimating the Global Burden of Endemic Canine Rabies

Katie Hampson^{1*}, Laurent Coudeville², Tiziana Lembo¹, Maganga Sambo³, Alexia Kieffer², Michaël Attlan², Jacques Barrat⁴, Jesse D. Blanton⁵, Deborah J. Briggs⁶, Sarah Cleaveland¹, Peter Costa⁶, Conrad M. Freuling¹, Elly Hilby⁴, Lea Knopf⁶, Fernando Leanes¹, François-Xavier Meslin¹⁰, Artem Metlin¹, Mary Elizabeth Miranda⁶, Thomas Müller⁷, Louis H. Nel¹², Sergio Recuenco³, Charles E. Rupprecht^{1,13}, Carolin Schumacher¹⁴, Louise Taylor⁴, Marco Antonio Natal Vigilato⁹, Jakob Zinsstag¹⁵, Jonathan Dushoff¹⁶, on behalf of the Global Alliance for Rabies Control Partners for Rabies Prevention



International Journal of Infectious Diseases

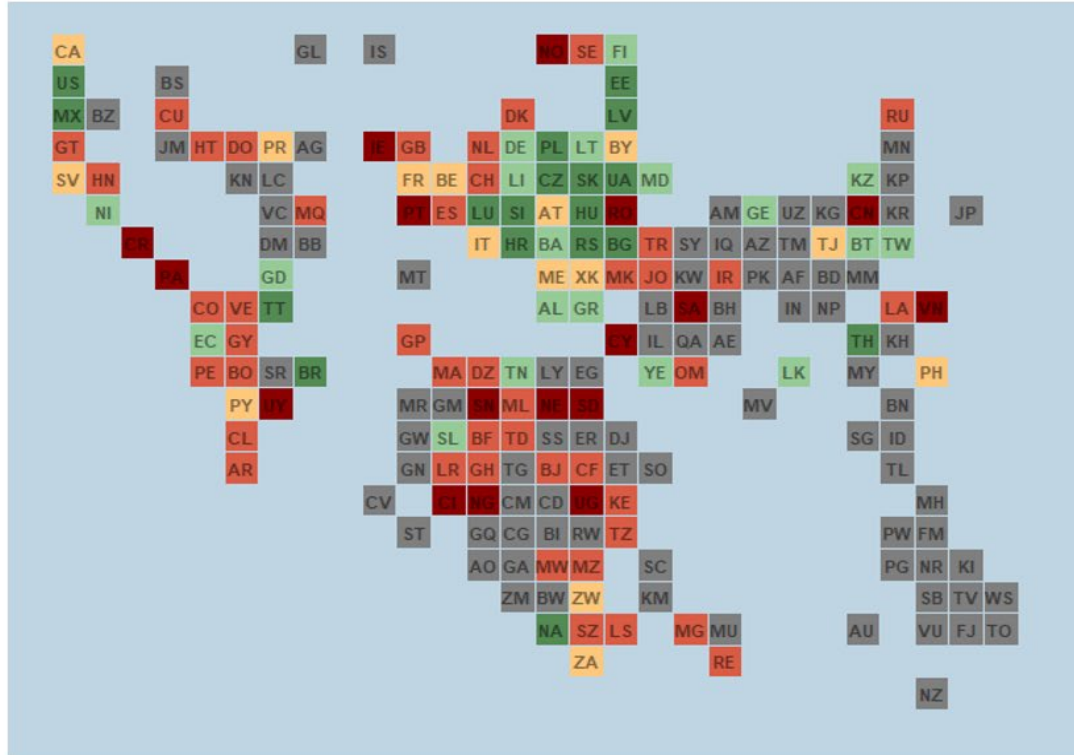
Available online 5 November 2022

In Press, Journal Pre-proof

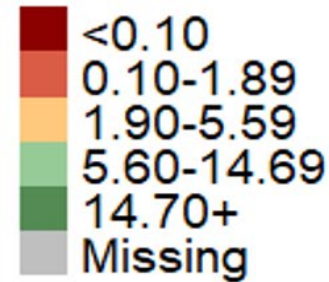


Global burden of Rabies in 204 countries and territories, from 1990 to 2019: results from the Global Burden of Disease Study 2019

Animal testing data is also lacking



All-Animal Rate



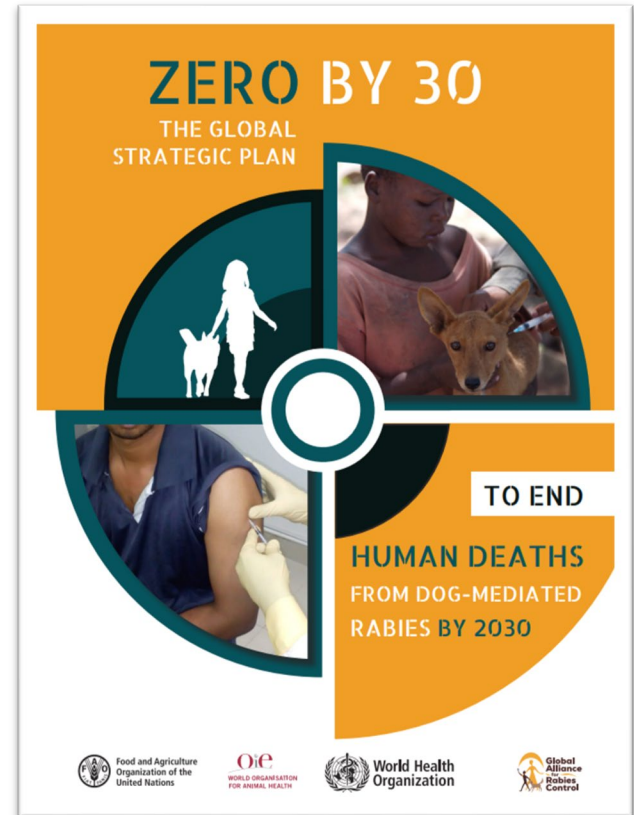
Other WHO Status

The global strategic plan to end human deaths from dog-mediated rabies by 2030

Objective 1: Effectively use vaccines, medicines, tools, and technology

Objective 2: Generate, innovate, and measure impact

Objective 3: sustain commitment and resources





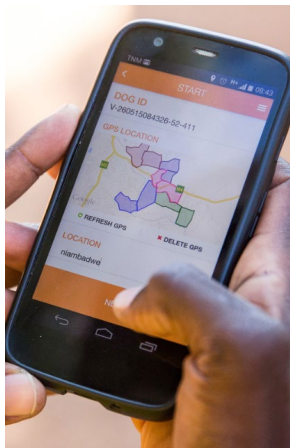
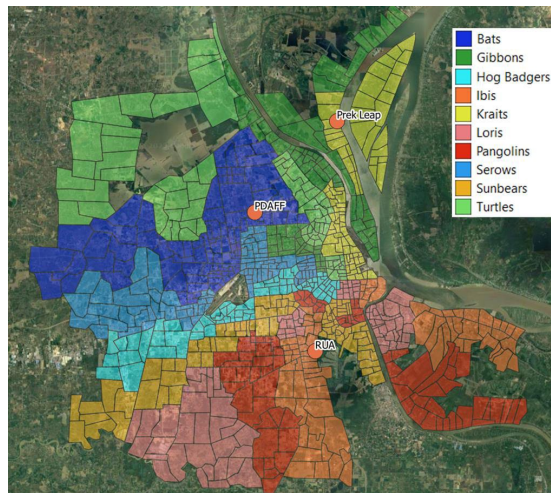
**Limitations in current methods of
rabies burden estimation are
stalling advocacy for resources
to work towards ZB30**

CDC Global Rabies Operations

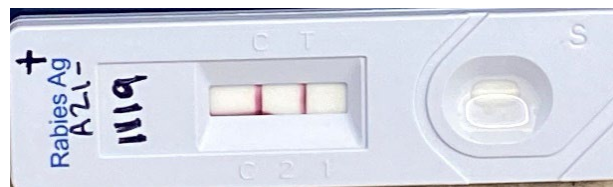
Services and tools provided by CDC

- Risk mapping
- PEP decision making tool for healthcare providers
- Vaccination technical guidance and support
- Surveillance capacity building
- Laboratory capacity building

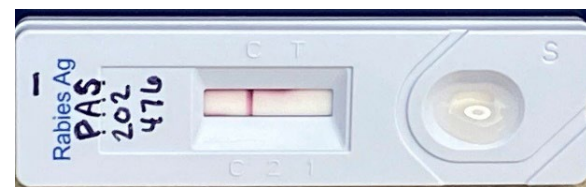
Technical assistance for vaccination campaigns



Build Laboratory capacity



Positive BionoteLFA test



Negative BionoteLFA test



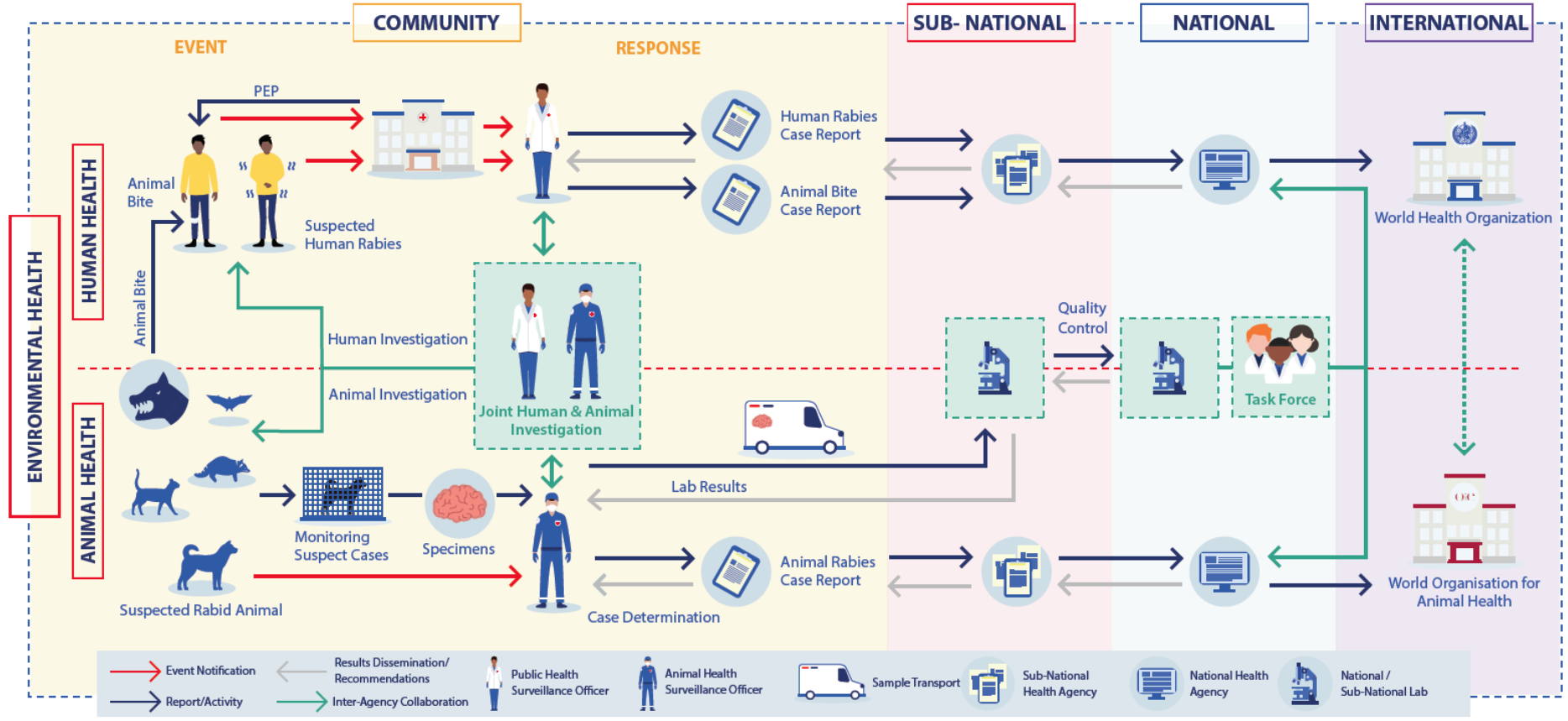
Build surveillance capacity through Integrated Bite Case Management (IBCM)

Integrating data collection and reporting at the community level to limit onward rabies transmission through:

- Rapid response
- Animal evaluation, contact tracing
- Implementation of control measures



RABIES



Cambodia perspective



Political instability



Rapidly developing



Limited surveillance



500,000 bites per year



Limited testing capacity



800 rabies deaths per year



Establishment of Integrated Bite Case Management (IBCM) in 3 provinces

← Case management

CASE MANAGEMENT

ID: EVE-152-181218170528-758-5

START: 18 December 2018, 05:05 pm

LOCATION: bicholim

Case status Positive	Rabies status CONFIRMED
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EVENT NOTIFICATION | **WAITING INVESTIGATION**

Human exposures 2	Animal exposures 0
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RABIES ASSESSMENT	DUE 18/12/2018	QUARANTINE IN PROGRESS
--------------------------	--------------------------	----------------------------------

QUARANTINE	UPDATE DUE 27/12/2018	WAITING RESULTS
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RESULT	POSITIVE
---------------	----------

REPORT

← EVE-152-181218162915-758-1

EVENT NOTIFICATION

Date of Notification PICK A DATE

Enter event ID

Tap here to scan Barcode

Enter bar code manually

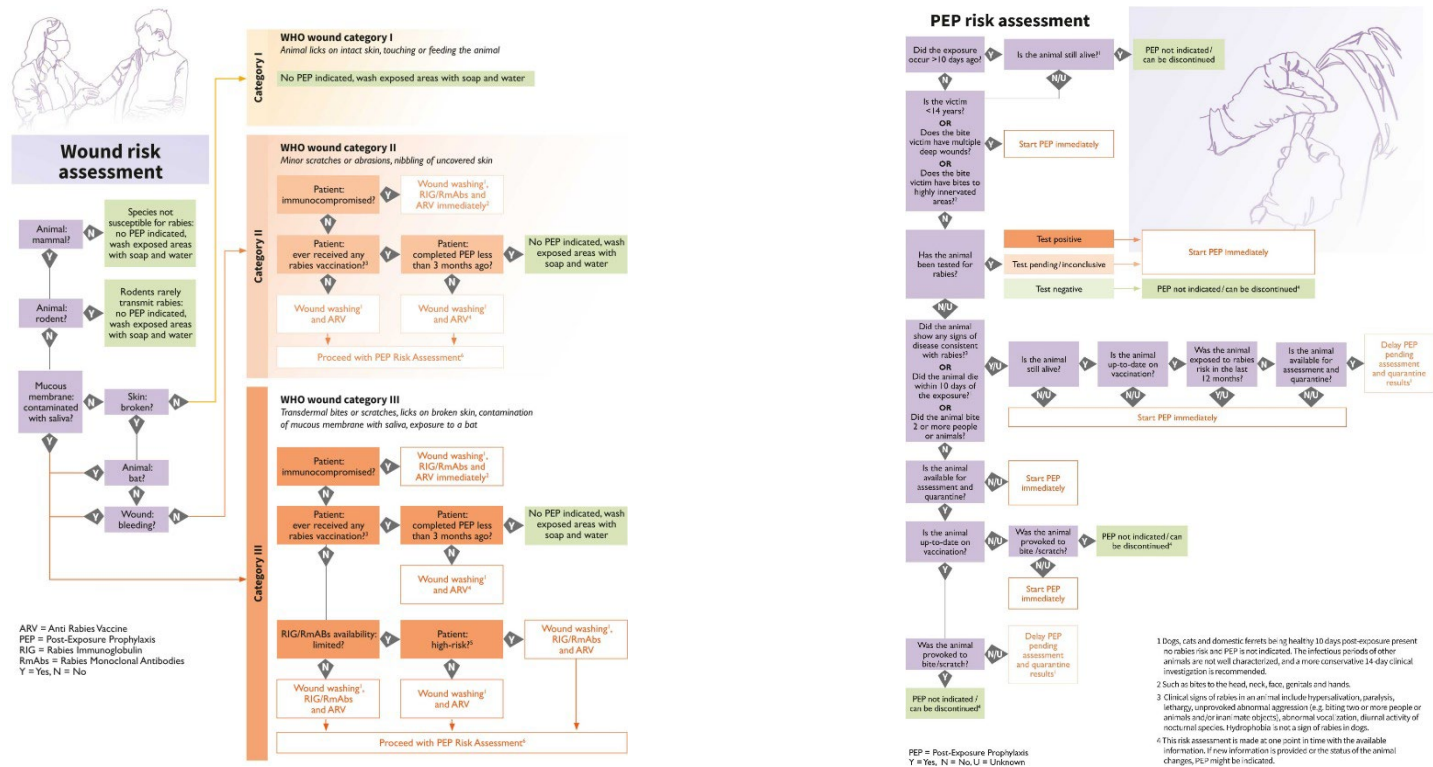
Reported by (mark all that apply, include names where appropriate)

- ☐ Health extension worker
- ☐ Health Department
- ☐ Hospital/clinics
- ☐ Agricultural extension workers
- ☐ Veterinarian
- ☐ Public
- ☐ Rumour (Rumour confirmed!)
- ☐ Other (specify)

Reporter details



Introduction of a healthcare provider PEP decision making tool



Piloted at Cambodia's first government run provincial PEP center

RABIES RISK ASSESSMENT TOOL FOR HEALTHCARE FACILITIES

Complete necessary information and follow prompts.

Questions marked with an asterick(*) are required for the risk assessment algorithm and PEP deviation calculator to work properly.

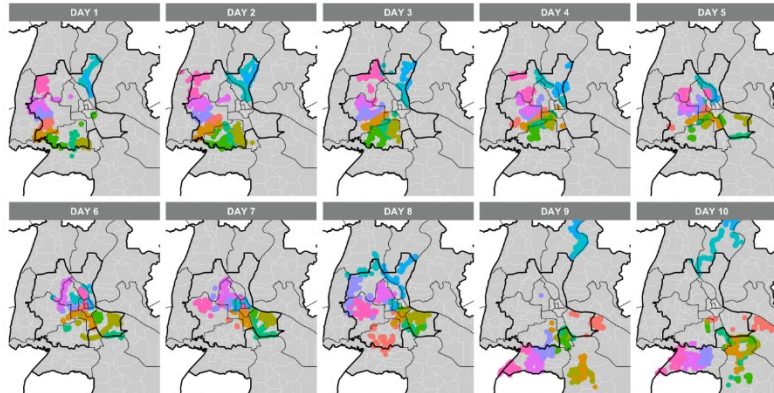
Patient Information			
Today's Date (MM/DD/YYYY)*	7-Feb-2023	Gender	Female
Name (Last, First)	Jane Smith	Patient weight (kg)*	80
Date of Birth (MM/DD/YYYY)	15-Jul-1987	History of Rabies Vaccination*	Post-Exposure Vaccination
Contact information	404-555-5555	Current Immune Status*	Healthy / Normal
Age	35	Current Health Status	Healthy / Normal

Exposure Wound Assessment		Wound Assessment Determination
Date of Exposure*	1-Feb-2023	
Days Since Exposure	6	
Highest Risk Anatomical Location of Exposure* ¹	Leg(s)	
Number of bite wounds*	1	
WHO Wound Category*	Category III - Punctured skin	
Was the wound treated prior to coming (e.g. at home or from another facility, traditional healer, medical practitioner)?		PEP MAY BE INDICATED - CONTINUE WITH RISK ASSESSMENT
No		

Exposure Risk Assessment		Species Risk Determination	
What type of animal was the patient exposed to?*	Dog	ANIMAL IS SUSCEPTIBLE TO RABIES, CONTINUE RISK ASSESSMENT	
Has the animal been tested for rabies?*	No / Unknown - Animal NOT currently undergoing testing	Risk Assessment Determination	PROBABLE RABIES EXPOSURE
Did the animal show any signs of disease?*	Unknown		
Is the animal available for veterinary assessment, quarantine, or diagnostic testing?*	No - Owner will not comply with veterinary assessment or quarantine		
Does the animal have a history of rabies vaccination?	Yes - Current on vaccination	Rabies PEP Recommendation	Rabies RIG Recommendation
Was the animal provoked to bite/scratch?*	Yes - Victim disturbed the animal		
Was the animal exposed to rabies in the last 12 months?*	Unknown		
Where did the bite occur (city / neighborhood)	Atlanta	START RABIES BOOSTER SERIES	RIG NOT RECOMMENDED AT THIS TIME
How many other people were bitten or scratched by this animal?*	1		
How many other animals were bitten or scratched by this animal?*	0		

Assisted with planning, implementation, and evaluation of mass dog vaccination campaign

Goal to
vaccinate **70,000**
dogs in Phnom
Penh over a 10-
day period in
May 2023



**Vaccinated
74,983 dogs
in 10 days!**



Rabies elimination programs are not one size fits all



**Socioeconomic
variables**



**Government
structure and
political stability**



**Access to
vaccines**

In conclusion

- The US has the most comprehensive rabies surveillance system and rabies wildlife control program in the world
- Changes in rabies epidemiology can have major economic and public health repercussions
- Rabies is a neglected tropical disease that is a major driver for human deaths in many middle- and low-income countries
- ZERO by 30 is helping to promote collaboration between international organizations to unite in the elimination of deaths from dog-mediated rabies by 2030



Questions?

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

