Rabies

A global threat requiring local vigilance

Jennifer Corder, MD, Deputy Health Officer Garrett
and Allegany County Health Departments

Steve Sherrard, Director Environmental Health Services
Garrett County Health Department

GARRETT COUNTY HEALTH DEPARTMENT

Public Health
Prevent. Promote. Protect.

Rabies

A global threat requiring local vigilance

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Objectives

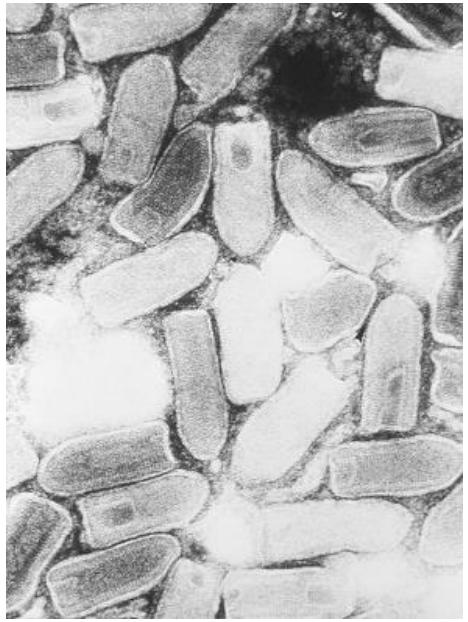
Appreciate the historical and geographical context of our local rabies challenges

Synthesize elements of the Maryland Post Exposure Prophylaxis (PEP) algorithm for nuanced clinical use

Review data reflecting local practice of PEP

Rabies Virus

- Family *Rhabdoviridae*
- Genus *Lyssavirus*
  - At least 6 lyssavirus species or genotypes cause rabies
- Distinct strains
  - Raccoon
  - Skunk
  - Bat
  - Coyote
  - Fox
  - Canine



Rabies Hosts

- All warm-blooded vertebrates susceptible to experimental infection
- Mammals are the natural hosts of rabies
- Reservoirs consist of
  - *Carnivora* (canids, skunks, raccoons, mongoose, etc.)
  - *Chiroptera* (bats)







Virus and Host Adaptations

- Rabies involving distinct rabies virus variants is associated with specific hosts in geographically definable regions (excluding bats) .
- Transmission is primarily between members of the same species (host adaptation).

Distribution of Major Terrestrial Reservoirs of Rabies in the U.S. and Puerto Rico, 2010

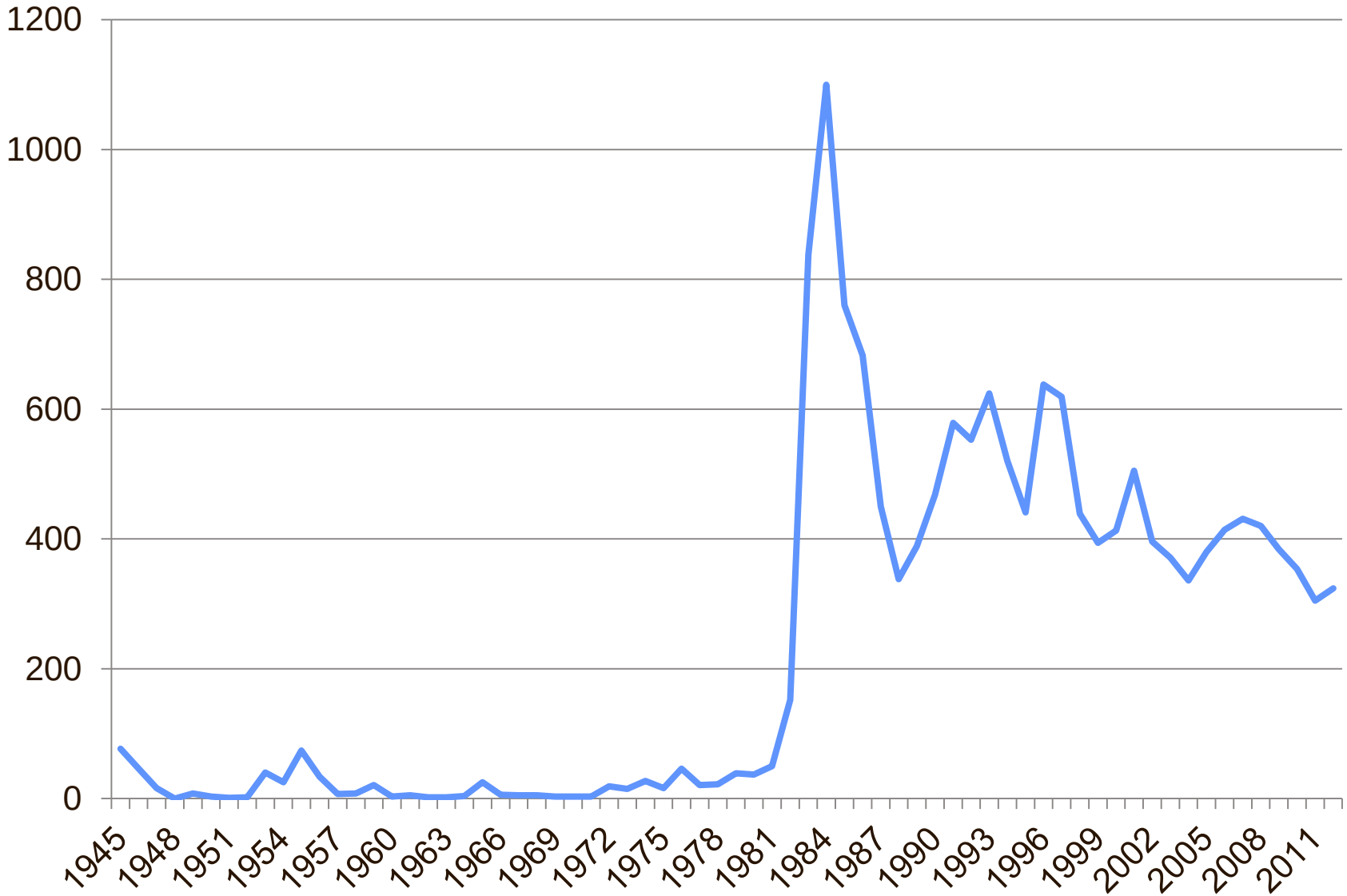
Strains of virus

- Identity of species of origin can be done by monoclonal antibody (mAb) testing.
- Reservoir (adapted) host to other species- spillover

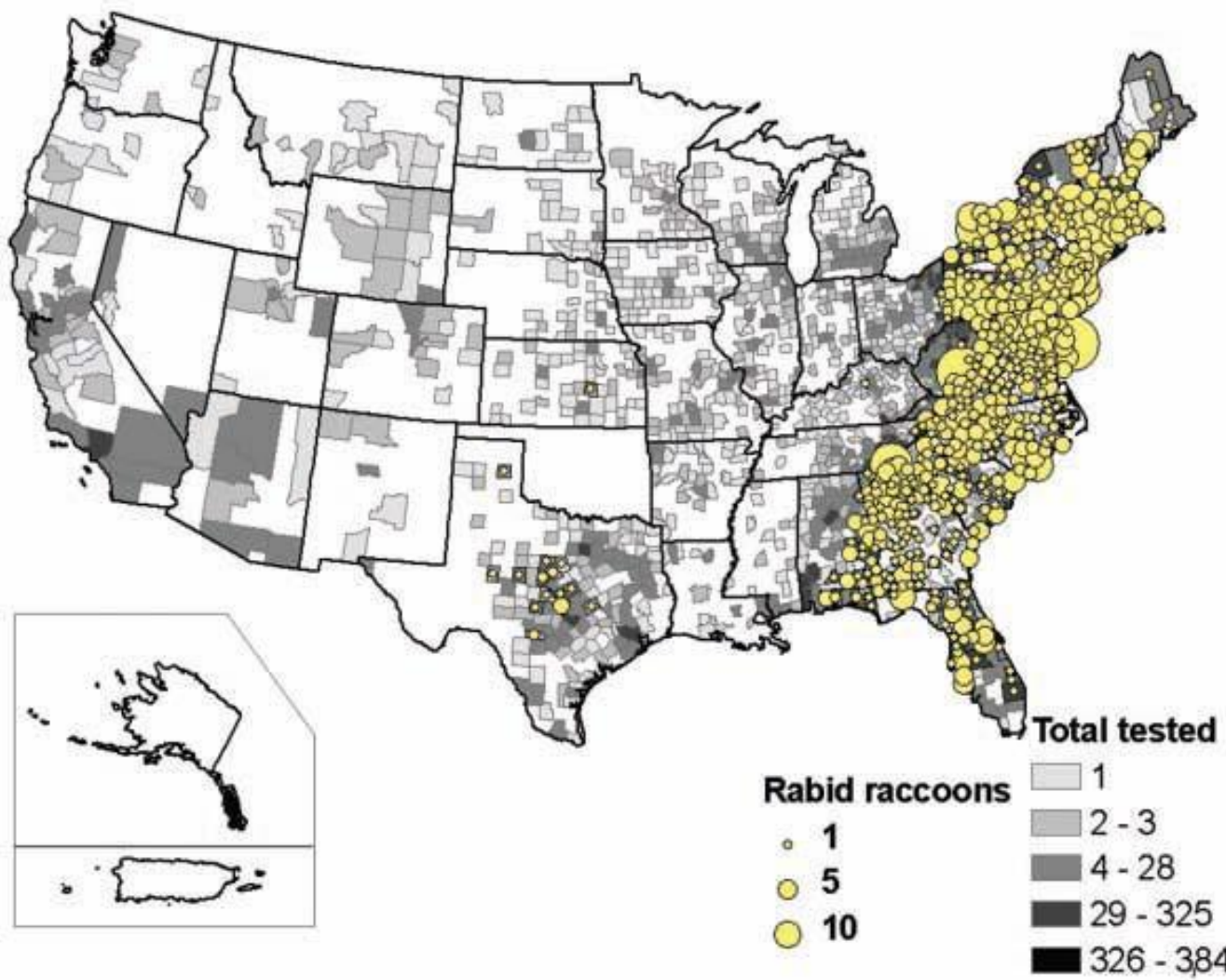
Distribution of rabies virus in the Mid-Atlantic Region

- No prior rabies in terrestrial mammals prior to 1979.
- Raccoon virus variant had been endemic in South Florida since early 1900's.
- Illegal translocation of raccoons (some rabid) to W.V.
- Spread up and down the east coast.
- Multiple species affected in region, all with raccoon strain.

Confirmed Rabid Animals – Maryland, 1945-2012



Reported cases of rabies in **raccoons**, by county, 2009

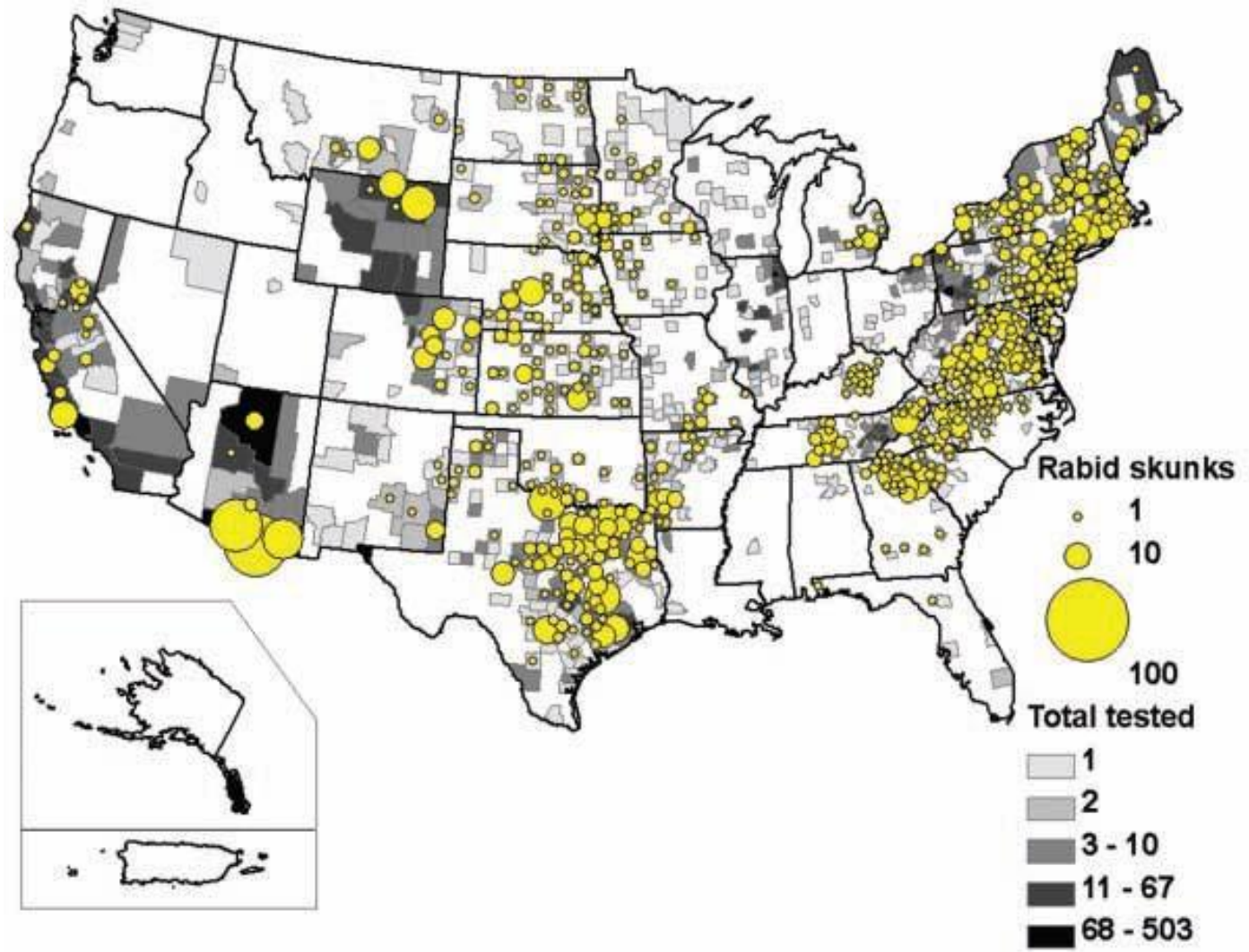


http://www.avma.org/avmacollections/rabies/javma_237_6_646.pdf

Why is raccoon rabies problematic?

- Raccoons thrive in suburban settings
- Aggressive and swift
  - Increase in dog and cat (2X) rabies
  - Increase in other rabid species (foxes, groundhogs, livestock, etc.)
- Increase in human exposures, need for PEP risk assessment, animal control calls

Reported cases of rabies in **skunks**, by county, 2009



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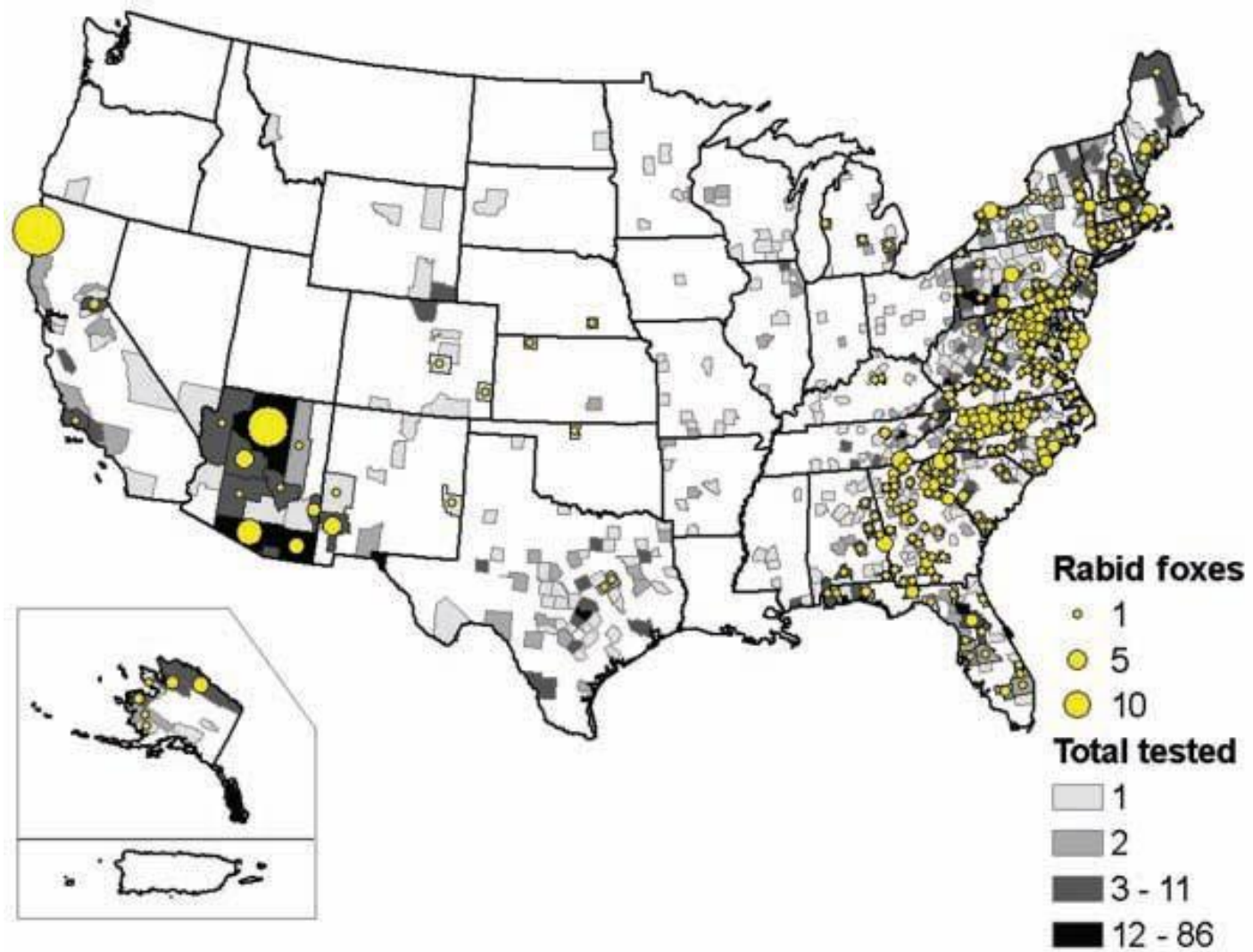
Reported cases of rabies in **foxes**, by county, 2009



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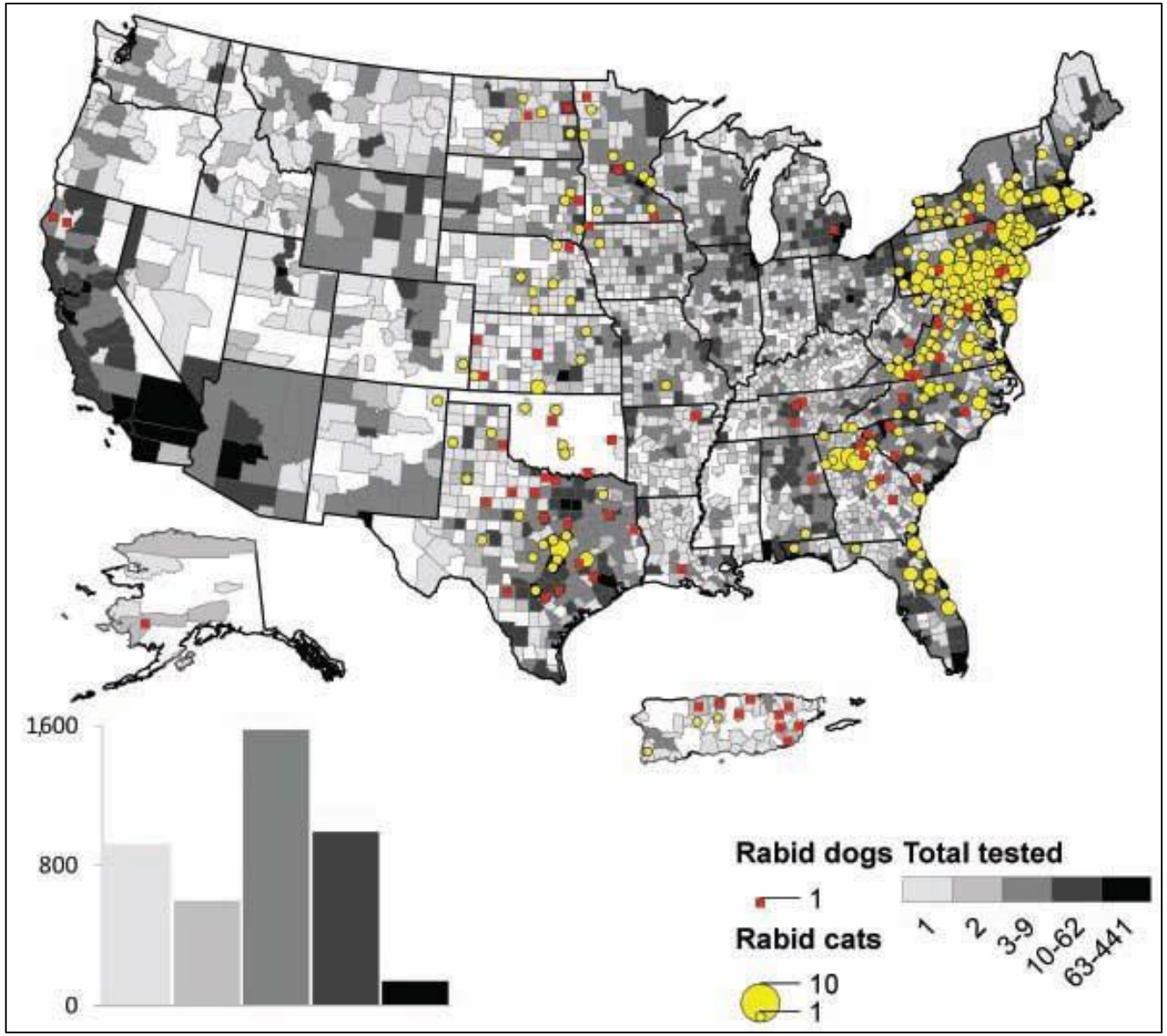
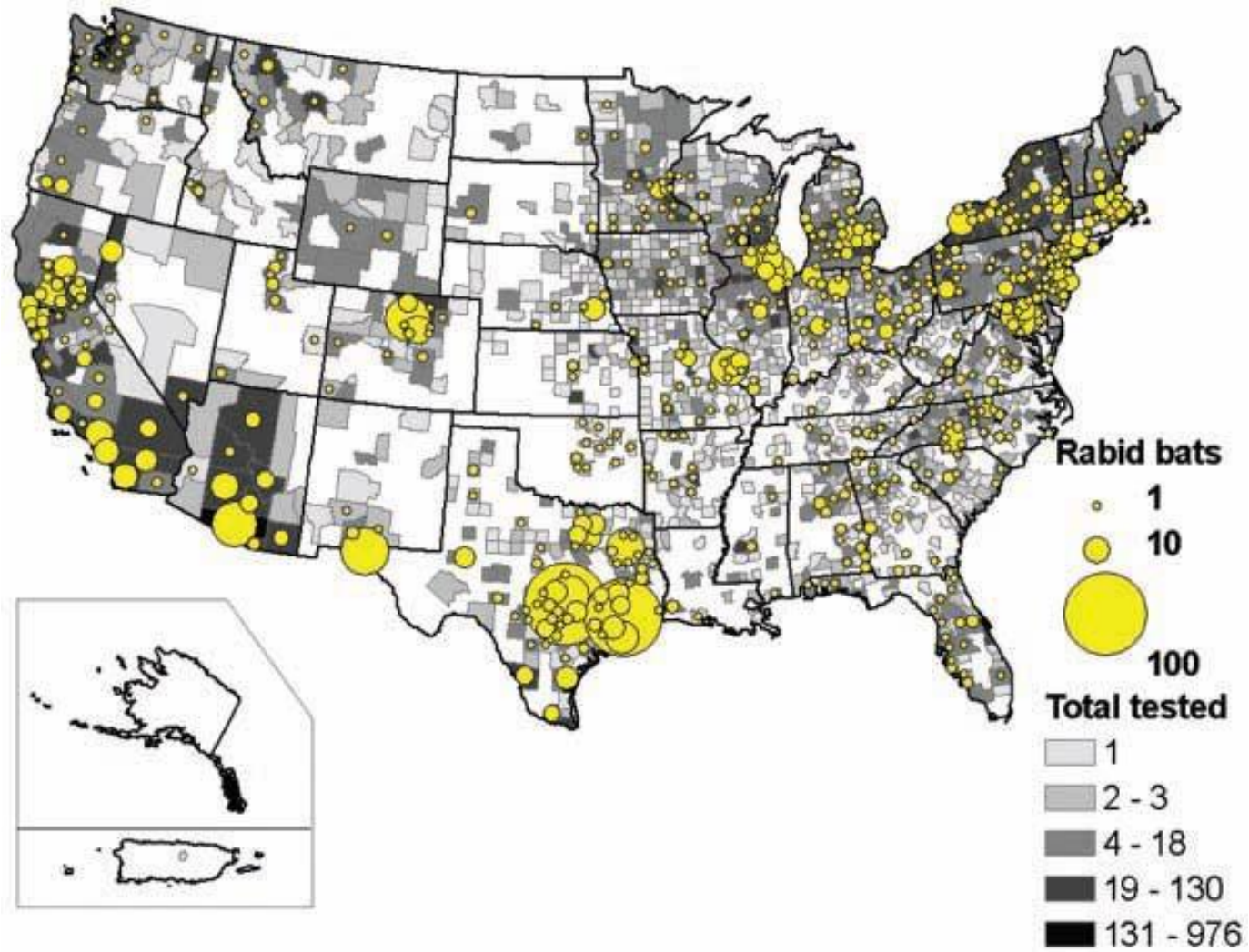
Reported cases of rabies in cats and dogs, 2010



Distribution of bat rabies virus

- All 49 continental United States
- Ongoing work to associate strains with species and geographic location
- Strains differ from terrestrial mammals.

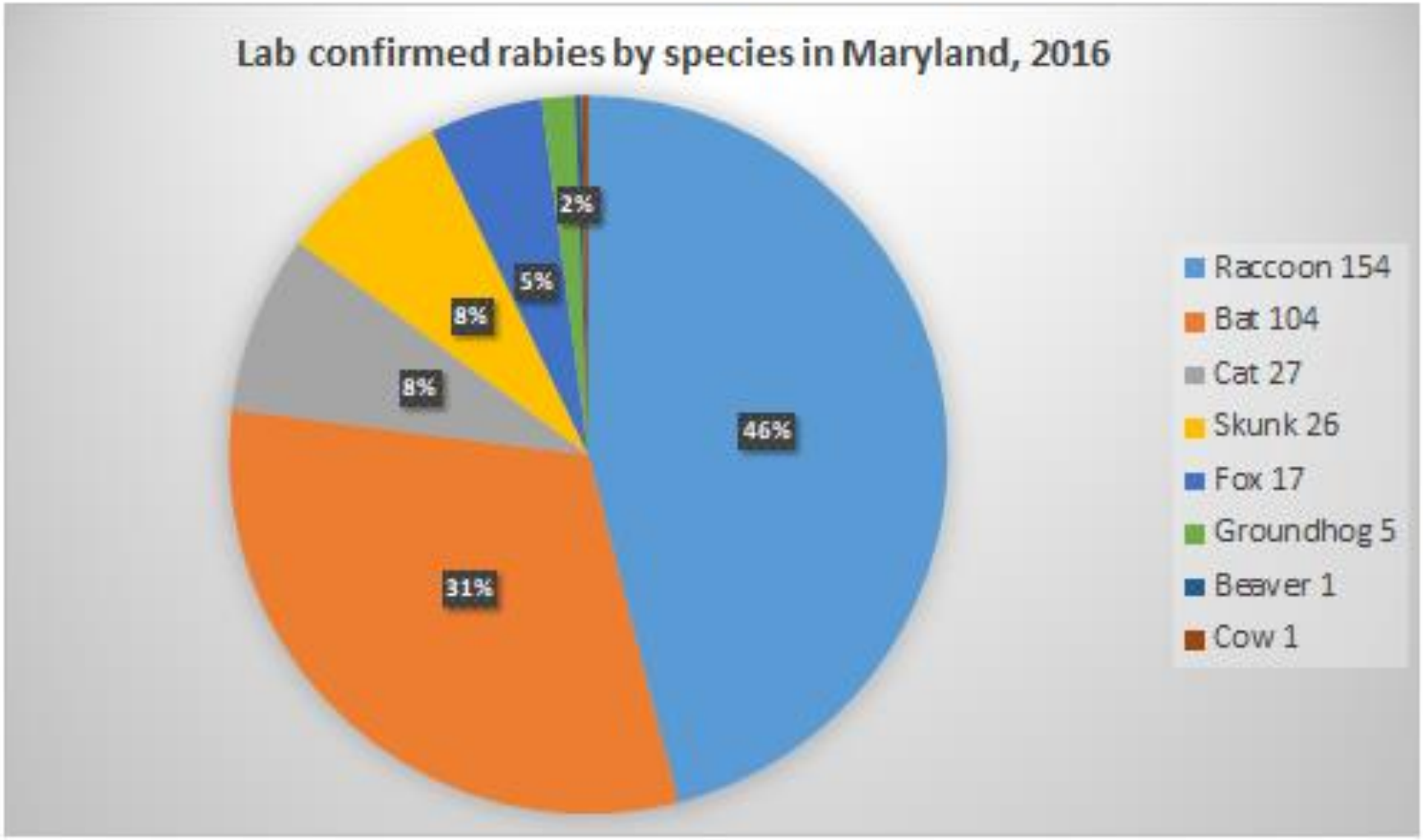
Reported cases of rabies in **bats**, by county, 2009



http://www.avma.org/avmacollections/rabies/javma_237_6_646.pdf

Epidemiology of Rabies in Maryland

- 300-500 rabid animals in MD annually
- Wildlife account for ~95% of all rabid animals
  - Raccoons most common (65% of total)
  - Bats, foxes, skunks next most common
  - Always weird ones: bear, beaver, otter
- Domestic animals account for ~5%
  - Cats most common domestic rabid animal



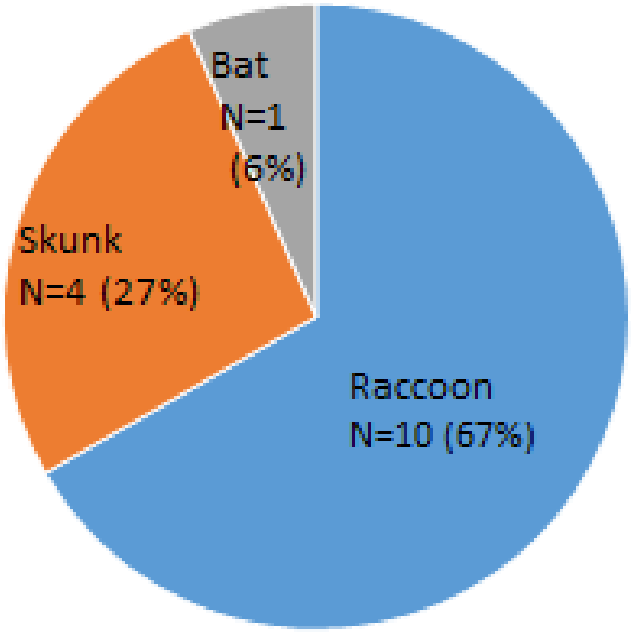
Maryland Department of Health, the Division of Rabies and Vector borne Diseases

Rabies in animals in Garrett County 2011-2017

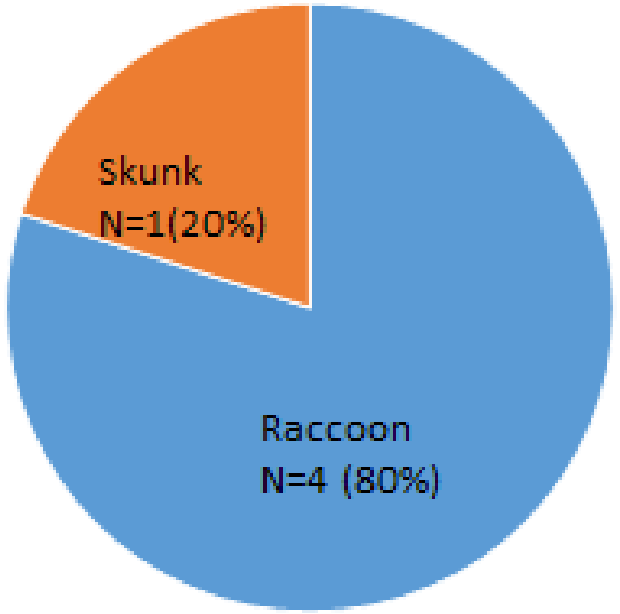
Species	Number of Positive	Total Number Tested
Alpaca	0	2
Bat	1	20
Bear	0	1
Cat	0	37
Chipmunk	0	1
Cow	0	11
White-tailed deer	0	3
Dog	0	24
Fox	0	7
Flying Squirrel	0	1
Goat	1	7
Groundhog	0	8
Horse	1	1
Llama	0	1
Opossum	0	4
Raccoon	23	60
Rat	0	1
Skunk	8	14
Weasel	0	1
TOTAL	34	204

Lab confirmed rabies cases by species in Garrett County*

2015



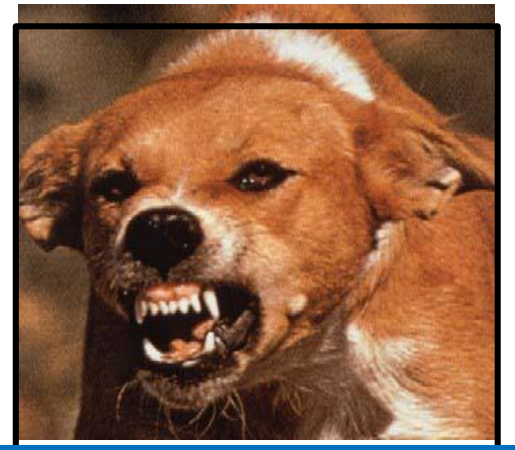
2016



*Garrett County Health Department through MDH, the Division of Rabies and Vector borne Diseases

Source of infection

- Human exposure usually from domestic animals or bats.
- Domestic animals acquire infection from wild terrestrial animals or bats.
- Rabies not self perpetuating in domestic animals except for dogs in Mexico, Latin America, Asia and Africa.



Principles of Rabies Prevention

- Human rabies can be prevented by
  - Eliminating exposure to rabid animals
    - Vaccination of pets
    - Avoidance of wildlife, especially if strange behavior
  - Prompt treatment of wounds
  - Administration of appropriate pre-exposure and post exposure prophylaxis

Authority for Rabies Prevention and Control in Maryland

- Annotated Code of Maryland, Health-General Article Title 18
  - Subtitle 2, Part IV
  - Subtitle 3, Part III
- Code of Maryland Regulations (COMAR) 10.06.02 Rabies
- Animal bites are reportable in Maryland (COMAR 10.06.02.05)

MARYLAND ANIMAL BITE REPORT AND RABIES QUARANTINE AGREEMENT

Garrett County Health Department
Enviromental Health Services
1025 Memorial Drive
Oakland, Maryland 21550
Telephone: 301-334-7760 – 301-895-3111

Investigation Date _____/_____/_____ Case Number _____

A. PERSON BITTEN

Date of Bite _____/_____/_____ AM PM Victim's Name: _____ (Last / First / M.I.) Age _____ M ☐ F ☐ Date of Birth _____/_____/_____

Permanent Address _____ (Street (Location - Not Box Number)) If a minor Parent: _____ (Last / First / M.I.)

Phone : H (_____)_____ W (_____)_____

_____ (City / County / State / Zip)

Date Reported: _____/_____/_____ AM PM by _____ Phone: (_____)_____

Address where bite occurred: _____ (If other than Permanent Address) State Zip

Activity when bitten: _____ Provoked ☐ Unprovoked ☐

Medical care required: Yes ☐ No ☐ Unknown ☐ by _____ (Physician or Hospital)

Body Part(s) bitten: _____ _____ (Hospital Location) Phone: (_____)_____

B. BITING ANIMAL IDENTIFICATION

Owner: _____ (Last Name / First / M.I.) Owner Unknown ☐

Permanent Address _____ (Street (Location - Not Box Number)) Phone: H (_____)_____ W (_____)_____

_____ (City / County / State / Zip)

SPECIES	SEX	AGE	SIZE	PREDOMINANT BREED	COLOR(S)
☐ Dog ☐ Cat Other (Specify)	☐ Male ☐ Female ☐ Unknown	☐ Less than 3 mos. ☐ 3 to 12 mos. ☐ Over 12 mos. ☐ Unknown	☐ Less than 20 lb. ☐ 20 to 50 lb. ☐ Over 50 lb. ☐ Unknown	_____	_____ _____

Name: _____ Unusual Features: _____

C. VACCINATION STATUS: Valid Rabies Vaccination Certificate: Yes ☐ No ☐ Expires: _____/_____/_____ Tag No.: _____

County _____ State _____ Veterinarian _____

D. ADDITIONAL INFORMATION: _____

E. QUARANTINE AGREEMENT

By the authority vested in Maryland County Health Officers (Title 18, Sec. 313) you are hereby ordered to keep this animal securely chained or locked up in an animal-proof building for ten days after the bite occurred. You must IMMEDIATELY telephone the local health department if the animal shows marked behavior changes, escapes, sickens, or dies. It is suggested that if the 10 day quarantine is completed on a Saturday, Sunday, or holiday, the quarantine may be extended. UNTIL THIS QUARANTINE IS ENDED BY THE HEALTH DEPARTMENT THIS ANIMAL MUST NOT BE KILLED, GIVEN AWAY, OR OTHERWISE DISPOSED OF WITHOUT PERMISSION FROM THE LOCAL HEALTH DEPARTMENT. In the event the animal dies, call the local health department immediately in order that the animal be examined for rabies. There is no charge for this examination.

I hereby agree to:

1) Quarantine the dog or cat identified on this form for 10 days and to comply with the Quarantine Instructions contained on the back of this form.
2) If unvaccinated, have the dog or cat given a physical rabies examination by a veterinarian and vaccinated for rabies at my expense on the last day of the quarantine period (or the next day if a Sunday or holiday).
3) Confine the animal at _____ (Address (Geographic location — not box number)) for the quarantine period beginning on _____/_____/_____ at _____AM _____PM until the end 240 hours later on _____/_____/_____.
4) Permit the inspection of the animal and confinement enclosure at all reasonable hours.

I hereby acknowledge that failure to comply with these instructions may subject me to a fine of up to $500.00 and may result in the identified dog or cat being quarantined at a Health Department approved facility at my expense for the 10 day quarantine period or remainder thereof.

Owner's or Custodian's Signature _____ Date _____/_____/_____

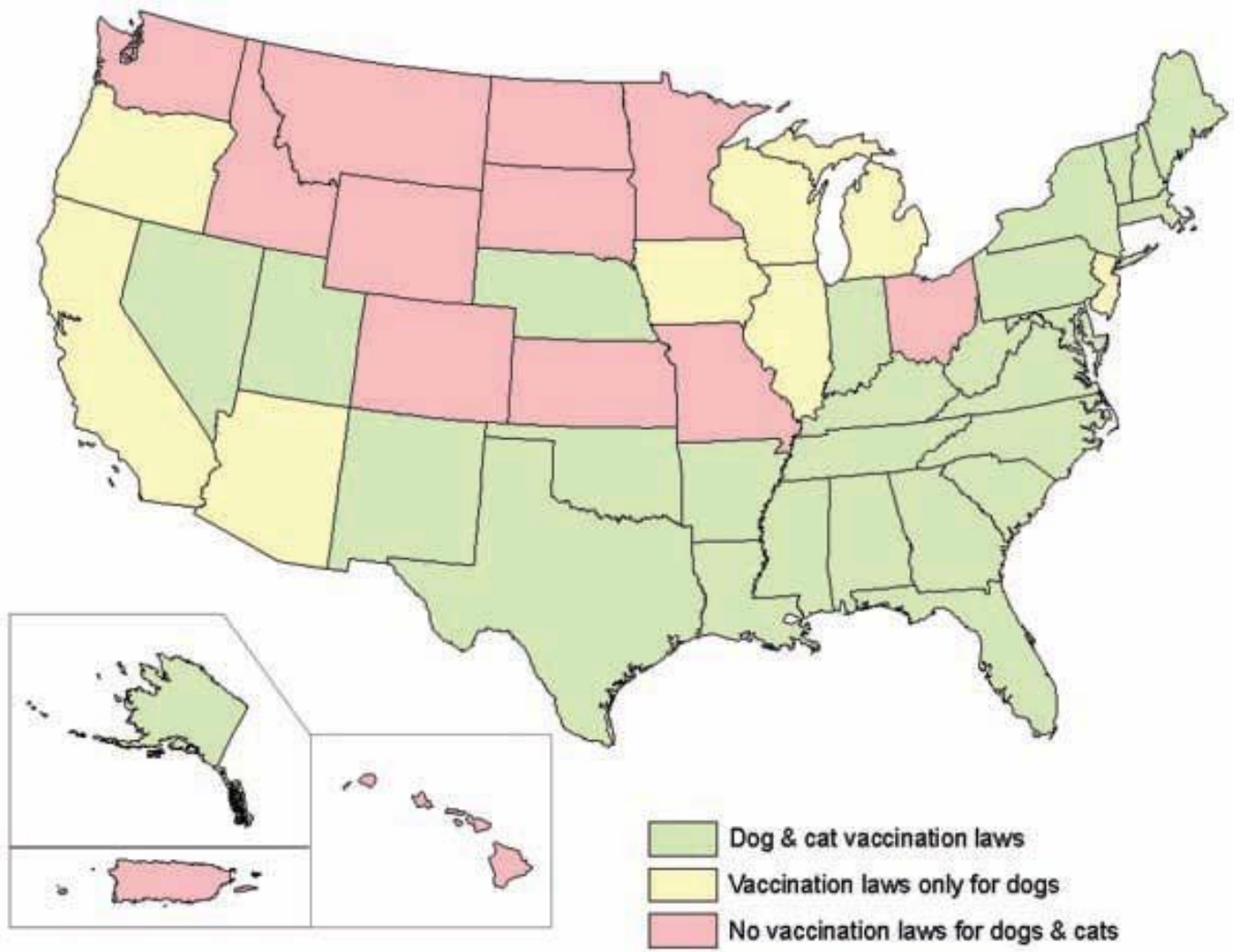
Investigator's Signature _____ (Agency) Date _____/_____/_____

WHITE COPY—LHD GREEN COPY—Owner YELLOW COPY—Quarantine Facility PINK COPY—Investigating Agency

Measures to Eliminate Exposure to Rabid Animals

- Pet and livestock vaccination
- Education
- Animal control
- Wild animal prohibitions
- Testing and quarantine

State legislation requiring rabies vaccination of cats and dogs, 2009



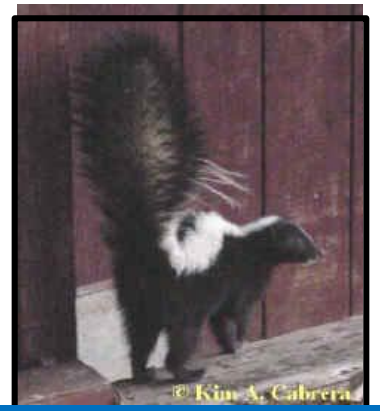
http://www.avma.org/avmacollections/rabies/javma_237_6_646.pdf

Period of Communicability

- Dog, cat and ferret
  - ***May*** shed up to 3 days prior to clinical signs until death.
  - Death usually occurs 3-5 days after clinical signs.
- Basis for 10-day quarantine if dog, cat or ferret bites a person.
- Other species - unknown

Incubation period

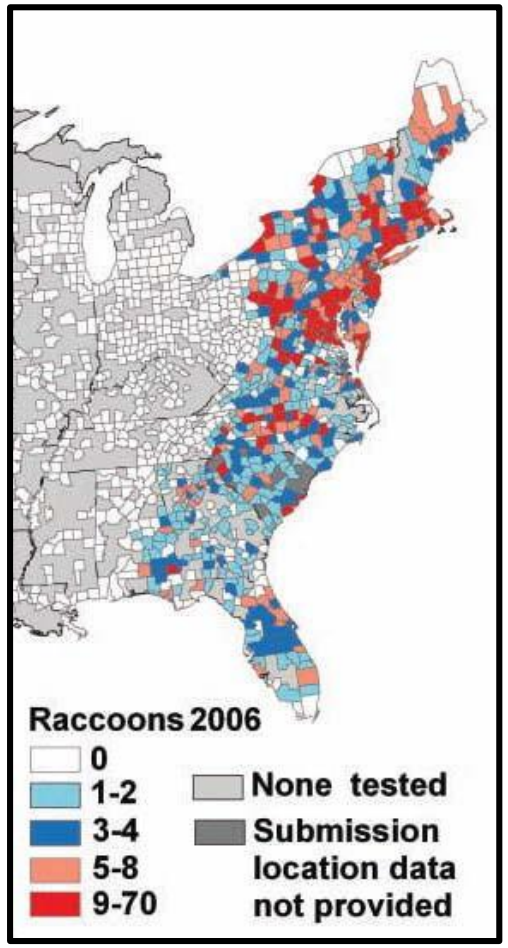
- Definition - the period of time from infection (exposure) until the onset of clinical signs (disease)
- Basis for 45-day or 6-month quarantine if dog, cat or ferret is exposed to rabies



Incubation period

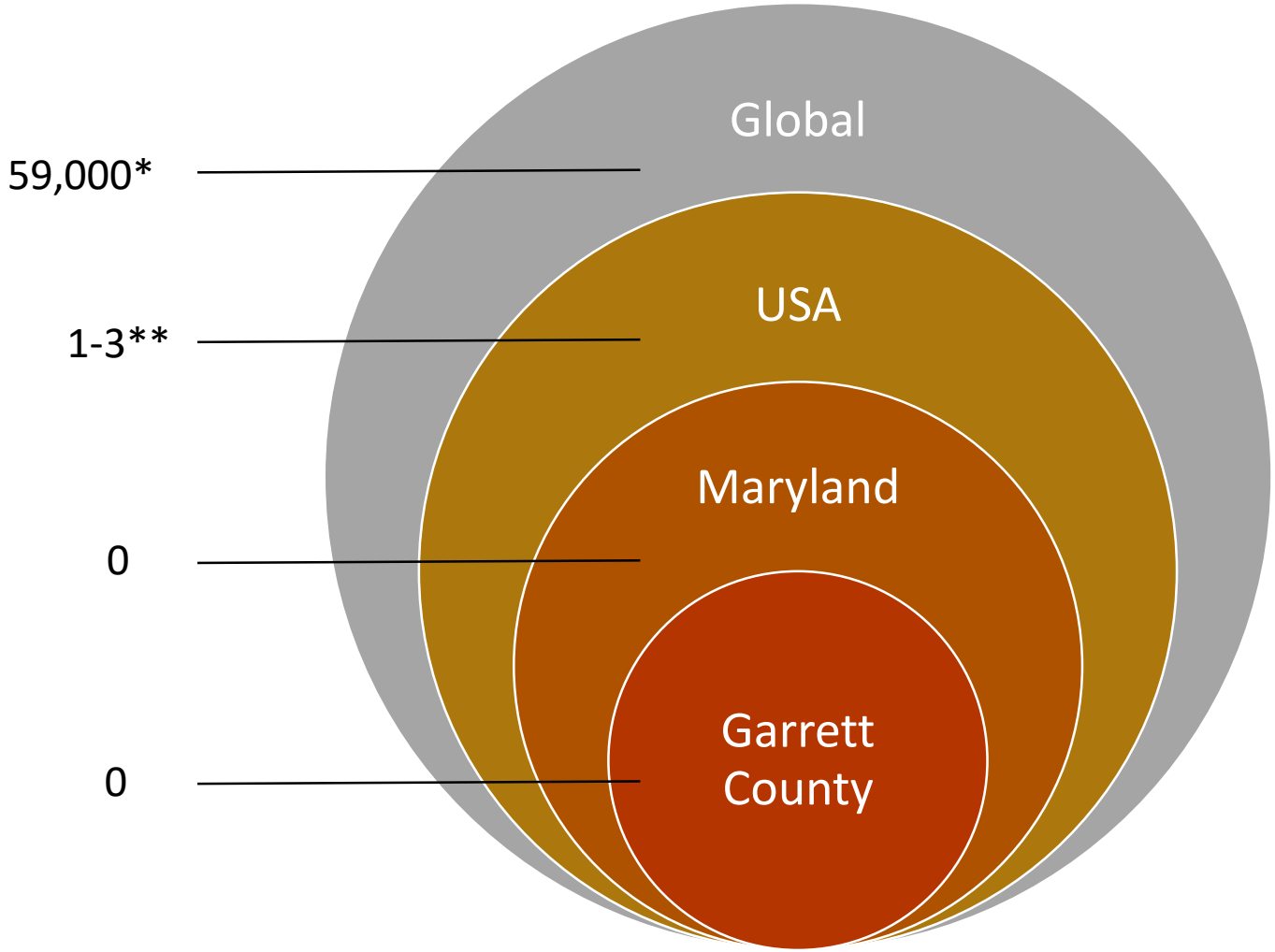
- Dog - average 3-8 weeks, 10 days to 6 months
- Cat (experimental) - 9-51 days, median 18
- Ferret- preliminary data - 10-41 days
- People- average 1.5 - 4 mo (range, 9 days-7yrs?)
- Extremes - >1 year wild animals & humans

ORV Barrier Zone for Raccoon Rabies in the United States



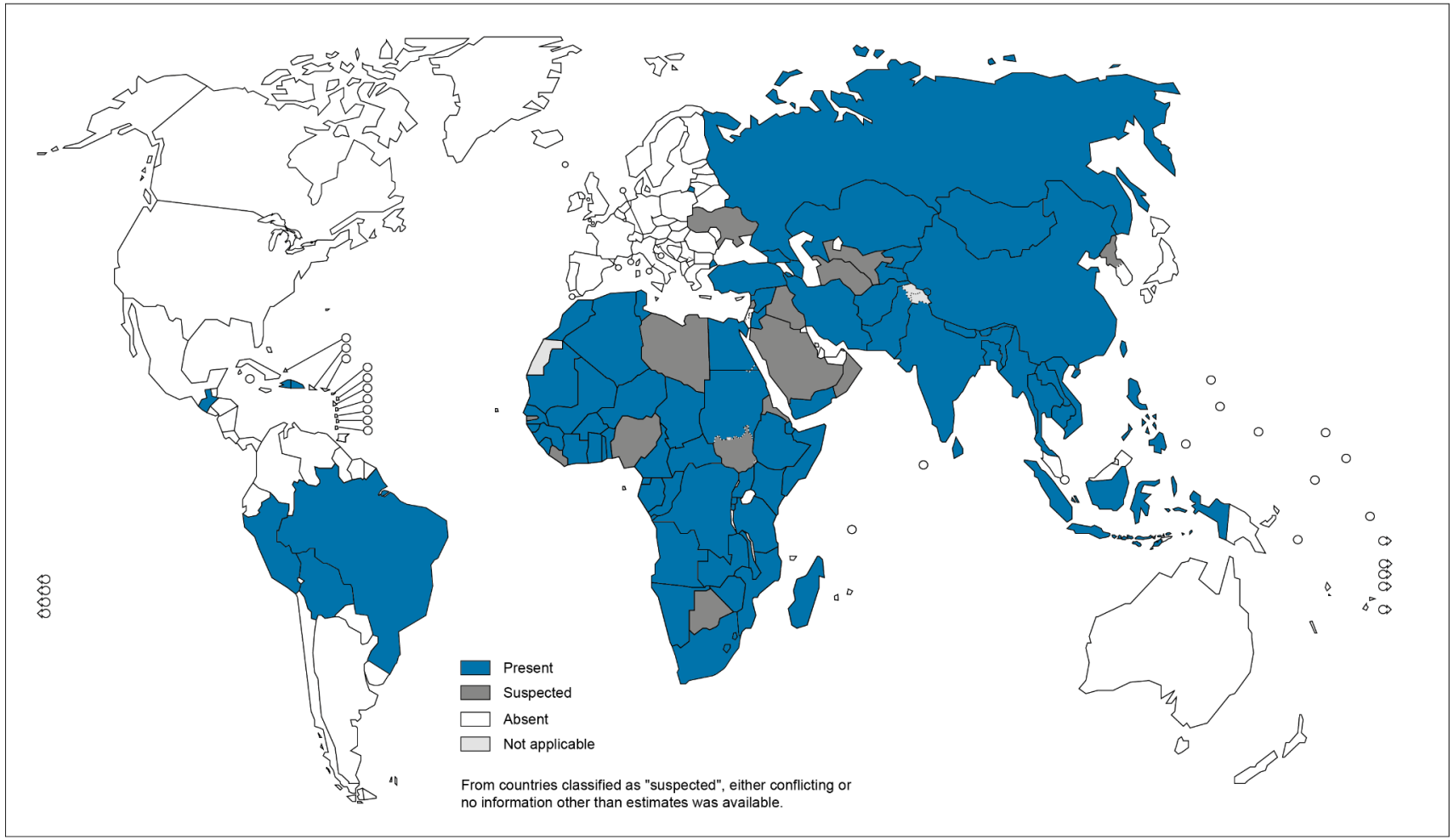
ORV Barrier

Average number of annual deaths from rabies in humans



*World Health Organization http://apps.who.int/iris/bitstream/10665/250643/1/WER9143.pdf?ua=1
**https://www.cdc.gov/rabies/location/usa/surveillance/human_rabies.html

Presence of dog-transmitted human rabies based on most recent data points from different sources, 2010-2014



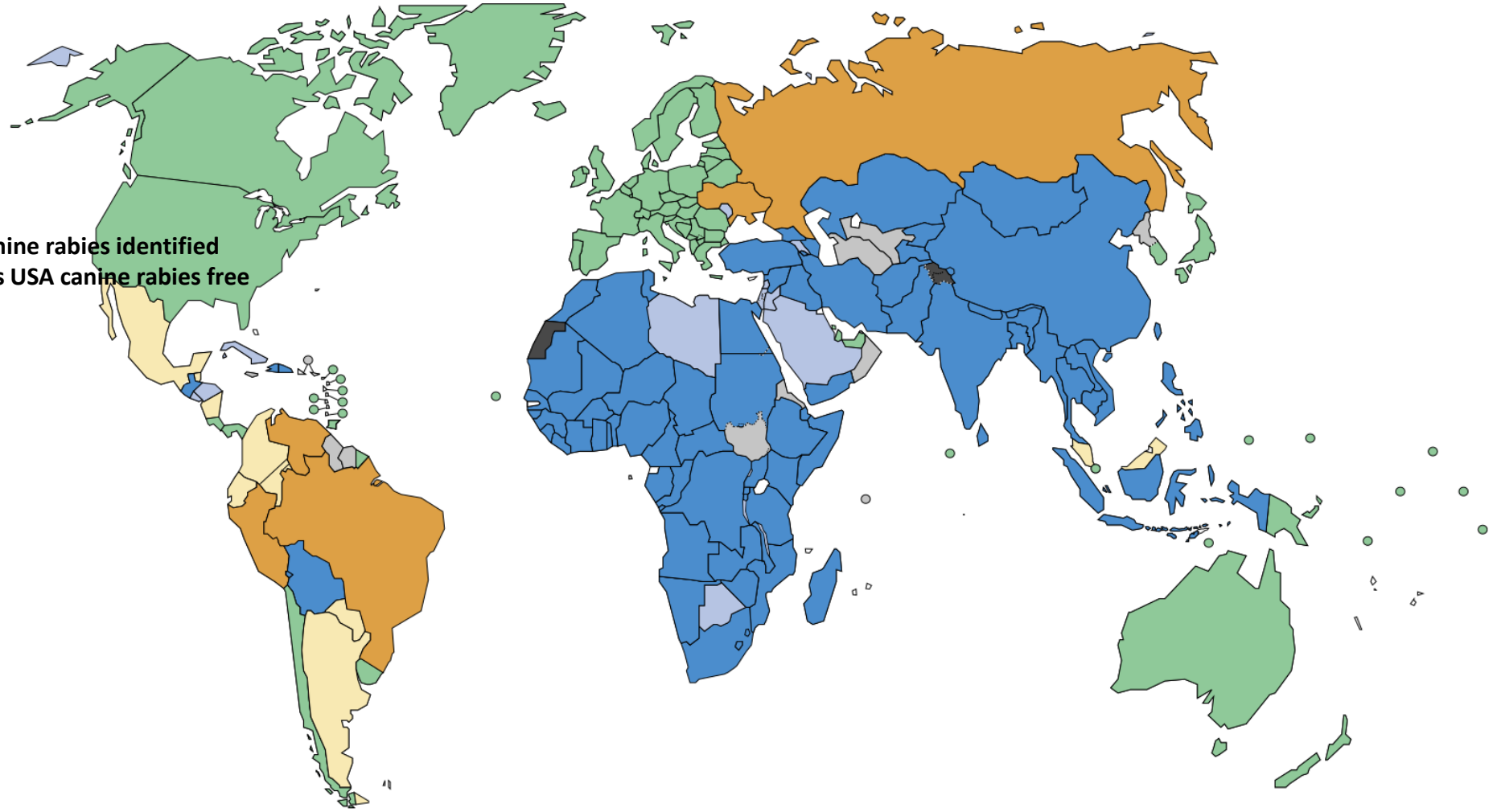
Data Source: World Health Organization
Map Production: Control of Neglected Tropical Diseases (NTD)
World Health Organization

World Health Organization

Map 1 **Endemicity of dog rabies and dog-transmitted human rabies, 2016**

Carte 1 **Endémicité de la rage canine et de la rage humaine à transmission canine, 2016**

2004 Last time canine rabies identified
2007 CDC declares USA canine rabies free



Endemic dog-transmitted human rabies: dog rabies and dog-transmitted human rabies present in the country – Endémie de la rage humaine transmise par les chiens: la rage canine et la rage humaine à transmission canine sont présentes dans le pays

Endemic dog rabies: dog rabies in the majority of the country, but no dog-transmitted human rabies cases – Endémie de la rage canine: rage canine présente dans la majeure partie du pays, mais aucun cas de rage humaine transmise par les chiens

Sporadic dog-transmitted rabies: dog rabies in few areas of the country with sporadic human cases – Cas sporadiques de rage transmise par les chiens: rage canine présente dans quelques zones du pays, accompagnée de cas humains sporadiques

Controlled dog rabies: few cases of dog rabies in limited areas of the country but no dog-transmitted human rabies cases – Maîtrise de la rage canine: quelques cas de rage canine dans des zones limitées du pays, mais aucun cas de rage humaine

No dog rabies: zero dog rabies and zero dog-transmitted human rabies cases (except from imported) – Absence de rage canine: aucun cas de rage canine et aucun cas de rage humaine transmise par les chiens (sauf cas importés)

No information – Aucune information

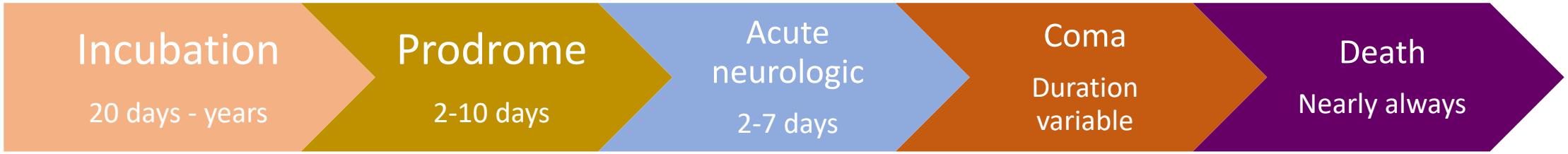
Not applicable – Sans objet

Cases of Rabies in Humans in the United States and Puerto Rico from January 2008 Through September 2017 by Circumstances of Exposure and Rabies Virus Variant

https://www.cdc.gov/rabies/location/usa/surveillance/human_rabies.html

Date of onset	Date of death	Reporting state	Age (y)	Sex	Exposure*	Rabies virus variant†
5-May-17	21-May-17	VA	65	F	Bite	Dog, India
25-Nov-15	1-Dec-15	PR	54	M	Bite	Dog-mongoose, Caribbean
17-Sep-15	3-Oct-15	WY	77	F	Contact	Bat, Ln
30-Jul-15	24-Aug-15	MA	65	M	Bite, Philippines	Dog, Philippines
12-Sep-14	26-Sep-14	MO	52	M	Unknown	Bat, Ps
16-May-13	11-Jun-13	TX	28	M	Unknown, Guatemala	Dog, Guatemala
31-Jan-13	27-Feb-13	MD	49	M	Kidney transplant	Raccoon, eastern USA
6-Jul-12	31-Jul-12	CA	34	M	Bite	Bat,Tb
22-Dec-11	23-Jan-12	MA	63	M	Contact	Bat, My sp
3-Dec-11	19-Dec-11	SC	46	F	Unknown	Bat,Tb
1-Sep-11	14-Oct-11	MA	40	M	Contact, Brazil	Dog, Brazil
21-Aug-11	1-Sep-11	NC	20	M	Unknown (organ donor)§	Raccoon, eastern USA
14-Aug-11	31-Aug-11	NY	25	M	Contact, Afghanistan	Dog, Afghanistan
30-Jun-11	20-Jul-11	NJ	73	F	Bite, Haiti	Dog, Haiti
30-Apr-11	**Survived**	CA	8	F	Unknown	Unknown
24-Dec-10	10-Jan-11	WI	70	M	Unknown	Bat, Ps
2-Aug-10	21-Aug-10	LA	19	M	Bite, Mexico	Bat, Dr
23-Oct-09	20-Nov-09	VA	42	M	Contact, India	Dog, India
20-Oct-09	11-Nov-09	MI	55	M	Contact	Bat, Ln
5-Oct-09	20-Oct-09	IN	43	M	Unknown	Bat, Ps
25-Feb-09	**Survived**	TX	17	F	Contact	Bat, unknown
19-Nov-08	30-Nov-08	MO	55	M	Bite	Bat, Ln
16-Mar-08	18-Mar-08	CA	16	M	Bite, Mexico	Fox,Tb related

Stages of clinical rabies



https://emedicine.medscape.com/article/220967-clinical

Incubation period duration	
Average	20-90 days
Usually	90% of cases <1 year
Rarely	7-19 years have been described

There is no antibody response during the incubation period

Prodromal period **(virus enters CNS)**	
Duration	2- 10days
Symptoms	50% have neuropathic pain @ bite site (dorsal root ganglionitis- pathognomonic)
	Anxiety, insomnia, agitation, anorexia, depression, headaches, fever, chills, malaise, pharyngitis, nausea, emesis, diarrhea

Acute neurologic period

Classic rabies encephalitis (70%)	Paralytic rabies (30%)
Altered mental status Seizure (focal or generalized) Anorexia Irritability Inspiratory spasms and cough Autonomic dysfunction Hydrophobia Aerophobia Hypersalivation Agitation Priapism Muscle fasciculations	Bilateral global motor weakness Bilateral facial weakness Quadriparesis Sparing of sensory system

http://www.who.int/mediacentre/factsheets/fs099/en/

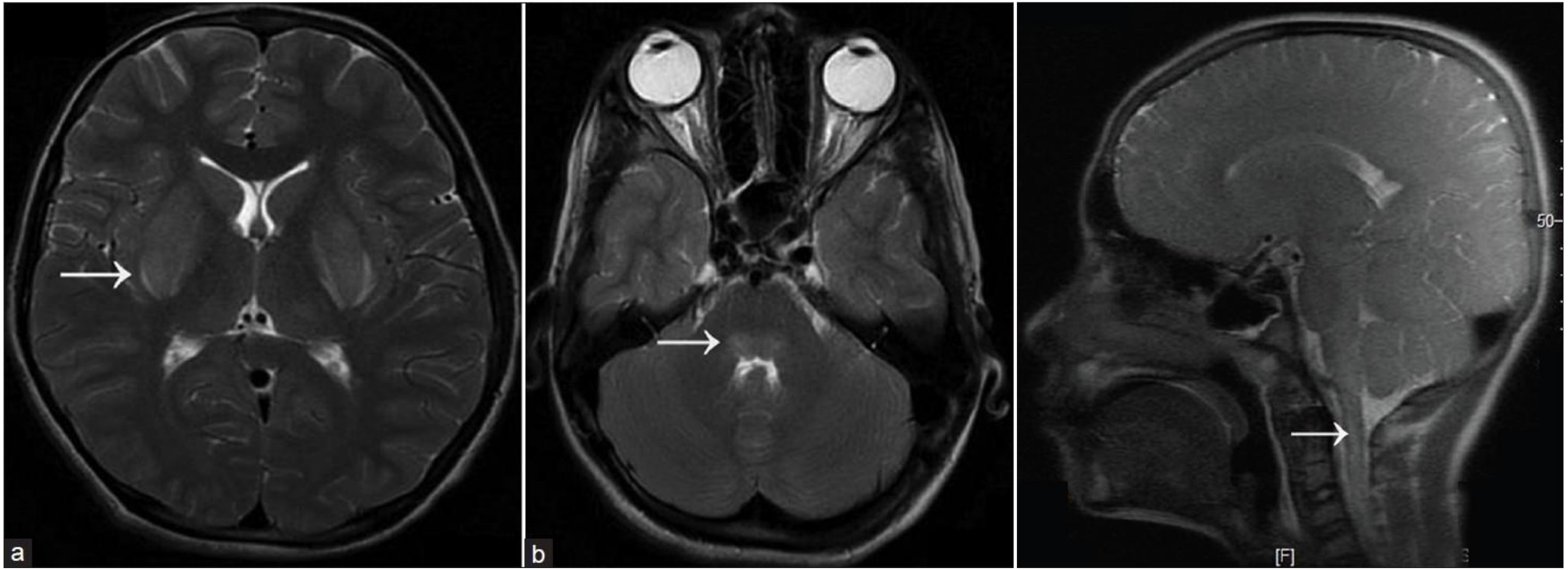
Coma	
Onset	Within 10 days of onset of symptoms
Duration	Depends on intensive life support availabillity
Death	Almost inevitable, in absence of life support, shortly after coma begins

Differential diagnosis

Classic rabies encephalitis	Paralytic rabies
Other viral encephalitides -HSV -Japanese -Eastern equine -WNV -enteroviruses Transverse myelitis Atropine poisoning CVA Psychosis Acute disseminated encephalomyelitis (ADEM)	Guillian-Barré Poliomyelitis Tetanus

Radiographic appearance

Modality	Early	Late
CT (often times normal)	Hypoattenuation brainstem, temporal lobes, basal ganglia and periventricular white matter	Hemorrhage and cerebral edema
MRI	Increase T2 in basal ganglia, thalami, hypothalami, brainstem, limbic system, spinal cord, frontal and parietal lobes	Edema, petechial hemorrhages, contrast enhancement
Angiography		Narrowing of terminal internal carotids and distal basilar artery (may be related to arterial spasm)


a
b
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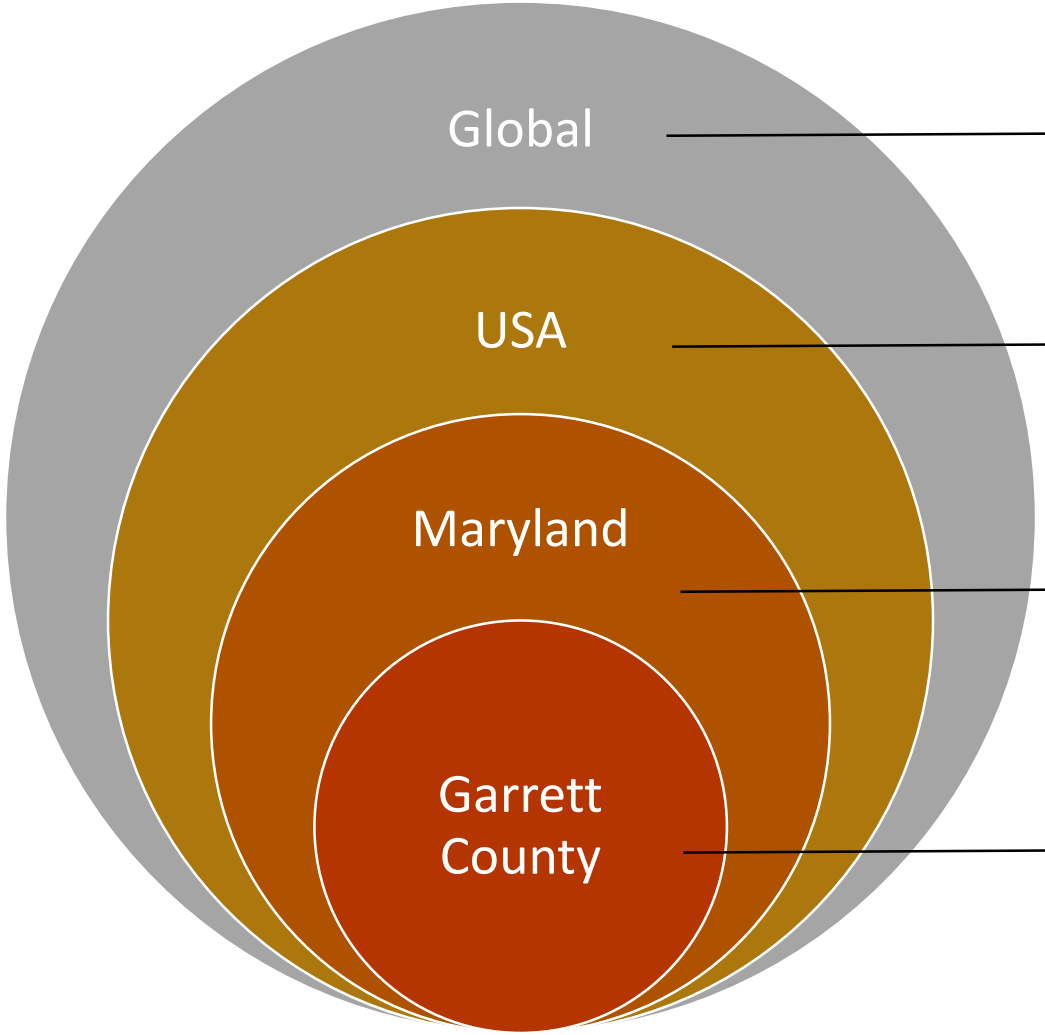
Prevention

Upstream approaches	Downstream approaches
Pre-exposure administration of vaccine* -occupational risk -remote communities with endemic rabies -travelers to certain areas	Post-exposure administration of RIG and vaccine (PEP)
Immunization of animals	
Avoiding contact with wild or unimmunized animals	

*Kessels JA, Recuenco S, Navarro-Vela AM, et al. Pre-exposure rabies prophylaxis: a systematic review. *Bulletin of the World Health Organization*. 2017;95(3):210-219C. doi:10.2471/BLT.16.173039.

Average annual human PEP administration



>15,000,000*

~ 40,000

~ 1,000**

~20***

*WHO
** State of Maryland Veterinarian
*** Garrett County Health Department

Who needs PEP?

Category of exposure	Description
I	touching or feeding of animals, licks on intact skin, contact of intact skin with secretions or excretions of a rabid animal or human no exposure therefore **no prophylaxis** if history reliable
II	minor scratches or abrasions without bleeding and/or nibbling of uncovered skin use **vaccine alone**
III	single or multiple transdermal bites or scratches, licks on broken skin, contamination of mucous membrane with saliva (i.e. licks) and suspect contacts with bats: **use immunoglobulin plus vaccine**

Algorithm for Rabies Postexposure Prophylaxis (PEP) for Healthcare Providers and Public Health Professionals in Maryland

Maryland Department of Health and Mental Hygiene, Infectious Disease Epidemiology and Outbreak Response Bureau, Center for Zoonotic and Vector-borne Diseases 2016

In some situations, it may be appropriate to initiate PEP before test results are available (such as for a bite to the face by a stray animal or rabies vector species); consult your local health department.

Report exposure to local health department, animal control, or police

Perform Risk Assessment
Risk assessment includes species, immunization status, health status, type & circumstances of exposure (bite vs. non-bite, provoked vs. unprovoked), & availability for quarantine or testing.

Was the person bitten or was an open wound or mucous membrane exposed to the saliva or neural tissue of a mammal?

Yes

No

Other mammals

Consult local health department

Animal Species

Rabbit or small rodent (including squirrel, hamster, guinea pig, gerbil, chipmunk, rat, & mouse)

PEP is usually not necessary (consult local health department).

Rabbits & small rodents are *almost* never found to be infected with rabies & have not been known to transmit rabies to humans. Woodchucks (groundhogs) account for most cases of rabies in rodents. Rabies testing of rodents is rarely recommended either, unless the animal bit a person and appeared ill or was behaving aggressively or unusually.

Dog, cat, ferret, or livestock (horse, cow, pig, sheep, & goat)

Captured?

Yes

Quarantine the animal for ≥10 days after the exposure

Did the animal exhibit signs of rabies during the quarantine?

Yes

Test the animal immediately: begin PEP if the animal tests positive or inconclusive.

No

No PEP

No

Begin PEP if indicated by risk assessment (consult local health department).

Raccoon, skunk, fox, bat, or woodchuck (groundhog)

Captured?

Yes

Test the animal immediately: begin PEP if the animal tests positive or inconclusive.

No

Begin PEP

No PEP
Exception: bats

PEP is recommended for all persons with direct exposure to a bat, unless the bat tests negative for rabies. Without direct contact, the risks from bat exposure are low. It is possible to be unaware of a bat bite (e.g., a sleeping person awakens to find a bat in the room or an adult witnesses a bat in the room with a previously unattended child, mentally disabled person, or intoxicated person). PEP would not be automatically warranted for other household members.

Management of acute wound

Wound cleansing (15 minutes)
Debridement
Exploration for FB
Leave wounds to close by secondary intention
Tetanus prophylaxis
Animal for investigation
Consult LHD

Exposure Level II-III		
Previously Vaccinated	Not Previously Vaccinated	
Vaccine only	Rabies Immune Globulin (RIG) 20 IU/kg IM	Vaccine 1 ml IM
Day 0	Day 0- Day 7	Day 0
Day 3		Day 3
		Day 7
		Day 14
		(Day 21)
	In and around wound	**Not in gluteus**
	Away from vaccine site	**Away from RIG**

Special populations	
Pregnant woman	No contraindication
Breastfeeding woman	No contraindication
Infant	RIG weight based, vaccine dose the same
Delayed presentation	Start as you would at time of initial exposure
Immunosuppressed	Add 5th dose vaccine on Day 21

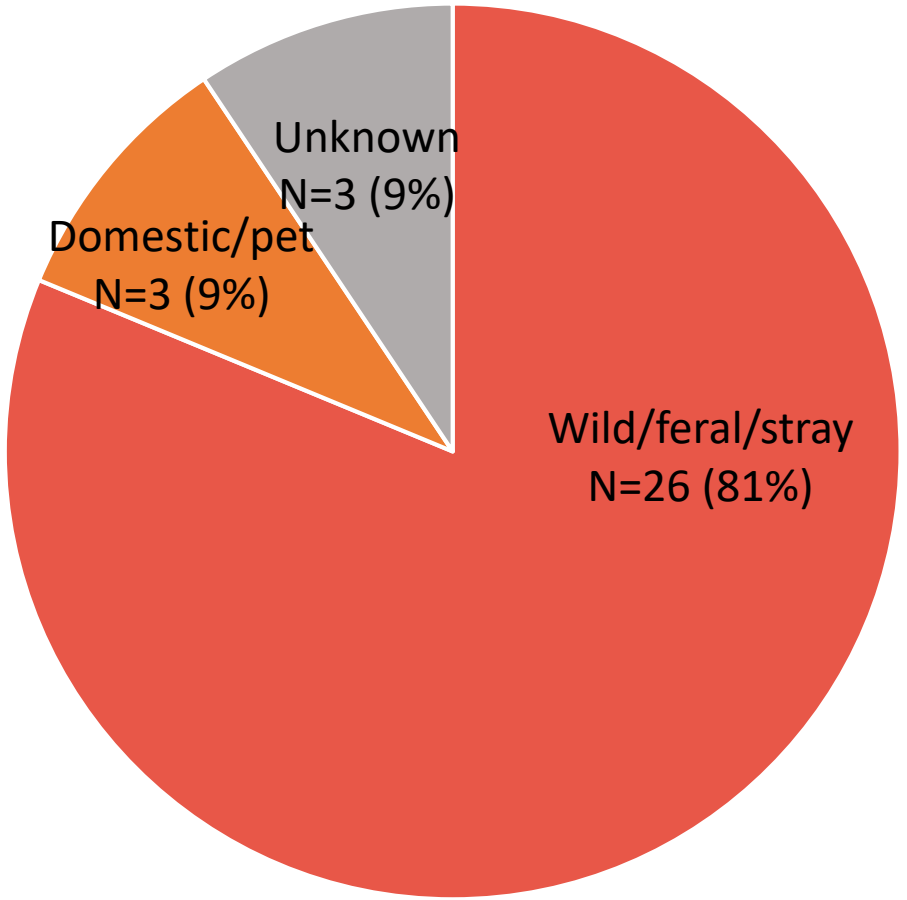
- http://www.immunize.org/askexperts/experts_rab.asp

Rabies PEP administered by species exposure, Garrett County 2015-2016

Species	Number of PEP
Raccoon	9
Cat-feral	5
Dog	5
Bat	4
Fox	3
Skunk	2
Cat-pet	1
Chipmunk	1
Groundhog	1
Unknown	1
TOTAL	**32**

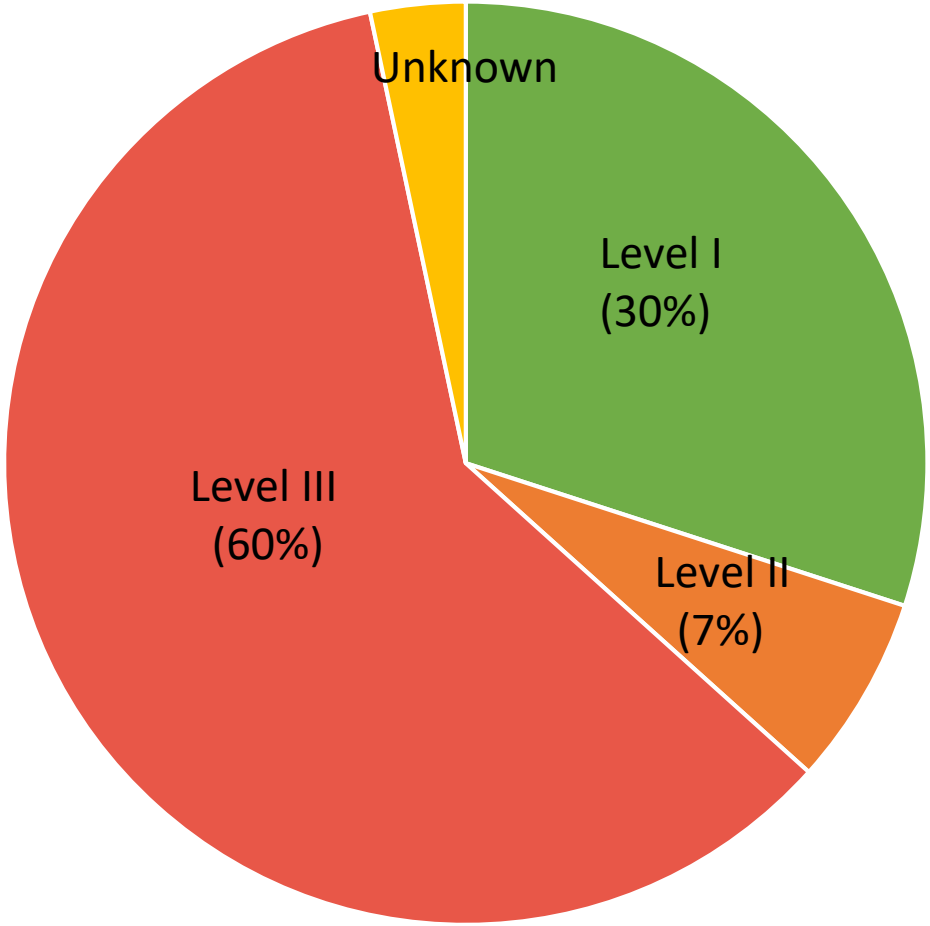
*Garrett County Health Department

Animal encounters resulting in PEP, Garrett County 2015-2016*



*Garrett County Health Department

Category of exposure as documented on bite reports from PEP recipients, Garrett County 2015-2016



*Garrett County Health Department

Human exposure levels to known rabid animals Garrett County, 2015-2016*

Rabid Species	Exposure Level
Raccoon	I
Raccoon	I
Raccoon	I
Raccoon	I
Raccoon	I
Bat	III
Bat	I
Skunk	I
Skunk	I
Dog	?
Dog	?

*Garrett County Health Department

Observations on rabies PEP in Garrett County

Some overutilization

Abundant non-adherent RIG administration

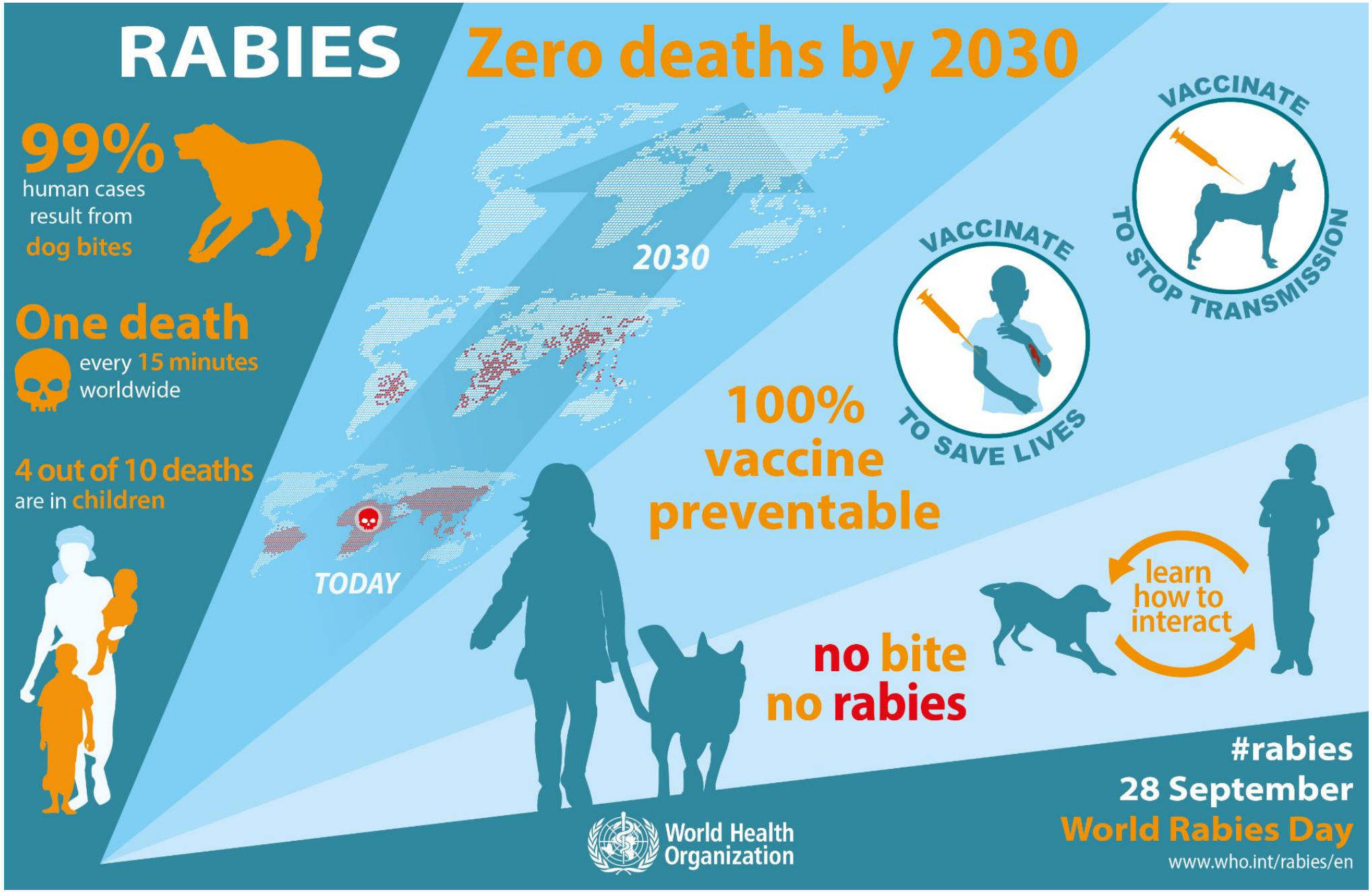
Quarantine underutilized

Improvements can possibly be made with coordination of case follow up for missed doses

Did not address possible underutilization

No person in the United States has ever contracted rabies from a dog, cat or ferret held in quarantine for 10 days

https://www.cdc.gov/rabies/exposure/animals/domestic.html


RABIES
Zero deaths by 2030
99%
human cases result from dog bites
One death
every 15 minutes worldwide
4 out of 10 deaths
are in children
2030
TODAY
VACCINATE
TO STOP TRANSMISSION
VACCINATE
TO SAVE LIVES
100% vaccine preventable
learn how to interact
no bite
no rabies
World Health Organization
#rabies
28 September
World Rabies Day
www.who.int/rabies/en

QUESTIONS?

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