The Intersection of Immunization and One Health: Addressing Human, Animal and Environmental Health

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ARIZONA DEPARTMENT OF HEALTH SERVICES

Speaker Info

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- Irene Ruberto, faculty for this CE activity, has no relevant financial relationship(s) with ineligible companies to disclose.
- None of the planners for this activity have relevant financial relationships to disclose with ineligible companies.
- The Arizona Alliance for Community Health Centers is accredited by the Arizona Medical Association to provide medical education for physicians.
- The Arizona Alliance for Community Health Centers designated the 2025 Arizona Immunization Conference educational activity for a maximum of 11 hours AMA PRA Category 1 Credits Physicians should only claim credit commensurate with the extent of their participation in the activity.
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Learning Objectives:

1. What is One Health,
    a. Why it matters
    b. How does it work
    c. Examples
2. One Health and vaccines
3. Rabies
4. Rift Valley Fever virus
5. West Nile virus
6. Influenza virus

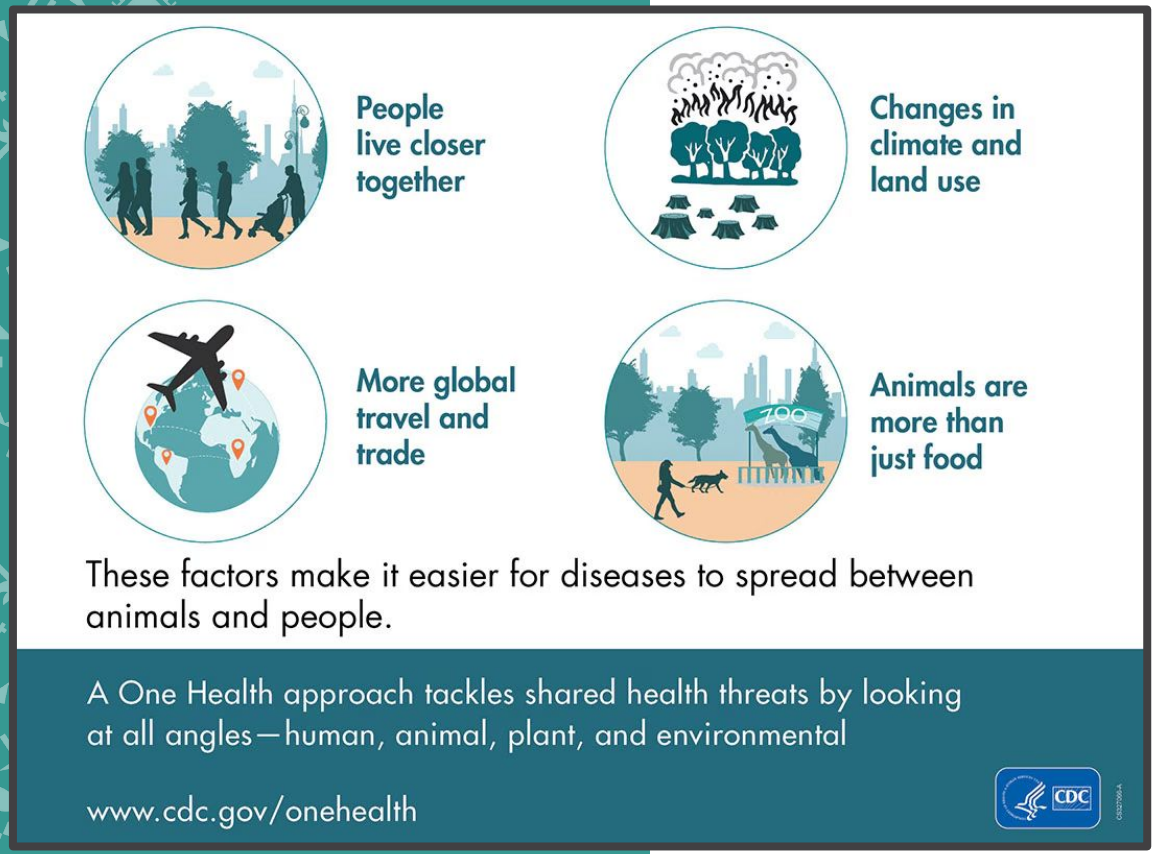
One Health

The approach that highlights the importance of **animal**, **environmental** and **human** health.

- ★ By controlling the disease in one, you can protect the other.
- ★ Not new, but more important in recent years due to changes to the environment.

https://www.cdc.gov/healthy-pets/index.html

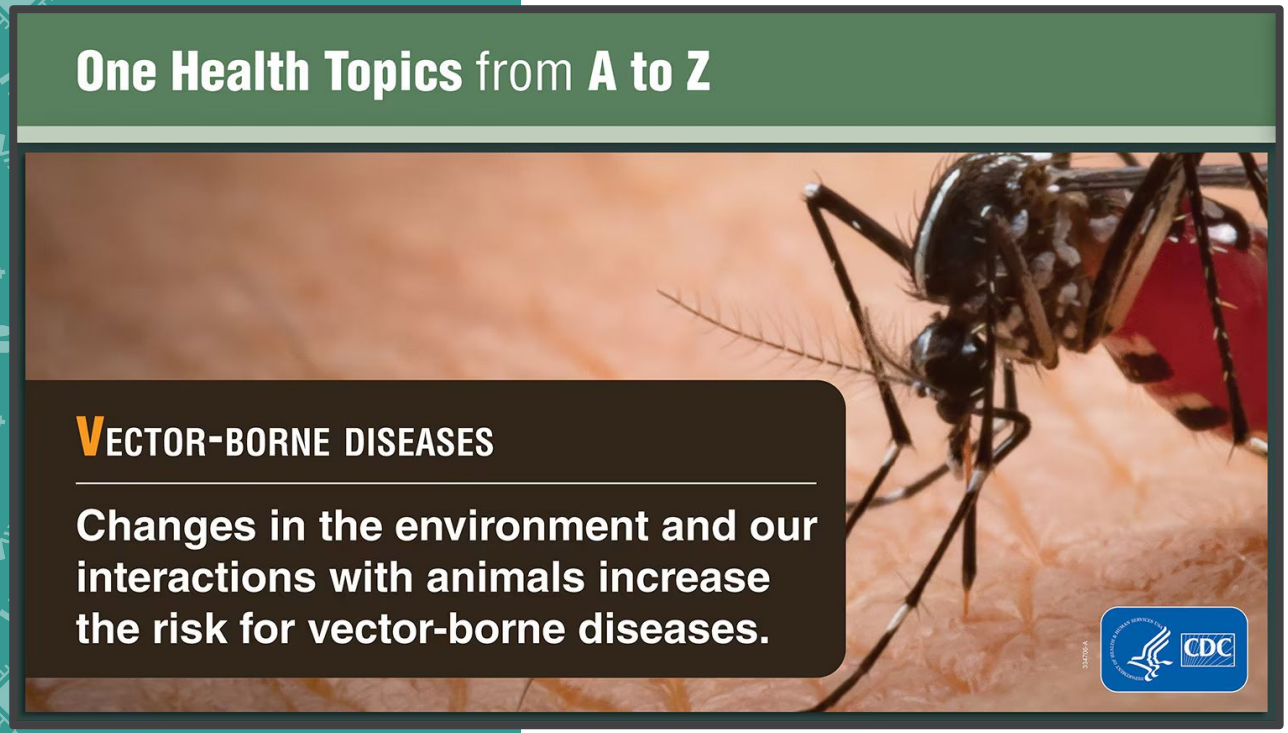
Why is One Health especially important now?



How does it work?

One Health Examples

One Health Examples



One Health Examples

Rabies serves as a key illustration of a disease that profoundly affects human populations, highlighting the need for a ‘One Health’ approach to its management.

By vaccinating your dog against rabies you can keep your family safe from rabies from bats, skunks and foxes (the common virus reservoirs in Arizona)

https://wsava.org

One Health and Vaccines

- Animal vaccines serve as an important barrier to prevent the transmission of some zoonotic diseases to humans
    - Vaccination in **wildlife** to prevent disease in domestic animals and humans.
    - Vaccination of **domestic animals** to prevent disease in humans.

https://pmc.ncbi.nlm.nih.gov/articles/PMC9319643/

One Health and Vaccines Examples

- Rabies
- Rift Valley fever virus
- West Nile virus
- Avian Influenza

https://pmc.ncbi.nlm.nih.gov/articles/PMC9319643/

Rabies

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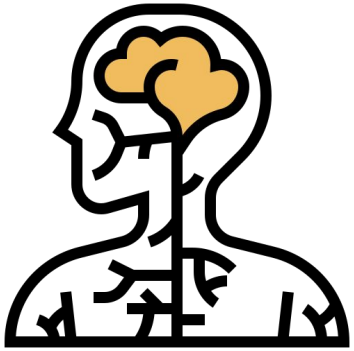
The Rabies Virus



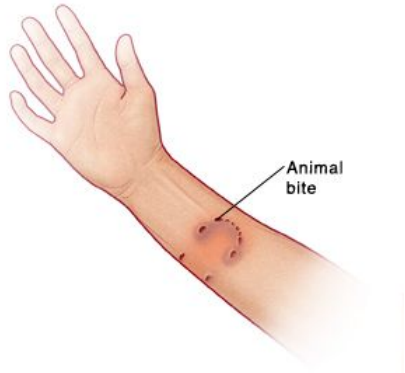
- Probably evolved from a bat-associated progenitor
- **Broad host range**: can infect almost all mammals*
- Found in the **central nervous system (brain and and cerebral spinal fluid) and saliva** of infected animals (*NOT in the blood*)

*Small rodents (like squirrels, hamsters, guinea pigs, gerbils, chipmunks, rats, and mice) and lagomorphs (including rabbits and hares) are almost never found to be infected with rabies and have not been known to transmit rabies to humans.

Transmission

- **Bite**: wound from a tooth that **penetrates the skin** (rabid animal **saliva**> tissues).
- **Non-bite**: **contact with saliva, brain tissue, or cerebral spinal fluid** from a potentially rabid animal into an open wound or in mucous membrane (eyes, nose, or mouth).
- **Other** (very rare):
  - Inhalation of aerosolized rabies virus
  - Through corneal and solid organ transplants (two recorded in the US)

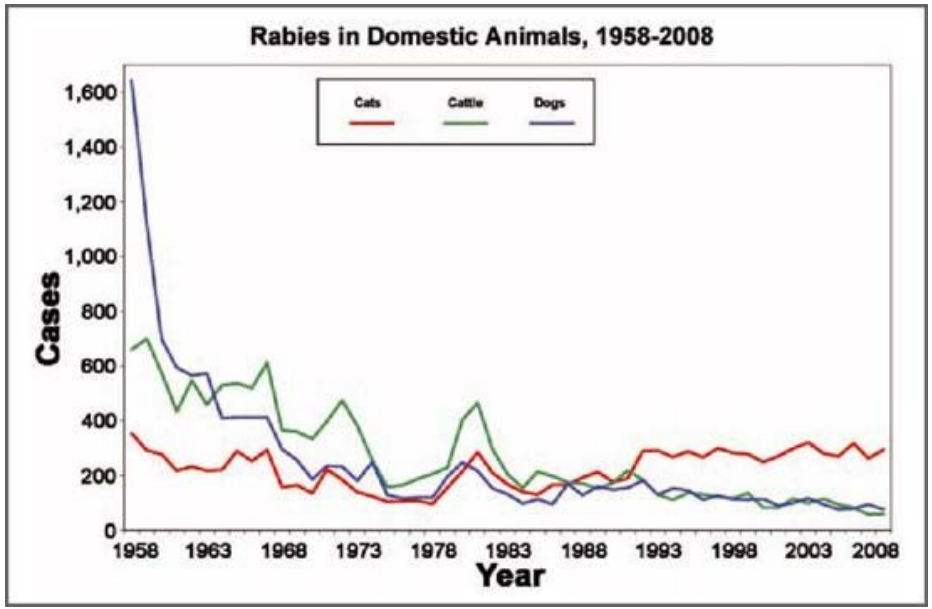
Petting a rabid animal or contact with the **blood, urine or feces** does **not** constitute an exposure.



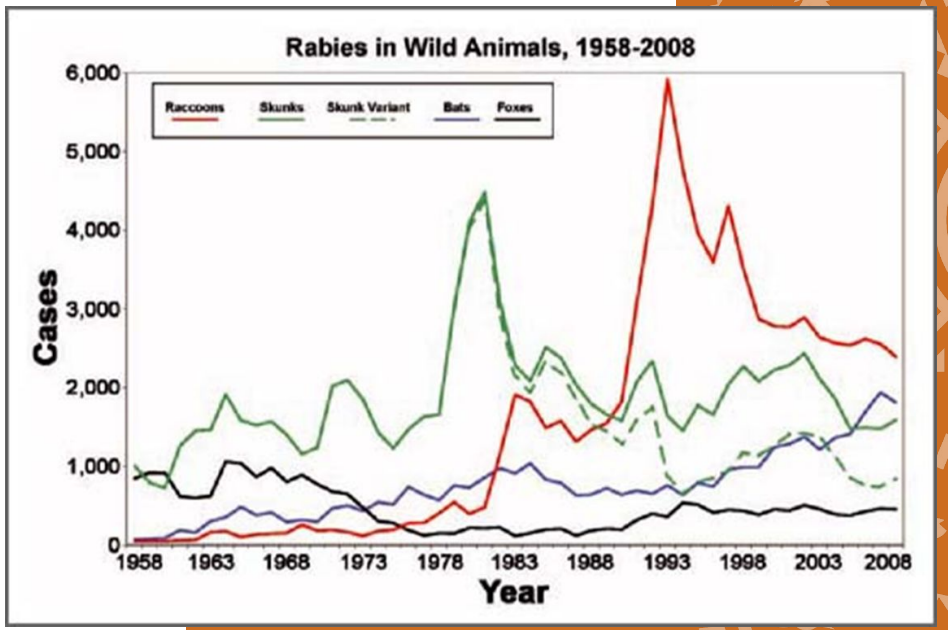
Rabies is a public health **urgency** (=requires immediate action), NOT an **emergency** (=immediate threat to well being), and it **IS preventable** with rabies postexposure prophylaxis (PEP).

Rabies in the US

Decrease in domestic animals



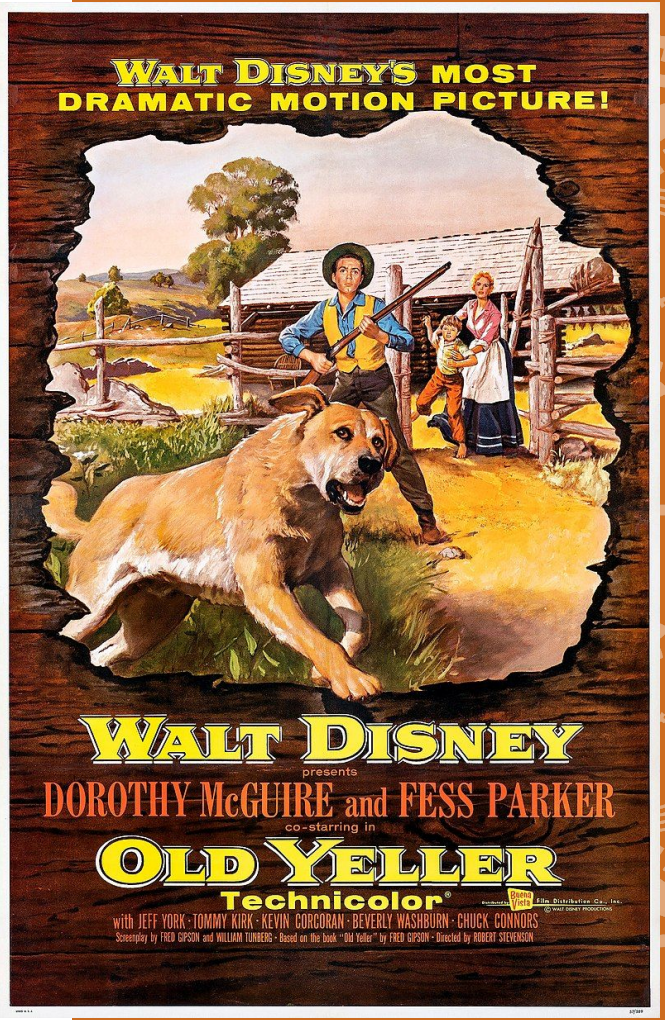
Increase in wild animals
(raccoons, skunks, bats and foxes)



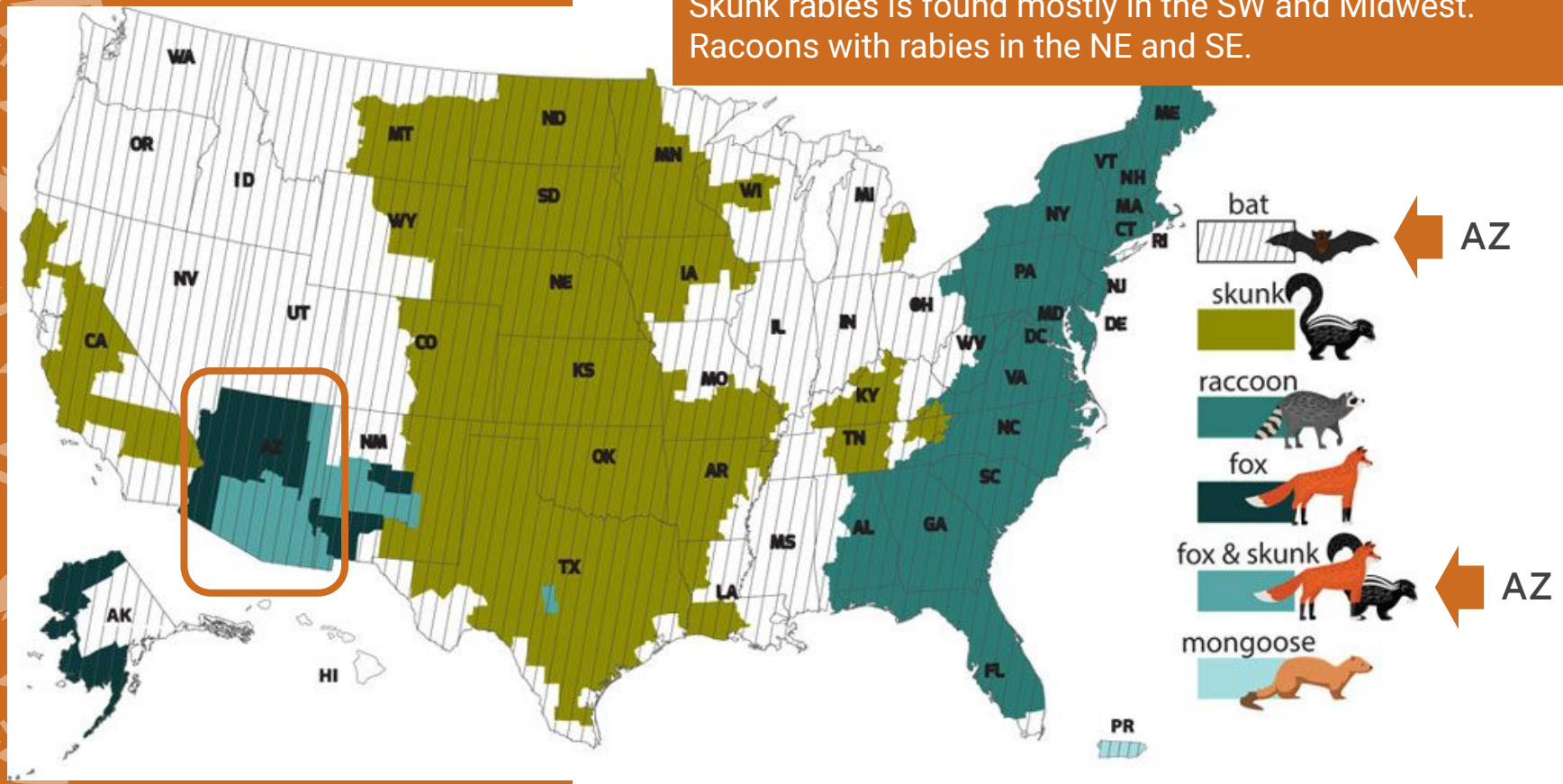
https://avmajournals.avma.org/view/journals/javma/235/6/javma.235.6.676.xml

Canine Rabies Control

- **Vaccinating** dogs, including puppies, is the most cost-effective strategy for preventing rabies in people
- **Mass dog vaccination campaigns** have been the key to end dog-transmitted rabies
- Education on dog behaviour and bite prevention for both children and adults
- In the US national canine rabies control efforts began in the early 1940s with elimination in 2007



Bat rabies is found in every state except Hawaii.
Skunk rabies is found mostly in the SW and Midwest.
Raccoons with rabies in the NE and SE.



https://avmajournals.avma.org/view/journals/javma/262/11/javma.24.05.0354.xml

What animals carry rabies in Arizona?

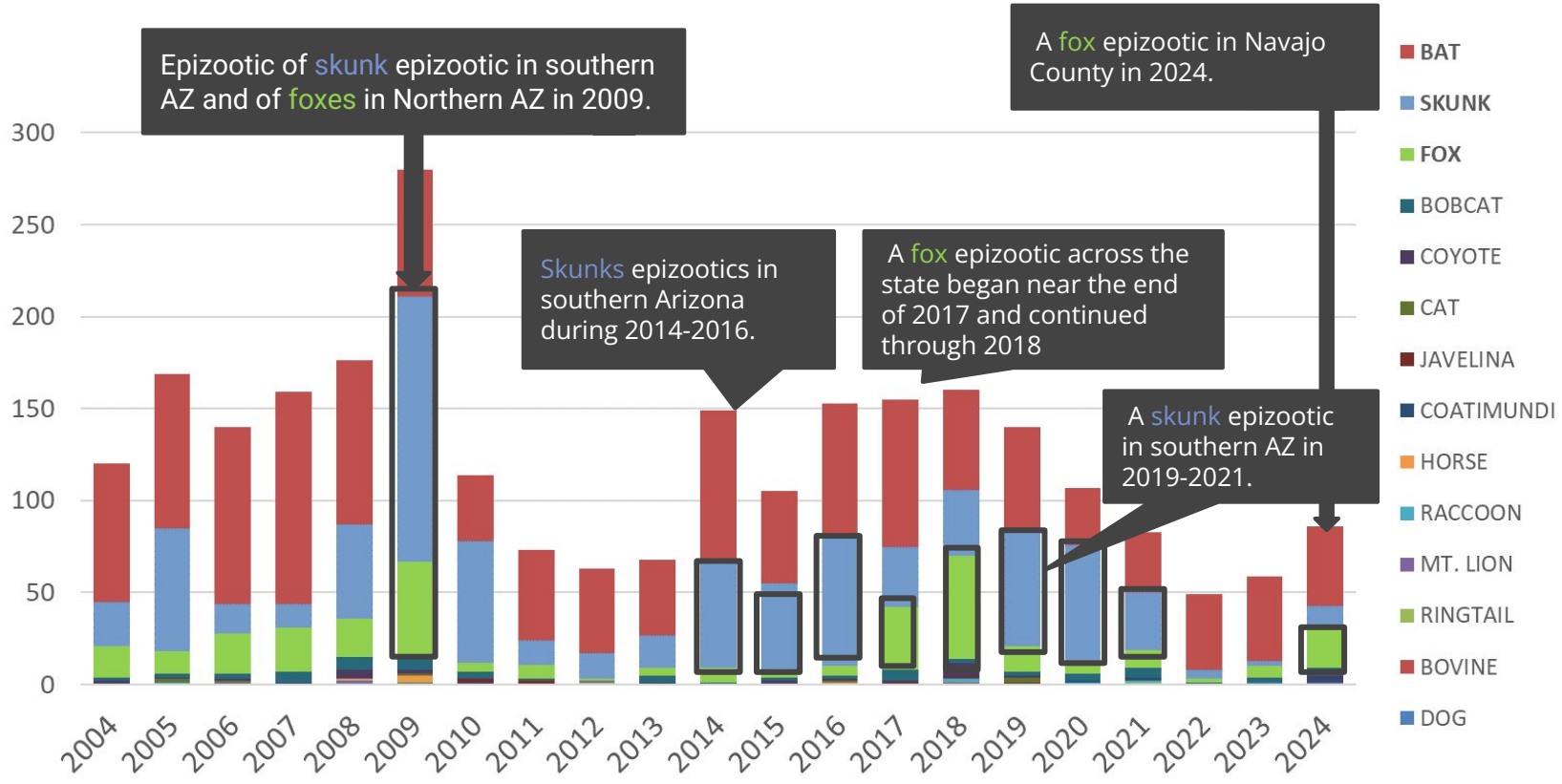
Although all mammals are susceptible to rabies virus infection, certain **reservoir*** species are responsible for maintaining enzootic transmission.

Occasionally coyotes, bobcats, ringtails, javelina, and domestic livestock or pets are infected as a result of interaction with the most commonly infected wildlife species.

Reservoir*= the habitat in which the agent normally lives, grows, and multiplies.

For more data see the ADHS web page here.

Rabid Animals in Arizona 2004-2024



6-year-old Florida boy dies of rabies contracted from a bat

Associated Press

Published 1:42 p.m. ET Jan. 15, 2018

(Thinkstock) *Florida Times-Union*

ORLANDO, Fla. — A 6-year-old Florida boy has died from rabies he contracted

Texas boy, 7, dies from rabies after being bitten by a BAT — as US records decade-high number of fatalities

- Bats are the main cause of rabies in the US, but people often think it from dogs
- The boy was bitten after picking up the bat with his bare hands playing outside
- His parents did not realize he needed medical attention as there were no marks
- Four out of five 2021 fatal rabies cases did not receive the shots to prevent death

By CAITLIN TILLEY, HEALTH REPORTER FOR DAILYMAIL.COM

UPDATED: 18:07 EST, 8 December 2022

California teacher dies from rabies month after being bitten by bat in her classroom

Leah Seneng, 61, carried the winged mammal out of her classroom and released it, not kn she had been bitten and fatally infected.

Dec. 3, 2024

Two rabid cats due to exposure to an infected skunk.

https://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=490973

Rabies confirmed in kittens attacked by rabid skunk

Jun 11, 2019 | Read More News

Share

Pima Animal Care Center has more than a dozen animals in quarantine after exposure to a confirmed case of rabies in Amado. A woman called PACC on June 4 saying she and several animals had been exposed to a possibly rabid skunk about two weeks prior.

Animal Protection Officers removed 15 cats and kittens and two dogs from the property. The woman and exposed family members, neighbors and all the animals are being treated for rabies exposure. The two dogs will be on 45-day quarantines as they have had prior rabies vaccines. The cat/kittens will all have 120-day quarantines due to no previous vaccine history. The skunk died and was buried. Four of the kittens died and two of the deceased kittens tested positive for rabies.

PACC Chief Veterinarian Dr. Jennifer Wilcox recommends residents living in areas where pets may come into contact with wildlife get a booster rabies vaccine for their pets and livestock, and that they keep them under close observation over the next several months, looking for any changes in behavior or health. PACC also recommends all Pima County residents vaccinate their dogs and cats against rabies, whether they reside indoors or out.

Human and pet cases in Arizona

The last human rabies case in Arizona was in 1981, due to a dog bite in Mexico.

From 1990 to 2024 rabid pets:

- **5** unvaccinated dogs (3 with fox variant)
- **12** unvaccinated cats (fox, skunk and bat variants)

To combat this risk, **dog owners are required** by Arizona Revised Statutes to have their **dogs vaccinated against rabies** and licensed (ARS Title 11, Chapter 7 Article 6. 11-1010).

It is also **strongly recommended for cats** to be vaccinated against rabies as cats are more likely than other pets to roam and hunt, and therefore be exposed to wildlife.

Recommended Vaccine Schedule for Animals

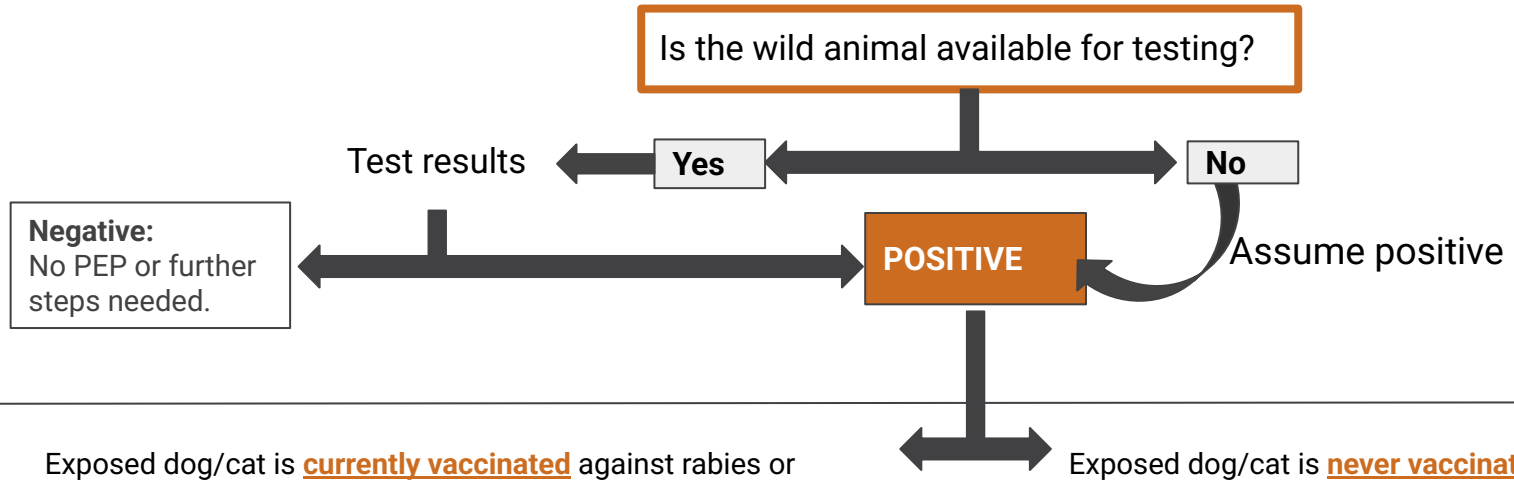
Dogs and cats should:

- Be initially immunized at 3 months of age
- Re-immunized 12 months after the first vaccination,
- Given a booster every 3 years or annually according to the type of licensed rabies vaccine used

Ferrets, horses, and cattle should be vaccinated annually against rabies.

Protocol for Dog/Cat Exposed to a Potentially Rabid Animal

From the National Association of State PH Vets [Compendium of Animal Rabies Prevention and Control, 2016]



Exposed dog/cat is **currently vaccinated** against rabies or **overdue for a booster vaccination but with proof of older vaccination**:

1. Take the dog/cat to a veterinarian for medical evaluation and booster vaccination.
2. Confine the dog or cat under the owner's control and observe closely for 45 days (escape proof enclosure).
3. At the first sign of illness or behavioral change, the animal should be taken to a veterinarian and euthanized.

Exposed dog/cat is **never vaccinated or no proof available**:

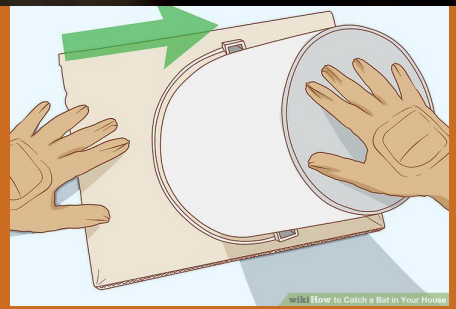
Animal control will quarantine the animal for 120 days (4 months) in an approved facility run by either a veterinarian or an animal shelter (at owner's expense)

- Vaccination prior to release

Or

- Euthanasia

Bats and Rabies



Bats are consistently the most common source of rabies exposures to humans in Arizona because rabid bats often **fall to the ground** where they are easily accessible to people and pets.

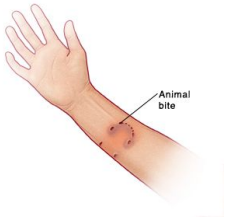
Bats found on **school grounds** are of concern due to the potential exposure of numerous kids:

Teach kids not to touch bats and Inform staff on what to do:

- Cover it with a small box or other solid container.
- Gently slip a piece of cardboard between the ground and box and slide the bat into the box.
- Use **leather gloves** to prevent accidental contact between hands and the bat. Make sure that all seams are tightly sealed, because bats can fit through small crevices.
- Call your local animal control agency. Assure that the bat is not within a child's or pet's reach.

https://www.azdhs.gov/preparedness/epidemiology-disease-control/rabies/index.php#school-safety

Protocol for dog/cat bite to humans



Bite

Observe the dog for 10 days*

Symptoms/death

Humanely euthanize the dog and **submit the head for testing** to ASPHL

Negative

Not rabies, consider alternative diagnoses

POSITIVE

Start PEP for the exposed person(s) immediately and notify animal control or health department officials.

No Symptoms/death

The dog/cat did not have rabies virus in its saliva at the time of the exposure, and there is no further risk to the person.

* if the bite was caused by the animal being in the furious stage of rabies then other symptoms/death would appear

- Day 0 is day of the bite
- Ok at home if animal current on rabies vaccination
- At Vet or animal control otherwise

Rabies Postexposure Prophylaxis (PEP)

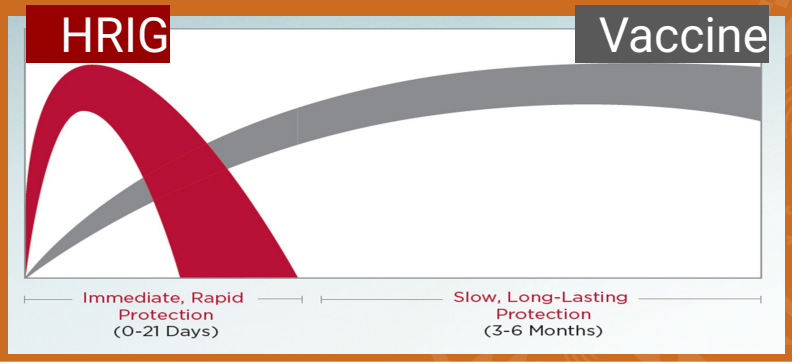
Administration of human rabies immune globulin (HRIG)

- Recommended dose is 20 IU/kg body weight (all age groups)
- It provides immediate antibodies until the body can actively produce them
- Should be given in the **area around the wound and the rest in the deltoid**
- If there is no wound, the entire dose of HRIG should be administered intramuscular (IM)
- Can be administer the first 7 days from the exposure

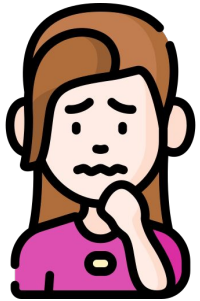
Rabies vaccine series :

- Four doses (day 0, 3, 7, 14) - day 0=start of the vaccine series
- Given in the **opposite deltoid from HRIG**
- Immunocompromised Individual: 5th dose on day 28 + tested for seroconversion
- Previously Vaccinated Individual : Only days 0 and 3, and NO HRIG.

Deviations of up to one week from the schedule are acceptable per CDC and do not warrant restarting postexposure prophylaxis. (For example, if the patient comes in for their second dose of vaccine on day 5, instead of day 3, they do not need to “start over”.)



What should I do if receive and animal bite?



1. Immediately **wash the bite wound** with soap and water.
2. If the wound requires medical treatment, call your family doctor.
3. **Call your local animal control** or local health officials for assistance, for pets or bats you may try to capture the animal but without damaging its head or risking further exposure (to animal saliva, brain or CSF)
    - If the animal is a **dog/cat, or livestock** animal, they will place it under **10-14 day observation (respectively)**.
        i. If it remains healthy for that period, no risk of rabies transmission exists, no need of PEP.
        ii. If the animal dies or develop signs, it should be tested, **if + then start PEP**.
    - If a bat, skunk, fox, coyote, or other **wild animal** bites you
        i. PEP can wait until test is done.
        ii. If severe injury to head or neck, or high suspicion of rabid animal, PEP can be started immediately and stopped if animal test is negative
    - If the wild or domestic animal is **not captured**, consult with your doctor, and the local health department about whether you need to **start PEP** (recommended for wild animals).

Prevention

- Avoid contact with wild or unfamiliar animals, especially sick or wounded animals.
- Teach children to keep a safe distance from wildlife and strays.
- Vaccinate your pets against rabies.
- Keep pets from having contact with wild animals.
- Do not leave pet food outside and use only animal-proof trash cans.

Rift Valley fever virus

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Rift Valley Fever (RVF)

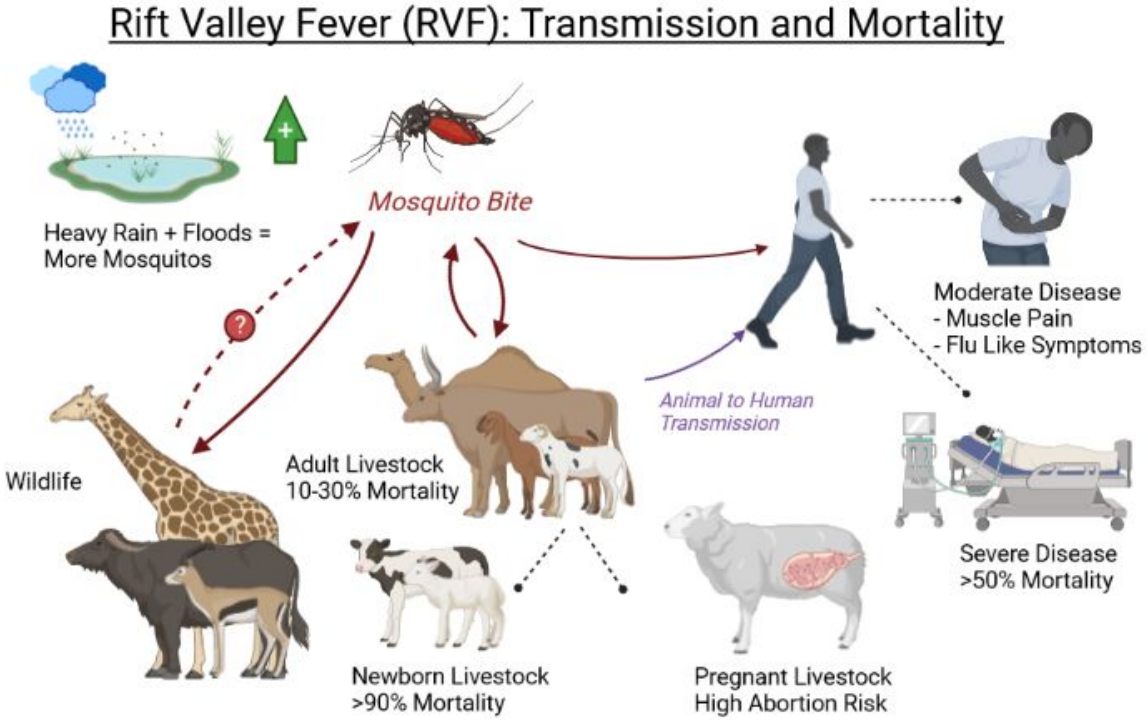
- One of the most significant foreign animal disease
- RVF virus has caused multiple outbreaks in Africa and the Middle East
- The virus can cause severe disease in both animals and humans
- People can be infected from the bite of a mosquito (*Aedes* sp) or through direct contact with the blood and tissues of infected animals
- Important for the US due to possible (compatible vector) and economic impact on livestock industry

Albert Gonzalez Farran, UNAMID / Flickr cc

https://www.cdc.gov/one-health/php/stories/rvf-virus-vaccine.html

Transmission

- RVF outbreaks often occur in years of unusually heavy rainfall.
- The effects of RVF are most pronounced in newborn lambs and pregnant ewes where mortality and abortion rates approach 100%,
- In humans, the clinical spectrum varies from a mild febrile illness to the more severe manifestations of encephalitis and haemorrhagic diathesis that are frequently fatal



https://www.cdc.gov/one-health/php/stories/rvf-virus-vaccine.html

https://www.jenner.ac.uk/research/emerging-pathogens/rift-valley-fever-rvf

RVF Vaccine

- No human vaccine available (but under development)
- Current livestock vaccines are based on live-attenuated or formalin-inactivated virus
- By preventing RVF in animals, fewer humans will be infected from mosquitoes carrying the virus or from direct contact with a sick animal
- Vaccinations also protect the animals that the people rely on for food and as a source of income.

Human vaccines generally are more expensive and take longer than animal vaccines to develop, highlighting the importance of the One Health approach.

One Health in Action: By collaborating effectively with individuals from many fields, public health professionals can prevent outbreaks of RVF and better protect the health of people.

West Nile virus

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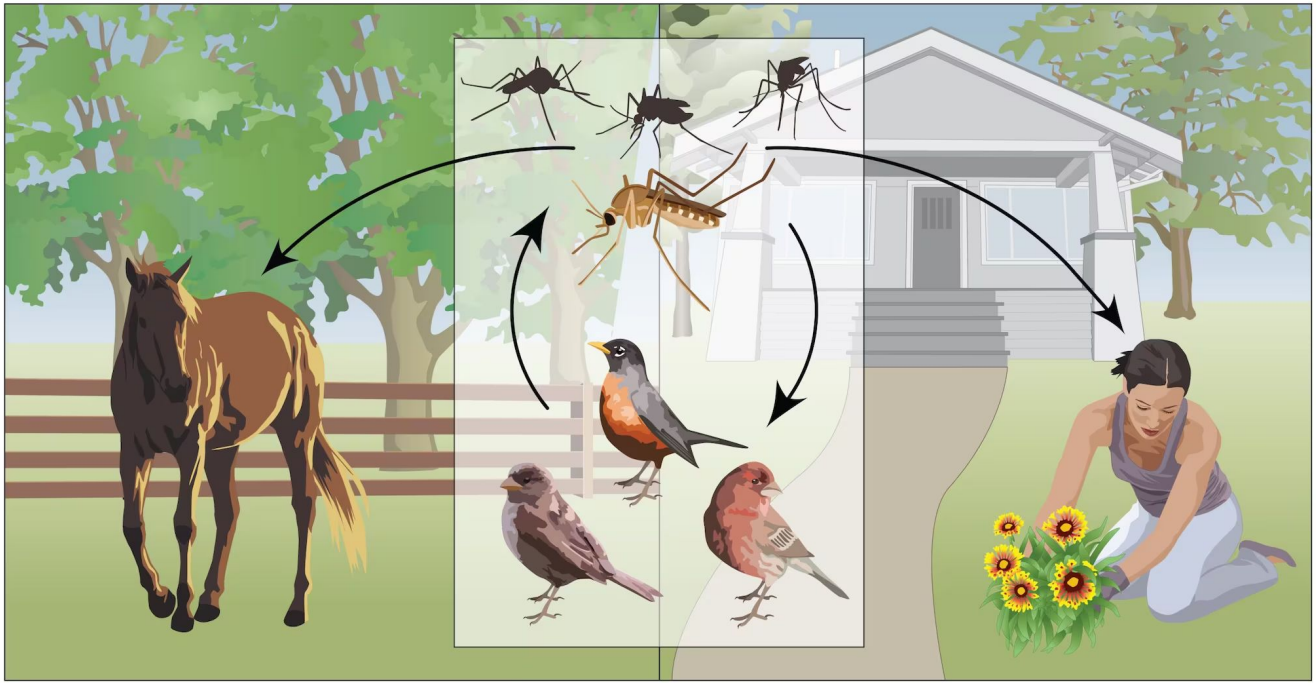
West Nile Virus



- Virus amplified in birds
- Transmitted from birds to humans via mosquitoes
- Horses and other mammals can also be infected (but cannot transmit it further)

https://www.cdc.gov/west-nile-virus/php/transmission/index.html

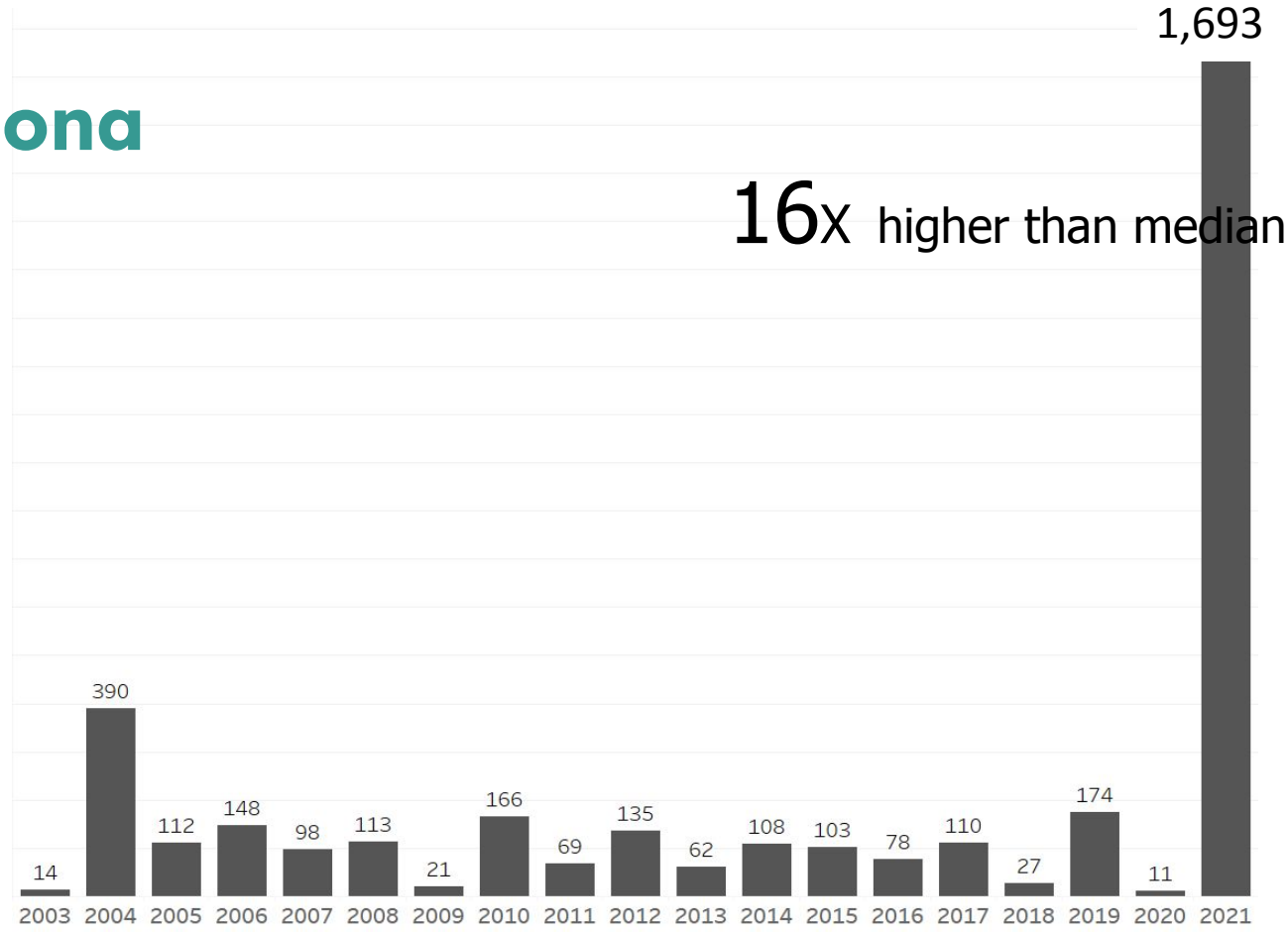
WNV in Humans

- Most symptomatic persons experience an acute systemic febrile illness that often includes headache, weakness, myalgia, or arthralgia;
- gastrointestinal symptoms and a transient maculopapular rash also are commonly reported.
- 1% of infected persons develop neuroinvasive disease, which typically manifests as meningitis, encephalitis, or acute flaccid myelitis
- 10% fatality rate

WNV in Arizona

108 cases

Historical median, with alternating cycles



WNV in Horses

- Since 1999, more than 25,000 cases of WNV encephalitis have been reported in U.S. horses.
- Horses represent 96.9% of all reported non-human mammalian cases of WNV disease.
- The case fatality rate for horses exhibiting clinical signs of WNV infection is approximately 33%
- 40% of horses that survive the acute illness caused by WNV still exhibit residual effects

Signs of WNV: fever, incoordination, hind-end weakness, anorexia, tremors,etc.

https://aaep.org/resource/west-nile-virus-vaccination-guidelines/
https://www.aphis.usda.gov/livestock-poultry-disease/equine

Vaccine Co-development

- During the early phase of the epidemic (1999), veterinary and human vaccine candidates were developed in tandem
- The data gathered from both programs were shared across sectors to help inform the pathway to advanced clinical trials
- In two years, a veterinary vaccine was developed for use in horses, and one of the developed vaccines was able to protect California Condors from extinction

Example of vaccine co-development in animals and humans.

https://pmc.ncbi.nlm.nih.gov/articles/PMC9319643/

WNV Vaccine Saved California Condors from extinction

- Condor numbers dramatically declined in the 20th century due to agricultural chemicals, poaching, lead poisoning, and habitat destruction
- In 1987 the surviving wild condors were only 27
- They were bred at the San Diego and LA Zoos and then reintroduced in the wild in 1991
- WNV DNA vaccine used to vaccinate 250 California Condors in 2002

https://landtrustalliance.org/
https://www.latimes.com/archives/la-xpm-2002-nov-26-me-vn condor26-story.html

WNV Vaccine in Humans

There is currently no licensed vaccine for humans due to:

- Obstacles with obtaining efficacy (Phase III) data because of unpredictable WNV transmission patterns
- Not being cost-effective (as case numbers are low, and vaccine costs are high, the amount of money necessary to avoid a single case is consequently very high)
- More recent analysis has shown an improved cost-effectiveness if used for
    - persons aged 60 years and
    - who live in high-incidence areas

https://pmc.ncbi.nlm.nih.gov/articles/PMC9319643/

Influenza virus

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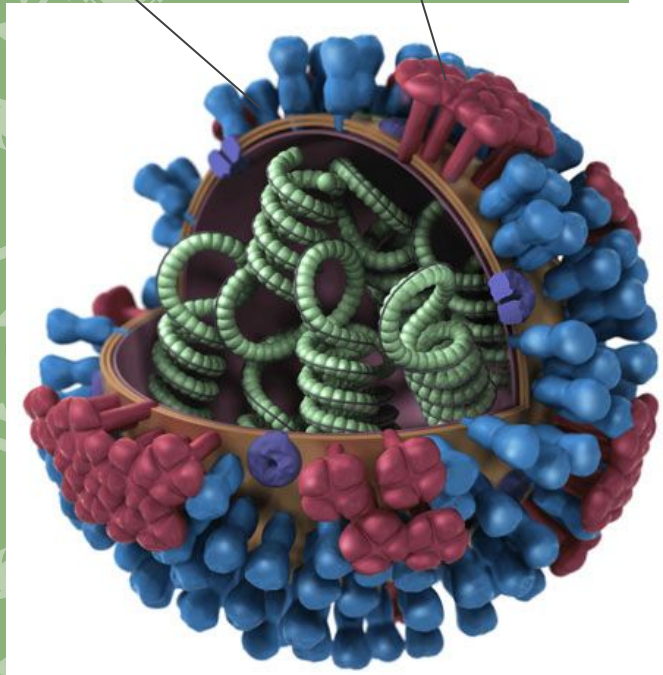
Influenza A viruses subtypes



- **More than 130 subtypes** have been identified in nature primarily from wild aquatic birds
- 18 different H subtypes and 11 different N subtypes
- They are **constantly evolving**, making it possible for animal influenza viruses to change in such a way that they can easily infect people, so monitoring is key.

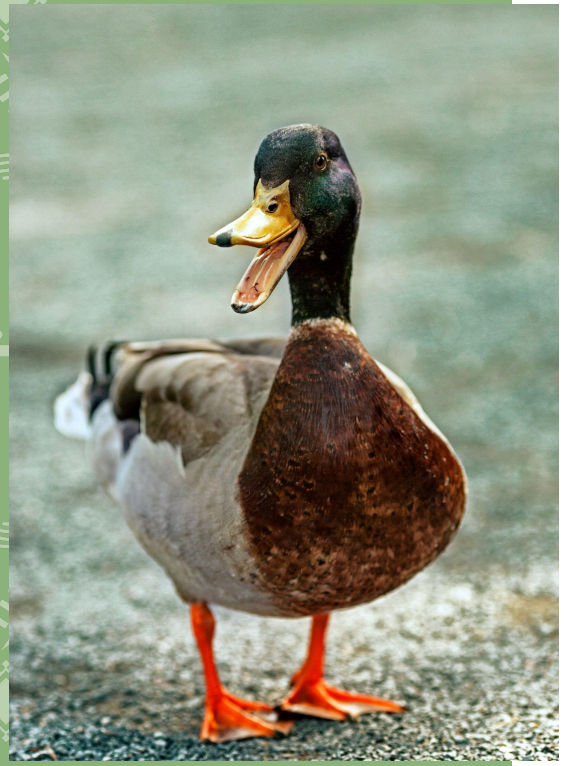
Subtype	People	Poultry	Swine	Bats	Cats	Dogs	Horses	Cows	Other*
N1									X
N2									X
N3									
N4									
N5									X
N6									
N7									X
N8									X
N9									
N10									
N11									

The current N1 can infect people, wild birds, poultry, swine, pets and cattle

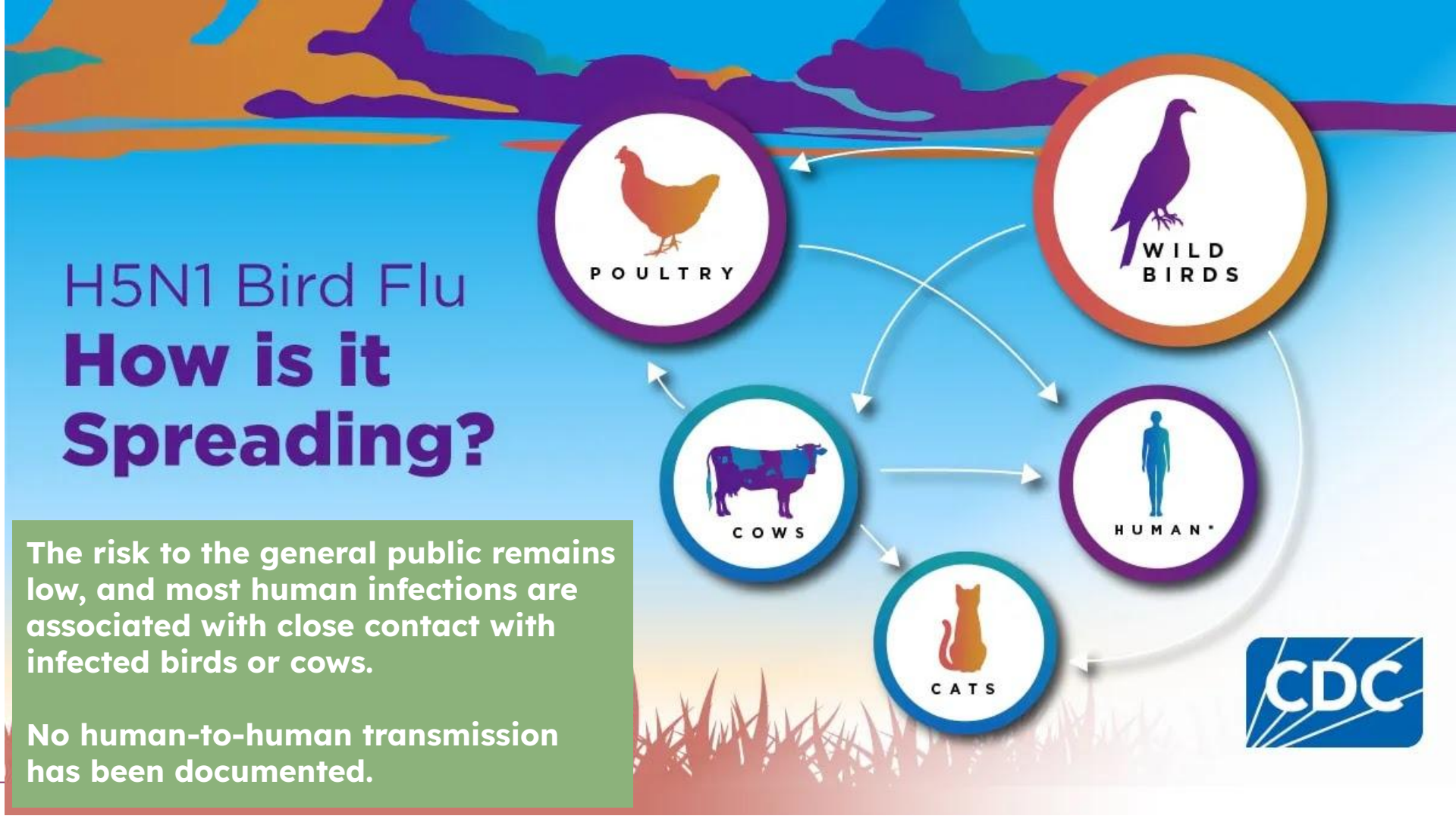
Influenza A viruses occur **naturally among wild aquatic birds** worldwide and can infect domestic poultry and other bird and animal species.

https://www.cdc.gov/flu-in-animals/about/index.html

Influenza A viruses



- Wild aquatic birds, especially **dabbling ducks**, are considered **reservoirs** (hosts) and don't get sick but can spread the virus.
- Infected birds can shed the virus in their **saliva, nasal secretions, and feces**.
- Transmission through **contact with infected birds** or through contact with **surfaces** that are contaminated with virus from infected birds.


H5N1 Bird Flu
How is it Spreading?
POULTRY
WILD BIRDS
COWS
HUMAN*
CATS
CDC
The risk to the general public remains low, and most human infections are associated with close contact with infected birds or cows.
No human-to-human transmission has been documented.

Influenza vaccines

- Seasonal influenza human vaccine
- 12 licensed animal influenza vaccines (poultry, swine, horses and dogs)
- Influenza vaccines protect against specific influenza viruses, with minimal cross protection against other influenza viruses
    - ex. Seasonal flu vaccine does not protect against avian flu H5N1 currently spreading

However, influenza vaccination in animals remains an important measure to control and prevent transmission from animals to humans, and to reduce influenza illness in humans and animals.

Influenza vaccines challenges

- High variability and rapid evolution of the virus
- This results on a constant chase for the vaccine to match the circulating strains
- Thus current vaccine programs are dependent on extensive surveillance

Successful control of influenza can only be achieved through collaborative support between human and animal health.

Poultry vaccine in the US?

In Feb 2025 the USDA conditionally approved a license for an avian flu vaccine for poultry made by Zoetis.

Not clear currently exactly where the USDA stands on it, and in their recent strategy emphasize more biosecurity.

The issues are:

- Concerns for exports (some countries bar poultry imports from nations that vaccinate commercial poultry due to concerns that their use could mask ongoing avian flu circulation as infected vs. vaccinated bird can be difficult to discern)
- Vaccination is only available in injection form, so may not be always be feasible.

Photo by Sahand Babali on Unsplash

https://www.usda.gov/about-usda/news/press-releases/2025/02/26

SUMMARY

- **One Health** - Successful public health interventions require the cooperation of human, animal, and environmental health partners
- **Rabies** - Vaccinating pets protects people and post-exposure vaccination (PEP) protects exposed people from the disease
- **Rift Valley Fever** - Vaccination in animals protects both animals and humans
- **West Nile virus** - Example of animal and human vaccine co-development
- **Influenza** - Variety and challenges of vaccines in humans and animals

THANK YOU!

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