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Facts About Wildlife Diseases: Eastern Equine Encephalitis[1]

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*Please note: terms in **bold** are defined in the glossary at the end of the document.*

What is EEE?

The Eastern equine encephalitis virus (EEEV) causes Eastern equine encephalitis (EEE) disease in birds, humans, horses, and other animals in the eastern United States, including Florida. EEEV is in the genus *Alphavirus*, along with the Western equine encephalitis virus (WEEV) and Venezuelan equine encephalitis virus (VEEV). Enzootic VEEV (limited to non-human hosts) has been found in Florida, while WEEV has not been reported in Florida at all. The last epizootic outbreak of VEEV (with human and non-human infection) in the United States occurred in 1971; it is not currently in the United States and is a reportable Foreign Animal Disease.

Who can be infected with EEE?

- Mammals
  - Humans
  - Equines—horses, mules, donkeys, zebras
  - Cattle
  - Dogs
  - Pigs
  - Goats
  - Llamas
  - White-tailed deer
  - Opossums
  - Rodents
  - Bats
- Birds
  - Turkeys
  - Ducks
  - Pheasants
  - Emus
  - Ostriches
  - Cassowaries
  - Starlings
  - Robins
  - Pigeons
  - Sparrows
  - Whooping cranes
  - Partridges
  - Owls
- Reptiles
  - Copperheads
  - Cottonmouths
- Amphibians

How is EEE transmitted?

The black-tailed mosquito (*Culiseta melanura*), which lives in Florida, is the primary **vector**, or carrier, of the virus to birds. This relationship creates a cycle of transmission between birds and mosquitoes. Only female mosquito bites transmit the virus, which can then cause disease in the host. Because of this cycle, birds are considered **reservoirs** for the disease, but some species, such as chickens, often do not show signs of infection, while other birds, such as emus, have severe signs of illness and high mortality rates. Multiple **genera** of mosquitoes, such as *Aedes*, *Coquillettidia,* and *Culex*, cause further spread of the virus when the females feed on birds, then on other hosts. Infected birds (specifically farmed pheasants and emus) can transmit the virus without the help of a mosquito. An infected individual can have the virus on its feathers, and transmission of the virus can occur through pecking and preening. The individual can also shed the virus in feces, blood, saliva, or vomit, and individuals that come in contact with the excretions and secretions can become infected. Humans can also pick up the virus by handling infected birds. Humans and horses are considered to be "dead-end" hosts because the virus does not spread when mosquitoes feed on these infected individuals. Because the virus does not spread between people, it is not contagious. It is not known if other animals are dead-end hosts.

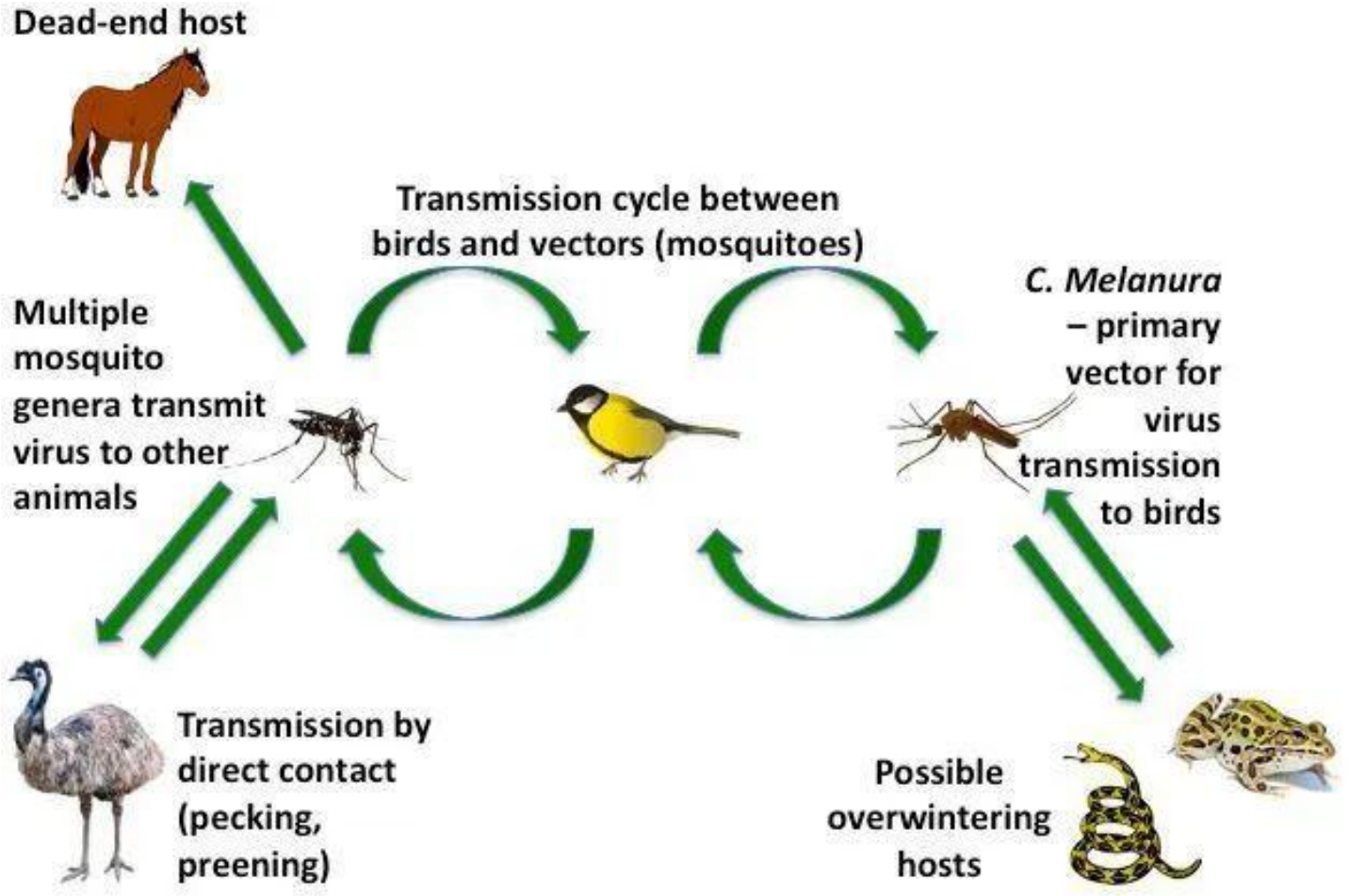


Figure 1. Transmission cycle for EEEV between vector and hosts. The disease cycle is maintained between female mosquitoes and birds. Horses are an example of a dead-end host, contact with which will not transmit the disease. Certain birds such as emus or pheasants can spread the virus through pecking and preening of feathers. Amphibians and reptiles could be hosts for the virus in winter months, when birds have migrated

EEE in Florida

Florida is especially receptive to the virus because of its freshwater hardwood swamps and wetlands, which promote good **niches** for the mosquitoes and consequently, the virus. The subtropical-tropical climate, warm winters, and high humidity and rainfall in Florida also contribute to increased mosquito breeding and activity year round, and transmission of EEEV year round. In colder climates, the disease is only apparent during warmer months when mosquitoes are out.

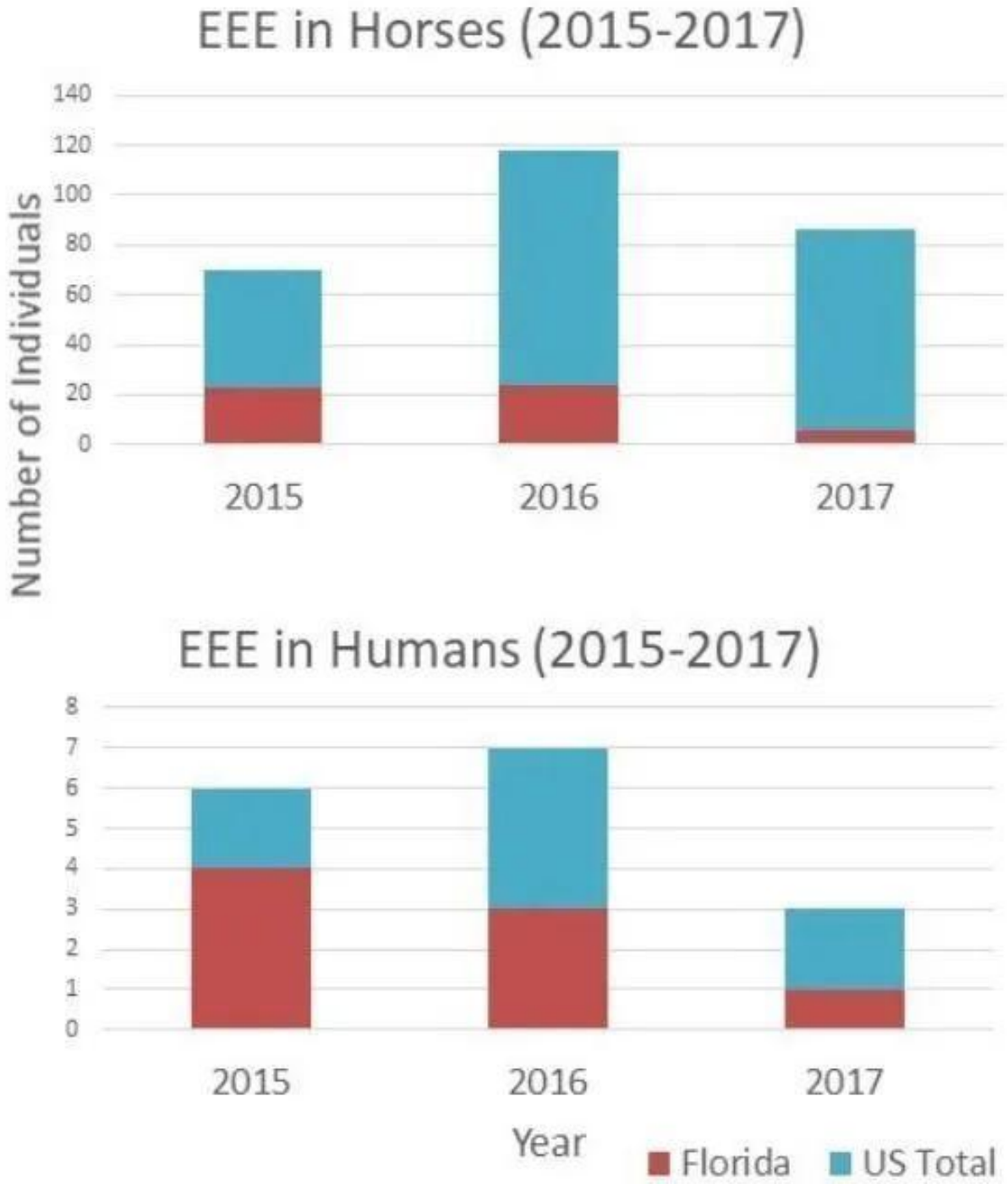


Figure 2. Bar graph comparing number of people and number of horses infected with EEE in Florida (burgundy) and in the United States (teal) from 2015–2017.
Credit: CDC, About Eastern Equine Encephalitis

What are the signs and symptoms of EEE?

- Fever appears 18–24 hours after viral infection.

Horses

- Clinical signs can develop 4–15 days after, and include:
  - Neurological signs—head-pressing, circling, facial paralysis, tongue weakness, blindness, seizures, difficulty swallowing, brain and spinal cord inflammation
  - Behavioral changes—aggression, self-mutilation, drowsiness
  - Gait abnormalities
  - Fever
  - Lack of appetite
  - Join pain
  - Bloody diarrhea
  - Constipation
  - Depression

Fatality in unvaccinated horses is estimated to be 70–90%, but the vaccine provides effective protection. There is no cure and no effective treatment once the animal is infected.

Birds

- Asymptomatic in most bird species (i.e., chickens)
- Vomiting
- Bloody diarrhea
  - In emus and ostriches, the only signs might be vomiting and bloody diarrhea
- Death can occur 24 hours after onset of signs
- Tremors
- Leg paralysis
- Drowsiness
- Decline in egg production; egg formation abnormalities
  - In turkeys: small, soft, white eggs
- Depression

The infection rate tends to be lower and more benign in wild birds than in farmed birds, though in epidemic periods (due to warmer temperatures and higher rainfall when mosquito populations are high) it can also be higher and more severe than normal.

Humans

- Can be asymptomatic

Systemic infections:

- Fever
- Headache
- Chills
- Sore throat
- Lethargy

Encephalitic infections:

- Targets central nervous system
- Fever
- Headache
- Brain inflammation
- Irritability
- Seizures
- Coma
- Death

Complications for Horse and Human Survivors

- Brain and cranial nerve dysfunction
- Paralysis
- Seizures
- Intellectual impairment
- Personality disorders

It is estimated that only 4–5% of humans infected with the virus actually contract the disease. In humans that have contracted the disease, fatality is estimated to be 50–70%. Only 1–2 human cases are reported in Florida each year, out of 7 people on average in the United States. Diagnosis of infection is based on clinical signs and symptoms, and blood and spinal fluid tests for antibodies to the virus. Because there is no cure, **supportive care** is the only treatment available to an infected individual.

How can you limit the spread of EEE?

Avoid stagnant water and eliminate mosquito-breeding sources

- Drain water from containers like pool covers, buckets, and garbage cans.
- Discard items that fill with standing water
- Replace water in birdbaths and pet bowls weekly
- Use tarps that don't accumulate water
- Maintain pools regularly

Protect yourself—decrease mosquito exposure

- Use mosquito repellent
- Wear long sleeves
- Wear long pants tucked into socks
- Contact your doctor if you think you are infected
- Use yellow "bug lights" for your outdoor lighting

Protect your herds and flocks

- Equine vaccinations are available
  - Effective at preventing disease or reducing severity of disease
  - Annual revaccinations before vector season in the spring
    - In Florida: due to year-round mosquito activity, vaccines may be administered at 4- to 6-month intervals for uniform protection
  - Equine vaccinations have been successfully used for birds, particularly emus, but the product was developed for horses and is therefore not labeled for use in birds.
  - A vaccine will not help an already infected animal
- Frequently change water in troughs and buckets
- Keep animals in a protected area (like a barn) during dawn and dusk when mosquitoes are most active
  - Install fans to help avoid mosquito bites
- Apply fly spray or mosquito repellent
- Remove infected individuals from the group
- Contact your veterinarian if you think your animal is infected

How is EEE monitored and reported?

Chickens are currently used in virus surveillance, as sentinels. They are effective as early warnings for EEEV transmission (amongst other illnesses) in Florida, because even though they might be infected with the virus, they do not get sick and die from it. Rather, they build antibodies that can be detected through blood tests.

Florida is part of a national surveillance system for mosquito-borne diseases, including EEE. Mosquitoes are trapped and collected from pools and tested for these diseases. EEE is a nationally reportable disease, so when it is detected it must be reported to the CDC (Center for Disease Control). Animals that are suspected to have EEE or that have been diagnosed with EEE should be reported to the Florida Department of Agriculture Division of Animal Industry.

The CDC has an interactive map that allows the viewer to see where EEE (and other viruses) has occurred in the United States, broken down by state, county, year, number of infected, and species (select EEE from the tabs in the blue bar above the map).

Wildlife and EEE

Studies on white-tailed deer report that though they can be infected with EEEV, because of their constant exposure to the virus, they have developed antibodies that allow infected deer to clear the infection and survive, or in some cases live with subclinical infection exhibiting no external signs of illness. The first fatal report of a white-tailed deer with EEEV occurred in 2001 in Georgia. Diagnostic testing confirmed the presence of the virus in the animal. Post mortem findings demonstrated that the deer had brain inflammation, meningitis, and internal and external bruising and lesions throughout the body. A possibility for surveillance of the virus, then, may be screening wildlife such as deer, rodents, and birds for EEEV antibodies to understand where the virus is present.

Considering that amphibians and reptiles live in hardwood swamps where mosquitoes are also abundant, they have been studied as possible winter hosts for EEEV. After birds have migrated elsewhere, the mosquitoes still feed on these cold-blooded animals. The virus survives in the animal's blood during winter, while the mosquitoes are in their larval stage. Come spring, the adult mosquitoes feed on the infected reptiles and amphibians, then bite other individuals, infecting them as well.

Further Readings

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United States Centers for Disease Control https://www.cdc.gov/easternequineencephalitis/index.html

Glossary

Vector

Carries and transfers an infectious agent.

Reservoir

Habitat of the disease agent, in this case virus, where it will live, grow, and multiply.

Genera

Genera is plural for genus, the classification of an organism falling between family and species. The genus is the first word of a binomial scientific name, for example, *Culiseta* is the genus name for *Culiseta melanura.*

Niche

Comprised of interactions with other organisms and factors such as soil and climate. Each species has its own niche. It can also be considered an organism's "role" within nature.

Supportive Care

Treatment given to control or relieve complications and side effects of a patient and improve or maintain their comfort and quality of life.

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