

West Nile Virus

A. M. Tucker, Learning and Training Specialist 3: Vectors and Vector-Borne Diseases, Department of Entomology and Plant Pathology
 R. T. Trout Fryxell, Professor of Medical and Veterinary Entomology, Department of Entomology and Plant Pathology

Introduction

West Nile Virus (WNV) was first isolated in the African country of Uganda in 1937. The first successful experimental instance of a mosquito biting and transmitting the virus to humans was in 1942. In 1999, the virus was first discovered in the United States, and it is now found throughout the continental U.S. Multiple mosquito species are successful vectors of WNV. Depending on the location, one or more species are better than others at transmitting and/or amplifying the virus. There are no preventative vaccines or medicines for WNV; therefore, it is critical for individuals to use strategies which prevent mosquito bites to reduce their risk of contracting WNV.

Transmission of Disease Pathogens

Female mosquitoes become infected with WNV by feeding on infected birds and crocodiles. The infected female can transmit the pathogen to humans, horses and other animals (Figure 1). Except for birds and crocodiles, animals including humans are dead-end hosts, meaning the virus cannot be obtained while a mosquito is feeding on the host, thereby ending the pathogen's life cycle. Additional information for horse owners and caretakers can be found in the UT Extension Publication W775 For the Equine Owner: West Nile Virus.

West Nile Virus Transmission Cycle

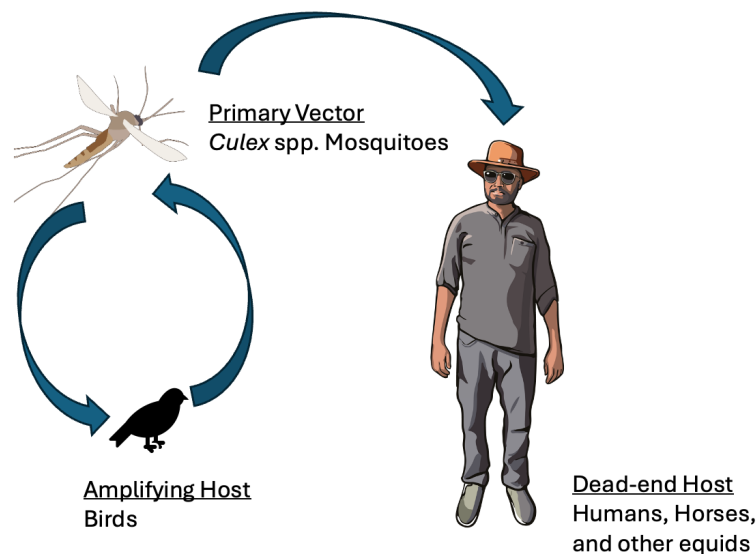


Figure 1. The transmission cycle of WNV. Graphic Credit: A. M. Tucker developed in PowerPoint, mosquito (NIAH BIOART Source #000360), and standing person (NIAH BIOART Source #000555).

Mosquito Life Cycle

In the U.S., the primary vectors of WNV are *Culex* species and members of the *Cx. pipiens* complex, a group of species which are difficult to identify using external characteristics. Specifically, the *Cx. pipiens* complex includes the Northern house mosquito (also called the common house mosquito, *Cx. pipiens*) and, the Southern house mosquito, *Cx. quinquefasciatus* (See Figure 2). The Western encephalitis mosquito, *Cx. tarsalis*, is not a member of the complex and is one of the primary vectors of WNV. All three mosquito species are commonly found in Tennessee.



Figure 2. Southern house mosquito, *Cx. quinquefasciatus*, lateral view (left) and ventral thorax view (right). Photo credit; Walter Reed Biosystematics Unit (WRBU).

All mosquito species require water for their development from eggs to adults. Most female *Culex* species lay their eggs in a raft formation on stagnant water (e.g., pond, neglected pool, sewer water). The larvae will feed on organic matter in the water before developing into pupae and eventually adults. Only female adults bite to feed on blood, which is required for successful egg development. Both sexes will feed on nectar sources.

WNV in the US and World

West Nile Virus is endemic, or naturally occurring, in many countries including those in Africa, Europe, parts of Russia, India, Indonesia and North and South America. WNV is also endemic in all 48 continental states with one travel case reported in Alaska. The number of cases every year is sporadic, and the location of cases is not consistent from year to year. But most cases occur in the Midwest and occur May through December. In southern states, cases can occur as early as February and peak in August.

Signs and Symptoms of WNV

Most individuals who become infected with WNV have no symptoms (asymptomatic). Those who become symptomatic develop a fever and often recover quickly but may experience lingering fatigue for weeks or months. In rare cases, individuals will develop a neuroinvasive disease, which is more severe and tends to be more common in individuals over the age of 60 with a weakened immune system (immunocompromised) and/or with a preexisting disease (e.g., cancer, diabetes, or hypertension). The symptoms of WNV neuroinvasive disease include disorientation, numbness, loss of vision, paralysis and/or coma.

Human cases of WNV are nationally reportable to state health departments and the Centers of Disease Control and Prevention (CDC). Reporting cases to the CDC allows them to detect early signs of WNV outbreaks and provide information and support to state public health agencies. Since WNV occurrence is not easily predicted, case reporting coupled with mosquito surveillance are crucial components of WNV detection.

Medical Testing and Treatment of WNV

There are no specific treatments or human vaccine for WNV infection. Most human cases are treated similarly as the common influenza or flu with bed rest, fluids and over-the-counter medications to reduce fever and manage symptoms. In more severe, neuroinvasive disease cases, hospitalization may be necessary to relieve symptoms. There are serum and spinal fluid tests which can be recommended by your doctor to confirm the diagnosis of WNV.

Control Measures for Mosquitoes

The first and most important step for reducing exposure to mosquitoes is to remove habitats where they lay eggs and develop as larvae. This is achieved by removing or treating stagnant water around the home or business. Stagnant water locations include sewer systems, neglected pools, rain gutters and other areas where water accumulates and is left untreated for two or more weeks. Additional information on sites where mosquitoes develop and different control measures can be found in UT Extension

Publication SP503-B Mosquito Control Around Homes. Control measures that include the use of pesticides will vary according to local and state laws. Always read the product label prior to purchase and use.

Steps to Prevent Culex Mosquito Bites

Since there is no vaccine to prevent WNV cases in humans, it is necessary to prevent mosquito bites which can reduce the potential for transmission of WNV. Prevent mosquitoes from entering the home or business and prevent them from biting you when outside by using protective clothing and repellents.

- Maintain intact screens on windows and doors
- Avoid known areas (e.g., stagnant ponds, sewer openings, rain barrels) where *Culex* mosquitoes are active and when these mosquitoes are actively looking for hosts at night (nocturnal).
- Maintain clean swimming pools and minimize stagnant water by removing it weekly.
- Wear protective clothing such as long-sleeved shirts, long pants and/or clothing which is treated with permethrin when outdoors.
- Use a repellent when working or playing outdoors. Refer to 'Find the Repellent That is Right For You' on the EPA website.

Online Resources and References

Aardema, M. L., Olatunji, S. K., and Fonseca, D. M. 2022. The Enigmatic *Culex pipiens* (Diptera: Culicidae) Species Complex: Phylogenetic Challenges and Opportunities from a Notoriously Tricky Mosquito Group, *Annals of the Entomological Society of America*, Volume 115, Issue 1, Pages 95–104, doi.org/10.1093/aesa/saab038

Centers for Disease Control & Prevention (CDC). 2024. Guidelines for West Nile Virus Surveillance and Control. [cdc.gov/west-nile-virus/php/surveillance-and-control-guidelines/index.html](https://www.cdc.gov/west-nile-virus/php/surveillance-and-control-guidelines/index.html).

Centers for Disease Control & Prevention. 2024. Life Cycle of *Culex* Mosquitoes. [cdc.gov/mosquitoes/about/life-cycle-of-culex-mosquitoes.html](https://www.cdc.gov/mosquitoes/about/life-cycle-of-culex-mosquitoes.html).

Centers for Disease Control & Prevention. 2024. Preventing Mosquito Bites. [cdc.gov/mosquitoes/prevention/index.html](https://www.cdc.gov/mosquitoes/prevention/index.html).

Centers for Disease Control & Prevention. 2024 Transmission of West Nile Virus. [cdc.gov/west-nile-virus/php/transmission/index.html](https://www.cdc.gov/west-nile-virus/php/transmission/index.html).

Centers for Disease Control & Prevention. 2024. West Nile Virus: Historic Data (1999-2023). [cdc.gov/west-nile-virus/data-maps/historic-data.html](https://www.cdc.gov/west-nile-virus/data-maps/historic-data.html).

Centers for Disease Control & Prevention. 2024. West Nile: Symptoms, Diagnosis, and Treatment. [cdc.gov/west-nile-virus/symptoms-diagnosis-treatment/index.html](https://www.cdc.gov/west-nile-virus/symptoms-diagnosis-treatment/index.html).

Foster, W.A. and Walker, E.D. 2009. Mosquitoes (Culicidae). *Medical and Veterinary Entomology*. 14: 207-259.

Habarugira, G., Suen, W. W., Hobson-Peters, J., Hall, R. A., and Bielefeldt-Ohmann, H. 2020. West Nile Virus: An Update on Pathobiology Epidemiology, Diagnostics, Control and “One Health” Implications. *Pathogens*, 9, 589, doi:10.3390/pathogens/9070589.

McDonald E, Mathis S, Martin SW, Staples JE, Fischer M, and Lindsey NP. Surveillance for West Nile Virus Disease — United States, 2009–2018. *MMWR Surveill Summ* 2021;70(No. SS-1):1-15. DOI: <http://dx.doi.org/10.15585/mmwr.ss7001a1>.

National Institute of Allergy and Infectious Diseases (NIAID). 2024. NAID Visual & Medical Arts. Mosquito. NAID BIOART Source. bioart.niaid.nih.gov/bioart/360. (Revised 7 October 2024).

National Institute of Allergy and Infectious Diseases (NIAID). 2024. NAID Visual & Medical Arts. Person Standing. NAID BIOART Source. bioart.niaid.nih.gov/bioart/555. (Revised 7 March 2025).

Peterson, L. R. 2019. Epidemiology of West Nile Virus in the United States: Implications for Arbovirology and Public Health. *Journal of Medical Entomology*, 56 (6), 1456-1462.

Tennessee Department of Health. 2024. Mosquitoes in Tennessee. tn.gov/health/cedep/vector-borne-diseases/mosquito-borne-diseases/mosquitoes-in-tennessee.html.

United States Environmental Protection Agency (EPA). 2024. [Find the Repellent that is Right for you](#)

Vail, K. Gottfreid, K., and Gerhardt, R. 2006. UT Extension Publication SP503-B Mosquito Control Around Homes: tiny.utk.edu/SP503-B

Walter Reed Biosystematics Unit (WRBU). No Date. Mosquito Identification Keys.

Wicks, H., Trout-Fryxell, R.T., and Ivey, J No Date. UT Extension Publication W775: For the Equine Owner: West Nile Virus. tiny.utk.edu/w775

World Health Organization (WHO). 2024. West Nile Virus. [who.int/news-room/fact-sheets/detail/west-nile-virus](https://www.who.int/news-room/fact-sheets/detail/west-nile-virus).

Funding Acknowledgement

This publication was supported by the Centers of Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (HHS) as part of a financial assistance reward, cooperative agreement number NU50CK000637, with 100 percent funded by CDC/HHS. The contents are those of the author(s) and do not necessarily represent the official views of, nor the endorsement, by the CDC/HHS, or the U.S. government.



UTIA.TENNESSEE.EDU

Real. Life. Solutions.™