WEST NILE VIRUS:
WHAT YOU NEED TO KNOW

PennState Extension
Introduction

Q: What is the West Nile virus?
A: The West Nile virus, which can cause encephalitis (an inflammation of the brain), is a mosquito-transmitted virus that is commonly found in humans, birds, and other vertebrates in Africa, Eastern Europe, West Asia, and the Middle East, but had not been documented in the Western Hemisphere before August 1999.

Q: Where did the West Nile virus that was first detected in the New York City area come from?
A: It is not known where the United States virus originated, but it is most closely related, genetically, to strains found in the Middle East.

Q: How did the West Nile virus get into the United States?
A: The most likely explanation is that the virus was introduced by an infected mosquito or bird.

Transmission of the West Nile Virus

Q: What is the basic transmission cycle?
A: Mosquitoes become infected when they take a blood meal from an infected bird. The virus circulates and multiplies in the mosquito’s hemolymph (blood) for several days. The virus then penetrates and infects the mosquito’s salivary glands. After an incubation period of 10–14 days, the infected mosquito can transmit West Nile virus to humans and animals while taking blood meals. When the mosquito feeds, it injects saliva and virus into the animal or human, where the virus multiplies and may cause illness.

Basic Transmission Cycle of the West Nile Virus

The primary West Nile virus transmission cycle is between mosquitoes (especially Culex species) and birds.

Humans, horses, and other mammals are “dead end” hosts, which means they cannot pass the virus on to other biting mosquitoes, thereby ending the transmission cycle.
Q: Can any mosquito transmit West Nile virus?
A: No. Pennsylvania is home to over sixty species of mosquitoes. The mosquito species primarily responsible for vectoring (or transmitting) West Nile virus belong to the genus *Culex*, especially the northern house mosquito (*Culex pipiens*) and the white-spotted mosquito (*Culex restuans*). In addition, some species of mosquitoes, especially from the genera *Aedes* and *Culex*, may contribute to the spread of West Nile virus to a lesser extent. Of the remaining mosquitoes, many do not bite people at all, and the others are incapable of transmitting West Nile virus, though they may vector other pathogens that cause disease.

Q: Do all the mosquitoes that can transmit the West Nile virus actually carry the virus?
A: No. Even in areas where mosquitoes have tested positive for West Nile virus, very few are infected. However, the proportion of mosquitoes in a population that are infected with West Nile virus varies by location, with seasons, and from year to year.

Q: How are mosquitoes tested for West Nile virus?
A: Collected mosquitoes are tested in laboratories. Disease screenings of mosquitoes commonly combine up to 100 mosquitoes per sample and will test positive even if only 1 mosquito in the group contains viral RNA, which indicates West Nile virus is present. This sampling method allows many more mosquitoes to be screened, but the data must be interpreted differently than if mosquitoes were screened individually. The data is used to prioritize where mosquito-control measures should be applied to prevent West Nile virus outbreaks.

Q: Can you get the West Nile virus from ticks or insects other than mosquitoes?
A: Infected mosquitoes are the primary source for West Nile virus transmission. Ticks infected with West Nile virus have been found in Asia and Africa. Their role in the transmission and maintenance of the virus is uncertain.

Q: Can you get the West Nile virus from another person?
A: No. The West Nile virus is not transmitted from person to person. You cannot get West Nile virus from touching, kissing, or caring for a person who has the disease, or from a health care worker who has treated someone with the disease.

Q: Can you get the West Nile virus directly from birds?
A: There is no evidence that a person can get the virus from handling live or dead infected birds. However, avoid bare-handed contact when handling dead animals, including dead birds, because they may carry other pathogens or parasites that could spread through contact. Use gloves or double plastic bags to place the carcass in a garbage can.

Q: Is the disease seasonal in its occurrence?
A: In temperate climates, West Nile encephalitis cases occur primarily in hot weather during the late summer or early fall. The risk for infection ends when sustained freezing temperatures occur and mosquito activity ceases for the season. In warmer climates, where mosquitoes are active all year, the West Nile virus can be transmitted year-round.

Q: Are there any means other than mosquito transmission by which West Nile virus may be transmitted to humans?
A: The CDC has confirmed West Nile virus transmission through blood transfusions and organ transplants. There is documentation of transplacental (mother-to-child) transmission of West Nile virus in humans during pregnancy and delivery and transmission through breast feeding. Finally, a few transmissions have also occurred from accidents in a laboratory setting, which are described later.

Q: What are the risks of these other transmission methods?
A: Although persons needing blood transfusions or organ transplants need to be aware of the risk for West Nile virus infection, the benefits of receiving needed transfusions or transplants greatly outweigh the potential risk for West Nile virus infection. All donated blood is now screened for West Nile virus to minimize risk. Also, the above-mentioned transmission incidents represent a very small proportion of the total number of West Nile virus human cases. Remember, the vast majority of West Nile virus infection in humans occurs through the bite of a West Nile virus infected mosquito.

**Spread of the West Nile Virus**

Q: Where was the West Nile virus first detected in the United States?
A: The 1999 outbreak of West Nile virus occurred primarily in the New York City metropolitan area.
Q: How quickly did the West Nile virus spread across the United States?
A: The West Nile virus spread across the United States in just four years. In 1999, the West Nile virus was detected in four states: New York, New Jersey, Connecticut, and Maryland (62 cases, 7 deaths); in 2000, West Nile virus was in twelve Northeast and Mid-Atlantic states (including Pennsylvania) and Washington, D.C. (21 human cases, 7 deaths); in 2001, West Nile virus was in twenty-seven states and included states in the Southeast and Midwest (66 cases, 10 deaths); and by 2002, West Nile virus was detected in forty-four states and had reached the West Coast (4,156 cases, 284 deaths).

Q: Where and how many human infections of West Nile virus have occurred in the United States?
A: Human infections of West Nile virus were first identified in New York in 1999 and spread to forty states by 2002 and to forty-five states by 2003. After the initial spread of the virus, the number of cases across the United States have varied tremendously, from a high of 9,862 human cases in 2003 to a low of 712 human cases in 2011. From 1999 to 2020, a total of 52,532 human infections have been confirmed. In recent years, human infections of West Nile virus per 100,000 people are highest in the following states: Arizona, California, Colorado, Illinois, Louisiana, Nebraska, North Dakota, South Dakota, and Texas.

Q: Where and how many human infections of West Nile virus have occurred in Pennsylvania?
A: From 1999 to 2020, Pennsylvania has had 707 confirmed infections of West Nile virus, with 464 of those causing West Nile encephalitis. The specific distribution of cases varies from year to year, but most commonly affects the central, southeastern, and southwestern portions of the state, with the northern and south-central portions less frequently reporting cases.

Q: If I live in an area where birds or mosquitoes with the West Nile virus have been reported, and I am bitten by a mosquito, am I likely to get sick?
A: No. Even in areas where mosquitoes do carry the virus, very few mosquitoes are infected. The chances that any one bite will be from an infected mosquito are very small. In addition, only about 20 percent of people who become infected with the West Nile virus from a mosquito bite will develop West Nile fever and less than 1 percent will develop West Nile encephalitis.

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Health Information about West Nile Encephalitis

Q: What is the difference between West Nile encephalitis, West Nile fever, and West Nile virus?
A: West Nile encephalitis and West Nile fever both refer to disease (a combination of symptoms) that humans can experience, while West Nile virus refers to the virus that causes them.

Q: What is encephalitis?
A: Encephalitis is an inflammation of the brain that can be caused by head injury, bacterial infections, or most commonly, viral infections.

Q: What are the symptoms of West Nile encephalitis and West Nile fever?
A: The majority of human infections with West Nile virus are thought to be asymptomatic, meaning an infection with no symptoms. Approximately 20 percent of West Nile virus infections result in West Nile fever, a mild disease with symptoms including fever, headache, body aches, mild skin rash, and/or swollen lymph glands. Less than 1 percent of infections cause West Nile encephalitis, the severe form of the disease with symptoms including headache, high fever, stiff neck, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and occasionally, death. West Nile fever has a less than 1 percent death rate, while West Nile encephalitis has a 9 percent death rate.

Q: What is the incubation period in humans for West Nile virus?
A: The incubation period of West Nile virus infection is usually 3–15 days.

Q: How is West Nile encephalitis treated?
A: There is no specific treatment, medication, or cure, but the symptoms and complications of the disease can be treated. More severe cases may require intensive supportive therapy, such as hospitalization, intravenous (IV) fluids, airway management, ventilatory support, and prevention of secondary infections, such as pneumonia. Some effects to the central nervous system might be permanent. West Nile fever typically does not require treatment.

Q: Is there a vaccine for humans against West Nile virus?
A: No. Although much research and even early clinical testing has been done, no human vaccines against West Nile virus are available as of May 2022.
Q: Who is at risk of developing West Nile encephalitis?
A: All residents of areas where virus activity has been identified are at risk of getting West Nile encephalitis. People over 50 years of age and immunocompromised individuals have the highest risk of severe illness.

Q: What should be done if you think you have West Nile encephalitis?
A: See a doctor immediately if you develop symptoms such as high fever, confusion, muscle weakness, and severe headaches. Patients with mild symptoms should recover completely and do not require specific medication or laboratory testing.

Q: Are people who tested positive still at risk from future infections of West Nile virus?
A: Probably not. After being infected with West Nile virus, a person’s immune system “learns” the virus and becomes more effective at fighting it, and this acquired immunity is thought to last for life. However, weakening of the immune system due to aging or other health conditions may decrease acquired immunity over time. Scientists may yet discover more nuances to the long-term epidemiology of West Nile virus as more research is conducted in the future.

Effects of the West Nile Virus on Animals

Q: Do wild birds infected with the West Nile virus die or become ill?
A: Although this has not been previously reported in nature, beginning with the 1999 New York epidemic, more than 20 exotic birds died at the Bronx Zoo and a large die-off of American crows was confirmed. To date, more than 250 species of birds have been found with West Nile virus. Members of the crow family (Corvidae), which include crows, ravens, jays, and magpies, are typically affected the most. The Pennsylvania Game Commission has reported a correlation between high West Nile virus prevalence and low ruffed grouse populations, suggesting that the virus may have population-level effects on grouse. Autopsied hawks and owls have also tested positive for West Nile virus, though it is unclear if West Nile virus was the cause of death or if it negatively affects their populations.

Q: Can birds transmit the West Nile virus to other birds?
A: Yes, though the role of direct bird-to-bird transmission without a mosquito vector is likely to be minor compared to mosquito-to-bird transmission. Experiments testing for direct transmission have examined at least twenty-four species of birds across fifteen families, and direct transmission has been found in members of the families Corvidae (crows, ravens, and jays) and Laridae (gulls), as well as in common goose, chicken, and red-legged partridge. Fecal-oral, oral-oral, or skin and feather picking are probably the main routes of bird-to-bird transmission.

Q: How do dogs, cats, and horses become infected with West Nile virus?
A: From the bite of infectious mosquitoes, the same way humans become infected. During blood feeding, the virus is injected into the blood stream of the animal with the mosquito’s saliva. The virus then multiplies and may cause illness. Some other transmission mechanisms have been discovered but are unlikely to be as significant as mosquito-to-animal transmission. Cats have been experimentally shown to contract West Nile virus after feeding on infected mice. Several predatory or scavenging birds, including a variety of owls, falcons, and members of the crow family, can contract West Nile virus from feeding on infected mice or sparrows.

Q: Can the West Nile virus cause illness in dogs or cats?
A: Yes, but only rarely. Serosurveys of dogs conducted in different West Nile virus-affected regions of the world have found infection rates ranging from 5–37 percent; despite this high prevalence of infection, only two case studies of dogs becoming severely sick from West Nile virus have been reported. Similar serosurveys of cats revealed similar results, though reports of illness in cats are lacking.

Q: Have horses gotten ill or died from West Nile encephalitis?
A: Yes. Between 1999 and 2021, almost 28,900 U.S. horses have been confirmed with West Nile encephalitis, with 33–35 percent of those horses dying from the infection and 40 percent that survive acute illness may still exhibit residual effects 6-months post-diagnosis. However, from 2012 to 2021, the total number of horse infections reported significantly decreased to under 3,000 horses.
Q: Can infected dogs, cats, and horses carry and transmit West Nile virus to humans?
A: West Nile virus is transmitted by infectious mosquitoes. There are only a few examples of direct animal-to-person transmissions that occurred in laboratory or veterinary settings where people were directly exposed to infected animal brains and nerves. Of these few examples, most involved accidental needle sticks or scalpel cuts with contaminated equipment. Veterinarians should take normal infection-control precautions when caring for an animal suspected to have West Nile or any viral infection.

Q: Can a horse infected with West Nile virus infect horses in neighboring stalls?
A: No. There is no documented evidence that the West Nile virus is transmitted from horse to horse.

Q: My horse is vaccinated against eastern equine encephalitis (EEE), western equine encephalitis (WEE), and Venezuelan equine encephalitis (VEE). Will these vaccines protect my horse against infection by the West Nile virus?
A: No. EEE, WEE, and VEE belong to another family of viruses for which there is no cross-protection.

Q: Does a vaccine for horses against West Nile virus exist?
A: Yes. Several vaccines are available and have been shown to effectively reduce the risk of horses developing severe illness if they contract West Nile virus, though the vaccines do not prevent horses from contracting West Nile virus. Owners should keep records of the vaccination because current testing methods cannot distinguish between vaccinated and infected horses. This may affect international shipping of horses. Although vaccines for West Nile virus are available, mosquito control is still important.

Mosquito Breeding Sites

1. Storm drains 5. Leaky faucets and standing water
2. Clogged roof gutters 6. Garden ponds
3. Window wells 7. Swimming pools and covers
4. Uncovered containers 8. Tires and wheelbarrows
9. Birdbaths and children’s toys
Q: How long can a dog, cat, or horse be infected with West Nile virus?
A: Limited experimental data suggest that dogs, cats, and horses typically remain infected for a few days to about a week.

Q: Should a dog, cat, or horse infected with the West Nile virus be destroyed or treated?
A: No. There is no reason to destroy an animal just because it has been infected with the West Nile virus. Full recovery from the infection is likely for dogs and cats, and data suggest that most horses recover from the infection. Treatment should be consistent with standard veterinary practices for animals infected with a viral agent.

Q: Besides birds and horses, what other animal species have been infected with West Nile virus?
A: Many wild species, as well as zoo animals, have tested positive for West Nile virus, including alligators, bats, black bears, cats, cattle, chipmunks, dogs, harbor seals, mountain goats, llamas, reindeer, sheep, squirrels, skunks, and wolves.

Q: Are wild game hunters at risk for West Nile virus infection?
A: The primary risk facing wild game hunters is exposure to mosquitoes while hunting. Based on a limited number of cases of lab workers or veterinarians contracting West Nile virus while working with infected animals, it is hypothetically possible—but very unlikely—for a game hunter to contract West Nile virus while handling or cleaning animals.

Q: What should wild game hunters do to protect themselves against West Nile virus infection?
A: A hunter should follow the usual precautions when handling wild animals. If you anticipate being exposed to mosquitoes, apply insect repellents to clothing and skin, according to label instructions, to prevent mosquito bites. Wear gloves when handling and cleaning animals to prevent blood exposure to bare hands. Wash hands thoroughly with soap and water after handling animals or their parts. Cook meat thoroughly.

Mosquito Pest Management and Control

Q: How can I reduce the number of mosquitoes around my home and neighborhood?
A: You can reduce the number of mosquitoes around your home and neighborhood in a number of ways that eliminate breeding or resting sites or kill mosquitoes in various life stages. Here are some simple steps you can take:

- Dispose of any refuse that can hold water, such as cans and containers, that has collected on your property. Do not overlook containers that have become overgrown by aquatic vegetation.
- Pay special attention to discarded tires that may have collected on your property. Tires have become the most important mosquito breeding sites in the country.
- Drill holes in the bottom of recycled containers that are left outdoors. Containers with drainage holes on the sides can still collect enough water for mosquitoes to breed.
- Clean clogged roof gutters every year, particularly if leaves from surrounding trees tend to plug the drains. Roof gutters are easily overlooked, but they can produce millions of mosquitoes each season.
- Empty accumulated water from wheelbarrows, boats, cargo trailers, toys, and ceramic pots. If possible, turn them over when not using them.
- Turn over plastic wading pools when not in use. Check storm drains, leaky faucets, and window wells.
- Do not allow water to stagnate in bird baths, ornamental pools, water gardens, and swimming pools or their covers. Ornamental pools can be aerated or stocked with fish. Water gardens are fashionable but become major mosquito producers if allowed to stagnate.
- Clean and chlorinate swimming pools that are not being used. A swimming pool left unattended for several weeks can produce enough mosquitoes to result in neighborhood-wide complaints. Mosquitoes may even breed in water that collects on swimming pool covers.
- Alter the landscape of your property to eliminate standing water. During warm weather, mosquitoes will breed in any puddle of water.
• Trim bushes and shrubs so that wind and sunlight can penetrate the canopy, making them unappealing as resting sites.
• Work with a licensed pest management professional or vector control agency to more thoroughly manage mosquitoes, including placing traps and/or applying insecticides to kill larvae or adults, if the above methods are insufficient.

Q: Can I encourage mosquito predators on my property to reduce mosquito populations?

A: Probably not. There is no evidence that birds or bats can consume enough mosquitoes to provide a detectable change in their populations, so installing bird houses or bat houses to attract these insect-eaters will not reduce mosquito populations. The most effective mosquito predators feed on their larvae, and include aquatic bugs, diving beetles, dragonflies and damselflies, and fish. These insect predators freely fly between bodies of water, making them beneficial but uncontrollable, unpredictable, and unreliable. Small, insect-eating fish may be stocked into ornamental ponds or water gardens to prevent these isolated water bodies from becoming sources of mosquitoes, but regulations from the Pennsylvania Fish and Boat Commission prevent stocking fish into “waters of the state.”

Q: What can I do to reduce my risk of being bitten by a mosquito?

• Stay indoors at dawn, dusk, and in the early evening when mosquitoes are most active.
• Make sure window and door screens are “bug-tight.”
• Use the proper type of lighting outside: incandescent lights attract mosquitoes, while florescent lights neither attract nor repel them.
• Wear long-sleeved shirts and long pants if you must go outdoors. Also, wear headnets when venturing into areas with high mosquito populations.
• Mosquitoes are repelled by high winds, so electric fans may provide some relief at outdoor events.
• Insect repellents can be used on your skin and clothing. Read and follow all the directions for use on the product label before applying.
• Vitamin B and “ultrasonic” devices have not been proven effective in preventing mosquito bites.

Q: Are DEET insect repellents safe for everyone?

A: DEET products have a remarkable safety record when used according to the product label. For most adults, products containing 10–35 percent DEET (N,N-diethyl-meta-toluamide) will provide adequate protection under most conditions. Generally, the higher the concentration of DEET, the longer lasting the protection. For children, the American Academy of Pediatrics has indicated that products containing DEET with a concentration of 10–30 percent are appropriate.

Q: Should I consider insect repellents other than DEET?

A: DEET has shown an excellent safety record and is the standard against which other repellents are compared, but some people find its oily texture, smell, or potential reactivity with plastics problematic. Several other repellent active ingredients have been shown to provide comparable protection to DEET, including Picaridin (also known as KBR 3023), Oil of Lemon Eucalyptus (OLE), p-menthane 3,8-diol (PMD, a synthetic form of OLE), IR3535 (also known as ethyl butylacetylaminopropionate), and 2-undecanone. Be sure to select repellents that are registered with the EPA, and always follow product label instructions. The EPA has an online tool to help find the best repellent to fit your needs at www.epa.gov/insect-repellents/find-repellent-right-you.

Q: How do you safely apply insect repellents?

• Apply insect repellent sparingly to exposed skin and clothing. Do not saturate the skin or apply beneath clothing. To apply to your face or a child, first dispense or spray it onto your palms and rub your hands together. Then apply a thin layer to your face or to your child’s skin.
• Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands of children. According to the American Academy of Pediatrics (AAP), insect repellents should not be used on infants under two months of age. Other guidelines recommend not using insect repellents until children are two years of age.
• Whenever you use an insecticide or insect repellent, be sure to read and follow the directions for use on the product label before applying.
• Once indoors, wash all treated skin and clothing with soap and water.
• For more detailed information on insect repellents and how to use them, see the Penn State Extension publication Using Insect and Tick Repellents Safely.
What Steps Are Being Taken to Monitor the West Nile Virus?

Q: How is West Nile virus monitored?
A: Several techniques are often used together to monitor for West Nile virus. These include sampling mosquitoes and testing them for the presence of West Nile virus, deploying sentinel chickens and periodically checking them for West Nile virus, sampling wild bird populations for West Nile virus, and sampling sick or dead wild birds, as well as horses and humans, for West Nile virus.

Q: What is being done at the federal level?
A: U.S. Geological Survey researchers are coordinating with the CDC, state health officials, and the U.S. Fish and Wildlife Service to conduct field investigations. They also are requesting the assistance of natural resource and conservation managers and local public health officials in a joint national surveillance effort to document crow mortality. West Nile virus is a nationally notifiable condition, so physicians report cases to their state departments of health, who in turn report data to the CDC.

Q: What is Pennsylvania doing to manage the West Nile virus?
A: The Pennsylvania Departments of Health, Environmental Protection, and Agriculture developed a comprehensive surveillance program to help detect, track, and control the West Nile virus. The plan is based on integrated pest management (IPM) principles and focuses on education, habitat reduction, surveillance, and—if the surveillance program determines a risk—the control of mosquitoes. In addition, other state agencies, local governments, health professionals, and the public have contributed to implementing this plan since its inception.

Q: What role does the public have in this surveillance program?
A: Most of the birds submitted for testing have been reported to state officials by the public. When you find a dead or dying bird, in particular corvids (crows, ravens, and jays) and raptors (eagles, falcons, hawks, and owls), report it online at the West Nile Virus Control Program website at gis.dep.pa.gov/wnv (look under WNV and birds).

Q: Why do some states have a mosquito-control program?
A: Mosquito-borne diseases affect millions of people worldwide each year. Some can transmit diseases such as encephalitis, dengue fever, and malaria to humans. The United States has at least 150 species of mosquitoes. To combat mosquitoes and the nuisance and potential public health hazards they present, many states and localities have established mosquito-control programs. These programs can include ground and aerial application of pesticides along with nonchemical forms of control and prevention.

Pesticides Used for Mosquito Control

Q: How does the Environmental Protection Agency (EPA) ensure the safest possible use of pesticides?
A: It is a priority of the EPA to protect human health and the environment and to provide support to states dealing with serious outbreaks of infectious diseases from mosquitoes. The EPA helps to ensure that states and localities use the proper pesticide application methods to reduce human exposure. The EPA must evaluate and register pesticides before they may be used, sold, or distributed in the United States. To evaluate a pesticide registration application, the EPA assesses a wide variety of potential human health and environmental effects associated with use of the product. The producer of the pesticide must provide data from tests done according to EPA guidelines. These tests must determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish, and plants, including endangered species and nontarget organisms, as well as possible contamination of surface water or groundwater from leaching, runoff, and spray drift. If a pesticide meets EPA’s registration requirements that ensures it can be used effectively without causing unreasonable risks to human health and the environment when used according to label directions, the label of the pesticide is approved by EPA and the product can be registered and brought to market. However, no pesticide is 100 percent safe, and care must be exercised in the use of any pesticide.

Q: What insecticides for mosquito control are available for state and local authorities to use?
A: Two types of insecticides are used, which target either mosquito adults or mosquito larvae.

Mosquito Adulticides
Mosquito adulticides may be applied in three different forms: ultra-low-volume fogs, barrier mists or sprays, and attractive toxic sugar baits. Ultra-low-volume fogs may use organophosphate active ingredients such as malathion or naled, or
pyrethroid active ingredients such as sumithrin or resmethrin. These pesticides affect the nervous system and kill mosquitoes when tiny airborne droplets land on the mosquitoes' bodies. Ultra-low-volume fogs have no residual effect and break down within minutes or hours of application, so they are typically applied in the early morning or evening when mosquitoes are most active. The active ingredients of these products are applied in very small quantities, and vertebrates (including humans) are generally capable of breaking them down or excreting them quickly. However, ultra-low-volume treatments will also affect non-target insects that are actively flying, so plan these applications at dawn or dusk to reduce the harm to pollinators as they tend to be less active at these times.

Barrier mists or sprays use pyrethroid active ingredients such as bifenthrin or lambda-cyhalothrin. They are applied to areas where mosquitoes rest, including the undersides of leaves in dense vegetation and other areas that are dark, cool, humid, and out of the wind such as the undersides of porches or decks. The insecticides have residual activity and are absorbed through the mosquito's tarsi (feet) when it lands on a treated surface, killing the mosquito. Depending on the pesticide product and environmental conditions, barrier treatments may remain effective for one to two months. Barrier treatments generally pose very little risk to humans after the product has dried completely. Mosquito barrier treatments will also affect non-target insects that land or crawl on treated surfaces as well as mosquitoes.

Attractive toxic sugar baits are a relatively new type of pesticide available to manage adult mosquitoes. They include a sugar attractant that is eaten, and the active ingredient is based on garlic oil. The mechanisms are unclear, but attractive toxic sugar baits are much more attractive to mosquitoes than to non-target, sugar-feeding insects. The baits are sprayed onto vegetation, either in a continuous band or in baiting patches around the perimeter of a property to be protected. Attractive toxic sugar baits are slower-acting than ultra-low-volume fogs or barrier mists. However, their increased safety makes them appropriate for use when mosquito populations are low to moderate but rising or when environmental conditions such as flooding make a future mosquito outbreak likely.

Mosquito Larvicides
Several types of insecticide classes are used to kill mosquito larvae or prevent their development. These are applied to water where mosquito larvae develop, and may be applied from helicopters, from trucks, by hand, or through autodissemination traps. Because they are applied to water, they are not expected to have significant direct impacts to land animals (including humans). Some mosquito larvicides are somewhat specific, while others have broad-spectrum activity.

Temephos, an organophosphate active ingredient, is used to control mosquito larvae. Temephos is applied most commonly by helicopters. This chemical breaks down within a few days in water, and post-application exposure is minimal.

Insect-growth regulators include methoprene, hydroprene, and pyriproxyfen, and they cause mosquito larvae to die before maturing into adults. When used according to label directions, they do not pose unreasonable risks to human health. The toxicity of insect-growth regulators to birds and fish is low. Depending on the active ingredient and formulation, insect-growth regulators may break down quickly or remain effective for months after application. Insect-growth regulators tend to have broad-spectrum activity against a wide range of insects, but little toxicity to other types of animals. Insect-growth regulators may be directly applied to mosquito-breeding sites or distributed through autodissemination traps, which contaminate egg-laying mosquitoes with enough insect-growth regulator that the mosquitoes effectively treat small, hard-to-access breeding sites such as tree holes.

Bacillus sphaericus and Bacillus thuringiensis israeliensis are biological active ingredients used for mosquito larvicide control in water. When the larvae eat them, the mosquitoes die. Bacillus sphaericus and Bacillus thuringiensis israeliensis are naturally occurring bacteria and have low toxicity to humans. Both are effective against insects in the order Diptera (true flies), and applications to manage mosquitoes may harm populations of midges, which are important food sources to a variety of insect-eating amphibians, birds, fish, and reptiles. Bacillus products break down fairly quickly in the environment and may break down faster or be diluted by bacteria and decomposing organic matter in the treatment area.

Spinosad is also a biological pesticide derived from bacteria, though it affects the nervous system. It has broad-spectrum activity against insects but low toxicity to vertebrates. Spinosad tends to have comparable residual activity to Bacillus products but is not as sensitive to bacteria and decomposing organic matter in the treatment area.

Oils are used to form a coating on top of water, and monomolecular films are used to spread a thin film on the surface of water. Both drowned larvae, pupae, and emerging adult mosquitoes. Oils are specially derived from petroleum distillates and have been used to kill aphids on crops and orchard trees. Oils and monomolecular films do not pose a risk to human health. If misapplied, oils may be toxic to fish and other aquatic organisms. Monomolecular films pose minimal risks to most non-target organisms. However,
oils and monomolecular films both can drown other air-breathing aquatic insects such as diving beetles and backswimmers, which are among the most effective predators of mosquito larvae.

Q: What should I do to reduce exposure to pesticides during mosquito-control spraying?
A: EPA recommends commonsense steps to help reduce possible exposure to pesticides during spraying:

- Look for notices about pesticide applications in the newspapers, listen for radio and TV announcements, and follow local social media accounts.
- Whenever possible, remain indoors with the windows closed and air conditioning turned off when pesticide applications are taking place.
- If you must stay outdoors, avoid eye contact with the pesticide. If you get pesticide in your eyes, immediately rinse them with water or eye drops and call the Poison Center at 1-800-222-1222 for additional instructions and information.
- Your child's health should not be affected by the low levels of pesticides used in mosquito control. However, you should still bring laundry and toys indoors before a pesticide application begins and wash items exposed to pesticides with soap and water.
- Bring your pets indoors and cover ornamental fish ponds to avoid direct exposure.
- Cover outdoor tables and play equipment or rinse them off with water after a pesticide application is finished.
- Cover swimming pool surfaces when feasible; however, given the small concentrations of pesticides used, special precautions or waiting periods usually are not necessary for outdoor swimming pools.
- Wash exposed skin surfaces with soap and water if you come in contact with pesticides.
- Wash any exposed fruits and vegetables, such as homegrown products or those purchased from an outside vendor, with water before storing, cooking, or eating them.
- There is no need to relocate during mosquito pesticide applications but consult your physician if you have serious physical or psychological concerns.
- If you think pesticides are making you sick, call the National Pesticide Information Center toll-free at 800-858-7378.

For More Information

Q: Where can I get more information?
A: The following is a list of West Nile encephalitis websites and phone numbers.

- American Academy of Pediatrics
  www.aap.org and healthychildren.org
- Centers for Disease Control and Prevention
  www.cdc.gov/westnile
- Animal and Plant Health Inspection Service, U. S. Department of Agriculture
- Pennsylvania's West Nile Virus Control Program
  gis.dep.pa.gov/wnv
- U.S. Environmental Protection Agency
  www.epa.gov/mosquitocontrol
- National Pesticide Information Center
  npic.orst.edu/pest/mosquito/wnv.html
  Call toll-free (800-858-7378) for information about the toxicity of pesticides
- National Wildlife Health Center, United States Geological Survey
  www.usgs.gov/centers/nwhc

References

In addition to the websites listed above, information for this fact sheet was taken from:


This publication was prepared on the recommendation of the West Nile Virus Coordinating Committee at Penn State. Development of this fact sheet was supported in part by a contract from the Pennsylvania Department of Agriculture to the Penn State Pesticide Education Program.