

Mosquitoes and Seasons

By: Phoebe Prince

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Mosquitoes are considered a nuisance by most people, but did you know they are the deadliest animal in the world? Mosquitoes are the vectors for diseases like Malaria, Dengue Fever, and West Nile Virus. It is important to understand the life cycle and habits of mosquitoes to reduce mosquito populations and reduce the risk for vector-borne diseases that mosquitoes can carry.

In the eastern United States in North America and specifically, Beaver County Pennsylvania, the temperate climate determines the mosquito species found in an area and their life cycles. Köppen climate types describes Beaver County as a mild temperate climate (Cfa) and is defined as, "Warm temperate fully humid with hot summer (Cfa): A climate where the coldest month is warmer than -3°C (27°F) but colder than $+18^{\circ}\text{C}$ (64°F) and precipitation is generally the same throughout the year. This climate is usually found inland in the interior of continents or on their east coast, usually between 25° and 35° latitude." (Arnfield, 2023)

Climate affects the length of active mosquito populations and the potential for mosquito-borne diseases in our area. Mosquito life cycles in our area are seasonal and to best understand mosquito viability is to review mosquito behavior during each season.

1. Winter. (December, January, and February)
2. Spring. (March, April, and May)
3. Summer. (June, July, and August)
4. Fall. (September, October, and November)

1. WINTER.

Winter in Beaver County has average temperatures between 19.8°F and 32.5°F and an average snowfall of 22 inches a year. Mosquitoes in Beaver County can overwinter as adults, larvae, and eggs. Over 60 species of mosquitoes can be found in Pennsylvania and a few of the most common in Beaver County are *Culex pipiens* and *Culex restuans*.



Culex pipiens

Culex pipiens aka. the common house mosquito is one of the most established mosquitoes in Pennsylvania and is a vector for West Nile Virus. They are medium in size (4-10 mm) and brown in coloration and are most active during dawn and dusk. They are found in urban areas and are sometimes found in homes looking for a bloodmeal. *Culex pipiens* likes to lay eggs in stagnant water from organic water to polluted water and can be found wherever water is left standing for extended periods of time. During the summer months mosquitoes can develop from egg to adult in 7-10 days.



Culex restuans
Courtesy of Walter Reed Biosystematics Unit

Culex restuans is another vector of West Nile Virus. They are very similar to *Culex pipiens* and are medium in size (4-10 mm) and brown in color. They are sometimes referred to as the “white dotted mosquito” because of white dots found on the scutum (section on the thorax) but this isn’t always reliably identifiable. They lay eggs in stagnant water from organic water to polluted water but not as likely in polluted water as *Cx. pipiens*.

Since *Culex spp.* are vectors of West Nile Virus, they are a concern in our area. In winter, *Culex spp.* mosquitoes overwinter as adults. They can survive the cold temperatures by a process called “diapause”. Diapause is described in Oxford Languages as “a period of suspended development in an insect, other invertebrate, or mammal embryo, especially during unfavorable environmental conditions.”

Most male mosquitoes do not survive during the winter. Male mosquitoes do not bite us, they only feed on nectar and usually have a lifespan of 10-15 days. Female *Culex* mosquitoes need to take a blood meal to lay their eggs. As winter approaches, female mosquitoes can take blood meals but mostly feed on sugars from nectar to sustain nourishment to overwinter. During diapause, a mosquito’s metabolism slows, and they don’t grow or reproduce.

Some researchers believe that for mosquitoes to enter diapause, they must be a certain age and a certain size. The mosquito develops a layer of fat under the skin to help them survive the winter, as they don’t eat or drink during diapause. As winter approaches and weather conditions change, diapause can be triggered by factors such as, the length of daylight, and lower temperatures. The adult *Culex* find cryptic protected spaces that maintain a constant average temperature and can be found in manmade structures like basements, garages, wells, and cisterns. They can also overwinter in crevices, and tree holes in nature. Mosquitoes can survive temperatures below freezing (32 degrees Fahrenheit) but it is more likely that once we have a “killing frost” (temperatures below freezing) that it reduces mosquito activity and reproduction until temperatures return to above 50 degrees Fahrenheit consistently the next spring season. Some mosquitoes are able to diapause by producing a protein that prevents their cells from crystallizing during long freezing temperatures of winter. These mosquitoes find cryptic places like wells, basements, and garages and cling to the walls and ceilings. They use a technique referred to as a “hibernation squat” that was defined by J. Turner Brakeley in 1901 where they fold onto their legs and “squat” to stay close to the surface and protected during the diapause period.

Other species of mosquitoes can overwinter as eggs. *Aedes* species of mosquitoes can overwinter as eggs in mud and only continue the life cycle when the area is flooded, and larval emergence occurs after rainfall raises the water level. The eggs can survive desiccation and may require several submersions

before hatching (Hawley, 1988). Another means of eggs overwintering is by the female mosquito laying eggs in water before the water freezes. The eggs can then diapause and can even withstand being frozen for an extended time until the temperatures increase, and optimal conditions revitalize the eggs to hatch and resume the life cycle to become adult mosquitoes.

There is even a species of mosquito that can overwinter as larvae. *Coquillettidia perturbans* is a mosquito species that prefers wetlands and can remain submerged during the entire larval development. They obtain oxygen by piercing the stems of submerged vegetation and utilizing the air tubes in the vegetation.

2. SPRING.

Beaver County can get 38 inches of rain, on average, per year. The average temperatures vary from 36.9°F in February to 71.2°F in May. Temperatures and rainfall vary from year to year but the spring season, usually April, sees the beginning of larval breeding in Beaver County. Unused containers and areas of standing water on properties that hold stagnant, organic water are prime breeding areas for mosquitoes. Once the temperatures rise above 50°F for an extended period, diapause ends and mosquitoes become active once again.

Understanding mosquito life cycles helps to eliminate mosquito habitat and reduce mosquito populations. There are 4 stages in the life cycle of mosquitoes: egg, larval, pupal, and adult.

Eggs are the first stage in the life cycle. In the springtime when mosquitoes resume their activity, they are ready to take a bloodmeal and produce eggs. Female *Culex pipiens* mosquitoes mate in the fall before diapause. Only female mosquitoes bite hosts like birds, mammals, and humans. Female mosquitoes must take a bloodmeal for proteins vital in the production of eggs. Life cycles vary with different species of mosquitoes. Some species, like *Ochlerotatus sticticus*, are univoltine which means they only have one brood of offspring a year. *Ochlerotatus sticticus* is a floodwater mosquito and overwinters in egg form. This species is an aggressive biting species and will usually hatch after a flood event, which makes them a large nuisance problem when they hatch. Other species, like *Culex pipiens*, are multivoltine and have multiple broods of offspring throughout the year. These species also lay eggs differently. *Ochlerotatus sticticus* lay single eggs on damp ground which can dry out and hatch after submersion in flood waters. While *Culex pipiens* lay eggs in a “raft” which consists of hundreds of eggs together in an oval formation that float on the water.



Culex pipiens laying eggs as egg raft.



Close up of 2 egg rafts.



Close up of individual eggs of *Aedes sp.*
(Courtesy of CDC)

Culex spp. will find stagnant organic or polluted water to lay their eggs, mosquito eggs require water to hatch. *Culex spp.* lay egg rafts on the surface of the water (one egg raft can contain between 100 to 300 eggs and each egg is approximately ¼ inch long and 1/8 inch wide). The egg raft appears whitish in color when first laid but turn a dark brown color after laying on the water. It takes eggs approximately 24 to 48 hours to hatch into larvae.

Larval (larvae) is the second stage in the life cycle. There are four stages of larval growth called “instars” and it takes approximately a week for larvae to molt through the four stages to become a pupa (depending on the temperature of the water). 1st Instar are the first to emerge and can be as small as 1/8 inch long. 2nd and 3rd instar each grow and molt until they reach the 4th instar. Larvae eat microorganisms in the water and filter the food through fan-like mouth brushes until they reach the 4th instar. Larvae are sometimes referred to as “wigglers” because they move and wriggle when they sense movement. Larvae need to come to the surface of the water to breathe and have air siphons located on their body to be able to breathe. The 4th instar is the largest larvae, approximately ½ inch in length, and stop eating at this stage. At this stage the larvae molt into pupae.

The third stage is the pupal stage. Pupae do not eat but they do breathe through “trumpets” located on their head. They are sometimes referred to as “tumblers” because they come to the surface to breathe and then tumble back down in the water. It usually takes 1-4 days for pupae to molt into an adult.

The fourth stage in the life cycle is the adult stage. The adult will sit on the water until its wings dry and its body hardens, and it is able to take flight.



Mosquito Larvae (magnified)



Mosquito Pupae (magnified)



Adult mosquito

3. SUMMER

The summer months in Beaver County have an average temperature of 78° F in June to 81° F in August with an average rainfall of approximately 3 inches. Female mosquitoes take a blood meal after she mates with a male mosquito. Multivoltine species of mosquitoes can lay eggs many times throughout the year and have several generations of offspring. Female mosquitoes usually only mate once in their lifetime but can then lay eggs throughout the year. Whereas males can breed throughout their lifetime. Mosquitoes breed by a technique called a “mating swarm”. Male mosquitoes will form swarms and generations of the same species swarm at the same place every year and usually swarm around dusk.

The swarm is made mostly of males with only a few females entering the swarm at a time. It is not clear how the females find the swarm, but it is thought they use several cues like visual and olfactory cues, and sense pheromones released by males. In many species, male mosquitoes can mate a few days after becoming an adult while female mosquitoes can mate after they have emerged from the pupal stage.

Mosquitoes sense sound through their antennae. The crucial part of the mating swarm is for the male to be able to hear when a female has entered the swarm. Males can mate with females by varying the

speed of their wing beats. When we hear the buzz of a mosquito, we hear their wing beats. Each species of mosquito has a different frequency to their wing beats, males from 500 to 1,000 wing beats per second and females 300 to 600 wing beats per second. *Culex pipiens* male mosquitoes beat their wings approximately 500 times a second and females 280 times a second. Once the female enters the swarm, males will seek them out by adjusting their wing beat frequency to match the female, this process is called “harmonic convergence”. Once the female selects the male, they will mate. Most females will only mate once in their lifetime. Mating only lasts a few seconds; males have a pincer like apparatus on their abdomen where they seize the female and insert the reproductive organ known as “aedeagus”. The female gains proteins from mating which is thought to initiate the female to seek out a bloodmeal for egg production. Once the female has mated, she will seek out a bloodmeal. Different species of mosquitoes prefer different hosts for a bloodmeal, there is a species of mosquito (*Culex territans*) that even feeds on reptiles and amphibians. *Culex pipiens* prefers birds and mammals (including humans) which makes it a vector of West Nile Virus. After taking a bloodmeal, the female mosquito rests for a few days while she produces eggs. Once she is ready to lay her eggs, she will find a stagnant water source to lay her eggs. *Culex spp.* can lay many broods throughout their lifetime and each brood can include hundreds of eggs. The average life span of a female *Culex* mosquito is 4-6 weeks during the summer months.



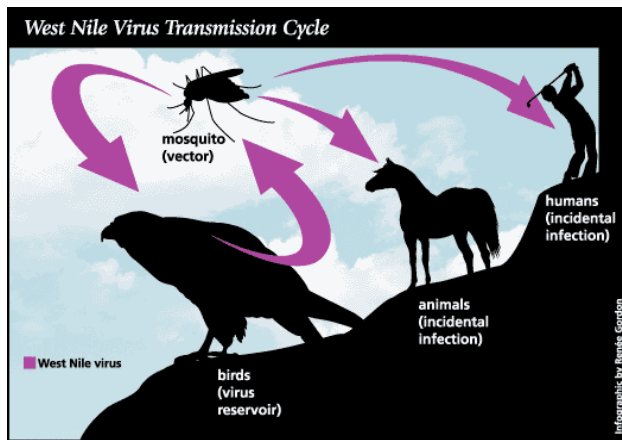
Close up of Aedes mosquitoes mating (Courtesy of The Atlantic)

4. FALL

The autumn months in Beaver County start with moderately warm temperatures in September with average high temperatures of 75° F to an average high of 48° F in November. Killing frosts (temperatures below 32°F) that end the growing season in our area can occur in October or November.

West Nile Virus is a mosquito-borne disease that can be detected anytime during the year, but most cases are reported in mosquitoes and humans during the summer months and peaks in late summer and early fall.

West Nile Virus is a virus transmitted from infected birds to mosquitoes when a mosquito bites an infected bird. It is then transmitted to humans when the infected female mosquito bites the human and takes a bloodmeal. Humans are considered an incidental infection or dead-end host, which means we cannot pass the virus on to other biting mosquitoes which in turn ends the transmission cycle.



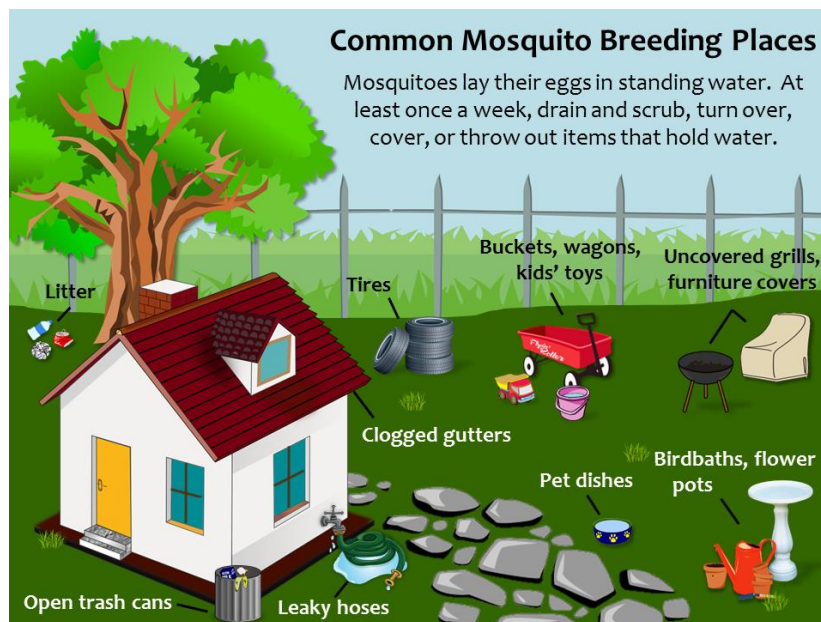
West Nile Virus Transmission Cycle

Most people infected with West Nile virus will either have no symptoms or mild flu like symptoms as fever, aches, headache, and fatigue with recovery in a few days. But a small percentage, 1 in 150 people, can develop more serious conditions that can lead to encephalitis (inflammation of the brain) with symptoms such as tremors, convulsions, paralysis, and even death.

There is no treatment or vaccine for humans.

The importance of knowing the habits of mosquitoes can help reduce the risk of diseases like West Nile Virus by removing habitat and breeding areas where mosquitoes are found.

Mosquitoes can breed in a container as small as a bottle cap. It is important to drain unused containers like buckets, uncovered trash cans, and litter and debris that can hold water for longer periods of time. Areas around homes that can hold water are unused tires, flowerpots, birdbaths, pet bowls, outdoor children's toys, as well as gutters that may be clogged with organic debris and holding water.



Mosquitoes can be a significant problem in urban areas with exceptional potential breeding areas in a concentrated area of population. *Aedes albopictus* is a species that is prolific in urban areas. *Aedes albopictus* aka. Asian Tiger Mosquito is a nuisance mosquito in Beaver County. Although this mosquito is not known for transmitting disease in our area, it is a vector for viruses such as Zika and Dengue in other areas of the world. This species of mosquito is active during the day and is an aggressive biter, it has adapted to urban areas due to greater access to breeding areas and greater populations. *Aedes albopictus* prefer cryptic, dark, or shady locations and do not fly very far distances. The females lay eggs in small amounts of water, preferring artificial containers such as tires, plastic containers, and litter that holds water. *Aedes* eggs are individual eggs, black in coloration, oval shaped, and are extremely small, with a length of 0.5 mm (.02 inch). Eggs can withstand desiccation for up to one year. Removing the habitat for this mosquito is crucial for reducing mosquito populations in urban areas.



Aedes albopictus, Asian Tiger Mosquito

Whether it is winter, spring, summer, or fall, mosquitoes can be found every season of the year. By identifying and removing mosquito habitat and using protective measures, we can reduce the risk of being bitten by mosquitoes and the risk for mosquito-borne diseases like West Nile Virus.



Bird baths



Tires



Outdoor Toys

Dump It! Drain It! Treat It!



Litter



Tarps



Buckets

REFERENCES

- Aladin. (2023) *Yearly & Monthly weather-Beaver, PA*. Weather U.S.
<https://weather-us.com/en/pennsylvania-usa/beaver-climate>
- Arnfield, A. John. "Köppen climate classification". *Encyclopedia Britannica*, 16 Oct. 2023,
<https://www.britannica.com/science/Koppen-climate-classification>.
- Brogi, G. (2022, August 23). *How Do Mosquitoes Survive the Winter?* CGAA.
<https://www.cgaa.org/article/how-do-mosquitoes-survive-the-winter>
- Bug Zappers. (2021, April 18). *How Do Mosquitoes Mate?*
<https://bugzapperz.com/how-do-mosquitoes-mate/>
- Castro, J. (2022, October 21). *Animal Sex: How Mosquitoes do it*. Livescience.com
<https://livescience.com/56059-animal-sex-mosquitoes.html>
- Denlinger, D.L., Armbruster, P.A. (2014). Mosquito Diapause. *Annual Review of Entomology*. 2014. 59 (1), 73-93.
- Hawley, W.A. (1988). The biology of *Aedes albopictus*. *Journal of the American Mosquito Control Association*. 1988. Supplement #1. P. 1-40
- Oxford Languages. (2023). *Diapause*. <https://www.languages.oup.com>
- PA DEP Vector Management. (2023). *Vector Management Mosquitoes, Ticks, and Black Flies*.
<https://www.dep.pa.gov/business/programintegration/vector-management/pages/default.aspx>
- Steele, C.H., McDermott, E.G. (2021). Male and Female Mosquito (Diptera: Culcidae) Attraction to Sound and Its Relevance to Potential Applications in Vector Surveillance. *Annals of the Entomological Society of America*. 115(1), 2022, 113-126.
- Webb, C. (2022, June 20). *Where do all the mosquitoes go in the winter?* The Conversation.
<https://theconversation.com/where-do-all-the-mosquitoes-go-in-the-winter-185021>