

# Integrated Mosquito Management (IMM) for Golf Courses

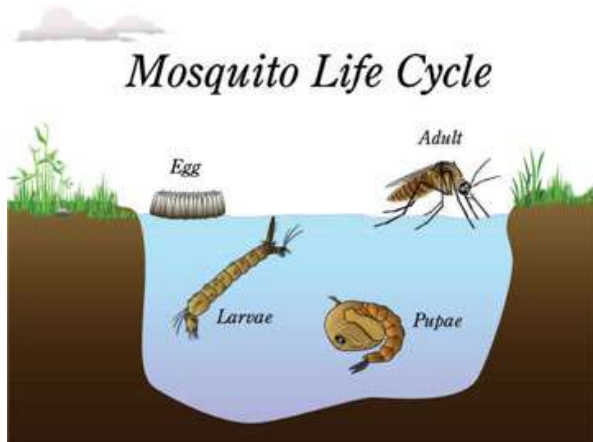
## An important component of a sustainable ecosystem

### Pest or Peril

Some mosquitoes are strictly an annoyance. Others can transmit diseases. Mosquitoes (Culicidae) are responsible for more death and human suffering than any other animal on the planet. Worldwide, there are over 3500 species of mosquitoes. In North America, there are 181. They carry malaria, dengue fever, filariasis, Chikungunya virus, yellow fever, several encephalitic viruses, and Rift Valley fever, and cause over one million fatalities yearly.

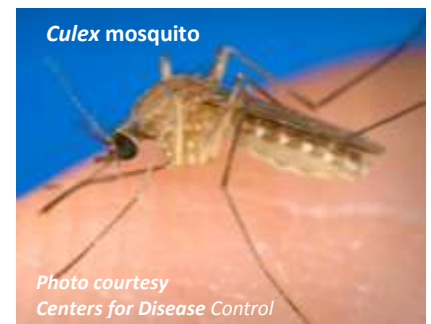
According to a recent statewide survey, there are 62 species of mosquitoes in Pennsylvania. Most of these require particular habitat and may not be encountered in typical golf course settings, but a number of species can be found across the state in predictable situations. Several of these common mosquitoes transmit diseases including West Nile virus (WNV), Eastern Equine Encephalitis and dog heartworm.

Mosquitoes of the genus *Culex* are the species of most concern in the transmission of WNV. Birds are the reservoir for WNV. Mosquitoes carry the virus from bird to bird and to humans and animals. Several species of *Ochlerotatus* and *Aedes* mosquitoes act as possible vectors for WNV or are problematic as nuisance mosquitoes.



### Know Your Enemy

All mosquitoes require water for development. *Culex* lay eggs in rafts that can contain up to



200 eggs. *Ochlerotatus* and *Aedes* lay eggs singly in damp soil that is

prone to flooding. Some species require a period of drying before hatching. A few overwinter in the egg stage and can remain viable for several years. Other species overwinter as larvae or hibernating adults. Mosquitoes can be uni-voltine, having only one generation per year or multi-voltine, breeding continuously until late summer or early autumn.

The eggs hatch and the larvae go through four successive molts before becoming a pupa from which the adult emerges. The larval and pupal stages breathe at the surface of the water and can be readily observed. The completion of the life cycle is dependent upon species and temperature. In the heat of the summer, certain species can go from egg to adult in 7-10 days.

Mosquitoes feed mainly on nectar as an energy source. Only female mosquitoes bite. They need to acquire additional protein prior to laying eggs. The biting times of different species vary throughout the day. *Culex* actively seek blood at dusk and dawn. *Aedes* and *Ochlerotatus* can be aggressive daytime biters. Because there may be people on the course from early morning until dusk, it is important to keep mosquito populations in check.

During the day, adult mosquitoes seek harborage in vegetation that can sometimes be quite a distance from the breeding area. The edges of woods, shrubs, tall grasses and emergent plants in swampy areas all provide resting places

for mosquitoes. They may be disturbed when people walk through the area and begin to bite. Prevailing winds can carry significant numbers of insects into open areas.

### Seek Them Out

In recreational settings, the most frequent problem spots for mosquito breeding are flood pools, swales, catch basins, retention ponds, storm water structures, ditches, riprap, compost sites and containers. *Culex* prefer highly organic water and are most often found in containers, catch basins, small organic pools and puddles in grassy areas. *Aedes* and *Ochlerotatus* are prevalent in larger

open areas and woodland pools.



Catch basins that hold water on greens and fairways are a favorite habitat for *Culex* species of mosquitoes.



Flooded swales can be prolific breeding sites in sun or shade. The dipper shows hundreds of larvae collected from one dip. Tree lines and shrubs provide harborage.

The easiest way to reduce mosquitoes is through source reduction. Grading can eliminate standing water in grassy fields or around buildings and parking areas. Garbage cans should have holes so water can drain. Gutters on buildings should be free of debris. Swales should drain completely within 24 hours. Pay attention to the soil type. Heavy soils and slow-draining clay may hold water long enough for mosquitoes to complete their life cycle, especially during periods of frequent summer rains. Vernal woodland pools are an important source of insect diversity and provide habitat for other amphibians, reptiles, birds and animals. Rather than elimination, they should be treated specifically for mosquito breeding only when necessary.

### Products for Mosquito Control

It should be stated that not every puddle or swale will become a breeding area for mosquitoes. But, if surveillance by visual inspection and/or dipping shows that larvae are present, control measures should be taken. All products should be applied according to label specifications and be appropriate to the habitat being treated.

Larvicides are the first line of defense. It is easier, more economical and most effective to control mosquitoes in the water than to use adulticide sprays. Several biological formulations are available. *Bacillus thuringiensis israeliensis* (Bti) and *Bacillus sphaericus* (Bs) are biological larvicides that are efficient against mosquitoes. The larvae die after ingesting the bacteria which causes disruption of the insect gut. These products must be applied when the larvae are actively feeding in order to be effective. Late fourth instars and pupae do not feed, so *Bt* products must be used at the appropriate time. There are specific pupicidal monomolecular formulations that kill pupae by spreading a film over the water surface to prevent respiration.

Methoprene is an insect growth regulator (IGR) that can be applied to inhibit the emergence of viable adults. This product is sometimes preferred because it has the advantage of keeping the larvae in the food chain until the pupal stage.

It is available in several forms, some offering residual effects of up to 150 days. It can be applied as a prophylactic treatment in areas known to breed such as floodpools that may be hard to access later in the season.

To control an overabundance of adults, a spray may be needed. Barrier sprays are effective and pose significantly less risk to non-targets than large-scale Ultra Low Volume (ULV) sprays. But it should be remembered that any spray will kill most insects that happen to be in the area including butterflies, honeybees and other beneficial insects.

A barrier uses a backpack sprayer. Insecticide is applied to the foliage surrounding a harborage area. Mosquitoes die when they land to rest and contact the pesticide. Synthetic pyrethroids are the most commonly applied barrier product. Many of the products listed for mosquito control are labeled against their use when honeybees are actively foraging. Additionally, some are toxic to fish and have restrictions and set-backs for use near water.

In Pennsylvania, certification is required for application of pesticides. Golf course maintenance personnel are typically certified in Category 7, Lawn and Turf. If you need to perform repeated or large scale mosquito control applications, it would be prudent to obtain certification in Category 16, Public Health--Invertebrate Pests. More information about how to find certification meetings and testing sites can be obtained from the Pennsylvania Department of Agriculture (PDA) website or by contacting your regional PDA office. And, of course, as with all pesticide applications, accurate records must be maintained.



### A New Invasive Mosquito

*Aedes albopictus* was first identified in the United States in Texas. It arrived in a shipment of tires in 1985 and rapidly spread throughout the southeastern states. Although a tropical species, *albopictus* is adapting itself to cooler temperatures. It is firmly established in southeastern Pennsylvania and is increasing its range.

Known as the Asian Tiger mosquito, *Aedes albopictus* is an aggressive daytime biter. It is multi-voltine and outcompetes native species in confined habitats. This mosquito is an efficient vector for Eastern Equine Encephalitis, Chikungunya virus and dog heartworm and is a possible vector for West Nile virus. *Albopictus* has the distinction of being quite a beautiful insect, but that is of little consequence if it invades your territory. It is characterized by its black and white striped legs and small black and white body.

### Mistaken Identities

Crane flies (Tipulidae) are the insects most often mistaken for mosquitoes. There are over 300 native species in Pennsylvania, ranging in size from ¼ inch to 2 inches. They do not bite. The larval stage of the European crane fly can cause some damage to turf. It is an invasive insect that has been found in neighboring states, but has not yet been identified in Pennsylvania.



Midges (Chironimidae) resemble mosquitoes and are often seen in mating swarms or “clouds.” They do not bite. Fungus gnats (Sciaridae) and wood gnats (Anisipodidae) can cause problems in decaying vegetation or turf areas that are continuously damp and compacted. They may be annoying, but they do not bite.

### **An Ounce of Prevention ...**

The easiest way to reduce the need for extended mosquito control is to remove areas where mosquitoes can breed. If possible, source reduction is the best method. Fill in low spots in turf. Grade swales so they drain quickly. Pay close attention to containers, garbage cans, tarps, rain gutters, tires and litter that may accumulate in wooded areas.

### **A Pound of Cure**

Surveillance can be incorporated into regular mowing and maintenance programs. A quick visual inspection or dip can determine if larvae are present and they can be eliminated promptly. Remember that if control is needed, it is a time-sensitive endeavor. Some of the products are life-stage specific, in particular the *Bt* formulations that must be used when the larvae are feeding.



Mosquito abatement is a matter of public health, as well as public comfort.

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For more information:

Links to mosquito control and pesticides -- PA West Nile virus website <http://www.westnile.state.pa.us>  
Pesticide certification -- Pennsylvania Department of Agriculture <https://www.paplants.state.pa.us/>  
Crane flies -- <http://www.agmkt.state.ny.us/CAPS/pdf/European%20Crane%20Fly%20Poster.pdf>

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