Disease

Mosquito-borne diseases do occur in Michigan, at one time, **malaria** (carried by *Anopheles* mosquitoes) was common in Michigan, but it has been effectively eradicated. **West Nile virus (WNV), St. Louis encephalitis (SLE)**, **Eastern Equine encephalitis (EEE)**, and different types of the California group of encephalitis occur in Michigan. The viruses that cause these diseases are transmitted by different species of mosquitoes, and they also infect various kinds of wild birds and mammals.

West Nile virus is a mosquito-borne infection that can cause serious disease and death. It is maintained in nature by transmission between birds and primarily *Culex* mosquitoes. Humans and horses are affected by WNV but are probably dead-end hosts (we do not develop high enough levels of virus to infect new mosquitoes and continue the cycle). *Culex* and other mosquitoes may transmit the virus to humans. WNV was first seen in the United States in New York City in 1999. It was first detected in Michigan's bird population in 2001 and the following year it was responsible for over 640 cases of human disease and 50 deaths statewide. There have been approximately 20 to 60 human cases per year reported from Michigan since 2002.

Other mosquito-borne viral diseases are not common annually, but because they may occur in epidemics in certain years, they remain a true concern for human and animal health. For example, in 1975 an epidemic of SLE resulted in 93 human cases and four deaths in Michigan, mainly in the southeastern part of the state.

Blue Jays and Crows are important WNV sentinels.

Eastern equine encephalitis has occurred in widespread outbreaks in southern Michigan. The first Michigan resident known to die of EEE was a 10-year old boy in 1980. In 1991, about 60 horses in 11 southern counties died of this disease. Two humans were ill from this disease, and one died. In 1994, another outbreak of EEE occurred in southern Michigan, and about 22 horses contracted the disease.(all died)

The status of the California group of encephalitis viruses is rather less well known in Michigan compared to other, nearby states. **Jamestown Canyon virus** is mainly transmitted by spring *Aedes* mosquitoes with deer as the vertebrate host of the virus. However, it is not a major cause of human illness and does not affect domestic animals. **LaCrosse encephalitis virus**, another California group virus, is a serious disease of children, but it is not common in Michigan. **Dog heartworm** is common in Michigan and is transmitted by a variety of *Aedes* mosquitoes. It is not a human health problem but it is a significant veterinary concern. Prophylactic drugs are available to prevent dogs from contracting this disease.

Mosquito Control on Private Property

The easiest way to control mosquitoes on private property is to eliminate items that hold water and can be used as "artificial" habitat. Items such as: birdbaths, children's' toys, wading pools, buckets, planters and old tires, etc. need to be dumped out and put under cover or throw out. Water in ornamental ponds needs to be kept moving by use of a fountain or waterfall, to prevent mosquitoes from using them as habitat. Since fish will eat mosquito larvae, adding fish to these ponds will also help eliminate mosquitoes.

Sources

There are several sources of information on mosquitoes and their management that are appropriate for Michigan conditions. The Michigan Department of Public Health produced a manual entitled "Michigan Mosquito Manual: Fight the Bite!", and the Michigan Department of Agriculture produced the 7F manual which contains material on mosquito control activities, mosquito biology, mosquito-borne diseases such as encephalitis and dog heartworm, and organizational tips. This and other information are available from the Michigan Mosquito Control Association. Information is available online at www.mimosq.org . Mosquito control offices in Bay, Midland, Saginaw or Tuscola Counties may also have brochures and other information available.

MMCA is a Partner in the Pesticide Environmental Stewardship Program

Regulating Application

The Michigan Department of Agriculture certifies persons who apply insecticides for mosquito control. The certification process requires taking a core exam and the specialty exam for mosquito control (Category 7F). Interested parties can call their local Michigan Department of Agriculture office to schedule an examination or to get further information. Study booklets for both of these exams are available from the Michigan State University Bulletin Office and from local County Extension Services offices.

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Biology & Control of Michigan Mosquitoes

Contents:

General Control	2
Source Reduction	2
Larval Control	2
Pupal Control	2
Adult Control	3
Natural Predators	3
Sources/Habitats	4
Regulating Application	4

Purpose

The purpose of this brochure is to provide you with basic facts about biology and control of pest mosquitoes in Michigan, and the significance of mosquitoes as transmitters of disease-causing agents. Knowledge of the different kinds of mosquitoes in Michigan is essential if they are to be controlled using the integrated pest management philosophy. Modern mosquito control involves integration of a variety of methods to achieve the single end of preventing mosquito bites, and can be done in an environmentally acceptable manner through the use of physical methods, personal protection measures, biological controls, and appropriate and judicious application of insecticides.

Biology

Mosquitoes are annoying because the female bites in order to acquire a blood meal for the development of her eggs. Male mosquitoes do not bite. Mosquito bites may simply cause a short-term itching sensation in the skin, or can lead to inflammation, allergic reactions and possibly to secondary infection with bacteria at the site of the bite. In large numbers, mosquitoes comprise a nuisance and can greatly reduce the quality of life for people and animals. Large populations of mosquitoes can also impact economic activity, including recreation and tourism industries.

Mosquitoes are true flies and like other insects have a development cycle involving complete metamorphosis from the egg to the adult stage. Mosquito eggs are laid singly or in clusters on water or in mud and debris near water-prone areas. Tiny larvae hatch from the eggs and develop in the water. The larvae feed on a variety of microorganisms and organic matter in the water, and develop through four larval stages to the pupal stage. Adult mosquitoes emerge from the pupal stage and fly away. Male mosquitoes feed on nectar and do not bite for blood; female mosquitoes of most species require a blood meal to develop their eggs, and may bite several times during their lives. Female mosquitoes not only bite people, but also other animals including birds, mammals, amphibians and reptiles.

Michigan has five major classes of pest mosquitoes based upon larval habitat and life history: spring floodwater mosquitoes, summer floodwater mosquitoes, the cattail mosquito, swamp/marsh mosquitoes and container-breeding mosquitoes. Overall, there are about 60 different species of mosquitoes in Michigan. From a pest point of view, the most important groups of mosquitoes are the floodwater mosquitoes.

Larvae of **spring floodwater mosquitoes** hatch from the eggs in March, in pools of water formed by melted snow in the woods. The eggs occur in the leaf litter at the bottom of the pools. These larvae develop slowly because of low water temperatures, and emerge as adults in May, before the pools dry up. The female spring floodwater mosquitoes can be very long-lived, and may bite several times. They lay eggs in depressions in the woods where they will be flooded the following year. Spring floodwater mosquitoes have only one generation per year, so even if these eggs are flooded by summer rains, they will not hatch until the following spring. The species' names of some spring floodwater mosquitoes are: *Aedes stimulans, Aedes excrucians, Aedes provocans,* and *Aedes canadensis*. There are several more species as well, but they all have the same type of life history pattern.

Summer floodwater mosquitoes include several of our common pest mosquitoes in Michigan, such as *Aedes vexans, Aedes trivittatus,* and *Aedes sticticus*. Larvae of these mosquitoes hatch from eggs after rainfall in the summer (usually one inch or greater) in shallow flooded areas such as meadows, roadside ditches, highway right-of-ways, tire tracks, cow hoof prints, and other habitats. The larvae develop very quickly (7-10 days) and several generations may occur each summer depending upon the frequency and intensity of rainfall. For any given summer, we cannot predict in advance how bad the summer mosquitoes will be, because we can't predict the rainfall.

Control

Mosquito control should involve careful consideration of the biology of the mosquitoes that are forming the nuisance problem or disease threat. In all cases, larval mosquito control should be considered as the first option for control. This involves location of larval habitats, followed by their modification or treatment in such a way that the integrity of the habitat is preserved but the mosquito larvae are reduced in numbers. By dealing with larval mosquitoes, the adults may never become a problem. Adult mosquito control invariably involves the use of insecticides.

The larval habitats of spring and summer floodwater mosquitoes can be permanently eliminated through environmental sanitation and civil engineering, and should be the first thing to consider for mosquito control. Because of the temporary nature and small size of mosquito floodwater habitats, they often can be altered to prevent mosquito production. However, there are laws and policies regulating alterations of wetlands, and the Michigan Department of Natural Resources should be consulted before activities take place. Indeed, professionals responsible for mosquito control are in the unique position of finding a balance between preservation of our wetlands and elimination of mosquito sources, but this balance can often be achieved with the careful planning and consultation with authorities. Landscape planners should consider carefully the kinds of mosquito habitats they may be creating when wetlands are integrated into landscape or neighborhood designs. However, it is entirely possible to reduce larval mosquito sources and at the same time preserve wetlands and other desirable habitats.

Spring woodlots pools are treated in April

Egg Raft

Source Reduction

Source reduction of larval mosquitoes can be as simple as dumping out a container holding water or as complex as designing and installing a storm water sewer system. These systems can be large, involving several parcels, or as simple as changing the slope of a yard to prevent water from pooling. In both cases it will eliminate the standing water that is the source of mosquito breeding. The cost of installing a storm sewer system can be high, but if maintained properly, it can provide a lifetime of control. Eliminating the mosquito breeding sources will also greatly reduce the need for insecticides.

Catch basin

Control of the Larval Stage

Often, larval mosquitoes must be controlled through the use of insecticides that are applied directly into the water where larvae occur. In such instances, presence of larvae should be confirmed with use of a mosquito dipper and visible inspection. There are many registered larval mosquito insecticides. A bacterial insecticide, *Bacillus thuringiensis israelensis* H-14, is available in both liquid and granular formulation from commercial sources under trade names such as Vectobac and Teknar. Granular formulations are particularly effective against spring mosquitoes when applied during April when the larvae are in the second and third stage. Larvae eat the bacteria, which then disrupt the gut cells of the larvae. Abate (temephos) as a plaster pellet or sand granular and Altosid (methoprene) as a charcoal pellet, granule or liquid are also effective insecticides. Abate is an organophosphate with relatively low toxicity. Altosid is an insect growth regulator. Both are effective against the spring and summer floodwater mosquitoes. Application equipment for granular or pelletized formulations of these larvicides includes hand-cranked equipment or motorized backpack sprayers. Liquid formulations can easily be applied with compression sprayers.

Control of the Pupal Stage

Mosquito pupae do not eat, so the methods used to control larvae would not be effective on them. In order to control pupae, a highly refined mineral oil known as Golden Bear or Bonide is applied to the water's surface. The oil plugs the breathing tubes of both the larvae and pupae and they will suffocate.

Monomolecular films such as Arosurf or Agnique can also be applied to the water, reducing surface tension. Larvae and pupae are not able to attach to the water's surface and they drown.

Control of the Adult Mosquitoes

Adult mosquito control can also be accomplished through the application of registered insecticides. Essentially, there are three ways to accomplish this. First, adult mosquitoes can be killed on the wing during their normal flight time (dusk) using ultra-low volume (or ULV) equipment (a type of sprayer that is hand-held, mounted on a vehicle, or fixed to aircraft) and an insecticide. This method is sometimes called "cold fogging", although the droplet size of ULV applications comprise a cloud that is technically not a fog. This is an excellent method for controlling mosquitoes, because it allows for use of a small amount of material (generally about 1 fl oz per acre) in a narrow band of time and space. In Michigan, malathion (an organophosphate) and sumithrin & permethrin (synthetic pyrethroids) work well as adulticides applied as ULV. None of these insecticides are very toxic to non-target organisms when used at the labeled dosages. In general, malathion in a ULV formulation may be more effective on warmer evenings, while pyrethroids (synergized with piperonyl butoxide) may be more effective in cooler evening temperatures.

A second approach to killing adult mosquitoes is using thermal fogs. In this technology, an insecticide is heated along with another combustible material such as kerosene or oil, thus creating a fog that moves through the air, around vegetation, among flying insects. For mosquito control, the best time to make a thermal fog application is in the evening when thermal inversion conditions exist. A thermal inversion occurs when the warm air (heated by the earth during the day) has not yet mixed with cooler air above it. The insecticidal fog remains most stable and near the ground under conditions of thermal inversion. Thermal foggers can be purchased commercially in sizes small enough for backyard use to sizes large enough for widescale application. Currently, formulations of malathion, sumithrin or permethrin are recommended, following the label directions.

Another way to control mosquitoes is to use "harborage" or "barrier" techniques. This involves spraying a dilution of malathion or other registered insecticide onto vegetation surrounding the area to be protected. These areas could be a backyard, a cemetery, a park, golf course, etc. The insecticide provides a residual of active ingredient on plant leaf surfaces, and when mosquitoes fly from the harborage areas (the woods) through this zone, they die or are repelled and do not move into the open to bite. Equipment for harborage application varies with the size of the area to be protected, but can range from a small hand pump sprayer to a motorized backpack sprayer to a large Buffalo turbine rig.

Night-time fogging to reduce the population of adult mosquitoes

Hand-held fogging equipment

Adult mosquitoes live an average of two weeks in the summer but may live as long as several months.

Mosquitoes made up only .7% of the stomach contents in a bat.

Actually, birds and bats do not include many mosquitoes in their diets, despite some claims to the contrary.

Control using Natural Predators

Aerial predators are often cited in the popular press as means for controlling mosquitoes by predation. However, scientific studies do not support the contentions that bats, swallows, purple martins, dragonflies, or other aerial predators are effective, even though these methods might sound appealing and the animals themselves have aesthetic and intrinsic value. One has to keep in mind that predation is a natural process that is ongoing, yet we have mosquitoes anyway, often in large numbers. Actually, birds and bats do not include many mosquitoes in their diets, they prefer larger, more energy-rich prey such as moths and beetles. The idea that they eat thousands of mosquitoes per night comes from statements in the natural history literature indicating that these predators would have to eat this many to maintain their existence. Outdoor, electronic bug zappers with ultraviolet lights do not control mosquitoes.

So-called "mosquito plants" do not effectively repel mosquitoes, and are not recommended for this purpose despite advertisements to this effect. Other devices such as those advertised to repel mosquitoes by high frequency sound do not actually repel mosquitoes.