

Public Health

Department of Entomology

COMMUNITY-WIDE MOSQUITO MANAGEMENT

Timothy J. Gibb and Gary W. Bennett, Extension Entomologists

More than 50 species of mosquitoes aggravate and annoy residents of Indiana. However, certain mosquitoes can seriously threaten public health because of their ability to transmit human diseases.

Mosquito-borne viruses that have been of concern in Indiana include those that are responsible for causing such diseases as St. Louis encephalitis and La Crosse fever, Eastern equine encephalitis, Western equine encephalitis, and West Nile virus. Mosquitoes that transmit the Zika virus are not commonly found in Indiana at the present time.

Wild birds serve as the reservoir for West Nile and many other mosquito-borne encephalitis viruses. Mosquitoes acquire the virus by feeding on infected birds and then transmit the virus to other animals. Infected birds may either die or become ill and recover or may exhibit no noticeable symptoms. The virus becomes widespread in the wild bird population by midsummer, when mosquitoes are abundant. The likelihood that mosquitoes will become infected and transmit the virus to people and horses is highest between July and late October.



Mosquito engorged with blood while feeding on a human.
 (Photo credit: John Obermeyer)

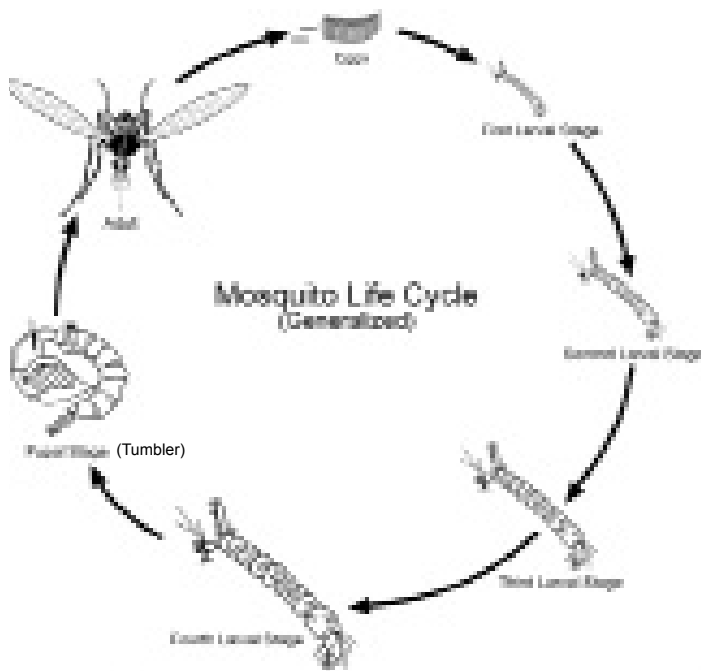


Mosquito larvae, commonly called "wrigglers".
 (Photo credit: John Obermeyer)

MOSQUITO BREEDING AND DEVELOPMENT

Mosquitoes always develop in water, but the type of breeding place varies with the species. Common breeding places are flood waters, woodland pools, and slowly moving streams and ditches, particularly if these moving waters are polluted with organic waste. Mosquitoes may complete development in any container that holds water for more than 10 days, such as tree cavities, rain barrels, fish ponds, rain gutters, bird baths, discarded tires, tin cans, and catch basins.

Mosquitoes lay eggs on the surface of water or in low places where water is likely to accumulate. The eggs may hatch in fewer than three days or may wait until flooding occurs. Immature stages are often identified by their swimming behavior. The larvae, commonly called "wrigglers," mature in 7 to 10 days and change into pupae or "tumblers". Two or three days later, adult mosquitoes emerge. After taking a blood meal, each female may lay 100 to 200 eggs. The entire life cycle may be completed in as few as 11 days.



Mosquito life cycle. (Illustration by: Scott Charlesworth, Purdue University)



Mosquito breeding site.

be submitted to specialists for species identification if disease transmitting mosquitoes are suspected. Sites identified as actively breeding mosquitoes should be noted for follow-up control efforts.

Adult mosquito surveillance measures mosquito populations that have successfully developed and emerged from aquatic habitats. Use of light traps (e.g., New Jersey light trap, CDC light trap) are standard tools for adult sampling. Landing counts can also be used. If disease transmitting mosquitoes are confirmed, breeding site elimination must be considered.

COMMUNITY-WIDE MANAGEMENT

To reduce annoyance and public health concerns, mosquito management should be undertaken on a community-wide basis. Mosquito management on a large area is a complex program. The administration of community programs must be flexible and be based upon the established principles of integrated mosquito management. Specific techniques are recommended, depending upon the target species involved and the priorities that have been established. For example, the control of mosquitoes that spread disease can be quite different from strictly nuisance mosquitoes. Community-wide mosquito control programs must emphasize species identification as well as habitat management, if they are to be effective.

Health Education

All viable public health programs must include public education. This is especially important for mosquito management because homeowners and property managers must be taught to assist by monitoring their own property to eliminate mosquitoes. Empowering the public, through education, is especially critical for community-wide mosquito management.

Survey for Breeding Places

An effective, community-wide mosquito management program is based on a survey of major potential breeding sites. Mosquitoes usually require standing water for breeding. A survey will identify which waters are infested, and must be eliminated or treated. The most effective and long-term management programs concentrate on the control of mosquito larvae rather than adult mosquitoes.

Any site that accumulates standing water should be inspected for possible mosquito breeding. Mosquito larvae may

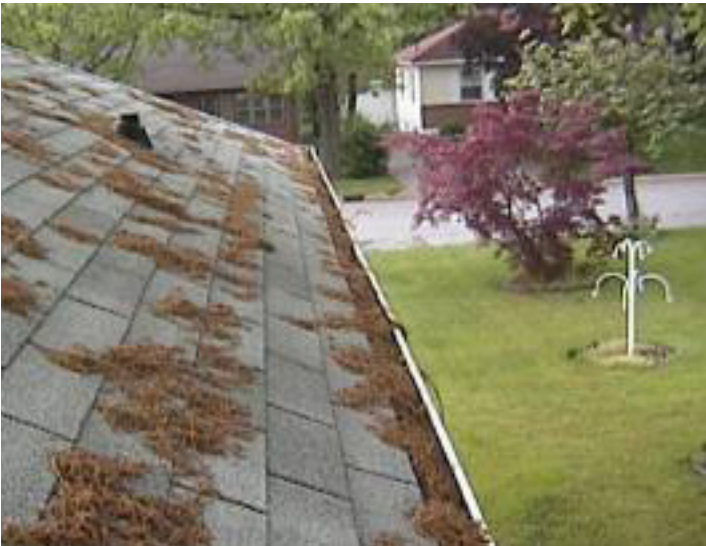
Source Reduction and Habitat Alteration

Systematically eliminating breeding sites where known populations of mosquitoes originate is the best long-term control practice for mosquito control. Large bodies of water may be drained or filled in after permission has been obtained from the local drainage board or other authorities and after it has definitely been established that problem species breed there.

Many mosquito problems can be permanently reduced by altering the habitat in such a way as to reduce the number of larvae that can be supported. This might include cleaning a shoreline of vegetation that provides natural harborage for larvae or eliminating a source of organic pollution. These efforts not only deprive larvae of harborage and nutrients, but also may provide an environment in which mosquito predators can survive and become established.

The following practices have been shown to reduce mosquito populations.

1. Ditch and clean stagnant streams to insure a continuous flow of water.
2. Drain or fill back-water pools and swamps where stagnant water accumulates.
3. Remove vegetation and debris from along the shores of lakes and ponds to discourage mosquito breeding. Such bodies of water should have a steep clean shoreline with as little vegetation as possible. Weed killers may be used in some cases to eliminate or prevent emergent plant growth. Refer to Purdue Extension Publication APM-3-W "Aquatic Pest Management" for further information on the use of aquatic herbicides.



Improperly maintained gutters retain water and become likely habitats for mosquito development.



Discarded tires trap water and become common breeding sites for mosquitoes.

4. Stock small lakes and ponds with top-feeding minnows if allowable.
5. Improve wetlands and marshes to encourage development of mosquito predators (e.g., frogs, predatory insects, predatory fish).

Residential Mosquito Management

The most effective control of mosquitoes around the home is to prevent them from breeding. This can be done by eliminating or altering existing breeding sites as follows:

1. Search for and dispose of discarded or unused tin cans, old tires, tarps, boat covers, or any other artificial water containers.
2. Make weekly inspections of the water in flower pots and plant containers. If mosquito larvae are seen, change the water. Also, be sure to loosen soil in flower pots regularly to ensure that water penetrates through the soil instead of forming a stagnant pool on the surface for mosquitoes to breed in.

3. Change the water in bird baths and wading pools weekly. Drain wading pools when not in use.
4. Stock garden and lily ponds with top-feeding minnows.
5. Keep rain gutters unclogged and flat roofs dry.
6. Eliminate stagnant pools, puddles, ditches, or swampy places around the home and property.
7. Keep margins of small ponds clear of vegetation.
8. Place tight covers over cisterns, cesspools, septic tanks, fire barrels, rain barrels, and tubs where water is stored.
9. Chlorinate and filter swimming pools and outdoor hot tubs.
10. Remove all tree stumps that may hold water.

CHEMICAL MANAGEMENT CONSIDERATIONS

The use of chemicals is, at best, a temporary expedient that should be limited to only those situations for which no other alternatives exist. In general, chemical control can be directed at larval mosquitoes (larviciding) or at adult mosquitoes (adulticiding). Larviciding, is the most efficient and effective, and should be the backbone of any mosquito treatment program. By comparison, adulticiding, is less efficient and as such should be used strictly for supplemental or emergency purposes. The detection of active transmission of mosquito-borne disease is an example of such an emergency. The Indiana State Department of Health routinely monitors levels of disease transmission throughout the state and may be contacted for up-to-date information.

A number of insecticides have been registered for use in mosquito control. The relative effectiveness of chemical control varies with the mosquito species and the location conditions where control is to be applied. Because each situation differs, care must be taken to select the proper insecticide for each particular situation. Considerations in choosing specific chemical controls and application methods include the following:

- Non target impacts to people and the environment
- Effectiveness against target species (resistance)*
- Potential contamination of food, plants, and recreation areas
- Cost
- Availability in quantities needed
- Need for retreatment
- Chemical stability
- Ease of preparation and application.

*Before assuming that resistance is the cause of poor control, other causes such as improper identification of mosquitoes, spray techniques, or faulty source reduction procedures must be ruled out. Decreases in susceptibility should be studied in carefully controlled tests by professional scientists before assuming that resistance is the cause.

PESTICIDE SAFETY MEASURES

The key to the safety of humans and other nontarget organisms is knowledge of the hazards involved in handling and applying pesticides. All pesticides must be handled in such a way that any possibility of harm to nontarget organisms (including humans), either through contamination of food and water or by contact, is kept to a minimum. Before using any pesticide it is essential to first **READ THE LABEL**. In prepar-

ing and applying the pesticide, **FOLLOW ALL DIRECTIONS CAREFULLY.**

- Wear protective clothing to avoid exposure to pesticides.
- Take care to avoid contamination of food or drinking water.
- Keep application equipment clean and in good condition.
- Store pesticides only in their original containers with the proper label, and out of reach of children and animals.
- Dispose of empty containers properly, and know the emergency measures for treating accidental poisoning and cleaning up of spills or other pesticide contamination.

Many chemical insecticides registered for use in mosquito control are toxic to birds, fish, and other wildlife, so appropriate precautions must be taken. In addition, most of these insecticides are toxic to bees exposed to direct treatment or to residues on crops. Instructions on the label will give precautions or restrictions while using insecticides for mosquito control.

TECHNIQUES FOR CHEMICAL TREATMENTS

Larval Control Options

Mosquito breeding sites that cannot be altered or eliminated may be treated with an appropriate larvicide. The application of larvicides should only be made at sites where mosquito larvae are present. The degree of control obtained with larvicide applications often depends upon the amount of pollution and the type and amount of vegetative cover present.

Application of specifically formulated oil emulsions have been effectively used to control the pupal stage of mosquito populations. However, where cover is heavy or wind is a factor, granular formulations or traditional pesticides frequently provide better control than emulsions or oil sprays.

Generally, three or four treatments each season will be needed. Application rates may vary depending on the area to be treated, extent of vegetative cover and/or degree of pollution of the water to be treated.

Granular larvicides may be applied from the air if the plane does not have to fly over populated areas. Aerial applicators are responsible for any damage that their applications may cause. Knowing where sensitive sites are located is essential. Subscriptions to Driftwatch <<https://driftwatch.org/>> or other location awareness tools are valuable.

Granules can be applied on the ground by crank-operated spreaders similar to those used for spreading seeds and fertilizers. Knapsack or other hand sprayers that can be carried by field workers may be used for liquid formulations. Power sprayers may be satisfactory if advantage is taken of the wind so that the larvicide drifts into mosquito-infested areas. Larvicide treatment of fish-bearing waters should be avoided.

Homeowners and managers of small properties may treat standing water (ornamental ponds, ditches, etc.) with a relatively safe material called *Bacillus thuringiensis israelensis* (*Bti*). This material is applied to stagnant water to kill the larval mosquitoes. Briquet, granular, and pellet formulations

are often preferred for use in catch basins and in containers not easily disposed of.

Adult Control Options

Various application methods are available for adult mosquito control. Thermal fogs can provide rapid, temporary control of adult mosquitoes with little residual effect. Thermal fog generators break up the insecticide by means of hot gases or superheated steam to produce a fog or smoke. This method is effective only where there is little or no wind present. Choice of insecticides used must be specifically labeled for use in thermal fogging equipment.

A more effective method of ground application is the use of ULV (ultra low volume) cold aerosol equipment. These machines produce very tiny droplets of concentrated insecticide, which results in a greater area coverage with less dosage. This type of application is designed to kill active adult mosquitoes with little or no residual control. Like the thermal fog generator, the cold aerosol machine should be used during the time of day that adult mosquitoes are most active (from twilight until about midnight), and when atmospheric conditions are best (little wind). ULV application is generally the preferred space treatment for adult mosquito control.

The cold aerosol method has certain advantages over thermal fog generators. Less insecticide is applied, resulting in fewer pollution problems. Smaller holding tanks and consequently smaller vehicles are needed because smaller quantities of insecticide are used. There is less of a traffic hazard compared with thermal fog applications, which reduce visibility. ULV ground applications, however, are somewhat less effective than thermal fogs in heavy vegetation, because the larger ULV droplets tend to be filtered out more rapidly. Note that only certain insecticides can be used with ULV ground equipment.

CONTROLLING MOSQUITOES INDOORS

Mosquitoes can be excluded from the home by keeping windows and porches tightly screened. Regularly inspect screens in windows, doors, and porches for holes or tears. Fill gaps around windows and doors with weather-stripping. Space sprays or aerosols containing synergized pyrethrins released into the air are effective against mosquitoes found in the home.

TIPS FOR PERSONAL PROTECTION

The most basic personal protection against mosquitoes is awareness. Avoiding places and times (dawn and dusk) when mosquitoes are most active is the first line of defense. When in mosquito infested areas, wear light colored long-sleeved shirts and long pants with enough thickness to prevent mosquitoes from reaching the skin. Dark colors attract mosquitoes.

Repellents are very useful in protecting against mosquito bites. Repellents that contain the active ingredient diethyl toluamide (DEET) are the most effective.

Citronella candles may be of limited effectiveness because of variable outdoor wind movement. Granular repellent containing naphthalene compounds, (Mosquito Beater), can be applied on lawns and other mosquito-infested areas to repel mosquitoes for several hours. Other products and

devices such as “thermacell” also have application in certain situations out-of-doors.

PROTECTING PETS

Mosquitoes not only bite humans but other animals as well. Generally, animals are not harmed by mosquitoes; however, some species of mosquitoes may play a role in transmitting heartworm in dogs. During times of high infestation, keep dogs inside the house, a screened-in kennel or

porch area, especially during prime mosquito feeding times. Check with a veterinarian for preventative measures for dog heartworm. Horses are particularly susceptible to West Niles virus, transmitted by mosquitoes. A West Niles virus vaccine for horses has become available and should be used prophylactically.

Consult a veterinarian for more specific recommendations regarding symptoms of and treatments for mosquito-transmitted diseases of pets and livestock.

READ AND FOLLOW ALL LABEL INSTRUCTIONS. THIS INCLUDES DIRECTIONS FOR USE, PRECAUTIONARY STATEMENTS (HAZARDS TO HUMANS, DOMESTIC ANIMALS, AND ENDANGERED SPECIES), ENVIRONMENTAL HAZARDS, RATES OF APPLICATION, NUMBER OF APPLICATIONS, REENTRY INTERVALS, HARVEST RESTRICTIONS, STORAGE AND DISPOSAL, AND ANY SPECIFIC WARNINGS AND/OR PRECAUTIONS FOR SAFE HANDLING OF THE PESTICIDE.

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