



BARN SWALLOWS ARE EXCELLENT MOSQUITO PREDATORS.
PHOTO CREDIT: ALAN PETERSON

Best Practices for Managing Mosquitoes

Mosquitoes may be annoying, but like any wildlife, they deserve informed management. With the increasing prevalence of invasive species and mosquito-borne illnesses in the U.S., it's more important than ever for individuals and land owners to understand their role in managing local mosquito populations in effective and safe ways. However, one of the most popular backyard mosquito control methods—pesticide spraying—can pose a serious threat to other wildlife, pets, and even humans. In this handout, we will cover the dangers of garden pesticide spraying and recommend natural alternatives to reducing mosquitoes in your local community.

THE MOSQUITO PROBLEM

Believe it or not, mosquito populations around the globe play a role in pollination—but they are not significant, specialized pollinators like bees and hummingbirds. While some mosquito species may incidentally transfer pollen while feeding on plant nectar, their impact is relatively minor compared to bees and other pollinating animals. Unfortunately, the mosquito's role as a disease vector means that controlling their populations is often necessary for human and wildlife health despite the pollination services they might provide.

Invasive mosquito species have become especially prevalent in the U.S. For example, the tiger mosquito (*Aedes albopictus*), introduced in the 1980s, is highly adaptable and capable of carrying diseases that native species typically do not, such as Zika and chikungunya virus. These diseases can pose a threat in the tropical regions of the world, including the American southeast, but are less common across the rest of the country.

Additionally, human activity has played a big role in artificially inflating mosquito populations, invasive or not. Mosquitoes are often attracted to artificial sources of standing water, such as gutters, tires, and buckets, which provide ideal breeding grounds in areas that might have otherwise remained mosquito-free.

A mounting need for mosquito management has resulted in the development of powerful pesticide sprays that, unfortunately, can cause harm to the environment and to ourselves. In a sense, the cure can become worse than the disease, especially in areas where mosquito-borne illnesses are less prevalent.

Although invasive species, inflated populations, and worsening disease risk can be problematic issues in themselves, the real challenge of the "mosquito problem" has been gaining support for alternative methods to control these populations in ways that are both effective *and* safe for humans, pets, and wildlife.



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THE DANGERS OF PESTICIDES

Many garden mosquito sprays, even those used by professional services, contain chemicals such as pyrethroids. These pesticides work by disrupting the nervous system of the mosquito, leading to paralysis and death. The big problem is that pyrethroids and related chemicals act as broad-spectrum insecticides and are not only harmful to mosquitoes, but to other animals as well.

The toxic chemicals in these sprays have no way of differentiating between mosquitoes and other creatures. Thus, their use as a broadcast garden spray can cause neurological damage to pets and other wildlife in the area, and can contribute to the decline of beneficial pollinators— especially our native bees and monarch butterflies.

While broadcast spraying of pyrethroids to kill mosquitoes in the environment is problematic, the good news is that they can be safely applied as a repellent to fabrics such as clothing, tents, or camping/hiking gear.

ESSENTIAL OILS FOR MOSQUITO CONTROL

Essential oil repellent sprays applied to yourself or your clothes generally offer a more wildlife-friendly alternative to broad-spectrum chemical sprayed into the environment. These oils are volatile compounds produced by certain plants as a natural defense against herbivorous insects.

Although mosquitoes do not feed on plant leaves, feasting on nectar and blood instead, they are still affected by essential oils as they evolved from a plant-eating ancestor. When mosquitoes come into contact with essential oils, their sensory receptors become blocked, causing them to become disoriented and leave the area.

While simply planting essential oil-producing plants is not effective for mosquito control, repellent sprays made with distilled essential oils can be. It is important to note that essential oils may affect other insects, like bees, so it is best to apply them directly to clothing rather than spraying any plant

material directly—especially flowers.

The most effective essential oils for repelling mosquitoes include:

- » Citronella and lemon eucalyptus (as effective as DEET)
- » North Indian Rosewood
- » Peppermint
- » Loop-root Mangrove

However, some essential oils are known to contain carcinogens and should generally be avoided for repellent purposes.

These include:

- » Basil
- » Nutmeg
- » Rosemary
- » Cajeput

TIPS FOR AVOIDING MOSQUITO BITES

These simple solutions can help reduce the chances you will encounter mosquito bites:

1. Use an effective wildlife-friendly spray repellent, such as citronella or lemon eucalyptus oil. DEET is also safe for use when applied according to instructions.
2. Wear long sleeves and pants to protect your skin.
3. Stay indoors during dawn and dusk, when most mosquitoes are active.
4. Use screens on windows and doors to keep mosquitoes out of your home.
5. Use fans to discourage mosquitoes from coming near, as they are weak fliers.
6. Keep moving! If you are outside, stay in motion, as mosquitoes are less likely to bite when you are in moving.

MOSQUITO LARVAE IN A STORM PUDDLE. PHOTO CREDIT: MARY HOLLINGER, NOAA





A MOSQUITO-EATING COPEPOD MEASURING 2 MM IN LENGTH.

PHOTO CREDIT: DREED41, OPENVERSE

CONTROLLING MOSQUITOES NATURALLY

The most effective and safest ways to reduce mosquito populations are to eliminate breeding areas and aquatic larvae rather than spraying for adults. By taking the following steps, you can encourage the presence of natural predators in your area and reduce local mosquito populations:

- » Regularly remove or drain sources of standing water such as gutters, corrugated PVC drainage pipes, kids' playsets, and any debris left outside.
- » For sources of water that cannot be drained, use mosquito dunks or other products containing *Bacillus thuringiensis* (Bt) which targets mosquito larvae but is safe for other wildlife and people.
- » Build bird houses to encourage mosquito-eating songbirds to nest in the area.
- » Use native plants and shrubs in landscaping that can serve as a natural habitat for native mosquito predators.
- » Supply bat roosting boxes to encourage mosquito-eating bats to visit your land.
- » If you have a pond, add native wetland and aquatic plants as habitat for turtles, frogs and dragonflies, which are natural mosquito predators.
- » If you have a pond, provide habitat for copepods—tiny but voracious native crustaceans that eat mosquitos—by allowing leaf litter and detritus to remain in and around the water.



WHAT ARE COPEPODS?

Copepods are tiny, unassuming aquatic organisms. They are zooplanktonic crustaceans with big appetites, and although most species only eat algae or dead plant matter, some prefer to feast on mosquito larvae developing in the water. The most effective species can kill more than 40 mosquito larvae per copepod, per day—and healthy copepod colonies are typically several thousand strong.

These copepods especially love to eat the larvae of *Aedes* mosquito species, such as the invasive tiger mosquito. Large, healthy copepod populations typically reduce local *Aedes* mosquito populations by 99-100%.

Natural populations of copepods are near-ubiquitous. They can be found in almost every outdoor body of water, including ponds, pools, lakes, rivers, drainages, and even small puddles and blocked gutters. They are able to populate these places because, being so small, they can ride the flow of runoff water into new areas and may even be transported on wet vegetation or animals, including birds.

Many garden ponds very likely already support a population of native copepods that will kill mosquito larvae developing in the water. However, filtered or regularly-cleaned ponds may not sustain copepods, especially when bleach is used.

ALL-STAR MOSQUITO PREDATORS

You can help reduce local mosquito populations by gardening with a purpose, and providing food, water, shelter, and places to raise young for these all-star mosquito predators:

- » Copepods
- » Bats
- » Nighthawks, Swifts, and Swallows
- » Dragonflies
- » Aquatic Turtles
- » Hummingbirds





IN SOME AREAS OF THE FLORIDA KEYS, MOSQUITO POPULATIONS ARE SO DENSE THAT FIELD RESEARCHERS MUST WEAR PROTECTIVE SUITS. CREDIT: FLORIDA FISH AND WILDLIFE

IS GENETIC CONTROL OF MOSQUITOES SAFE?

Genetic engineering is a promising solution for managing mosquitoes and reducing disease transmission, and although it is not a method available to everyday people, it is important to be aware of and informed about such large-scale efforts to control mosquitoes. In fact, genetic methods present a promising way to massively reduce the amount of harmful pesticides sprayed into the environment.

Scientists at Oxitec have been exploring genetic methods of mosquito control for over a decade. In this method, male mosquitoes bred from wild stock are genetically altered to carry a lethal gene that is passed on to wild populations when they mate with wild females. The lethal gene causes female mosquitoes' eggs or larvae to perish during development, effectively reducing the size of the next generation of mosquitoes.

In the lab, these mosquitoes are given an antidote to the lethal gene, called tetracycline, which allows them to develop to adulthood. Once released into the wild, the altered males will mate with wild females, producing eggs that fail to develop. The lethal gene has a time limit and will not persist in the environment longer than a few generations. In an extreme case, if the target mosquito population needs to be recovered, wild mosquito breeding pools can be treated with tetracycline. This allows the next generation to survive and repopulate the area.

This process has been extremely successful so far. Lethal genes have effectively repressed wild, disease-carrying mosquito populations in the Cayman Islands and Brazil, and in 2021, testing also began in the Florida Keys. This garnered national attention due to concerns over using Florida as a 'GMO testing ground,' but the truth is that these methods have already been in development for many years, and have been successful in every previous field trial.

Past field tests have shown no direct effects on non-target species and no effects on target mosquitoes outside of the lethal gene. These experiments have successfully eliminated 97-98% of mosquitoes that are capable of carrying Zika, Dengue virus, and yellow fever in target areas.

The latest versions of the lethal genes delay the effects until the larval stage, reducing the risk of removing mosquito eggs as an important food supply for native wildlife. Currently, we do not know of any species that relies on mosquito larvae or adults as a food source—it seems that only eggs are important. Therefore, reducing mosquito populations past the egg stage is not known to have negative affects on any of our wonderful mosquito predators.

MOSQUITO ILLNESSES AND STATISTICS

The following deadly mosquito-borne diseases have been documented in the United States:

- » West Nile Virus
- » Yellow Fever
- » Dengue Fever
- » Chikungunya virus
- » Zika Virus
- » Malaria

According to the World Health Organization (WHO):

- » 219 million cases of malaria occur annually, resulting in more than 400,000 deaths every year. Most of the deaths occur in children under the age of 5 years.
- » Dengue is the most prevalent viral infection transmitted by *Aedes* mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue.
- » West Nile virus can cause severe difficulties or death, but 80% of people infected do not show symptoms.