

Success in Mosquito Control: An Integrated Approach

The Centers for Disease Control (CDC) and the U.S. Environmental Protection Agency (EPA) collaborate on mosquito control activities throughout the United States to control diseases. By looking at biological information about the life and reproduction of the mosquito and epidemiological information about the disease, the two organizations have developed a methodology on how best to control mosquitoes. Both CDC and EPA are helping Puerto Rico apply this methodology to develop a successful, sustainable program and approach to controlling mosquitoes that transmit Zika, dengue, chikungunya, and other diseases. Successful mosquito management requires intervening at some point during the mosquito's life cycle before they bite and infect a human.

The best approach to controlling mosquitoes takes advantage of every life stage of a mosquito to achieve control, using a unified approach referred to as integrated pest management (IPM).

Integrated Pest Management

EPA and CDC encourage all communities and mosquito control districts, including those in territories like Puerto Rico, to strictly adhere to IPM. IPM is a science-based, common-sense approach for managing pests and vectors, such as mosquitoes. IPM uses a variety of pest management techniques that focus on pest prevention, pest reduction, and the elimination of conditions that lead to pest infestations. IPM programs also rely heavily on resident education and pest monitoring.

A successful IPM strategy can use pesticides. IPM uses a combination of ways to control mosquito populations with decisions based on surveillance, such as keeping track or count of the numbers and types of mosquitoes in an area. Surveillance is a critical component to any successful IPM program because the results from the surveillance will help determine the appropriate response to an infestation. Extensive infestations, or those where disease is present, merit a different response than will lower levels of infestations.

Both CDC and EPA recognize a legitimate and compelling need for the use of chemical interventions, under certain circumstances, to control adult mosquitoes. This is especially true during periods of mosquito-borne disease transmission or when source reduction and larval control have failed or are not feasible. ***Puerto Rico has been actively working to control mosquitoes that transmit Zika (and dengue and chikungunya) for about six months; however, mosquito populations are increasing and additional methods are needed to control the mosquitoes during their adult stage.***

A successful integrated mosquito control strategy includes several tactics to eliminate mosquitoes and their habitat. Four critical tactics include:

1. [Remove Mosquito Habitats](#)
2. [Use Structural Barriers](#)
3. [Control Mosquitoes at the Larval Stage](#)
4. [Control Adult Mosquitoes](#)

1. Remove Mosquito Habitats

An important part of mosquito control around homes is making sure that mosquitoes don't have a place to lay their eggs. Because mosquitoes need water for two stages of their life cycle, it's important to monitor standing water sources.

- Get rid of standing water in rain gutters, old tires, buckets, plastic covers, toys or any other container where mosquitoes can breed.
- CDC is providing a large amount of funding to purchase tire shredders for Puerto Rico. This is important because used or waste tires can collect standing water that attracts mosquitoes and leads to increased mosquito breeding.
- Empty and change the water in bird baths, fountains, wading pools, rain barrels and potted plant trays at least once a week to eliminate potential mosquito habitats.
- Drain temporary pools of water or fill with dirt.
- Keep swimming pool water treated and circulating.

2. Use Structural Barriers

Because *Aedes* mosquitoes frequently bite indoors, using structural barriers is an important way to reduce the incidence of bites. Examples of structural barriers include:

- Install window and door screens if they are not already in place.
- Cover all gaps in walls, doors and windows to prevent mosquitoes from entering.
- Make sure window and door screens are "bug tight."
- Completely cover baby carriers and beds with netting. Nets can be especially important for protecting a sick person from getting more mosquito bites, which could transmit the disease to other people.

3. Control Mosquitoes at the Larval Stage

The greatest impact on mosquito populations will occur when they are *concentrated*, *immobile* and *accessible*. This emphasis focuses on habitat management and controlling the immature stages (egg, larva, and pupa) before the mosquitoes emerge as adults. This approach maximizes the effectiveness of pesticide application and minimizes the use from widespread pesticide application. Larvicides target larvae in the breeding habitat before they can mature into adult mosquitoes and disperse. Larvicide treatment of breeding habitats helps reduce the adult mosquito population in nearby areas.

Aedes aegypti mosquitoes can use natural locations or habitats (for example tree holes and crevices in plants) and artificial containers with water to lay their eggs. They lay eggs during the day in water containing organic material (e.g., decaying leaves, algae, etc.) in containers

with wide openings. They prefer dark-colored containers located in the shade. Other sites where they may lay their eggs include: old tires, buckets, toys, potted plant trays and saucers, plastic covers and even places as small as bottle caps.

Egg and larva interventions are generally the most effective, least costly, way to control mosquitoes. However, these interventions are unlikely to be 100% effective, especially for mosquitoes like the *Aedes aegypti* that breed in varied and scattered locations. In these cases, eliminating or treating all or even most standing water can be nearly impossible. Successful control efforts will need to supplement habitat removal with other means of control.

Involvement of the community is essential to these interventions, especially in urban areas such as San Juan, Puerto Rico. Residents, neighbors, and landlords can all be proactive in eliminating standing water or alerting others to its presence to eliminate even the smallest sources of standing water. *Aedes aegypti* have evolved so that they can reproduce in even the most challenging environment.

There are a number of EPA-registered active ingredients used in larvicides. Choosing which larvicide to use in a given area is best done by experts and will depend on a variety of factors, including potential human or environmental risk, cost, resistance, and ease of use.

4. Control Adult Mosquitoes

Using an EPA-registered pesticide is one of the fastest and best options to combat an outbreak of mosquito-borne disease being transmitted by adult mosquitoes. The pesticides registered for this use are known as adulticides. Adulticides are applied either using aerial applications by aircraft or on the ground by truck-mounted sprayers.

Aerial spraying techniques can treat large areas with only small amounts of pesticide and have been used safely for more than 50 years. These aerial sprays are fully evaluated by EPA and don't pose risks to people or the environment when used according to the directions on the label.

Mosquito adulticides are applied as ultra-low volume (ULV) sprays. ULV sprayers dispense extremely small droplets. The naled insecticide, for example, uses 80 microns or less which means hundreds of thousands of droplets could fit inside something as small as one pea. When released from an airplane, these tiny droplets are intended to stay airborne as long as possible and drift through an area above the ground killing the mosquitoes in the air on contact. The small droplet size makes the pesticide more effective, which means less pesticide is used to better protect people and the environment.

Extensive scientific research has been conducted by academia, industry, and government agencies to identify appropriate droplet sizes for individual compounds. The equipment nozzles undergo rigorous testing before being sold to the mosquito controllers. ULV applications involve very small quantities of pesticide active ingredient in relation to the size of the area treated.

There are a number of registered adulticides to choose from. Choosing which adulticide to use in a given area is a job best done by experts and will depend on a variety of factors such as the type of mosquito, whether the mosquitoes are resistant to particular types of pesticides, weather, etc. In Puerto Rico, naled was the only existing product to show 100% mosquito death in all populations tested.

The mainland U.S. has successfully used naled to quickly reduce mosquito populations.. This pesticide has been used for routine mosquito control and following natural disasters such as hurricanes and floods on millions of acres across the U.S. Naled was used recently for mosquito control in FL, TX, LA, GA, SC, WA, CA, NV, and in a number of other states. The insecticide is used highly populated metropolitan areas, such as Miami, and in less populated areas.

In 2004, naled was used extensively to treat eight million acres across Florida as part of the emergency responses to hurricanes. In 2005 after Hurricane Katrina, five million acres of Louisiana, Mississippi, and Texas were treated with naled to kill mosquitoes. Naled is effective at controlling Zika, dengue and chikungunya.