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The Biology of the Mosquito

by Timothy D. Deschamps

Mosquitoes are small, long legged, two winged insects belonging to the order *Diptera* and the family *Culicidae*. Adult mosquitoes differ from other flies because they have scales on the wing veins and wing margin, and they have an elongate proboscis used to bite and draw blood from their host, which is needed for egg development. This group contains over 2,600 species, with about 162 species in the US, belonging to 13 genera and 3 subfamilies[1].

Life History:

Mosquitoes have four separate stages in their development: egg, larvae, pupae and adult. The first three stages occur in the water (the eggs may be on wet or damp soil). The larvae also goes through four stages (called instars) in its development into a pupae. The adult is the active, flying insect most of us are familiar with, and feeds upon plant juices and nectar for food, and needs blood from a host for egg development.

Eggs:

The behavior of the female mosquito determines where they eggs are laid, and this behavior is quite constant for a given species. Eggs are white when first deposited, and darken after an hour or two. In general, mosquito eggs fall into three distinct groups:

1): Those that are laid singly on the water's surface.

2): Those that are glued together to form rafts, which float on the water.

3): Those that are laid singly out of the water, on the soil. Examples of the different types are explained below:

1): Those that are laid singly on the water: Eggs of the *Anophelene* mosquito. These are elongated and oval, usually pointed at one end, and are provided with a pair of lateral floats.

2): Those that are glued together to form rafts: Eggs of the *Culex, Culiseta, Coquillettidia* and *Uranotaenia* mosquito. This raft, which may contain 200 or more eggs, remains afloat on the surface of the water until hatching occurs, usually within a few days.

3): Those that are laid singly out of the water, on the soil: Eggs of the *Orthopodomyia, Oc. triseriatus* and *Oc. atropalpus* are laid on the sides of tree or rock holes, or in artificial containers (like tires) just above the water line, so that with a rise in the water the eggs hatch. These are known as container species. Other species of *Aedes* and *Ochleratatus*, and all species of *Psorophora* lay their eggs on moist ground where they remain until flooding occurs. In some cases, hatching occurs as soon as the eggs are flooded, and several generations may occur each year (multivoltine). This includes the *Psorophora* group, and *Ae. vexans, Oc. canadensis,* and *Oc. sollicitans*. These are the reflood species. Most others must be subjected to cold-conditioning in order for hatching to occur, thus there is only one generation per year (univoltine). Examples are *Oc. stimulans, Oc. aurifer, Oc. excrucians, Oc. fitchii* and *Oc. abserratus*. These are known as spring brood mosquitoes.

[1] See classification on page 5

The eggs of these species that are deposited on the soil are able to survive for long periods of time, sometimes years or more, until such a time that they get flooded and are able to hatch.

Larvae:

The larvae of all mosquitoes live in still, slow or non-flowing water. Some species live in permanent swamps and marshes, some in water contained in tree holes or other containers (tires, catch basins, etc.), and some develop in areas that are only wet for a period of time (such as vernal pools or floodplains). Mosquitoes have adapted to live in many types of water; fresh water, salt water, and even water as polluted as septic discharge. Mosquito larvae feed on bacteria and debris found in the water, but are dependent on the stillness of the water to be able to use the surface tension on the top to attach their siphon tube and breath air. Because of this limitation, larvae are not found in fast moving streams and river, open lakes and seas. One notable exception to this rule are the larvae of *Coquillettidia perturbans*, which is able to attach itself to the roots and tubers of under water plants (typically cattails).

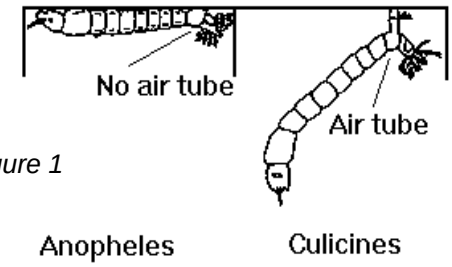


Figure 1

They breathe air through the plants roots itself. Floodplains alongside many rivers provide an ideal site for breeding once the flood waters subside.

The larvae goes through four different stages, called instars. At the end of each instar the larvae molts, or sheds it's skin. The fourth instar is the mature larvae; the final aquatic stage is the pupae. This process requires a minimum of 4-10 days (in the summer) to as long as several months (in the spring). Most larvae have similar characteristic position and movements, with the exception of the *Anophelene* larvae. (See figure 1)

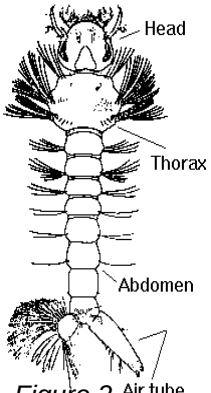


Figure 2

The three body segments, head, thorax and abdomen are distinct (See figure 2). No other *Diptera* larvae share this characteristic.

Most species of mosquito larvae eat minute organisms found in water, bacteria and other debris. These organisms flourish in water polluted with garbage, and organic waste from humans and animals. Polluted water such as this will produce an amazing number of larvae compared to a similar amount of clean water. A few species such as *Psorophora ciliata* and *Toxorhynchites rutilus* are predaceous, and will feed on aquatic insects, including other mosquito larvae. The rate of development depends mainly on the availability of food and the temperature of the water. In the spring, larvae of *Culex pipiens* may require 15 days to mature, but in the summer may only need 5 days. Larvae that overwinter, such as *Cq. perturbans* and *C. melanura*, may need several months to complete their life cycle.

Pupae:

The mosquito pupae is the final stage before the adult, and like the larvae also lives in the water. It is very active, does not feed, and must come to the surface for air like the larvae. One exception is the pupae of the *Cq. perturbans*, whose pupae (and larvae) are attached to the roots of underwater plants. Like the larvae, this depends on the temperature of the water and other factors.

Mosquito pupae are one of the most active of all insect pupae. Most are lighter than water, their buoyancy due to an air space in the pupae itself. By vigorous movements of it's abdomen, pupae are able to move with remarkable speed, but rise directly to the surface when movement stops. (See figure 3)

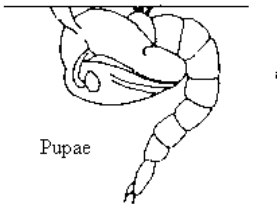


Figure 3

The pupal stage lasts from 1 day to a few weeks. No species at this time are known to overwinter as pupae. At the ends of this stage, the pupal skin is broken along the dorsal mid-line and the adult works its way out onto the surface of the water. This is another reason the stillness of the water is important. Once free of the pupal skin, the adult rests for a time to dry it's wings, then it's ready to fly away.

Adult:

The adult mosquito is a fragile insect with a slender abdomen, one pair of narrow wings, three pairs of legs and a proboscis. (see figure 4) The adult varies in length from 1/16 inch to 1/2 inch. The three body regions, head, thorax and abdomen are distinct.

The range of flight of the adult is a difficult problem to answer. Many factors are involved in this area. No clear statement can be made because the answer depends to a on large extent the species involved and the weather conditions, especially wind. When *Cx. pipiens*, *Oc. japonicus* or *Oc. triseriatus* is the pest the source is usually close by, often within a few hundred feet. When *Ae. vexans*, *Cq. perturbans* or *Oc. sollicitans* are involved, the larval habitat may be several miles away from the point of annoyance.

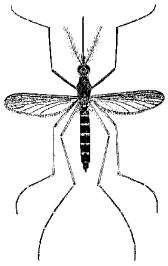


Figure 4

The sex ratio in adult mosquitoes is usually 1:1. Males ordinarily emerge up to a day first. The male mosquito remains close to the breeding area to await the hatching of the females. Some females are receptive to mating soon after emergence, but others require 1 to 2 days to become ready. Males of most species congregate into small swarms, usually over an object such as a bush or tree limb. Females are audio attracted to these swarms and once they fly into the swarm are grasped by a male and copulate while falling or on the ground. Most species do not seek a blood meal until after mating has occurred. Sperm are stored in a specialized structure in the female, and she may lay several fertile egg batches following a single mating.

The primary source of energy for both sexes is nectar. Male mosquitoes do not seek blood. The females of most species require a blood meal in order to obtain protein needed to produce a batch of eggs. Some species have specific hosts. *Culex territans* and *Uranotaenia sapphirina* seek cold blooded hosts such as amphibians and reptiles. Some species, such as *Wyeomyia smithii,* develop eggs without taking a blood meal (autogenous). Some species may be partially autogenous; they may be able to produce a small first batch without a blood meal, but need blood to develop additional egg batches. Most species need from 4-8 days after a blood meal before the eggs are fully mature and ready for laying (oviposition). In some species, as soon as the eggs are deposited the female may feed again.

Most species will feed on a wide range of both birds and mammals but are often mainly associated with 2 or 3 major hosts in a given area. A few species appear to be restricted to specific hosts, and can be broadly grouped into four major types: those that feed on mammals (*Anopheles, Aedes, Ochleratatus, Psorophora* and *Coquillettidia*), those that feed mainly on birds (*Culiseta melanura, Culiseta morsitans* and *Culex restuans*), those that feed on cold blooded vertebrates (*Culex territans* and *Uranotaenia sapphirina*) and general feeders that feed on a variety of hosts. Of special concern are the species that will seek out both birds and mammals, because they can be a vector of EEE (Eastern Equine Encephalitis) and WNV (West Nile Virus), which are *arboviruses* (viruses of birds).

Some species have a single generation in a year, such as *Oc. stimulans, Oc. abserratus* and *Oc. excrucians* to name a few. The eggs of these species need to be cold conditioned. Others are able to have multiple generations in a year, *Ae. vexans, Oc. sollicitans, Culex* and *Anophelene* species are a few found in this area. Most northern species are mainly active during and just after dusk, and a short while before dawn. But several species (mainly *Aedes* and *Ochleratatus*) will bite during daylight hours in subdued light in our homes, or in the shade. A few species, such as *Oc. sollicitans* will bite in bright sunlight if their resting habitat is disturbed by a host. *Culiseta, Coquillettidia, Anopheles* and *Culex* are generally more active in the later part of the twilight period and after dark than are *Aedes, Ochleratatus* and *Psorophora.*

The greatest part of an adult mosquitoes lifetime is spent at rest. Most mosquitoes rest in moist places with subdued light, where there is little wind. One of the biggest concerns for the adult is loss of water from its tissues. This loss may become critical during the daytime when temperature is high and humidity low. During the daytime mosquitoes often hide near the damp soil in grass, in dense shrubbery or in the woods. Because of this behavior, many people assume mosquitoes develop in these areas, but these are only resting places for the adults.

Mosquitoes have a unique biology, and have adapted to many types of habitats. No other insect has played such an important role in the development of mankind throughout history.

This group contains over 2,600 species, with about 162 species in the US, belonging to 13 genera and 3 subfamilies.

Order: **Diptera**
Family: **Culicadae**
Subfamily: **Anophelinae**
Genus: **Anopheles***
Subfamily: **Culicinae**
Genus: **Aedes***
Culex*
Culiseta*
Deinocerites
Haemagogus
Ochleratatus*
Coquillettidia* (Mansonia)
Orthopodomyia
Psorophora*
Uranotaenia
Wyeomyia
Subfamily: **Toxorhynchitinae**
Genus: **Toxorhynchites**

** Genera found in Massachusetts, and considered important as pest or vector species.*

Suspected and/or Confirmed Carriers of Virus in Massachusetts*

SPECIES	VIRUS
Aedes vexans	EEE
Coquillettidia perturbans	EEE
Culex pipiens	WNV
Culex restuans	WNV
Culex salinarius	EEE & WNV
Culiseta melanura	EEE
Ochlerotatus canadensis	EEE
Ochlerotatus japonicus	EEE & WNV

ACKNOWLEDGMENTS

Note: The information about the mosquito's biology is gathered from several sources, but primarily from the Commonwealth of Massachusetts State Pesticide Bureau's Certified Applicator's Training Manual, Category 47, Mosquito & Biting Fly Control.

*From the Mass. Dept. of Public Health's Massachusetts Arbovirus Surveillance and Response Plan, 2010

Bacillus thuringiensis var. israelensis

Bti stands for *Bacillus thuringiensis israelensis*, a non-reproducing bacterium discovered in the soil of Israel's Negev Desert in 1977. When the mosquito eats the Bti spores and crystals, they enter the larvae's stomach and dissolve. These crystals produce a toxin that is fatal to the mosquito, but has little or no impact on other aquatic life. Commercial manufacturers have produced several different formulations to provide a variety of application methods.

Larviciding with Bti

Liquid Bti can be used in hand held pump cans, back pack sprayers, hydraulic sprayers or truck mounted sprayers. Another formulation is called a Bti briquet, where Bti is applied to an organic carrier (usually ground up corn cob) and pressed into a hard, round disc. This type can last up to 30 days. They are applied to permanent mosquito habitat or catch basins, and provide a sustained means of control.

The Project uses a granular type of Bti, and it can be used in different ways. Aircraft, either fixed wing or helicopter, are used to deliver it to large, widespread areas inaccessible to any truck or hand application because of size or location. It can also be broadcast by hand, where the applicator can access areas not available to truck mounted equipment or aerial applications due to a heavy tree cover (canopy).

Bti granules

AQUABAC® (200 G)

ACTIVE INGREDIENT: *Bacillus thuringiensis* subspecies *israelensis* Strain BMP 144 solids, spores and insecticidal toxins* 2.86%

OTHER INGREDIENTS: 97.14%

TOTAL: 100.00%

*Equivalent to 7,000 International Toxic Units (ITU/mg) (0.091 Billion ITU/pound).
Note: The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID	
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment.	
See back panel for additional precautionary statements and directions for use.	

EPA Reg. No. 62637-3 **Net Contents: 40 Pounds (18.2 kg)**

EPA Establishment No. 9198-OH-1^{M}, 9198-OH-2^{B}, 9198-AL-1^{A}, 9198-PA-1^{P}

Superscript letter is first letter used in run code on bag.

MANUFACTURED FOR: Becker Microbial Products, Inc., 11146 NW 69th Place, Parkland, FL 33076

OMRI Listed®

The following product is OMRI Listed. It may be used in certified organic production or food processing and handling according to the USDA National Organic Program regulations.

Product

Aquabac (200G) Mosquito Biolarvicide Granule

Company

Becker Microbial Products Inc.
Terry Couch
11146 NW 69th Place
Parkland FL 33076-3846 USA

Status

Allowed with Restrictions

Category

NOP: Microbial Products

Issue date

06-Jan-2016

Product number

bmb-6012

Class

Crop Pest, Weed, and Disease Control

Expiration date

01-Mar-2020

Restrictions

For use as a pest lure, repellent, or as part of a trap, or as a disease control.
May be used for other pesticidal purposes if the requirements of 205.206(e) are met, which requires the use of preventive, mechanical, physical, and other pest, weed, and disease management practices.

Peggy Miars
Executive Director/CEO

OMRI LISTED® For Organic Use

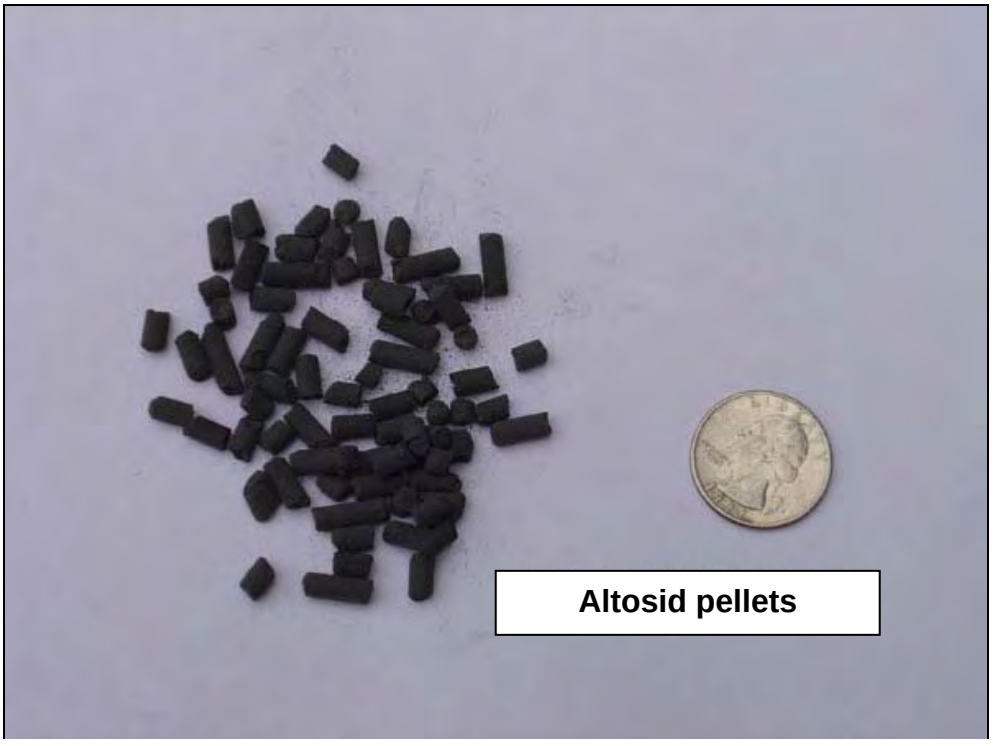
Organic Materials Review Institute
P.O. Box 11558, Eugene, OR 97440-3758, USA
541.343.7600 · info@omri.org · OMRI.org

Insect Growth Regulator

Altosid® (methoprene)

Methoprene is an Insect Growth Regulator (IGR), which is the active ingredient in the larvicide Altosid. A larvicide attacks mosquitoes in the larval stage, when they are waterborne and concentrated together, before they emerge as biting adults. Methoprene's disruption of the mosquito growth cycle allows it to be defined as a biorational agent, rather than a conventional pesticide. It specifically targets mosquito larvae, but does not kill them until they reach their next developmental stage, the pupae. Extensive studies have shown that methoprene breaks down quickly in the environment, spares non-target organisms, and poses no hazard to humans. Altosid can be used in briquet form, a formulation which contains only 7.9% methoprene, and 92.1% inert ingredients, in the shape of a hard, round disc. These briquets are placed in areas where mosquito breeding occurs, and over a period of 30 or 150 days (depending on formulation), methoprene is continually released. However, methoprene has no effect on mosquitoes which have already reached the pupal or adult stage.

Liquid and a pellet form of Altosid are also available, and can be applied by hand, truck or aerial methods. CMMCP currently uses methoprene pellets in catch basins as part of our West Nile Virus program targeting the *Culex* species of mosquito.



Altosid pellets

Altosid® PELLETS WSP

MOSQUITO GROWTH REGULATOR

ZOËCON®

- **A GRANULAR PRODUCT TO PREVENT ADULT MOSQUITO EMERGENCE *(including those which may transmit West Nile virus)***
- **IDEAL WHEN TREATING HARD-TO-REACH STORMWATER SITES**
- **READY-TO-USE WATER SOLUBLE POUCHES (WSP)**
- **A SINGLE WSP COVERS UP TO 135 FT² OF WATER SURFACE AREA**

SPECIMEN LABEL

ACTIVE INGREDIENT:

(S)-Methoprene (CAS# 65733-16-6).....	4.25%
OTHER INGREDIENTS:.....	95.75%
TOTAL	100.00%

EPA Reg. No. 2724-448 EPA Est. No. 2724-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

See additional Precautions

PRECAUTIONARY STATEMENTS – HAZARDS TO HUMANS & DOMESTIC ANIMALS CAUTION

Causes moderate eye irritation. Harmful if absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

FIRST AID
Call a poison control center or doctor for treatment advice.
IF IN EYES • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
IF ON SKIN • Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-248-7763 for emergency medical treatment information.

ENVIRONMENTAL HAZARDS

Do not contaminate water when disposing of rinsate or equipment washwaters.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling

INTRODUCTION

ZOECON® ALTOSID® Pellets WSP (ALTOSID® Pellets WSP) release ALTOSID®, an Insect Growth Regulator as they erode. **ALTOSID® Pellets WSP** prevent the emergence of adult standing water mosquitoes, including *Anopheles, Culex, Culiseta, Coquillettidia,* and *Mansonia* spp., as well as adults of the floodwater mosquitoes, such as *Aedes, Ochlerotatus,* and *Psorophora* spp. from treated sites.

GENERAL DIRECTIONS

ALTOSID® Pellets WSP release effective levels of ALTOSID® Insect Growth Regulator for up to 30 days under typical environmental conditions. Continue treatment through the last brood of the season. Treated larvae continue to develop normally to the pupal stage where they die.

NOTE: This insect growth regulator has no effect on mosquitoes which have reached the pupal or adult stage prior to treatment.

ALTOSID® Pellets WSP are convenient ready-to-use pouches for treating mosquito breeding sites. The pouches are water-sensitive and when in contact with water, the pouches dissolve, releasing the pellets. Use care when handling unused pouches so that moisture does not collect on the pouches. Keep pouches sealed in the original package until ready for use. Once outer foil bag containing water soluble pouches is opened, use pouches within one day.

APPLICATION SITES

ALTOSID® Pellets WSP are effective against *Anopheles, Culex, Culiseta, Aedes, Ochlerotatus, Coquillettida, Mansonia* and *Psorophora* mosquito species. Use pouches to treat small bodies of water such as: catch basins, storm drains, roadside ditches, tree holes, flooded crypts, transformer pits, fish ponds, woodland pools, fountains, septic tanks, ornamental ponds, manmade depressions, animal watering troughs, ditches, and other natural or artificial water-holding containers.

APPLICATION RATE

Place one pouch into each catch basin. For other mosquito breeding sites, one pouch will treat up to 135 ft^2 of surface area. **ALTOSID® Pellets WSP** will provide up to 30 days control of emerging adult mosquitoes.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal. Store closed containers of Altosid® Pellets WSP in a cool, dry place. **Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. **Container Handling:** Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available, or dispose of empty outer foil pouch in the trash as long as Water Soluble Pouch (WSP) is unbroken.

WARRANTY AND CONDITIONS OF SALE

Seller makes no warranty, expressed or implied, concerning the use and handling of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

For information or in case of an emergency, call 1-800-248-7763.

www.altosid.com

Produced for:

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

300512279

February, 2012
Schaumburg, IL

Pupacide
BVA2
Mosquito larvicide oil

BVA2 Mosquito Larvicide Oil is a highly refined oil used for the control of mosquito pupa. When applied evenly over the water surface it rapidly interrupts the air/water interface and suffocates the larvae. BVA2 can be applied to any mosquito habitat with standing water. Pupae and larvae are dependent on surface tension to attach their siphon tubes and breathe air. This oil creates a monomolecular surface film, whereby the pupae and larvae cannot attach to the surface, and either drown or suffocate due to the oil clogging their airways. This will also prevent the female from resting on the surface to lay her eggs.

Using conventional spraying methods, a monomolecular film rapidly spreads over the surface of standing water habitats. BVA2 may be used to control mosquito larvae in swamps, marshes, floodwater areas, drainage areas, storm sewer catch basins, waste treatment facilities, settling ponds, ditches, temporary rain pools and other man-made depressions containing stagnant water pools, including, abandoned swimming pools, fountains and ponds. BVA2 has a water-white clear color and is practically odorless.

BVA2 does not depend on life-cycle time for effectiveness. As it kills by suffocation, mosquitoes do not develop resistance because control is through a physical mode of action. When applied as directed this product does not leave a dark oily film. The oil photodegrades rapidly, breaking down into harmless components after a few days.

Another advantage of the physical mode of action is its effectiveness on all mosquito species. Although larvae are also susceptible to this oil, it is only used when a majority of pupae are present, because Bti and methoprene are more selective to mosquito larvae. Since Bti and methoprene do not affect mosquito pupae, this is the final method used to prevent the pupae from emerging into the adult mosquito. This oil is used at very low rates due to its nature to spread into a thin film over the water surface. This oil is applied by pump can, and other hand sprayers.

PRECAUTIONARY STATEMENTS
CAUTION

Harmful if swallowed. Avoid contact with eyes, skin and clothing. Wear goggles and chemical-resistant gloves. Avoid breathing spray, mists or vapors. Wash hands after using. Avoid contamination of food or food stuffs.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are chemical-resistant to this product are barrier laminate, nitrile rubber, neoprene rubber, and Viton. If you want more options, follow the instructions for category E on an EPA chemical-resistance selection chart.

Mixers, loaders, applicators, flaggers, and other handlers must wear:

- Long-sleeved shirt and long pants,
- Shoes plus socks, and
- Chemical-resistant gloves.

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

ENGINEERING CONTROLS

Pilots must use an enclosed cockpit that meets the requirements listed in the WPS for agricultural pesticides [40 CFR 170.240(d)(6)].

USER SAFETY RECOMMENDATIONS

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE if pesticide gets inside. Then, wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash outside of gloves before removing them. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, except as directed for use on this label. Aquatic organisms may be killed in waters where this product is used. Consult the State agency, with primary responsibility for regulating pesticides, before applying to public waters to determine if a permit is needed. Do not contaminate water when disposing of equipment washwater or rinsate. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.

PHYSICAL AND CHEMICAL HAZARDS

Do NOT store, use, pour or spill near flames or excessive heat. In case of fire, use water spray, foam, CO_2, or dry chemical.

TERMS

To the extent consistent with applicable laws, the seller's guarantee is limited to the terms on the label. The buyer accepts the product on these conditions. Timing and method of applications, crop conditions, weather, and mixtures with chemicals in the use of this product are beyond the control of the seller.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: Store in a cool, dry, locked area out of the reach of children. Do not store near excessive heat or open flame.
PESTICIDE DISPOSAL: Pesticide or pesticide waste rinse solution that cannot be used according to the label, must be disposed of according to applicable Federal, State, or local procedures or at an approved waste disposal facility.
CONTAINER DISPOSAL: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into the mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into the mix tank or store rinsate for later disposal. Repeat this procedure two more times. Then offer for recycling, if available. If recycling is not available, puncture container and dispose of it in a sanitary landfill or by other approved State and local procedures.

BVA 2 MOSQUITO LARVICIDE OIL

ACTIVE INGREDIENT:	**% BY WT.**
Mineral Oil*	97%
Other Ingredients	3%
Total	100%

*Contains petroleum distillate

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID	
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible. • Call a poison control center or doctor for further treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If in eyes	• Call a poison control center or doctor for treatment advice. • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
If swallowed	• Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.
Have the product container or label with you when calling a poison control center, or doctor, or going for treatment. You may also contact CHEMTREC 1.800.424.9300 for emergency medical treatment information.	
NOTE TO PHYSICIAN: This product contains petroleum distillate and may pose an aspiration pneumonia hazard.	

See left side panel for additional precautionary statements

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact adults, children, or pets, either directly or through drift. Do not allow adults, children, or pets to enter treated areas until sprays have dried.

BVA 2 Mosquito Larvicide may be used to control mosquito larvae in swamps, marshes, floodwater areas, drainage areas, storm sewer catch basins, waste treatment facilities, settling ponds, ditches, temporary rain pools and other man-made depressions containing stagnant water pools, including, abandoned swimming pools, fountains and ponds.

Apply **BVA 2 Mosquito Larvicide** at rates of 1-5 gallons per acre depending on how dense the vegetation and weeds may be. This product may be applied by the following methods: handgun or handwand sprayer and by air.

BVA 2 Mosquito Larvicide has a water-white clear color and is practically odorless.

DIRECTIONS FOR USE (continued)

BVA 2 Mosquito Larvicide does not depend on life-cycle time for effectiveness. As it kills by suffocation, mosquitoes do not develop resistance. When applied as directed this product does not leave a dark oily film.

SPRAY DRIFT MANAGEMENT

A variety of factors (e.g., wind direction, wind speed, temperature, and relative humidity) and method of application (e.g., handgun, handwand, ground or aerial) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

Wind Speed: Do not apply at wind speeds greater than 15 mph at the application site.

Temperature Inversions: If applying at wind speeds less than 3 mph, the applicator must determine if:
a) conditions of temperature inversion exist, or
b) stable atmospheric conditions exist at or below nozzle height.
Do not make applications into areas of temperature inversions or stable atmospheric conditions.

Droplet Size: Apply as a medium or coarser spray (ASABE standard 572), and the minimum volume mean diameter (VMD) for spinning atomizer nozzles.

Ground Spray (Handgun or Handwand) Applications

Ground applications must be in compliance with the specifications indicated above regarding **Wind Speed, Temperature Inversions,** and **Droplet Size**.
Apply using a nozzle height of no more than 4 feet above the ground, water surface, or crop canopy.

Aerial Applications

Aerial applications must be in compliance with the specifications indicated above regarding **Wind Speed, Temperature Inversions,** and **Droplet Size**.

Release Height: Do not release spray at a height greater than 10 feet above the ground, water surface, or the tops of plants that are to be sprayed.

Boom Length: The boom length must not exceed 75% of the wingspan or 90% of the rotor blade diameter.

Swath Adjustment: When applications are made with a cross-wind, the swath will be displaced downwind. The applicator must compensate for this displacement at the downwind edge of the application area by adjusting the path of the aircraft upwind. Leave at least one untreated swath at the downwind edge of the treated field.

TREATMENT RATES

Apply this product at rates of 1 to 5 gallons per acre (3 to 15 fl. oz. per 1000 sq. ft.) depending on water surface conditions and vegetative density. Use 1 to 2½ gallons per acre (3 to 7½ fl. oz. per 1000 sq. ft.) if trees are in green tip stage, vegetative cover is light and water is essentially clean.

To penetrate heavier or denser vegetative cover, or if water is substantially polluted, use 2½ to 5 gallons per acre (7½ to 15 fl. oz. per 1000 sq. ft.).

An average rate of 2½ to 3 gallons per acre (approximately 1 quart per 5000 sq. ft. (50'x100' area)), 7½ to 9 fl. oz. per 1000 sq. ft. or 2-4 teaspoons per 100 sq. ft. (10'x10' area) of water surface covers most conditions.

BVA Oils (a division of B-V Associates, Inc.)
29222 Trident Industrial Blvd.
New Hudson, MI 48165
800.231.3376
www.bvaoils.com
REV042913

LOT#_____ NET CONTENTS:_____

See right side panel for remainder of **DIRECTIONS FOR USE** section

EPA Reg. No. 70589-1 EPA Est. No. 55206-MI-001

Zenivex E4®

(etofenprox)

The product name of the mosquito adulticide used by the Project is called Zenivex E4®. It does not contain piperonyl butoxide like other products used in the past. Etofenprox is a 4% solution of the synthetic pyrethroid etofonprox. It is sprayed from the truck at 4.5 ounces per minute, at a vehicle speed of 5-15 miles per hour. This is 0.00175 pounds of active ingredient per acre. This presents a minimal risk to humans, pets and non-target species. The active ingredient in Zenivex E4® breaks down in sunlight in a few short hours.

Spraying with Zenivex E4®

The Project conducts an evening spray program which runs from approximately Memorial Day to mid-September. Weather, mosquito populations and virus activity determine the actual beginning and end of our spray program. The time of day the applications take place is after sunset up to about midnight. During this time the mosquito is actively seeking a blood meal, and spraying at this time allows us to control the adult mosquito with a minimal risk of exposure to the public and other non-target insects.

The type of spraying practiced by the Project is called "ULV" spraying. ULV is an abbreviation for ultra low volume, a method of spraying which allows us to control adult mosquitoes, and be as environmentally sensitive as possible. The spray machines are mounted on the back of pickup trucks, and the applicator drives the vehicle in the area to be sprayed. The vehicle operator controls the spray from inside the vehicle, without needing to shut down the spray machine. These applications are based on public request or after confirmation of mosquito-borne virus, and the applicator confirms the presence of a mosquito problem by conducting a landing count or by other surveillance methods. Spraying is done after sunset as a protection to honeybees and other native pollinator species.

Exclusions from Spraying

If for any reason a person wishes their property to be excluded from mosquito spraying, the Mass. Dept. of Agricultural Resources has information on the exclusion process (333CMR 13.04). The property to be excluded has to be marked every 50 feet with signs indicating "No Spray". Paper plates are recommended for these signs. Technicians keep a current list of no spray properties with them during all pesticide applications, and we also use GPS units to locate these properties. Any questions about our program or the exclusion process can be directed to our office at (508) 393-3055 during business hours.

Zenivex® E4 RTU

For use only by federal, state, tribal, or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

- **FOR THE CONTROL OF ADULT MOSQUITOES, NON-BITING MIDGES, AND BLACK FLIES**
- **FOR USE AS A SPACE SPRAY BY AIR AND GROUND APPLICATION TO CONTROL ADULT MOSQUITOES**
- **APPROVED FOR USE OVER AGRICULTURAL CROPS (INCLUDING THOSE INTENDED FOR HUMAN CONSUMPTION), PASTURE AND RANGELAND**
- **READY TO USE WITHOUT DILUTION**
- **CONTROLS ADULT MOSQUITOES THAT MAY CARRY WEST NILE VIRUS, EASTERN EQUINE ENCEPHALITIS, ST. LOUIS ENCEPHALITIS**
- **CONTROLS NON-BITING MIDGES, NUISANCE AND BITING FLIES**
- **QUICK, PERMANENT KNOCKDOWN OF ADULT MOSQUITOES**

SPECIMEN LABEL

ACTIVE INGREDIENT:	
Etofenprox (CAS #80844-07-1).	4%
OTHER INGREDIENTS*:	96%
Total:	100%

*Contains petroleum distillates
Contains 0.30 lbs etofenprox per gallon

EPA Reg. No. 2724-807 EPA Est. No. 2724-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

See additional Precautionary Statements,

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS CAUTION

Harmful if swallowed. Causes moderate eye irritation. Avoid contact with eyes, skin, or clothing. Applicators and other handlers must wear long-sleeved shirt, long pants, socks and shoes. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove contaminated clothing and launder before reuse. Repeated exposure to etofenprox can cause skin irritation.

FIRST AID

If swallowed • Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.

If in eyes • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. • Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-248-7763 for emergency medical treatment information.

NOTE TO PHYSICIAN: May pose an aspiration pneumonia hazard. Contains petroleum distillate.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates. Runoff from treated areas or deposition into bodies of water may be hazardous to fish and other aquatic organisms. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are

present, and weather conditions will facilitate movement of applied material away from water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or washwaters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Time applications to provide the maximum possible interval between treatment and the next period of bee activity. Do not apply to blooming crops or weeds when bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL/CHEMICAL HAZARDS

Combustible. Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. **READ AND FOLLOW ALL LABEL DIRECTIONS.** Before making the first application of the season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist.

GENERAL

ZENIVEX® E4 RTU is an effective insecticide used at low volumes to control adult mosquitoes, non-biting midges, biting and non-biting flies. Use **Zenivex® E4 RTU** undiluted as UltraLow Volume (ULV) for the control of pest species in or near residential, industrial, commercial, urban, recreational areas, woodlands, golf courses, and other areas where these pests are a problem. **Zenivex® E4 RTU** may be applied over agricultural areas prior to or following harvest for the control of adult mosquitoes within or adjacent to these areas. Apply **Zenivex® E4 RTU** aerially (both fixed and rotary aircraft) for low volume applications or through mist-blowers, backpack, and handheld sprayers for ground applications. **Zenivex® E4 RTU** will control mosquitoes and flies and can be used as part of a total integrated pest management program for controlling disease vectors. Apply **Zenivex® E4 RTU** at rates from 0.00175 to 0.0070 pounds of etofenprox per acre by ground ULV. Use this product undiluted only; do not mix with water. Apply when wind is ≥ 1 mph. Do not apply when wind speeds exceed 10 mph. A temperature inversion is preferable to keep the fog close to the ground and applications should be made when labeled insects are most active. Do not spray more than 0.18 lbs etofenprox per acre per site per year. Do not make more than 25 applications per site per year. More frequent treatments may be made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

GROUND APPLICATION

Use a vehicle-mounted cold aerosol ULV sprayer to apply the product. Direct the spray equipment nozzle to provide even distribution of the product. For best results, apply perpendicular to the wind direction using a swath width of 300 ft. Spray equipment must be adjusted so that the volume median diameter (VMD) is between 10-30 microns ($10\mu \leq D_{v0.5} \leq 30\mu$) and that 90% of the spray is contained in droplets smaller than 50 microns ($D_{v0.9} < 50\mu$). Directions from the equipment manufacturer or vendor, pesticide registrant, or test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

The appropriate application rate can be achieved by using the following table. Refer to the following chart for examples.

Application rate pound A.I. per acre	Flow rates Undiluted Oz/Acre	Flow rates Undiluted Oz/Minute	Vehicle Speed
0.00175	0.75	2.25	5
		4.50	10
		7.00	15
0.00350	1.5	4.50	5
		9.00	10
		13.50	15
0.00700	3.0	9.00	5
		18.00	10

Use the higher label rates when spraying areas where dense vegetation is present. Conduct applications when temperatures are between 50-95° F.

Backpack Sprayer ULV Application

Apply **Zenivex® E4 RTU** undiluted through non-thermal ULV backpack sprayer capable of applying the product in the 10 to 30 micron range. Apply product to the area as evenly as possible. Apply at the rate of 0.00175 to 0.0070 pounds etofenprox per acre.

Urban ULV Mosquito Control Applications

For control of resting or flying adult mosquitoes, biting flies and non-biting midges in areas such as utility tunnels, sewers, storm drains and catch basins, pipe chases, underground basements, underground passages, parking decks, crawl spaces or uninhabited

buildings, apply **Zenivex® E4 RTU** using mechanical foggers, hand-held or truck-mounted ULV equipment, thermal foggers or other spray equipment suitable for this application. Apply **Zenivex® E4 RTU** at rates up to but not exceeding 0.0070 pounds of etofenprox per acre.

Thermal Fogging Application
Apply using a truck, dolly mounted, handheld, or other thermal fogging equipment. Following the equipment manufacturer's instructions, apply this product at a rate of 0.00175 to 0.0070 pounds etofenprox per acre. Direct fog to areas where mosquitoes and other pests are located. The volume median diameter (VMD) of droplets produced by thermal foggers is less than 60 microns ($D_{v0.5}$ < 60µ) and 90% of the spray is contained in droplets smaller than 100 microns ($D_{v0.9}$ < 100µ).

AERIAL APPLICATION
Apply **Zenivex® E4 RTU** aerially, undiluted, by fixed wing or rotary aircraft. Apply at the rate of 0.00175 to 0.0070 pounds of etofenprox per acre. Apply using ULV equipped and capable aircraft. Spray equipment must be adjusted so that the volume median diameter (VMD) produced is less than 60 microns ($D_{v0.5}$ < 60µ) and that 90% of the spray is contained in droplets smaller than 100 microns ($D_{v0.9}$ < 100µ). The effects of flight speed and, for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant, or test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated. Do not apply **Zenivex® E4 RTU** at altitudes below 100 feet. Apply at altitudes from 100-300 feet. Apply when wind speed on the ground is ≥ 1 mph. Apply when labeled insects are most active. For best results, use Global Positioning System (GPS) equipped aircraft.

IN FLORIDA: Aerial applications of this product require trained personnel to perform industry accepted assays to monitor resistance formation In targeted mosquitoes.

APPLICATIONS OVER CROPS OR TO AREAS FAVORING DRIFT OVER CROPS

Zenivex® E4 RTU may be applied over crops (including row, tree, fruit, citrus, pasture and other areas where agricultural enterprises take place) or to areas, where drift over cropland could occur. **Zenivex® E4 RTU** can be applied to these areas by either ground or aerial application. Use label rates and follow directions for use as directed in this label. Applications over crops or where drift may occur over crops are limited to 4 applications per month to the same site but no more than two applications within a seven day interval. Do not apply more than 0.028 pounds of active ingredient per month to the same site within a month. Do not spray more than 0.18 lbs etofenprox per acre per site per year. Do not make more than 25 applications per site per year.

PESTICIDE STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

STORAGE AND SPILL PROCEDURES: Store upright at room temperature. Avoid exposure to extreme temperatures. In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, earth, fuller's earth, etc. Dispose of with chemical waste.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Refillable 30 Gallon Drums, 120 Gallon Mini-Tote and 275 Gallon Tote: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. If not refilled, offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration. To clean the container before final disposal, triple rinse (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with mineral oil or other suitable oil diluents. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Non-refillable 2.5 gallon containers: Non-refillable container.** Triple rinse (or equivalent), promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or mix tank and drain container for 10 seconds after the flow begins to drip. Fill the container ¼ full of with mineral oil or other suitable oil diluents and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank. Drain container for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Once triple rinsed, recycle if available, or puncture and dispose of in a sanitary landfill, or by incineration.

To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

In case of an emergency or for product use information, call **1-800-248-7763**.

www.zenivex.com

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON®

VEC 16-015

April, 2016
Schaumburg, IL

United States Environmental Protection Agency | Prevention, Pesticides and Toxic Substances (7506C) | May 2000

EPA Questions & Answers

Pesticides and Mosquito Control

Mosquito-borne diseases affect millions of people worldwide each year. In the United States, some species of mosquitoes can transmit diseases such as encephalitis, dengue fever, and malaria to humans, and a variety of diseases to wildlife and domestic animals. To combat mosquitoes and the public health hazards they present, many states and localities have established mosquito control programs. These programs, which are based on surveillance, can include nonchemical forms of prevention and control as well as ground and aerial application of chemical and biological pesticides.

The mission of the Environmental Protection Agency (EPA) is to protect human health and the environment. EPA reviews and approves pesticides and their labeling to ensure that the pesticides used to protect public health are applied by methods which minimize the risk of human exposure and adverse health and environmental effects. In relation to mosquito control, the Agency also serves as a source of information about pesticide and non-pesticide controls to address the concerns of the general public, news media, and the state and local agencies dealing with outbreaks of infectious diseases or heavy infestations of mosquitoes. The following questions and answers provide some basic information on mosquito control, safety precautions, and information on insecticides used for mosquito control programs.

1. How does EPA ensure the safest possible use of pesticides?

EPA must evaluate and register pesticides before they may be sold, distributed or used in the United States. The Agency is also in the process of reassessing and when appropriate, reregistering all older pesticides (registered prior to 1984) to ensure that they meet current scientific standards. To evaluate a pesticide for either registration or re-registration, EPA assesses a wide variety of potential human health and environmental effects associated with use of the product. The producer of the pesticide must provide data from tests done according to EPA guidelines. These tests determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms. Other tests help to assess the risks of contaminating surface water or groundwater from leaching, runoff or spray drift. If a pesticide meets EPA requirements, the pesticide is approved for use in accordance with label directions. **However, no pesticide is 100 percent safe and care must be exercised in the use of any pesticide.**

2. How are mosquitoes controlled with pesticides and other methods?

The first step in mosquito control is surveillance. Mosquito specialists conduct surveillance for diseases harbored by domestic and non-native birds, including sentinel chickens, and mosquitoes. Surveillance for larval habitats are conducted using maps, aerial photographs, and by evaluating larval populations. Other techniques include various light traps, biting counts; and analyzing reports by the public. Mosquito control programs also put high priority on trying to prevent a large population of adult mosquitoes from developing, so that additional controls may not be necessary. Since mosquitoes must have water to breed, methods of prevention may include controlling water levels in lakes, marshes, ditches, or other mosquito breeding sites, eliminating small breeding sites if possible, and stocking bodies of water with fish species that feed on larvae. Both chemical and biological measures may be employed to kill immature mosquitoes during larval stages. *Larvicides* target larvae in the breeding habitat before they can mature into adult mosquitoes and disperse. Larvicides include the bacterial insecticides *Bacillus thuringiensis israelensi*s and *Bacillus sphaericus*, the insect growth inhibitor methoprene, and the organophosphate insecticide temephos. Mineral oils and other materials form a thin film on the surface of the water which cause larvae and pupae to drown. Liquid larvicide products are applied directly to water using back-pack sprayers and truck or aircraft-mounted sprayers. Tablet, pellet, granular and briquet formulations of larvicides are also applied by mosquito controllers to breeding areas.

Key Tools in Combating Mosquitoes

Public education and prevention around the home – eliminating mosquito breeding habitats (any standing water) around the home. Proper use of mosquito repellants and common sense measures to reduce exposure to insecticides.

Larvicide – insecticide designed to kill mosquitoes during its larval stage. Larvicides are applied to known mosquito breeding areas to kill larvae.

Adulticide – insecticide designed to kill adult mosquitoes. Mosquito control professionals apply adulticides with ultra low volume (ULV) spray equipment which releases tiny particles of insecticide solution into the air. The amount of pesticide released is typically a few ounces per acre of treated area. Adulticides may be applied from aircraft, vehicles on the ground, or by professional applicators on foot.

Adult mosquito control may be undertaken to combat an outbreak of mosquito-borne disease, or a very heavy nuisance infestation of mosquitoes in a community. Pesticides registered for this use are *adulticides* and are applied either by aircraft or on the ground employing truck-mounted sprayers. State and local agencies commonly use the organophosphate insecticides malathion and naled, and the synthetic pyrethroid insecticides permethrin, resmethrin and sumithrin for adult mosquito control.

Mosquito adulticides are applied as ultra-low volume (ULV) sprays. ULV sprayers dispense very fine aerosol droplets that stay aloft and kill flying mosquitoes on contact. ULV applications involve

small quantities of pesticide active ingredient in relation to the size of the area treated, typically less than three ounces per acre, which minimizes exposure and risks to people and the environment.

3. What can I do to reduce the number of mosquitoes in and around my home?

The most important step is to eliminate potential breeding habitats for mosquitoes. Get rid of any standing water around the home, including water in potted plant dishes, garbage cans, old tires, gutters, ditches, wheelbarrows, bird baths, hollow trees, and wading pools. Any standing water should be drained, including abandoned or unused swimming pools. Mosquitoes can breed in any puddle that lasts more than four days. Make sure windows and screen doors are "bug tight." Replace outdoor lights with yellow "bug" lights. Wear headnets, long sleeve shirts, and long pants if venturing into areas with high mosquito populations, such as salt marshes or wooded areas. Use mosquito repellants when necessary, always following label instructions.

4. Should I take steps to reduce exposure to pesticides during mosquito control spraying?

Generally, there is no need to relocate during mosquito control spraying. The pesticides have been evaluated for this use and found to pose minimal risks to human health and the environment when used according to label directions. For example, EPA has estimated the exposure and risks to both adults and children posed by ULV aerial and ground applications of the insecticides malathion and naled. For all the exposure scenarios considered, exposures ranged from 100 to 10,000 times below an amount of pesticide that might pose a health concern. These estimates assumed several spraying events over a period of weeks, and also assumed that a toddler would ingest some soil and grass in addition to dermal exposure. Other mosquito control pesticides pose similarly low risks. (For more details on health and environmental risk considerations, see the separate EPA fact sheets on the specific mosquito control pesticides).

Although mosquito control pesticides pose low risks, some people may prefer to avoid or further minimize exposure. Some common sense steps to help reduce possible exposure to pesticides include:

* Listen and watch for announcements about spraying in the local media and remain indoors during the application to the immediate area.

* People who suffer from chemical sensitivities or feel spraying may aggravate a preexisting health condition, may consult their physician or local health department and take special measures to avoid exposure.

* Close windows and turn off window-unit air conditioners when spraying is taking place in the immediate area.

* Do not let children play near or behind truck-mounted applicators when they are in use.

5. Where can I get more information?

For more information about mosquito control in your area, contact your state or local health department. The federal Centers for Disease Control and Prevention is also a source of information on disease control, and their Internet web site includes a listing of state health departments. To contact the **Centers for Disease Control and Prevention (CDC):**

Telephone: 970-221-6400
Fax: 970-221-6476
E-mail: dvbid@cdc.gov
web site: http://www.cdc.gov

Information on pesticides used in mosquito control can be obtained from the state agency which regulates pesticides, or from the **National Pesticide Telecommunications Network (NPTN).** The NPTN web site includes links to all state pesticide regulatory agencies.
Toll-free hotline: 1-800-858-7378 (9:30 a.m. to 7:30 p.m. EST) daily except holidays. Callers outside normal hours can leave a voice mail message, and NPTN returns these calls the next business day.
E-mail: nptn@ace.orst.edu
web site: http://ace.orst.edu/info/nptn

Information on mosquito control programs can also be obtained from the **American Mosquito Control Association (AMCA)**
web site: http://www.mosquito.org
This site also lists many county mosquito agencies.

Other Helpful EPA Publications

For Your Information - How to Use Insect Repellents Safely (735-F-93-052R)

For Your Information - Mosquitoes: How to Control Them (735-F-98-003)

For Your Information - Larvicides for Mosquito Control (735-F-00-002)

For Your Information - Naled for Mosquito Control (735-F-00-003)

For Your Information - Malathion for Mosquito Control (735-F-00-001)

For Your Information - Synthetic Pyrethroids for Mosquito Control

For more information regarding the federal pesticide regulatory programs, contact:
EPA Office of Pesticide Programs
Telephone: 703-305-5017
Fax: 703-305-5558
E-mail: opp-web-comments@epa.gov
web site: http://www.epa.gov/pesticides

EPA Regional Offices

Region I - CT, MA, ME, NH, RI, VT
888-372-7341
www.epa.gov/region01

Region II - NJ, NY, PR, VI
212-637-3660
www.epa.gov/region02

Region III - DE, DC, MD, PA, VA, WV
800-438-2474 or **215-814-5000**
www.epa.gov/region03

Region IV - AL, FL, GA, KY, MS, NC, SC, TN
800-241-1754
www.epa.gov/region4

Region V - IL, IN, MI, MN, OH, WI
800-621-8431 (Region V only)
or **312-353-2000**
www.epa.gov/region5

Region VI - AR, LA, NM, OK, TX
800-887-6063 (Region VI only)
or **214-665-6444**
www.epa.gov/region6

Region VII - IA, KS, MO, NE
800-223-0425 or **303-312-6312**
www.epa.gov/region7

Region VIII - CO, MT, ND, SD, UT, WY
800-227-8917 (Region VIII only)
or **303-312-6312**
www.epa.gov/region08

Region IX - AZ, CA, HI, NV, AS, GU
415-744-1500
www.epa.gov/region09

Region X - AK, ID, OR, WA
800-424-4372 (Region X only)
or **206-553-1200**
www.epa.gov/r10earth

United States Environmental Protection Agency
Prevention, Pesticides and Toxic substances (7506C)
May 2000
735-F-00-002

FOR YOUR INFORMATION

Larvicides for Mosquito Control

EPA evaluates and licenses pesticides

The Environmental Protection Agency (EPA) evaluates and registers (licenses) pesticides to ensure they can be used safely. These pesticides include products used in the mosquito control programs which states and communities have established. To evaluate any pesticide, EPA assesses a wide variety of tests to determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms.

mosquito officials select control measures that best suit local conditions

Officials responsible for mosquito control programs make decisions to use pesticides based on an evaluation of the risks to the general public from diseases transmitted by mosquitoes or on an evaluation of the nuisance level that communities can tolerate from a mosquito infestation. Based on surveillance and monitoring, mosquito control officials select specific pesticides and other control measures that best suit local conditions in order to achieve effective control of mosquitoes with the least impact on human health and the environment. It is especially important to conduct effective mosquito prevention programs by eliminating breeding habitats or applying pesticides to control the early life stages of the mosquito. Prevention programs, such as elimination of any standing water that could serve as a breeding site, help reduce the adult mosquito population and the need to apply other pesticides for adult mosquito control. Since no pesticide can be considered 100% safe, pesticide applicators and the general public should always exercise care and follow specified safety precautions during use to reduce risks. This fact sheet provides basic information on larvicides, a type of pesticide used in mosquito control programs.

What are Larvicides?

larvicides kill insect larvae

The mosquito goes through four distinct stages during its life cycle: egg, larva, pupa, and adult (see box). Larvicides kill insect larvae. Larvicides include

biological insecticides, such as the microbial larvicides *Bacillus sphaericus* and *Bacillus thuringiensis israelensis*. Larvicides include other chemicals used for controlling mosquito larvae, such as temephos, methoprene, oils, and monomolecular films. Larvicide treatment of breeding habitats help reduce the adult mosquito population in nearby areas.

How are Larvicides Used in Mosquito Control?

larvicides are used as one of several tools in mosquito control

State and local agencies in charge of mosquito control typically employ a variety of techniques in an Integrated Pest Management (IPM) approach, which include *surveillance, source reduction, larviciding* and *adulticiding*, to control mosquito populations. Since mosquitoes must have water to breed, source reduction aims to cut down opportunities for breeding, and can be as simple as turning over trapped water in a container to large-scale engineering and management of marsh water. Larviciding involves applying chemicals to habitats to kill pre-adult mosquitoes. Larviciding can reduce overall pesticide usage in a control program by reducing or eliminating the need for ground or aerial application of chemicals to kill adult mosquitoes.

What are Microbial Larvicides?

microbial larvicides are bacteria that are registered as pesticides

Microbial larvicides are bacteria that are registered as pesticides for control of mosquito larvae in outdoor areas such as irrigation ditches, flood water, standing ponds, woodland pools, pastures, tidal water, fresh or saltwater marshes, and storm water retention areas. Duration of effectiveness depends primarily on the mosquito species, the environmental conditions, the formulation of the product, and water quality. Microbial larvicides may be used along with other mosquito control measures in an integrated pest management (IPM) program. The microbial larvicides used for mosquito control are *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (Bs).

Mosquito Life Cycle

egg - hatch when exposed to water;

larva - (pl. - larvae) lives in the water; molts several times; most species surface to breathe air;

pupa - (pl. - pupae) non-feeding stage just prior to emerging as adult;

adult - flies short time after emerging and after its body parts have hardened.

- ***Bacillus thuringiensis israelensis*** (*Bti*) is a naturally occurring soil bacterium registered for control of mosquito larvae. *Bti* was first registered by EPA as an insecticide in 1983. Mosquito larvae eat the *Bti* product which is made up of the dormant spore form of the bacterium and an associated pure toxin. The toxin disrupts the gut in the mosquito by binding to receptor cells present in insects, but not in mammals. There are 25 *Bti* products registered for use in the United States. Aquabac, Teknar, Vectobac, and LarvX are examples of common trade names for the mosquito control products.

microbial larvicides are harmful to insects but not mammals

- ***Bacillus sphaericus*** is a naturally occurring bacterium that is found throughout the world. *Bacillus sphaericus* was initially registered by EPA in 1991 for use against various kinds of mosquito larvae. Mosquito larvae ingest the bacteria, and as with *Bti,* the toxin disrupts the gut in the mosquito by binding to receptor cells present in insects, but not in mammals. VectoLex CG and WDG are registered *B. sphaericus* products, and are effective for approximately one to four weeks after application.

Do Microbial Larvicides Pose Risks to Human Health?

The microbial pesticides have undergone extensive testing prior to registration. They are essentially nontoxic to humans, so there are no concerns for human health effects with *Bti,* or *B. sphaericus,* when they are used according to label directions.

microbial larvicides do not pose concerns for human health or the environment when used according to product labels

Do Microbial Larvicides Pose Risks to Wildlife or the Environment?

Extensive testing shows that microbial larvicides do not pose risks to wildlife, non-target species or the environment.

What is Methoprene?

Methoprene is a compound first registered by EPA in 1975 that mimics the action of an insect growth regulating hormone and prevents the normal maturation of insect larvae. It is applied to water to kill mosquito larvae and it may be used along with other mosquito control measures in an IPM program. Altosid is the name of the methoprene product used in mosquito control and is applied as briquets (similar in form to charcoal briquets), pellets, sand granules, and liquids. The liquid and pelletized formulations can be applied by helicopter and fixed-wing aircraft.

methoprene is an insect growth regulator

Does Methoprene Pose Risks to Human Health?

methoprene used in mosquito control programs according to label directions does not pose unreasonable risks to human health or the environment

Methoprene, used for mosquito control according to its label directions, does not pose unreasonable risks to human health. In addition to posing low toxicity to mammals, there is little opportunity for human exposure, since the material is applied directly to ditches, ponds, marshes or flooded areas which are not drinking water sources.

Does Methoprene Pose Risks to Wildlife or the Environment?

Methoprene used in mosquito control programs does not pose unreasonable risks to wildlife or the environment. Toxicity of methoprene to birds and fish is low, and it is nontoxic to bees. Methoprene breaks down quickly in water and soil, and will not leach into groundwater. Methoprene is highly toxic to some species of freshwater, estuarine, and marine invertebrates if misused. For that reason, EPA has established specific precautions on the label to reduce such risks.

What is Temephos?

temephos is an organophosphate (OP)

Temephos is an organophosphate (OP) pesticide registered by EPA in 1965, to control mosquito larvae, and is the only organophosphate with larvicidal use. It is an important resistance management tool for mosquito control programs; its use helps prevent mosquitoes from developing resistance to the bacterial larvicides. Temephos is used in areas of standing water, shallow ponds, swamps, marshes, and intertidal zones. It may be used along with other mosquito control measures in an integrated pest management (IPM) program. Abate is the trade name of the temephos product used for mosquito control. Temephos is applied most commonly by helicopter, but can be applied by backpack sprayers, fixed-wing aircraft, and right-of-way sprayers in either liquid or granular forms.

Does Temephos Pose Risks to Human Health?

temephos used according to label directions does not pose unreasonable risks

Temephos, applied according to the label for mosquito control, does not pose unreasonable risks of human health effects. It is applied to water, and the amount of temephos is very small in relation to the area covered, less than one ounce of active ingredient per acre for the liquid and eight ounces per acre for the granular formulations. Temephos breaks down within a few days in water

high dosages of OPs can overstimulate the nervous system

and post application exposure is minimal. However, at high dosages, temephos, like other OPs, can overstimulate the nervous system causing nausea, dizziness, confusion.

Does Temephos Pose Risks to Wildlife or the Environment?

temephos is toxic to bees and it can be toxic to some birds and aquatic species if misused

Because temephos is applied directly to water, it is not expected to have a direct impact on terrestrial animals, but temephos can be highly toxic to some bird species and aquatic organisms if misused, and it is toxic to bees. For that reason, EPA has established specific precautions on the label to reduce such risks. The registrant of temephos has submitted studies on toxicity to aquatic invertebrates, which are being reviewed by EPA.

What is the Current Regulatory Status of Temephos?

EPA is currently reviewing temephos

As part of its responsibility to reassess all older pesticides registered before 1984, EPA is currently reviewing temephos as part of its reregistration process. The review of temephos is scheduled for completion this calendar year. A risk assessment covering all uses of temephos is available to the public on the EPA web site. From the pesticide program home page (see address below), select "OPs," then select "OP Schedule and Documents."

What are Monomolecular Films?

films drown larvae, pupae and emerging adults

Monomolecular films are chemicals that spread a thin film on the surface of the water that makes it difficult for mosquito larvae, pupae and emerging adults to attach to the water's surface, causing them to drown. Films may remain active for typically 10-14 days on standing water, and have been used in the United States in floodwaters, brackish waters, and ponds. They may be used along with other mosquito control measures in an IPM program. They are also known under the trade names Arosurf MSF and Agnique MMF.

Do Monomolecular Films Pose Risks to Human Health?

films do not pose a risk to humans

Monomolecular films, used according to label directions for larva and pupa control, do not pose a risk to human health. In addition to low toxicity, there is little opportunity for human exposure, since the material is applied directly to ditches, ponds, marshes or flooded areas which are not drinking water sources.

Do Monomolecular Films Pose Risks to Wildlife or the Environment?

films pose minimal risks to the environment

Monomolecular films, used according to label directions for larva and pupa control, pose minimal risks to the environment. They do not last in the environment for a long time, and are usually applied only to standing water, such as roadside ditches, woodland pools, or containers which contain few non-target organisms.

What are Oils?

oils form a coating on the water to drown mosquito larvae, pupae and emerging adults

Oils, like films, are used to form a coating on top of water to drown larvae, pupae and emerging adult mosquitoes. They are specially derived from petroleum distillates and have been used for many years in the U.S. to kill aphids on crops and orchard trees, and to control mosquitoes. They may be used along with other mosquito control measures in an IPM program. Trade names for oils used in mosquito control are Bonide, BVA2, and Golden Bear-1111 (GB-1111).

Do Oils Pose Risks to Human Health?

oils do not pose a risk to human health, but may be toxic to aquatic animals if misapplied

Oils, used according to label directions for larva and pupa control, do not pose a risk to human health. In addition to low toxicity, there is little opportunity for human exposure, since the material is applied directly to ditches, ponds, marshes or flooded areas which are not drinking water sources.

Do Oils Pose Risks to Wildlife or the Environment?

Oils, if misapplied, may be toxic to fish and other aquatic organisms. For that reason, EPA has established specific precautions on the label to reduce such risks.

Where Can I get More Information About Larvicides and Mosquito Control?

Centers for Disease Control and Prevention

For more information about mosquito control in your area, contact your state or local health department. The federal Centers for Disease Control and Prevention is also a source of information on disease control, and their Internet web site includes a listing of state health departments. To contact the

Centers for Disease Control and Prevention (CDC):
Call: 970-221-6400 **Fax: 970-221-6476**
E-mail: dvbid@cdc.gov **web site: http://www.cdc.gov**

national toll-free pesticide hotline

Information on pesticides used in mosquito control can be obtained from the state agency which regulates pesticides, or from the **National Pesticide Telecommunications Network (NPTN).** The NPTN web site includes links to all state pesticide regulatory agencies.
Toll-free hotline: 1-800-858-7378 (9:30 a.m. to 7:30 p.m. EST) daily except holidays. Callers outside normal hours can leave a voice mail message, and NPTN returns these calls the next business day.
E-mail: nptn@ace.orst.edu
web site: http://ace.orst.edu/info/nptn

mosquito control professionals

Information on mosquito control programs can also be obtained from the **American Mosquito Control Association (AMCA)** web site at: **http://www.mosquito.org.** This site also lists many county mosquito agencies.

federal pesticide program office

For more information regarding the federal pesticide regulatory programs, contact:
EPA Office of Pesticide Programs (OPP)
Telephone: 703-305-5017
Fax: 703-305-5558
E-mail: opp-web-comments@epa.gov
web site: http://www.epa.gov/pesticides

EPA's 10 Regional Offices are also a source of pesticide information, as well as on pesticide program activities in the individual regions.

10 EPA regional offices

EPA Region I - CT, MA, ME, NH, RI, VT
888-372-7341
www.epa.gov/region01

EPA Region II - NJ, NY, PR, VI
732-321-4391
www.epa.gov/region02

EPA Region III - DE, DC, MD, PA, VA, WV
800-438-2474

EPA Region IV - AL, FL, GA, KY, MS, NC, SC, TN
800-241-1754
www.epa.gov/region4

EPA Region V - IL, IN, MI, MN, OH, WI
800-621-8431 (Region V only) or **312-353-2000**
www.epa.gov/region5

EPA Region VI - AR, LA, NM, OK, TX
800-887-6063 (Region VI only) or **214-665-6444**
www.epa.gov/region6

EPA Region VII - IA, KS, MO, NE
800-223-0425 or **913-551-7020**
www.epa.gov/region7

EPA Region VIII - CO, MT, ND, SD, UT, WY
800-227-8917 (Region VIII only) or **303-551-7020**
www.epa.gov/region08

EPA Region IX - AZ, CA, HI, NV, AS, GU
415-744-1500
www.epa.gov/region09

EPA Region X - AK, ID, OR, WA
800-424-4372 (Region X only) or **206-553-1200**
www.epa.gov/r10earth

Other Helpful EPA Publications

For Your Information - How to Use Insect Repellents Safely
(735-F-93-052R)

For Your Information - Mosquitoes: How to Control Them
(735-F-98-003)

For Your Information - Naled for Mosquito Control
(735-F-00-003)

For Your Information - Malathion for Mosquito Control
(735-F-00-001)

For Your Information - Synthetic Pyrethroids for Mosquito Control
(735-F-00-004)

Questions and Answers - Pesticides and Mosquito Control

United States Environmental Protection Agency | Prevention, Pesticides and Toxic substances (7506C) | May 2000 735-F-00-004

FOR YOUR INFORMATION

Synthetic Pyrethroids for Mosquito Control

EPA evaluates and licenses pesticides

The Environmental Protection Agency (EPA) evaluates and registers (licenses) pesticides to ensure they can be used safely. These pesticides include products used in the mosquito control programs which states and communities have established. To evaluate any pesticide, EPA assesses a wide variety of tests to determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms.

mosquito officials select control measures that best suit local conditions

Officials responsible for mosquito control programs make decisions to use pesticides based on an evaluation of the risks to the general public from diseases transmitted by mosquitoes or on an evaluation of the nuisance level that communities can tolerate from a mosquito infestation. Based on surveillance and monitoring, mosquito control officials select specific pesticides and other control measures that best suit local conditions in order to achieve effective control of mosquitoes with the least impact on human health and the environment. It is especially important to conduct effective mosquito prevention programs by eliminating breeding habitats or applying pesticides to control the early life stages of the mosquito. Prevention programs, such as elimination of any standing water that could serve as a breeding site, help reduce the adult mosquito population and the need to apply other pesticides for adult mosquito control. Since no pesticide can be considered 100% safe, pesticide applicators and the general public should always exercise care and follow specified safety precautions during use to reduce risks. This fact sheet provides basic information on synthetic pyrethroids, a class of insecticides used in mosquito control programs.

What are Synthetic Pyrethroids?

synthetic pyrethroids are commonly used for mosquito control

Pyrethroids are synthetic chemical insecticides that act in a similar manner to pyrethrins, which are derived from chrysanthemum flowers. Pyrethroids are widely used for controlling various insects. **Permethrin, resmethrin** and **sumithrin** are synthetic pyrethroids commonly used in mosquito control programs to kill adult mosquitoes.

- **Permethrin** has been registered by EPA since 1977. It is currently registered and sold in a number of products such as household insect foggers and sprays, tick and flea sprays for yards, flea dips and sprays for cats and dogs, termite treatments, agricultural and livestock products, and mosquito abatement products.

- **Resmethrin** has been registered by EPA since 1971, and is used to control flying and crawling insects in the home, lawn, garden, and at industrial sites. It can also be used to control insects on ornamental plants (outdoor and greenhouse use), on pets and horses, and as a mosquitocide. Resmethrin is a Restricted Use Pesticide (RUP) which is available for use only by certified pesticide applicators or persons under their direct supervision because of its toxicity to fish.

- **Sumithrin** has been registered by EPA since 1975, and is used to control adult mosquitoes and used as an insecticide in transport vehicles such as aircraft, ships, railroad cars, and truck trailers. It is also used as an insecticide and miticide in commercial, industrial, and institutional non-food areas, in homes and gardens, in greenhouses, and in pet quarters and on pets.

How are Synthetic Pyrethroids Used in Mosquito Control?

tiny ultra-low volume (ULV) droplets kill mosquitoes on contact

Most pyrethroid mosquito control products can be applied only by public health officials and trained personnel of mosquito control districts. Mosquito control professionals apply pyrethroids as an ultra low volume (ULV) spray. ULV sprayers dispense very fine aerosol droplets that stay aloft and kill mosquitoes on contact. Pyrethroids used in mosquito control are typically mixed with a synergist compound called piperonyl butoxide, which enhances the effectiveness of the active ingredient. The product is applied at rates of between 0.003 and 0.007 pounds of active

Mosquito Life Cycle

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pupa - (pl. - pupae) non-feeding stage just prior to emerging as adult;

adult - flies short time after emerging and after its body parts have hardened.

ingredient per acre which is equivalent to 2 to 3.5 fluid ounces of the mixed formulation per acre.

Do Pyrethroids Pose Risks to Human Health?

pyrethroids do not pose unreasonable risks to human health

Pyrethroids can be used for public health mosquito control programs without posing unreasonable risks to human health when applied according to the label. Pyrethroids are considered to pose slight risks of acute toxicity to humans, but at high doses, pyrethroids can affect the nervous system.

Do pyrethroids pose risks to wildlife or the environment?

pyrethroids do not pose unreasonable risks to wildlife or the environment, but are toxic to fish

Pyrethroids used in mosquito control programs do not pose unreasonable risks to wildlife or the environment. Pyrethroids are low in toxicity to mammals, and are practically non-toxic to birds. Mosquito control formulations of permethrin quickly break down in the environment, and high temperatures and sunlight accelerate this process. However, pyrethroids are toxic to fish and to bees. For that reason, EPA has established specific precautions on the label to reduce such risks, including restrictions that prohibit the direct application of products to open water or within 100 feet of lakes, streams, rivers or bays.

What is The Current Regulatory Status of Pyrethroids?

EPA will review pyrethroids in approximately 2002

As part of its responsibility to reassess all older pesticides registered before 1984, EPA has given highest priority to reviewing more acutely toxic pesticides such as organophosphates and carbamates. Organophosphates are currently under review. Comprehensive reviews of the synthetic pyrethroids are scheduled for approximately 2002.

Where Can I get More Information About Pyrethroids and Mosquito Control?

Centers for Disease Control and Prevention

For more information about mosquito control in your area, contact your state or local health department. The federal Centers for Disease Control and Prevention is also a source of information on disease control, and their Internet web site includes a listing of state health departments. To contact the **Centers for Disease Control and Prevention (CDC):**
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Fax: 970-221-6476
E-mail: dvbid@cdc.gov
web site: http://www.cdc.gov

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E-mail: nptn@ace.orst.edu
web site: http://ace.orst.edu/info/nptn

mosquito control professionals

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federal pesticide program office

For more information regarding the federal pesticide regulatory programs, contact:
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Telephone: 703-305-5017
Fax: 703-305-5558
E-mail: opp-web-comments@epa.gov
web site: http://www.epa.gov/pesticides

10 EPA regional offices

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888-372-7341
www.epa.gov/region01

EPA Region II - NJ, NY, PR, VI
732-321-4391
www.epa.gov/region02

EPA Region III - DE, DC, MD, PA, VA, WV
800-438-2474
www.epa.gov/region03

EPA Region IV - AL, FL, GA, KY, MS, NC, SC, TN
800-241-1754
www.epa.gov/region4

EPA Region V - IL, IN, MI, MN, OH, WI
800-621-8431 (Region V only) or **312-353-2000**
www.epa.gov/region5

EPA Region VI - AR, LA, NM, OK, TX
800-887-6063 (Region VI only) or **214-665-6444**
www.epa.gov/region6

EPA Region VII - IA, KS, MO, NE
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www.epa.gov/region7

EPA Region VIII - CO, MT, ND, SD, UT, WY
800-227-8917 (Region VIII only) or **303-551-7020**
www.epa.gov/region08

EPA Region IX - AZ, CA, HI, NV, AS, GU
415-744-1500
www.epa.gov/region09

EPA Region X - AK, ID, OR, WA
800-424-4372 (Region X only) or **206-553-1200**
www.epa.gov/r10earth

Other Helpful EPA Publications

For Your Information - How to Use Insect Repellents Safely (735-F-93-052R)

For Your Information - Mosquitoes: How to Control Them (735-F-98-003)

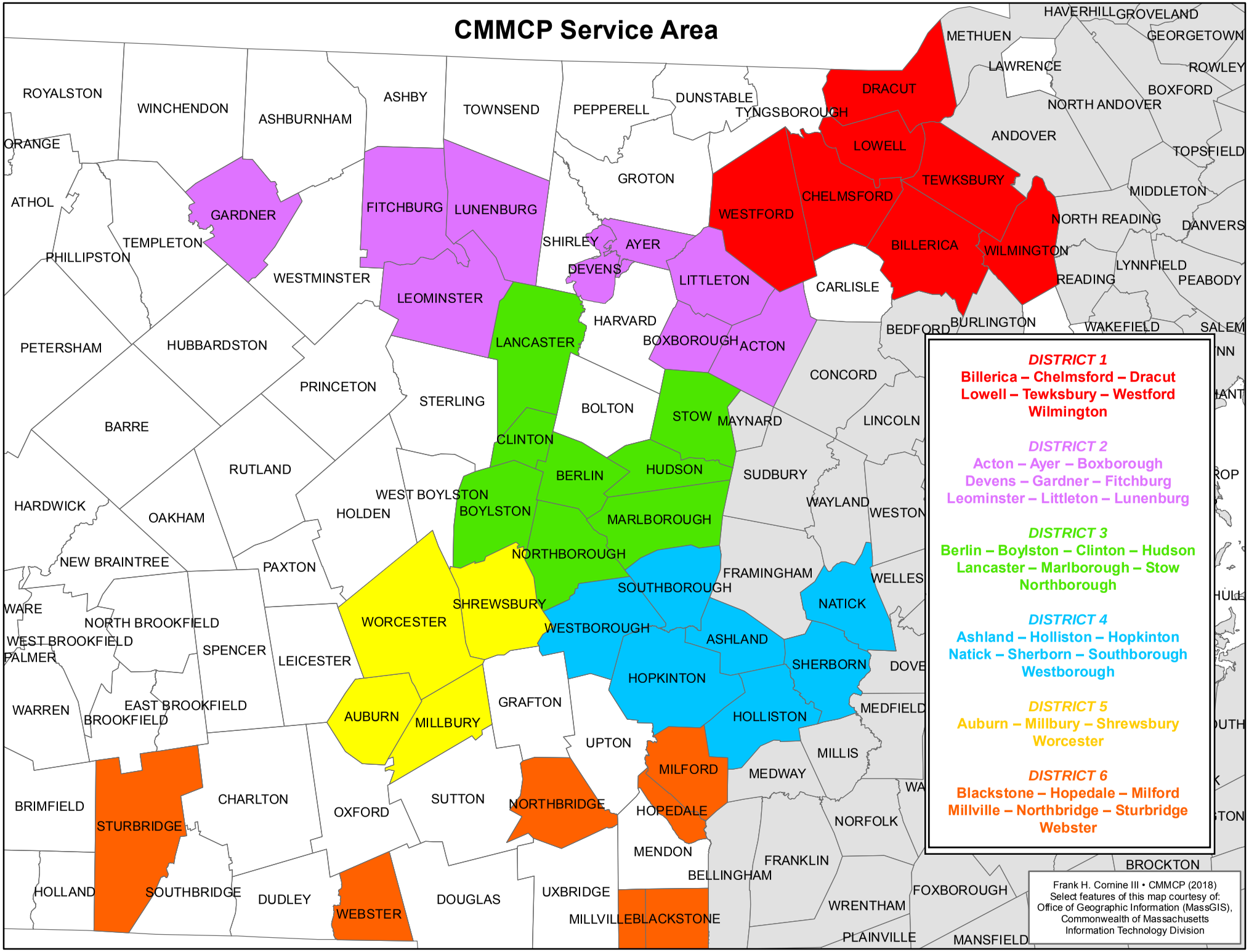
For Your Information - Larvicides for Mosquito Control (735-F-00-002)

For Your Information - Malathion for Mosquito Control (735-F-00-001)

For Your Information - Naled for Mosquito Control (735-F-003)

Questions and Answers - Pesticides and Mosquito Control

CMMCP Service Area



DISTRICT 1
Billerica – Chelmsford – Dracut
Lowell – Tewksbury – Westford
Wilmington

DISTRICT 2
Acton – Ayer – Boxborough
Devens – Gardner – Fitchburg
Leominster – Littleton – Lunenburg

DISTRICT 3
Berlin – Boylston – Clinton – Hudson
Lancaster – Marlborough – Stow
Northborough

DISTRICT 4
Ashland – Holliston – Hopkinton
Natick – Sherborn – Southborough
Westborough

DISTRICT 5
Auburn – Millbury – Shrewsbury
Worcester

DISTRICT 6
Blackstone – Hopedale – Milford
Millville – Northbridge – Sturbridge
Webster

Frank H. Cornine III • CMMCP (2018)
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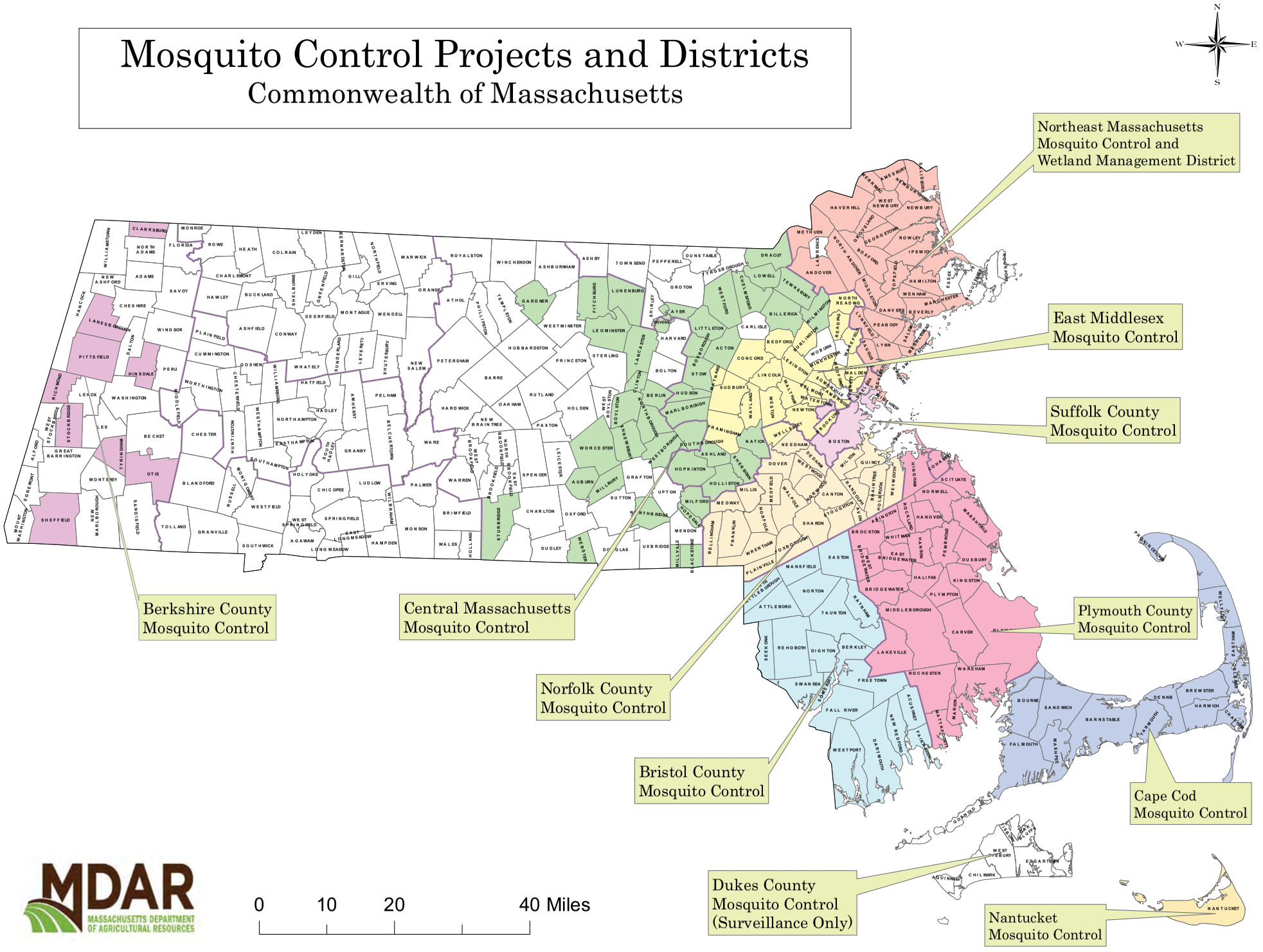
Mosquito Control Projects and Districts

Commonwealth of Massachusetts



MDAR
MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

5/4/2018

NEW JERSEY MOSQUITO CONTROL ASSOCIATION, Inc.

NEWSLETTER

FS867

RUTGERS COOPERATIVE EXTENSION

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

Products and Promotions That Have Limited Value for Mosquito Control

Wayne J. Crans
Associate Research Professor in Entomology

Virtually every year, a new product appears on the market that claims to be the answer for the elimination of mosquito nuisance. In nearly every case, the promotion is accompanied by a great deal of advertising, but the merits of the product are rarely backed with scientific testing. The American public has invested billions of dollars in zappers, repellers, and plants that claim they will keep mosquitoes from biting. Products and promotions for mosquito control are big business; unfortunately most have limited value in reducing mosquito annoyance.

Electronic Repellers

Hand-held electronic devices that rely on high-frequency sound to repel mosquitoes have become surprisingly popular in recent years. Prices range from $9.95 to $29.95 for units advertised in magazines. Heavy-duty repellers that claim to keep away spiders, hornets, and rats, in addition to mosquitoes may sell for more than $100.00. The manufacturer's rationale for using sound as a repelling factor varies from one device to the next. Some claim to mimic the wing beat frequency of a male mosquito. This, supposedly, repels females who have already mated and do not wish to be mated a second time. Others claim to mimic the sound of a hungry dragonfly, causing mosquitoes to flee the area to avoid becoming the predator's next meal. Most of the electronic repellers on the market hum on a single frequency. Top of the line devices allow for adjustment by the user to achieve the most effective frequency for the mosquito causing the problem. Scientific studies have repeatedly shown that electronic mosquito repellers do not prevent host seeking mosquitoes from biting. In most cases, the claims made by distributors border on fraud. Mated female mosquitoes do not flee from amorous males, and mosquitoes do not vacate an area hunted by dragonflies. Electronic mosquito repellers do little in the way of reducing mosquito annoyance.

Bug Zappers

Electrocuting devices, popularly known as *Bug Zappers*, are the most popular device on the market for reducing mosquitoes around the home. Most rely on ultraviolet light to draw insects through an electrified wire grid. A resounding pop followed by a series of sizzling sounds signals the homeowner that an insect has passed through the electrocuting device. Most homeowners keep the machine on a timer that turns the units off during the daylight hours, but some run the traps day and night during the summer season. Bug zappers kill a lot of insects, but very few of the insects killed function as pests. Most of the popping sounds are night-flying moths tricked into the trap while attempting to navigate by the moon. The long drawn-out sizzles are usually beetles, because they are heavier than most night flying insects and have considerably more bulk to fry. Scientific studies indicate that mosquitoes make up a very small percentage of bug zapper collections. Comparison trapping has also shown no significant difference in mosquito populations in yards with and without the traps. Biting insects, in general, make up less than 1 percent of the insects killed in zappers. Unfortunately, beneficial insects are usually well represented in an average night's catch. The continued popularity of these traps is probably due to the never-ending sound effects, which remind owners that their investment is working. Most trap operators are unaware that their zappers are killing harmless insects that would otherwise serve as food for wildlife.

Citrosa Plants

The Citrosa plant is a genetically engineered houseplant created by incorporating tissue cultures of the grass that produces citronella oil into hybrid varieties of geranium to produce a cultivar that emits a citronella aroma. Citronella oil is known to have mosquito-repelling properties, and the concept of allowing a plant to emit a barrier of repellent vapor appears sound. Unfortunately, the claims made by the distributors have not stood up to scientific testing.

Tests conducted in Florida indicated that Citrosa plants did not reduce the number of bites received by test subjects. Moreover, mosquitoes landed freely on the leaves indicating that the plant does not emit enough citronella oil to repel the insects. Crushing the leaf and rubbing it into the skin did not keep mosquitoes from biting and mixing the leaves into a slurry did not help. The idea of engineering a plant with mosquito repelling properties should be encouraged. Advertising and selling that plant before its effectiveness is documented takes advantage of the American consumer.

Insectivorous Bats

Every so often, a well-meaning conservation group promotes bats to eliminate mosquitoes from areas where nuisance has become intolerable. This undoubtedly leads to rediscovery of research conducted in the 1950s indicating that bats released in a room filled with mosquitoes could catch up to 10 mosquitoes per minute. The research was conducted to measure the effectiveness of echolocation in insectivorous bat species. The results have been extrapolated to suggest that wild bats can consume 600 mosquitoes per hour. Using that figure, a colony of 500 bats will remove 250,000 mosquitoes each hour and theoretically afford mosquito control for an entire neighborhood. Research since that time has shown that insectivorous bats are opportunistic feeders and that mosquitoes make up a very small percentage of their natural diet. Bats' behavior when locked in a room with nothing to feed upon but mosquitoes has no bearing on their behavior in the wild. Bats feed on the same insects that turn up in bug zappers and are no more effective for controlling mosquitoes than their electronic equivalent. Providing habitat to enhance bat populations is an admirable activity for conservation purposes. Using mosquito control as the reason to initiate public interest is misleading at best.

Purple Martins

The average person truly believes that Purple Martins control mosquitoes. No other form of biological control has been so broadly publicized, and the concept of using a colonial bird is easy to accept. Purple Martins are lovely birds and having a colony nearby is educational and aesthetic. Purple Martins, however, do not control mosquitoes and should not be propagated if eliminating mosquitoes is the central issue. Proponents of the Purple Martin cite the oft-quoted statement that a Purple Martin will eat 2,000 mosquitoes a day and up to 14,000 when the insects are extremely plentiful. The quote is based on an anecdotal account in the literature that was based on body weight of the bird and the number of mosquitoes that would be required to sustain its metabolism. Most ornithologists realize that mosquitoes form an insignificant portion of the Purple Martin's diet and would agree that the birds play a limited role controlling mosquito populations. If mosquitoes are plentiful, the birds will feed on them, but an adult Purple Martin that is foraging in mosquito territory will accept a dragonfly in place of a mosquito without hesitation. Purple Martins, as well as other insectivorous birds, should be encouraged to nest and be provided with housing whenever possible. Do not, however, believe that the birds will significantly diminish mosquito populations in your community. The manufacturers of Purple Martin houses cite mosquito control potential for their own economic gains. The birds do not need this hoax to retain public acceptance.

There are products on the market that will provide relief from mosquito attack. Commercial repellents that contain DEET can be highly effective for short periods. Many people, however, dislike the oily consistency or object because of health concerns connected with the product. Products that rely on fragrance to repel mosquitoes show considerable promise and have been under intense investigation since the Avon product, *Skin-So*-Soft showed proven repellent properties. Predacious fish feed on the immature stages of mosquitoes and are extremely efficient in terms of control. In salt marsh areas, native killifish can be managed to eliminate mosquitoes from some types of marshland. In upland areas, pond-raised mosquito fish can be stocked to eliminate mosquitoes. Electronic repellers, bug zappers, and mosquito-fighting plants represent hoaxes that are marketed solely for economic gain. The American consumer, should be aware that these products have little value for mosquito control.

The author is indebted to Lee Mitchell of the Toledo Area Sanitary District for much of the information included in this fact sheet. New Jersey Mosquito Control Association, Inc. Contributed funds to help defray the cost of this fact sheet.

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April, 1997

Why Mosquitoes Cannot Transmit AIDS

by Wayne J. Crans, Associate Research Professor in Entomology
Rutgers Cooperative Extension Fact Sheet # FS736

Media releases concerning the possibility of mosquitoes transmitting AIDS (Acquired Immune Deficiency Syndrome) were common when the disease was first recognized, and the subject is still addressed by tabloids that seek captivating headlines to increase their circulation. The topic was initiated by reports from a small community in southern Florida where preliminary evidence suggested that mosquitoes may have been responsible for the higher on average incidence of AIDS in the local population. The media was quick to publicize claims that mosquitoes were involved in AIDS transmission despite findings of scientific surveys of the National Centers for Disease Control (CDC) that clearly demonstrated that mosquito transmission of AIDS in that community appeared highly unlikely. Nevertheless, media releases perpetuated the concept that mosquitoes transmitted AIDS, and many people still feel that mosquitoes may be responsible for transmission of this infection from one individual to another.

There are three theoretical mechanisms which would allow blood-sucking insects such as mosquitoes to transmit HIV.

1. In the first mechanism, a mosquito would initiate the cycle by feeding on an HIV positive carrier and ingest virus particles with the blood meal. For the virus to be passed on, it would have to survive inside the mosquito, preferably increase in numbers, and then migrate to the mosquito's salivary glands. The infected mosquito would then seek its second blood meal from an uninfected host and transfer the HIV from its salivary glands during the course of the bite. This is the mechanism used by most mosquito-borne parasites, including malaria, yellow fever, dengue, and the encephalitis viruses.
2. In the second mechanism, a mosquito would initiate the cycle by beginning to feed on an HIV carrier and be interrupted after it had successfully drawn blood. Instead of resuming the partial blood meal on its original host, the mosquito would select an AIDS-free person to complete the meal. As it penetrated the skin of the new host, the mosquito would transfer virus particles that were adhering to the mouthparts from the previous meal. This mechanism is not common in mosquito-borne infections, but equine infectious anemia is transmitted to horses by biting flies in this manner.
3. The third theoretical mechanism also involves a mosquito that is interrupted while feeding on an HIV carrier and resumes the partial blood meal on a different individual. In this scenario, however, the AIDS-free host squashes the mosquito as it attempts to feed and smears HIV contaminated blood into the wound. In theory, any of the mosquito-borne viruses could be transmitted in this manner providing the host circulated sufficient virus particles to initiate re-infection by contamination.

Each of these mechanisms has been investigated with a variety of blood sucking insects and the results clearly show that mosquitoes cannot transmit AIDS. News reports on the findings, however, have been confusing, and media interpretation of the results has not been clear. The average person is still not convinced that mosquitoes are not involved in the transmission of a disease that appears in the blood, is passed from person to person and can be contracted by persons that share hypodermic needles. Here are just some of the reasons why the studies showed that mosquitoes cannot transmit AIDS:

Mosquitoes Digest the Virus that Causes AIDS

When a mosquito transmits a disease agent from one person to another, the infectious agent must remain alive inside the mosquito until transfer is completed. If the mosquito digests the parasite, the transmission cycle is terminated and the parasite cannot be passed on to the next host. Successful mosquito-borne parasites have a number of interesting ways to avoid being treated as food. Some are refractory to the digestive enzymes inside the mosquito's stomach; most bore their way out of the stomach as quickly as possible to avoid the powerful digestive enzymes that would quickly eliminate their existence. Malaria parasites survive inside mosquitoes for 9-12 days and actually go through a series of necessary life stages during that period. Encephalitis virus particles survive for 10-25 days inside a mosquito and replicate enormously during the incubation period. Studies with HIV clearly show that the virus responsible for the AIDS infection is regarded as food to the mosquito and is digested along with the blood meal. As a result, mosquitoes that ingest HIV-infected blood digest that blood within 1-2 days and completely destroy any virus particles that could potentially produce a new

infection. Since the virus does not survive to reproduce and invade the salivary glands, the mechanism that most mosquito-borne parasites use to get from one host to the next is not possible with HIV.

Mosquitoes Do Not Ingest Enough HIV Particles to Transmit AIDS by Contamination

Insect-borne disease agents that have the ability to be transferred from one individual to the next via contaminated mouthparts must circulate at very high levels in the bloodstream of their host. Transfer by mouthpart contamination requires sufficient infectious particles to initiate a new infection. The exact number of infectious particles varies from one disease to the next. HIV circulates at very low levels in the blood--well below the levels of any of the known mosquito-borne diseases. Infected individuals rarely circulate more that 10 units of HIV, and 70 to 80% of HIV-infected persons have undetectable levels of virus particles in their blood. Calculations with mosquitoes and HIV show that a mosquito that is interrupted while feeding on an HIV carrier circulating 1000 units of HIV has a 1:10 million probability of injecting a single unit of HIV to an AIDS-free recipient. In laymen's terms, an AIDS-free individual would have to be bitten by 10 million mosquitoes that had begun feeding on an AIDS carrier to receive a single unit of HIV from contaminated mosquito mouthparts. Using the same calculations, crushing a fully engorged mosquito containing AIDS positive blood would still not begin to approach the levels needed to initiate infection. In short, mechanical transmission of AIDS by HIV-contaminated mosquitoes appears to be well beyond the limits of probability. Therefore, none of the theoretical mechanisms cited earlier appear to be possible for mosquito transmission of HIV.

Mosquitoes Are Not Flying Hypodermic Needles

Many people think of mosquitoes as tiny, flying hypodermic syringes, and if hypodermic needles can successfully transmit HIV from one individual to another then mosquitoes ought to be able to do the same. We have already seen that HIV-infected individuals do not circulate enough virus particles to result in infection by contamination. However, even if HIV-positive individuals did circulate high levels of virus, mosquitoes could not transmit the virus by the methods that are employed in used syringes. Most people have heard that mosquitoes regurgitate saliva before they feed, but are unaware that the food canal and salivary canal are separate passageways in the mosquito. The mosquito's feeding apparatus is an extremely complicated structure that is totally unlike the crude single-bore syringe. Unlike a syringe, the mosquito delivers salivary fluid through one passage and draws blood up another. As a result, the food canal is not flushed out like a used needle, and blood flow is always unidirectional. The mechanics involved in mosquito feeding are totally unlike the mechanisms employed by the drug user's needles. In short, mosquitoes are not flying hypodermic needles and a mosquito that disgorges saliva into your body is not flushing out the remnants of its last blood meal.

For more in depth information on this topic see Staff Paper #I, Do Insects Transmit AIDS?, OTA series on AIDS-Related Issues, Health Program, Office of Technology Assessment, United States Congress, Washington, D.C. 20510-8025.

Thanks are due to the New Jersey Mosquito Control Association, Inc., who contributed funds to defray the cost of this fact sheet.

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Rutgers, the State University of New Jersey, New Brunswick

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Arbovirus Surveillance in Massachusetts 2018

Massachusetts Department of Public Health (MDPH)
Arbovirus Surveillance Program

INTRODUCTION

There are two mosquito-borne diseases of concern in Massachusetts, Eastern equine encephalitis (EEE), which was identified as a human disease in 1938, and West Nile virus (WNV) infection, which has been present in the United States since 1999. EEE is a rare but serious neuroinvasive disease that causes meningitis or encephalitis, and often results in death or severe disability. WNV infection is more common, though typically less severe than EEE; presentation of WNV ranges from febrile illness to neuroinvasive disease. Although 51 different species of mosquitoes have been identified in Massachusetts, only a few of these contribute to either WNV or EEE spread. For more information, visit the MDPH website to view Common Mosquitoes That Can Spread Disease in Massachusetts.

Currently, there are no available vaccines to prevent human infections from either mosquito-borne virus. Personal protection measures that serve to reduce exposure to mosquitoes and thereby prevent human infection remain the mainstay of prevention. To estimate the risk of human disease during a mosquito season, the MDPH, in cooperation with the local Mosquito Control Projects, conducts surveillance for EEE and WNV using mosquito samples, and specimens from human and veterinary sources. Detailed information about surveillance for these diseases in Massachusetts is available on the MDPH website at Arbovirus Surveillance and Control Plan.

EASTERN EQUINE ENCEPHALITIS VIRUS

Humans

No human cases of EEE virus infection have been identified in Massachusetts since 2013.

Mosquito Samples

Of 5,921 mosquito samples tested in Massachusetts in 2018, two samples (0.03%) were positive for EEE virus in 2018. The positive samples were identified in the towns of Hubbardston and Lakeville. For a complete list of positive mosquito samples by city/town, please see the 2018 Mosquito Summary by County and Municipality report posted on the MDPH website.

Animals

Fourteen samples were submitted for arbovirus testing. There were two animals that tested positive for EEE virus infection in 2018, a turkey in Hubbardston and a horse in East Brookfield.

Birds

Although birds are not routinely tested as part of EEE surveillance, species such as emus or exotic quail may experience sudden illness and mortality due to EEE. Farmed birds showing these signs must be reported promptly to the Massachusetts Department of Agricultural Resources (MDAR). A wild turkey in Hubbardston was reported in 2018 and tested positive for EEE.

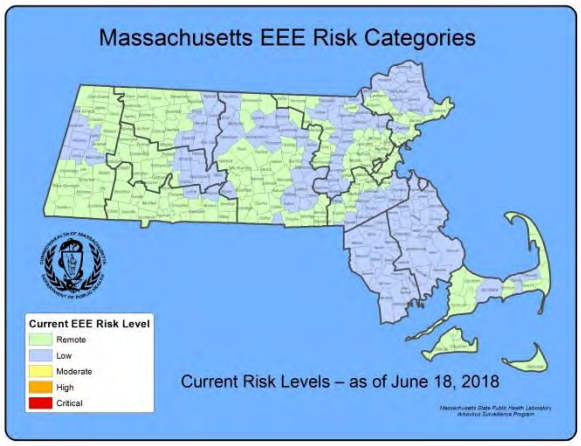
EEE Geographic Risk Levels

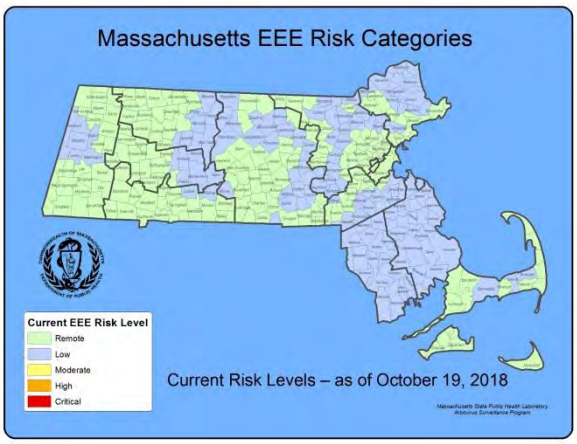
EEE risk maps combine historical data and areas of mosquito habitat with current data on positive virus isolations (in humans, mosquitoes, etc.) and weather conditions. Risk levels are an

estimate of the likelihood of an outbreak of human disease and are updated weekly based on surveillance data. Initial and final EEE risk levels from the 2018 season are shown in the following maps. This information will be used to help anticipate risk in 2019, and will be revised as 2019 surveillance data are collected. More detailed information about risk assessment and risk levels is available in the Arbovirus Surveillance and Response Plan on the MDPH web site.

Initial and Final 2018 EEE Risk Categories

(As defined in Table 2 of the MDPH Arbovirus Surveillance and Response Plan which can be found at www.mass.gov/dph/mosquito under "Surveillance Summaries and Data")

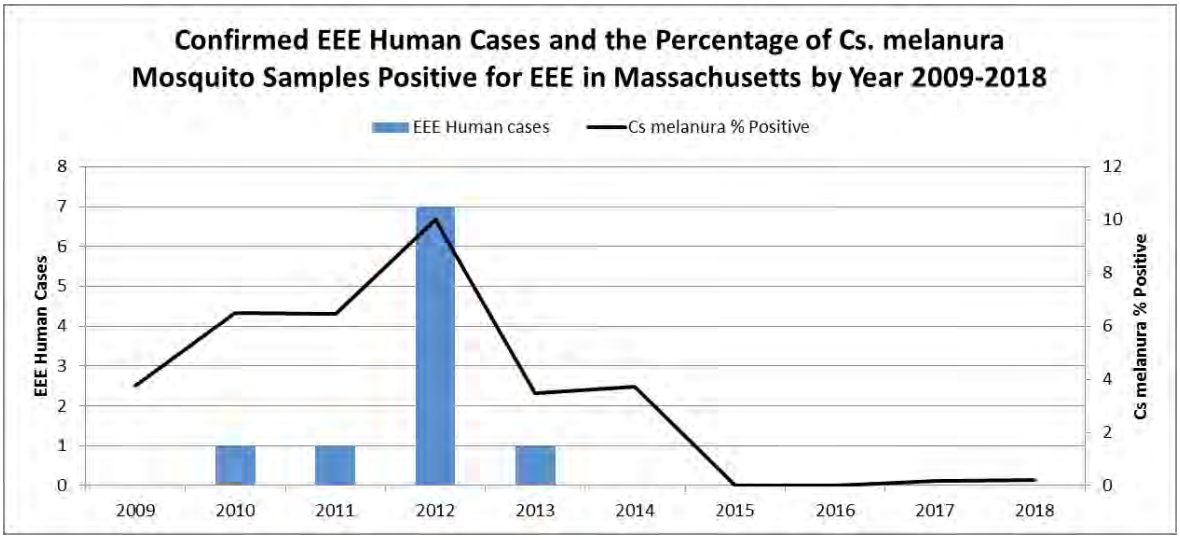




2018 EEE SEASON DISCUSSION

There were no confirmed human EEE cases in 2018 or 2017, compared to seven confirmed human cases in 2012 and one in 2013; 2012 was the most recent outbreak year in Massachusetts. The number of confirmed human cases nationwide was lower in 2018 (five) and 2017 (five) when compared to 2012 (15).

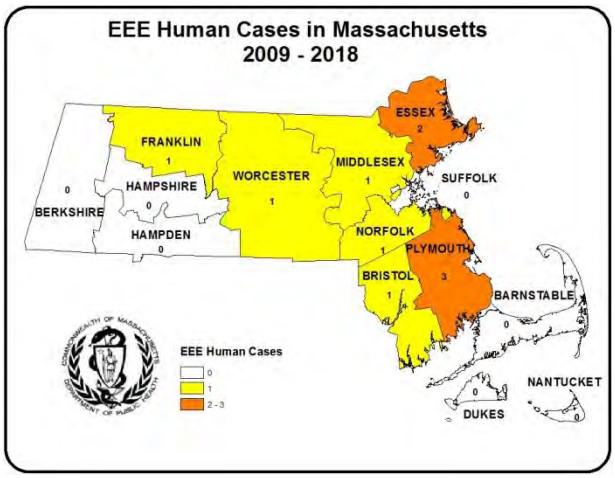
There was a similar decline in EEE virus positive mosquito samples from 267 in 2012 to two in 2018. In 2018, MDPH identified two EEE positive sample of *Culiseta melanura,* the enzootic vector of EEE. Mosquito surveillance activities are highly adaptive to identifications of EEE virus, with more mosquito trapping and testing in years when EEE activity is increased, this makes year-to-year comparisons somewhat difficult. In general, years with increased EEE human infections are associated with an increase in the percentage of *Cs. melanura* samples positive for EEE virus (see figure below).



Why has there been less EEE activity since 2012?

Historically, EEE outbreaks have rarely occurred during periods lasting more than three years, although evidence suggests that previously observed patterns may be changing and the situation must be monitored carefully. Intense EEE activity consistent with outbreaks occurred in 2004-2006 and 2010-2012. Outbreaks are probably supported, in part, by previously unexposed populations of birds that are susceptible to EEE virus infection, and therefore capable of maintaining the cycle of virus transmission. Current research also suggests that each of these cycles is associated with the introduction of a new strain of EEE virus by migratory birds. After three years (2010-2012) of intense virus activity, the population of susceptible birds may not have been adequate to maintain the virus cycle in more recent years. Important factors also impacting EEE virus cycles include large *Cs. melanura* mosquito populations which are more likely to support significant EEE activity, and weather conditions, such as significant precipitation events and prolonged periods of high temperature. In 2012, significant precipitation and prolonged periods of high temperatures provided favorable conditions for mosquito development. In 2017, average precipitation in winter, spring, and summer combined with above-average summer temperatures increased available breeding habitat for the traditional vectors of EEE and led to above average mosquito abundance rates throughout the breeding season. In 2018, the mosquito season began with above average precipitation events. Precipitation events remained consistently above average and summer temperatures were above average for the entire breeding season. Breeding habitat for *Cs. melanura* increased compared to prior years with abundance levels of *Cs. melanura* fully rebounding from the impact of drought conditions seen in 2016.

In Massachusetts, human EEE infection is associated with *Culiseta melanura* activity. The map to the right illustrates that one area at highest risk for transmission of EEE is Southeastern Massachusetts which has also been the historic area of risk. Northeastern Massachusetts has become an area of high risk more recently.



Variability in Geographic Range of EEE

In Massachusetts over the last ten years, some human EEE cases have occurred outside of the historic area of risk and there have been year-to-year variations in the geographic pattern of disease occurrence. This is not unique to Massachusetts; during 2013-2016, human cases of EEE were reported from neighboring states including Connecticut, Maine, New Hampshire, New York, Rhode Island, and Vermont. Many of these cases were unusual in that they occurred in: states which rarely see EEE cases (Connecticut and Rhode Island); states where EEE cases are a very recent occurrence (Maine, New Hampshire and Vermont); and in atypical areas in states that have historic areas of risk (New York). MDPH continues to perform adaptive surveillance activities to provide for early detection of EEE throughout the Commonwealth.

What are the expectations for EEE in 2019?

Mosquito abundance and vector-borne disease risk are affected by multiple environmental factors which vary over time and geographic location. The two most important contributors to mosquito development are precipitation and temperature. All species of mosquito depend on the presence of water for the first stages of life. Mosquito populations increase when precipitation is plentiful and decrease during dry periods. Warmer temperatures shorten both the time it takes for mosquitoes to develop from egg to adult and the time it takes for a mosquito to be able to transmit pathogens after ingesting an infected blood meal.

Warm and wet winters increase the likelihood of mosquito survival and may lead to higher spring mosquito numbers. The summer and fall of 2018 brought above average temperatures and precipitation events leading to extensive breeding habitat for the traditional vectors of EEE. A preliminary assessment of the winter of 2018-2019 has average temperatures combined with above average precipitation events. Early reports from the field indicate above average numbers of juvenile *Cs. melanura.*

Mosquito populations alone are not sufficient to produce significant EEE risk; infected bird populations are also necessary. Unfortunately, less is known about the factors that lead to large numbers of infected birds, making this component of risk impossible to predict. At this time there is no efficient method to conduct surveillance for infection levels in wild birds.

Both the variability of New England weather and the inability to detect EEE virus infection levels in wild bird populations require that Massachusetts maintain a robust surveillance system every year to detect EEE virus in mosquitoes as a tool to assess risk of human disease.

WEST NILE VIRUS

Humans

There were forty-nine human cases of WNV infection identified in Massachusetts in 2018. The results are summarized in the table below.

County	Age Range	Onset Date	Virus Result	Clinical Presentation
Barnstable	81-90	8/30/2018	WNV	Fever
Barnstable	61 - 70	9/16/2018	WNV	Meningoencephalitis
Barnstable	71-80	9/28/2018	WNV	Encephalitis
Barnstable	71-80	10/28/2018	WNV	Meningitis
Berkshire	61 - 70	8/26/2018	WNV	Encephalitis
Bristol	61 - 70	8/18/2018	WNV	Meningoencephalitis
Bristol	51-60	9/1/2018	WNV	Meningoencephalitis
Essex	21 - 30	8/21/2018	WNV	Meningitis
Essex	71 - 80	8/26/2018	WNV	Meningitis
Essex	61 - 70	8/27/2018	WNV	Meningoencephalitis
Essex	61-70	8/31/2018	WNV	Meningoencephalitis
Essex	41-50	9/17/2018	WNV	Fever
Essex	71-80	9/21/2018	WNV	Meningitis
Essex	81-90	9/26/2018	WNV	Encephalitis
Essex	51-60	10/9/2018	WNV	Meningoencephalitis
Franklin	71-80	9/19/2018	WNV	Encephalitis
Hampshire	71-80	9/12/2018	WNV	Meningitis
Hampshire	71-80	10/1/2018	WNV	Meningoencephalitis
Middlesex	61-70	7/23/2018	WNV	Fever
Middlesex	51-60	8/1/2018	WNV	Meningitis
Middlesex	71-80	8/19/2018	WNV	Meningitis
Middlesex	31 - 40	8/21/2018	WNV	Fever
Middlesex	31-40	8/23/2018	WNV	Meningitis
Middlesex	61 - 70	8/24/2018	WNV	Meningitis
Middlesex	21 - 30	8/30/2018	WNV	Meningitis
Middlesex	61 - 70	9/3/2018	WNV	Meningoencephalitis
Middlesex	61 - 70	9/4/2018	WNV	Fever
Middlesex	71-80	9/5/2018	WNV	Encephalitis
Middlesex	41-50	9/8/2018	WNV	Meningitis
Middlesex	61 - 70	9/17/2018	WNV	Meningoencephalitis
Middlesex	51 - 60	9/18/2018	WNV	Encephalitis
Middlesex	31 - 40	9/21/2018	WNV	Meningitis
Middlesex	51 - 60	9/22/2018	WNV	Fever

Middlesex	51 - 60	9/24/2018	WNV	Meningitis
Middlesex	61 - 70	9/27/2018	WNV	Meningitis
Norfolk	61 - 70	9/16/2018	WNV	Meningitis
Plymouth	61 - 70	9/15/2018	WNV	Encephalitis
Plymouth	61 - 70	10/8/2018	WNV	Meningitis
Suffolk	61 - 70	7/28/2018	WNV	Encephalitis
Suffolk	41 - 50	8/12/2018	WNV	Encephalitis
Suffolk	81 - 90	8/17/2018	WNV	Meningoencephalitis
Suffolk	51 - 60	8/23/2018	WNV	Encephalitis
Suffolk	61 - 70	9/2/2018	WNV	Meningitis
Suffolk	31 - 40	9/4/2018	WNV	Meningoencephalitis
Suffolk	51 - 60	9/12/2018	WNV	Meningitis
Suffolk	81 - 90	9/13/2018	WNV	Meningitis
Suffolk	51 - 60	9/17/2018	WNV	Encephalitis
Worcester	71 - 80	8/10/2018	WNV	Meningitis
Worcester	41 - 50	9/20/2018	WNV	Meningitis

Presumptive Viremic Blood Donors

WNV is transmissible through blood transfusion. Since June 2003, blood banks have screened donated blood for WNV using a nucleic acid test (NAT) that identifies viral genetic material. Positive units are not used and donors are deferred from future donation for 120 days. The AABB (formerly the American Association of Blood Banks) notifies states of all presumptive viremic donors (PVDs), i.e., individuals whose donated blood tests positive using the NAT test.

There were two PVD identified in Massachusetts in 2018. The number of PVDs nationwide increased in 2018 (357) from 2017 (247).

County	Donation Date	Virus Result
Barnstable	8/27/2018	WNV
Bristol	9/22/2018	WNV

Mosquito Samples

Of 5,921 mosquito samples collected in Massachusetts in 2018, 579 (9.8%) were positive for WNV. Positive mosquito samples included 522 (90%) *Culex* species. Positive samples were identified in 153 towns in 13 counties. For a complete list of positive mosquito samples by city/town, please see the 2018 Mosquito Summary by County and Municipality report posted on the MDPH website.

Animals

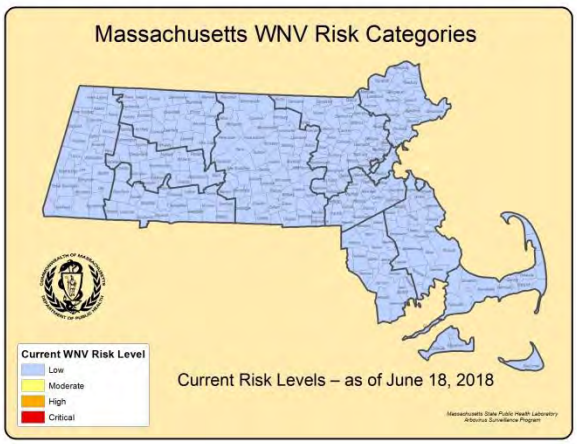
Fourteen veterinary samples were submitted for arbovirus testing. There were two animals that tested positive for WNV in 2018, a horse in Bernardston and a horse in Granby.

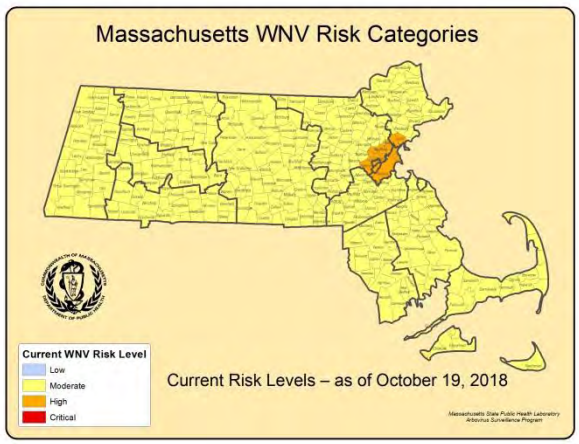
WNV Geographic Risk Levels

WNV risk maps are produced by integrating historical data and areas of mosquito habitat with current data on positive virus identifications (in humans, mosquitoes, etc.) and weather conditions. Risk levels serve as a relative measure of the likelihood of an outbreak of human disease and are updated weekly based on that week's surveillance data. Initial and final WNV risk levels from the 2018 season are provided in the following maps. This information will be used to help predict risk in 2019, and will be revised as 2019 surveillance data are collected. More detailed information about risk assessment and risk levels is available in the Arbovirus Surveillance and Response Plan on the MDPH web site during the arbovirus season.

Initial and Final 2018 WNV Risk Categories

(As described in Table 1 of the MDPH Arbovirus Surveillance and Response Plan which can be found at www.mass.gov/dph/mosquito under "Surveillance Summaries and Data")



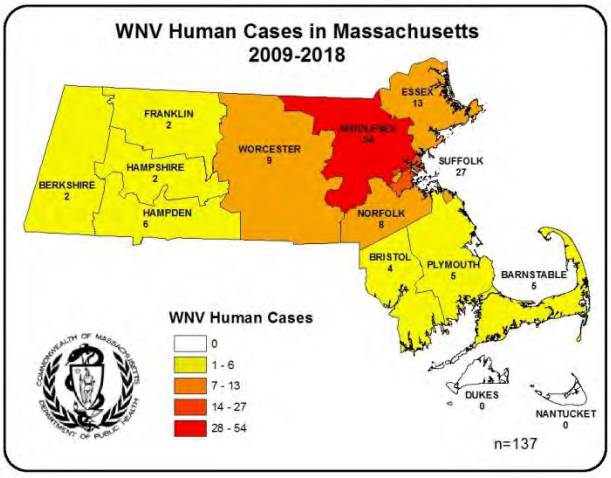


2018 WNV SEASON DISCUSSION

MDPH identified forty-nine confirmed human WNV infections in 2018 compared to six confirmed WNV cases in 2017. The 2018 WNV season stands out as the highest annual human case count since WNV arrived in MA in 2001. Above average precipitation events coupled with above average temperatures created conditions favorable to container breeding *Culex* mosquito species which transmit WNV. The number of confirmed human cases nationwide in 2018 (2,544) was an increase from 2017 (2,002) but far fewer than the 2012 outbreak (5,674).

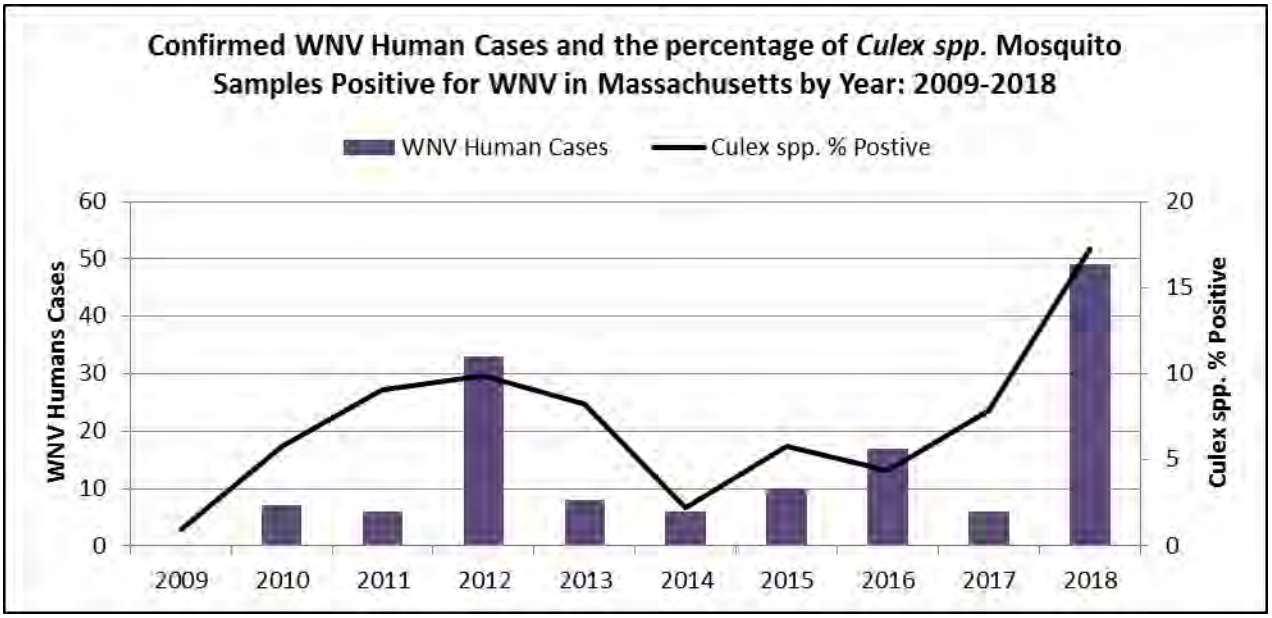
Of the cases identified nationally in 2018, 1,594 (63%) were classified as neuroinvasive disease (defined as meningitis or encephalitis) and 950 (37%) were classified as non-neuroinvasive disease. A major portion of the cases (33%) were reported from four states (Nebraska, California, North Dakota and Illinois). 10% of all cases were reported from Nebraska.

In Massachusetts, the vectors for WNV are primarily *Culex* species. *Culex* species are closely associated with human activity. The map to the right illustrates that transmission to humans is generally highest in counties with higher population densities.



WNV Positive Mosquitoes and Correlation with Human Disease

In 2018, MDPH identified 522 WNV positive *Culex* species mosquito samples compared to 277 WNV positive *Culex* species mosquito samples in 2017. In general, years with increased WNV human infections are associated with an increase in the percentage of *Culex* samples positive for WNV (see figure below). Considering the increase in human cases of WNV infection that occurred from 2014-2016, an increase in WNV positive mosquito samples might be expected. As the graph below demonstrates, the percentage of WNV positive *Culex* mosquito samples decreased sharply from a peak in 2012, associated with a notably hot summer resulting in a national outbreak, to a low in 2014 with an uptick in 2015, 2016 and 2017. In 2018 the increase in confirmed human cases compared to WNV positive mosquito samples matched the expected trend.



What are the expectations for WNV in 2019?
The primary determinants of human WNV disease risk during any particular season are populations of *Culex* mosquito species and the presence of infected birds. The two most important variables for mosquito development are precipitation and temperature. Warmer temperatures shorten both the time it takes for mosquitoes to develop from egg to adult and the time it takes for a mosquito to be able to transmit a pathogen after ingesting an infected blood meal. *Culex* mosquito populations tend to be greatest during seasons with periodic precipitation events (giving rise to stagnant puddles and containers that favor *Culex* breeding), separated by hot, dry days

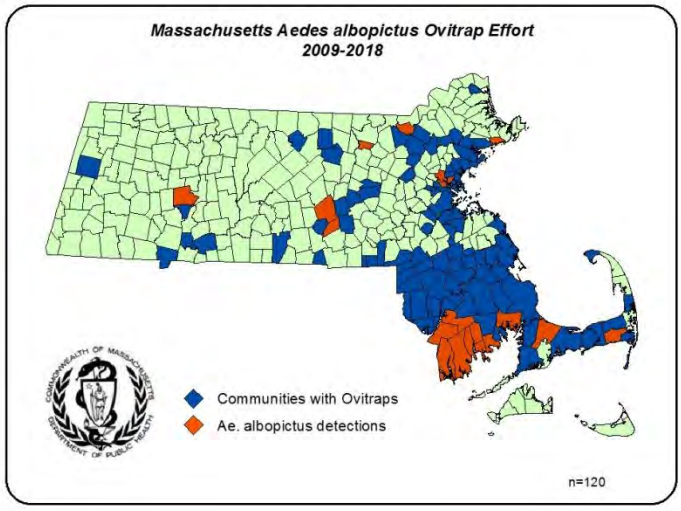
Mosquito populations alone are not sufficient to produce significant WNV risk; infected bird populations are also necessary. Unfortunately, less is known about the factors that lead to large numbers of infected birds making this component of risk impossible to predict and there is no efficient way to conduct surveillance for infection levels in wild birds.

The lack of useful pre-season predictive factors limits the ability of MDPH to make any accurate assessments regarding future WNV activity. Both the variability of New England weather, and the inability to detect WNV infection levels in wild bird populations, requires that Massachusetts maintain a robust surveillance system to detect WNV in mosquitoes as a primary tool to assess risk of human disease. MDPH continues to strive to identify reliable measures to aid in risk assessments.

Invasive Mosquito Species Surveillance

MDPH and its partners are taking proactive measures to conduct surveillance for invasive mosquito species that are expanding their geographic range northward, especially for *Aedes albopictus*. *Ae. albopictus* is an aggressive mammal-biting species that was introduced to North America from Asia around 1985. This species has been implicated in the transmission of arboviruses such as dengue, chikungunya, yellow fever, and Zika, in some parts of the world. Where it occurs, this species is generally more abundant in urban areas, breeding in artificial containers, such as birdbaths, discarded tires, buckets, clogged gutters, catch basins, and other standing water sources. These mosquitoes are aggressive biters that actively seek out mammals, including humans, during daytime hours.

Limited detections of *Ae. albopictus* were first identified in Southeastern MA in 2009. Since these initial detections, additional findings have been recorded outside Southeastern MA. With the use of ovitraps *Ae. albopictus* has now been detected in 20 communities throughout the state since 2009. MDPH will continue to conduct routine surveillance activities to monitor for the presence and expansion of *Ae. albopictus* and other invasive mosquito species.



The global Zika virus outbreak began in South America in December 2015. Throughout 2016 – 2017 Zika virus spread across much of the globe. In 2018 the Zika virus outbreak diminished substantially worldwide. Zika virus is transmitted by *Aedes* mosquitoes. Symptoms appear in only 20% of cases, the majority of patients experience no symptoms. Those individuals that do experience symptoms typically have low-grade fever, muscle and or joint pain, rash, conjunctivitis, nausea, and diarrhea. The disease resolves with supportive treatment. However, in pregnant women who become infected with Zika virus, it is possible for the virus to spread to the developing fetus. When this happens, it can result in birth defects, including abnormal brain and head development (microcephaly).

In 2018, the Massachusetts State Public Health Laboratory tested 360 residents for Zika virus compared to 3,013 in 2017. Of the 360 samples submitted for testing seven (1.9%) were positive. All cases were investigated and determined to be travel associated. There have been no cases of Zika virus acquired locally from mosquitoes in Massachusetts. Since Zika virus is not a locally transmitted mosquito-borne disease, there are no plans to test mosquitoes in Massachusetts for Zika virus.

COMMONWEALTH OF MASSACHUSETTS
STATE RECLAMATION & MOSQUITO CONTROL BOARD

CENTRAL MASSACHUSETTS MOSQUITO CONTROL PROJECT

est. 1973

EXECUTIVE SUMMARY
2018

March 2019

CMMCP MISSION STATEMENT

The objective of the Central Massachusetts Mosquito Control Project (CMMCP) is to attain an efficient, economic mosquito control operation which will provide the best results possible and be consistent with all ecological aspects and the best interests of the member towns.

Our goal is to reduce mosquito exposure to the public, and the potential for disease transmission by mosquitoes, by utilizing proven, sound mosquito control techniques. CMMCP believes the best way to accomplish this task is by practicing an Integrated Pest Management (IPM) approach as it relates to mosquito control in Massachusetts. IPM utilizes a variety of control techniques and evaluation procedures. Control efforts are undertaken only after surveillance data has been collected and analyzed. Training, experience and common sense dictate our response in any given situation.

It is our desire and responsibility for this Project to have the best mosquito control for the communities that we serve.

INTRODUCTION:

The Central Massachusetts Mosquito Control Project currently provides its services to 42 cities and towns throughout Middlesex and Worcester Counties. The Project's headquarters is located at 111 Otis Street, Northboro, MA. Please call (508) 393-3055 during business hours for information. Twenty-two (22) full time and eight (8) seasonal staff were employed at CMMCP in 2018. This the year we received a total of nineteen thousand, four hundred and ninety-two (19,492) requests for service from town residents and officials. A map of our service area is on page 7.

EDUCATION:

The Mosquito Awareness Program which we offer to elementary schools and other civic organizations in our district has become very popular. Project staff meets with students, teachers or residents to discuss mosquito biology, mosquito habitat, and control procedures. Much of the presentation is directed towards what can be done to prevent mosquitoes from breeding around their homes. This program is tailored to meet the needs of the specific audience. In 2017, CMMCP laboratory personnel and other administrative staff made sixty-four (64) educational presentations before two thousand five hundred fifty-eight (2,558) elementary school students in twenty-one (21) elementary schools. CMMCP admin staff were interviewed on several cable TV and local radio stations. 2011 marked the start of the “CMMCP Mosquito Education Program for Seniors” in which presentations are conducted at local senior centers to increase mosquito-borne disease awareness. Three (3) presentations to forty-five (45) senior citizens were conducted in 2018. Over 1,000 specialized brochures for this program were distributed through this program. Several different educational pamphlets are available to anyone interested in learning about mosquito control and the services provided by the Project, and these items are routinely stocked in member Town/City Halls and libraries. Display

boards with information on our program are rotated in area Town/City Halls throughout the year. Bookmarks with educational information have been printed and stocked in member libraries and town halls, and are used as part of the education program. We also have a website at www.cmmcp.org that has extensive information on mosquito biology, our control procedures, products we use, etc.

DITCH MAINTENANCE & WETLAND RESTORATION:

As part of our effort to reduce the need for pesticides we continue to place great emphasis our wetlands restoration program. By cleaning clogged, degraded and overgrown waterways, mosquito breeding from that area can be reduced or eliminated and drainage areas are restored to historic conditions. Three thousand, five hundred and thirty-one (3,531) culverts were cleaned in an attempt to eliminate unnecessary standing water and reduce mosquito breeding. This work was done in conjunction with cleaning, clearing, and digging of two hundred and seven thousand, nine hundred (207,900) feet of streams, brooks and ditches. This represents over thirty-nine (39) miles of waterways which were cleaned and improved by Project personnel in 2018.

ARBOVIRUS CONTROL:

As part of our West Nile Virus (WNV) prevention program, a record one hundred and four thousand, two hundred and thirty-one (104,231) catch basins were treated with larvicidal products to control the mosquitoes that seek out these cool dark wet areas to develop, including the *Culex* species of mosquito, a major target for West Nile Virus transmission. We identify priority areas in each town and treat the basins in these selected areas to reduce the emergence of this arbovirus. The priority areas are as follows: prior year WNV activity; senior centers & over 55 housing developments; recreation areas; schools and neighborhoods (higher density first); industrial areas. We performed pre-emptive treatments in late May in areas that showed West Nile Virus in the prior year, with follow up treatments throughout in the season as part of our standard protocol treatment. Additional seasonal staff and the new electronic mapping and routing program for adulticiding were responsible for this large increase in basin treatments.

MOSQUITO SURVEILLANCE:

The Project's surveillance program monitors adult mosquito and larval population density, and is the backbone for prescribing various control techniques. Specialized mosquito traps are deployed throughout the Project's service area to sample for mosquitoes that may be transmitting mosquito-borne diseases. In conjunction with the Mass. Dept. of Public Health we sample in areas suspected of harboring WNV and other viruses. One thousand nine hundred and sixty-four (1,964) pools (collections) of mosquitoes totaling forty-eight thousand nine hundred (48,900) individual specimens were tested for mosquito-borne viruses this year. A record one hundred and fifty-nine (159) collections were identified positive this year; all with West Nile Virus (WNV). CMMCP lab personnel processed at total of five thousand, two hundred and sixty-four (5,264) collections of mosquitoes containing ninety six thousand and ninety-eight (96,098) individual

specimens, representing thirty (30) mosquito species.

Target Species	*Ae. vexans*	*Cq. perturbans*	*Cs. melanura*	*Oc. canadensis*	*Culex spp.*	All Species
No. Pools	240	566	185	195	1,497	5,264
Total Specimens	3,369	47,187	507	2,240	33,589	96,068
No. Pools WNV +	1	2	0	1	154	159
No. Pools EEE +	0	0	0	0	0	0

A table with the 2018 arbovirus information for our service area as well as the statewide results is included on page 8. Adult mosquito surveillance began in May and concluded in September. Four (4) full time seasonable employees were hired for the summer to assist our Staff Entomologist, Staff Biologist and Field Biologist in their duties.

LARVAL MOSQUITO CONTROL:

Bti (*Bacillus thuringiensis* var. *israelensis*) mosquito larvicide is a species specific, non-reproducing bacterium and is used to treat areas where mosquito larvae are found. Our field crews will investigate areas we have databased and treat the area if surveillance gathered at the time shows an imminent threat of mosquito emergence. Ten thousand two hundred (10,200) pounds of Bti (*Bacillus thuringiensis israelensis*) was applied by helicopter over two thousand and forty (2,040) acres in 3 towns, Chelmsford, Billerica & Boxborough, resulting in an 83.67% reduction in larval counts. Two thousand, three hundred and sixty-six (2,366) pounds were applied by ground crews over four hundred and seventy-three (473) acres throughout our service area to area wetlands to reduce the emergence of adult mosquitoes. This represents over two thousand, five hundred and thirteen (2,513) acres of wetland that was treated with this mosquito-specific bacterium, significantly reducing adult mosquito populations in these areas. We have several thousand areas catalogued that are checked and treated as needed on a routine basis, and many applications are small, measured in ounces. Larval control began in late March and continued throughout the month of September.

ADULT MOSQUITO CONTROL:

Our goal is to manage all mosquito problems with education, wetlands restoration or larviciding, but we recognize that there are times when adult mosquito spraying is the only viable solution. In such cases specific areas are treated with either hand-held or pickup truck mounted sprayers if surveillance gathered at the time exceeds a pre-determined threshold to warrant an application. This program is offered on a **request-only** basis, and the exclusion process under 333CMR13 allows residents and/or town officials to exclude areas under their control from this or any part of our program. We apply the spray product at the lowest label rate unless mosquito-borne virus has been identified, and then we will consider other application rates depending on weather and other factors. Thirty-three (33) landing counts were performed by Project field staff as additional surveillance or prior to the application of etofenprox to confirm that pre-determined thresholds of mosquitoes

were exceeded to warrant an application. Landing rates are suspended when WNV or EEE is identified in Mass. Adult control began in early June and ended in mid-September with the onset of low nighttime temperatures, reduced service requests and low mosquito population density.

RESEARCH AND EFFICACY

While CMMCP is an agency charged with the control of mosquitoes, we strive to check for efficacy of our products and techniques, and whenever possible perform research in new or different areas of mosquito control. Some of our 2016 Research projects were:

- Asian Tiger Mosquito (ATM) Surveillance in Central Mass.
- Field Trials of Natular™ G30 for Pre-Hatch Control of Mosquito Larvae in Selected Spring Brood Locations
- Field Trials of Natular™ G for Control of *Coquillettidia perturbans* Larvae in Selected Cattail Locations
- Aerial Mosquito Larval Control Program
- Bottle Assays of Field Collected Mosquitoes for Levels of Resistance to Zenivex® E4 in Central Mass

The addition of a fulltime Field Biologist in 2007 allowed these research projects to become more standardized, resulting in increased validity of the findings, reinforced by multiple seasons of trials. We have annual strategy sessions in the fall/winter seasons to plan for field trials and other anticipated research for the upcoming year. CMMCP departments as determined by the Executive Director will be expected to publish annually in such journals as the Journal of the AMCA (JAMCA), the NMCA or NJMCA Proceedings, Wing Beats, and other publications. The Field Biologist composes reports as directed, such as weekly surveillance, rainfall data, aerial larval control, etc. and will graph and track trends as directed. These reports will be disseminated to various parties, i.e. SRMCB, MDPH, CMMCP Commission, posted on the CMMCP website, etc.

SOURCE REDUCTION/TIRE RECYCLING

For Earth Day 2010, CMMCP officially announced a tire recycling program added as a value added service to our member cities and towns. This program operates under grant monies received and the CMMCP operating budget. Tire piles provide suitable areas for larval mosquito development, including those species known to carry West Nile virus. During the course of one season, the potential exists for hundreds or even thousands of mosquitoes to emerge from just one tire. If tires infested with mosquito eggs, larvae or pupae are transported, the potential to introduce mosquito species into new areas and/or the potential for the spread of arboviruses and their transmission may increase significantly.

For these reasons and as a value added service to our member cites and towns, CMMCP has developed a used tire program, consisting of the following guidelines:

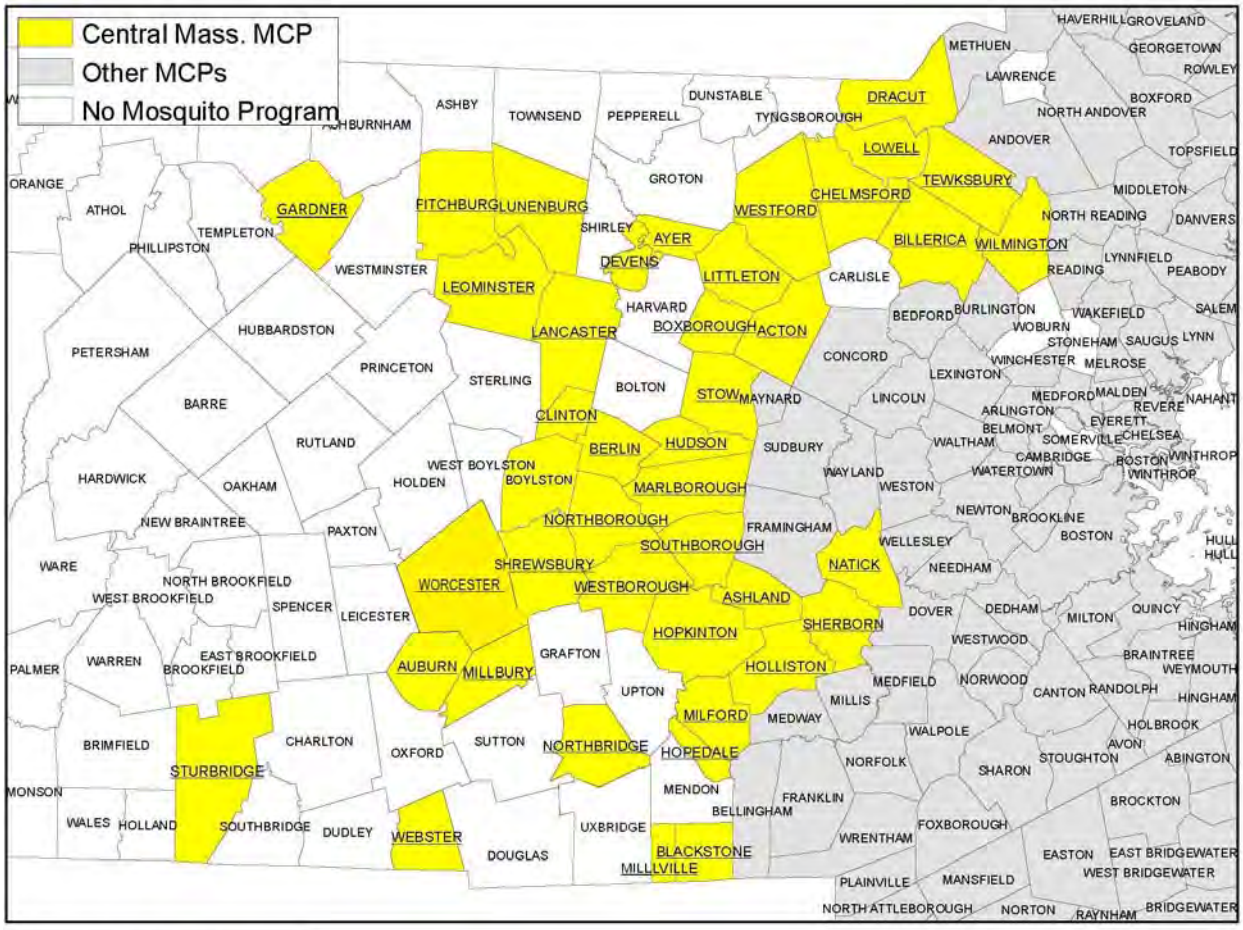
- We accept passenger and light truck tires only
- The maximum number tires from one property will be 10 at one time, subject to change without notice
- Requests for tire removal shall be done according to established procedures
- We reserve the right to refuse anything determined to be unsuitable for this program

Tires accepted as part of this program will be sent to an approved facility for recycling or disposal. This program is subject to end without notice. There is no additional cost to residents or municipalities; this program is part of the full suite of mosquito control services offered. In 2018 we collected a total of three thousand, four hundred and thirty-two (3,432) tires in thirty-seven (37) member cities and towns. Collections will continue as time and resources allow.

Some additional highlights from 2018:

- Resistance management study; no significant resistance to pyrethroids noted, no change recommended in adulticide material choice (see full report).
- Field trials of a naturally-occurring bacterium called spinosad shows promise for pre-hatch spring brood applications, as well as larval cattail mosquito (*Cq. perturbans*) control.
- Monitoring for the Asian Tiger Mosquito (*Ae. albopictus*) did not find specimens of this aggressive, invasive species in the Central Mass. area.
- CMMCP participates in the EPA's WasteWise program, tracking our source reduction (tire recycling) efforts. Our efforts in this program were recognized by the EPA – Region 1 in 2017 with a "Certificate of Achievement" for sustainable waste management practices.

CMMCP SERVICE AREA – 2018



Frank Cornine, CMMCP
Select features of this map courtesy of:
Office of Geographic Information (MassGIS),
Commonwealth of Massachusetts
Information Technology Division

Member,
Northeastern
Mosquito Control
Association

Member,
New Jersey
Mosquito Control
Association

Partner,
EPA Pesticide
Environmental
Stewardship Program

Partner,
EPA WasteWise
Program

Member, Massachusetts Municipal
Association

Member, MassRecycle

2018 SUMMARY TOTALS

Service Requests	Bti Lbs.	Bti Acres	Adulticide Gallons	Adulticide Acres
19,492	12,566	2,513	974	190,882

Pools Sent to MDPH	Landing Counts	Culverts Cleaned	Restoration Footage	Catch Basins Treated	Tires Recycled
1,964	33	3,531	207,900	104,231	3,432

ARBOVIRUS SUMMARY 2018

WNV Surveillance Summary – Statewide	**2018**
Mosquito Pools Positive	579
Animals Positive	2
Humans Positive	49
EEE Surveillance Summary – Statewide	**2018**
Mosquito Pools Positive	2
Animals Positive	2
Humans Positive	0
CMMCP Surveillance Summary	**2018**
Mosquitoes Collected and Identified	48,900
Mosquito Pools Submitted for testing	1,964
Mosquito Pools Positive WNV	159
Animals Positive WNV	0
Humans Positive WNV	0
Mosquito Pools Positive EEE	0
Animals Positive EEE	0
Humans Positive EEE	0

Town	Total Service Requests	Bti Pounds	Bti Acres	Adulticide Gallons	Adulticide Acres	Catch Basins Treated	Mosquito Pools Tested	Mosquito Pools WNV Positive	Culverts Cleaned	Total Restoration Footage	Tires Recycled
Acton	539	26.50	5.30	29	4,829	2,571	60	4	118	4,000	24
Ashland	469	64.75	12.95	24	3,855	2,817	42	4	91	8,940	71
Auburn	710	83.00	16.60	33	6,122	3,580	56	7	26	6,310	242
Ayer	191	20.00	4.00	10	2,028	1,448	55	7	111	2,689	1
Berlin	91	26.25	5.25	8	1,863	634	35	3	147	3,035	
Billerica	582	3,034.00	606.80	27	5,574	2,948	52	1	19	8,990	239
Blackstone	374	32.50	6.50	16	3,309	842	33	3	85	10,200	
Boxborough	85	4,228.00	845.60	13	3,513	985	45	3	58	3,150	
Boylston	287	34.00	6.80	7	1,485	1,263	39	2	131	2,590	
Chelmsford	1004	3,101.00	620.20	37	8,441	3,462	51	1	23	8,935	14
Clinton	201	43.00	8.60	17	3,367	1,502	33	7	47	3,240	232
Devens	6	24.00	4.80	7	1,610	772	49	4	102	2,702	
Dracut	923	35.00	7.00	36	7,808	2,728	47	3	27	2,550	10
Fitchburg	194	15.00	3.00	5	942	3,167	35	0	132	6,120	387
Gardner	75	26.25	5.25	4	661	3,235	33	1	146	3,365	401
Holliston	381	135.75	27.15	11	1,797	2,037	44	0	49	4,143	28
Hopedale	221	67.00	13.40	15	2,534	1,719	49	5	89	2,890	4
Hopkinton	672	112.25	22.45	29	2,766	2,530	43	0	51	6,560	28
Hudson	344	23.00	4.60	21	3,977	2,642	43	4	28	5,945	1
Lancaster	375	11.00	2.20	17	3,383	1,226	38	3	173	2,855	134
Leominster	212	26.00	5.20	15	3,060	3,675	39	3	164	3,865	527
Littleton	408	65.25	13.05	20	3,811	1,703	42	3	90	2,560	20
Lowell	169	35.00	7.00	5	1,052	5,259	53	1	28	3,225	4
Lunenburg	588	23.00	4.60	31	5,544	1,194	38	4	97	5,530	74
Marlboro	376	31.50	6.30	12	2,648	5,596	32	3	38	5,105	4
Milford	619	136.00	27.20	40	6,923	2,748	46	1	170	3,070	
Millbury	498	155.50	31.10	17	3,856	1,452	41	2	103	2,895	99
Millville	167	38.50	7.70	7	1,307	586	39	2	123	2,895	1
Natick	747	91.75	18.35	24	4,691	3,421	46	2	134	4,225	
Northboro	442	46.75	9.35	29	5,721	2,393	58	10	69	3,300	46
Northbridge	705	65.75	13.15	28	4,928	1,455	37	4	126	7,865	26
Sherborn	152	54.25	10.85	14	1,550	1,157	47	1	44	15,090	267
Shrewsbury	639	108.50	21.70	39	7,589	4,806	50	5	70	4,015	32
Southboro	249	30.50	6.10	15	3,354	1,344	40	11	39	12,730	2

Town	Total Service Requests		Bti Pounds	Bti Acres		Adulticide Gallons	Adulticide Acres		Catch Basins Treated		Mosquito Pools Tested	Mosquito Pools WNV Positive		Culverts Cleaned	Total Restoration Footage	Tires Recycled
Stow	557		60.25	12.05		26	4,671		1,360		46	3		132	4,620	28
Sturbridge	799		96.75	19.35		41	9,659		1,388		43	2		71	4,980	20
Tewksbury	1087		54.25	10.85		41	8,313		3,263		66	2		50	3,700	213
Webster	414		82.25	16.45		9	1,952		1,635		39	1		114	2,935	36
Westboro	510		123.00	24.60		21	5,030		785		26	3		55	6,066	5
Westford	897		60.00	12.00		52	11,221		1,687		45	0		60	4,810	15
Wilmington	1212		38.75	7.75		62	12,190		1,729		59	3		61	2,710	185
Worcester	321		0.00	0.00		60	11,948		13,487		150	31		40	2,500	12
Totals	**19,492**		**12,566**	**2,513**		**974**	**190,882**		**104,231**		**1,964**	**159**		**3,531**	**207,900**	**3,432**