CENTRAL MASSACHUSETTS MOSQUITO CONTROL PROJECT

111 Otis Street
Northborough, MA 01532
(508) 393-3055 ★ www.cmmcp.org

SERVICES GUIDE

revised 6/2021 ♦ TDD

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INTRODUCTION

- ★ CMMCP is a State agency, providing services in 44 cities & towns in Middlesex & Worcester counties and offers a full service, year-round program of mosquito control, with 8 key services. Please see our current service area map on page 3.

- ★ Mosquito control in Mass. is organized through M.G.L. Chapter 252. Each district has its own enabling legislation; CMMCP was formed under Chapter 583 of the Acts of 1973.

- ★ CMMCP is overseen by a 5 member Board of Commission, appointed by the State Reclamation & Mosquito Control Board (SRMCB). The SRMCB is comprised of representatives from the Dept. of Agricultural Resources, Dept. of Environmental Protection & Dept. of Conservation & Recreation – we also work in close coordination with Dept. of Public Health.

- ★ We also have important partnerships with the EPA in their PESP (Pesticide Environmental Stewardship Program) and their WasteWise Program, a program that encourages recycling.

- ★ CMMCP is one of 11 organized mosquito control districts in the state. Please see the current mosquito district map on page 4.

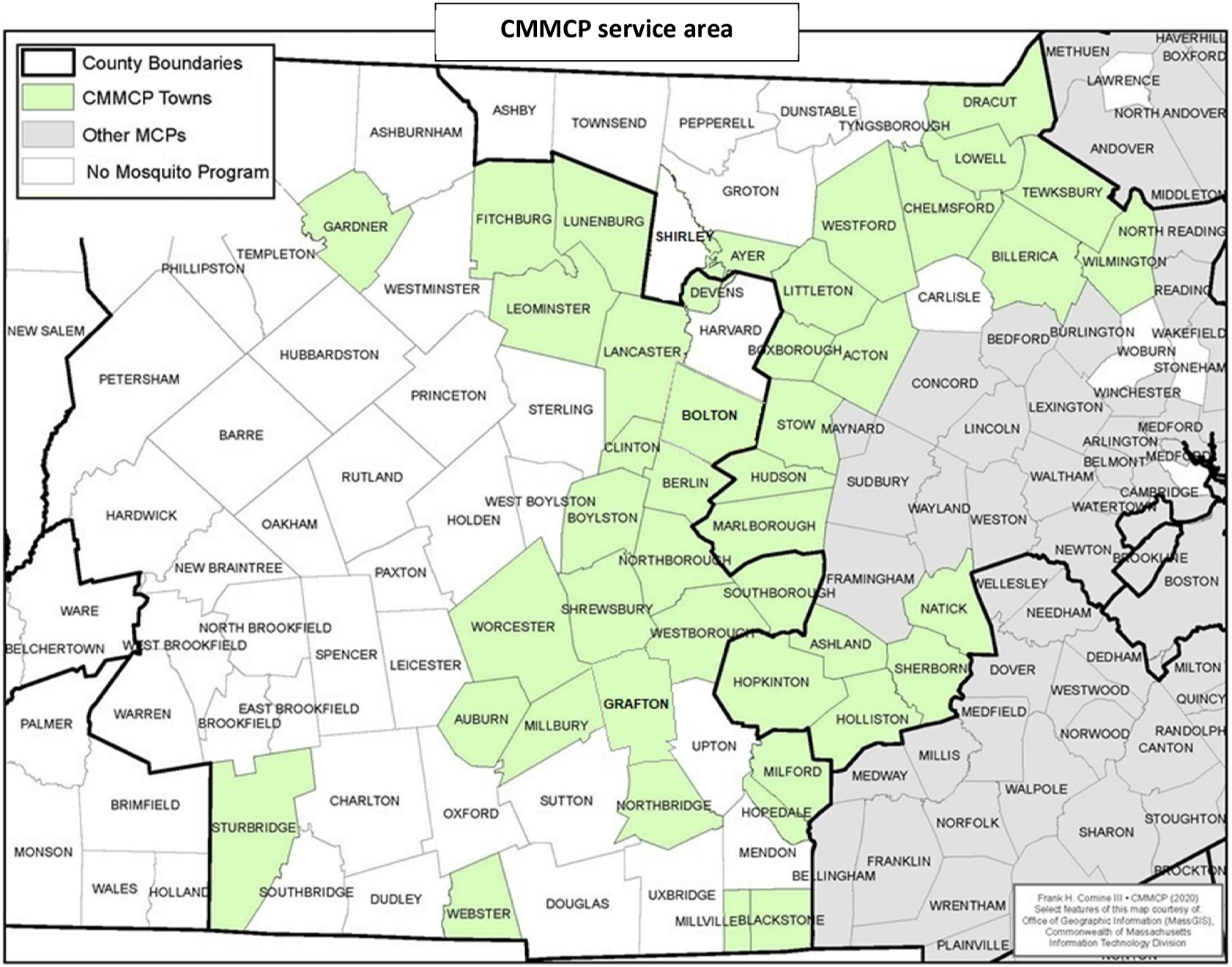
- ★ Towns can join our program by a majority vote at an annual or special town meeting; cities join by a majority vote of the City Council.

- ★ The annual assessment is derived from a formula administered by the Dept. of Revenue, and this amount is withheld from the local aid (cherry sheet) assessment. An approximate assessment and warrant language can be sent upon request. Please email CMMCP Executive Director Timothy Deschamps at deschamps@cmmcp.org for this information.

- ★ After confirmation of a vote to join, services typically begin at the start of the fiscal year (July 1), but a prorated invoice can be generated if the community would like services to begin before that date.

CMMCP offers 8 core services, most of which are proactive and occur before mosquitoes have hatched from their larval habitat (#'s 1-6). The 7th service, called "adulticiding", is the spraying program many people are familiar with. While this service is done *after* mosquitoes have hatched, and may be considered "reactive", it is also a proactive service, controlling mosquitoes before they become infected with virus or before they can transmit virus to a susceptible host. The 8th service acts as a "checks and balances" program, insuring that our products and procedures are effective, and testing out new products, equipment and application techniques.

Detailed explanations of each program are outlined in this document.


CMMCP service area
County Boundaries
CMMCP Towns
Other MCPs
No Mosquito Program
ASHBURNHAM
ASHBY
TOWNSEND
PEPPERELL
DUNSTABLE
TYNGSBOROUGH
METHUEN
HAVERHILL
BOXFORD
LAWRENCE
NORTH ANDOVER
ANDOVER
DRACUT
LOWELL
GROTON
TEWKSBURY
MIDDLETON
CHELMSFORD
WESTFORD
NORTH READING
GARDNER
FITCHBURG
LUNENBURG
SHIRLEY
AYER
BILLERICA
WILMINGTON
TEMPLETON
PHILLIPSTON
WESTMINSTER
DEVENS
LITTLETON
CARLISLE
READING
LEOMINSTER
HARVARD
NEW SALEM
BEDFORD
BURLINGTON
WAKEFIELD
LANCASTER
BOXBOROUGH
ACTON
WOBURN
STONEHAM
HUBBARDSTON
PETERSHAM
CONCORD
WINCHESTER
PRINCETON
STERLING
BOLTON
LEXINGTON
STOW
MAYNARD
LINCOLN
MEDFORD
BARRE
CLINTON
ARLINGTON
BELMONT
MEDFORD
RUTLAND
BERLIN
HUDSON
SUDBURY
WALTHAM
CAMBRIDGE
WEST BOYLSTON
WAYLAND
WATERTOWN
HARDWICK
OAKHAM
HOLDEN
BOYLSTON
MARLBOROUGH
WESTON
NEWTON
BROOKLINE
NEW BRAINTREE
PAXTON
NORTHBOROUGH
FRAMINGHAM
BOSTON
SOUTHBOROUGH
WELLESLEY
WARE
SHREWSBURY
NATICK
NEEDHAM
NORTH BROOKFIELD
WORCESTER
WESTBOROUGH
ASHLAND
BELCHERTOWN
WEST BROOKFIELD
SPENCER
LEICESTER
HOPKINTON
SHERBORN
DOVER
DEDHAM
MILTON
WESTWOOD
QUINCY
EAST BROOKFIELD
GRAFTON
MEDFIELD
PALMER
WARREN
BROOKFIELD
AUBURN
MILLBURY
HOLLISTON
NORWOOD
RANDOLPH
CANTON
UPTON
MILLIS
MILFORD
MEDWAY
WALPOLE
BRIMFIELD
CHARLTON
SUTTON
NORTHBRIDGE
HOPEDALE
NORFOLK
STOUGHTON
STURBRIDGE
OXFORD
SHARON
MONSON
MENDON
FRANKLIN
BELLINGHAM
BROCKTON
WALES
HOLLAND
SOUTHBRIDGE
DUDLEY
WEBSTER
DOUGLAS
UXBRIDGE
WRENTHAM
MILLVILLE
BLACKSTONE
PLAINVILLE
Frank H. Comine III • CMMCP (2020)
Select features of this map courtesy of:
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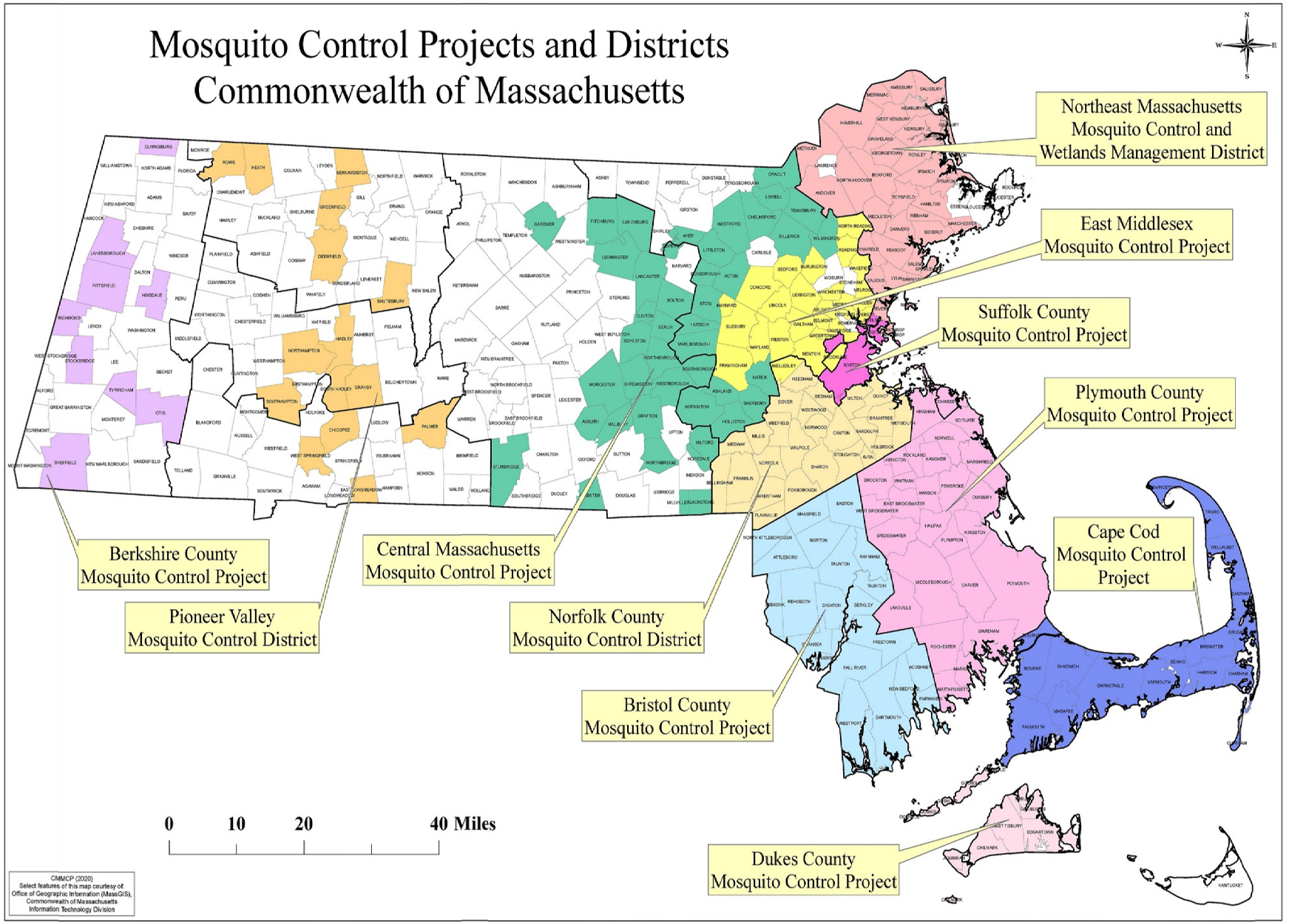
Commonwealth of Massachusetts
Information Technology Division


Mosquito Control Projects and Districts
Commonwealth of Massachusetts
Northeast Massachusetts Mosquito Control and Wetlands Management District
East Middlesex Mosquito Control Project
Suffolk County Mosquito Control Project
Plymouth County Mosquito Control Project
Cape Cod Mosquito Control Project
Berkshire County Mosquito Control Project
Pioneer Valley Mosquito Control District
Central Massachusetts Mosquito Control Project
Norfolk County Mosquito Control District
Bristol County Mosquito Control Project
Dukes County Mosquito Control Project
0 10 20 40 Miles
CMMCP (2020)
Select features of this map courtesy of:
Office of Geographic Information (MassGIS),
Commonwealth of Massachusetts
Information Technology Division

1. Mosquito Surveillance:

Data collection is at the core of any Integrated Pest Management (IPM) program. Specialized mosquito traps are deployed on a weekly basis in all member communities. Mosquito identifications are done in CMMCP office and samples are sent to Jamaica Plain (DPH lab) each week for testing. Each trap type lends itself to specific types of collections; viral exposure, population density and overall species composition.

All mosquitoes collected are identified to species by specially trained staff.

Mosquito identification at the CMMCP laboratory

Mosquitoes identified as potential vectors of disease are separated and prepared for testing by the Mass. Department of Public Health (MDPH). These mosquitoes are put together in "pools" of 50 specimens, and tested for EEE, WNV and other mosquito-borne disease of concern as designated by MDPH. Results are usually available within 24-36 hours after receipt of samples.

The arbovirus surveillance program at CMMCP deploys over 700 traps in member communities, and collects and identified up to 200,000 individual specimens each year. All communities receive weekly sampling and testing.

On pages 6-8 are samples and descriptions of the different trap types used at CMMCP.

The Reiter-Cummings Modified Gravid Trap:

This trap is designed to collect gravid (pregnant) mosquitoes searching for habitat to oviposit (deposit eggs). This trap type is an excellent tool for species that may transmit West Nile Virus. A wash basin is filled with a hay infusion (hay soaked in water, becoming bacteria-filled), and the collection device on top draws the sample into the collection chamber, where a surveillance technician makes the collection the next day.

The CDC light trap:

This trap is excellent for overall species composition and population density since it attracts a wide variety of mosquito species. The light is removed to discourage non-target insects from being collected, and bottled CO_2 gas is used as the attractant. The mosquito follows the stream of emitted CO_2 to the traps, and is then drawn into the collection cup on the bottom. These traps can be placed at head-height to trap mammal-biting mosquitoes, or in the tree canopy to sample for bird-biting species.

Since these sample host-seeking mosquitoes, not all collections may show viral results since some of these mosquitoes may not have bloodfed yet. They do give us important information on population densities which can give early indications of potential virus activity.

These are the two main types of traps, but we also deploy other specialized traps in other situations as described on pages 7 and 8.

Resting Boxes:

Female mosquitoes needs shelter to allow their eggs to develop after taking a bloodmeal. This process can take several days. Placing black boxes, painted red inside facing north attracts these female mosquitoes and allows for their collection. This trap type is a good method of collection for the *Culiseta melanura* species, a species known to transmit EEE in the bird population.

Mosquito Ovitrap:

This collection device attracts container-species such as *Aedes albopictus, Ochlerotatus j. japonicus* and *Ochlerotatus triseriatus*. The dark habitat and stagnant water is excellent mosquito habitat for several invasive species, including *Aedes albopictus* (Asian Tiger Mosquito) and other species that may transmit West Nile Virus. These cups are lined with paper, and the female mosquito will deposit her eggs on the paper just above the water line allowing for easy collection.

We then count the eggs and use a hatching protocol to determine the species prevalence in that area.

Since most of these species stay close to their larval habitat, these traps can give an indication of population densities in a more closely defined area.

The BG-Sentinel (right) and BG-GAT (below) are additional traps deployed by CMMCP in certain locations.

The function of the BG-Sentinel Mosquito Trap is to:

•Mimic convection currents created by a human body;

•Employ attractive visual cues;

•Release artificial skin emanations through a large surface area;

•Use without CO_2 to specifically capture selected mosquito species; and

•Use with CO_2 as an excellent general mosquito trap.

Used in combination with the BG-Lure, a dispenser which releases a combination of non-toxic substances that are also found on human skin (ammonia, lactic acid, and caproic acid), the BG-Sentinel is especially attractive to the Asian tiger mosquito.

The BG-GAT (Gravid *Aedes* Trap) uses water and other oviposition cues to attract female Asian tiger and other species of *Aedes* mosquitoes that are looking for a place to lay their eggs. Once in the trap, the mosquitoes are exposed to a sticky surface and die.

The big advantage of this trap version is that it is passive, which means it does not require power or supplemental attractants like CO_2 or chemical lures. This provides great flexibility in deployment and ease of handling.

2. Public education:

Comprehensive educational programs are offered to member schools, civic groups and town departments. The program is aimed towards mosquito biology, mosquito habitat, control techniques and efforts citizens can undertake to reduce the potential for mosquito emergence in their own neighborhood. This program is tailored to suit the requirements of the individual group, from elementary school children, to high school, to adult groups. Each year we reach out to well over 2,000 people in our service area. We stock our educational materials in town halls, schools & libraries, and we are active on social media platforms such as Facebook, Twitter & YouTube.

A recent public presentation

In 2011 we developed an educational program specifically geared towards senior citizens, an especially at-risk population from diseases such as West Nile Virus. The content is similar to the K-8 school program but has more in depth information on mosquito biology, and has information on West Nile Virus as well as Lyme disease and ticks. CMMCP personnel have exhibited at health fairs and other meetings organized by town departments or civic groups. Personnel are available to meet with town boards and committees, as well as other concerned groups. Presentations at Annual Town Meetings have been given to both member and potential member cities and towns.

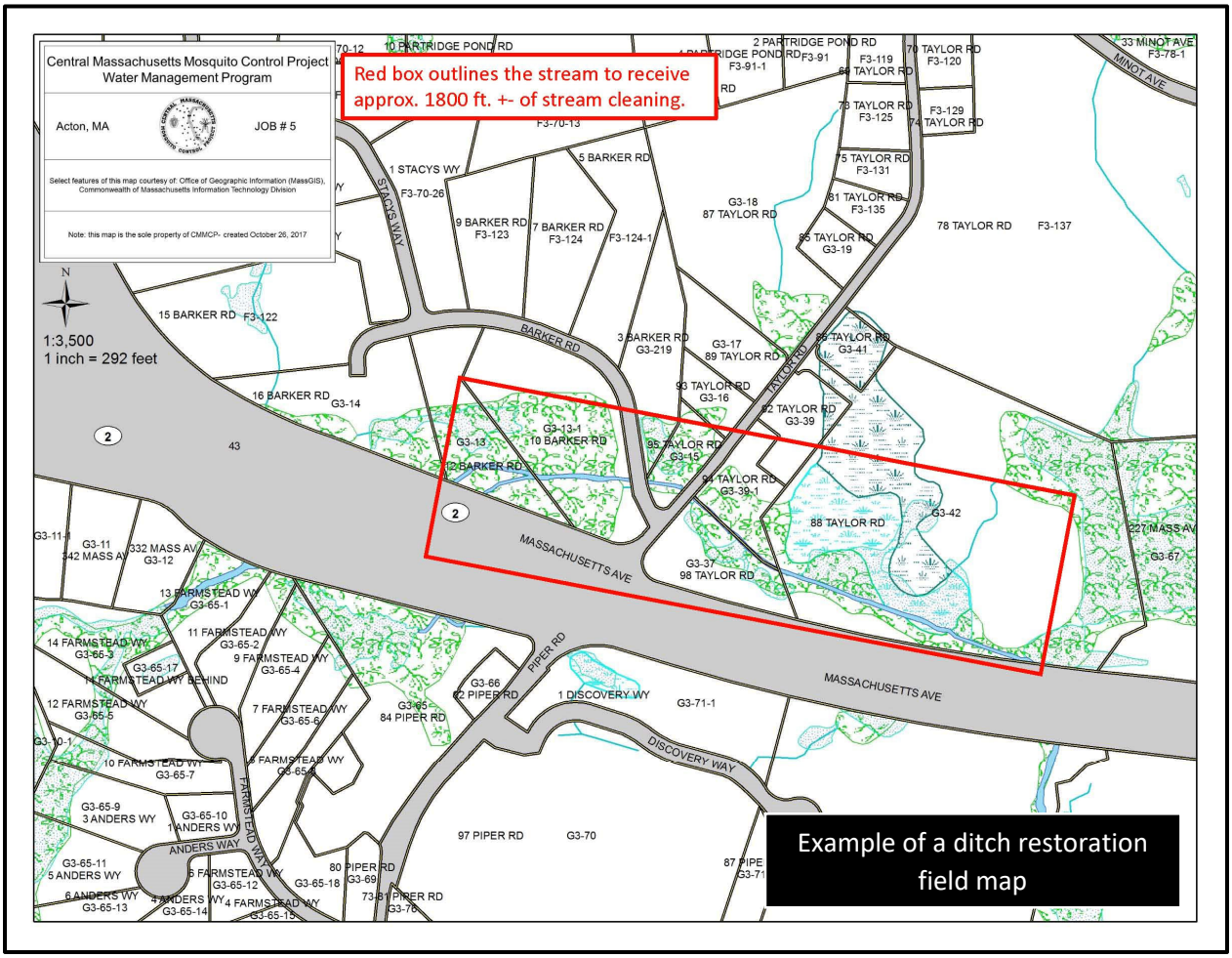
3. Ditch maintenance:

This program is designed to restore historical flow patterns, and is mostly done with hand/power tools, but we perform some mechanized work with specially-designed low-ground pressure equipment. We coordinate with local Conservation Commissions, the Dept. of Environmental Protection & the Army Corps of Engineers as necessary, and refer to a Best Management Practices manual created by DEP and other conservation groups as a guidance document. Ditch maintenance projects are supervised by a wetland scientist on staff (a former ConCom agent) and are scheduled after permission is received from property owners. The Natural Heritage and Endangered Species Protection habitat manual is also reviewed before any projects begin.

Hand cleaning a ditch

Ditch maintenance is an integral part of an Integrated Pest Management (IPM) plan. Restoration of degraded wetland areas consists of selectively clearing brush and removing debris from drainage systems to restore historical flow patterns. This can be accomplished with hand tools such as rakes, clippers and chain saws or may require more extensive restoration using mechanized equipment.

Restoration of drainage systems reduces or often eliminates the need for periodic applications of pesticides to control the larval mosquito. We becomes aware of potential projects through resident or town official requests, CMMCP field technician observations and data collections, or follow up on past restoration projects. The Wetlands Project Coordinator will investigate the site to see if the area will benefit from restoration, and if so, will determine the scope of the project. Ditch maintenance work focuses on those areas that have historic flow patterns and were maintained in the past.



It is our goal to reduce the amount of stagnant water in the restoration area, reducing the area to soil saturation, with less than 5,000 sq. ft. of impact to bordering vegetated wetland (BVW). Maintaining the area at soil saturation will encourage the present vegetation to remain, but will eliminate larval mosquito habitat.

In situations where beavers have caused issues, we have a separate program that determines if any work can be done in that area. Please see page 15 for more information.

4. Larval mosquito control:

This program is the first control option and most effective, which can result in the reduction in service calls for adulticiding (spraying). We use bacterial products that are species-specific. The larval program begins in March to coincide with the emergence of mosquito larvae from their egg casings. The exact date is determined by field observations of area swamps and wetlands. Once greater than 50% of area wetlands are found to contain mosquito larvae, then the field staff are dispatched to begin surveillance and applications wherever necessary. Field technicians are trained to identify mosquito larvae among the numerous other aquatic organisms found in wetlands.

Dipping for mosquito larvae

Larval mosquito habitats are monitored throughout the treatment season from March through September on a rotational basis in each member city and town. The threshold for larval control is a minimum average of 1+ per 5 dips. Pre-hatch larval control using extended release bacterial products is now used in areas of historical larval activity, and is applied before the eggs hatch. Most habitats are treated by ground personnel, but on occasion we have used aerial equipment (helicopter). UAV (drones) are also under consideration for treatment of larval habitats.

Beginning in late May, we begin to apply larval control products in catch basins for the control of *Culex* mosquitoes. This species of mosquito is implicated in the amplification of WNV among the bird population and possibly to humans. Swimming pools that have not been maintained are potential larval habitat for species such as *Culex* and *Oc. japonicus* among others. These species are capable of transmitting West Nile Virus, and are important species to control. If CMMCP

personnel are notified of an abandoned pool by a resident, treatment will be made with bacterial products and/or oil surfactants, as determined by the technician.

Identification of larval mosquito habitat is an important aspect of larval control. Many mosquito species have very precise criteria for oviposition (egg-laying) sites. Habitat types range from retention/detention areas, woodland pools, reflood/floodplain areas, white cedar/red maple swamps, permanent water habitat, degraded ditch systems, artificial containers and salt marsh. Each habitat has an associated species that has potential to develop there. Knowing where and when to treat for larvae is an important part of our Integrated Pest Management program.

Culiseta melanura crypt habitat in a red maple swamp

Some species have very specific needs; *Culiseta melanura*, the species involved in EEE transmission in the bird populations, will develop in "crypts" in white cedar/red maple swamps. These crypts are formed when tree root systems grow in an extended wet habitat.

Other species such as *Coquillettidia perturbans* will only develop in areas with emergent vegetation such as cattails; these larvae do not freely float and get air from the surface, but pierce the root system of the plants and breathe air through the plant's circulatory system.

5. Source reduction:

Source reduction in mosquito control means tire recycling, and consists of curb-side pickup, large tire pile removal, roadside pickup and collaboration with communities (Recycle Days, Hazardous Waste Days, etc). All tires are sent to a recycling plant for disposal. We have recycled over 30,000 tires in our member communities since the inception of this program. Tires are preferred larval habitat for *Ae. albopictus* (Asian Tire Mosquito), as well as *Culex pipiens* and *Oc. japonicus*, two species that can transmit West Nile Virus.

Tire collection

This program currently consists of:

1. Clean-up of large waste tire dumping sites that we have databased;
2. Residential waste tire removal (curb-side);
3. Removal of waste tires discarded on the side of the road; and
4. Coordination with communities during recycle events, hazardous waste collections, river cleanups, etc.

Certain restrictions may apply, please contact our office for more information.

6. Beaver control & mitigation:

This is a new program for us, and we work under emergency permits issued by Boards of Health & Conservation Commissions. Work consists of trapping (if needed), dam breaching, water level control devices (WLCD) installations – all done with CMMCP staff & materials in most cases.

Installation of a water level control device

Proper management of beaver populations is needed to address the negative aspects of beavers. City and town Boards of Health have the authority to determine whether a complaint is caused by beaver or muskrat and whether the situation constitutes a threat to public health and/or safety, as defined in the Massachusetts Beaver Law, M.G. L. c. 131, and s. 80A. CMMCP will assist cities and towns with beaver conflicts on a case-by-case basis.

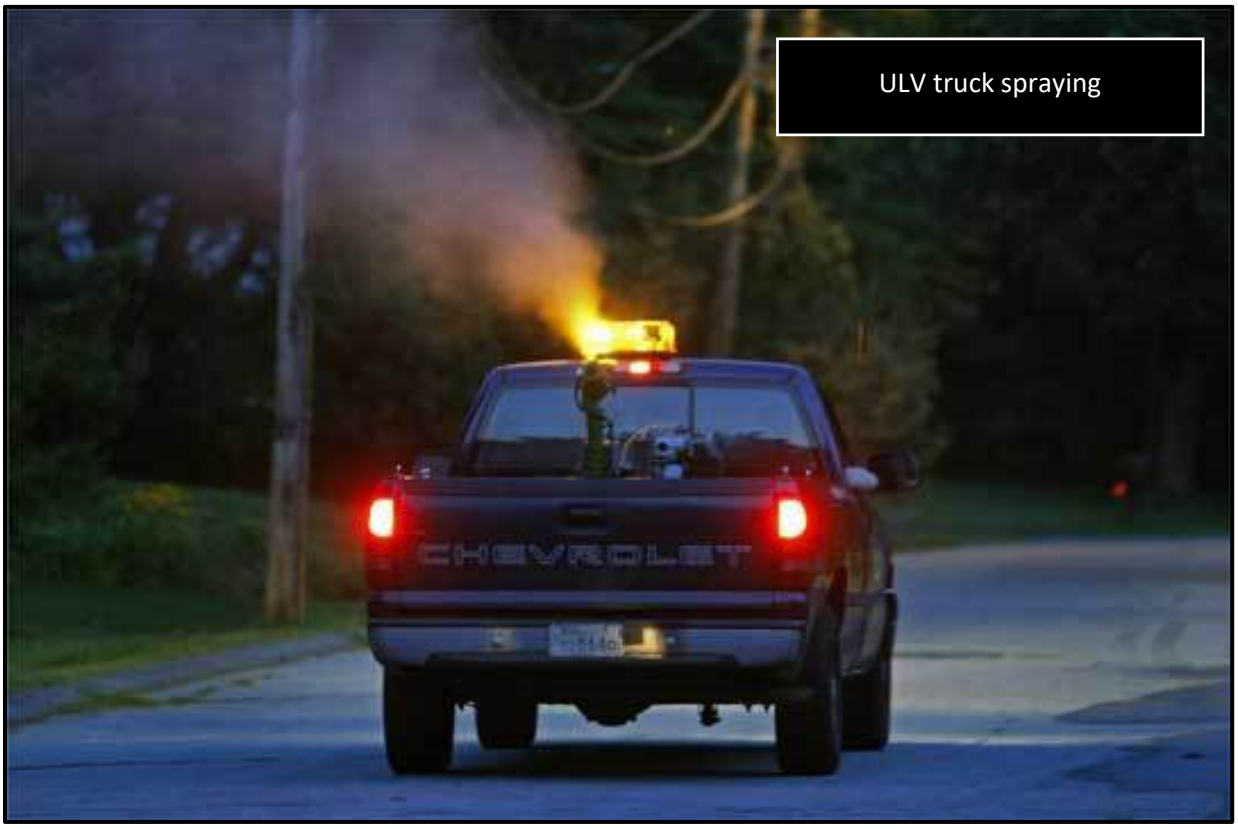
CMMCP supports and follows the recommended practices for beaver management per the Massachusetts Division of Fisheries and Wildlife. Beaver activity will not be interrupted unless it becomes a threat to public health and safety per the Massachusetts Beaver Law M.G.L. c. 131 S. 80A. CMMCP will fully adhere to the permitting process as regulated by the Division of Fisheries and Wildlife (DFW) and the Department of Public Health (DPH).

The most frequent issue in our service area is dam building activity which clogs culverts and drainage ditches. Increased flooding creates new habitat for mosquitoes and increases the need for Integrated Pest Management (IPM) techniques.

7. Adult mosquito control (spraying):

Another control method is to reduce the adult mosquito population before they become infected with mosquito-borne viruses, a method called adulticiding. The control of adult mosquitoes is done on a request-only basis, and the presence or absence of adult mosquitoes is confirmed before any application is done. Certain weather conditions also need to be present, such as wind speed less than 10mph, and temperatures above 50°F (other label restrictions may apply).

Adulticiding is an effective method of temporary control. Exemptions from spraying are handled through the Mass. Department of Agricultural Resources (https://www.mass.gov/how-to/how-to-request-exclusion-from-wide-area-pesticide-applications)



Wide area spraying for virus control is done after coordination with local health officials and if additional criteria are met. Adulticiding is done from approximately Memorial Day to Labor Day, depending on prevalent mosquito populations and virus confirmations.

There is a notification procedure in place, where we notify towns 2 weeks prior about the scheduled nights, and place a specific street listing on our website & phone system each afternoon for that evening's potential spray locations.

All pesticides used for this program are low concentration, non-residual and using the low or mid flow rates. More information on adulticiding products and procedures is on page 19.

8. Research & efficacy:

This is our “checks and balances” program. The goal is to check for the efficacy of our products and techniques, and perform research in new or advanced control methods. We perform annual pesticide resistance testing, as well as larvicide and adulticide program efficacy, and field trials on new products and formulations.

Past studies include:

1. Mosquito bloodmeal analysis,
2. Adulticide program efficacy evaluation,
3. Mosquito host-seeking activity,
4. Crowdsourcing for large-scale mosquito sampling,
5. Resident survey, and
6. Field trials of new bacterial products for larval control

Pesticide resistance testing is performed annually to determine if our pesticides are losing effectiveness. Potential resistance may also lead to the reemergence of several diseases that would have been otherwise contained through control measures. Current resistance in select mosquito populations may be the result of historical insecticide use in the agricultural, residential use and pest control industries.

THE PRODUCTS WE USE

Most larval control products used by CMMCP are bacterial, one is a growth regulator and one is a surfactant. Several are classified by the EPA as *reduced risk* and/or certified organic by OMRI (Organic Materials Review Institute). Labels and MSDS for all these products can be found on our website at https://www.cmmcp.org/pesticide-information/pages/products-we-use.

Bacterial:

1. **Bti:** Bti stands for *Bacillus thuringiensis israelensis*, a non-reproducing soil 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 due to the unique pH in the mosquito's stomach. Formulations are available to the general public, and certified organic formulations are also available and used by CMMCP.
2. **Bsph:** Bsph stands for *Bacillus sphaericus*, a naturally occurring spore-forming bacterium found throughout the world in soil and aquatic environments. Extended residual activity in the environment is one of the outstanding properties of Bsph due to the ability for Bsph to reproduce in dead mosquito larvae. Bsph also has high specificity to mosquitoes, and works well in highly organic environments.
3. **Spinosad:** Spinosad is biologically derived from the fermentation of *Saccharopolyspora spinosa*, a naturally occurring soil organism. It was discovered in 1985 in from soil collected inside a nonoperational sugar mill rum still in the Virgin Islands. Several formulations are available to the general public, and certified organic formulations are also available and used by CMMCP.

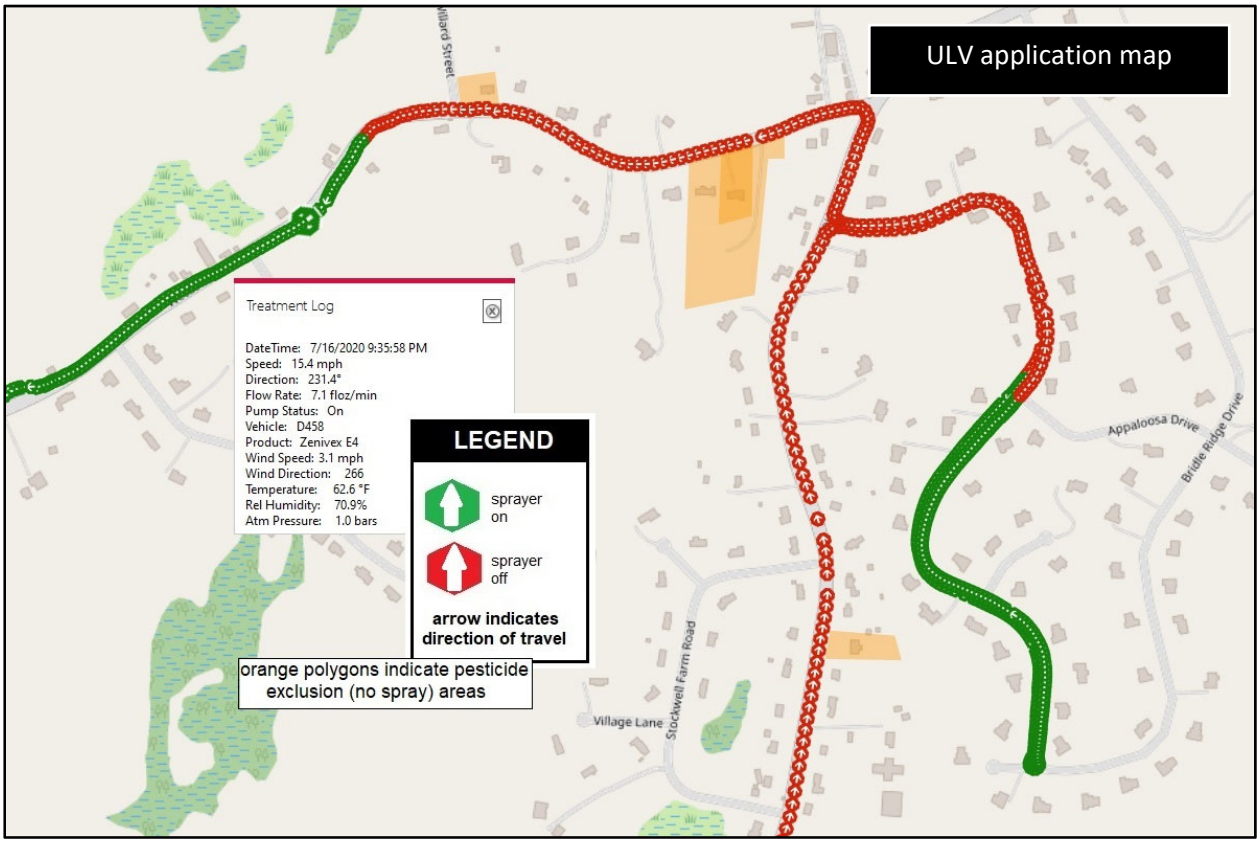
Growth regulator:

1. **Methoprene:** Methoprene is considered a low risk pesticide and is used in many topical pet products for fleas and ticks. Methoprene is an Insect Growth Regulator (IGR). Larval mosquitoes exposed to methoprene in the water do not fully develop, and either die upon pupation or pupate as a non-viable adult. Methoprene's disruption of the mosquito growth cycle allows it to be defined as a biorational agent, rather than a conventional pesticide. Extensive studies have shown that methoprene breaks down quickly in the environment, spares non-target organisms, and poses no hazard to humans.

Surfactant:

1. Bacterials and IGR's are effective on mosquito larvae but not mosquito pupae. Mosquito pupae do not eat so the bacterials are ineffective, and methoprene administered only in the pupal stage have no effect. Since mosquito larvae and pupae breathe surface air, surfactants, both plant-based and petroleum-based, create a monomolecular surface, disallowing the larvae or pupae to attach to the surface to breathe, and they drown. Surfactants are used in limited situations (majority of pupae observed) by CMMCP.

Adult control: The product name of the mosquito adulticide currently used by CMMCP is called Zenivex E4®. Zenivex E4® is classified by the EPA as a *reduced-risk* pesticide, and is a 4% solution of the pyrethroid **etofenprox**. The active ingredient in Zenivex E4® is non-residual and breaks down in a few hours. Etofenprox, like other pyrethroids, are toxic to fish in lab studies, but by observing setbacks from water and using low concentrations at low flow rates, no fish impacts have ever been reported in our area.



Spray applications: Applications do not begin until after sunset and continue up to about midnight. During this time mosquitoes are actively seeking a blood meal, and spraying at this time allows us to control the adult mosquito with low concentrations of pesticide, and with a minimal risk of exposure to the public and non-target insects. The type of spraying practiced by CMMCP is called "ULV" spraying. ULV is an abbreviation for *ultra-low volume*, a method of spraying which allows us to control adult mosquitoes at very low concentrations and flow rates. Spraying is done after sunset and before sunrise under a policy set forth by the State Reclamation Board in 2007 as a protection to honeybees and other pollinator species.

Exclusions from Spraying: If for any reason a resident wishes their property to be excluded from mosquito spraying, the Mass. Dept. of Agricultural Resources has an online and paper system, as well as other information on the exclusion process (333CMR 13.04). Technicians keep a current list of exclusion properties with them during all pesticide applications, and the exclusion parcels are outlined on the computer tablets in each truck, giving the technician an audible and visual warning as the tech approaches the parcel – see screenshot of a tablet above.

MOSQUITO BIOLOGY

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.

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; males and females feed upon plant juices and nectar for food, and the female seeks blood from a host for egg development.

Eggs:

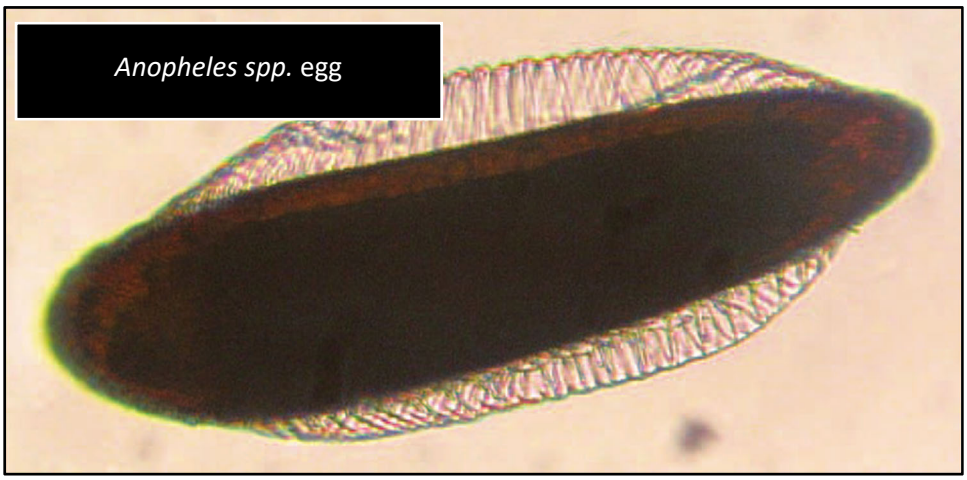
The biology of the mosquito species determines where their eggs are laid, and this behavior is quite constant for any given species. Eggs are white when first deposited, and darken after an hour or two. In general, mosquito eggs fall into three distinct groups:

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

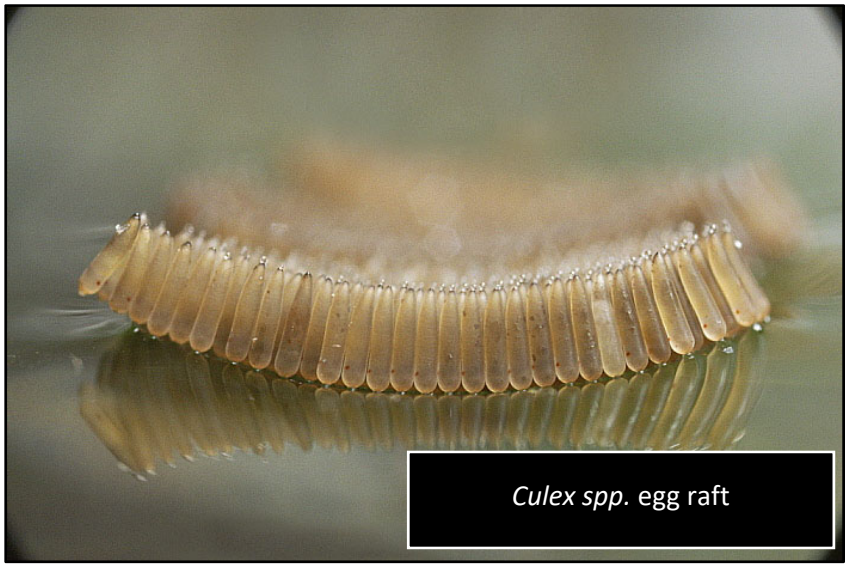
B): Those that are glued together to form rafts, which float on the water.

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

A): 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.



B): 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.



Culex spp. egg raft

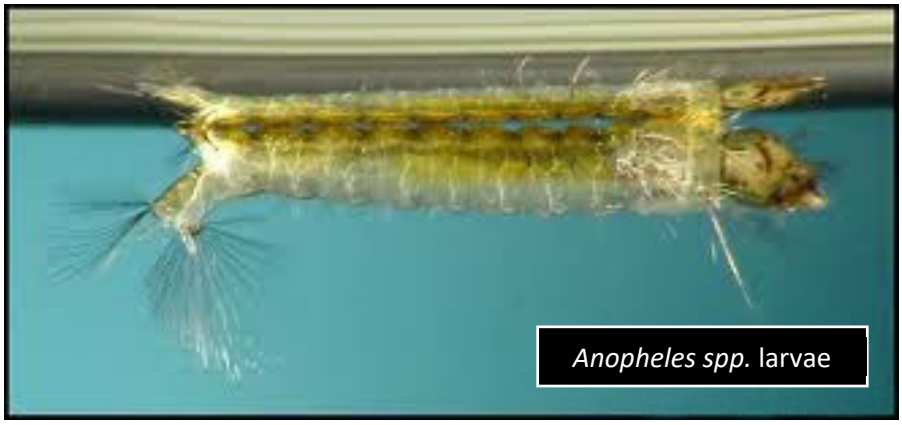
C): Those that are laid singly out of the water, on the soil: Eggs of the *Orthopodomyia*, *Oc*. *triseriatus* and *Oc*. *atropalpus* are laid on the sides of tree or rock holes, or in artificial containers (like tires) just above the water line, so that with a rise in the water the eggs hatch. These are known as container species. Other species of *Aedes* and *Ochlerotatus*, 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 (having gone through a freeze/thaw cycle) 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. 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.

Aedes spp. eggs on substrate

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 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 breathe air. Because of this limitation, larvae are not found in fast moving streams and rivers, 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 of underwater plants (typically cattails). 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 its 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 summertime to as long as several months (in the spring months. Most larvae have similar characteristic position and movements, with the exception of *Anophelene* and *Cq*. *perturbans* larvae. In *Anopheles* larvae their siphon tube is absent, so they lay parallel to the water surface for breathing. *Cq. perturbans* have a piercing siphon tube to attach to the roots of aquatic plants. The three body segments, head, thorax and abdomen are distinct. No other *Dipteran* larvae share this characteristic.

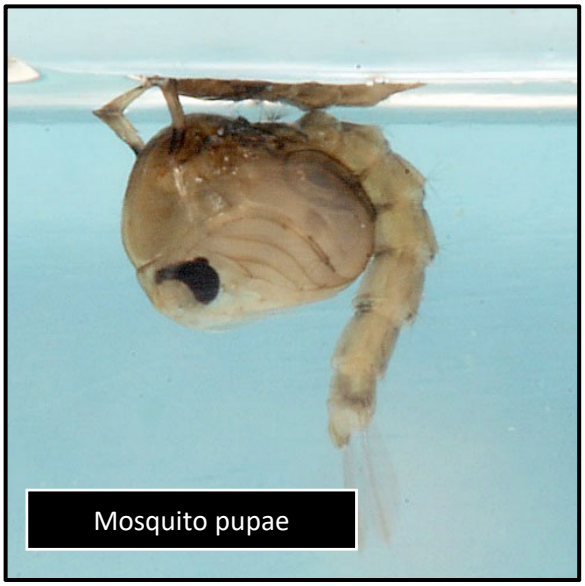


Anopheles spp. larvae

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 *Cs*. *melanura*, may need several months to complete their life cycle.

Pupae:

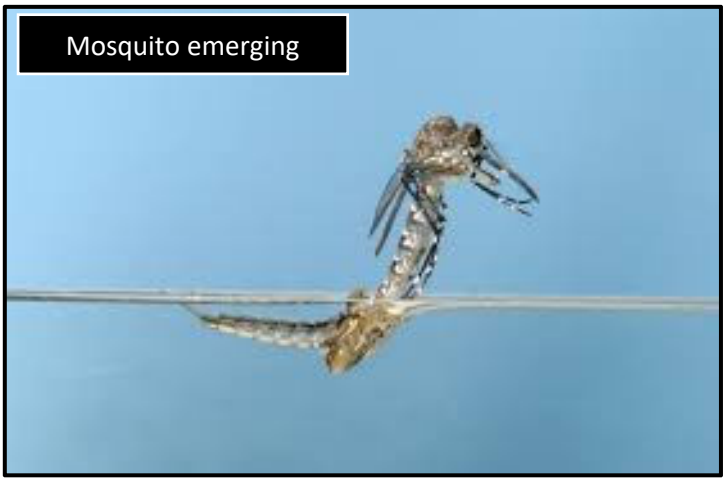
The mosquito pupae is the final stage before the adult, and like the larvae also lives in the water. It is very active, but does not feed, and must come to the surface for air like the larvae. One exception is the pupae of the *Cq*. *perturbans*, whose pupae (like the larvae) are attached to the roots of underwater plants. 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 its abdomen, pupae are able to move with remarkable speed, but rise directly to the surface when movement stops.



Mosquito pupae

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 its 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. 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.

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*, *Ochlerotatus*, *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 (have gone through a freeze/thaw cycle) in order to be viable for hatch. 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 *Ochlerotatus*) 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. *Aedes albopictus* (the Asian Tiger Mosquito) can be very aggressive during daytime. *Culiseta*, *Coquillettidia*, *Anopheles* and *Culex* are generally more active in the later part of the twilight period and after dark than are *Aedes*, *Ochlerotatus* and *Psorophora*.

The greatest part of an adult mosquito's 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.

MOSQUITO-BORNE DISEASES

West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) are viruses that occur in Massachusetts and can cause illness ranging from a mild fever to more serious disease like encephalitis (inflammation of the brain) or meningitis (inflammation of brain and spinal cord membranes). These are called arboviruses (**ar**thropod-**bo**rne **virus**). WNV is more common most years, and has a lower risk of serious complications, but EEE, while rarer than WNV, does also have more potential for serious illness and even death. There are other diseases spread by mosquitoes that people may be exposed to when traveling in other regions of the world. These include Malaria, Zika virus, Dengue fever, and Chikungunya. While these diseases may show up on occasion in residents of Massachusetts that travelled abroad, they are not considered endemic (regularly found among people or in a certain area).

The viruses that cause EEE and WNV are spread to mammals (typically humans and horses) through the bite of an infected mosquito (called a **vector**). These viruses particularly infect birds, often with no evidence of illness in the bird. Mosquitoes become infected when they bite the infected birds (called the **reservoir**). Although humans and several other types of mammals can also become infected, they do not spread EEE or WNV, even when bitten by another mosquito.

Specific species of mosquitoes are implicated in **amplification** (spreading the virus in the bird populations). *Culiseta melanura* is a species that amplifies EEE in birds, and *Culex pipiens* and *Culex restuans* amplify WNV amongst the birds. These species tend to be predominately bird-biting, however recent genetic studies of blood meals from these species have determined that a small percentage of their feeding does occur on mammals. Several other species are important in the **incidental infection** cycle. Mosquito species such as *Coquillettidia perturbans* and *Aedes canadensis* are more indiscriminate in their feeding habits, and may bite an infected bird and pick up the virus, then subsequently pass on the virus to a mammal the next time they feed. The CMMCP surveillance system is designed to trap and test for species of concern for viral transmission among both the bird and mammal populations.

Other viruses like Dengue, Zika and Malaria have human hosts as the reservoir. *Aedes aegypti* is the primary species of concern for transmission of these viruses in the human population in most of the world, but that species is no longer found in Massachusetts. *Aedes* albopictus has potential for transmission of some of these viruses, but their population has been limited in range in our state so far. With concerns about expanding mosquito ranges due to climate change, we are always on the lookout for new species or expansion of current ranges.

A graphic on page 27 shows the transmission cycle for both EEE and WNV.

No matter what species or virus is of concern at any given time, there are personal protection measures (PPM) that lower risk in addition to the control methods employed by CMMCP. Please see more information on PPM on page 28.

ARBOVIRUS TRANSMISSION CYCLE

MOSQUITO (VECTOR)

INCIDENTAL INFECTIONS

AMPLIFICATION

BIRD (RESERVOIR)

AMPLIFICATION

"ARBOVIRUS" - arthropod-borne virus. A mosquito (vector) picks up a virus from a bird (reservoir), lays eggs and transmit the virus to another bird - this is called amplification. Incidental infections occur when an infected mosquito bites a susceptible mammal.

PERSONAL PROTECTION MEASURES

Risk levels change throughout each summer, but usually only a small number of mosquitoes are infected at any given time. So being bitten by a mosquito does not mean you will get sick. However, the best way to avoid a mosquito-borne illness is to prevent mosquito bites.

1. Use mosquito repellent any time you are outdoors. Even being out a short time can be long enough to get a mosquito bite. Make sure to follow directions on the label.
2. Be aware of mosquitoes around you. If mosquitoes are biting you, reapply repellent, or think about going inside.
3. Be aware of peak mosquito hours. The hours from sunset to sunrise are peak biting times for most species of mosquitoes. Take extra care to use repellent and protective clothing during evening and early morning -- or consider avoiding outdoor activities during these times.
4. Use mosquito netting on baby carriages or playpens when your baby is outdoors.
5. When weather permits, cover as much exposed skin as possible.
6. Make sure screens are repaired and are tightly attached to doors and windows.
7. Remove standing water from places like ditches, gutters, old tires, wheelbarrows, and wading pools. Mosquitoes can begin to grow in any puddle or standing water that lasts for more than four days, so don't let water collect around your home.
8. Avoid camping overnight near freshwater swamps to reduce your risk of exposure to mosquitoes that carry the EEE virus. If you do go camping, use a tent with mosquito netting and use appropriate repellents.

What kind of mosquito repellent should I use?

Different repellents work against different bugs. It is important to look at the active ingredient on the product label. Repellents that contain DEET, permethrin, picaridin or IR3535 provide protection against mosquitoes. In addition, oil of lemon eucalyptus has been found to provide as much protection as low concentrations of DEET. DEET products should not be used on infants under 2 months of age. Children older than two months should use products with DEET concentrations of 30% or less. In general, the higher the percentage of DEET, the longer it lasts. Products with DEET concentrations higher than 30% do not provide better protection, but they do last longer. Be sure to read the label to see what the concentration of DEET is, and how often it should be reapplied.

Permethrin products are intended to be used on items such as clothing, shoes, bed nets and camping gear and should not be applied to skin. Apply the permethrin to your clothes before you put them on and follow the instructions on the label.

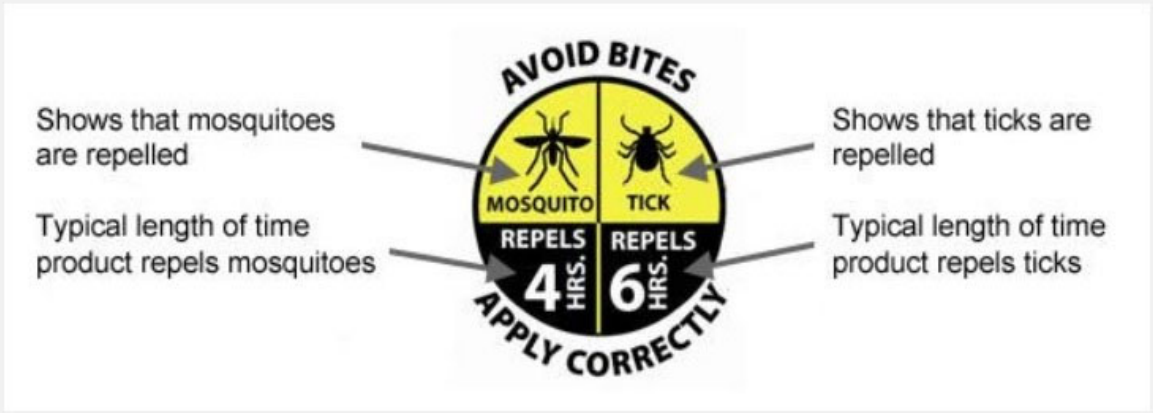
Oil of lemon eucalyptus products should not be used on children under the age of three.

Do "natural" repellents work?

A number of "natural" products are available for use as mosquito repellents. Tests show that most of these products **do not** provide the same level of protection, or work as long as products like DEET or permethrin. The exception is oil of lemon eucalyptus, which provides as much protection as low concentrations of DEET.

Other recommendations:

1. Only use EPA registered products – these will have an **EPA Registration #** on the label. These products have been tested to be sure they are effective and will not cause harm if applied properly.
2. Follow the instructions on the product label.
3. Don't use repellents under clothing or on cuts or irritated skin.
4. Don't use repellents near the mouth or eyes— and use them sparingly around the ears. When using spray products, spray the product onto your hands first and then apply it to your face.
5. Use just enough to lightly cover exposed skin and/or clothing. Putting on more does not provide better protection.
6. Don't let children handle the product. When using repellents on children, put some on your hands first, and then apply it to the child. Don't put repellent on a child's hands.
7. When you come inside, wash your skin and the clothes that had repellent on them.
8. Combination sunscreen and repellents are not recommended, sunscreen may need to be reapplied more or less often than the repellent.



The Repellency Awareness graphic will provide clear information about repellency on a product label to help you choose an insect repellent.

2020 EXECUTIVE SUMMARY

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 44 cities and towns throughout Middlesex and Worcester Counties. The towns of Bolton and Grafton voted at town meeting to join the Project. The Project's headquarters is located at 111 Otis Street, Northboro, MA. Please call (508) 393-3055 during business hours for information. Twenty-one (21) full time and ten (10) seasonal staff were employed at CMMCP in 2019. This the year we received a total of sixteen thousand, eight hundred and thirty-one (16,831) requests for service from town residents and officials.

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. Due to the COVID-19 pandemic in 2020, CMMCP laboratory personnel and other administrative staff were unable to meet in person for any educational sessions. 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. Over 1,000 specialized brochures for this program have been distributed to area seniors. 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 have a website at https://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 sixty (3,560) 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 fifty thousand, four hundred and fifty-one (250,451) feet of streams, brooks and ditches. This represents over forty-seven (47) miles of waterways which were cleaned and improved by Project personnel in 2020.

ARBOVIRUS CONTROL:

As part of our West Nile Virus (WNV) prevention program, eighty-eight thousand, six hundred and fifty (88,650) 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 two hundred and ten (1,210) pools (collections) of mosquitoes totaling twenty-eight thousand, four hundred and thirty-seven (28,446) individual specimens were tested for mosquito-borne viruses this year. Zero (0) collections were identified positive this year for Eastern Equine Encephalitis or West Nile Virus. CMMCP lab personnel processed at total of four thousand, three hundred and nineteen (4,319) collections of mosquitoes containing fifty thousand, three hundred and seventeen (50,317) individual specimens, representing thirty-four (34) mosquito species.

Target Species	*Ae. vex*	*Cq. per*	*Cs. mel*	*Oc. can*	*Culex*	All Species
No. Pools	252	753	115	198	673	4,319
Total Specimens	2,304	32,587	341	2,825	4,586	50,317
No. Pools WNV +	0	0	0	0	0	0
No. Pools EEE +	0	0	0	0	0	0

A table with the 2020 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. Six (6) 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:

Due to risk from EEE in 2019 and anticipated risk in 2020, an enhanced larval control program was implemented using organically-certified formulations of bacterial products Natular™ G and Natular™ G30, active ingredient spinosad. 21-member communities were identified as either "High" or "Critical" risk from EEE in 2019. Wetlands in these communities that were considered larval habitat for 2 species, *Cs. melanura* and *Cq. perturbans*, were identified in our GIS program and field checked for possible applications by rotary aircraft. Sites <5 acres would be treated by ground crews. Due to the specialized biology of these 2 species, larval control is difficult and the spinosad products would be field trialed to gauge control efficacy. Five hundred and fifty-one (551) acres were treated with five thousand, seven hundred and fifty-three (5,753) pounds of Natular™ G30 in *Cs. melanura* habitat in 6 communities. One thousand, nine hundred and thirty-seven (1,937) acres in twenty-one (21) communities were treated with nineteen thousand, five hundred and sixty-seven (19,567) pounds of Natular™ G in *Cq. perturbans* habitat.

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 six hundred and ninety (10,690) pounds of organically-certified Bti (*Bacillus thuringiensis israelensis*) was applied by helicopter over two thousand one hundred and thirty-eight (2,138) acres in 3 towns, Chelmsford, Billerica & Boxborough, resulting in an average 93.03% overall reduction in larval counts. One thousand, one hundred and fourteen (1,114) additional acres were treated by hand in our area, totaling over three thousand, two hundred and fifty-two (3,252) acres of wetland that was treated, 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, water management or larval control, but we recognize that there are times when adult mosquito spraying is the best viable solution. In such cases specific areas are treated with 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. Two hundred and ninety-six (296) 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 anywhere in Mass. Adult control began in early June and ended in early 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 2020 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 2020 we collected a total of four thousand, one hundred and seventeen (4,117) tires in forty-one (41) member cities and towns. Collections will continue as time and resources allow.

Some additional highlights from 2020:

- 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*) found 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.

2020 SUMMARY TOTALS

Service Requests	Larval/Pupal Acres Treated	Adulticide Gallons	Adulticide Acres
16,831	5,740	817	133,743

Pools Sent to MDPH	Landing Counts	Culverts Cleaned	Restoration Footage	Catch Basins Treated	Tires Recycled
1,210	296	3,560	250,451	88,650	4,117

ARBOVIRUS SUMMARY 2020

WNV Surveillance Summary – Statewide	**2020**
Mosquito Pools Positive	97
Animals Positive	0
Humans Positive	8
EEE Surveillance Summary – Statewide	**2020**
Mosquito Pools Positive	66
Animals Positive	0
Humans Positive	5
CMMCP Surveillance Summary	**2020**
Mosquitoes Collected and Identified	50,317
Mosquito Pools Submitted for testing	1,210
Mosquito Pools Positive WNV	0
Animals Positive WNV	0
Humans Positive WNV	0
Mosquito Pools Positive EEE	0
Animals Positive EEE	0
Humans Positive EEE	0

Arbovirus Surveillance in Massachusetts, 2020

Massachusetts Department of Public Health (DPH)
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 DPH website to view Common Mosquitoes That Can Spread Disease in Massachusetts.

Currently, there are no available vaccines to prevent human infections from either of these mosquito-borne viruses. 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, DPH, in cooperation with the local Mosquito Control Districts (MCD), 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 DPH website at Arbovirus Surveillance and Control Plan.

EASTERN EQUINE ENCEPHALITIS VIRUS

Humans

There were five human cases of EEE with one death identified in Massachusetts in 2020. The results are summarized in the table below.

County	Age Range	Onset Date	Virus Result	Clinical Presentation
Plymouth	<20	7/20/2020	EEE	Meningoencephalitis
Hampden	60 - 69	8/1/2020	EEE	Meningoencephalitis
Plymouth	90 - 99	8/14/2020	EEE	Meningoencephalitis
Norfolk	60 - 69	8/28/2020	EEE	Meningoencephalitis
Bristol	60 - 69	9/10/2020	EEE	Meningitis

Mosquito Samples

Of 7,156 mosquito samples tested in Massachusetts in 2020, 66 samples (0.92%) were positive for EEE virus. Positive mosquito samples included 42 (63.6%) *Coquillettidia perturbans*, 20 (30.3%) *Culiseta melanura*, 3 (4.6%) *Culex salinarius*, and 1 (1.5%) *Aedes vexans*. Positive samples were identified in 12 towns in five counties.

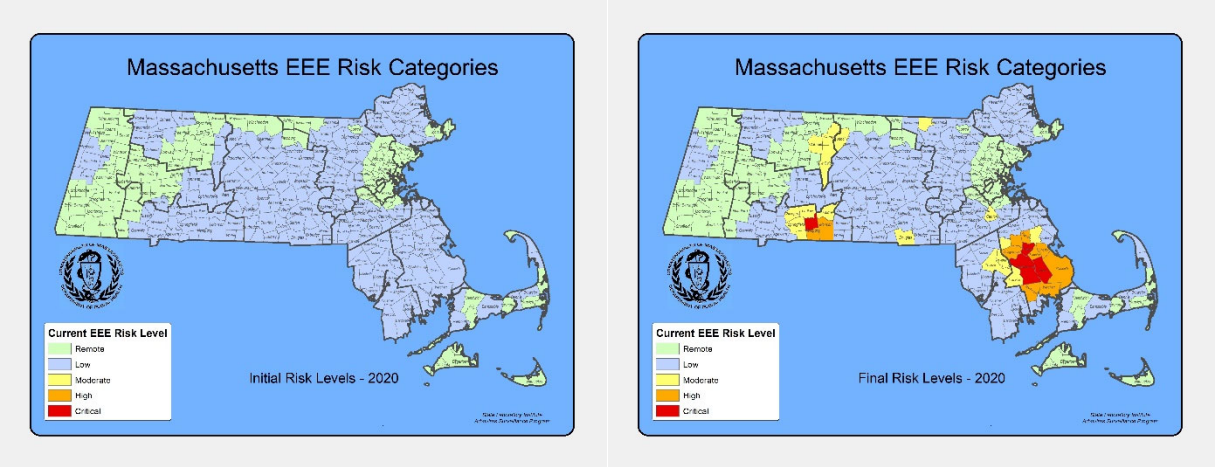
Animals

Twelve animal samples were submitted for arbovirus testing, none tested positive for EEE virus infection in 2020.

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).

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 2020 season are shown in the following maps. This information will be used to help anticipate risk in 2021 and will be revised as 2021 surveillance data are collected. More detailed information about risk assessment and risk levels is available in the Arbovirus Surveillance and Response Plan on the DPH web site.

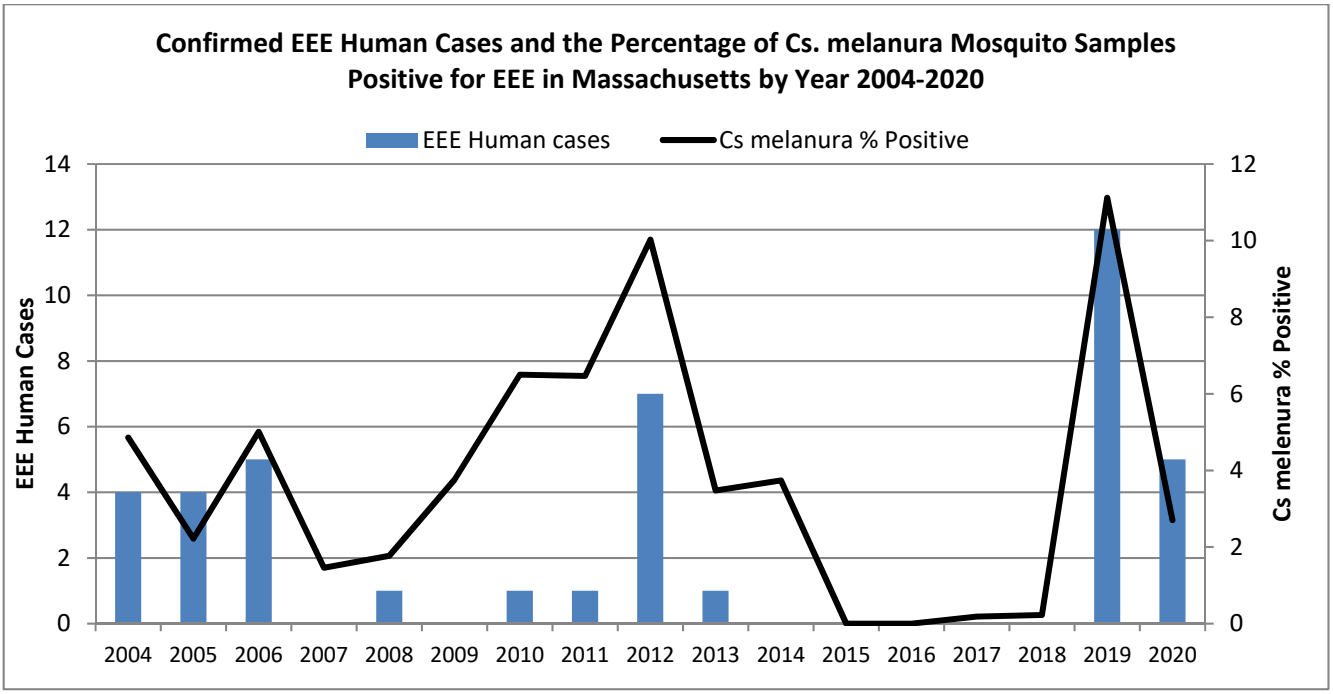
Initial and Final 2020 EEE Risk Categories
(As defined in Table 2 of the DPH Arbovirus Surveillance and Response Plan)



2020 EEE SEASON DISCUSSION
DPH confirmed five human EEE cases in 2020. Prior to 2020, 2019 was the most recent outbreak year in Massachusetts with twelve confirmed human cases. The number of confirmed human cases nationwide was lower in 2020 (9) when compared to 2019 (38).

Of the nine confirmed cases identified nationally in 2020, a majority of the cases (44%) were reported from Massachusetts. Additional cases were also reported by Michigan (18%) and Wisconsin (18%). Indiana reported a single case.

There was a decrease in EEE virus positive mosquito samples from 428 in 2019 to 66 in 2020. In 2020, DPH identified 20 EEE positive samples of *Cs. melanura,* the primary bird-biting vector species of EEE, as well as 42 EEE positive samples of *Cq. perturbans*, the most important mammal-biting EEE vector. 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, as was seen in 2019 (see figure below).



Why did EEE activity decline in 2020?

EEE outbreaks are supported by three main components: bird populations with no or minimal immunity to the virus; large populations of bird- and mammal-biting mosquito vectors; and favorable weather conditions including significant precipitation events in the prior fall and spring and prolonged periods of high temperatures. Previously unexposed populations of birds are susceptible to EEE virus infection, and therefore are capable of maintaining the cycle of virus transmission. Current research also suggests that each EEE outbreak cycle is associated with the introduction of a new strain of EEE virus by migratory birds. The last major EEE outbreak ended in 2012 providing ample time for populations of birds that lacked immunity to EEE to increase.

The 2019 arbovirus season ended with large populations of *Cs. melanura.* This species overwinters as larvae in woodland crypts, water-filled voids under the roots of trees. The winter of 2019-2020 was mild with above average temperatures and periodic precipitation events. There was little insulating snow cover which increased larval mortality during periods of extreme low temperatures. The spring of 2020 had average temperatures and average precipitation events, however significant larval mortality led to reduction in *Cs. melanura* emergence when compared to the spring of 2019. *Cq. perturbans* populations also exhibited limited mortality associated with the 2019-2020 winter weather conditions and had moderate emergence rates. This was also true for other vector species possibly associated with EEE transmission including *Culex salinarius* and *Ochlerotatus canadensis*.

Response to EEE in 2020

As EEE outbreaks often occur over 2-3 years, DPH and partnering agencies were prepared for and aware that 2020 might be another significant year for EEE. The 2019 EEE season was the first active year, in terms of human disease, since the 2012 EEE outbreak. Weather conditions were favorable, the virus had been largely absent from Massachusetts since 2012, making it likely that the majority of host birds would

be susceptible to EEE, and there was evidence of a possible introduction of EEE virus to Massachusetts at the very end of the 2018 season.

The first EEE mosquito isolations were collected on 7/01/20 in Orange and again on 7/5/20 in Wendell. Both isolations were detected in the primary epizootic vector *Cq. perturbans.* These initial isolations did not repeat, however on 7/13/20 MDPH detected five isolations of EEE from *Cq. perturbans* in Carver. These isolations were followed by a rapid focal expansion in Plymouth County with EEE mosquito detections increasing from 7/13/20 – 8/10/20. The majority of isolations occurred in *Cq. perturbans*. The first EEE positive human case occurred in Plymouth County with a symptom onset of 7/20/20.

Due to the rapidly expanding EEE activity observed in 7/13/20 – 8/10/20 and in accordance with the 2020 Massachusetts Arbovirus Surveillance Plan, DPH, the Massachusetts Department of Agricultural Resources (MDAR), the State Reclamation and Mosquito Control Board (SRMCB) Mosquito Control Districts (MCD) and the Mosquito Advisory Group (MAG) met to discuss options for public health communication and EEE control resources. Aerial intervention targeting the intense Plymouth County EEE foci was selected as the most viable control option available. A single aerial adulticiding intervention was conducted by MDAR on 8/10/20 in Bristol and Plymouth Counties.

Efficacy of Aerial Interventions

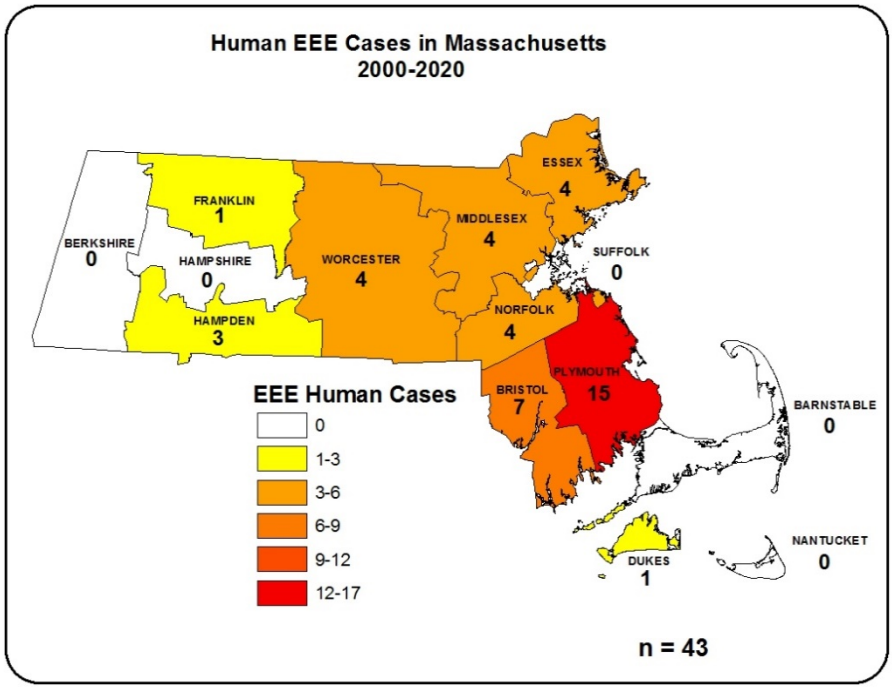
DPH and partnering agencies assess an aerial treatment to determine if was effective in reducing the total population of mosquitoes. This work is conducted by setting mosquito traps pre-treatment and post-treatment at control and target locations. DPH also examines trends post-spraying to determine if viral intensity within the spray zone decreases. The table below the 2020 aerial intervention and the percent achieved control.

Percentage Control by Intervention and Species			
Aerial Intervention Location	**Start Date**	**End Date**	**% Total Control**
Bristol / Plymouth	8/10/2020	8/11/2020	70

Interpreting Efficacy

The 2020 arbovirus season included a single focused spray zone selected for treatment in 2020 compared to the six large-scale aerial spray events occurring in 2019. The environmental conditions which impact aerial spraying efficacy, such as temperature, wind and precipitation, were all favorable on 8/10/20. Mosquitos are sensitive to low temperatures and conserve energy by not flying at lower temperatures. Products used for mosquito control are not labelled for use below 50ºF but mosquito species respond differently to temperature with some species becoming increasingly inactive at temperatures below 60ºF. The result is that efficacy begins to decrease substantially at temperatures below 60ºF. On 8/10/20 temperatures remained above 60ºF throughout the spray event leading to increased efficacy. The aerial spray event was completed in a single evening attempt. This supported uninterrupted efficacy trapping over the prescribed two collection days improving data quality.

In Massachusetts, human EEE infection is associated with *Cs. melanura* activity. The map to the right illustrates that southeastern Massachusetts remains the area of highest EEE transmission. However, EEE appears to be spreading from the historic area of risk. Northeastern, Central and Western Massachusetts have become areas of high risk more recently.



Variability in Geographic Range of EEE

In Massachusetts over the last ten years an increasing number of 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. In 2020 in Massachusetts, one case occurred outside the historic area of risk. 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).

MCDs in Massachusetts are heavily focused in the eastern part of the state, including Southeastern Massachusetts where EEE activity has been concentrated. However, 40% of municipalities statewide do not have access to a MCD. Historically, DPH has offered mosquito trapping in these underserved communities but some areas may go extended periods of time without surveillance activities. For 2020 DPH increased its capability to provide routine testing for larger portions of the state providing for broad arbovirus surveillance coverage. DPH will continue to perform adaptive surveillance activities to provide for early detection of EEE throughout the Commonwealth in 2021.

What are the expectations for EEE in 2021?

The 2020 season ended with warm fall conditions accompanied by below average precipitation events. The winter consisted of average temperatures with insulating snow cover for the short duration cold periods. In spring 2020, below average precipitation events adversely impacted *Cs. melanura* abundance. Early season larval surveillance activities for *Cs. melanura* have shown low populations at historic EEE breeding habitat. Cooler spring temperatures will likely delay emergence of EEE vector species for 1-2 weeks but will not increase mortality. It is expected that low populations of *Cs. melanura* and average populations of *Cq. perturbans* will exist in early summer and bird populations will likely consist of some susceptible birds possibly supporting amplification of virus. It is anticipated that EEE transmission to

humans will occur. Unexpected weather patterns including drought or cold weather could further limit transmission. Early detection along with early public awareness will be key for the prevention of human disease.

WEST NILE VIRUS

Humans

There were eight human cases of WNV infection identified in Massachusetts in 2020. The results are summarized in the table below.

County	Age Range	Onset Date	Virus Result	Clinical Presentation
Middlesex	50 - 59y	8/2/2020	WNV	Fever
Middlesex	80 - 89y	8/8/2020	WNV	Encephalitis
Middlesex	50 - 59y	8/12/2020	WNV	Encephalitis
Bristol	< 20y	8/19/2020	WNV	Meningoencephalitis
Middlesex	40 - 49y	8/21/2020	WNV	Fever
Middlesex	60 - 69y	8/23/2020	WNV	Fever
Middlesex	80 - 89y	8/24/2020	WNV	Meningoencephalitis
Norfolk	50 - 59y	8/27/2020	WNV	Fever
Middlesex	40 - 49y	9/9/2020	WNV	Fever
Middlesex	70 – 79y	9/18/2020	WNV	Meningoencephalitis
Hampden	60 – 64y	10/1/2020	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 four PVD identified in Massachusetts in 2020. The number of PVDs nationwide increased in 2020 (130) from 2019 (105).

Mosquito Samples

Of 7,156 mosquito samples collected in Massachusetts in 2020, 97 (1.4%) were positive for WNV. Positive mosquito samples included 90 (92.8%) *Culex* species, 4 (4.1%) *Coquillettidia perturbans*, and 3 (3.1%) *Culiseta melanura*. Positive samples were identified in 35 towns in 6 counties.

Animals

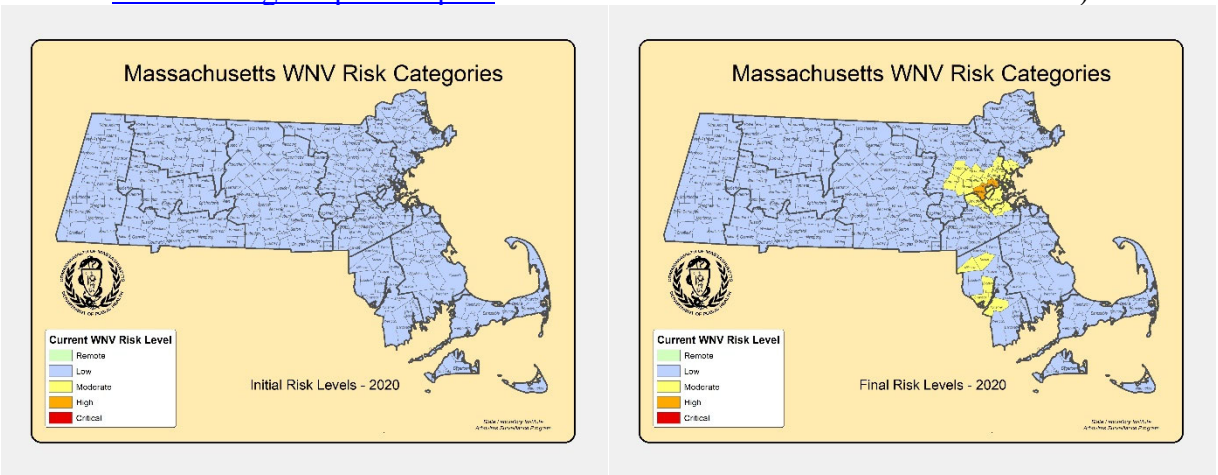
Twelve veterinary samples were submitted for arbovirus testing, none tested positive for WNV in 2020.

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 2020 season are provided in the following maps. This information will be used to help predict risk in 2021 and will be revised as 2021 surveillance data are collected. More detailed information about risk assessment and risk levels is available in the Arbovirus Surveillance and Response Plan on the DPH web site during the arbovirus season.

Initial and Final 2020 WNV Risk Categories

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

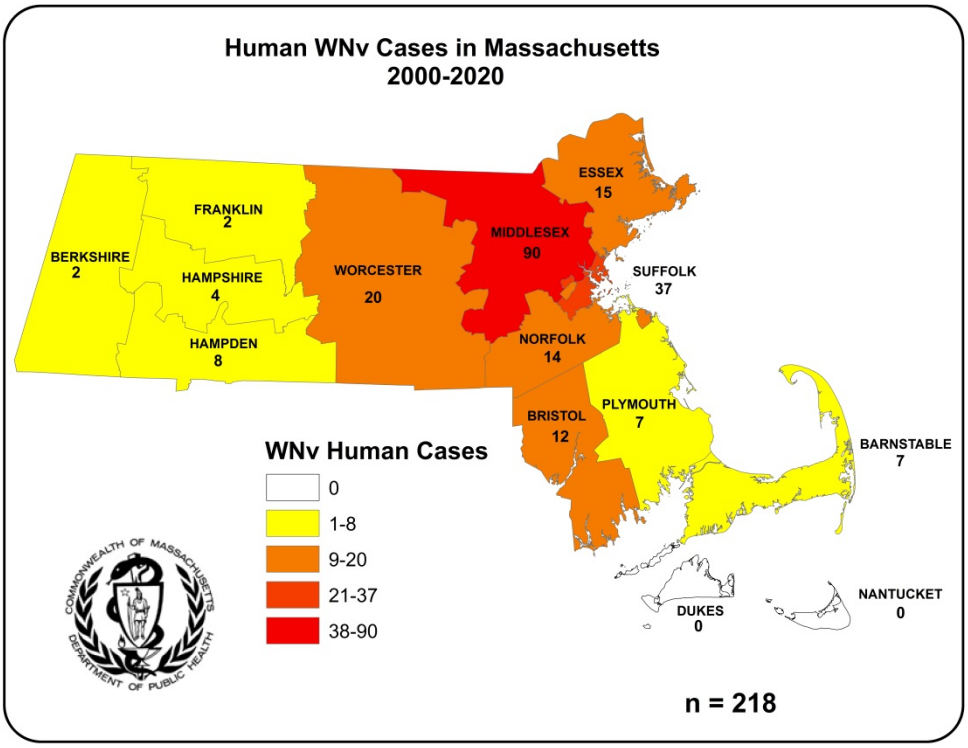


2020 WNV SEASON DISCUSSION

DPH identified 11 confirmed human WNV infections in 2020 compared to five confirmed WNV cases in 2019. *Culex pipiens,* the primary mosquito vector of WNV, had larger populations in 2020 as compared to 2019. Average temperature and precipitation events maintained consistent larval development and amplification of the virus. The number of confirmed human cases nationwide in 2020 (557) was a decrease from 2019 (971).

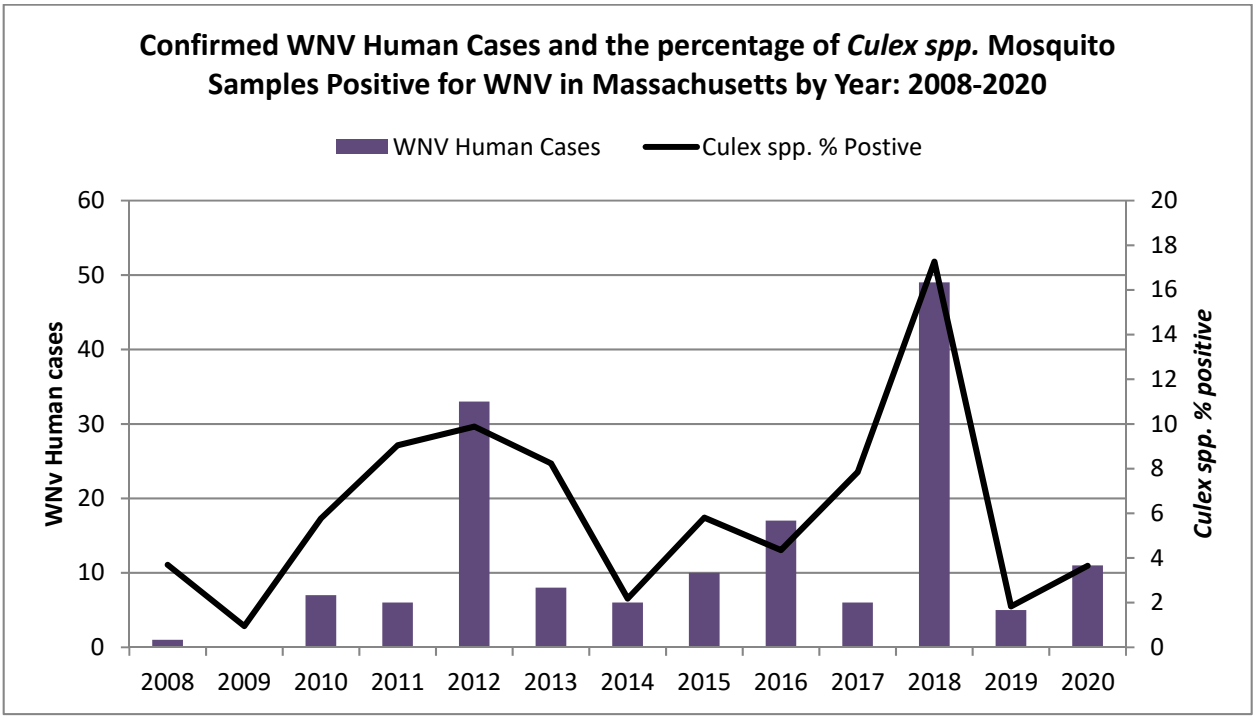
Of the cases identified nationally in 2020, 422 (76%) were classified as neuroinvasive disease (defined as meningitis or encephalitis) and 135 (24%) were classified as non-neuroinvasive disease. A major portion of the cases (33%) were reported from California

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 2020, DPH identified 97 WNV positive mosquito samples, including 90 samples of *Culex* species, compared to 56 WNV positive *Culex* species mosquito samples in 2019. 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).



What are the expectations for WNV in 2021?

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 water-filled containers that favor *Culex* breeding), separated by hot, dry days.

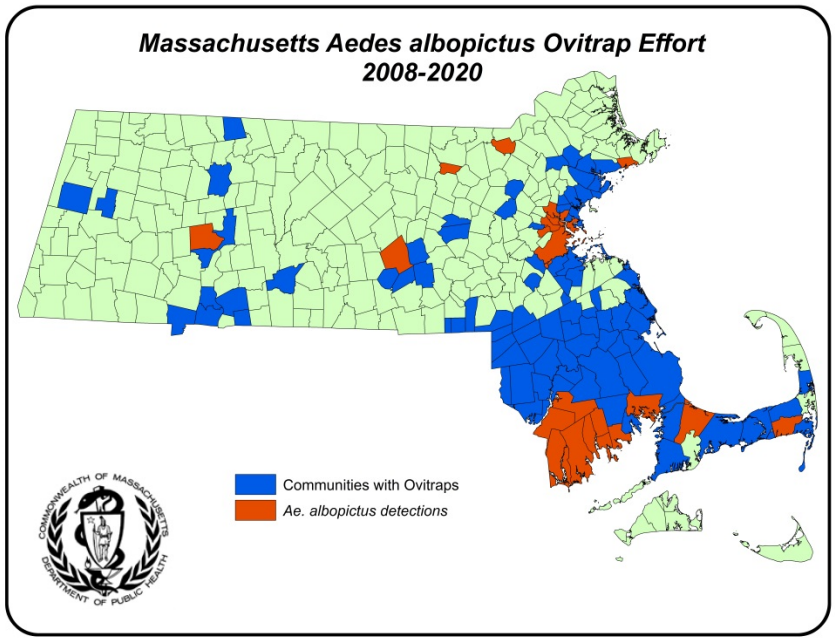
Mosquito populations alone are not sufficient to produce significant WNV risk; infected bird populations are also necessary. Unfortunately, less is known about the factors that lead to large numbers of infected birds making this component of risk impossible to predict and there is no efficient way to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

The lack of useful pre-season predictive factors limits the ability of DPH 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. DPH continues to strive to identify reliable measures to aid in risk assessments.

Invasive Mosquito Species Surveillance

DPH 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 22 communities throughout the state since 2009. DPH will continue to conduct routine surveillance activities to monitor for the presence and expansion of *Ae. albopictus* and other invasive mosquito species.



CONCLUSION

CMMCP is unlike other state agencies and authorities; communities in the CMMCP program choose to be a partner, and can withdraw from membership if they determine that is an appropriate action. Due to this, it is important that we listen to the needs of each partner community, and respond in appropriate fashion and timely manner.

CMMCP also has flexibilities unlike other agencies, and can respond quickly in an urgent situation. We tailor our program to meet the needs of the individual community. In towns with large wetlands, larval control is heavily weighted. In areas that have issues with beavers, that may be a major focus. Some communities rely heavily on our school programs as curriculums wind down, others use a more passive approach. Several communities are heavily involved in our source reduction (tire recycling) program; coordinating hazardous waste day events, collecting tires in a central location for our staff to retrieve, or notifying staff of abandoned tires piles – some communities participate in several of these areas.

All communities in our service area benefit from our surveillance program. This information is key to develop risk messaging, and notifications to the public about mosquito-borne disease that have been found in their area.

It is key for our staff to partner with each municipality to develop strong working relationships and determine the unique areas of focus for each community. In most areas this is a Board of Health liaison, but in many communities we also have strong partnerships with Highway and DPW personnel, Conservation Commission and Schools.

For many people not familiar with our program, they think that spraying is the main focus, and in some instances, the only thing we do. Nothing is further from the truth. While spraying is an important part of our program, we heavily emphasize proactive controls such as larviciding, education, source reduction and ditch maintenance. Spraying is an option for residents, and they determine the extent of that service since it is based on citizen's request. If weather conditions do not permit, or exclusion areas negate the ability to reasonably perform an application, or any other reasons determined by the technician, the applications is not done. Spraying is an effective means of lowering mosquito populations and reducing exposure and risk from mosquito-borne diseases, but it must be done with the utmost care and attention. In areas of identified mosquito viruses, we always consult with our local Boards of Health to determine the appropriate response. Sometimes, that may involve spraying an area around the locations of the virus positive. Other times, it may only be recommendations for personal protection measures. In any case, the opinions, knowledge and guidance from our local officials is key to any response.

Our website at www.cmmcp.org has much more information that is contained in the document, and we encourage you to logon and take some time to review when possible. Our staff is always available by phone, email and in person, even on the weekends in the summer. We are here to meet your mosquito control needs. Thank you.