Commonwealth of Massachusetts

STATE RECLAMATION AND MOSQUITO CONTROL BOARD

NORTHEAST MASSACHUSETTS MOSQUITO CONTROL AND WETLANDS MANAGEMENT DISTRICT

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2019 INTEGRATED PEST AND VECTOR MANAGEMENT PLAN

District Updates:

- ***Residential Pesticide Exemption**:* Residents who request their property be excluded from pesticide applications must comply with the legal process to exempt their property. Pursuant to 333 CMR 13.03, individuals may request exclusion from wide area applications of pesticides by the district for the 2019 calendar year starting January 1st 2019. Requests **must be made to the Department of Agricultural Resources** online, and **will go into effect 14 days** from the date the request is received. All exclusion requests expire on December 31st, 2019. The exclusion request can be accessed from either our District's website or directly from the Department of Agricultural website:

  https://www.mass.gov/how-to/exclusion-from-wide-area-pesticides-application

Introduction

Mosquito-borne viruses such as Eastern Equine Encephalitis virus (EEE) and West Nile Virus (WNV) have been and continue to be the cause of disease outbreaks in humans and animals in Massachusetts. Community-level mosquito control can be a practical and meaningful method of protecting people especially when risk levels of virus become moderate or high. Efforts to reduce risk of arbovirus transmission include but are not limited to public awareness and prevention, adult and larval surveillance, and standard mosquito control methods utilized by established Mosquito Control Projects or Districts (MCPs).

Northeast Massachusetts Mosquito Control and Wetlands Management District

Mosquito control districts serve as critical elements in the surveillance network, and in performing and facilitating intervention efforts to reduce the burden of mosquitoes and mosquito-borne diseases. Districts coordinate the placement of traps, collecting, identifying and submitting mosquitoes and associated data with the Massachusetts Department of Public Health (MDPH).

District personnel have greater knowledge of local habitats and proper equipment that may be rapidly deployed to reduce mosquito populations. Personnel also increase public outreach/educational efforts for mosquito control, disease prevention, personal protection and IPM strategies. Districts also provide weekly summaries on mosquito abundance, diversity and local conditions that may be conducive to mosquito development and survival.

The purpose of the 2019 Integrated Pest and Vector Management Plan (IPVMP) is to summarize the NEMMC mosquito and arbovirus surveillance and management strategies specific to northeastern Massachusetts communities. This plan also outlines specific responses to arboviruses and how our resources will be directed toward implementing these responses effectively and efficiently.

Massachusetts Department of Public Health (MDPH)

Main objectives:

- Monitor trends in EEE and WNV in Massachusetts
- Provide timely information on the distribution and intensity of WNV and EEE activity in the environment
- Perform laboratory diagnosis of WNV and EEE cases in humans, horses and other animals
- Testing mosquito batches for disease through the Public Health Laboratory
- Communicate effectively with officials and the public
- Provide guidelines, advice, and support on activities that effectively reduce risk for disease
- Provide information on the safety, anticipated benefits, and potential adverse effects of proposed prevention interventions

Refer to the 2018 Massachusetts State Arbovirus Surveillance and Response Plan viewed online at
https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data#response-plan-

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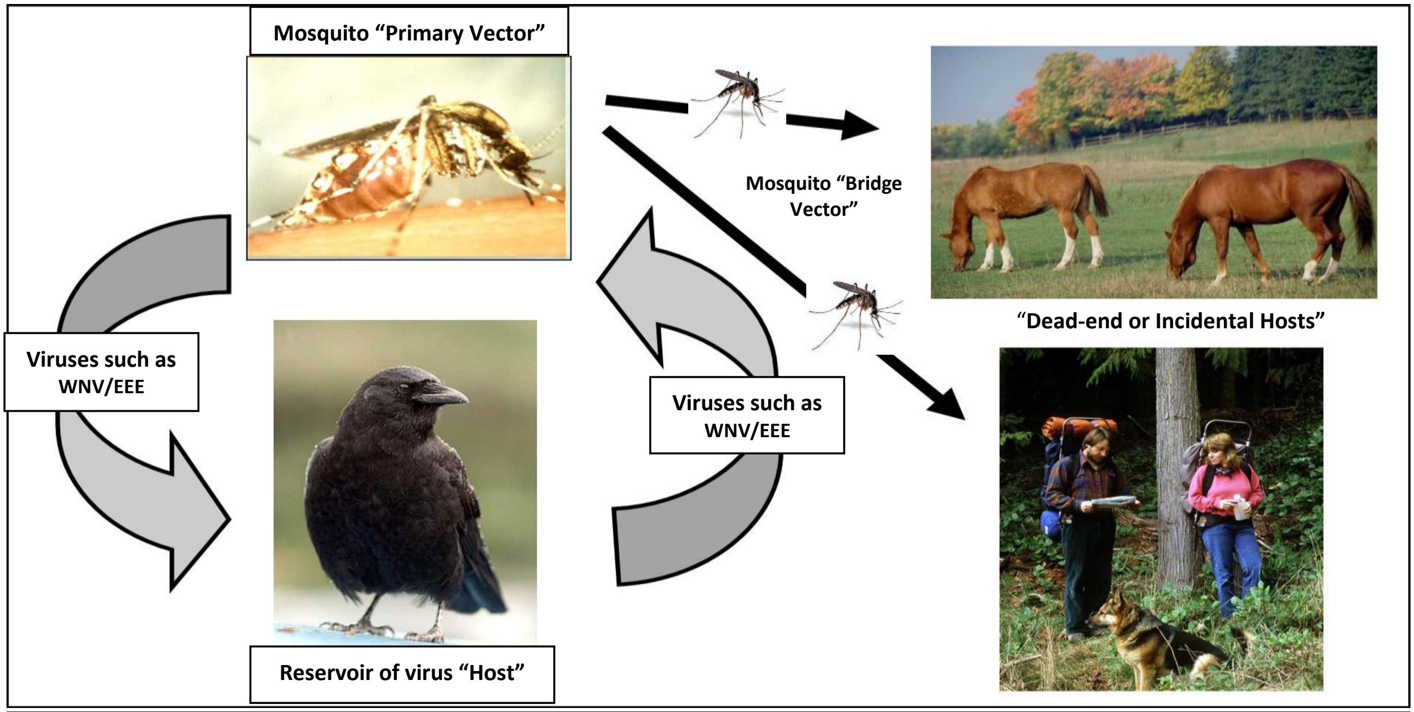
The Arbovirus Life Cycle

Arbovirus: A class of viruses transmitted to humans by arthropods such as mosquitoes and ticks.



Some mosquito species rarely bite humans; they feed on infected birds called "hosts". Newly infected mosquitoes then feed on non-infected birds causing an amplification of that virus in the local bird population. These mosquitoes are referred to as "primary vectors".

These infected birds become a blood-meal source for other mosquito species who themselves become infected. These other infected mosquito species may then bite humans. The species capable of infecting humans are known as "bridge vectors".

Humans and other mammals affected in this cycle are known as "dead end or incidental hosts". This means they do not develop the high levels of virus in their bloodstream needed to pass the virus to other biting mosquitoes.

Northeast District Mosquito Species of Concern

There are about 51 mosquito species present in Massachusetts. Approximately 12 species are associated with arboviral activity in Massachusetts and are targeted for control. Other species are listed as nuisance/pest species and can reduce the overall quality of life and recreation during a specific time of year. This list may expand over time.

Aedes vexans – Is a common nuisance mosquito. Temporary flooded areas such as woodland pools and natural depressions are the preferred larval habitat of this mosquito. It feeds on mammals and is an aggressive human biter. This species is typically collected from May to October. *Ae. vexans* is a bridge vector of EEE virus.

Anopheles punctipennis - Is found occasionally in the spring and summer. This pest of humans has a mildly annoying bite. The larvae are found in a wide variety of wetlands including permanent swamps and along the edges of ponds and slow moving streams. *An. punctipennis* has been implicated as a bridge vector of WNV.

Anopheles quadrimaculatus - Is a common summer mosquito. This species is a pest of humans and other mammals that readily enters houses and has a mildly annoying bite. The population increases during the summer. The larvae are found in clear water amongst low vegetation or floating debris, in permanent swamps and along the edges of ponds and slow moving streams. *An. quadrimaculatus* has been implicated as a bridge vector of WNV.

Coquillettidia perturbans – Marshes containing cattails, *Phragmites* and other emergent vegetation types such as rushes and arrow root are the primary larval habitat of this mosquito. It feeds on both birds and mammals. It is a persistent human biter and one of the most common mosquitoes in Massachusetts. This species is typically collected from June to September. *Cq. perturbans* is a bridge vector of EEE and WNV.

Culex pipiens – Artificial containers, including catch basins, are the preferred larval habitat of this mosquito. It feeds mainly on birds and occasionally on mammals. It will bite humans, typically from dusk into the evening. This species is regularly collected from May to October but can be found year round as it readily overwinters as an adult in manmade structures. *Cx. pipiens* is the primary vector of WNV.

Culex restuans – Natural and artificial containers, including catch basins, are the preferred larval habitat of this mosquito. It feeds mainly on birds and occasionally on mammals. This species is typically collected from May to October but can be found year round as it readily overwinters as an adult in man-made structures. *Cx. restuans* has been implicated as a vector of WNV.

Culex salinarius – Brackish and freshwater wetlands are the preferred habitat of this mosquito. It feeds on birds, mammals, and amphibians and is well known for biting humans. This species is typically collected from May to October but can be found year round as it readily overwinters as an adult in natural and manmade structures. *Cx. salinarius* may be involved in the human transmission of both WNV and EEE.

Culiseta melanura and *Cs. morsitans* - Swamp mosquitoes that occur in Atlantic White Cedar and Red Maple swamps and sphagnum bogs characterized by low pH. The larvae often are found within subterranean crypts and root mats that are difficult to treat with conventional larvicide agents. *Cs. melanura* obtains most of its blood meals from birds but is known to feed on mammals. This species is our primary vector and responsible for the amplification of EEE in birds in our area. It has also been found to carry WNV.

Aedes abserratus and *Ae. punctor* - Are a very common early spring to early summer mosquito pest of humans and other mammals. Larvae are found in temporary spring pools and margins of permanent waters in April. Readily bites in shaded areas during the day.

Aedes canadensis – Shaded woodland pools are the preferred larval habitat of this mosquito. It feeds mainly on birds and mammals but is also known to take blood meals from amphibians and reptiles. This mosquito can be a fierce human biter near its larval habitat. This species is typically collected from May to October. *Ae. canadensis* is a bridge vector of eastern equine encephalitis EEE virus.

Aedes cantator - This salt-marsh mosquito is a fairly large mosquito that can be a serious pest along the immediate coast from late spring to mid-summer. It is active during both daytime and nighttime periods, and can fly great distances from its original source.

Aedes excrucians and *Ae. stimulans* - Are freshwater spring snowmelt mosquitoes. Larvae develop in temporary or semi-permanent woodland pools. The females will bite in the woods any time of day, but are most active in the evening. They are aggressive and long-lived pests.

Aedes sollicitans - The “brown salt-marsh mosquito” is a fairly large mosquito that can be a serious pest along the immediate coast from early summer into fall. It is active during both daytime and nighttime periods, and can fly great distances from its original source. It has been reported to carry EEE in the northeastern US.

Aedes japonicus – Natural and artificial containers such as tires, catch basins, and rock pools are the preferred larval habitat of this mosquito. It feeds mainly on mammals and is an aggressive human biter. This species is typically collected from May to October. *Ae. japonicus* may be involved in the transmission of both WNV and EEE.

Aedes taeniorhynchus - The “black salt-marsh mosquito” is a nuisance mosquito species that is capable producing tremendous numbers of adults after coastal flooding events caused by rains or extreme high tides. *Ae. taeniorhynchus* may be involved in the transmission of both WNV and EEE.

Aedes triseriatus - Is also a pest of humans and other mammals. Most of these larvae are found in tire casings although some are found in other shaded artificial containers and in tree holes. When this mosquito is a pest its breeding source is usually close by. *Ae. triseriatus* may be involved in the transmission of both WNV and EEE.

Psorophora ferox – The “white footed woods mosquito” is also a pest of humans and other mammals. Most of these larvae are found in floodwater areas and temporary woodland pools during the summer. It is active during both daytime, near its breeding site, and nighttime periods. *Ps. ferox* may be involved in the transmission of both WNV and EEE.

Regional Adult Mosquito Surveillance

The District’s surveillance program forms the basis for mosquito control operations. Surveillance of mosquito populations is based on protocols established by the Centers for Disease Control (CDC) and Massachusetts Department of Public Health (MDPH). To monitor adult populations, the District maintains 35 historical trapping stations set every year at the same locations for an entire season. There is at least one trapping station in each subscribing municipality. Each trapping station uses two types of traps to collect mosquitoes (Figures 1 and 2).

The stations are generally located at municipal-owned facilities which are secure, have access to electrical power and are within the general vicinity of major population centers. The traps operate from mid-May through mid-October, with one collection cycle per week, each cycle lasting 24-hours. Trap contents are collected at the end of each cycle and all adult female mosquitoes are identified and recorded with certain species sent for disease testing.

Figure 1. CDC CO2/Light Trap

Figure 2. Reiter-Cummings Gravid Trap

The first of the two traps is the Light/CO_2-baited CDC trap (Figure 1). To attract mosquitoes, a light is used along with carbon-dioxide gas released from a pressurized cylinder into a hose located at the top of the trap. As mosquitoes approach the gas released at the hose's opening, they are drawn inside by an internal fan, then blown into a container that hangs below. With this trap, nearly all mosquito species in a community are collected during that night. Because the traps are placed at the same locations every year, population trends can be predicted, studied and compared between years, as well as during the year.

To determine whether infected bridge vectors are present, portable CDC-CO_2 traps (Figure1) are often placed at locations when infected *Cs. melanura* and *Cx. pipiens/restuans* mosquitoes have been collected. These traps collect other species which upon identification, are tested. Knowing the "infection status" of bridge vectors in EEE-known habitats can result in more effective targeted adulticiding responses.

The second trap is the Reiter-Cummings Gravid Trap (Figure 2), our principal WNV detection tool. This trap is designed to attract container-breeding mosquitoes including *Culex pipiens* and *Cx. restuans* the key carriers of West Nile Virus (WNV) and these mosquitoes breed proficiently in heavily urbanized areas. The trap is baited with aged organic material-filled water, held below in a pan, to attract female mosquitoes for egg laying. These blood-fed females come to lay their eggs on the water's surface and when they approach the trap's underside opening, they are drawn into the collection container. The mosquitoes are later removed from the container. After identification of the mosquitoes, all WNV-vector species are separated and sent to the state lab to be tested for the presence of virus.

Our third surveillance trap is a Resting Box. Due to the behavior and habitats preferred by another disease carrying mosquito, resting boxes are not placed at the historical trapping stations. Instead, these traps are situated in the vicinity of cedar and red maple swamps where *Culiseta melanura* (Figure 4) resides. *Cs. melanura* is a primary vector of Eastern Equine Encephalitis (EEE). Resting boxes are designed to simulate the tree holes and cavities where these mosquitoes normally rest during the day after they feed on blood. Resting boxes (Figure 3) are visited once weekly from mid-May through the end of September; *Cs. melanura*, and the closely related *Cs. morsitans*, are gathered, identified, tallied, then separated to be later tested for the presence of viruses.

An "epicenter" of EEE activity developed in southeastern New Hampshire during 2005 and monitoring for EEE vectors became another component of the NEMMC surveillance program. Initially, nine resting box stations were placed at fixed locations along the southeastern New Hampshire border from Methuen through Salisbury. Additional resting box stations were added gradually since 2006 in Boxford, Topsfield, Hamilton, Wenham, Newbury, Georgetown, Lynnfield, and Middleton. These additional stations were set in response to EEE infections in mosquitoes, horses, alpacas, or humans in these communities. Additional boxes are ready for deployment and stations have been selected in more communities if resting box surveillance must be expanded. Because *Cs. melanura* can also transmit WNV, resting box surveillance has enhanced our WNV monitoring.

Figure 3. Resting Boxes (left back view; right front view)

Figure 4. BG-Sentinel Trap

The BG-Sentinel Trap (Figure 4) mimics the motions and chemicals produced by a human host. The attractants are given off by various lures through a dispenser which releases a combination of lactic acid, octenol, ammonia, caproic acid and CO2; substances found on human skin or released through respiration. These traps were specifically developed for attracting *Aedes albopictus* (see exotic species below). The trap consists of an easy-to-transport, collapsible white cylinder with white mesh covering the top. In the middle of the mesh cover is a black funnel through which a down draft is created by a 12V DC fan that causes mosquitoes in the vicinity of the opening to be drawn into a catch bag. The catch bag is located above the suction fan to avoid damage to specimens passing through the fan. The air then exits the trap through the mesh top. We plan on using a few of these traps as well as oviposition traps near large tire collection facilities in 2019 to monitor potential movement of *Ae. albopictus* into this area. In 2018, we did collect 1 adult female *Ae. albopictus* from a gravid trap in Manchester-by-the-Sea. No additional collections of this species were made to confirm if a resident population exists in our district.

Virus Testing

After trapping, specimens of the principal WNV and EEE vectors are collected, counted and sorted into groups by species. At the William A. Hinton State Laboratory Institute (HSLI), MDPH tests these samples (up to 50 mosquitoes per sample) for WNV and EEE. These are frequently referred to as mosquito "pools" which indicates the batching of mosquitoes for testing purposes and is not a reference to any body of water. Test results from routine mosquito collections are usually available within 24 hours after delivery of mosquitoes to HSLI. Routine collections from fixed and long-term trap sites provide the best available baseline information for detecting trends in mosquito abundance and virus prevalence, and for estimating the relative risk of human infection from EEE virus and WNV. On average, 75 samples (i.e., pools or batches) of mosquitoes are sent each week to the State Labs from this district.

Testing of adult female mosquito specimens starts on June 15th for primary vector species, August 1st for bridge vector species and ceases for all species on October 1st; unless there is an expressed need to extend the testing season due to increased arboviral risk.

Mosquito virus testing criteria for 2019:

Phase I

- June 15th to August 1st
- Primary vectors (Bird biters): *Cs. melanura, Cs. morsitans, Cx. pipiens* and *Cx. restuans*
- Other mosquito species may be tested on a case by case basis.

Phase II

- August 1st to October 1st (or October 15th for MADHP extended season)
- Primary vectors (species listed above) + Bridge vectors (bird/mammal biters): *Ae. cinereus, Ae. vexans, Cq. perturbans, Cx. salinarius, Ae. canadensis, Ae. japonicus, Ae. taeniorhynchus, Ps. ferox* and *Ae. sollicitans*
- Other mosquito species may be tested on a case by case basis.

Supplemental Trapping

To determine whether infected bridge vectors are present, portable CDC-CO_2 traps are often placed at locations when infected primary vector *Cs. melanura* and/or *Cx. pipiens/restuans* mosquitoes have been collected. These supplemental traps collect other species of mosquitoes that are attracted to and would bite humans/mammals. Knowing the infection status of bridge vectors in EEE/WNV known habitats can result in more effective targeted adulticiding responses.

After the 1st positive WNV/EEE primary vector species (bird biters) in any municipality, supplemental traps are set based on a number of factors including but not limited to:

- Radius of collection
- Distance from historic trap
- Topography
- Human population density
- Bridge vector potential breeding sites
- Schools/parks/recreation areas
- Trap Security
- Wetland/wooded/shaded areas

Collections are then sent for additional MDPH arboviral testing.

District Operations

Larviciding:

General Wetlands- Larviciding sites from the District's data base, including spring snowmelt areas, woodland pools, agricultural pastures, riverine floodplains, flooded lawns, shrub/cattail/*Phragmites* swamps, salt marshes, and other areas requested by the local Board of Health will be checked and treated for mosquito larvae as necessary, beginning in March or as snowmelt allows, to September 30th and beyond if circumstances warrant and conditions allow.

Aerial Salt Marsh- Coastal salt marshes in neighboring communities from Ipswich to the New Hampshire border will be aerially larvicided by helicopter to control salt marsh mosquitoes in accordance with the respective Best Management Practice Plans. Salt marsh mosquitoes are capable of flying up to 25 miles in search of a blood meal and then return to the salt marsh to lay eggs. Coastal communities as well as many inland cities and towns receive direct and immediate benefit from the control of salt marsh mosquitoes.

Catch Basins- The preferred long-term and more cost-effective vector control strategy is to eliminate larvae before they become adults. While *Culex* mosquitoes can develop in a variety of freshwater habitats, the greatest concentration of *Culex* breeding is in the estimated 80,000 catch basins found in the district (Figure 5). The two principal urban *Culex* mosquitoes, *Cx. pipiens* and *Cx. restuans* breed in highly organic or polluted water that collect in catch basins, ditches, storm water structures including retention ponds (Figure 6), and discarded tires, clogged gutters, bird baths, and the like (Figures 7-8). Applications to schools must be in compliance with 333 CMR 14.00: PROTECTION OF CHILDREN AND FAMILIES FROM HARMFUL PESTICIDES.

Figure 5. Catch Basin

Figure 6. Retention pond.

Figure 7. Discarded tire yard

Figure 8. Clogged rain gutter filled with water

Treating catch basins consists of the application of either a bacterial agent or growth regulator. Short term surveillance data showed an 80% reduction in *Culex* species in communities where basins are treated as compared to communities with untreated basins. In a study conducted in Portsmouth, NH in 2007 by Municipal Pest Management Services Inc., there was a 75% reduction in mosquitoes breeding in treated catch basins compared to untreated basin (34). Long term surveillance data has shown that continual annual treatment of basins significantly decreases *Culex* populations throughout the district.

The order of catch basin larvicidal treatments for 2019 will be prioritized as follows. First to be treated will be the basins north of Boston and the basins in the municipalities bordering Lawrence. These cities are suspected of being the prime WNV foci in northeast Massachusetts. Treatments of basins in these communities will begin in May through June as conditions allow, followed by the remaining municipalities in the District.

It is preferred that basins be treated in the late spring to early summer to maximize the effects of the larvicidal agents. However, applications of larvicides are often delayed in some communities until basins are cleaned of debris by the local DPW's. Basins filled with organic debris will reduce the effectiveness of the bacterial larvicides and other larvicide types must be used.

Municipal DPWs can further assist the district in efficient treatments of basins by scheduling annual cleanings before the end of May. Clean basins reduce organic material in the basins and allow for greater efficacy and interval of the bacterial larvicide treatments. If the basins cannot be cleaned early, then waiting until after August would suffice. This would allow the district to use a methoprene based larvicide in lieu of the bacterial product for the entire virus season.

Time, weather, DPW basin-cleaning schedules, and extent of other District operations will determine when basins will be treated and which product will be most efficient.

Source Reduction and Sanitation: The District has facilitated the removal and proper disposal of used tires and other potential container habitats from its service area for several years through petitioned wetland management projects, coordinated clean-ups and participation in Household Hazardous/Zero Waste Day Events. These practices are considered an important part of the District's integrated pest management (IPM) approach and have become a valuable vector mosquito habitat management tool. We ask that communities petition (request on letterhead) for tire removal through an assigned town department petitioning body such as the Board of Health, Conservation Commission and/or Public Works Department.

Waste Water Treatment Facilities Inspection: The District also inspects wastewater treatment facilities, when requested. This way, actual or potential *Culex* breeding can be reduced or eliminated. We wish to be a resource of information and technology to assist facility managers to prevent and/or abate mosquito breeding to the mutual benefit of the facility and the community.

Property Inspection: The District will represent the town's mosquito control concerns in an advisory capacity relative to proposed development and where prudent as requested by local health officials. District personnel are authorized, under the provisions of Chapter 252 Section 4 of the General Laws of the Commonwealth, to enter upon lands for the purpose of inspections for mosquito breeding.

Socioeconomics often plays an important role in mosquito control and associated public health risk. In a study conducted in California in 2007, there was a 276% increase in the number of human WNV cases in association with a 300% increase in home foreclosures. Within most foreclosed properties in Bakersfield (Kern County, CA) were neglected swimming pools (Figure 9) which led to increased breeding and population increases of *Cx. pipiens/restuans*.

Figure 9. Abandoned swimming pool.

Figure 10. Abandoned home property with containers of all types collecting water.

In recent years we have received requests from Boards of Health to inspect abandoned properties (Figure 10) and we will continue this practice in 2019. In the course of our routine activities, we will also inspect and report such properties to your Board. We will offer any support that may be appropriate to resolve mosquito problems related to such properties. With the support of the Boards of Health, we will implement the necessary control measures to mitigate any immediate mosquito problem associated with such properties.

The District will also consult with project developers to prevent/reduce mosquito breeding during and after phases of residential/commercial construction.

Selective truck-based ULV Adulticiding: As a final measure to reduce the risk of WNV/EEE infections, the District may recommend selective and targeted adulticiding applications when WNV-infected mosquitoes are discovered. The District uses "Ultra Low Volume" (ULV) truck-based adulticiding operations. One advantage of ULV applications is that only very minute amounts of pesticides are dispersed over a large area (Figure 11); between 0.41 and 1.23 fluid ounces per acre are applied, depending on truck speed, which ranges between 5 and 20 miles per hour. Due to the pesticides employed, adulticiding is done **only at night** (30 minutes after sunset to 30 minutes before sunrise).

Applications to schools must be in compliance with MGL Ch. 85 and **333 CMR 14.08** : PROTECTION OF CHILDREN AND FAMILIES FROM HARMFUL PESTICIDES. **Only the local Board of Health can authorize truck-based ULV adulticide operations.**

Residential Pesticide Exemption: Residents who request their property be excluded from **all pesticide applications** must comply with the legal process to exempt their property. Pursuant to 333 CMR 13.03, individuals may request exclusion from wide area applications of pesticides by the district. Requests **must be made to the Department of Agricultural Resources** and **will go into effect fourteen (14) days** from the date the request is received. All exclusion requests expire on December 31st of the calendar year in which it was made. The exclusion request may be accessed from either our District's website or directly from the Department of Agricultural website https://www.mass.gov/how-to/exclusion-from-wide-area-pesticides-application


Figure 11. Truck spray at night


Figure 12. Truck applying barrier treatment.

Barrier Treatment: While ULV is a cost-effective procedure on a large scale, it only affects those mosquitoes active at the time of the application; repeated applications are sometimes necessary to sustain population control. To reduce the need for repeated applications and provide more sustained relief from mosquitoes in high public use areas, the District may recommend a smaller scale "barrier spray treatment". This application would be made to public use areas such as schools (applications to schools must be in compliance with MGL Ch. 85 and **333 CMR 14.08**: PROTECTION OF CHILDREN AND FAMILIES FROM HARMFUL PESTICIDES.), playgrounds, parks and athletic fields (Figure 12). A barrier spray may reduce mosquito presence for up to 3 weeks. The District strongly recommends member municipalities take advantage of this service when necessary.

Special Circumstance- Droughts: During intense drought seasons, normal development and distributions of *Cx. pipiens/restuans* can be increasingly unpredictable. Prolonged droughts together with periods of intense heat result in "explosions" of these species, as was seen in our district in 2010, 2013, 2015 and 2016. Patterns of heavy rainfall followed by stretches of intense heat lasting weeks will also result in greater than normal populations of these species, as exhibited in 2011. The availability of standing water diminishes during droughts and most mosquito species suffer significant population losses. The breeding habits of *Cx. pipiens/restuans* allow this species to take advantage of conditions provided by droughts. Recall that these species breed in waters with high organic content. One type of artificial container filled with such water is the catch basin, as discussed earlier. Basins in urbanized areas can dry during severe drought conditions. However, people continue to water lawns and wash their cars during droughts. The excess runoff from these activities keep catch basins filled. If basins have been treated with a larvicide, breeding should be kept in check. If the basins are property of a municipality, and we have records of their locations, they will be treated. However, we may not know of their existence on private properties and thus, they remain untreated and become a continual source of *Culex* mosquitoes throughout the season.

Normally, *Cx. pipiens/restuans* mosquitoes do not breed in great abundance in wetlands and definitely do not breed in moving water. However during a drought, large expanses of water become smaller, shallower, and more concentrated with more organic debris, presenting *Culex* mosquitoes with more breeding habitats to exploit. With more urbanization, *Culex* populations can move in and thrive. There are also fewer predators present (especially fish) as wetlands dry and the survivorship of the developing larvae is dramatically increased. Also during droughts, flowing waters such as rivers, streams, and brooks gradually slow and decrease in volume. Either in the very slow moving water or more likely, along the puddles and pools formed at the edges (usually filled with organic debris; see Figure 13), more breeding sites are available for *Culex* to utilize.

As any large body of water dries, containers and tires that were dumped into these bodies (when full of water) now become exposed (Figure 14). Being filled with polluted water, these also become ideal breeding sites for *Culex*. Debris-filled ground holes and depressions (either naturally-occurring or artificial) can become filled with water in a sudden downpour and also become instant breeding habitats for these species. Therefore, breeding areas for *Culex* mosquitoes are always in abundance, even in the middle of the worst drought.

Figure 13**.** Powow River (Amesbury) during June 2010 drought.

Figure 14. Drying pond in Newburyport in August 2010 exposing debris and containers originally found under water.

Beaver Impacted Waterway Protocol

Following the adoption of the Wildlife Protection Act in 1996, the beaver population in Massachusetts increased from 24,000 to nearly 70,000 in the first five years. Waterways subject to beaver activity are often altered from narrow, free flowing systems to large, slow or no flow systems. Additionally, many beaver impacted waterways contain multiple dams, further slowing water flow. As a result, many previously unaffected areas adjacent to waterways may become flooded, resulting in the appearance of potential for increased breeding habitat for mosquitoes.

The District's response to inquiries regarding beaver impacted waterways will take into consideration Best Management Practices. All beaver related projects must have a documented mosquito component. All efforts will be made to work with local, state, and federal agencies responsible for the management of wildlife within the municipality of the permitted or proposed project. Removal and/or alteration of beaver dams by the District should be considered as a last resort. The following protocol is designed as a working document and guideline to address beaver concerns within the District's member municipalities.

1. All residential inquiries shall be advised to contact the Board of Health and/or Department of Public Works of the resident's municipality.
2. Municipalities may submit a petition to the Biologist to have beaver impacted waterways evaluated.
3. Petitioned beaver sites will be evaluated for mosquito activity and documented. The District should seek the guidance and cooperation of local, state, and federal agencies responsible for the management of wildlife.
4. All efforts shall be made to coordinate with local, state, and federal agencies responsible for the management of wildlife for the removal and/or alteration of beaver dams. District personnel may assist in the removal and/or

alteration of beaver dams if needed, to the extent that such work is necessary to perform mosquito control activities authorized by M.G.L. c. 252.

5. All efforts shall be made to work with the local conservation commission and municipal authorities to ensure that all interested parties are aware work is performed only on an as-needed basis and in accordance with M.G.L. c. 252, or that work is performed by another authorized entity and all legally appropriate steps have been taken.

Invasive Plant Protocol

Phragmites australis (Phragmites)

Phragmites is an invasive wetland plant that provides habitat for a number of mosquito species, including those involved in various virus cycles (*Culiseta melanura, Culex salinarius, Coquillettidia perturbans)*, as well as opportunistic species (*Ochlerotatus spp, Anopheles spp, Aedes spp*) that may be involved in the virus cycle in addition to impacting quality of life near *Phragmites* stands. Mosquito control efforts may be inhibited by dense stands of *Phragmites*, either by preventing the spray from aerial larval applications from reaching the breeding pools or by inhibiting the ability of mosquito control personnel from accessing the breeding sites.

Phragmites control shall be at the discretion of District personnel and/or local municipality to provide effective mosquito control in these habitats. Use of control measures may include mowing, cutting, herbicide applications or a combination of methods.

The District's use of herbicides will be carefully considered for each proposed project. Invasive plants growing within the working area and along the path of access or egress of a proposed wetlands project will be surveyed during the initial site evaluation. Careful consideration of all Best Management Practices should be taken, with a timeline developed for the removal and disposal of invasive plants prior to the start of a permitted project.

All efforts should be made to coordinate with local, state, and federal agencies responsible for the management of invasive plants for the removal, disposal and management of invasive plant material associated with proposed wetlands projects. Removal of invasive plants by the District should be considered as a last resort in an effort to reduce the spread of invasive plants. District personnel may assist in the removal of invasive plants if needed, to the extent that such removal is necessary to perform mosquito control activities authorized by M.G.L. c. 252.

Emergency Response Aerial Adulticiding Plan

In the event that the risk of WNV/EEE infection escalates to a point that truck-based ULV adulticiding is insufficient to reduce that risk, an emergency aerial adulticiding application may be warranted. Fixed-winged aircraft would be employed to release adulticides over targeted areas. For this aerial application to proceed, a consensus must be reached by the District, State Reclamation and Mosquito Control Board, Massachusetts Department of Health and an independent advisory board. A declaration of a Public Health Emergency from the Governor is also required.

Typically, once the decision is made, the need for action is immediate and the window of opportunity is short. Please refer to pages 16 and 17 of the MA Department of Public Health's 2018 Arbovirus Surveillance Plan https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data#response-plan- for the Multi-Agency Response Flowchart on Aerial Adulticide Application in Response to Threat of EEE.

Risk Communications and Public Relations

Dissemination of mosquito and arbovirus information is paramount to the success of any mosquito control operation. With the speed which information, as well as rumors and even disinformation, can be conveyed in all public informational media, it is crucial that Boards of Health and subscribing municipality residents are kept correctly informed. The District continues to improve its communication regarding mosquito species, potential arboviral threats, and details of larviciding and adulticiding operations.

At the end of the season, the District sends detailed Best Management Practice Plans (BMPs) to each participating municipality. Each BMP includes summaries of the previous year's mosquito and arbovirus activities, descriptions of suggested and agreed-upon control operations, as well as their costs. When necessary, the District conducts a Mosquito/Arbovirus Surveillance Workshop to inform/educate health agents and Boards of Health members of District communities. Potential mosquito and arboviral threats along with response options are discussed. When requested, lectures are presented to Boards of Health and other interested municipal organizations. These are often recorded for broadcast on public-access television as well as posted on the internet. District personnel are available to residents for site requests and answering questions about integrated pest management and homeowner risk reduction.

Please visit our website for more information: www.nemassmosquito.org

District Phased Response to WNV/EEE Virus Isolations

NEMMC Phased Response to WNV Virus Isolations- 2019		
MDPH Risk Category	**Definition of Risk Category in a Focal Area[1]**	**NEMMC District Recommended Response[2]**
1. WNV-Low	All localities begin the year at low <u>Current Year</u> 1. No evidence of WNV activity in mosquitoes in the focal area. OR 1. **<u>Sporadic</u>** WNV activity in mosquitoes in the focal area. AND 2. No animal or human cases	1. Routine collection and testing of mosquitoes at historic trap sites 2. Emphasize the need for schools to comply with MA requirements for filing outdoor IPM plans. 3. Continued assessments of adult and larval mosquito populations 4. Continued source reduction and routine larvicide efforts 5. Local BOH is notified immediately of WNV isolates 6. Supplemental trapping may be implemented for sporadic activity depending on mosquito populations, time of year and weather

2. WNV-Moderate	Current Year 1. **Sustained** or increasing WNV activity in mosquitoes in the focal area. OR 2. WNV activity in a mammal biting mosquito species (bridge vector) detected from a supplemental trapping event 3. One confirmed animal or human case	Response as in category 1, plus: 1. Increased larval control and source reduction measures. 2. Locally targeted ground-based ULV adulticiding operations should be considered. The decision to use ground-based adult mosquito control will depend on the time of year, mosquito populations and proximity of virus activity to human populations. 3. Consideration of barrier treatments at schools, parks and recreation areas. The decision will depend on School IPM plans, time of year, mosquito populations, human activity and vegetation surrounding the proposed treatment area.
3. WNV-High	Current Year 1. Multiple WNV isolations in vector and/or mammal biting (bridge vector) mosquitoes during the same week from the focal area. AND 2. At least one multiple meteorological or ecological condition (such as above average temperatures, dry conditions, or larval abundance) associated with increased abundance and increased risk of human disease. OR 3. Two or more confirmed animal or human cases of WNV occurring within the focal area (focal area based on exposure history of cases)	Response as in category 2, plus: 1. Intensify larviciding and/or adulticiding control measures where surveillance indicates human risk. 2. Municipal wide, ground-based ULV applications of adulticide that may be repeated as necessary to achieve adequate mosquito control. 3. Communicate risk to neighboring communities if focal area is bordering those communities. 4. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests.
4. WNV-Critical	Current year An excessive number of human cases clustered in time and space. AND	Response as in category 3, plus: 1. MDPH will confer with local boards of health, the SRMCB and Mosquito Control projects to discuss the need for additional intervention

	Evidence that the risk is likely to increase based on time of year, weather patterns, mosquito populations or other factors specific to the situation.	If additional mosquito control activities are indicated, the SRMCB will determine the appropriate pesticide and extent, route and means of treatment. 2. MDPH recommends reduction of outdoor activities, during peak mosquito activity hours, especially by the elderly and others at higher risk for severe WNV disease, in areas of intensive virus activity for high risk populations or individuals

Sporadic WNV activity- 1-2 mosquito isolates are detected during non-consecutive weeks within one focal area.

Sustained WNV activity-when mosquito isolates are detected for at least 2 consecutive weeks within one focal area.

[1] Focal Area- May incorporate multiple communities, towns or cities. Factors considered in the assessment of human risk and the outlining of a particular focal area include: mosquito habitat, prior virus isolations in surveillance specimens from previous years, human population densities, type and timing of recent isolations of virus in mosquitoes, occurrence of human case(s) in the current or previous years, current and predicted weather patterns, and seasonality of conditions needed to present risk of human disease.

[2] Please refer to Table 1. Guidelines for Phased Response to WNV Surveillance Data in the 2017 Massachusetts State Arbovirus Surveillance and Response Plan for MDPH Primary Recommended Response.

NEMMC Phased Response to EEE Virus Isolations- 2019

MDPH Risk Category	Definition of Risk Category in a Focal Area[1]	NEMMC District Recommended Response[2]
1. EEE-Remote	All of the following conditions must be met: Prior Year 1. No EEE activity detected in community or focal area in at least 10 years AND Current Year 1. No current surveillance findings indicating EEE activity in mosquitoes in the focal area AND 2. No confirmed animal or human EEE cases	1. Routine collection and testing of mosquitoes at historic trap sites 2. Continued assessments of adult density and larval mosquito populations 3. Continued source reduction and routine larvicide efforts 4. Emphasize the need for schools to comply with MA requirements for filing outdoor IPM plans. 5. BOH notified by NE District and Public health alert sent out by MDPH in response to first EEE virus positive mosquito pool detected during the season. The alert will summarize current surveillance information and emphasize personal prevention strategies.

2. EEE-Low	<u>Prior Year</u> Any EEE activity detected within the last 10 years OR <u>Current Year</u> 1. **<u>Sporadic</u>** EEE isolations in *Cs. melanura* mosquito in the community or focal area AND 2. No confirmed animal or human EEE cases	Response as in category 1, plus: 1. Increased larval control and source reduction measures. 2. Supplemental trapping for bridge vectors may be implemented for sporadic activity depending on mosquito populations, time of year and weather
3. EEE-Moderate	<u>Prior year</u> **<u>Sustained</u>** EEE activity in bird-biting mosquitoes; or EEE isolate from mammal-biting mosquitoes; or confirmation of one human or animal EEE case in the community or focal area OR <u>Current year</u> 1. **<u>Sustained</u>** EEE activity in *Cs. melanura* with minimum infection rates that are at or below mean levels for focal area trap sites OR 2. A single EEE isolate from mammal-biting mosquitoes (bridge vector species) OR 3. Sustained EEE activity plus at least one multiple meteorological or ecological condition (rainfall, temperature, seasonal conditions, or larval abundance) associated with elevated mosquito abundance thus likely to increase the risk of human disease AND 4. No confirmed animal or human EEE cases in current year	Response as in category 2, plus: 1. Supplemental mosquito trapping and testing in areas with positive EEE findings. Notify all boards of health of positive findings. 2. If not already in progress, standard, locally targeted ground-based ULV adulticiding operations should be considered where surveillance indicates human risk. The decision to use ground-based adult mosquito control will depend on the time of year, mosquito populations and proximity of virus activity to human populations. 3. Consideration of barrier treatments at schools, parks and recreation areas. The decision will depend on School IPM plans, time of year, mosquito populations, human activity and vegetation surrounding the proposed treatment area. 4. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests.

4. EEE-High	Current Year 1. **Sustained** or increasing EEE activity in *Cs. melanura* with weekly mosquito minimum infection rates above the mean OR 2. 2 or more EEE isolates in mammal-biting mosquitoes from 2 different traps AND/OR 3. **Sustained** or increasing EEE activity in mosquitoes plus multiple meteorological or ecological condition (such as above average temperatures, dry conditions, or larval abundance) associated with increased abundance and thus very likely to increase the risk of human disease AND 4. No confirmed animal or human EEE cases in current year	Response as in category 3, plus: 1. Intensify larviciding and/or adulticiding control measures where surveillance indicates human risk. 2. Municipal wide, ground-based ULV applications of adulticide that may be repeated as necessary to achieve adequate mosquito control. 3. Communicate risk to neighboring communities if focal area is bordering those communities. 4. Urge towns and schools to consider reschedule outdoor, evening events † 5. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. 6. MDPH will confer with local health officials, SRMCB and MCPs to determine if the risk of diseasetransmission warrants classification as level 5. 7. MDPH will confer with local health agencies, SRMCB and Mosquito Control Projects to discussthe use of intensive mosquito control methods. Ifelevated risk is assessed in multiple jurisdictions and evidence exists that risk is likely to either increase (based on time of season, weather patterns, etc.) or remain persistently elevated, the interventions may include state-funded aerial application of mosquito adulticide which, if conditions warrant, may be repeated as necessary to interrupt the virus transmission cycle and protect public health
5. EEE-Critical	Current year 1. Multiple quantitative measures indicating critical risk of human infection (e.g. early season positive surveillance indicators, and sustained high mosquito infection rates, plus multiple meteorological or ecological conditions (rainfall, temperature, seasonal conditions, or larval abundance) indicating rapidly escalating epizootic activity)	Response as in category 4, plus: 1. Continued highly intensified public outreach messages on personal protective measures. Frequent media updates and intensified community level education an outreach efforts. Strong recommendation for rescheduling of outdoor, evening events.†

	OR 2. A single confirmed EEE human or animal case	2. MDPH will confer with local health agencies, SRMCB and Mosquito Control Projects to discuss the use of intensive mosquito control methods and determine the measures needed to be taken by the agencies to allow for and assure that the most appropriate mosquito control interventions are applied to reduce risk of human infection. These interventions may include state-funded aerial application of mosquito adulticide. Factors to be considered in making this decision include the seasonal and biological conditions needed to present a continuing high risk of EEE human disease and that those same conditions permit the effective use of an aerially applied pesticide. Once critical human risk has been identified, the SRMCB will determine the adulticide activities that should be implemented in response to identified risk by making recommendations on: A. Appropriate pesticide B. Extent, route and means of treatment C. Targeted treatment areas 3. MDPH Bureau of Environmental Health will initiate active surveillance for pesticide-related illness via emergency departments and with health care providers only if aerial spraying commences. 4. MDPH will designate high-risk areas where individual no spray requests may be preempted by local and state officials based on this risk level. If this becomes necessary, notification will be given to the public. 5. MDPH recommends restriction of group outdoor activities, during peak mosquito activity hours, in areas of intensive virus activity. 6. MDPH will communicate with health care providers in the affected area regarding surveillance findings and encourage prompt sample submission from all clinically suspect cases.

Sporadic WNV activity- 1-2 mosquito isolates are detected during non-consecutive weeks within one focal area.

Sustained WNV activity-when mosquito isolates are detected for at least 2 consecutive weeks within one focal area.

[1] Focal Area- May incorporate multiple communities, towns or cities. Factors considered in the assessment of human risk and the outlining of a particular focal area include: mosquito habitat, prior virus isolations in surveillance specimens from previous years, human population densities, type and timing of recent isolations of virus in mosquitoes, occurrence of human case(s) in the current or previous years, current and predicted weather patterns, and seasonality of conditions needed to present risk of human disease.

[2] Please refer to Table 2. Guidelines for Phased Response to EEE Surveillance Data in the 2018 Massachusetts State Arbovirus Surveillance and Response Plan for MDPH Primary Recommended Response

† See Appendix 2 for schedule of recommended cancellation time for use in the 2018 Massachusetts State Arbovirus Surveillance and Response Plan

Emergent Exotic and Invasive Mosquito Species

Newly imported and exotic mosquito species becoming established in our area is a growing problem. Within the past ten years, we have seen the appearance and rapid spread of *Ochlerotatus japonicus*, the "Japanese Rock Pool Mosquito", throughout our district (Figure 15). While this species is a competent disease vector in other areas, there is little to suggest it is currently a major disease vector in the northeast. As we monitor our local mosquitoes, we are also conscious of the appearance of any new species.

Another exotic and geographically-expanding species is *Aedes albopictus*, the “Asian Tiger Mosquito” (Figure 16). It is a notorious daytime human-biting species and competent disease vector. We are currently monitoring the progression of this species as it potentially moves into the northeast. Originally from northeast Asia, it has spread rapidly throughout the temperate regions of the world assisted by the importation of used automobile tires and ship hulls. Water-filled discarded tires, flower pots, and other containers left outdoors is where this species tends to lay its eggs. Similar to salt marsh mosquitoes near coastal regions, this species will aggressively attack humans (usually around the lower extremities) during the daytime in urban areas.

Ae. albopictus was first found in the U.S. in Houston in 1985 and has spread nationwide as far northeast as southern and central Massachusetts; it has become the dominant mosquito species in New Jersey. Climate change predictions suggest *Ae. albopictus* will continue to be a successful invasive species that will spread beyond its current geographical boundaries. This mosquito is already showing signs of adaptation to colder climates which may result in disease transmission in new areas. *Ae. albopictus* is a great concern in public health because of its ability to transmit many arboviruses that cause serious disease in humans, including Chikungunya and Dengue (discussed below) and may be implicated in potential transmission of Zika virus. *Ae. albopictus* has been collected in Bristol County on repeated occasions since 2011 in used tire-collection facilities. In 2018, a single adult female *Ae. albopictus* was collected from a gravid trap at a DOT station in Manchester-by-the-Sea. Although ovitrap surveillance is ongoing, no other collections were made in our District for this species.


Figure 15. Japanese Rock Pool Mosquito (***Ae. japonicus***) Figure 16. Asian tiger mosquito (***Ae. albopictus***)
Both Photographs copyright: Steve A. Marshall Published on *The Diptera Site* (http://diptera.myspecies.info)

Mosquito-Borne Arboviruses Endemic to our Region:

West Nile Virus

West Nile Virus (WNV) was introduced to New York City in 1999 and within five years had spread to all 48 continental US states. It was first isolated in Essex County in 2000, and is now endemic throughout eastern MA, particularly in the Boston metropolitan area. Since its first appearance in North America, WNV has caused significant illness to over 39,000 persons in the United States; Table 1 shows WNV cases/fatalities in Massachusetts since 2000. While about 80% of all West Nile virus infections in humans are not symptomatic, approximately 20% of infections are manifested as some form of fever and varying degrees of serious neurological ailments are displayed by less than 1%. These neurological diseases include acute febrile paralysis, encephalitis, and meningitis; resulting in death to about 10% of all neurological cases. Of the over 17,000 neuroinvasive cases since 1999, there have been almost 1,600 deaths. Descriptions of all neurological manifestation of West Nile infections can be found at the Iowa State University Center of Food Security and Public Health website: http://www.cfsph.iastate.edu/Factsheets/pdfs/west_nile_fever.pdf.

It was thought that WNV associated neurological ailments were short-lived, affecting only a small percentage of those infected. However, recent studies suggest that neurological disorders may be more prolonged and serious, affecting more people than originally thought. According to an article published in November of 2016, the American Society of Tropical Medicine and Hygiene reported death rate rises from 'delayed' fatalities long after recovery. https://www.eurekalert.org/pub_releases/2016-11/b-nst110816.php

Table 1. Total Number of Human WNV Cases/Fatalities in Massachusetts 2001-2018.

Year	Neuroinvasive (1)	Non-Neuroinvasive (2)	Total	Fatalities
2001	3	0	3	1
2002	19	4	23	3
2003	12	5	17	1
2004	0	0	0	0
2005	4	2	6	1
2006	2	1	3	0
2007	3	3	6	0
2008	1	0	1	0

2009	0	0	0	0
2010	6	1	7	1
2011	5	1	6	1
2012	27	6	33	1
2013	7	1	8	0
2014	5	1	6	0
2015	7	3	10	2
2016	10	6	16	0
2017	5	0	5	0
2018	44	5	49	1
Totals	**160**	**39**	**199**	**12**

1) Neuroinvasive disease= Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, **AND** Meningitis, encephalitis, acute flaccid paralysis, or other acute signs of central or peripheral neurologic dysfunction, as documented by a physician, **AND** Absence of a more likely clinical explanation.

2) Non-neuroinvasive disease= Fever (≥100.4°F or 38°C) as reported by the patient or a health-care provider, **AND** Absence of neuroinvasive disease, **AND** Absence of a more likely clinical explanation.

Culex pipiens and Cx. restuans are primarily responsible for the transmission and amplification of WNV within the bird population. The larvae of both these species develop in the high-organic content water that accumulate in catch basins, containers, tires, pools and other water-holding structures that are in greater abundance in urbanized areas. Since some water-holding structures are permanent (catch basins) and the water contained cannot often be drained, the water itself must then be treated with larvicides to reduce the number of larvae breeding in these sites.

The principal strategy used by the district to minimize WNV transmission and risk is by reducing and/or eliminating larval development in catch basin and other container-like habitats.

Table 2. Summary of Arbovirus-infected mosquito pools* in Massachusetts 2000-2018.

	Total number of WNV mosquito pools			Total number of EEE mosquito pools	
Year	Statewide	NEMMC District		Statewide	NEMMC District
2000	4	0		16	0
2001	25	4		12	0
2002	68	14		1	0
2003	48	2		9	0
2004	15	4		39	0
2005	99	11		45	2
2006	43	5		157	11
2007	65	15		31	0
2008	135	10		13	0
2009	26	2		54	13
2010	121	21		65	0
2011	275	58		80	0
2012	307	48		267	14

2013	335	77		61	4
2014	56	7		33	2
2015	164	8		1	0
2016	189	39		4	0
2017	290	28		1	0
2018	**579**	**18**		**2**	**0**
Totals	**2,844**	**371**		**891**	**46**

*A mosquito pool is a batch of collected mosquitoes that are separated into individual species for testing.

Eastern Equine Encephalitis Virus

Eastern Equine Encephalitis (EEE) human infections manifest symptoms similar to West Nile encephalitis and while the human infection rate is lower; the fatality rates are much higher with EEE infections, about 33%. Also, the recovery rates from EEE disease are longer and most often are incomplete. EEE seems to attack the young as readily as the elderly; unlike WNV which the elderly are far more susceptible.

EEE was first discovered in horses hence, the basis for the name "Equine Encephalitis". The name "equine" stuck even after it was later discovered that this was the virus that caused the same encephalitis in humans. Humans and horses are "dead-end hosts", meaning that the virus cannot be transmitted from infected horses or humans. Like WNV, EEE is an avian virus, transmitted bird-to-bird principally by *Cs. melanura*.

While *Cs. melanura* mosquitoes are primarily responsible for the amplification of virus in bird populations, they typically do not bite humans if adequate bird populations are present. It is usually other mosquito species (bridge vectors) with wider host preferences that can transmit EEE to humans. Bridge vectors such as *Ae. vexans* and *Ae. canadensis* are notorious human-biting mosquitoes and may effectively transmit EEE. While risks to humans directly from infected *Cs. melanura* are extremely low, we will continue to take preemptive protective operations directly against *Cs. melanura* when infected mosquitoes are detected. Lack of early intervention can result in EEE amplification in bird populations, then to other mosquito species, which can increase human risk to infection later in the season.

Prior to 2004 there were never serious concerns about Eastern Equine Encephalitis in Essex County. EEE seemed to be restricted to southeast Massachusetts (Table 2) and its vector, *Cs. melanura*, seemed to thrive in the expansive habitat of the great cedar swamps found there. No such huge cedar swamps are found in northeast Massachusetts nor has *Cs. melanura* been collected here with any abundance. Historically, clusters of human cases have occurred over a period of two to three years, with a variable number of years between clusters. In the years between these case clusters or outbreaks, isolated cases can and do occur. Outbreaks of human EEE disease in Massachusetts occurred in 1938-39, 1955-56, 1972-74, 1982-84, 1990-92, 2004-06 and 2012.

2010- 65 of 3558 mosquito samples collected in Massachusetts were positive for EEE. They were collected from 19 towns in 3 counties. One human case of EEE infection was identified in a Plymouth County resident. A case from Rhode Island was also suspected to have been caused by an exposure in Southeastern Massachusetts.

2011- 80 of 4604 mosquito samples collected in Massachusetts were positive for EEE virus. They were collected from 17 towns in 5 counties. One fatal case of EEE infection was identified in a Bristol County resident. A case was also identified in a Missouri resident. An epidemiologic investigation determined that this individual was most likely exposed in Southeastern Massachusetts.

2012- 267 of 6828 mosquito samples collected in Massachusetts were positive for EEE virus. They were collected from 43 towns in 8 counties. There were seven human cases of EEE reported in Massachusetts in 2012, one from Middlesex County, which was believed to have been acquired out of state, one from Worcester County, one from Franklin County, two from Plymouth County, and two from Essex County.

2013- 61 of 6092 mosquito samples collected in Massachusetts were positive for EEE. These positive samples were from 27 towns and 6 counties in the Commonwealth; one positive sample was found in Quincy. There was one human case and fatality in 2013, from Norfolk County.

2014- 33 0f 5039 mosquito samples collected in Massachusetts were positive for EEE. These positive samples were from 13 towns in four counties in the Commonwealth. No positive samples were found in Quincy. There were no human cases or fatalities in Massachusetts for 2014.

In our District during 2004 and 2005 reports of EEE-infected mosquitoes, birds, horses, and humans came from just over the border from Essex County in southeast New Hampshire. The more EEE that was reported in New Hampshire, the more the virus began to present itself in our district beginning in 2005. Infected mosquitoes were collected from one or more of our border towns annually from 2005 through 2009 and again in 2012-2016 (Table 3).

2016 to 2018 have been quiet years in our District with no human or animal EEE cases or positive EEE mosquito batches. The entire State of Massachusetts had 1 positive EEE mosquito batch and no human or animal cases reported during 2017, and 2 EEE positive mosquito batches and 2 EEE positive animals (Horse/Turkey) during 2018.

Table 3. EEE detections and infections in southeastern New Hampshire and northeastern Massachusetts from 2001 through 2018.

	Southeastern New Hampshire (EEE)(1)			Northeastern Massachusetts (EEE)(2)		
Year	# infected mosquito "batches"	Veterinary infections	human infections/deaths	# infected mosquito "batches"	Veterinary infections	human infections/deaths
2001	**0**	**0**	**0**	**0**	**0**	**0**
2002	**0**	**0**	**0**	**0**	**0**	**0**
2003	**0**	**0**	**0**	**0**	**0**	**0**
2004	**19**	**3**	**0**	**0**	**1** (3)	**0**
2005	**15**	**14**	**7 / 2**	**2**	**2**	**0**
2006	**40**	**1**	**0**	**11**	**0**	**0**
2007	**6**	**2**	**3 / 0**	**0**	**0**	**0**
2008	**8**	**1**	**0**	**0**	**0**	**1** (4) **/ 1**
2009	**73**	**7**	**1 / 0**	**13**	**1** (5)	**0**
2010	**0**	**1**	**0**	**0**	**0**	**0**
2011	**0**	**0**	**0**	**0**	**0**	**0**
2012	**9**	**4**	**0**	**14**	**2**	**2 / 2**
2013	**24**	**3**	**0**	**4**	**0**	**0**
2014	**18**	**3**	**3 / 2**	**33**	**2**	**0**
2015	**2**	**0**	**0**	**0**	**0**	**0**

2016	0	0	0		0	0	0
2017	1	0	0		0	0	0
2018	6	0	0		0	0	0

1: Includes Merrimac, Hillsborough, Strafford, & Rockingham counties
2: Essex County + Winthrop/Revere
3: Also an emu was infected with EEE
4: Resident of Newburyport but acquired infection in either NH or ME
5: Alpaca

***Cs. melanura* habitat surveillance:** Predictive models of EEE cycles and distributions are apparently no longer reliable as EEE activity can no longer be estimated by high populations of *Cs. melanura*. It was seen in several resting box sites in 2012 that even with lower than usual populations of *Cs. melanura*, EEE was still being transmitted. Monitoring their populations to help in predicting EEE activity has been troublesome due to the locations where this species breeds and develops. *Cs. melanura* is one of only a few mosquitoes that survive the winter in the larval stage. Instead of open water, they develop inside flooded root mats, holes and tunnels (crypts) under trunks of trees and in tree hummocks in acidic Atlantic White Cedar, Red Maple swamps and sphagnum bogs (Figure 17 & 18).

Figure 17. Red Maple/sphagnum and peat bog
http://www.co.oswego.ny.us/info/news/2012/061112-1.html

Figure 18. "Inside the Atlantic White Cedar Swamp Trail"
http://www.paulscharffphotography.com/occ-insidetheatlanticwhiteceda.htm

These habitats are in relative abundance in northeast MA, although they exist more as isolated pockets and are difficult to access. Since 2004, we have been searching for *Cs. melanura* habitat to monitor in winters, to date we have been unsuccessful in locating such sites with consistency. During the winters, we continue to narrow our search for *Cs. melanura* breeding to areas within a one mile radius of our surveillance stations in communities bordering NH and in the Hamilton/Topsfield area. The objective is to find these breeding locations from which we can monitor larval populations through the winter; the expectation is to make better projections of what may happen in the following seasons and prepare better for intervention.

Jamestown Canyon Virus (JCV)

Jamestown Canyon virus (JCV) was first isolated in 1961 from a mosquito in Colorado and was first recognized to cause human disease in 1980. JCV persists among white-tailed deer and 22 different species of mosquitoes including *Aedes* and *Anopheles*. The infection occurs in June through September with a peak in mid-June to mid-July. Although rare, this disease has potentially severe and even fatal consequences for those who contract them. Clinical features include mild febrile illness with acute central nervous system infection including meningitis and encephalitis and frequently respiratory system involvement in patients more than 18 years old.

In 2013, of 10 states reporting cases, 8 states (Georgia, Idaho, Massachusetts, Minnesota, New Hampshire, Oregon, Pennsylvania, and Rhode Island) reported their first JCV cases. In Connecticut, human cases have been rare, but mosquitoes in 8 towns, including Stamford and Norwalk, have tested positive for the virus in 2014. In August 2015, the Iowa Department of Public Health announced that one case of JCV has been confirmed.

In 2017, 2 Maine residents from Kennebec and Franklin Counties were diagnosed with JVC. Both had onset dates in June. Also, 2 New Hampshire residents were diagnosed with JVC in 2017 and 1 resident in 2018. Although the 2017 cases were not travel related the single 2018 infection in NH was most likely acquired out of state.

For more information on JCV please visit: https://www.dhhs.nh.gov/dphs/cdcs/documents/jamestown-canyon-virus.pdf

Saint Louis Encephalitis Virus (SLEV)

Saint Louis encephalitis virus (SLEV) is transmitted to humans by the bite of an infected mosquito. Most cases of SLEV disease have occurred in eastern and central states. *Culex pipiens* are one of the primary mosquito vectors for this bird disease. Most persons infected with SLEV have no apparent illness. Initial symptoms of those who become ill include fever, headache, nausea, vomiting, and tiredness. Severe neuroinvasive disease (often involving encephalitis, an inflammation of the brain) occurs more commonly in older adults. In rare cases, long-term disability or death can result. There is no specific treatment for SLEV infection; care is based on symptoms.

The majority of cases have occurred in eastern and central states, where episodic urban-centered outbreaks have recurred since the 1930s. New Hampshire reported one human case in 2006.

For more information on SLEV please visit: https://www.cdc.gov/sle/index.html

Emergent and Travel Related Mosquito-Borne Viruses

Mosquito-borne disease is continually on the rise world-wide. The potential for invasion, transmission, and establishment of new arboviruses in the United States is on the increase. After the introduction and establishment of West Nile Virus in 2000 and continuous introduction of invasive tropical mosquito species, potential arboviral threats in the district are considered and even anticipated.

Zika Virus

Zika virus is transmitted to people primarily through the bite of an infected *Aedes* species mosquito (*Ae. aegypti* and *Ae. albopictus*). These mosquitoes become infected when they feed on a person already infected with the virus. Infected mosquitoes can then spread the virus to other people. The virus can also be spread from mother to child, sex, blood transfusions and in the laboratory/healthcare exposure setting. The most common symptoms of Zika are fever, rash, joint pain, and red eye. The illness is usually mild with symptoms lasting from several days to a week. Severe disease requiring hospitalization is uncommon. There is no vaccine to prevent or medicine to treat Zika.

The first locally acquired US case of Zika was reported in Florida in August of 2016. Local transmission means that mosquitoes in the area have been infected with the virus and are spreading it to people. By the end of 2016: there were 139 locally acquired mosquito-borne cases and 4,115 travel-associated cases reported.

There were 349 symptomatic Zika virus disease cases reported in the US by the end of November 2017.

- 344 cases in travelers returning from affected areas (584 cases reported in the US territories)
- 2 cases acquired through presumed local mosquito-borne transmission in Florida (N=1) and Texas (N=1)
- 3 cases acquired through sexual transmission

For more information on Zika, please visit: https://www.cdc.gov/zika/reporting/2017-case-counts.html

Chikungunya Virus (CHIKV)

Chikungunya virus is transmitted to people by mosquitoes. The most common symptoms of Chikungunya virus infection are fever and joint pain. Other symptoms may include headache, muscle pain, joint swelling, or rash. There is no vaccine to prevent or medicine to treat Chikungunya virus infection. Travelers can protect themselves by preventing mosquito bites. When traveling to countries with Chikungunya virus, use insect repellent, wear long sleeves and pants, and stay in places with air conditioning or that use window and door screens.

Prior to 2006, Chikungunya virus disease was rarely identified in U.S. travelers. From 2006–2013, studies identified an average of 28 people per year in the United States with positive tests for recent chikungunya virus infection (Range 5–65 per year). All were travelers visiting or returning to the United States from affected areas in Asia, Africa, or the Indian Ocean. In late 2013, the first local transmission of Chikungunya virus in the Americas was identified in Caribbean countries and territories. Beginning in 2014, Chikungunya virus disease cases were reported among U.S. travelers returning from affected areas in the Americas and local transmission was identified in Florida, Puerto Rico, and the U.S. Virgin Islands. During 2016, there have been 139 travel-associated but no locally acquired cases reported in the US and 159 locally acquired cases in Puerto Rico. By the end of 2017, there have been 97 travel-associated but no locally acquired cases reported in the US and only 8 locally acquired cases in Puerto Rico.

For more information on Chikungunya Virus please visit: http://www.cdc.gov/chikungunya/index.html

Dengue Virus (DENV)

A continuing arboviral concern in the continental United States is Dengue virus (DENV), also known as "Break bone fever". It was thought that, except for occasional imported cases, Dengue had vanished from the U.S. There were localized outbreaks near the Texas-Mexican border in the late 1990's and in Hawaii in 2000. However, the threat level was raised considerably beginning in 2009 when a New York resident visiting Key West, Florida contracted Dengue. In December 2010, there were 55 confirmed cases of locally-acquired Dengue in Key West. Six cases of locally-acquired Dengue were confirmed in Florida for 2011, four more in 2012 and 20 in 2013. And last November, it was announced that a Long Island (NY) man, who had not traveled in the previous months, contracted Dengue. The suspected vector was *Ae. albopictus*, recently becoming established on Long Island.

Containment of DENV transmission is not easily accomplished when at the same time there are concurrent imported cases of Dengue (infections of patients when traveling outside the US and returning ill); there were 133 imported Dengue cases in the US in 2011, 100 more in 2012, and 519 in 36 states in 2013.

DENV is the greatest mosquito-borne virus circulating in the world today, affecting anywhere from 50 to 100 million people annually in about 100 countries. If *Ae*. *albopictus* becomes established in Massachusetts, it can acquire DENV from an infected returning traveler, and transmit the virus locally, causing a public health havoc. Symptoms of Dengue include high fever, severe headache, severe pain behind the eyes, joint pain, muscle and bone pain, rash, and mild bleeding. A more dangerous manifestation, frequently when there have been multiple dengue episodes in an individual, is Dengue hemorrhagic fever. After the fever declines, there is persistent vomiting, severe abdominal pain, and difficulty in breathing. This can be followed by excessive bleeding into the body cavities leading to circulatory failure and shock, followed by death. There is no medication for the prevention or treatment of Dengue.

For more information on Dengue Virus please visit: https://www.cdc.gov/dengue/index.html

2018 Massachusetts State Arbovirus Summary

WNV and EEE MA State Virus Surveillance Summary Results contained in this report reflect data inclusive of MMWR Week 45, November 5, 2018

Mosquito Surveillance – Cumulative 2018	
Number of Mosquito Samples Tested	5921
Number of WNV Positive Samples	579
Number of EEE Positive Samples	2
Equine/Mammal Surveillance – Cumulative 2018	
Number of Mammal Specimens Tested	14
Number of WNV Positive Horses	2
Number of other WNV Positive Animals (Alpaca)	1
Number of EEE Positive Horses	1
Number of other EEE Positive Animals (Turkey)	1
Human Surveillance - Cumulative 2018	
Number of Human Specimens Tested	434
Number of Human WNV Cases	49
Number of Human EEE Cases	0

	Total number of positive WNV mosquito batches (positive WNV human cases)	
Year	Statewide	NEMMC District
2000	4 (0)	0 (0)
2001	25 (3)	4 (0)
2002	68 (23)	14 (3)
2003	48 (17)	2 (0)
2004	15 (0)	4 (0)
2005	99 (6)	11 (0)
2006	43 (3)	5 (0)
2007	65 (6)	15 (0)
2008	135 (1)	10 (0)
2009	26 (0)	2 (0)
2010	121 (7)	21 (1)
2011	275 (6)	58 (1)
2012	307 (33)	48 (0)
2013	335 (8)	77 (2)
2014	56 (6)	7 (1)
2015	164 (10)	8 (1)
2016	189 (17)	39 (1)
2017	290 (6)	28 (0)
2018	**579 (49)**	**18 (9)**
Totals	**2,844 (199)**	**371 (19)**

2018 District Mosquito & Arbovirus Surveillance Summary

<u>18 WNV positive mosquito batches identified in the Northeast District during 2018</u>

- 11 municipalities had WNV positive mosquito isolates
- 547 total mosquito batches were sent to the MDPH Lab, 18 mosquito batches were WNV positive (3.3%)
- 9 WNV positives were in primary vector bird feeder species (*Cx. pipiens/restuans*)
- 9 WNV positives were in bridge vector bird/mammal feeder species (*Cx. salinarius*)
- 9 WNV human cases were identified in 8 municipalities in the northeast district during 2018
- 16 supplemental traps were placed in the district following WNV mosquito isolations

- First positive WNV mosquito in the northeast district: Lynnfield- July 17th
- Greatest number of adult female mosquito collections occurred during the 1st week of July
- Last positive WNV mosquitoes in the northeast district: Wenham- September 17th

- No EEE isolations in the district for 2018
- No EEE human/animal cases in the district for 2018

Detections of West Nile (WNV) and Eastern Equine Encephalitis (EEE) viruses in infected mosquitoes in Northeast Massachusetts Mosquito Control District from 2002 through 2018.

Year	Number of pools* Submitted for Testing	WNV Positive Batches No.	WNV Positive Batches Percentage	EEE Positive Batches No.	EEE Positive Batches Percentage
2002	740	14	1.9	0	0.0
2003	646	2	0.3	0	0.0
2004	604	4	0.7	0	0.0
2005	870	11	1.3	2	0.3
2006	1,181	5	0.4	11	0.9
2007	850	16	1.9	0	0.0
2008	774	10	1.3	0	0.0
2009	567	2	0.4	13	2.3
2010	714	21	2.9	0	0.0
2011	1,009	58	5.7	0	0.0
2012	1,039	48	4.6	14	1.3
2013	1,315	77	5.9	4	0.3
2014	804	7	0.9	2	0.2
2015	541	9	1.7	0	0.0
2016	1,324	39	2.9	0	0.0
2017	596	28	4.7	0	0.0
2018	**547**	**18**	**3.3**	**0**	**0.0**

* "Pool or batch" is a sample containing from 1 to 50 mosquitoes, all of the same species collected on the same date from the same location later tested by the Massachusetts Department of Public Health.

Red highlighted area denotes years with greater percentage of positive WNV/EEE batches.

CDC CO2/Light traps –WNV/EEE bridge vectors/human biters

- There was a 2% increase in collections in these traps from 2017 to 2018. Due to mid-summer to fall rain events there was an increase in the floodwater species *Ae. vexans* of 89%. *Cq. perturbans* has made a partial recovery from consecutive years of drought with a population increase from 2017 of 39%. Most other targeted species, such as *Cx. salinarius* populations were reduced from last year due to increased larvicide efforts throughout the district.

Gravid Traps- WNV primary vectors/bird biters
(*Cx. pipiens/restuans*)

- There was a 29% decrease in collections in these traps from 2017 to 2018. Early catch basin cleaning and treatments help by reducing *Culex* mosquito populations responsible for potential WNV amplification in birds during the early season and to keep populations of these mosquitoes down during the peak season.

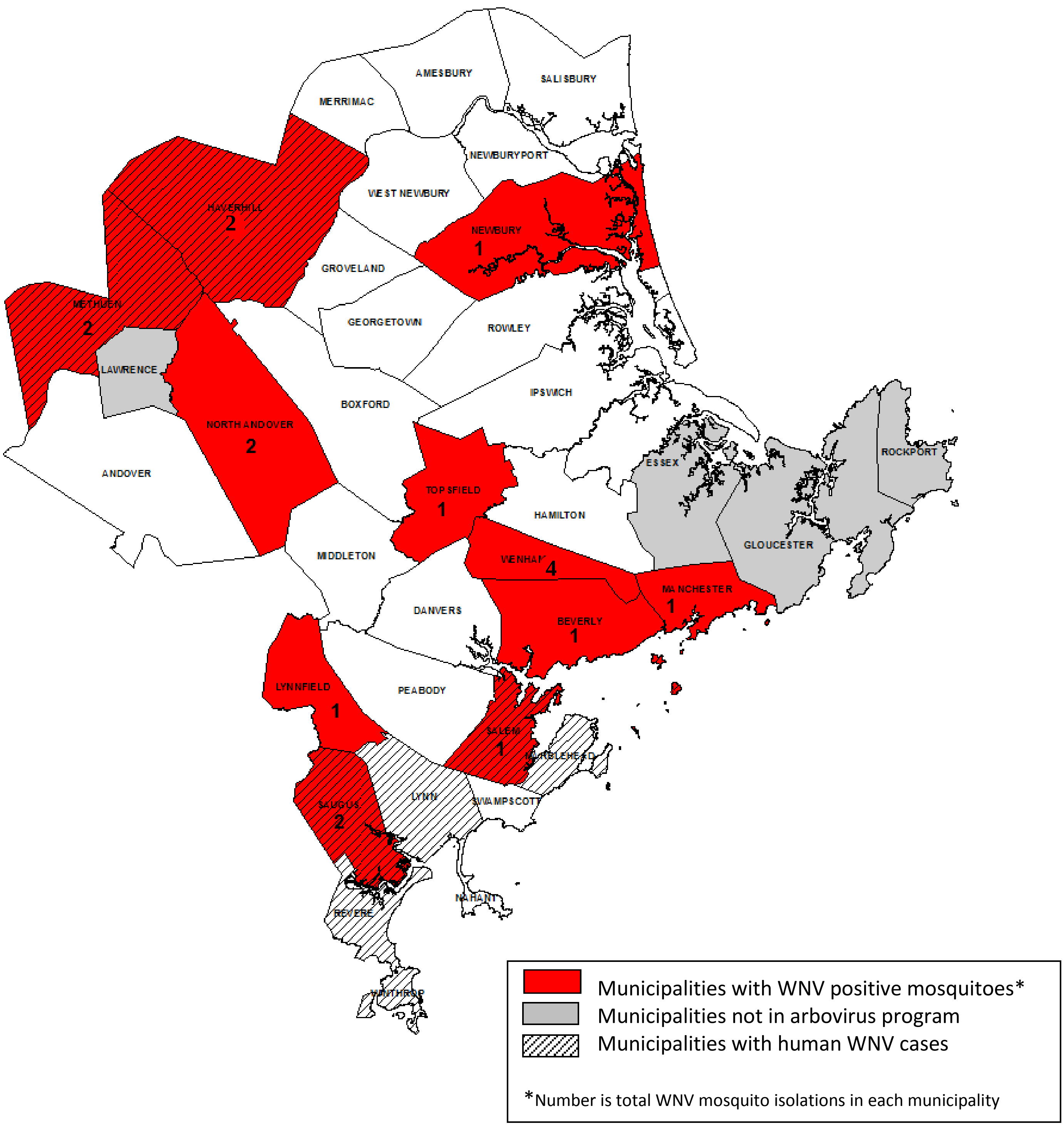
Resting Boxes- EEE primary vectors/bird biters
(*Cs. melanura*)

- 2018 saw a 38% increase in resting box collections. There was a 12% increase in 2017 in the primary vector for EEE, *Cs. melanura,* and 99% increase during 2018. Additional rebounding of *Cs. melanura* populations for 2019 will depend on future precipitation and groundwater conditions through the winter in the species hummock/crypt habitat.

Total Mosquito Collected by NE Mosquito Control District	**2017**	**2018**
Supplemental Traps	2,107	1,528
Resting Boxes	1,169	1,608
CDC CO2/Light traps	43,209	44,162
Gravid Traps	3,382	2,408
Pest and Medically Important Mosquito Species (habitat)*	**2017**	**2018**
Culiseta melanura (red maple /acid bog/sphagnum swamp)	539	1,072
Culex pipiens (container/catch basins)	2,129	1,365
Culex restuans (container/catch basins)	937	374
Culex salinarius (brackish water/*Phragmites*/roadside ditches)	9,618	2,527
Coquillettidia perturbans (cattail/*Phragmites*)	19,705	27,474
Aedes vexans (rainwater/fresh floodwater)	430	813
Aedes japonicus (tree hole/container breeder)	469	501
Aedes sollicitans (salt marsh)	872	932
Aedes cantator (salt marsh)	5,349	5,848
Aedes canadensis (spring/summer woodland pool)	2,675	1,109

*Combined total of mosquitoes collected in Resting boxes, CDC/CO2 Light traps and Gravid traps only, supplemental traps are not included in this total.

Figure 19. NE MA Mosquito Control District municipalities reporting WNV isolations in 2018



Positive Virus Events in the NE Massachusetts District (mosquitoes) - 2018

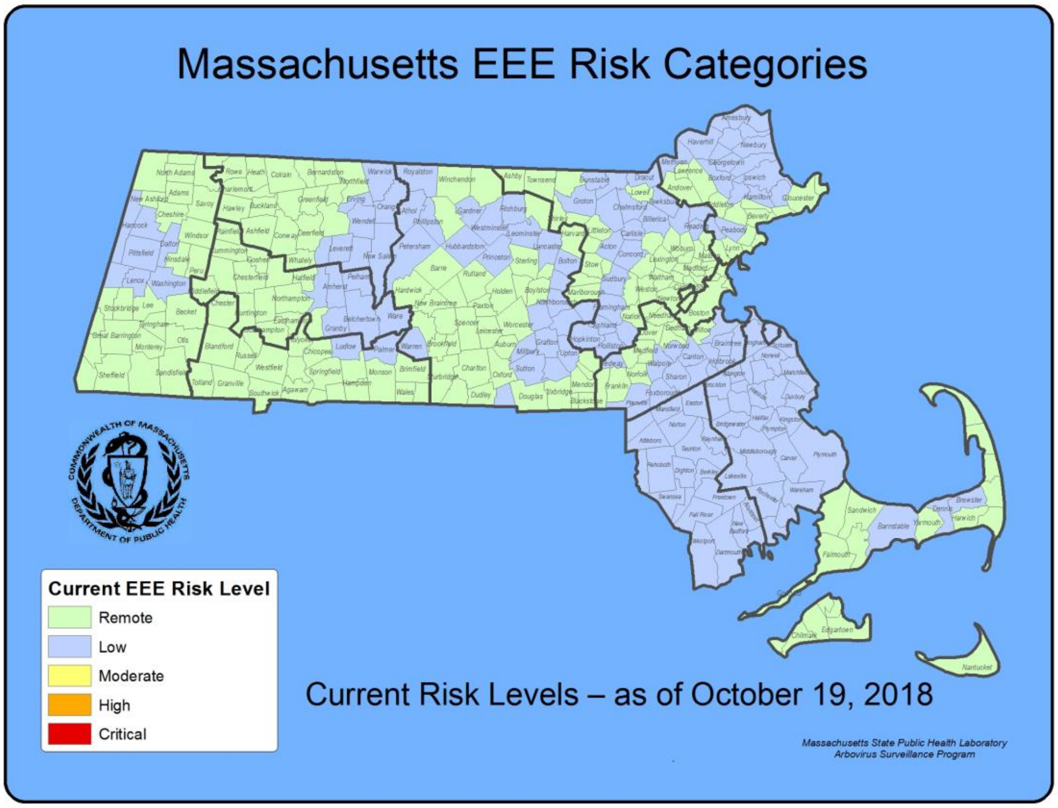
7/17/2018	Lynnfield	Essex	WNV	*Culex pipiens/restuans complex*
8/13/2018	Newbury	Essex	WNV	*Culex salinarius*
8/27/2018	Beverly	Essex	WNV	*Culex pipiens*
8/27/2018	Wenham	Essex	WNV	*Culex salinarius*
8/28/2018	Methuen	Essex	WNV	*Culex salinarius*
8/28/2018	Methuen	Essex	WNV	*Culex pipiens*
8/28/2018	North Andover	Essex	WNV	*Culex pipiens*
9/4/2018	Haverhill	Essex	WNV	*Culex pipiens/restuans complex*
9/4/2018	Manchester-by-the-Sea	Essex	WNV	*Culex salinarius*
9/4/2018	North Andover	Essex	WNV	*Culex pipiens*
9/4/2018	Topsfield	Essex	WNV	*Culex salinarius*
9/4/2018	Wenham	Essex	WNV	*Culex salinarius*
9/4/2018	Wenham	Essex	WNV	*Culex salinarius*
9/5/2018	Salem	Essex	WNV	*Culex pipiens*
9/5/2018	Saugus	Essex	WNV	*Culex pipiens*
9/10/2018	Saugus	Essex	WNV	*Culex salinarius*
9/11/2018	Haverhill	Essex	WNV	*Culex pipiens*
9/17/2018	Wenham	Essex	WNV	*Culex salinarius*

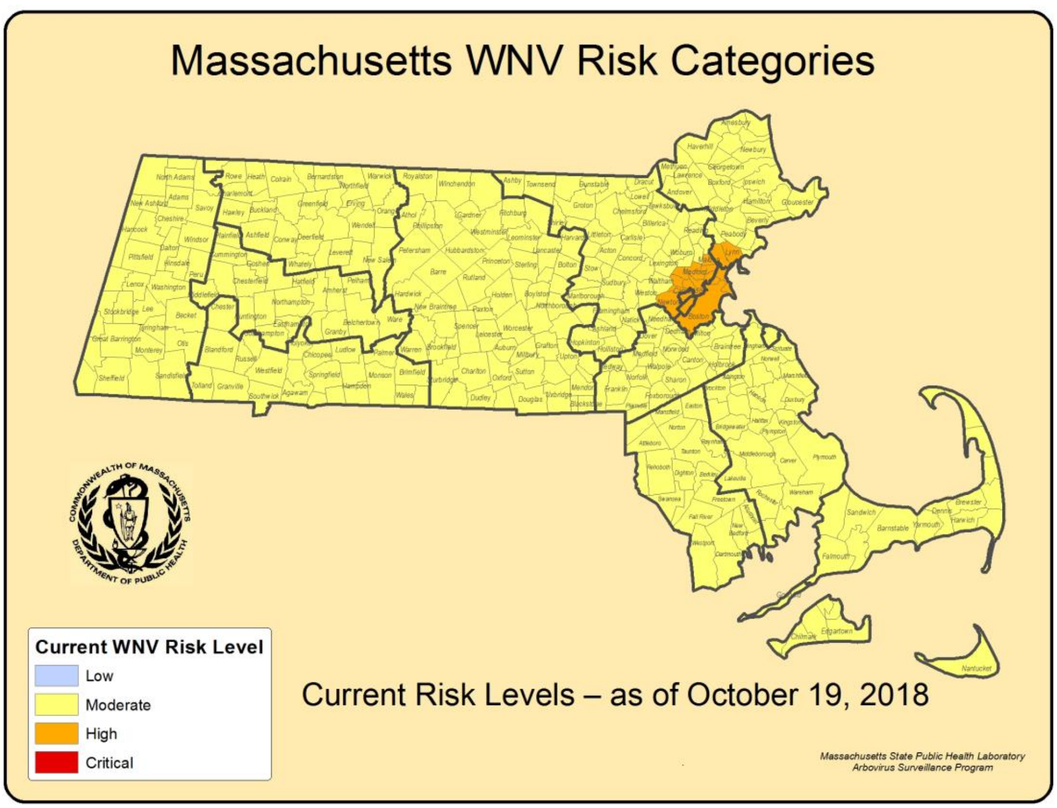
-No Eastern Equine Encephalitis (EEE) identified in NE District in 2018

DHP Risk level changes in NEMMC for 2018 (See risk maps on Page 36):

WNV: MODERATE RISK: The entire state was raised to Moderate Risk on 8/21/2018
WNV: HIGH RISK - Lynn, Revere, Saugus and Winthrop were raised to High Risk on 9/7/2018
EEE: LOW-REMOTE – NEMMC had no risk level changes during 2018

Figure 20. Massachusetts arboviral risk level maps as of October 19th 2018.





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