Commonwealth of Massachusetts

State Reclamation Board

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2010 VECTOR MANAGEMENT PLAN

Introduction: The U.S. Department of Health and Human Services' Centers for Disease Control and Prevention (CDC) declared that the introduction of West Nile Virus (WNV) to the United States in 1999 raised the issue of how prepared are public health agencies to identify and respond quickly to outbreaks of vector-borne disease. The CDC concluded that "mosquito control is the most effective way to prevent transmission of West Nile" and "the most effective and economical way to control mosquitoes is .... through locally funded abatement programs" (1).

Mosquito control projects and districts in Massachusetts, although considered state agencies, are unique in that they are **accountable directly to the subscribing member communities**. As such, the needs and concerns of those communities drive operational policy and strategies. That is the operational "mantra" that has presided over the Northeast Massachusetts Mosquito Control District for almost twenty years. As the needs of our member communities have changed and evolved, so have the services we've provided. With the invasion and establishments of new arthropod-borne viruses ("arboviruses") threatening our communities in the past decade, we have transformed our operational strategy from \ primarily nuisance mosquito control to protecting public health. Consider the World Health Organization (WHO) definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (2). It is not a stretch of the imagination to say that astronomical numbers of mosquitoes affecting quality of life is not only a nuisance, but is in fact a health issue! The Federal Insecticide, Fungicide and Rodenticide Act defines "vector" as "any organism capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury, including mosquitoes..." (3). This make clear that by definition, all mosquitoes are potential vectors and all mosquito control activities are in the interest of public health.

The invasion, transmission, and establishment of arboviruses to the United States is on the increase. WNV is now endemic to northeast Massachusetts and since 2004, Eastern Equine Encephalitis Virus (EEEV) has had an almost annual presence here as well; 2009 marked the most EEEV-mosquito isolations ever in Northeast Massachusetts! According to Dr. Jean-Paul Mutebi of the CDC, there are currently three circulating international arboviruses with the greatest potential of establishing themselves in the US, namely those causing Chikungunya, Rift Valley Fever, and Japanese Encephalitis (4). Mosquito species that can easily spread the

causative viruses are all found in abundance in the US, most of these species are found in New England as well! Therefore, the purpose of this year's Vector Management Plan (VMP), updated for 2010, is to present both our current and revised mosquito and arbovirus surveillance strategies, outline our specific responses to these arboviruses, and how we will direct our limited resources effectively and efficiently toward implementing these responses. We begin first with an overview of our surveillance, focusing on both currently and potentially new invading species, then on potential arboviral threats and finally, our plan for response. Our surveillance and responses specifically to the current circulating arboviruses, WNV and EEEV, are specifically addressed as well.

Regional Adult Mosquito Surveillance: The District will again in 2010 continue its surveillance of mosquito vectors based on protocols established by the CDC and Massachusetts Department of Public Health (DPH). The District's Surveillance Program will again operate and maintain 32 historical trapping stations (HTS) across the region at fixed locations. As done previously, there will be one HTS in each subscribing municipality and each HTS will have two traps. The first is the CO_2-baited "New Jersey trap", designed to attract nearly all species of host-seeking female mosquitoes. All mosquitoes collected are identified and tallied. NJ traps are used to sample the general adult mosquito population to determine dominant human-biting and disease-carrying mosquito species. Because the traps are at the same location every year, population trends can be studied and compared between years as well as during a single year. The other trap is the gravid trap designed to attract bloodfed females that lay their eggs in containers of some sort, either natural or artificial. These traps are baited with aged organic material-filled water to attract primarily ***Culex*** species mosquitoes that are most responsible for West Nile Virus transmission. Gravid traps have been our most successful tool in identifying WNV-infected mosquitoes. Egg-laying mosquitoes have already fed on blood and thus have a higher probability of being infected with WNV they acquired from biting infected birds. Additional portable gravid traps may be deployed, as necessary, in areas with disturbing ***Culex*** population trends and in response to virus activity. The District will collect and identify samples from each trap twice a week from early May through the end of September and all specimens of key vector species (principally from ***Culex*** and ***Culiseta*** species, described below) will be submitted to DPH for virus testing.

In addition for 2010 the District will enhance gravid trap surveillance in communities that have demonstrated a higher risk for WNV. Five additional pre-chosen stations will be established in each of these communities and portable gravid traps will be set there in a random rotation pattern. In the short term, this will provide us with a broader view of ***Culex*** mosquito population distributions and densities in these communities; over the long term, better historical data for background on vector populations and viral activity trends will be recorded.

Resting boxes form our third principal surveillance tool and are an effective tool of monitoring mosquitoes for EEEV. The boxes have proven to be invaluable as an early warning system for viral presence in the District. Since 2004 we have set out between 60 and 80 resting boxes in fixed historic locations in communities immediately bordering southeastern New Hampshire; these are our primary EEEV monitoring stations we call our "EEEV Front Line Surveillance". Southeastern NH is a new epicenter for EEEV and from here, the virus migrates south into our District. ***Culiseta melanura*** mosquitoes are primarily responsible for the transmission and amplification of EEEV in local bird populations.

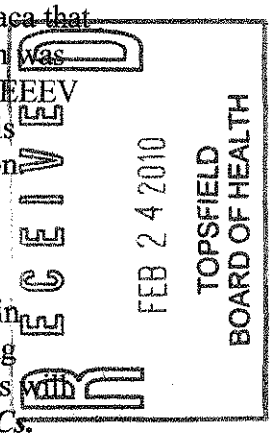
These mosquitoes, especially after bloodfeeding, rest in tree holes and cavities during the heat of the midday and resting boxes are designed to simulate this habitat. This arrangement allows for effective and abundant collecting. How the data collected is interpreted for response is discussed in the EEEV section below.

In 2010, the District will set up again resting boxes in the "Front Line" communities. Eight resting boxes will be placed at each fixed location, with two locations in each of Front Line community with the exception of Salisbury, which will have just one location. Resting boxes will again be visited twice weekly from June through the end of September; the contents will be collected, identified, and tallied, and vector species (***Cs. melanura*** and the closely related ***Cs. morsitans***) will be sent to DPH for virus testing. With the 72 boxes set in the "Front Line" sites, together with the supplemental sites described below with at least another 56 boxes, a total of at least 128 boxes will be used. Additional boxes are ready and sites already selected if resting box surveillance is needed to be expanded.

Last year, in response to the increase in EEEV-infected mosquito pools, additional Resting Box sites were established in eleven communities directly south of the "Front Line", as specified in the 2009 VMP. Collections from these additional sites were made in September. Only one site, Hamilton, had an EEEV isolation in ***Cs. melanura*** and only in one instance, in mid-September. We have planned for 2010 expanded season-long Resting Box surveillance beyond the "Front Line". But because of current budgetary constraints, expanded surveillance will proceed only in three areas with (and adjacent to) recent EEEV activity. These areas are Hamilton-Topsfield-Boxford (one site in each), West Peabody-Lynnfield (up to two sites each), and the Byfield-Newbury (at least one site).

In mid September 2009, a horse died of EEEV in West Peabody. Previous, there was no history of EEEV activity in Peabody or in adjacent towns. However, a week after the horse fatality, the East Middlesex Mosquito Control District recovered EEEV from a pool of mosquitoes collected from Reading, which borders Lynnfield and west of Peabody. Therefore, we will conduct season-long resting box surveillance in West Peabody-Lynnfield.

On December 4, another EEEV animal fatality was announced by DPH. This was an alpaca that lived in the Byfield section of Newbury and died on 14 October 2009. The cause of death was not conclusive at that time and only after repeated tests by the CDC was it confirmed that EEEV had stricken the animal. When and how the animal became infected is not known, but it is assumed that it became ill in September during the height of the EEEV transmission season. Therefore, we will also expand our EEEV surveillance in 2010 to include the Byfield and adjacent areas.



In an attempt to gain an understanding of the "infection status" of other mosquito species in established "EEEV-habitats", beginning in 2010 we will place portable CO_2 traps at resting boxes locations where infected ***Cs. melanura*** mosquitoes have been collected. These traps will collect other species which upon identification, will be sent to DPH for testing. Whereas ***Cs. melanura*** rarely bites humans, they have been biting and infecting local birds which in turn serve as bloodmeal sources for other species which then can bite humans the next time they feed. These additional species with the potential of infecting humans are known as "bridge vectors".

While infected ***Cs. melanura*** specimens have compelled us to take action against them, it may be more prudent to target responses against infected bridge vectors so knowing the "infection status" of bridge vectors in EEEV-known habitats will result in more effective targeted adulticiding responses.

Risk Communications and Public Relations: Access to and effective dissemination of mosquito and arbovirus information is paramount to 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, as well as subscribing municipality residents, are kept correctly informed. To that end, the District has improved its methods of communication regarding mosquito species, potential arboviral threats, and details of larviciding and adulticiding operations. At the end of every winter, the District sends detailed "Best Management Practice Plans" to each District subscribing municipality which includes summaries of the previous year's mosquito and arbovirus activities, descriptions of current year control operations suggested and agreed-upon, as well as their costs. Every spring, the District conducts an "Arbovirus Surveillance Workshop" (at Endicott Park in Danvers), targeted to health agents and Board members of District subscribing communities. This workshop informs the audience on potential arboviral threats and how the District will plan to combat these threats. The District operates a website (http://www.northeastmassmosquito.com) with all relevant information on mosquitoes, arboviruses, and operations (both larvicidal and adulticidal) however, it is difficult to be updated regularly throughout the summer due to obligations by District personnel to the various control operations. Therefore, a "District Bulletin" is prepared periodically and sent electronically to all subscribing Boards of Health describing current mosquito and arboviral problems, both current and potential, as well as information on current control operations. And finally, our phones line remains open at all times and while we are often unable to respond immediately, being that we are all in the field, we return all our ca

Emergent Exotic and Recent Immigrant Mosquito Species: Through our Surveillance Program, we will also be vigilant for the appearance of mosquito species new to the region. Within the past ten years, we have seen the appearance and rapid spread of an exotic species, ***Aëdes japonicus***, the "Japanese Rock Pool Mosquito", throughout our District. While this species is a competent disease vector in other areas, there is little to suggest it is currently a disease vector in the Northeast.

Another competent disease vector that could become established in northeast Massachusetts is the "Asian Tiger Mosquito", ***Aëdes albopictus***. It was first found in Houston in 1985 and has spread rapidly throughout the temperate regions of the world (5), including the U.S. up to southeastern New England; it has become the dominate mosquito species in New Jersey. ***Aë. albopictus*** is the principal vector of a Chikungunya pandemic in countries along the Indian Ocean basin and an outbreak in Northern Italy in 2007. Although this species has yet been readily collected in our district, the possibility of its arrival is very real and its potential as a disease causing agent should not be underestimated.

In 2007 District personnel collected specimens believed to be ***Aë. albopictus*** and targeted surveillance was conducted in 2008 in the attempt to collect additional specimens and possibly locate breeding sites. Towards this endeavor, the District deployed a new type of surveillance trap called the "BG Sentinel trap" (BGS trap). While these traps have been reported being effective in attracting ***Aë. albopictus***, our experience with them was disappointing. Last year, we tested the effectiveness of the BGS traps for our general surveillance, both alone and in

conjunction with our other traps and baits. Again our experience with these traps was disappointing and we have no plans to use these traps in 2010. Instead, we plan to survey for ***Aë. albopictus*** in potential breeding areas, namely those facilities that import and recycle used tires. Gravid traps will be deployed randomly at these facilities and collections will be carefully inspected. Imported used tires were the means by which this species entered the US and facilitated its spread throughout the country. Discarded water-filled tires simulate tree-holes, the natural breeding site for this species, and after eggs are deposited inside the tires, the tires are collected and transported to new locations, they are then again left outside to become filled with water and the eggs subsequently hatch, facilitating the invasion! (5) Therefore, if ***Aë. albopictus*** is to become established in the District, it will most likely be that the "beachhead" will be at recycled tire depositories.

Therefore, the possibility of additional mosquito species establishing in our area, some even more effective at transmitting virus and other disease causing agents, cannot be dismissed. Such ignorance of history and arrogance against reality had led to successful invasions and establishment of exotic species. Thus, our Surveillance Program will carefully monitor mosquitoes we collect, not only to measure unusually high populations or unusual distributions, but also to detect any new species.

Virus Testing: Specimens from our trap collections will be sent weekly to Arbovirus Surveillance Laboratories of the Department of Public Health in Jamaica Plain in Boston, to be tested for the presence of encephalitis viruses. The District was charged last year, for the first time, a fee for each mosquito sample submitted ("pool"), $25 per submitted pool with minimum number of ten individuals in each pool (to a maximum of fifty); we are still limited to sending a maximum of sixty pools per week. And the species to be submitted for testing was restricted primarily to the principal WNV vectors, ***Cx. pipiens*** and ***Cx. restuans***, and the EEEV vectors, ***Cs. melanura*** and ***Cs. morsitans***. However, during suspected peak transmission periods, the District has an agreement with DPH to increase the number of pools, as well as the number of species, including bridge vectors, to be tested.

Emergent Virus: West Nile Virus was introduced to New York City in 1999 and within five years it has spread to all fifty US states! It was first isolated in Massachusetts in 2000 and is now endemic in Northeast MA, specifically the Boston metro area. Prior to 2004 there were no serious concerns about Eastern Equine Encephalitis in the Essex County. Every year since 2004, EEEV-infected mosquitoes have been recovered, often in multiple scores, from southeastern New Hampshire and "spilling over" into our District in two of the past four years. World-wide, the threat of mosquito-borne disease is on the rise and the possible introduction into our District of other exotic vector borne disease can no longer be disregarded and deemed as heresy, but must now be seriously considered.

Earlier in this discussion, three exotic arboviral diseases were listed as having the greatest potential of becoming established in the US in the near future: Chikungunya, Rift Valley Fever, and Japanese Encephalitis. The one generating the most concern is Chikungunya (CHIK). While CHIK is rarely fatal, it has the potential to infect large numbers of people very quickly. It is a debilitating illness, causing excessive and prolonged fatigue and extreme pain in joints lasting up to several weeks. (5,6) In 2005 and 2006 it sickened almost one third of the 800,000 inhabitants of the French island of La Reunion, off the east African coast (7). There is still a CHIK pandemic in countries along the Indian Ocean basin (and with nearly 2 million people infected).

A CHIK epidemic broke out in northern Italy in September of 2007 (with over 200 cases); the Italian epidemic is the first known outbreak of this virus outside the tropics (8). According to Dr. Randy Gaugler, director of the Center for Vector Biology at Rutgers University, it is likely we will have outbreaks of CHIK in the U.S. within the next five years (9).

Rift Valley fever virus (RVF) is a fast-developing ("acute") fever causing mosquito-borne viral disease that affects livestock animals and humans. Whereas many infected persons do not exhibit symptoms, others develop fever, generalized weakness, back pain, dizziness and extreme weight loss at the onset of illness. Some suffer a mild illness with liver abnormalities while a small percentage may suffer hemorrhagic fever (10). Approximately 1% to 10% of affected patients may have some permanent vision loss. Approximately 1% of humans that become infected with RVF die of the disease. There is no established treatment for infected patients and there is neither a cure nor a vaccine currently available.

RVF was first identified in 1931 and has historically been confined primarily in eastern and southern Africa. However, in 2000, there was an outbreak of RVF in the Arabian peninsula and since then, there has been concerns of RVF spreading into North America. The virus is transmitted primarily via floodwater mosquitoes (***Aëdes*** species). While no mosquitoes in RVF endemic regions are found in the US, several common species have been infected experimentally and at least one species found in Massachusetts has demonstrated the ability to infect laboratory animals (11).

Japanese encephalitis virus (JEV) is similar to St. Louis Encephalitis virus and whose infection causes signs and symptoms similar to that of West Nile Virus, namely encephalitis to the minority of human cases which can progress to paralysis, seizures, coma, and death. The case fatality rate averages about 30%. It is the leading cause of encephalitis in Asia (Japan west through Korea, eastern China to India and south through Indonesia to New Guinea) averaging between 30,000 to 50,000 cases annually (12). Although its vector is not found in the United States, several domestic species have shown the capacity to transmit this virus (4).

Through our affiliations and associations with the scientific and mosquito control communities, we will monitor these potential threats. Necessary and appropriate vector/virus intervention measures will continue to be developed and implemented when required.

West Nile Virus

Introduction: According to the CDC, since 1999 WNV has infected 29,584 people killing 1,144 as of 8 December 2009 (13). 12,011 have been inflicted with encephalitis and meningitis, 16,795 have suffered with serious and longer than normal fever, and 778 have manifested other clinical disorders. It was previously thought that WNV-associated neurological ailments were short-lived and affected only a small percentage of those infected. However, recent studies suggest that neurological disorders may be more prolonged and serious, affecting more victims then original thought (14). Another recent study has shown that renal disease can be manifested in patients several years after infection with WNV and thought to have recovered (15). WNV, primarily an avian virus, has been far deadlier for birds with dramatic declines in seven species (16). WNV has had a devastating ecological impact in North America and avian populations have yet to recover.

Culex species are primarily responsible for the amplification of virus in birds and are vectors to humans in endemic areas. Dr. Ted Andreadis of the Connecticut Agriculture Experiment Station, concluded that a WNV vector, ***Culex salinarius*** feed on mammals 55% of the time. This supports an earlier study by his group that suggested that ***Cx. salinarius*** may be the primary vector of WNV in the northeast U.S. (17).

Catch Basin Treatments: While spraying against infected adult mosquitoes is the short-term approach for immediate risk reduction, the preferred long-term and more cost-effective strategy is to eliminate larvae before they become adults. ***Culex*** mosquitoes can develop in a variety of freshwater habitats, but the greatest concentration of ***Culex*** breeding in the District is in the estimated 80,000 catch basins. While ***Cx. salinarius*** can be present in catch basins, this is not its preferred breeding habitat. Instead, the basins are well populated by the two principal urban ***Culex*** mosquitoes, ***Cx. pipiens*** and ***Cx. restuans***. ***Cx. pipiens/restuans*** breed in highly organic or polluted water that collect in artificial containers such as catch basins; they can also breed in storm water structures including detention and retention ponds, as well as discarded tires, gutters, bird baths, etc. With the ability to proliferate in basins to produce massive adult populations, we are confident that these are the principal vectors of WNV in our District, and thus the target of our long-term WNV control strategy.

Treating of catch basins consist of applying either bacteria that are effective towards killing exclusively mosquito larvae or a "growth regulator" that retards or completely ceases their development into adults. Short term surveillance data shows 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 demonstrated a 75% reduction in mosquitoes breeding in treated catch basins compared to untreated basin and that 92% of the species breeding in the basins are ***Cx. pipiens/restuans***; only 5% of mosquitoes tallied in this study were ***Cx. salinarius.***

Contrary to what one would think, drought conditions do not deter breeding of ***Cx. pipiens /restuans*** but instead, may enhance it! In a drought, expansive wetlands dry becoming numerous smaller, shallow pools concentrated with more organic debris, providing ***Culex*** with far more breeding habitats. More importantly, catch basins continue to accumulate water during droughts from car washing, lawn watering and concentrated sheet flow from minor rainfall events, etc. Breeding area are therefore always in abundance, even in the driest of circumstances! This is why human WNV-infections are at their highest during a drought. Targeting ***Culex*** in basins will eventually reduce adult ***Culex*** populations, reduce the transmission of virus from bird-to-bird, reduce the number of infected mosquitoes and ultimately, reduce risk of infection to humans.

Long term surveillance data has shown that the continued annual treatment of basins has gradually and significantly decreased ***Culex*** populations throughout the District. The result is fewer WNV positive mosquitoes when compared to areas bordering our district, as seen in Figures 1 and 2. This translates to reduced risk of infection to District residents. It is for this reason our early-season intervention strategy of treating catch basin has been successful in reducing ***Cx. pipiens/restuans*** populations, and therefore reducing virus amplification in birds and reducing risk to humans. This early-season basin-treatment strategy will continue in 2010.

Catch basin treatments in 2010 will be prioritized as follows. As previously stated, WNV is endemic in the Boston metro area and it is clear that the WNV epicenter in our District is the urban coastal communities of Winthrop, Revere, Lynn, Nahant, Saugus, Swampscott, Marblehead, Salem, and to a lesser degree Danvers and Beverly. The basins in these communities will be treated first, starting in May. Another area of concern is the Merrimack River Valley, specifically Andover and North Andover and basins here will be treated early as well. A WNV isolation in North Andover late last season may indicate a potential for renewed WNV activity in the area in 2010.

Waste Water Treatment Facilities Inspection: An additional "preemptive strategy" to reduce WNV risk, the District will request to inspect all wastewater treatment facilities. This way, actual or potential ***Culex*** breeding can be reduced or eliminated in these facilities. While the District is 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, we are not a regulatory agency. It is not our intention to cause any imposition to the management of wastewater facilities. Rather, we wish to be a resource of information and technology to assist wastewater facility managers to prevent and/or abate mosquito breeding to the mutual benefit of the facility, the community and mosquito control.

Property Inspection: Socioeconomics often plays an important role in mosquito control and associated public health risk. This is evident by a study conducted in California in 2007 in which there was a 276% increase in the number of human WNV cases in association with a 300% increase in home foreclosures (18). Within most foreclosed properties in Bakersfield (Kern County, CA) were neglected swimming pools which led to increased breeding and population increases of ***Cx. pipiens/restuans***.

In recent year we have received several requests from Boards of Health to inspect abandoned properties. The district has had a policy of property inspections, albeit a passive approach, at the requests of Boards of Health. Given the current economic climate and likelihood of increasing properties abandonment (with the potential for increased health risk associated with properties abandonment), the District in 2010 will apply a more aggressive approach to property inspections. In the course of our routine activities in your community, we will be "on the lookout" and report such properties to your Board of Health. We understand that addressing abandoned properties is a matter of time and process. In the long term, we will offer any support that may be appropriate to resolve mosquito problems related to such properties.
In the short term, with the support of the Board of Health, we will implement the necessary control measures to mitigate the immediate mosquito problem associated with such properties.

Selective Ground Adulticiding: As a final preemptive measure, the District may recommend selective and targeted adulticiding applications to reduce ***Culex*** populations when WNV isolations in mosquitoes are discovered. The District uses a system called Ultra Low Volume (ULV) for ground adulticiding applications which dispenses very small amounts of pesticides over a large area. The District may recommend a targeted application within a municipality based on the following criteria: two or more WNV-mosquito isolations in close proximity; one or more human cases of WNV. On occasions, when WNV has yet been recovered but ***Culex*** populations are seen increasing at higher-than-usual rates, we have recommended that adulticiding operations be commenced. These operations would only be recommended only during high WNV-transmission periods (late July through September) in communities with historical WNV activity.

Barrier Treatment: While ULV is a cost-effective means of reducing mosquito populations on a large scale, it only affects those mosquitoes active at the time of the application; repeated applications are sometimes necessary to sustain the initial reduction in some areas. To reduce the need for repeated applications and provide more sustained relief from mosquitoes in high public use areas, the District may recommend a "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), playgrounds, athletic fields, etc. A barrier spray may reduce mosquitoes for up to two or more weeks. The District strongly recommends member municipalities take advantage of this service when offered.

Eastern Equine Encephalitis Virus

Introduction: From what we have experienced over the past five years, EEEV has become a serious public health threat in our area. It is clear that the current EEEV focus is Southern New Hampshire, in particular area including the towns of Exeter, Kingston and Newton. There has been EEEV activity in these towns from the beginning of the current cycle in 2004 to the present; see Figures 3 through 5. Figure 6 is a summary of the combined isolations in the past six years and it can be clearly seen where the "epicenter" of the EEEV is and how the northern portion of our District is in risk to EEEV.

EEEV was first discovered in horses thus, the basis for the name "Equine Encephalitis". This however is a misnomer as horses are not the source of infection, but unsuspected innocent casualties. When it was later discovered that this same virus caused the same type of encephalitis in humans, the horse discovery superseded and the name "equine" stuck. Humans and horses are not sources of infection and are considered "dead end hosts", meaning that the virus cannot be transmitted from infected horses or humans. Like West Nile Virus, EEEV is an avian virus, transmitted from bird to bird principally by the Cedar Swamp mosquito, ***Culiseta melanura***. While ***Cs. melanura*** mosquitoes are primarily responsible the amplification of virus in bird populations, they typically do not bite humans. It is other mosquitoes that feed on both birds and humans, referred to as "bridges vectors", that are responsible for human infections. Nonetheless, it is our judgment that while risks to human from infected ***Cs. melanura*** are extremely low, we will continue to take preemptive protective operations when infected ***Cs. melanura*** are detected. Lack of early intervention activity can result in accelerated EEEV amplification which later in the season can increase human risk to infection.

In last year's VMP it was stated that "we do not anticipate any EEEV activity in our service area in 2009 but we are prepared for any contingence." This prediction was made in part because in areas where EEEV has historically been a problem, its appearances have followed a cyclical pattern. In southeast Massachusetts, EEEV occurs in outbreaks lasting about three years, followed by almost no activity for 15 to 20 years. With little activity in New Hampshire in 2007 and 2008, we assumed that EEEV was in a "dormant" phase and would stay as such for an extended period. In fact EEEV escalated in 2009, demonstrating that the cyclical model used for southeast MA does not yet apply to New Hampshire and northeast MA. The 2009 outbreak also demonstrated the need for continued vigilance in surveillance and readiness to implement preemptive strategies. Beginning in late August and escalating into September there were numerous EEEV isolations in mosquitoes throughout southern New Hampshire cumulating in a human case. EEEV-infected mosquitoes were found in Massachusetts communities bordering New Hampshire in late August through September and appropriate measures, coordinated with

boards of health of these communities, were taken. As describe earlier, a horse died in West Peabody from EEEV and virus was found in mosquitoes in nearby Reading. As there was no previous history of EEEV activity in Peabody and surrounding areas (it was considered to be outside the EEEV risk area), it is more than clear that previously reliable predictive models of EEEV cycles and distribution may no longer apply.

Habitat Surveillance: While predictive models of EEEV cycles and distributions no longer reliable, one consistent observation still valid is that higher populations of ***Cs. melanura*** are a good indicator of EEEV activity. ***Cs. melanura*** is one of only a few mosquitoes that survive ("overwinter") in the larval stage. They develop not in open water, but in flooded root meshes, holes and tunnels ("crypts") under tree hummocks in Atlantic white cedar and red maple swamps. These habitats are relatively abundant in northeast MA, although they are remote, isolated and difficult to access. With greater numbers that usual of ***Cs. melanura*** adults appearing last September, one result was that they laid more eggs in more habitats; more habitats became available thanks to abundant ground water from last summers rains. Hence, there are currently more larvae developing at this time (winter 2009-2010) which, depending on the severity of the winter, could lead to greater adult populations emerging in the spring. A higher that normal spring adult emergence of ***Cs. melanura*** may commence the EEEV transmission cycle earlier than normal and ultimately result in earlier (and more abundant) human infections of EEEV.

Since 2004 when EEEV first became a serious concern in our area, we have been searching for ***Cs. melanura*** habitat in the winter to be monitored. Trying to find ***Cs. melanura*** larvae breeding in crypts in cedar swamps is very much like trying to find a needle in a hay stack; to date we have been unsuccessful in locating such sites with consistency. In the winter of 2009/2010, we will narrow our focus to areas within a one mile radius of resting box location in communities bordering NH. The objective is to find breeding locations associated with each of our resting boxes location from which we can monitor larval populations through the winter and make better projections of what we may happen and what we can do.

Selective Ground Adulticiding: Because of the elusive nature of ***Cs. melanura*** larval breeding habitat in our area, larviciding is not a viable option as a preemptive strategy. Therefore, the District may recommend selective and targeted adulticiding applications to reduce ***Cs. melanura*** populations in an effort to break the bird-to-bird transmission phase of the virus cycle. Often by the time there are horse and human infections, other mosquito species, the "bridge vectors" are also transmitting the virus and are targeted for adulticiding. But it is late in the season when these intervention efforts are made and their effectiveness in reducing risk are limited at best and often nonexistent. The District will recommend a targeted adulticide application in a subscribing municipality (-ities) based on the following criteria: above average ***Cs. melanura*** populations in a year of anticipated EEEV activity; one or more EEEV isolations in ***Cs. melanura*** mosquitoes; one or more EEE virus isolations in horses; one or more human EEE cases. As with WNV intervention, the District uses Ultra Low Volume (ULV) for ground adulticiding applications.

Barrier Treatment: While ULV is a cost-effective means of reducing mosquito populations on a large scale, it only affects those mosquitoes active at the time of the application; repeated applications are sometimes necessary to sustain the initial reduction in some areas. To reduce the need for repeated applications and provide more sustained relief from mosquitoes in high public use areas, the District may recommend a "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), playgrounds, athletic fields, etc. A barrier spray may reduce mosquitoes for up to two or more weeks. The District strongly recommends member municipalities take advantage of this service when offered.

Emergency Response Aerial Adulticiding Plan: In the event that the risk level escalates to a point that ground adulticiding is insufficient to reduce that risk, an emergency aerial adulticiding application may be warranted. To be implemented, it would require a consensus of the District, the State Reclamation and Mosquito Control Board (SRB), the Massachusetts Department of Health, an independent advisory board and a declaration of a Public Health Emergency from the Governor.

Typically, once the decision is made, the need for action is immediate and the window of opportunity is short. It is imperative that the complex logistics of executing the application are already in place. There are four components to this plan; 1) Global Positioning Satellite (GPS) mapping; 2) Securing airport facilities and use; 3) Availability of aircraft and pesticides; 4) Last but not least, availability of necessary funds.

1. The District has in place and continually revises a Global Positioning Satellite (GPS) mapping program that designates areas to be excluded from an aerial adulticide operation, such as reservoirs, endangered species areas, etc. The areas to be sprayed would be determined by the current mosquito and risk data and circumstances; the GPS program would be supplemented immediately prior to the operation. This data can be quickly downloaded into an aircraft's navigation system to direct the aircraft and pilot to areas to be sprayed and areas to be avoided.

2. The District has in place and annually revises a "Memorandum of Understanding" (MOU) with the Lawrence and Beverly Airports. In the event an aerial adulticiding application is necessary, Lawrence airport would be closest to the likely target area. In the event Lawrence airport is unavailable or the target area has broadened, then Beverly Airport would be used.

3. Through the state's procurement program, contracts are in place for the acquirement of aircraft and pesticides. If events warrant, the District will communicate with aircraft and pesticide contractors to inform them that an aerial adulticiding application may be necessary and equipment and materials are to be made available for our use.

4. The District has resources in its stabilization fund to conduct an aerial adulticiding application in the communities bordering the New Hampshire most likely to be treated to contain EEEV spread. In the event further applications are needed, additional funding would be necessary.

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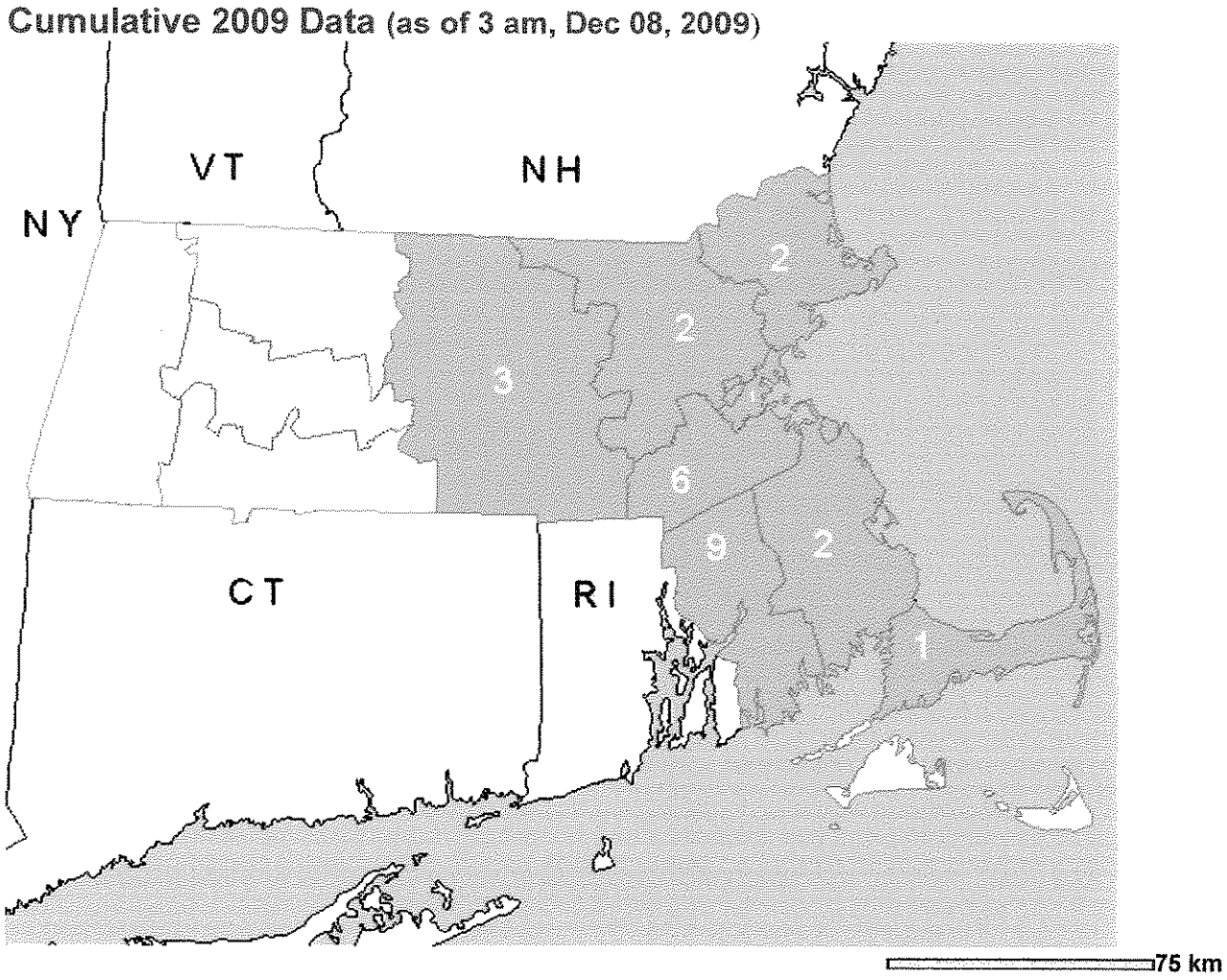
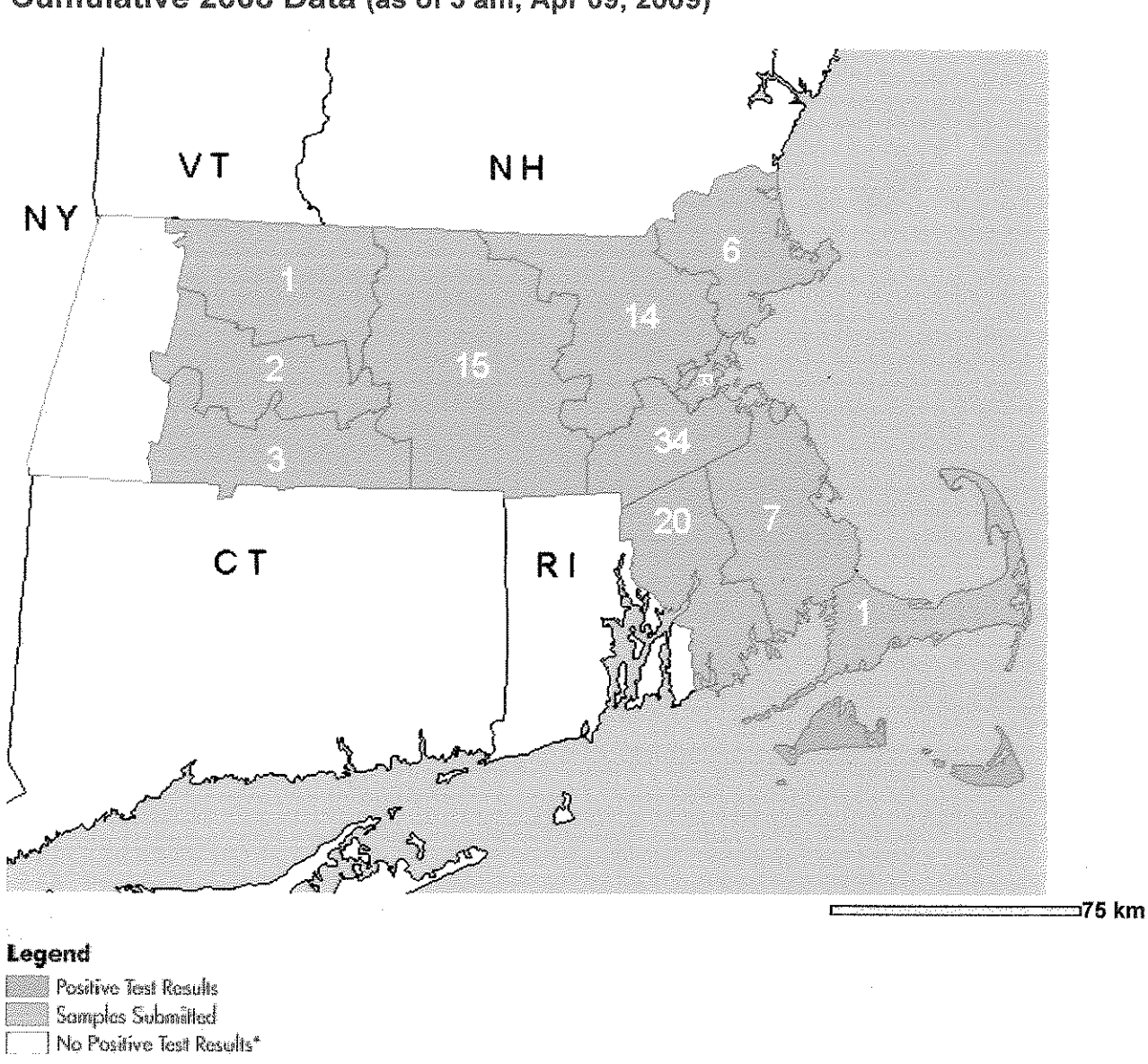
Figure 1. West Nile Virus-infected mosquito pool reports in Massachusetts in 2009.



Note: Number of pools submitted for testing are not the same for each MCP; map reflects positive pools at the county level but MCP are not exclusive for each county (e.g., NE MA Mosquito Control includes most towns in Essex county and Revere and Winthrop which are in Suffolk county).

Compiled by U.S. Geological Survey (http://diseasemaps.usgs.gov/index.html)

Figure 2. West Nile Virus-infected mosquito pool reports in Massachusetts in 2008.



Note: Number of pools submitted for testing are not the same for each MCP; map reflects positive pools at the county level but MCP are not exclusive for each county (e.g., NE MA Mosquito Control includes most towns in Essex county and Revere and Winthrop which are in Suffolk county).

Compiled by U.S. Geological Survey (http://diseasemaps.usgs.gov/index.html)

Figure 3. Combined Eastern Equine Encephalitis virus infection reports (infected mosquito pools, animal and human cases) in southeast NH and northeast MA from 2004 through 2006.

Figure 4. Combined Eastern Equine Encephalitis virus infection reports (infected mosquito pools, animal and human cases) in southeast NH in 2007 and 2008; there were no EEEV reports in northeast MA during these years.

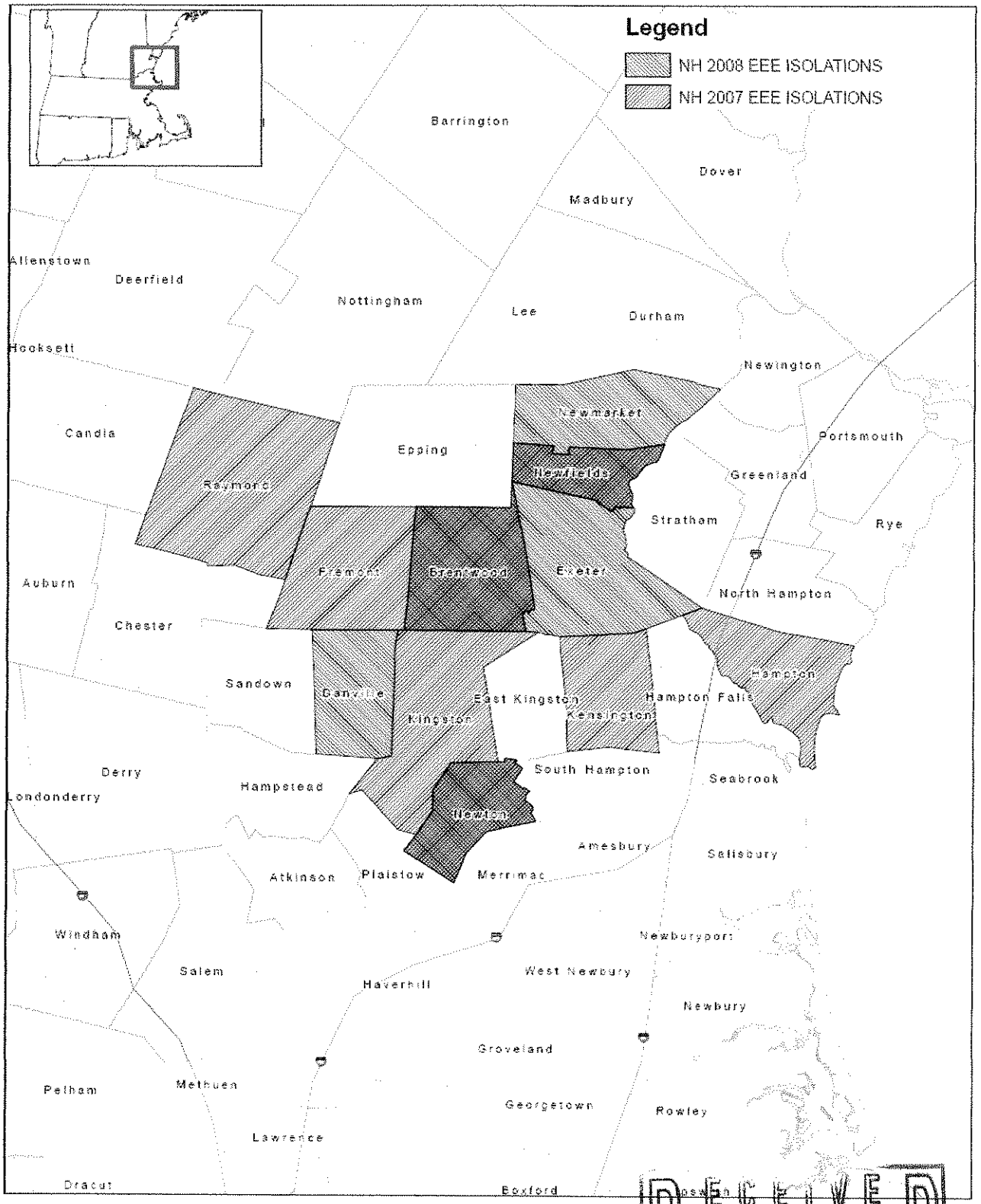


Figure 5. Combined Eastern Equine Encephalitis virus infection reports (infected mosquito pools, animal and human cases) in southeast NH and northeast MA in 2009.

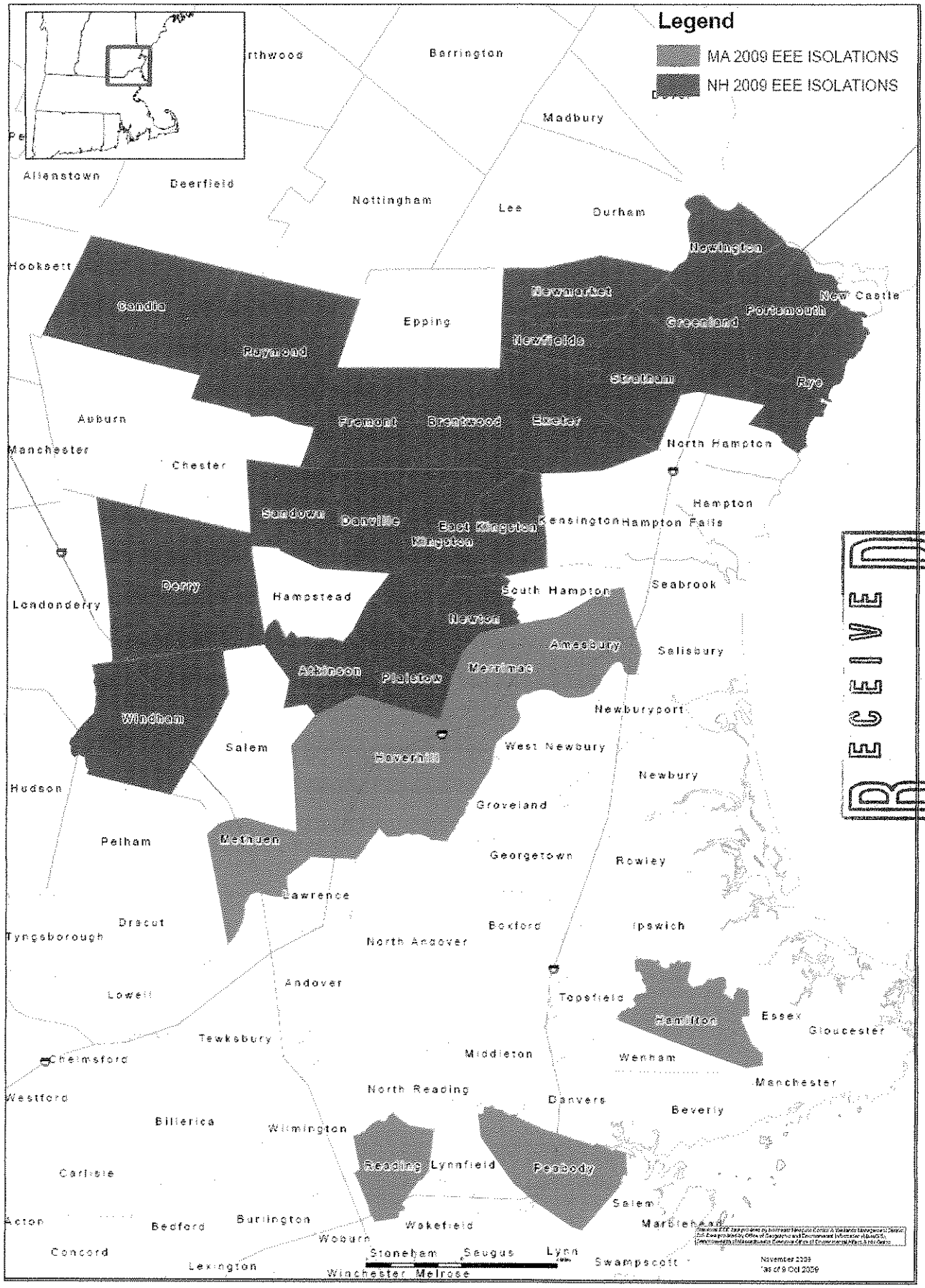


Figure 6. Combined annual Eastern Equine Encephalitis virus infection reports (infected mosquito pools, animal and human cases) in southeast NH and northeast MA communities with more than three annual reports from 2004 through 2009.