Efficacy of Select Arbovirus Response Interventions of 2012 Season

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ABSTRACT

By the end of the 2012 season, the Central Mass. Mosquito Control Project (CMMCP) had collected a total of 75 positive virus isolations of both EEE & WNV from mosquito samples in CMMCP surveillance traps. These findings were widespread in the service area, involving 31 of 40 member towns. In response to each of these isolations, additional surveillance and intervention recommendations were coordinated with local boards of health and other town officials. Due to the tremendous volume and frequency of virus findings in our district and statewide, organized efficacy trials eventually became limited to available resources. The efficacy of several such interventions has been investigated to ensure proper level of control. The success of these applications is vital in helping to reduce the public health risk for local residents of acquiring arboviruses such as West Nile virus (WNV) and Eastern Equine Encephalitis (EEE). Investigated interventions produced an overall reduction above 65% despite a degree of suspected new emergence. Importantly, the local populations of *Coquillettidia perturbans* and *Culex*, whose infections helped initiate these public health responses, were lowered 81.1% and 59.8% respectively.

INTRODUCTION

Following the 2011 season in which CMMCP found 26 positive mosquito samples (21 WNV, 5 EEE), the 2012 season resulted in 75 total isolations (65 WNV, 10 EEE). Not only was there a tremendous increase in the level of virus activity in the CMMCP service area, but it was also quite vast spatially being found in 31 of 40 member cities and towns. The majority of virus isolations were found in *Culex* mosquitoes, although there were several positive collections of mammal-biting species such as *Coquillettidia perturbans* and *Aedes vexans* (Central Massachusetts Mosquito Control Project, 2012).

Upon confirmation of positive mosquito samples, CMMCP begins coordinating with the particular municipality regarding potential response activities that may be conducted to reduce the likelihood of mosquito-borne disease transmission to local residents. These activities can include

increased mosquito surveillance at the positive trap site and surrounding area, as well as local larval and adult mosquito control applications. Press releases in local media and additional public health education can also take place to increase awareness and encourage residents to take simple personal protection measures to reduce risk.

If it is determined that an adulticide application is the proper course of action, a perimeter is designated around the positive trap site location for treatment. Streets within this perimeter are included in the application, while any exclusion areas are highlighted for these spray applications. These proposed application areas are mapped and posted for officials and local residents along with the potential treatment times. Unlike residential adulticide applications, these arbovirus response treatments cover a larger area and may use higher application rates to further lower mosquito-borne disease risk to the public. The product used during the 2012 season was ANVIL® 10+10 (Clarke Mosquito Control Products, Inc., Roselle, IL) (EPA Reg. No. 1021-1688-8329), a synthetic pyrethroid composed of 10% SUMITHRIN® (Sumitomo Chemical Company, Ltd., Osaka, Japan)(d-phenothrin) and 10% piperonyl butoxide (Clarke Mosquito Control Products, Inc., n.d.). The efficacy of these interventions is of utmost importance to CMMCP, as this tool's ability to reduce risk of mosquito-borne disease cannot be compromised.

METHODS

A traditional method to gauge the level of control achieved from one of these arbovirus treatments is to compare the surveillance data obtained prior to the event along with collections conducted after the application. The use of local trapping data from outside the treatment area can also provide additional indication of control level. This collective surveillance can give us a picture of how effective the intervention was, along with noting any generational changes in specimens. Newly emerged mosquitoes following an application would not indicate an ineffective intervention as they would have been unavailable for exposure. With 75 virus isolations in 2012, there were numerous arbovirus response treatments, but this tremendous volume hampered the ability of CMMCP to examine every event. Described here are six response applications from late July and early August 2012.

The first highlighted 2012 intervention occurred July 30th in the town of Westborough. Following the identification of Eastern Equine Encephalitis positive *Culex* mosquitoes collected on July 17th, a coordinated adulticide application was discussed and organized for the area surrounding the positive collection. CMMCP responded by also establishing supplemental local trap sites for the area. A post-treatment surveillance trap was set on July 31st, and collected the next day. This trap data was used in conjunction with a similar trap

collection from the same location on July 27th.

The second intervention described is from the town of Shrewsbury, occurring the evening of July 31st. West Nile virus had been isolated from a gravid trap collection of *Culex* mosquitoes on July 18th. CMMCP responded by performing additional mosquito surveillance and conducting the adulticide application of the area surrounding the positive collection. The post-treatment surveillance trap was set the following day, and collected after one evening. A collection from July 27th was used as the corresponding collection for efficacy evaluation.

The day after the Shrewsbury application another coordinated control response was conducted, this in the town of Tewksbury. West Nile virus had been isolated from a Tewksbury gravid trap collection of *Culex* mosquitoes on July 20th, which led to CMMCP establishing additional local trap sites and conducting an adulticide application on August 1st of the area surrounding the positive collection. To gauge the efficacy of the intervention, a surveillance trap was setup prior to and following the application. These traps were collected on July 31st and August 3rd and used to evaluate the level of control.

On August 2nd there were two separate arbovirus response applications. One of these interventions was in town of Chelmsford, prompted by an isolation of West Nile virus from a gravid trap collection of *Culex* mosquitoes on July 25th. CMMCP responded by again establishing additional local trap sites, while also conducting an adulticide application on August 2nd of the area surrounding the positive collection. The pre-treatment surveillance for this event was conducted on August 1st, while the corresponding collection occurred on August 6th.

The second application on August 2nd, in the town of Westborough, was also the town's second of the season. Although local mosquito populations in Westborough were reduced following the July 30th area adulticide application, West Nile virus and Eastern Equine Encephalitis were isolated from a gravid trap and a CDC trap collection later on July 31st and August 2nd respectively. The West Nile virus isolation was in *Culex* mosquitoes, while the isolation of Eastern Equine Encephalitis was in *Culiseta melanura*. Due to these new findings, additional mosquito collections were made and the second adulticide application of the area surrounding the positive collections was performed. As with Chelmsford, pre-treatment surveillance for this intervention occurred on August 1st, but alternatively the second collection for Westborough occurred on August 7th.

The final examined intervention took place on August 6th in the town of Westford in response to West Nile virus being isolated from a gravid trap collection of *Culex* mosquitoes on July 25th. After this finding, CMMCP once again established

additional local trap sites in addition to the adulticide application. A pre-treatment surveillance trap was set on August 2nd, while a collection from August 7th was used in conjunction for efficacy evaluation.

RESULTS

The surveillance data surrounding the July 30th response application in Westborough showed tremendous control. The pre-intervention surveillance collection was comprised of 103 specimens, while the post-application collection only contained 2 specimens (~98% reduction) (Figure 1). This application lowered both the *Culex* population, which harbored the initial Eastern Equine Encephalitis isolation, as well as several mammal-biting mosquito species, from the time of the virus isolation as well as the week prior.

The post-application trap collections from Shrewsbury indicate that the local mosquito population was lowered from the time of the virus isolation as well as the week prior. Surveillance from prior to the July 31st intervention exhibited a significant population present with 487 specimens. An overall reduction of approximately 72% was observed with specific reductions of 63% and 83% in the *Culex* and *Coquillettidia perturbans* (mammal-biting) species respectively (Figure 1). A positive West Nile virus isolation of *Culex* mosquitoes is what prompted the control activity.

The post-application trap collections from Tewksbury suggest that the overall mosquito population lowered from the time of the initial virus isolation. The pre-application population figures were not overly impressive, but were reduced nonetheless from the August 1st application. Comparable traps indicate that the local mosquito population has been lowered approximately 42% following the spray event (Figure 1). Also of note is the reduction in *Coquillettidia perturbans* mosquitoes of approximately 65% post-spray.

The overall mosquito population in Chelmsford was lowered from the time of the virus isolation according to the post-application trap collections. Comparable traps indicate that the local mosquito population was lowered approximately 32% following the August 2nd spray event (Figure 1). Also of note is the reduction in *Coquillettidia perturbans* mosquitoes of approximately 78% post-spray. The type of mosquito that the West Nile virus isolation was initially found in, *Culex*, also had a significant decrease of 94% following the spray event.

The second Westborough area adulticide application, which took place on August 2nd, further reduced the local mosquito population. The reduction was not as significant for this intervention as the initial. The post-application trap collections from this area indicate that the overall mosquito population was lowered approximately 40%, with *Coquillettidia perturbans* mosquitoes being decreased approximately 67% from the time of the virus isolations

to following the second application (Figure 1).

Finally, the post-application trap collections from the August 6th Westford application indicate that the overall mosquito population was lowered from the time of the initial virus isolation. Comparable traps indicate that the local mosquito population has been lowered approximately 79% following the spray event (Figure 1). Also of note is the reduction in *Coquillettidia perturbans* mosquitoes of approximately 81% post-spray. The type of mosquito that the West Nile virus isolation was initially found in, *Culex*, also had a decrease of 50% following the spray event.

The cumulative control achieved through these six interventions was over 65%, indicated from surveillance collections prior to the interventions and those conducted soon afterwards. Overall, these interventions resulted in specific *Coquillettidia perturbans* and *Culex* reductions of 81.1% and 59.8% respectively. The corresponding local mosquito collections from outside the application areas showed relatively stable mosquito populations surrounding the interventions. This further reinforces the level of control achieved through these coordinated responses to mosquito-borne disease.

DISCUSSION

Following the isolation of mosquito-borne disease, CMMCP coordinates with local boards of health and other town officials to determine the proper course of action to reduce risk for area residents. If consensus for an adulticide application is reached, the proposed treatment area is developed, the public is notified, other authorizations are obtained, and the intervention is conducted. During the 2012 season 66 such events took place across the CMMCP service area. Surveillance conducted around these applications was performed to gauge efficacy. The intensity and frequency of virus isolations limited the ability of CMMCP to monitor every event, but when resources permitted, proper control was shown as a result of these response applications.

Variation in level of control among interventions is expected and can be attributed to a several factors including differences in weather conditions at application, local mosquito habitat, application coverage variations, population dynamics, and reinfestation from neighboring areas (Curtis 1996; Efird 1991; Mount 1998). Despite these potential obstacles, the interventions examined here exhibited a range of control level over 65% with individual reductions of approximately 81.1% and 59.8% in *Coquillettidia perturbans* and *Culex*. In conclusion, interventions such as these assist in the reduction of risk for local residents in acquiring mosquito-borne disease such as West Nile virus and Eastern Equine Encephalitis. CMMCP will continue to monitor the efficacy of these arbovirus response events to ensure proper control is achieved.

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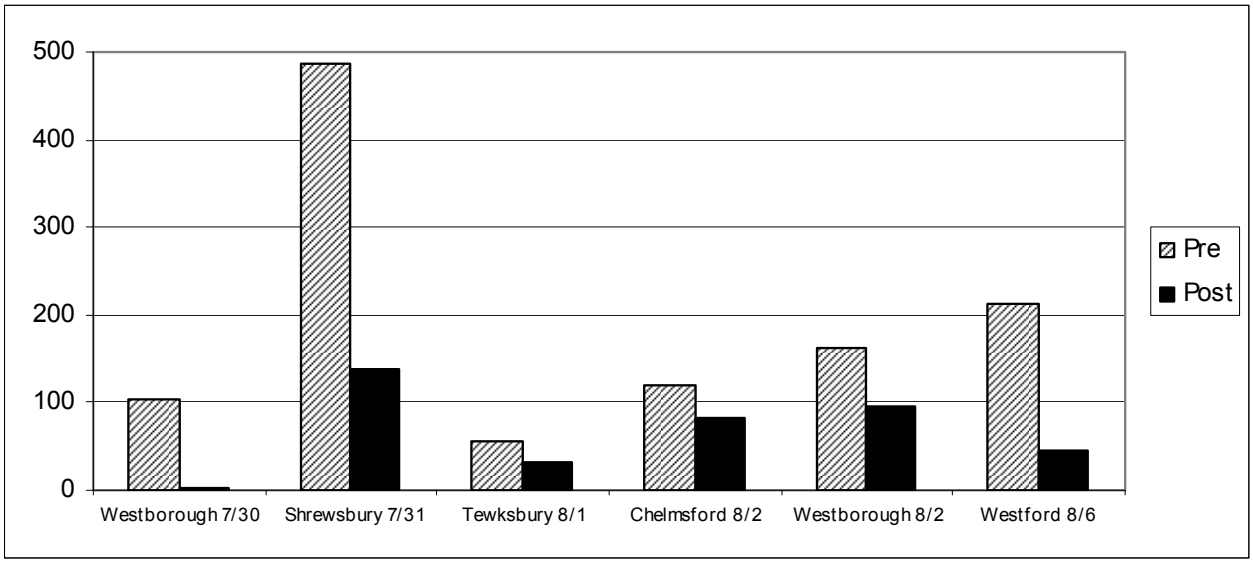

Figure 1: Mosquito Collections around Select Interventions