Efficacy Trials of the Central Massachusetts Mosquito Control Project Adulticide Program - 2011

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ABSTRACT

During the summer of 2011, the Central Mass. Mosquito Control Project (CMMCP) conducted field trials for the efficacy of their current adulticide product and procedure. By observing natural mosquito populations before and after adulticide applications at treatment and control sites, it was determined that the current protocol results in adequate control before eventually returning to pre-application levels. These findings are believed to be influenced by the low residual nature of the product used for control and repopulation by neighboring mosquito populations. New mosquito emergence is a factor although less influential than the simple migration. These results are consistent with previous efficacy trials conducted by CMMCP. Despite these findings, the application rates are considered sufficient at this time, although changes in insecticide application rates and target areas size could increase the efficacy of this program when responding to mosquito-borne disease.

INTRODUCTION

At the forefront of any vector control operation should be the efficacy of their practices. As one of several tools in any mosquito control project's integrated mosquito management (IMM) plan, adulticide applications are no different (Crockett 2002). Like many mosquito control projects, CMMCP uses ultra-low volume (ULV) application machines, which allow for the use of micron-level insecticide droplets (Mount 1998). Currently CMMCP uses 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 (PBO)(Center for Disease Control and Prevention 2002; PHEREC 2001).

During the 2011 season, CMMCP applied ANVIL® 10+10 at a flow rate of 1.9oz/min at 15mph, which results in the application of .0012lbs of active ingredient per acre. This is the lowest active ingredient rate available on the product label (CMMCP 2012). In order to maintain proper application equipment standards, CMMCP conducts a ULV Sprayer Maintenance and

Calibration Program as detailed in its Standard Operating Procedures Manual. This program involves the periodic testing of droplet size and flow rate calibration, and well as other maintenance for the ULV machines such as spray head flushing and ultrasonic cleaning.

Efficacy trials of the past tend to use caged mosquitoes over natural populations because of their rapid, economical, and more standardized results. Despite these differences, studies have shown that the percent reduction of caged mosquitoes is the same as the reduction of the natural populations (Mount 1998). Any poor results of a ULV application could be caused by an ineffective insecticide dosage, mosquito resistance to that insecticide, unfavorable weather conditions, reduced target coverage due to dense vegetation, or quick repopulation of the area (Curtis 1996; Efird 1991; Mount 1998).

In recent years, mosquito insecticide resistance has been observed in areas domestically, as well as internationally. Routine resistance surveillance is needed to ensure that resistance is not impacting the efficacy of local ULV applications (Brogdon 1998). CMMCP has been conducting resistance surveillance for several years and the results indicate that resistance to the current insecticides is not an issue with the mosquito populations in the CMMCP service area (Cornine 2009).

Weather conditions can also have a great impact on the effectiveness of an ULV application. Important factors include wind direction and velocity, temperature and temperature gradients (Mount 1998). Wind direction and velocity are important in that they are needed to create the drift for the adulticide across the target area. Velocities of 1-7mph are ideal with gusts of no more than 11mph. Ambient temperatures are important to the efficacy of ULV applications in that they influence mosquito activity as well as possibly compromising the effectiveness of the insecticide itself.

Another temperature factor is the temperature gradients in the atmosphere which can impact the inversion of the application product into the elevated levels of tree canopies (Mount 1998). This can be important for vector control efforts due to the fact that certain potential vector species of Eastern Equine Encephalitis (EEE) and West Nile virus (WNV) tend to congregate in the canopies, namely *Culiseta melanura* and *Culex pipiens* (Anderson 2004). These meteorological factors all play a part in the mosquito control efficacy of ULV applications. With these factors in mind, it is generally more advantageous to perform applications in the evenings due to mosquito activity and weather conditions (Mount 1998).

Vegetated areas can also be a factor in the efficacy of a ULV application (Mount 1998). For example, a higher dosage rate may have to be used to obtain the same control level in areas where there is heavy vegetation compared to open spaces (Curtis 1996). This is due in part to the idea that the size and amount of

droplets at the regular dosage rates may be unable to physically reach the adult mosquitoes in the vegetative cover. In fact, it has been reported that for a ULV application in vegetative areas compared to open spaces, the effectiveness of the normal dosage rates can be reduced by over 4 times (Curtis 1996; Mount 1998). With cost and environmental impact in mind, mosquito control personnel tend to use insecticide at a lower acceptable rate, but in situations where there is dense cover for adult mosquitoes these rates may be less effective, resulting in the need for additional applications, increasing costs and impact overall (Curtis 1996). Dense housing, fencing and other wall structures can also have similar impacts on the effectiveness of ULV ground applications as vegetation (Mount 1998).

A major problem with efficacy studies using natural populations is that mosquitoes in neighboring areas may repopulate the area after the application (Efird 1991; Mount 1998). In areas where the street layout allows a large coverage area, ULV applications can provide increased control over smaller targeted areas because of the possibility of reinfestation. In these small target areas situations, additional and more frequent applications may have to be made for adequate control (Mount 1998).

To help determine the efficacy of the CMMCP adulticide program, research trials were conducted during the summer of 2011 to evaluate if any procedural changes were warranted.

METHODS

To test the efficacy of the CMMCP standard adulticide procedure, three permanent sites were chosen for the study with multiple mosquito collections made weekly at each location throughout the season. Two of these sites were selected to be treated during the CMMCP adulticide program while the other not, being used as a control site. Test sites were chosen from areas with above average numbers of service requests received, while the control site was selected from a nearby area, and was treated as an application exclusion location.

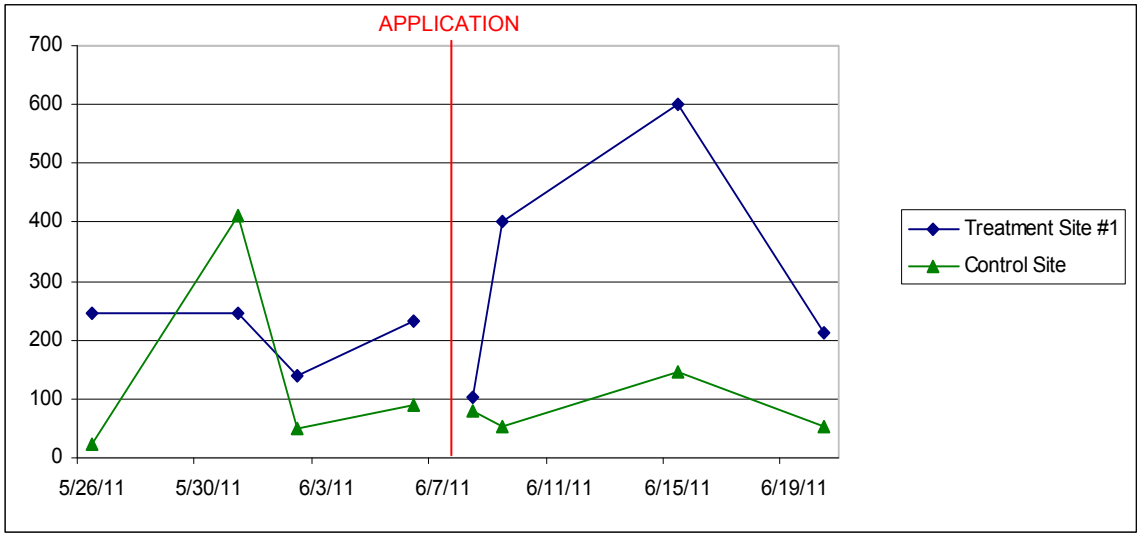
Mosquito collections were made using model 512 CDC miniature light traps baited with CO_2 (500ml/min) (John W. Hock Co., Gainesville, FL). Specimens were recorded by trap location and date of collection. Several collections were made prior to and following applications to help determine control. After plotting the data for both treatment sites and the control site, comparisons were made to help determine to what affect the adulticide applications had on the local mosquito population. On the evenings of applications, field technicians noted the time, temperature and wind direction prior to beginning.

RESULTS

Several collections were made at both treatment sites and the control site prior to applications. Treatment

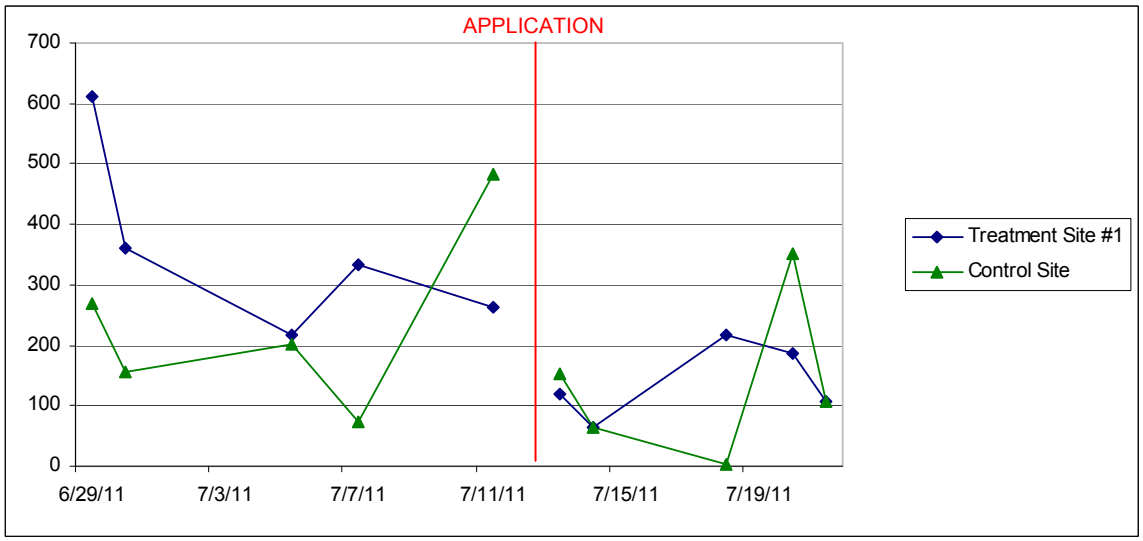
site #1 had area applications conducted on the nights on June 7th as well as July 12th, while the applications at treatment site #2 were on June 7th and June 28th. Further applications were anticipated but lack of adequate requests in the treatment areas and decreases in local mosquito abundance prevented the additional trials. Data surrounding the first application of treatment site #1 showed initial control following the adulticide event but collections soon rebounded (Figure 1). Species identification of collections made around this application, indicate that the local populations of *Ochlerotatus canadensis* may have been in the process of emerging. Although low in numbers prior to the application, this species was found in significant numbers in the subsequent collections, partly accounting for the observed increase at the treatment site.

Figure 1: Collection Comparison for Treatment Site #1 and Control Site



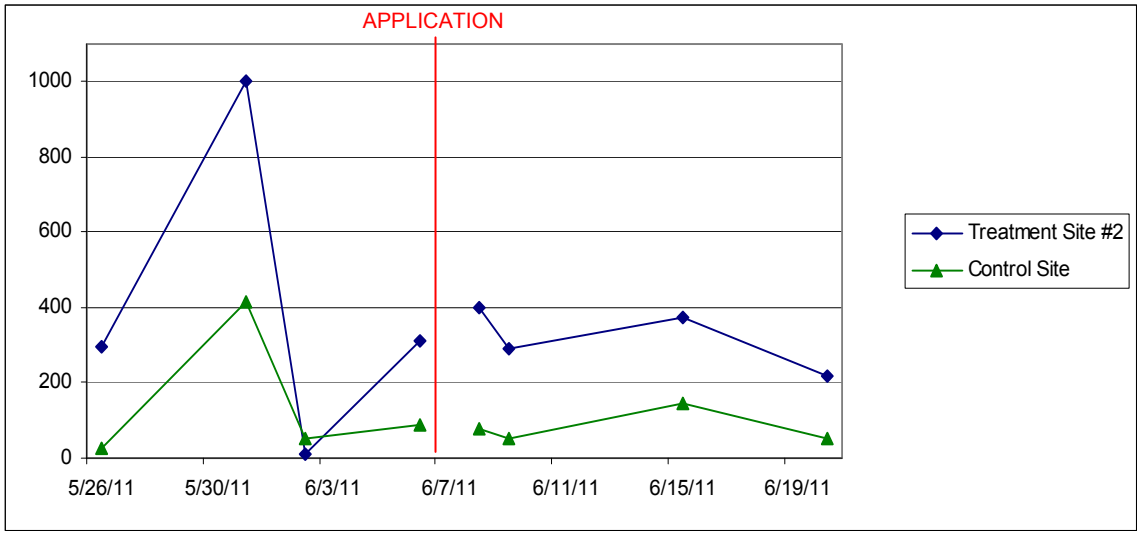
Collections around the second application at treatment site #1, conducted on July 12th, showed a decrease in local mosquitoes, although somewhat similar results were observed around the control site as well (Figure 2). In the collections prior to the application, both sites had relatively similar tracks. Following the event and initial control, collection numbers from both locations eventually began to track well with one another once again.

Figure 2: Collection Comparison for Treatment Site #1 and Control Site



The initial application at treatment site #2 occurred on June 7th, and was followed by a trend of decreasing mosquito numbers (Figure 3). This decrease was also seen in the control site collections, although not as drastic. Pre and post application collections at the treatment and control sites generally tracked well during the project. Although collections indicate that it was not as significant a factor as with treatment site #1, an emergence of *Ochlerotatus canadensis* may have impacted the findings around this application.

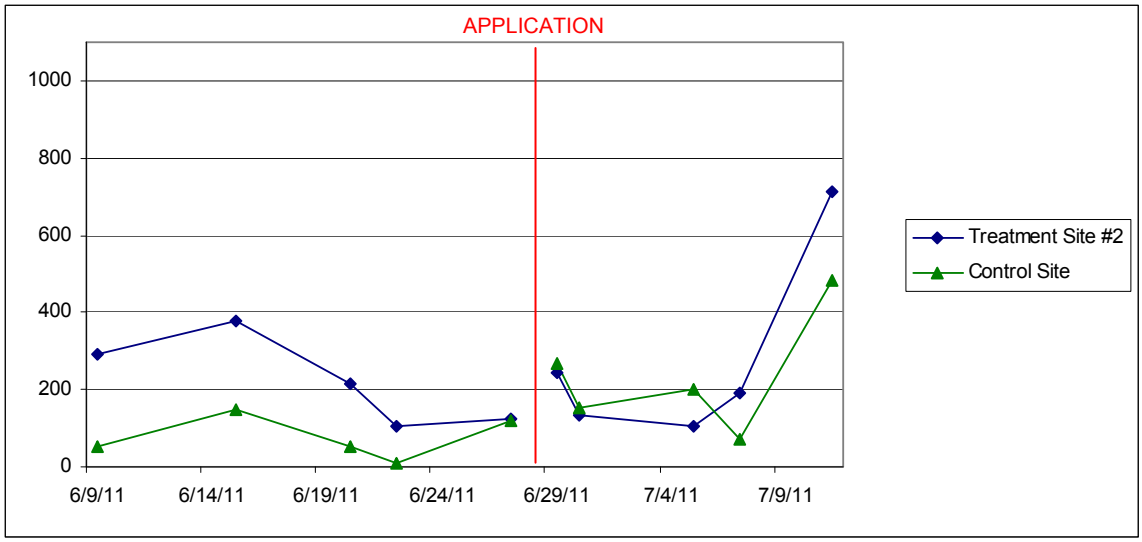
Figure 3: Collection Comparison for Treatment Site #2 and Control Site



The final application at treatment site #2, conducted on June 28th, again resulted in a decreasing collection trend for several evenings (Figure 4). The control site showed an earlier increase than the treatment site, although collections from both areas eventually began to imitate one

another. Collections indicate that the eventual post-application increase in collection numbers at both sites was primarily the result of *Coquillettidia perturbans* emergence.

Figure 4: Collection Comparison for Treatment Site #2 and Control Site



DISCUSSION

Often efficacy studies of ULV applications will use caged mosquitoes instead of field populations. This study design has several advantages, but may not accurately represent the reality of actual applications in the field. Caged mosquitoes can gauge the effectiveness of the adulticide product and spray equipment very well, but may not be representative of that particular adulticide program. For instance, our residential trials using field populations will be significantly impacted by adverse meteorological conditions present at the time of application. Other potential factors that will impact our residential field trials include irregular road design, heavy vegetation, residential obstructions, and migration of neighboring mosquitoes. Many of these issues unique to field trials using natural mosquito population were present to varying degrees in this study.

The trials of this study showed that control was achieved for a few nights before the mosquito populations returned to pre-application levels. This reinforces previous findings by CMMCP, and also Mount (1998), who found that initial control was achieved, but populations began to return to pretreatment levels two days post-treatment. It was believed that this rebound was due primarily to quick repopulation of area and as well as some meteorological conditions (Mount 1998).

Indications are that the findings in this study were primarily the result of repopulation by neighboring mosquito populations. This migration of local mosquitoes was facilitated through the localized

nature of target areas, as well as the low residual quality and quick decomposition of ANVIL® 10+10 (Lesser 1998). This product characteristic permits a quicker mosquito repopulation, whereas chemicals used in barrier treatments would not, due to their increased persistence after application. The various designs of local road networks may not have facilitated greater penetration of the insecticide into vegetated areas, even if the application areas were expanded. Ideally, if applications could have been made in an area with a grid design street layout, control could have been improved. Most of these locations also contained at least moderate vegetative barriers, which could have impacted the results.

In conclusion, it is not believed that a significant change in procedure is needed at this time. If any modification to current protocol were to be proposed, it would be a low increase in product flow rate. This operational change would enhance control, especially in heavy vegetative cover and during suboptimal weather conditions, while still being well within the allowable application rates. Applications in unsuitable conditions will result in lower levels of control, wasting costly product and increasing the possibility of environmental impact. For these reasons technicians need to constantly monitor conditions in the field both before and during applications. The control achieved in this study's field trials was reflective of the various conditions present at the times of application. Improved field conditions during future applications would likely result in longer control than was observed in this study.

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REFERENCES

Anderson AL, Apperson CS, Knake R. 1991. Effectiveness of Mist-blower Applications of Malathion and Permethrin to Foliage as Barrier Sprays for Salt Marsh Mosquitoes. *J Am Mosq Control Assoc* 7(1):116-117.

Anderson JF, Andreasdis TG, Main AJ, Kline DL. 2004. Prevalence of West Nile virus in tree canopy-inhabiting *Culex pipiens* and associated mosquitoes. *Am J Trop Med Hyg* 71:112-119.

Brogdon WG, McAllister JC. 1998. Insecticide Resistance and Vector Control. *Emerg Infect Dis* 4:605-613.

Center for Disease Control and Prevention. 2002. *Resistance Assays* [Internet]. Atlanta,

GA: Center for Disease Control and Prevention [accessed January 4, 2012]. Available from: http://www.cdc.gov/ncidod/wbt/resistance/assay/index.htm.

CMMCP [Central Massachusetts Mosquito Control Project]. 2012. ANVIL 10+10® Pesticide Label [Internet]. Available from the Central Massachusetts Mosquito Control Project, Northborough, MA [accessed January 4, 2012]. http://www.cmmcp.org/Anvil%2010+10%20label.pdf.

Cornine FH. 2009. Bottle Assays of Field Collected Mosquitoes For Level of Resistance to ANVIL® 10+10 in Central Massachusetts: Update 2009 [Internet]. Available from the Central Massachusetts Mosquito Control Project, Northborough, MA [accessed January 4, 2012]. http://www.cmmcp.org/BottleAssayAmendment2009.pdf.

Crockett RJ, Dennett JA, Ham CM, Nunez RD, Meisch MV. 2002. Efficacy of Biomist 30:30® and Aqua Reslin® Against *Anopheles quadrimaculatus* in Arkansas. *J Am Mosq Control Assoc* 18(1):68-69.

Curtis GA, Beidler EJ. 1996. Influence of Ground ULV Droplet Spectra on Adulticide Efficacy for *Aedes taeniorhynchus*. *J Am Mosq Control Assoc* 12(2):368-371.

Efird PK, Inman AD, Dame DA, Meisch MV. 1991. Efficacy of Various Ground-applied Cold Aerosol Adulticides Against *Anopheles quadrimaculatus*. *J Am Mosq Control Assoc* 7(2):207-209.

Lesser CR. 2002. Field Trial Efficacy of Anvil 10+10® and Biomist 31:66® Against *Ochlerotatus Sollicitans* in Delaware. *J Am Mosq Control Assoc* 18(1):36-39.

Mount G. 1998. A Critical Review of Ultralow-volume Aerosols of Insecticide Applied With Vehicle-mounted Generators for Adult Mosquito Control. *J Am Mosq Control Assoc* 14(3):305-334.

PHEREC [Public Health Entomology Research and Education Center]. 2001. Dilution of ANVIL 10+10® for the Bottle Bioassay [Internet]. Available from the Public Health Entomology Research and Education Center, Panama City, FL [accessed June 16, 2005]. http://www.pherec.org/memoranda/anvil10.html.