Boulder County Mosquito Control District 2014 Season Report

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SUMMARY

Boulder County Mosquito Control District (BCMCD) and Boulder County Public Health Department (BCPH) contracted OtterTail Environmental, Inc. (OtterTail) to operate an Integrated Mosquito Management (IMM) program to protect public health from the transmission of West Nile Virus (WNV) and other vector-borne diseases, and to suppress local populations of nuisance mosquitoes. Through surveillance of potential mosquito breeding sites (larval sites), areas that produced mosquito larvae were identified and treated with control materials known as larvicides. During the 2014 season, 17,331 individual larval site inspections were performed on 1,873 potential sites within the District. Of the sites inspected, 693 were found producing mosquitoes at least once over the course of the season. OtterTail conducted 4,026 site treatments covering approximately 2,056 acres of active mosquito breeding habitat.

Adult mosquito populations and WNV activity were also monitored during the season by using 23 adult mosquito traps placed throughout the project area. Weekly trap collections enabled OtterTail to monitor nuisance levels and provide any needed mosquito pools for WNV testing throughout the season. Adult mosquito monitoring also allowed county officials and OtterTail to make informed decisions on when and where adult mosquito control should occur.

During the 2014 season, adult control was performed along approximately 175 linear route miles (at an application rate of 0.0035 lbs Permethrin a.i. per acre) in the BCMCD. OtterTail and BCMCD continued to offer a Spray Notification and Shutoff Service as part of the adult control program. During the 2014 season, OtterTail received 19 shutoff requests and 10 requests to be notified before spraying. OtterTail's shutoff and notification list currently includes 698 households that want to be notified before spraying in their neighborhood and 309 households that have requested spray shutoffs. In 2014, OtterTail completed 422 notification calls.

The State of Colorado experienced a significant decrease in WNV activity in 2014 when compared to the 2013 season. The climate patterns and cooler temperatures that occurred during the 2014 season caused mosquito populations to remain at below average levels throughout the season; consequently, there was significantly less WNV activity within the region. Boulder County's IMM program coupled with education and personal protection measures, also likely continued to help reduce mosquito populations and WNV activity in the county during 2014.

1.0 INTRODUCTION

Boulder County continued to partner with OtterTail Environmental, Inc. (OtterTail) in 2014 to operate an Integrated Mosquito Management (IMM) program. The county's goals were the same as they were in previous years, which were to protect local residents from the effects of mosquito-borne disease and to suppress the local populations of nuisance mosquitoes.

To accomplish this, specific objectives were established for the program. First, the county wanted to monitor possible mosquito breeding (larval) habitats and treat those sites when mosquito larvae were present. Treatment of these areas with control methods during this stationary larval stage, before mosquitoes become airborne, is the most cost-effective and efficient means to reduce mosquito populations. Secondly, they wanted to monitor adult mosquito populations and use the population numbers as a possible trigger for adult mosquito control to reduce nuisance to the public. The county also wanted to limit the effect on the environment from control materials and be as cost-effective as possible.

This report explains the methods used in the IMM program and provides a detailed summary of the results of this year's effort.

2.0 WEST NILE VIRUS (AND OTHER MOSQUITO-BORNE DISEASE) UPDATE

West Nile is a mosquito-transmitted virus that can cause a wide range of effects, from an asymptomatic infection to a neuroinvasive disease termed West Nile meningitis or encephalitis. West Nile Virus was first detected in the United States during the summer of 1999 in New York City while conducting routine St. Louis Encephalitis (SLE) and Eastern Equine Encephalitis (EEE) surveillance. The virus has since spread across the U.S. and has been confirmed in all continental states. Bird populations act as a reservoir for the virus until a mosquito bites an infected bird. Only then can an infected mosquito pass the virus on to humans, horses and other animals through their bite. While many people who contract WNV experience mild or no symptoms, the more severe cases of West Nile meningitis or encephalitis can result in severe illness and even death.

There are over 50 mosquito species in Colorado, yet only species from the genus Culex are known to be effective transmitters of WNV. Mosquitoes and other insects that transmit disease are called vectors; mosquitoes that are not known to transmit a disease are often called nuisance mosquitoes. The most abundant mosquito in Boulder County, *Aedes vexans*, is an aggressive nuisance mosquito. The two primary vector mosquitoes that are most likely to spread WNV in Colorado are *Culex tarsalis* and *Culex pipiens*.

As of October 14th, 2014, there were 1,444 WNV human cases and 49 WNV related deaths in 40 states and the District of Columbia (**Table 1**). Colorado ranked fifth in the national case count with 98 human WNV cases and 3 WNV related deaths reported as of September 26, 2014. Most WNV cases occurred in Colorado within the populous regions of the Front Range **(Table 2)**. The Colorado Department of Public Health did not report any mosquito pools, horses, birds or humans as positive for St. Louis Encephalitis or Western Equine Encephalitis during the 2014 season**.**

As of September 26, 2014 there were 10 WNV related illnesses and no WNV related deaths in Boulder County reported by Colorado Department of Public Health and Environment (CDPHE) **(Table 2)**. With widespread and frequent testing of mosquito pools throughout the county, 16 of the 131 submitted pools of mosquitoes tested WNV positive from Boulder County in 2014.

Adult mosquito surveillance data, submitted mosquito pools, and the resulting WNV infection rates were used by BCPH throughout the season to calculate Vector Index (VI) levels to help city and county officials determine local areas of concern for public awareness and safety. The VI is a tool used by health officials that takes into account the presence and density of Culex mosquitoes and their WNV infection rates, resulting in an early indicator for the risk of human WNV infection. Once the VI reaches levels above 0.75, state and local health departments typically recommend communities take higher levels of mosquito prevention and control. With the lower WNV activity in 2014, no widespread emergency spraying was conducted within Boulder County during the season.

The decreased WNV activity and number of human infections in Colorado may be attributed to the temperature and precipitation patterns observed during the 2014 mosquito season and the affect they had on mosquito populations, as discussed further in **Section 3.0**.

Table 1 West Nile Virus Incidence, 2002 - 2014

Total WNV Human Cases	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Cases in the United States[1]	4,156	9,862	2,539	3,000	4,269	3,630	1,356	720	1,021	712	5,674	2,318	1,444
Deaths in the United States[1]	284	264	100	119	177	124	44	32	57	43	286	105	49
Highest State Count in United States[1]	884	2,947	779	880	996	578	445	115	167	158	1,868	364	427
Cases in Colorado[2]	13	2,947	291	106	345	578	71	103	81	7	131	317	98
Deaths in Colorado[2]	0	66	4	2	7	7	1	3	4	0	5	7	3
Cases in Boulder County[2]	0	421	14	5	74	95	18	12	6	2	1	51	10
Deaths in Boulder County[2]	0	7	0	0	1	2	0	0	0	0	0	1	0
Total WNV Positive Results	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Mosquito Pools in Boulder County[2]	0	118	8	0	107	55	3	4	1	9	8	69	16
Birds in Boulder County[2]	5	50	0	1	12	2	0	0	1	0	0	0	0
Horses in Boulder County[2]	3	18	0	0	1	0	0	0	0	0	0	0	0

1. Reported by the Center for Disease and Control (CDC); 2014 data reported as of October 14, 2014.
2. Reported by the Colorado Department of Public Health and Environment (CDPHE); 2014 data reported as of September 26, 2014.

There were no WNV related deaths in Boulder County and the number of Boulder County cases and WNV positive mosquito pools comprised approximately 10 percent and 8 percent of the state totals, respectively (**Table 2**). When populations of nearby Front Range Counties are taken into account, Boulder County had the third highest crude attack rate (cases per 100,000 individuals) in the region **(Table 3).** The lower number of human WNV cases, WNV positive mosquito pools and WNV crude attack rate suggests that the viral activity in Boulder County was significantly lower in 2014 than the 2013 season. It is likely that the continued widespread mosquito control efforts to reduce mosquito populations, coupled with public education and personal protection measures, helped reduce the exposure and disease transmission within Boulder County.

Table 2 Colorado WNV Human Cases and WNV Positive Mosquito Pools, 2014

County	Human Cases[1]		Human Deaths[1]		Positive Mosquito Pools[1]	
	Number	% of State	Number	% of State	Number	% of State
Adams	4	4.1%	0	0.0%	9	4.6%
Arapahoe	4	4.1%	0	0.0%	2	1.0%
Boulder	10	10.2%	0	0.0%	16	8.2%
Broomfield	1	1.0%	0	0.0%	0	0.0%
Cheyenne	1	1.0%	0	0.0%	0	0.0%
Delta	3	3.1%	0	0.0%	19	9.7%
Denver	5	5.1%	2	66.7%	1	0.5%
El Paso	1	1.0%	0	0.0%	0	0.0%
Freemont	1	1.0%	0	0.0%	0	0.0%
Jefferson	3	3.1%	0	0.0%	2	1.0%
Larimer	14	14.3%	0	0.0%	70	35.9%
Logan	3	3.1%	0	0.0%	0	0.0%
Mesa	7	7.1%	0	0.0%	6	3.1%
Montrose	1	1.0%	0	0.0%	0	0.0%
Morgan	3	3.1%	0	0.0%	0	0.0%
Otero	1	1.0%	0	0.0%	0	0.0%
Prowers	6	6.1%	0	0.0%	0	0.0%
Pueblo	4	4.1%	1	33.3%	6	3.1%
Saguache	1	1.0%	0	0.0%	0	0.0%
Weld	25	25.5%	0	0.0%	64	32.8%
Colorado Totals	**98**		**3**		**195**	

1. Reported by CDPHE as of September 26, 2014

Table 3 Human WNV Crude Attack Rates[1] of Front Range Counties, 2014

County	Population	# of WNV Cases	% of Front Range Cases by # of Cases	2014 Crude Attack Rates (per 100,000)	% of Front Range Cases by Population	Crude Attack Rank
Adams	441,603	4	5.7%	0.91	3.6%	6
Arapahoe	572,003	4	5.7%	0.70	2.7%	8
Boulder	294,567	10	14.1%	3.39	13.4%	3
Broomfield	55,889	1	1.4%	1.79	7.0%	5
Denver	600,158	5	7.0%	0.83	3.3%	7
El Paso	622,263	1	1.4%	0.16	0.6%	10
Jefferson	534,543	3	4.2%	0.56	2.2%	9
Larimer	299,630	14	19.7%	4.67	18.4%	2
Pueblo	159,063	4	5.6%	2.51	9.9%	4
Weld	252,825	25	35.2%	9.89	38.9%	1

***** WNV human case information used for Crude Attack Rate calculations was obtained from CDPHE (CDPHE 2014); Population information for Crude Attack Rate calculations was obtained from U.S. Census Bureau's 2010 Census of Population (USCB 2011); Crude Attack Rates are listed as cases per 100,000 people.

3.0 REGIONAL 2014 CLIMATOLOGICAL DATA AND MOSQUITO ACTIVITY OVERVIEW

The weather patterns leading into and during the mosquito season (April – September) are important factors that influence mosquito abundance and WNV activity. The following section describes the regional climate, weather during the season, and how that may have affected the mosquito populations.

Boulder County is located in a semi-arid environment with elevations in the project area ranging from approximately 4,900 feet to 5,500 feet. The typical mosquito season for the Boulder County area is from April to September. Current and historical climate data from the National Oceanic Atmospheric Administration's (NOAA) Boulder, Colorado weather station was used for regional temperature and precipitation patterns.

Historical records for the mean monthly temperature at the station suggest that temperatures usually have a steady increase from April to July, making July, on average, the hottest month of the year. Typically there is then a steady temperature decrease into September. In 2014, every month of the mosquito season except April and September had below normal temperatures. The month of August experienced the highest variation from normal during the summer with a monthly mean temperature approximately 2 degrees below normal (**Figure 1**).

The historical averages for the monthly mean precipitation indicate that April, May and June are usually the wettest months of the year (**Figure 2**). During 2014, the accumulated precipitation from January through September was significantly higher than the historical average for the same period. During this time period in 2014, there was an accumulation of 20.16 inches. This is approximately 30 percent more than the normal amount of accumulation when compared to the historical average, which is 15.65 inches. Five of the nine months received precipitation amounts higher than their normal averages. The most significant variations during the mosquito season were the months of June and July. June received approximately half of its normal precipitation, making it the driest month of the 2014, while July received approximately 2.5 times more precipitation than average, making it wettest month of 2014 (NOAA 2014).

High precipitation amounts in May led to most mosquito habitats being inundated with water early in the season, but this was followed by a drier than normal June, and temperatures that remained below their normal averages throughout the rest of the mosquito season. The below average temperatures in June led to lower than average nuisance and Culex mosquito production. July was then much wetter and cooler than normal with frequent occurrences of heavy rain falls. These frequent rainstorms helped further reduce Culex mosquitoes by flushing out or refilling those habitats that were beginning to stagnate during the drier month of June. The larval habitat sites that filled up with water were closely monitored by OtterTail and were then quickly treated if any larval development occurred to minimize the adult mosquito production from the rainstorms. The below normal temperatures throughout the mosquito season, the July rainstorms with their flushing effect, and the District's larval control program were the likely causes of the below average abundances of nuisance and Culex mosquitoes throughout the majority of the summer.

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Figure 1 2014 Monthly Mean Air Temperature and Historical Averages

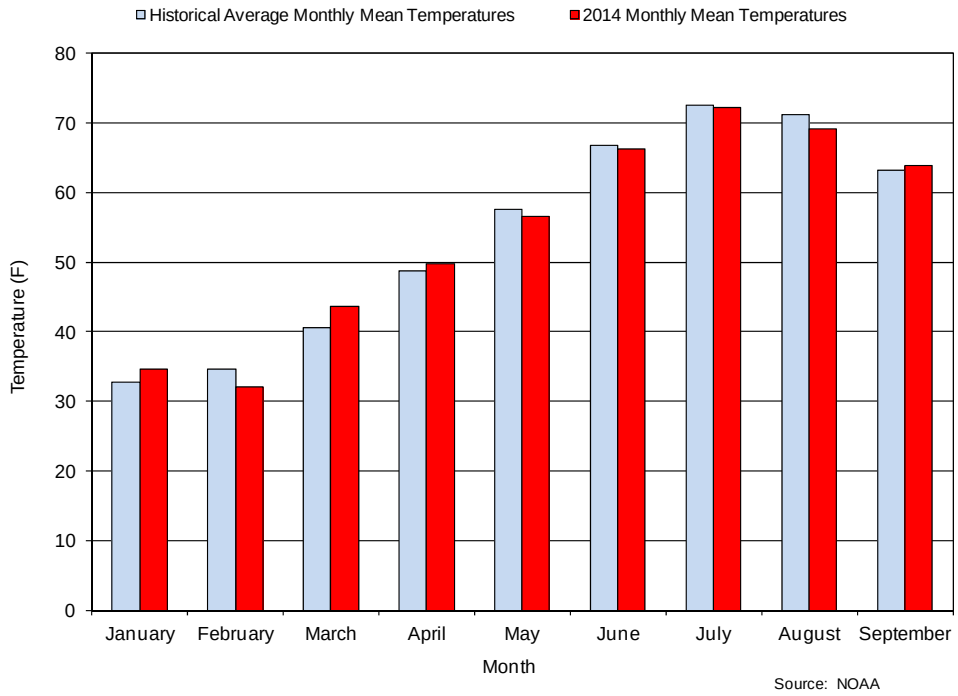
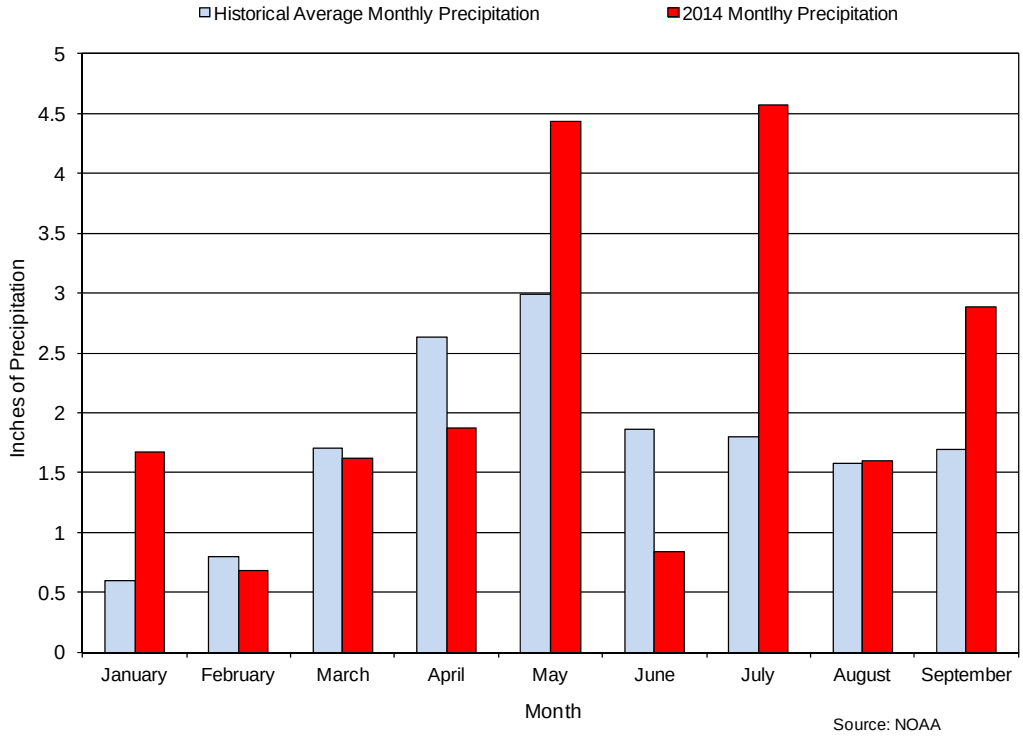


Figure 2 2014 Monthly Total Precipitation Data and Historical Averages



4.0 LARVAL MOSQUITO SURVEILLANCE AND CONTROL

LARVAL SURVEILLANCE METHODOLOGY

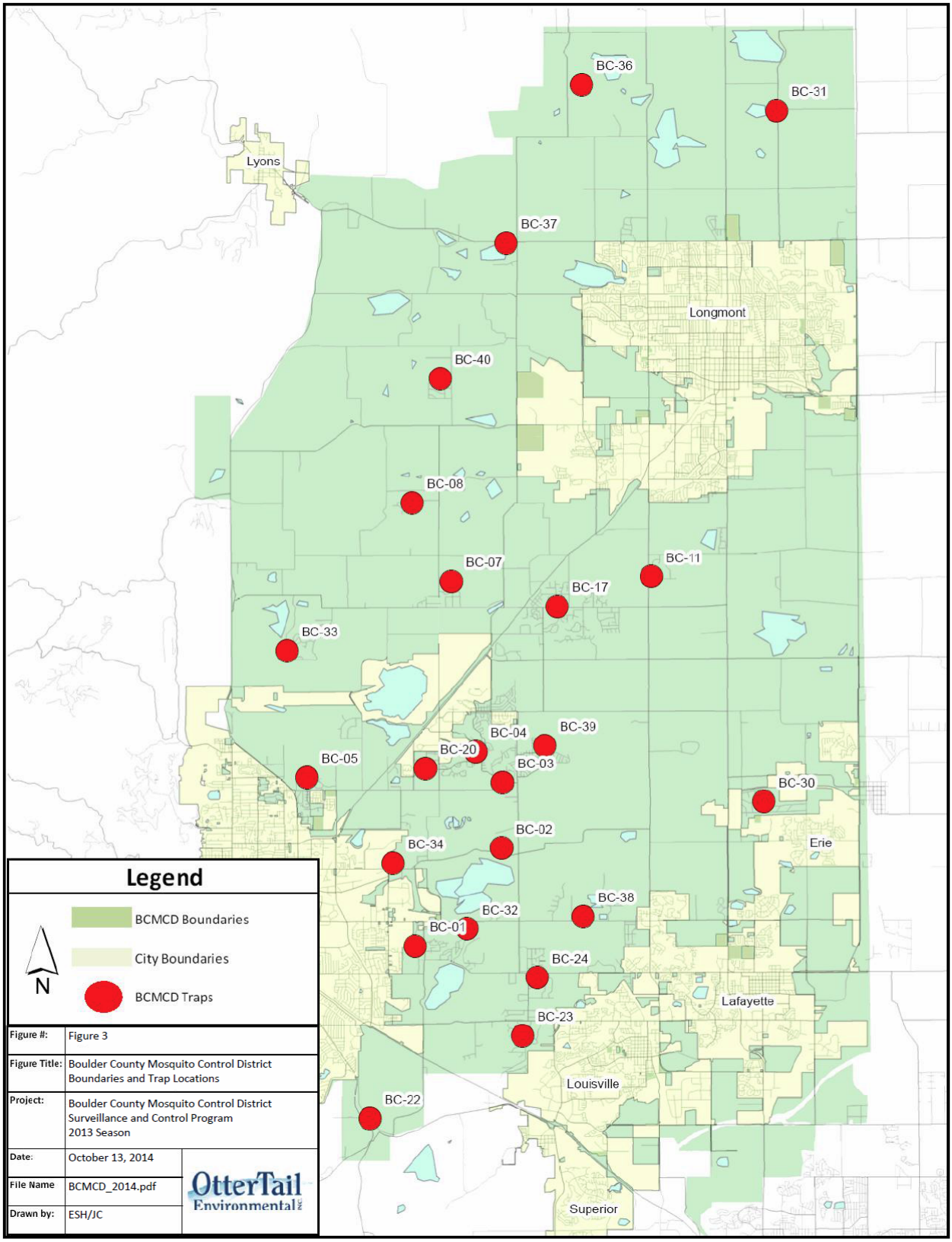
To inspect a mosquito source, a plastic dipper cup with a 3-foot wooden handle was used to collect water from the site. Each sample (dip) was closely examined for mosquito larvae presence. Many of the sites inspected had mosquito-sustaining habitat around the perimeter of the site, but the middle remained mosquito free due to water circulation and/or natural predators. At these sites, the dipping effort was completed using a *linear approach* (walking around the perimeter and sampling the margins).

In sites with widespread mosquito habitat, the entire site was methodically sampled using the *surface area approach*. With this approach, sites were dipped approximately every 10 to 20 square feet. Since each site's characteristics could vary as the season progressed (e.g., become drier, wetter, increased vegetation), there were changes made during the field season to adjust the appropriate number of dips.

OtterTail staff began the season in April by performing surveillance and control on habitats within the District that have historically been found to be breeding mosquitoes early in the season. This effort increased gradually during the season to a full crew by the beginning of June when several of the sites were producing larvae. Many of the habitats were those with stagnant water high in nutrients and organic matter including: cattail marshes, non-flowing drainage ditches, small stagnant ponds, and temporary pools. Larval habitat sites were routinely inspected throughout the season based on their production potential. Depending on the time of the season, sites found to have a high production potential were generally inspected every 5-10 days. During the height of the mosquito season (late June to mid-August), OtterTail re-inspected many of the sites that were found actively producing within 5 days to ensure efficient control. If potential sites were not found to be producing mosquitoes during this time, they were generally re-inspected in 7-10 days, depending on the site's breeding potential. Habitat sites continued to be added and refined throughout the field season as needed.

When larval mosquito habitat was observed on private property, efforts were made to gain permission to access the land for surveillance and treatment. As directed by the county, OtterTail only accessed private property if permission was granted by the owner.

Figure 3 2014 BCMCD Boundaries and Trap Locations



LARVAL CONTROL METHODOLOGY

The primary focus for OtterTail's IMM program is to control mosquitoes while they are in the larval stage. Larval mosquito control methods employed by OtterTail were aimed at preventing adult mosquito emergence, which reduces the potential of the mosquito-borne disease, WNV, and minimizes the annoyance level of mosquitoes to local residents. To achieve a high level of effectiveness and efficiency of larval control efforts, OtterTail identified and inspected mosquito larval habitats on a regular basis. The threshold for larval control was presence of any mosquito larvae. Finding and documenting consistent mosquito-producing sites was an important component of the program because it created a pattern that is monitored and systematically controlled to help understand mosquito populations and WNV trends. Being environmentally sensitive, Boulder County and OtterTail believe in concentrating on larval control to reduce the need for adult mosquito control spraying.

The application of *Bacillus thuringiensis israelensis* (*Bti*), *Bacillus sphaericus (Bs)* and BVA-2 mosquito larvicide oil (BVA-2) were the primary methods used for larval mosquito control. Control materials were applied within the labeled rates, thereby minimizing any potential adverse impacts to areas being treated. Routine post-treatment checks were conducted to ensure the larval control was effective. If any larvae were found during the post-check, a second application was conducted.

In balancing environmental resources, cost effectiveness, and public health needs, *Bti* was selected as the primary treatment product. *Bti* is a naturally occurring protein that is toxic to mosquito larvae upon its ingestion. It provides a residual treatment that lasts for approximately two days. Since new mosquito larvae may hatch after the product dissipates, the sites must be inspected for mosquito larvae every one to two weeks. The presence of mosquito larvae between monitoring periods has the added benefit of allowing these larvae to continue to be part of the aquatic food web. However, larvae are eliminated before they can emerge as adults. This helps protect the public from potential WNV transmission, while still providing a food source for many aquatic animals.

Bacillus sphaericus is a larvicide very similar to *Bti*, but has a longer residual time. The protein in *Bs* products is able to provide continuous treatment of mosquito larvae for up to four weeks and was typically used on sites found to be continuously producing mosquitoes. Although the longer residual time of *Bs* allows for fewer site checks and cost savings in labor and travel, it is only practical in certain situations because it costs substantially more than *Bti*.

Bti and *Bs* are the primary control materials used but they are ineffective if pupae are found at a site. Mosquitoes do not feed during their pupal stage; therefore, the use of *Bti* and *Bs* is ineffective against mosquito pupae since they must ingest the proteins. In these instances of pupae occurrence, BVA-2 is used. BVA-2 is a highly refined mineral oil that creates a thin film on the water surface. The film interrupts the air and water interface during the mosquito's larval and pupal development stages, causing them to drown.

OtterTail also used the predatory fathead minnow (*Pimephales promelas)* in limited habitats to serve as a biological control for mosquito larvae. Fathead minnows are a native fish species in Colorado that regularly feed off of surface dwelling aquatic organisms, including mosquito larvae. OtterTail provided minnows to residents that had "closed system" habitats such as ornamental ponds or small farm ponds that were isolated from streams or other areas where the fish could not spread out indiscriminately.

LARVAL DATABASE MANAGMENT

In an effort to improve the larval surveillance and control program, and the efficiency of field operations, OtterTail provided handheld Personal Data Assistants (PDA's) to our field crew. The PDA's allowed us to incorporate the Sentinel™ GIS Larviciding Software into the District's program during the 2010 season and their use continued through the 2014 season. This ESRI GIS based system is integrated with Global Positioning System (GPS) technology and is designed to provide spatially accurate data for mosquito larvae habitat inspections and pesticide applications. In addition to the typical site data that are recorded during a site visit, the Sentinel™ system allows each inspection and treatment record to be complemented by a date/time stamp and GPS coordinates. This helps ensure that larval inspections and treatments are being conducted at the correct locations, while also improving the program's surveillance efficiency.

The PDA's also allowed for site inspection and treatment data to be entered in the field at each site location. The PDA's guide the technician through a step-by-step site-protocol using a series of drop-down menus, requiring the technician to fill out each section before allowing the entry to be completed. This aids in a more consistent and accurate dataset by minimizing potential data-entry errors. Entering the data on the PDA's interface also reduces the need for multiple entries on various paper forms.

In addition to providing data of each site visit for record keeping purposes, the information is also used in the field to improve the efficiency and timing of site visits. For example, field technicians have access to updated database information within the PDA's to inform them when a habitat site inspection visit is due. New mosquito sites can also be recorded by technicians in the field and the software will allow automatic updates of the new sites' GIS records.

The information recorded on each PDA was uploaded and automatically merged into OtterTail's electronic database on a regular basis throughout the season. This electronic uploading and merging of data directly from the handheld device into the database eliminates the need for the manual data entry from traditional paper field forms and site information cards. Although data entry errors can still occur when entering information into the PDA's in the field, the new system has significantly decreased the number of errors that can be made during the paper to electronic database transfer process of the past.

LARVAL RESULTS AND DISCUSSION

The 2014 larval surveillance season started in April and continued through September. During the season, a total of 17,331 individual larval site inspections were performed on 1,873 sites within the District. Of the sites inspected, 693 sites were found producing mosquitoes at least once over the course of the season. Approximately 13,477 lbs of *Bti*, 135 lbs of *Bs*, 1.9 gallons of AGNIQUE® MMF, and 124 gallons of BVA 2 Oil were used to treat approximately 2,056 acres of actively producing larval habitat. In addition to the control products used, OtterTail also distributed approximately 1,100 fathead minnows to District residents for private larval control (**Tables 4 and 5**).

Table 4 Larval Surveillance and Control Summary, 2009 - 2014

Habitat Site Surveillance & Control	OtterTail Contract						2008	Historical Average	Historical Range
	2014	2013	2012	2011	2010	2009			
Site Inspections[1]	17,331	17,542	20,622	19,661	20,395	15,931	5,470	6,836	5,470 - 8,546
Total # Sites Wet[2]	14,418	12,824	13,289	14,189	13,632	11,711	3,958	4,875	3,958 -6,123
% of Sites Wet[2]	83%	73%	64%	72%	67%	74%	72%	75%	72% - 80%
Site Treatments[1]	4,026	3,751	2,872	3,189	2,702	3,273	1,386	2,075	1,386 - 2,637
% Sites Treated[2]	28%	29%	22%	22%	20%	28%	35%	37%	35% - 41%
Amount of Acres Treated[1]	2,056	2,693	1,515	2,341	1,225	1,265	1,128	1,554	1,113 - 2,470

Notes: **1.** Historical avg. and range based on 2004 - 2008 BCPH provided data; 2. Historical avg.and range based on 2006 - 2008 BCPH provided data

Table 5 Larval Control Types and Amounts Used, 2009 - 2014

Control Type	2014	2013	2012	2011	2010	2009
AGNIQUE® MMF	1.9 gal	13.9 gal	7.5 gal	29.6 gal	22.5 gal	10.6 gal
Bacillus thuringiensis israelensis	13,477 lbs	16,204 lbs	9,657 lbs	13,696 lbs	7,726 lbs	5,350 lbs
Bacillus sphaericus	135 lbs	203 lbs	20 lbs	498 lbs	353 lbs	792 lbs
Fathead Minnows	1,100 fish	1,200 fish	1,200 fish	1,000 fish	1,200 fish	3,000 fish
Methoprene	N/A	N/A	6.6 lbs	22 lbs	2.9 lbs	1.4 lbs
BVA 2 Oil	123.6 gal	1.8 gal	N/A	N/A	N/A	N/A

Many of the habitat sites produced mosquito larvae multiple times during the season causing the treated acres at certain sites to be counted multiple times for the season total. As the season progressed, the sites were categorized according to larval abundance and occurrence. Low priority mosquito sites which were not producing mosquitoes had poor habitat or had the presence of aquatic predators. High priority mosquito sites typically had larvae when sampled and consistently produced mosquitoes every seven to ten days during the peak season.

As discussed in the **Boulder County Mosquito Control District 2009 Season Report**, OtterTail staff expended approximately 1,085 labor hours during its 2009 preseason mapping operations that were beyond the required scope of work for the project. This large expenditure of time and resources, along with the continual process of locating and adding additional habitat sites throughout the 2009-2014 seasons, has allowed OtterTail to add 642 new unique potential larval habitat sites to the District over the five year contract period. Despite our intensive mapping effort of 2009, adding 526 sites, OtterTail was still able to add another 150 sites between the 2010-2014 seasons. The new sites added to the program far exceeded the BCMCD's goal of a 10 percent annual increase of the contract (**Table 6**).

Table 6 Results of OtterTail's Mapping Effort to Find New Larval Breeding Sites, 2009 - 2014

	2014 New Sites[3]		2013 New Sites[3]		2012 New Sites[3]		2011 New Sites[3]		2010 New Sites[3]		2009 New Sites[3]		Existing	Contract Goal Per Year[4]	
	# Sites	Increase	# Sites	% Increase	# Sites	% Increase	# Sites	% Increase	# Sites	% Increase	# Sites	% Increase	(2008)	# Sites	% Increase
Total Sites	34	3%	31	3%	18	2%	13	1%	54	5%	526	49%	1,072	107	10%
Preseason Site Mapping Effort[1]	0	---	---	---	---	---	---	---	---	---	457	43%	---	---	---
In-Season Site Mapping Effort[2]	34	3%	31	3%	18	2%	13	1%	54	5%	69	6%	---	---	---
In Season Sites Added by Hotline Calls	17	2%	13	1%	6	1%	4	0.4%	16	1%	20	2%	---	---	---
In Season Sites added by Field Techs	17	2%	18	2%	12	1%	9	1%	38	4%	49	5%	---	---	---

Notes:
1. Preseason mapping is defined as an out-of-scope mapping effort that was conducted by full time staff, biologists with multiple years experience in mosquito surveillance and control. Because it was prior to the primary breeding season, they could focus on mapping rather than just during surveillance and control duties as is the standard procedure.
2. In-season mapping effort is defined as the more typical way sites are mapped. This consisted of seasonal field technicians finding new sites while they were out conducting their routine surveillance and control, or by resident calls alerting OtterTail of a possible new site.
3. New site is defined as unique site location completely separate from an existing 2008 site. Only sites that were considered probable mosquito breeding habitat were added as a "new site". The preseason mapping was conducted by experienced staff, because they could readily distinguish between areas worthy of being added as a site and those not likely to be habitat.
4. Contract goal was a 10 percent site increase per year (or 107 sites).

To ensure a comprehensive IMM program, OtterTail continued to maintain a toll-free telephone hotline for residents to report areas of concern. Calls received from the hotline resulted in 76 new potential mosquito producing sites being added to the program during the 2009 - 2014 seasons (**Table 6**).

5.0 ADULT MOSQUITO SURVEILLANCE AND CONTROL

ADULT SURVEILLANCE METHODOLOGY

Adult mosquito population surveillance is a crucial component of any successful IMM program. Adult surveillance provides information on what types of mosquito species are in an area as well as information on their abundance. Mosquitoes collected in the traps can be tested for a variety of mosquito-borne diseases and are critical for monitoring and forecasting vector threats, particularly WNV.

Most mosquito species prefer to rest during the heat of the day in areas known as harborage areas. A mosquito harborage area is usually a shaded, wind protected and moist area because adult mosquitoes can dehydrate quickly during the daylight hours if they do not have a shady area to rest and escape the heat. Relevant examples are groves of trees with a layer of shrubby undergrowth, dense bushes, tall live grasses, or in residential areas under roof eaves and inside tires. Adult mosquito trapping efforts target these harborage areas to monitor adult mosquito populations.

OtterTail used the CDC style carbon dioxide (CO_2) baited light trap to monitor the adult mosquito populations within the District. The CO_2 baited light trap is based on the principle that most adult mosquitoes are attracted to light, CO_2 (via respiration), and heat. The CO_2 baited light trap collects adult female mosquitoes that are seeking a blood meal, so that she may produce eggs. This type of trap is set overnight and, on the following morning, the nets are collected and returned to OtterTail's laboratory to be identified and counted. Once identified, the mosquitoes were sorted by species and the data were provided to BCPH. A detailed explanation of the trap used during the season can be found in **Appendix A**.

Adult mosquito traps were placed and monitored at 23 sites around the county from the first week in June through the last week in August. Traps were set in areas of suitable harborage for adult mosquitoes and were set in the same locations used during previous years of the program (**see Figure 3**).

Boulder County Public Health submits vector mosquitoes collected throughout the county to CDPHE for WNV testing on a weekly basis during each mosquito season. As discussed in **Section 2.0**, the adult mosquito data, submitted mosquito pools, and the resulting WNV infection rates are used by BCPH throughout the season to calculate Vector Index levels to help city and county officials determine local areas of concern for public awareness and safety.

ADULT SURVEILLANCE RESULTS AND DISCUSSION

Over the season, from all 23 traps, there was an average of 54 total adult mosquitoes per trap per night and an average of 14 adult vector mosquitoes per trap per night. The total adults collected during the season resulted in Aedes/Ochlerotatus species being the most abundant (71.0 percent), followed by Culex /vector species (24.9 percent), Coquillettidia species (2.5 percent) and Culiseta species (1.6 percent); (**Table 7**). This results in approximately 75 percent non-vector vs. 25 percent vector adults being collected over the entire season.

As described in **Section 3**, Colorado experienced below normal temperatures and climate patterns that led to the second lowest recorded mosquito populations on record during the 2014 season (**Figures 4 - 7**). High precipitation amounts in May led to most mosquito habitats being inundated with water early in the season, but this was followed by a drier than normal June, and temperatures that remained below their normal averages throughout the rest of the mosquito season. The below average temperatures in June led to lower than average nuisance and Culex mosquito production. July was then much wetter and cooler than normal with frequent occurrences of heavy rain falls. These frequent rainstorms helped further reduce Culex mosquitoes by flushing out or refilling those habitats that were beginning to stagnate during the drier month of June. The larval habitat sites that filled up with water were closely monitored by OtterTail and were then quickly treated if any larval development occurred to minimize the adult mosquito production from the rainstorms. The below normal temperatures throughout the mosquito season, the July rainstorms with their flushing effect, and the District's larval control program were the likely causes of the below average abundances of nuisance and Culex mosquitoes throughout the majority of the summer. Detailed seasonal information (including weekly populations and species compositions) for each individual trap can be found in **Appendix B.**

Figure 4 Season-Wide Weekly Adult Trap Counts of All Trap Stations, 2014

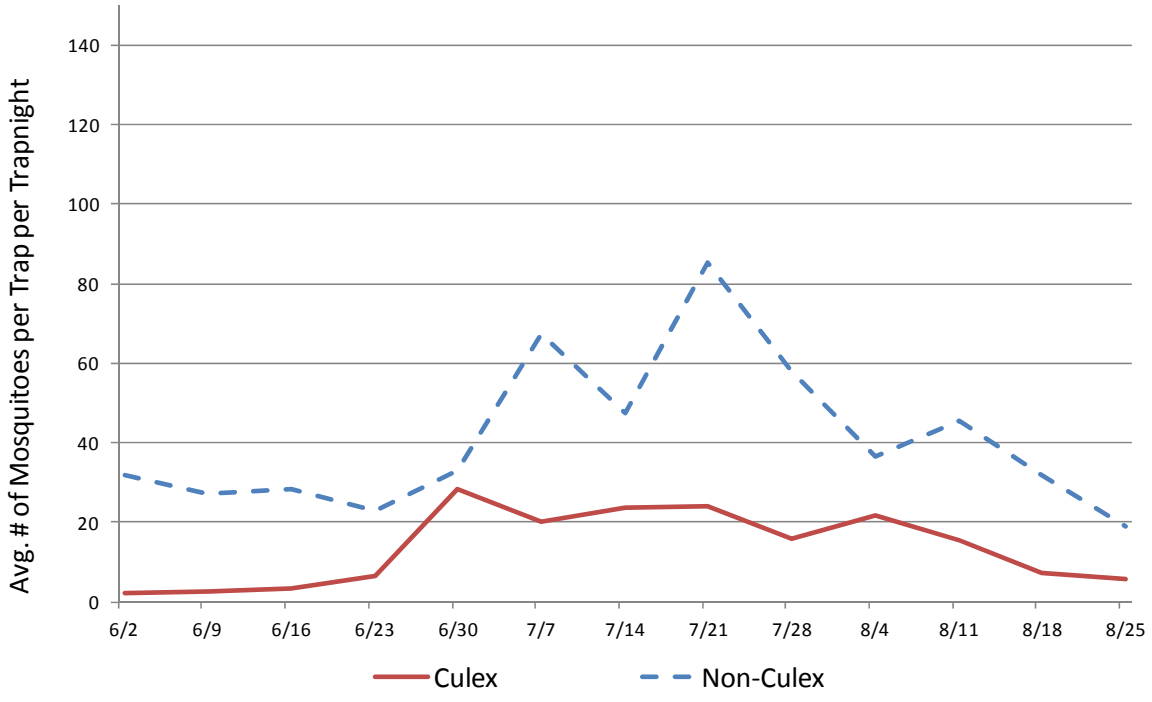
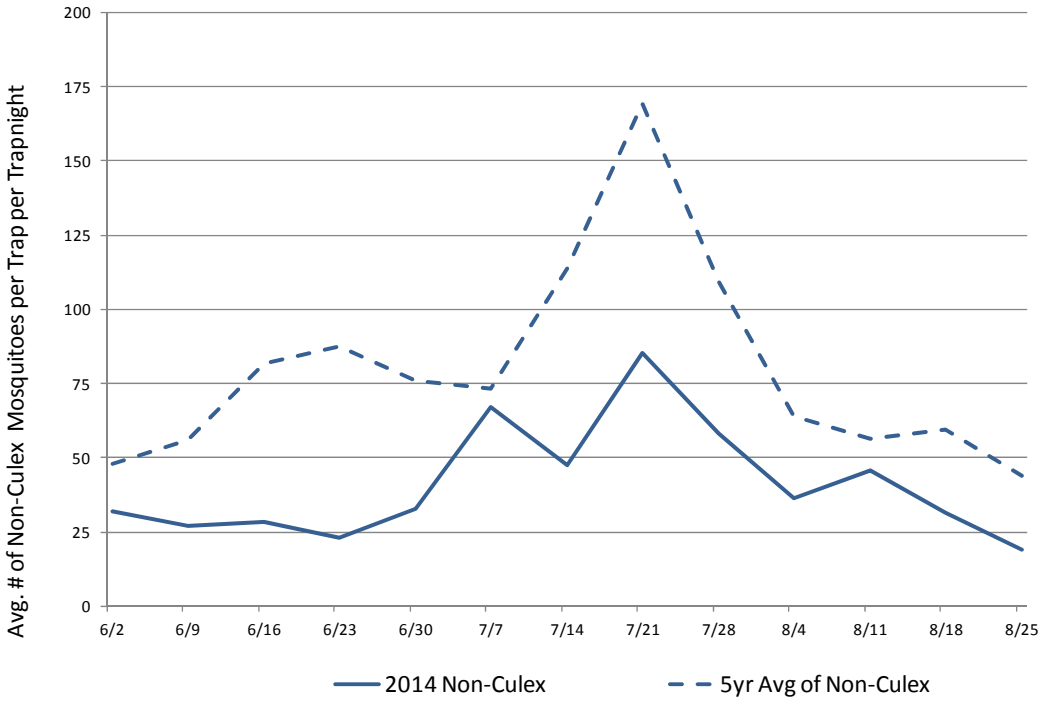
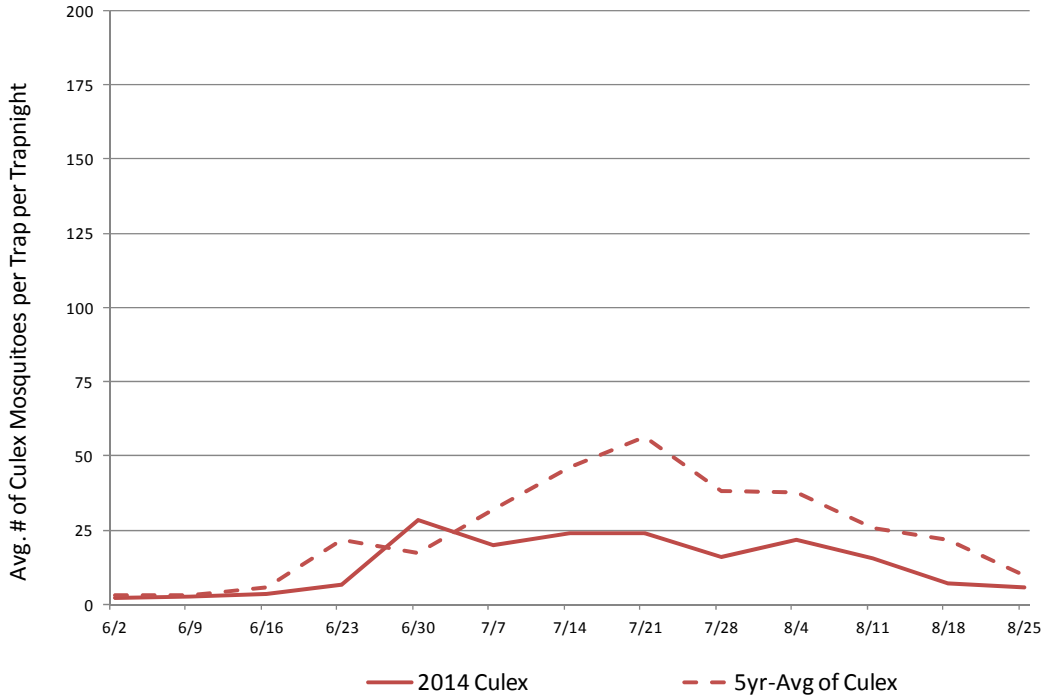


Figure 5 **Average Numbers of Total Mosquitoes per Trap per Trapnight, 2014 and 5yr-Avg***



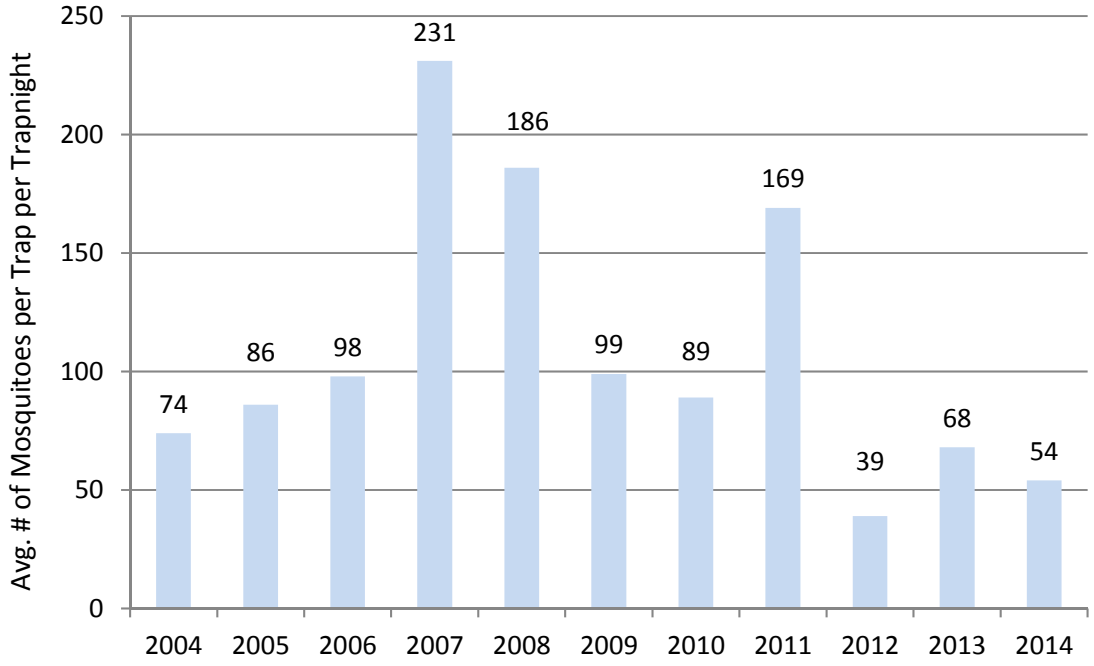
*Note: 5yr-Average based on 2009-2013 data

Figure 6 **Average Numbers of Culex Mosquitoes per Trap per Trapnight, 2014 and 5yr-Avg***



*Note: 5yr-Average based on 2009-2013 data

Figure 7 Average Numbers of Mosquitoes per Trap per Trapnight, 2004 - 2014*



*Note: 2004 - 2008 data provided by BCPH

Table 7 Total Number of Adult Mosquitoes per Trap for the 2014 Season[1]

Trap Name and Location	*Culex spp.*		*Ae./Oc. Spp.*		*Coquillettidia spp.*		*Culiseta spp.*		Trap Total	Avg. Per Trapnight	Trap %RA	Historical Avg. Per Trap Night	Range of Historical Trap Nights
	#	%RA	#	%RA	#	%RA	#	%RA					
BC-01[2] Old Tale Road	77	19.3	322	80.5	0	0.0	1	0.3	**400**	**31**	2.5	93	31 - 314
BC-02[2] Cottonwood Kennels	92	12.6	629	86.3	3	0.4	5	0.7	**729**	**56**	4.5	422	64 - 1,018
BC-03[2] Gunbarrel SE-Pali	135	22.4	457	75.8	3	0.5	8	1.3	**603**	**46**	3.7	120	45 - 257
BC-04[2] Gunbarrel NW-Idylwild	233	21.0	769	69.2	96	8.6	14	1.3	**1,112**	**86**	6.8	159	75 - 295
BC-05[2] Orange Orchard	53	28.8	129	70.1	0	0.0	2	1.1	**184**	**14**	1.1	120	24 - 271
BC-07[2] Brigadoon Glen	181	20.9	675	77.8	0	0.0	12	1.4	**868**	**67**	5.3	134	17 - 327
BC-08[2] Boulder Hills	514	39.2	780	59.5	0	0.0	17	1.3	**1,311**	**101**	8.1	162	56 - 448
BC-11[2] Niwot East - Majestic	361	39.9	513	56.7	0	0.0	30	3.3	**904**	**70**	5.6	101	25 - 255
BC-17[2] Niwot Central	144	28.3	362	71.3	0	0.0	2	0.4	**508**	**39**	3.1	45	10 - 94
BC-20[2] Willows	106	23.4	346	76.4	1	0.2	0	0.0	**453**	**35**	2.8	96	67 - 194
BC-22[2] Marshall / S.Boulder Creek	73	13.7	165	31.0	294	55.2	1	0.2	**533**	**41**	3.3	153	50 - 422
BC-23[2] Louisville Spanish Hills	113	57.9	78	40.0	3	1.5	1	0.5	**195**	**15**	1.2	35	8 - 63
BC-24[2] Louisville Wewonka Dr.	107	76.4	30	21.4	0	0.0	3	2.1	**140**	**11**	0.9	19	3 - 37
BC-30[3] Erie/Brownsville Random Ct.	125	9.2	1,150	85.0	0	0.0	78	5.8	**1,353**	**104**	8.3	59	22 - 124
BC-31[3] Divide Reservoir	237	15.9	1,222	81.8	0	0.0	34	2.3	**1,493**	**115**	9.2	164	58 - 403
BC-32[3] Baseline Heights	127	23.2	414	75.5	0	0.0	7	1.3	**548**	**42**	3.4	122	18 - 269
BC-33[4] Lake Valley Estates	138	60.8	85	37.4	1	0.4	3	1.3	**227**	**17**	1.4	89	31 - 238
BC-34[4] Cline Trout Farm	112	9.6	1,050	89.8	5	0.4	2	0.2	**1,169**	**90**	7.2	253	127 - 452
BC-36[4] Yellowstone Road	81	16.1	417	83.1	0	0.0	4	0.8	**502**	**39**	3.1	121	50 - 326
BC-37[4] Burch Reservoir	317	25.1	908	72.0	0	0.0	36	2.9	**1,261**	**97**	7.7	131	64 - 259
BC-38[4] Willow Glen Teller Lake	280	33.1	554	65.6	0	0.0	11	1.3	**845**	**65**	5.2	219	33 - 575
BC-39[5] Heatherwood	314	66.8	154	32.8	1	0.2	1	0.2	**470**	**36**	2.9	82	32 - 155
BC-40[5] Chance Acres	129	27.0	346	72.5	0	0.0	2	0.4	**477**	**37**	2.9	48	11 - 108
Total	**4,049**	24.9	**11,555**	71.0	**407**	2.5	**274**	1.6	**16,285**	**1,253**	100.0	2,947	- - -
Average	176	- - -	502	- - -	18	- - -	12	- - -	**708**	**54**	- - -	128	- - -

Notes: **1.** 2014 season includes one trap night per week from June 2 to August 25, 2014 for a total of 299 trap nights; **2.** Historical avg.per trapnight and range based on 2004-2012 BCPH data. **3**. Historical avg. per trapnight and range based on 2005-2012 BCPH data.**;** **4.** Historical avg.per trapnight and range based on 2006-2012 BCPH data; **5.** Historical avg.per trapnight and range based on 2009-2012 BCPH data due to new trap locations beginning in 2009; **%RA**= Percent Relative Abundance; **Ae./Oc.** = Aedes/Ochlerotatus

ADULT CONTROL METHODOLOGY

The overwhelming majority of the program's efforts are focused on larval control (**see Appendix D**), but many IMM programs still include ultra-low volume (ULV) adult control to enhance control options. Although every effort is made to identify and control all mosquito larval habitats within the District, it is possible that additional mosquito habitats occur in inaccessible lands and locations outside of the project area. Mosquitoes originating from these uncontrolled habitats can migrate into the project area, causing adult populations to exceed local annoyance levels, increase the populations in excess of the BCMCD's threshold level, increase the potential WNV risk, and trigger the need for adult control. OtterTail and BCMCD made adult control decisions based on a combination of the weekly trap counts, residential complaints, and WNV activity levels. When trap populations were high and there was a correspondingly high number of residential complaints, OtterTail would then perform adult control in those areas of the county with the increased mosquito activity.

OtterTail's philosophy with adult control applications is to provide effective control of adult mosquito populations and minimize potential impacts to the public and the environment. OtterTail's trained staff follows the appropriate application practices and utilize state-of-the-art equipment for adult control. OtterTail uses ULV equipment designed and calibrated to effectively control adult mosquitoes with a minimal amount of active ingredients. ULV delivery techniques, such as timing and weather monitoring, are also designed to minimize environmental and non-target impacts, while at the same time effectively managing populations of adult mosquitoes.

BCMCD recognized the need for increasingly accurate pesticide application and documentation. Ottertail's GPS/GIS based software and hardware implementation for ULV applications was added to the program in 2009 and continued its use through the 2014 season. OtterTail maintains a fleet of ULV-equipped vehicles enhanced with the Monitor 4 system, which is a GPS based variable flow pump and sprayer control system. This system gives OtterTail the ability to incorporate GPS and GIS into truck-mounted ULV applications, which can dramatically improve several components of an adulticiding program.

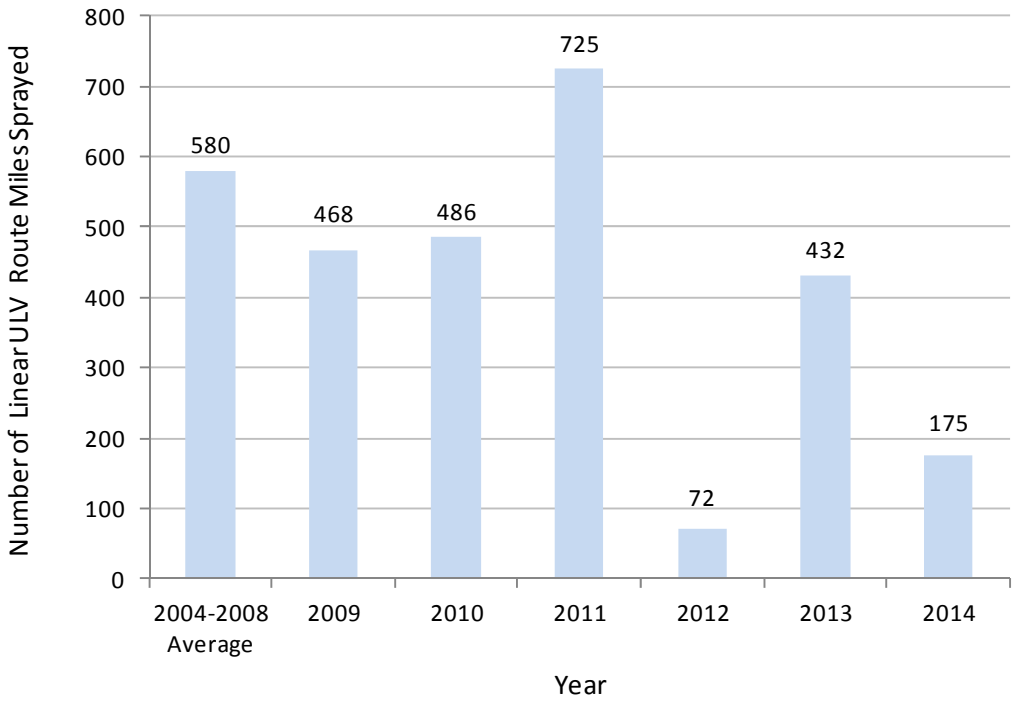
In general, this system has increased the accuracy of pesticide applications and documentation. Specific improvements include 1) complete documentation of specific locations and amounts of spray applications; 2) assurance of consistent application rate by its adjustment of spray volume with vehicle speed (including shutoff if vehicle speed exceeds pesticide label recommendations); 3) the ability to report linear miles of actual spraying rather than total vehicle trip miles; 4) the documentation of spray shutoff for residents on "no spray lists"; 5) enhanced GIS data management and reporting efficiency; and 6) the ability to graphically display data in GIS mapping formats. OtterTail's incorporation of these technologies into its entire fleet of ULV trucks has proven to be a valuable improvement to our adulticiding programs.

OtterTail's 2014 adult mosquito control applications were performed with the water-soluble adulticide Aqualuer® 20-20. This product is highly effective for the quick knockdown and control of adult mosquitoes and its water-soluble formulation is safer and easier to work with than more traditional pesticides. The active ingredient in Aqualuer® 20-20 is a synergized permethrin (a synthetic pyrethroid). Synthetic pyrethroids are synthesized derivatives of naturally occurring pyrethrins, which are taken from pyrethrum, an extract of chrysanthemum flowers. These products generally cause rapid knockdown of adult mosquitoes, exhibit low mammalian toxicity, and degrade rapidly in sunlight with little or no residual product.

ADULT CONTROL RESULTS AND DISCUSSION

During the 2014 season, approximately 175 linear route miles (at an application rate of 0.0035 lbs Permethrin a.i. per acre) of adult control were performed for the BCMCD (**Figure 8**). A detailed summary of the District's 2014 adult treatment applications can be found in **Appendix C**.

Figure 8 Total Linear ULV Route Miles Sprayed, 2004 - 2014*



*Note: 2004 - 2008 data provided by BCPH

OtterTail and BCMCD acknowledge that adult mosquito control can be a sensitive matter to many residents; therefore, we offer a *Spray Notification and Shutoff Service* as part of the adult control program. This allows residents to call OtterTail's Mosquito Control Hotline and request that they be notified before adult control applications are performed near their properties and/or request that the ULV sprayer be shutoff in areas bordering their address.

During the 2014 season, OtterTail received 19 shutoff requests and 10 requests to be notified before spraying. When these were added into the on-going list, OtterTail's shutoff and notification list included 698 households that wanted to be notified before spraying in their neighborhood and 309 households that

requested spray shutoffs. OtterTail notified residents on both the notification and shutoff lists if their community was scheduled to be sprayed 24 hours in advance using an automated messaging service. In 2014, OtterTail completed 422 notification calls.

6.0 PUBLIC OUTREACH AND EDUCATION

Public education is an important component to any mosquito control program and is vital in combating WNV. BCPH continued to provide valuable educational materials to residents and the general public through local media outlets, bulletins, pamphlets and their internet website. The educational materials stressed the importance of actions that residents could take to aid in the effort to combat WNV; topics included personal protection, property maintenance for source reduction, and general information related to the WNV disease cycle. BCPH staff also provided insect repellent wipes, with the BCMCD website information printed on packaging, to communities within the county during the 2014 season. BCPH released several press releases throughout the season with detailed information regarding its mosquito control program. BCPH and OtterTail staff also conducted numerous interviews and provided an abundance of mosquito control related information to several media outlets throughout the 2014 season.

OtterTail offers an extensive amount of information on its website, including sections on mosquito biology and control, and actions residents and land users could take to help aid the District in its mosquito control efforts. The website provided online spray notifications for the areas where OtterTail would be performing adult control applications each week, as well as allowing residents to fill out an online request form to be included in OtterTail's *Spray Notification or Shutoff Service.* These notification systems allowed the District to cease running spray location advertisements in local newspapers beginning in 2011, which has provided a substantial cost savings to the District.

OtterTail provided a toll-free hotline and email address to residents in order to report mosquito complaints and request services. In 2014, OtterTail received 161 Mosquito Hotline calls from households within BCMCD, which were classified into five categories. As shown in **Table 8, t**he majority of the calls received in 2014 were to report nuisance mosquito activity (39 percent) and to obtain general mosquito and program information (26 percent). Adult mosquito nuisance reports were used to shift surveillance into areas, if needed, and used in conjunction with trap counts to focus adult mosquito control operations. Habitat assessment calls received in 2014 resulted in an increase in monitored sites; 19 percent of these calls were reporting sites already being monitored and 63 percent of the calls resulted in the addition of 17 new mosquito habitat sites to the program (**Table 9**). Due to the low mosquito populations throughout the season, the total number of hotline calls received in 2014 (161) was significantly lower than the average number of calls typically received in recent years (**Figure 9**), which have a historical average of 333 calls a year. OtterTail provided site inspections and any consequential treatments to potential larval habitat as necessary. If landowners gave permission, then these sources were added to the project site list and incorporated into the surveillance schedule. OtterTail field technicians only accessed private properties if permission was granted by the owner.

Educating residents on the need for property maintenance, source reduction, and the use of personal protection measures continued to be crucial in the efforts to control WNV in 2014. Increased awareness and actions taken by the public likely prevented many more WNV cases from occurring in 2014.

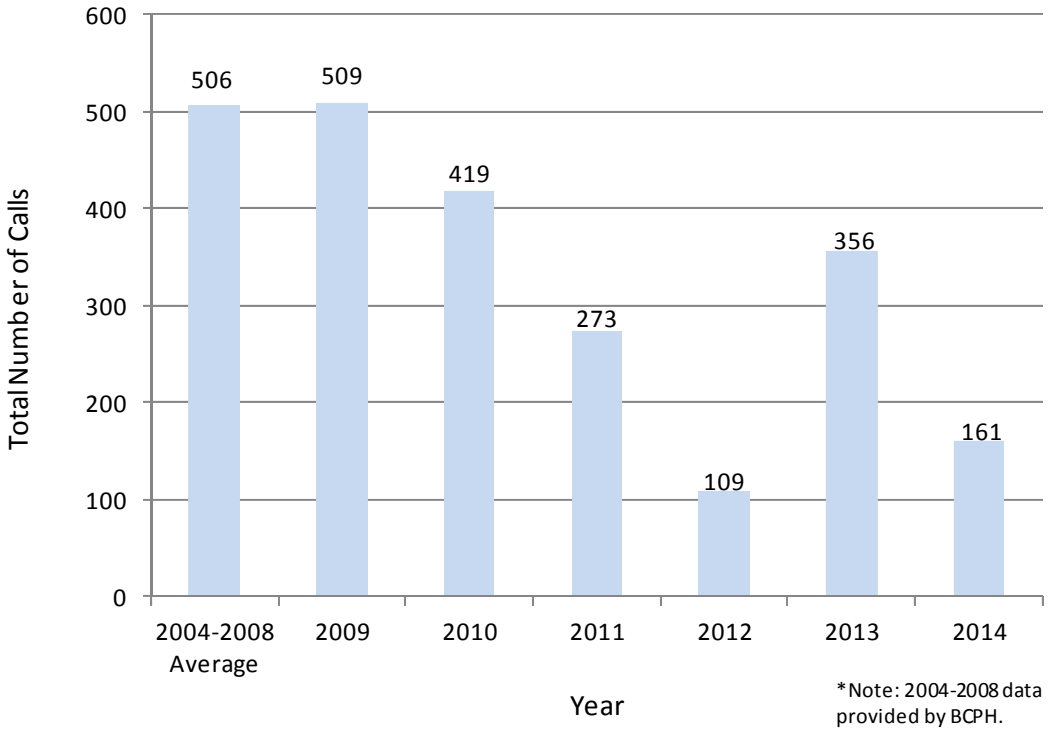
Table 8 **Service Requests by Type, 2009 - 2014**

Call Types	2014		2009-2013 Average	
	Number of Calls	Percentage	Number of Calls	Percentage
Nuisance Complaint	64	39.8%	165	49.5%
Habitat Assessment	27	16.8%	43	12.9%
Spray ShutOff	19	11.8%	33	10.0%
Spray Notification	10	6.2%	47	14.2%
General Info/Questions	41	25.5%	45	13.5%
Total	**161**	100.0%	333	100.0%

Table 9 **Results of Habitat Inspections from Hotline Calls, 2009 - 2014**

Results			2009-2013 Average	
	Number of Calls	Percentage	Number of Calls	Percentage
Pre-Existing Site	5	18.5%	20	53.7%
Added New Site	17	63.0%	11	29.5%
Not a Suitable Site	5	18.5%	6	16.8%
Total	**27**	100.0%	**38**	100.0%

Figure 9 **Total Number of Hotline Calls, 2004 - 2014**



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APPENDIX A - ADULT MOSQUITO TRAP DESCRIPTION

For the 2014 season, the carbon dioxide (CO_2) baited Centers for Disease Control (CDC) Light Trap was incorporated into Boulder County's adult mosquito surveillance system. OtterTail followed the CDPHE trapping and handling protocol (CDPHE 2013) for the traps used in its WNV surveillance and testing program. The following is a detailed description of the CO_2 light trap used.

CO_2 Light Trap

To capture the most representative sample of adult mosquitoes in an area, CDC Light Traps are baited with CO_2 in the form of dry ice and set overnight in adult mosquito harborage areas throughout the mosquito season. The traps are designed with the knowledge that the female mosquito species we target are attracted to light, CO_2, and heat. The number and types of mosquitoes captured in these traps can provide local officials with a valuable early indication of the threat of WNV.

The traps consist of a plastic insulated thermos filled with enough dry ice (CO_2) to last throughout the trapping cycle. Units consist of a light, fan unit, and fine mesh net which hang below the thermos. The device is placed on a tree branch with the thermos approximately five to seven feet off the ground and is suspended by a small chain or rope to allow the thermos and net to hang free. Holes at the base of the thermos allow dissipating CO_2 to be emitted as an attractant around the trap. Batteries run the small fan and light positioned above the net. The light provides further attraction and once the mosquitoes are near the light, they are pulled down into the net by the downward force of the fan.

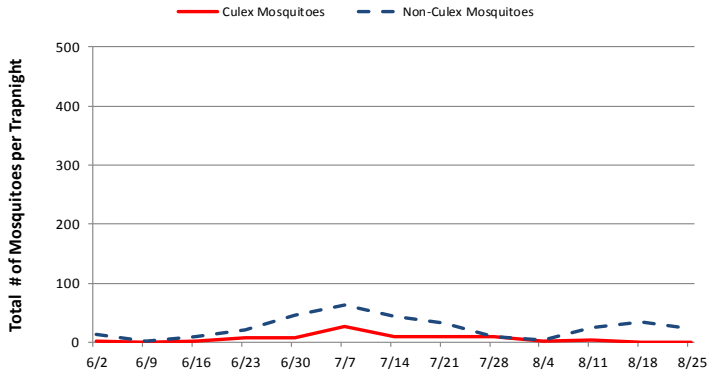
In the morning, the mosquitoes are removed and frozen to prepare for identification. During the identification process, the mosquitoes are sorted by species and sex. Female vector mosquitoes are routinely submitted to the Colorado Department of Public Health and Environment (CDPHE) lab for WNV testing as needed.

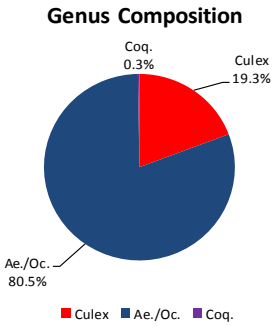
APPENDIX B - 2014 WEEKLY TRAP COUNTS

BC-01 Old Tale Rd

Trap ID/Trap Location	**BC-01/Old Tale Rd**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	9	2.3%
Culex tarsalis	68	17.0%
Total Culex	**77**	**19.3%**
% RA Culex	**19.3%**	
Aedes vexans	245	61.3%
Oc. dorsalis	1	0.3%
Oc. hendersoni	4	1.0%
Oc. increpitus	30	7.5%
Oc. melanimon	23	5.8%
Oc. trivittatus	19	4.8%
Total Aedes/Ochlerotatus (Ae./Oc.)	**322**	**80.5%**
% RA Ae./Oc.	**80.5%**	
Anopheles spp.	0	0.0%
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	0	0.0%
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	1	0.3%
Total Culiseta	**1**	**0.3%**
% RA Culiseta	**0.3%**	
Trap Total	400	100.0%
Average # of Total Mosquitoes per Trapnight	31	
Average # of Culex per Trapnight	6	

*%RA= Percent Relative Abundance

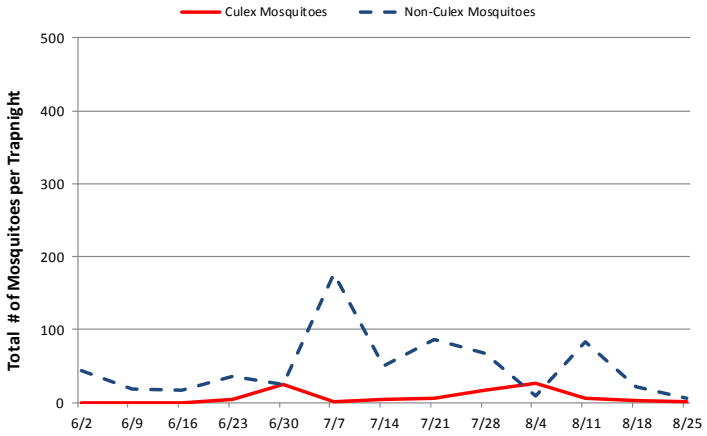


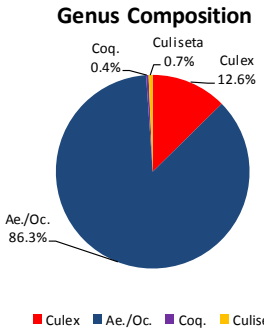


BC-02 Cottonwood Kennels

Trap ID/Trap Location	**BC-02 Cottonwood Kennels**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	14	1.9%
Culex salinarius	2	0.3%
Culex tarsalis	76	10.4%
Total Culex	**92**	**12.6%**
% RA Culex	**12.6%**	
Aedes vexans	430	59.0%
Oc. dorsalis	7	1.0%
Oc. hendersoni	1	0.1%
Oc. increpitus	14	1.9%
Oc. melanimon	121	16.6%
Oc. trivittatus	56	7.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**629**	**86.3%**
% RA Ae./Oc.	**86.3%**	
Anopheles spp.	0	0.0%
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	3	0.4%
Total Coquillettidia (Coq.)	**3**	**0.4%**
% RA Coquillettidia	**0.4%**	
Culiseta inornata	5	0.7%
Total Culiseta	**5**	**0.7%**
% RA Culiseta	**0.7%**	
Trap Total	729	100.0%
Average # of Total Mosquitoes per Trapnight	56	
Average # of Culex per Trapnight	7	

*%RA= Percent Relative Abundance

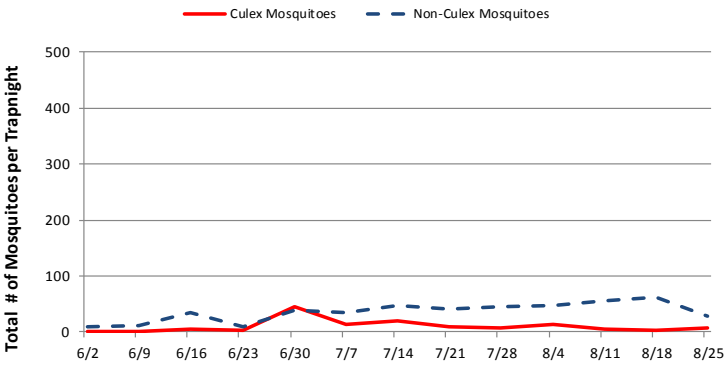


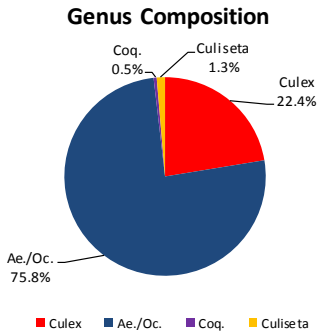


BC-03 Gunbarrel SE-Pali

Trap ID/Trap Location	**BC-03/Gunbarrel SE-Pali**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	22	3.6%
Culex tarsalis	113	18.7%
Total Culex	**135**	**22.4%**
% RA Culex	**22.4%**	
Aedes vexans	394	65.3%
Oc. dorsalis	9	1.5%
Oc. hendersoni	2	0.3%
Oc. increpitus	6	1.0%
Oc. melanimon	36	6.0%
Oc. trivittatus	10	1.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**457**	**75.8%**
% RA Ae./Oc.	**75.8%**	
Anopheles spp.	0	0.0%
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	3	0.5%
Total Coquillettidia (Coq.)	**3**	**0.5%**
% RA Coquillettidia	**0.5%**	
Culiseta inornata	8	1.3%
Total Culiseta	**8**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	603	100.0%
Average # of Total Mosquitoes per Trapnight	46	
Average # of Culex per Trapnight	10	

*%RA= Percent Relative Abundance

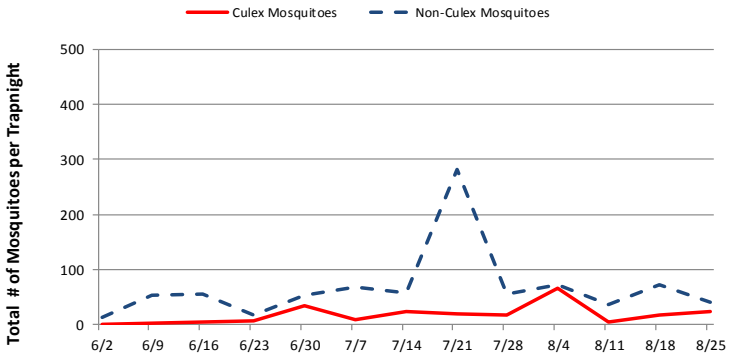


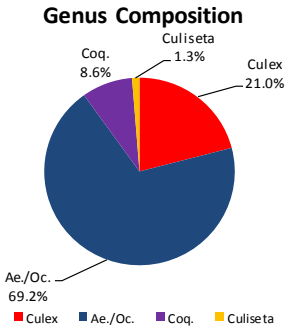


BC-04 Gunbarrel NW-Idylwild

Trap ID/Trap Location	**BC-04/Gunbarrel NW-Idylwild**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	77	6.9%
Culex tarsalis	156	14.0%
Total Culex	**233**	**21.0%**
% RA Culex	**21.0%**	
Aedes vexans	535	48.1%
Oc. dorsalis	20	1.8%
Oc. increpitus	20	1.8%
Oc. melanimon	145	13.0%
Oc. trivittatus	49	4.4%
Total Aedes/Ochlerotatus (Ae./Oc.)	**769**	**69.2%**
% RA Ae./Oc.	**69.2%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	96	8.6%
Total Coquillettidia (Coq.)	**96**	**8.6%**
% RA Coquillettidia	**8.6%**	
Culiseta inornata	14	1.3%
Total Culiseta	**14**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	1,112	100.0%
Average # of Total Mosquitoes per Trapnight	86	
Average # of Culex per Trapnight	18	

*%RA= Percent Relative Abundance

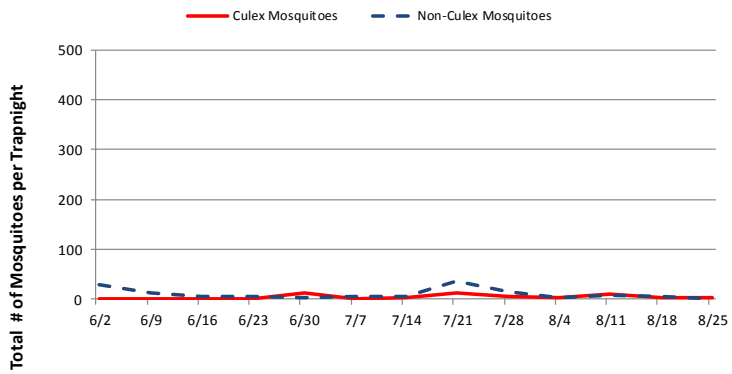


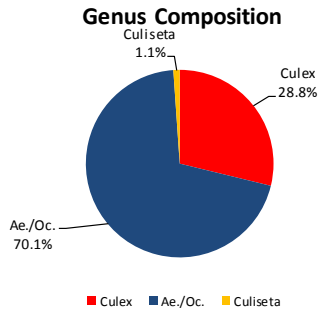


BC-05 Orange Orchard

Trap ID/Trap Location	**BC-05/Orange Orchard**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	7	3.8%
Culex salinarius	1	0.5%
Culex tarsalis	45	24.5%
Total Culex	**53**	**28.8%**
% RA Culex	**28.8%**	
Aedes vexans	122	66.3%
Oc. increpitus	1	0.5%
Oc. melanimon	1	0.5%
Oc. trivittatus	5	2.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**129**	**70.1%**
% RA Ae./Oc.	**70.1%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	2	1.1%
Total Culiseta	**2**	**1.1%**
% RA Culiseta	**1.1%**	
Trap Total	184	100.0%
Average # of Total Mosquitoes per Trapnight	14	
Average # of Culex per Trapnight	4	

*%RA= Percent Relative Abundance

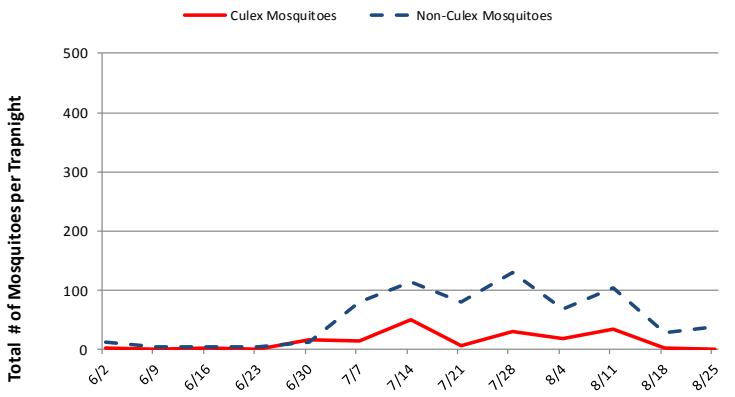


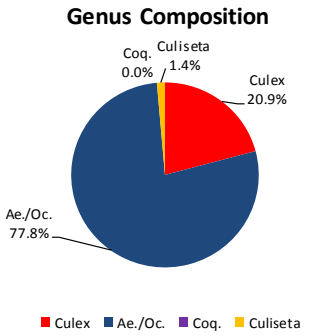


BC-07 Bridgadoon Glen

Trap ID/Trap Location	**BC-07/Bridgadoon Glen**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	45	5.2%
Culex tarsalis	136	15.7%
Total Culex	**181**	**20.9%**
% RA Culex	**20.9%**	
Aedes cinereus	0	0.0%
Aedes vexans	403	46.4%
Oc. dorsalis	12	1.4%
Oc. Increpitus	7	0.8%
Oc. melanimon	22	2.5%
Oc. nigromaculis	0	0.0%
Oc. trivittatus	231	26.6%
Total Aedes/Ochlerotatus (Ae./Oc.)	**675**	**77.8%**
% RA Ae./Oc.	**77.8%**	
Anopheles spp.	0	0.0%
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	0	0.0%
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	12	1.4%
Total Culiseta	**12**	**1.4%**
% RA Culiseta	**1.4%**	
Trap Total	868	100.0%
Average # of Total Mosquitoes per Trapnight	67	
Average # of Culex per Trapnight	14	

*%RA= Percent Relative Abundance

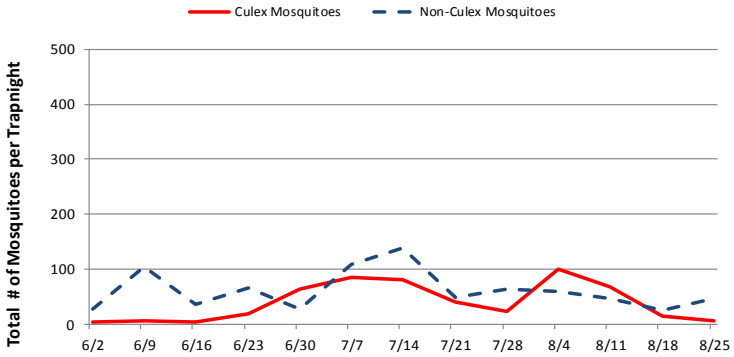


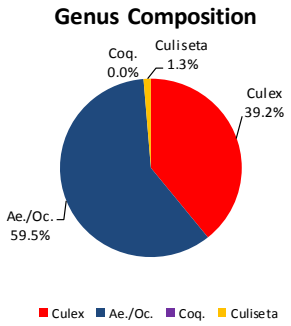


BC-08 Boulder Hills

Trap ID/Trap Location	**BC-08/Boulder Hills**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	104	7.9%
Culex Salinarius	1	0.1%
Culex tarsalis	409	31.2%
Total Culex	**514**	**39.2%**
% RA Culex	**39.2%**	
Aedes vexans	526	40.1%
Oc. dorsalis	53	4.0%
Oc. Hendersoni	3	0.2%
Oc. increpitus	25	1.9%
Oc. melanimon	22	1.7%
Oc. trivittatus	151	11.5%
Total Aedes/Ochlerotatus (Ae./Oc.)	**780**	**59.5%**
% RA Ae./Oc.	**59.5%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	0	0.0%
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	17	1.3%
Total Culiseta	**17**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	1,311	100.0%
Average # of Total Mosquitoes per Trapnight	101	
Average # of Culex per Trapnight	40	

*%RA= Percent Relative Abundance

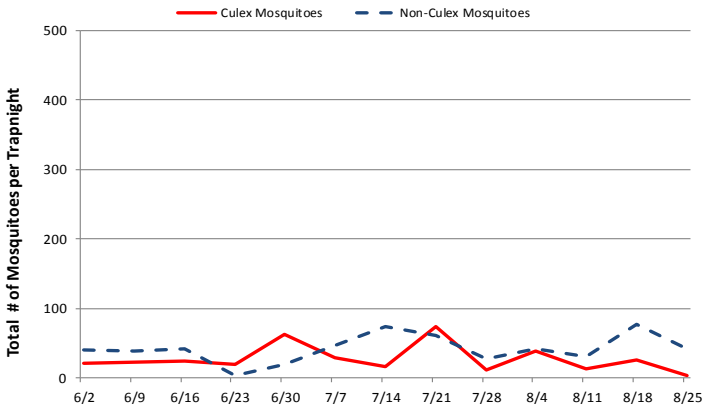


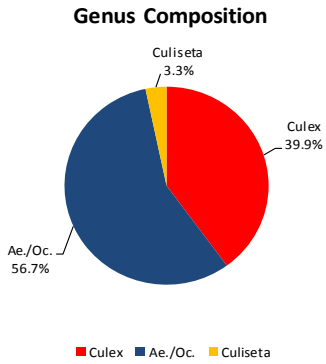


BC-11 Niwot East Majestic

Trap ID/Trap Location	**BC-11/Niwot East Majestic**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	44	4.9%
Culex salinarius	1	0.1%
Culex tarsalis	316	35.0%
Total Culex	**361**	**39.9%**
% RA Culex	**39.9%**	
Aedes vexans	404	44.7%
Oc. dorsalis	98	10.8%
Oc. increpitus	1	0.1%
Oc. melanimon	4	0.4%
Oc. nigromaculis	2	0.2%
Oc. trivittatus	4	0.4%
Total Aedes/Ochlerotatus (Ae./Oc.)	**513**	**56.7%**
% RA Ae./Oc.	**56.7%**	
Anopheles spp.	0	0.0%
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	0	0.0%
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	30	3.3%
Total Culiseta	**30**	**3.3%**
% RA Culiseta	**3.3%**	
Trap Total	904	100.0%
Average # of Total Mosquitoes per Trapnight	70	
Average # of Culex per Trapnight	28	

*%RA= Percent Relative Abundance

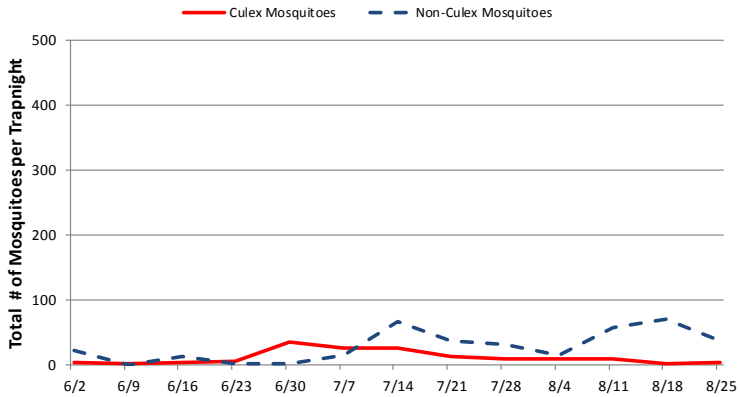


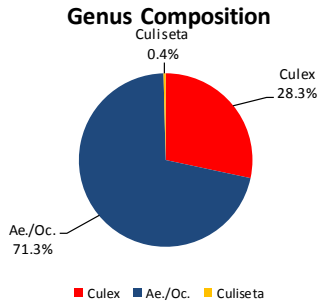


BC-17 Niwot Central

Trap ID/Trap Location	**BC-17 Niwot Central**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	15	3.0%
Culex tarsalis	129	25.4%
Total Culex	**144**	**28.3%**
% RA Culex	**28.3%**	
Aedes vexans	306	60.2%
Oc. dorsalis	19	3.7%
Oc. increpitus	10	2.0%
Oc. melanimon	6	1.2%
Oc. trivittatus	21	4.1%
Total Aedes/Ochlerotatus (Ae./Oc.)	**362**	**71.3%**
% RA Ae./Oc.	**71.3%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	2	0.4%
Total Culiseta	**2**	**0.4%**
% RA Culiseta	**0.4%**	
Trap Total	508	100.0%
Average # of Total Mosquitoes per Trapnight	39	
Average # of Culex per Trapnight	11	

*%RA= Percent Relative Abundance

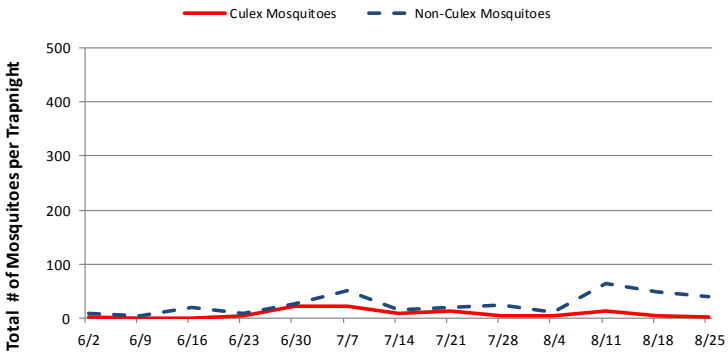


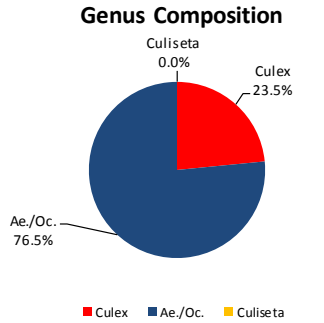


BC-20 Willows

Trap ID/Trap Location	**BC-20/Willows**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	23	5.1%
Culex tarsalis	83	18.3%
Total Culex	**106**	**23.4%**
% RA Culex	**23.4%**	
Aedes vexans	308	68.0%
Oc. dorsalis	7	1.5%
Oc. increpitus	13	2.9%
Oc. melanimon	12	2.6%
Oc. trivittatus	6	1.3%
Total Aedes/Ochlerotatus (Ae./Oc.)	**346**	**76.4%**
% RA Ae./Oc.	**76.4%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	1	0.2%
Total Coquillettidia (Coq.)	**1**	**0.2%**
% RA Coquillettidia	**0.2%**	
Total Culiseta	**0**	**0.0%**
% RA Culiseta	**0.0%**	
Trap Total	453	100.0%
Average # of Total Mosquitoes per Trapnight	35	
Average # of Culex per Trapnight	8	

*%RA= Percent Relative Abundance

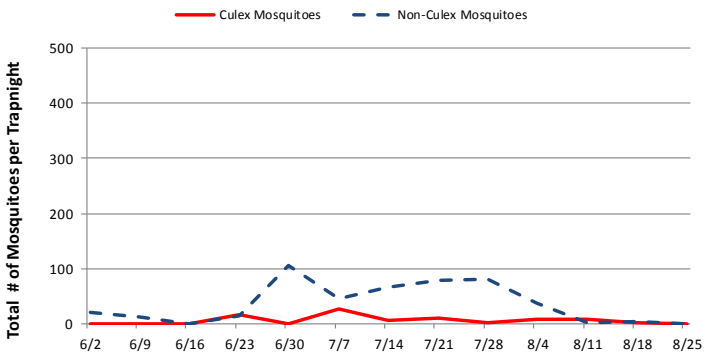


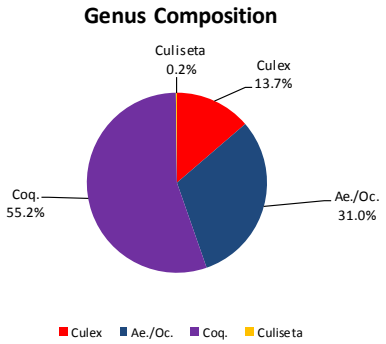


BC-22 Marshall-S Boulder Crk

Trap ID/Trap Location	**BC-22/Marshall-S Boulder Crk**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	44	8.3%
Culex tarsalis	29	5.4%
Total Culex	**73**	**13.7%**
% RA Culex	**13.7%**	
Aedes vexans	120	22.5%
Oc. dorsalis	5	0.9%
Oc. hendersoni	1	0.2%
Oc.increpitus	23	4.3%
Oc. melanimon	2	0.4%
Oc. trivittatus	14	2.6%
Total Aedes/Ochlerotatus (Ae./Oc.)	**165**	**31.0%**
% RA Ae./Oc.	**31.0%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	294	55.2%
Total Coquillettidia (Coq.)	**294**	**55.2%**
% RA Coquillettidia	**55.2%**	
Culiseta inornata	1	0.2%
Total Culiseta	**1**	**0.2%**
% RA Culiseta	**0.2%**	
Trap Total	533	100.0%
Average # of Total Mosquitoes per Trapnight	41	
Average # of Culex per Trapnight	6	

*%RA= Percent Relative Abundance

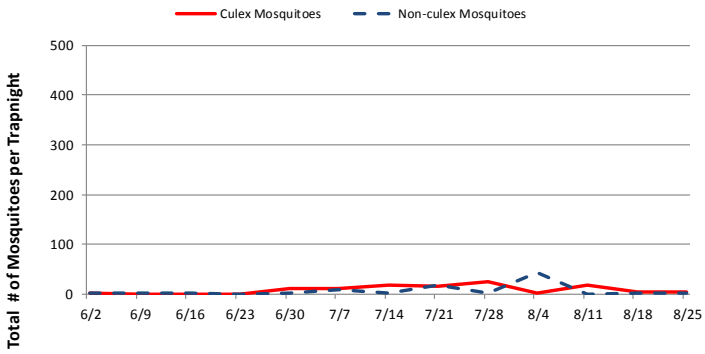


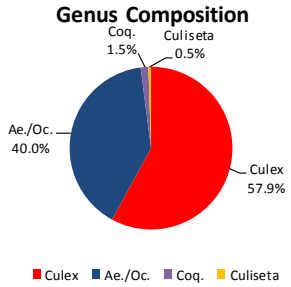


BC-23-Louisville-Spanish Hills

Trap ID/Trap Location	**BC-23/Louisville-Spanish Hills**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	23	11.8%
Culex salinarius	2	1.0%
Culex tarsalis	88	45.1%
Total Culex	**113**	**57.9%**
% RA Culex	**57.9%**	
Aedes vexans	60	30.8%
Oc. dorsalis	8	4.1%
Oc. increpitus	3	1.5%
Oc. melanimon	7	3.6%
Total Aedes/Ochlerotatus (Ae./Oc.)	**78**	**40.0%**
% RA Ae./Oc.	**40.0%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	3	1.5%
Total Coquillettidia (Coq.)	**3**	**1.5%**
% RA Coquillettidia	**1.5%**	
Culiseta inornata	1	0.5%
Total Culiseta	**1**	**0.5%**
% RA Culiseta	**0.5%**	
Trap Total	195	100.0%
Average # of Total Mosquitoes per Trapnight	15	
Average # of Culex per Trapnight	9	

*%RA= Percent Relative Abundance

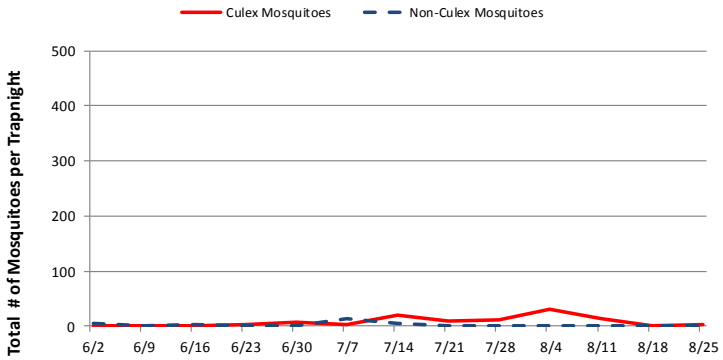


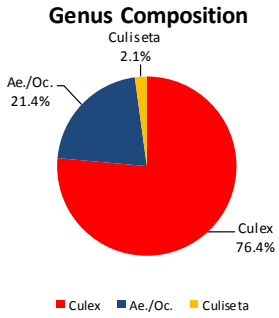


BC-24 Louisville-Wewonka Dr

Trap ID/Trap Location	**BC-24/Louisville-Wewonka Dr**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	23	16.4%
Culex salinarius	1	0.7%
Culex tarsalis	83	59.3%
Total Culex	**107**	**76.4%**
% RA Culex	**76.4%**	
Aedes vexans	20	14.3%
Oc. dorsalis	2	1.4%
Oc. increpitus	5	3.6%
Oc. melanimon	3	2.1%
Total Aedes/Ochlerotatus (Ae./Oc.)	**30**	**21.4%**
% RA Ae./Oc.	**21.4%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	3	2.1%
Total Culiseta	**3**	**2.1%**
% RA Culiseta	**2.1%**	
Trap Total	140	100.0%
Average # of Total Mosquitoes per Trapnight	11	
Average # of Culex per Trapnight	8	

*%RA= Percent Relative Abundance

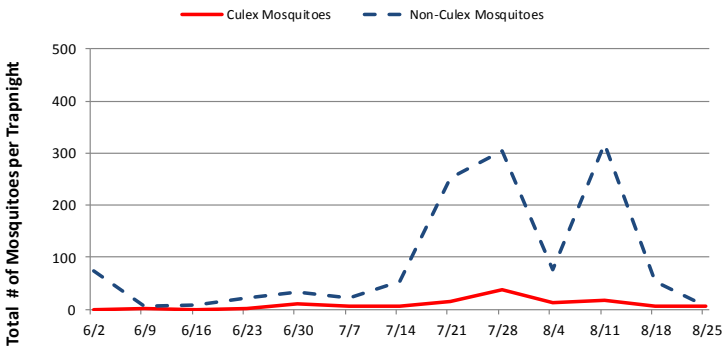


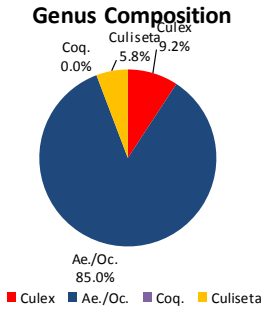


BC-30 Erie-Brownsville Random Ct

Trap ID/Trap Location	**BC-30/Erie-Brownsville**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	10	0.7%
Culex tarsalis	115	8.5%
Total Culex	**125**	**9.2%**
% RA Culex	**9.2%**	
Aedes vexans	848	62.7%
Oc. dorsalis	87	6.4%
Oc. increpitus	24	1.8%
Oc. melanimon	114	8.4%
Oc. trivittatus	77	5.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**1,150**	**85.0%**
% RA Ae./Oc.	**85.0%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	78	5.8%
Total Culiseta	**78**	**5.8%**
% RA Culiseta	**5.8%**	
Trap Total	1,353	100.0%
Average # of Total Mosquitoes per Trapnight	104	
Average # of Culex per Trapnight	10	

*%RA= Percent Relative Abundance

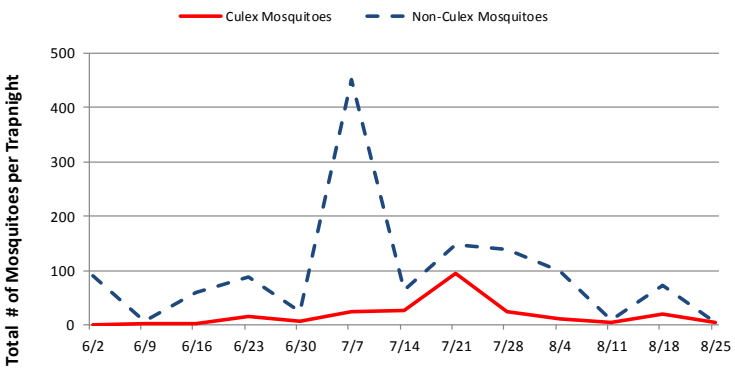


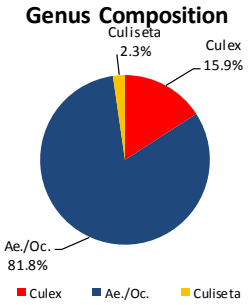


BC-31 Divide Reservoir

Trap ID/Trap Location	**BC-31/Divide Reservoir**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	50	3.3%
Culex salinarius	1	0.1%
Culex tarsalis	186	12.5%
Total Culex	**237**	**15.9%**
% RA Culex	**15.9%**	
Aedes vexans	991	66.4%
Oc. dorsalis	115	7.7%
Oc. increpitus	21	1.4%
Oc. melanimon	26	1.7%
Oc. trivittatus	69	4.6%
Total Aedes/Ochlerotatus (Ae./Oc.)	**1,222**	**81.8%**
% RA Ae./Oc.	**81.8%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	34	2.3%
Total Culiseta	**34**	**2.3%**
% RA Culiseta	**2.3%**	
Trap Total	1,493	100.0%
Average # of Total Mosquitoes per Trapnight	115	
Average # of Culex per Trapnight	18	

*%RA= Percent Relative Abundance

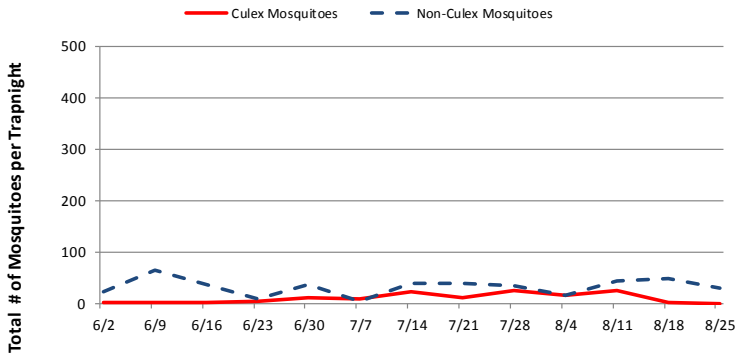


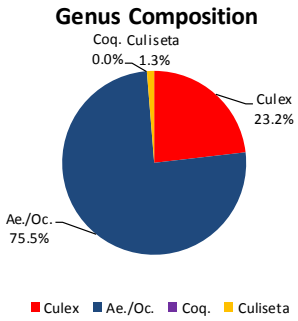


BC-32 Baseline Heights

Trap ID/Trap Location	**BC-32/Baseline Heights**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	27	4.9%
Culex tarsalis	100	18.2%
Total Culex	**127**	**23.2%**
% RA Culex	**23.2%**	
Aedes vexans	298	54.4%
Oc. dorsalis	46	8.4%
Oc. increpitus	10	1.8%
Oc. melanimon	56	10.2%
Oc. trivittatus	4	0.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**414**	**75.5%**
% RA Ae./Oc.	**75.5%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	7	1.3%
Total Culiseta	**7**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	548	100.0%
Average # of Total Mosquitoes per Trapnight	42	
Average # of Culex per Trapnight	10	

*%RA= Percent Relative Abundance

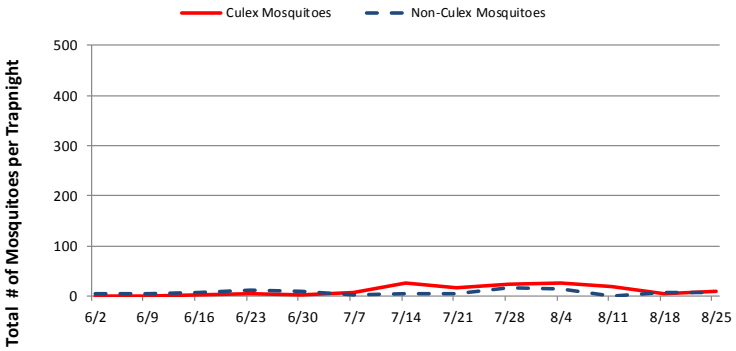


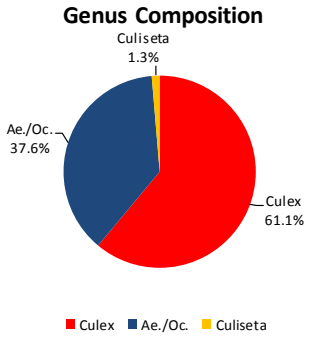


BC-33 Lake Valley Estates

Trap ID/Trap Location	**BC-33/Lake Valley Estates**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	59	26.0%
Culex salinarius	1	0.4%
Culex tarsalis	78	34.4%
Total Culex	**138**	**60.8%**
% RA Culex	**60.8%**	
Aedes vexans	77	33.9%
Oc. increpitus	1	0.4%
Oc. melanimon	3	1.3%
Oc. trivittatus	4	1.8%
Total Aedes/Ochlerotatus (Ae./Oc.)	**85**	**37.4%**
% RA Ae./Oc.	**37.4%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	1	0.4%
Total Coquillettidia (Coq.)	**1**	**0.4%**
% RA Coquillettidia	**0.4%**	
Culiseta inornata	3	1.3%
Total Culiseta	**3**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	227	100.0%
Average # of Total Mosquitoes per Trapnight	17	
Average # of Culex per Trapnight	11	

*%RA= Percent Relative Abundance

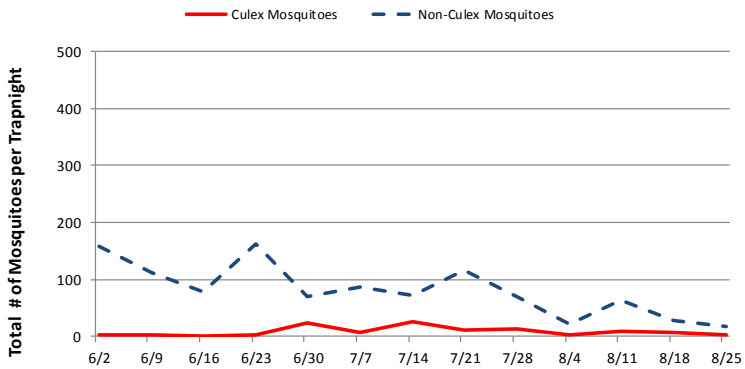


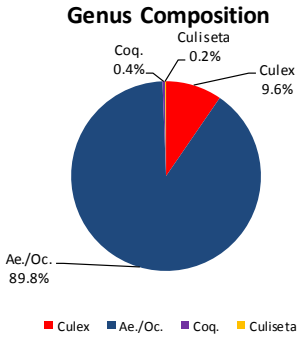


BC-34 Cline Trout Farm

Trap ID/Trap Location	**BC-34 Cline Trout Farm**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	19	1.6%
Culex tarsalis	93	8.0%
Total Culex	**112**	**9.6%**
% RA Culex	**9.6%**	
Aedes vexans	475	40.6%
Oc. dorsalis	20	1.7%
Oc. increpitus	516	44.1%
Oc. melanimon	30	2.6%
Oc.nigromaculis	1	0.1%
Oc. trivittatus	8	0.7%
Total Aedes/Ochlerotatus (Ae./Oc.)	**1,050**	**89.8%**
% RA Ae./Oc.	**89.8%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	5	0.4%
Total Coquillettidia (Coq.)	**5**	**0.4%**
% RA Coquillettidia	**0.4%**	
Culiseta inornata	2	0.2%
Total Culiseta	**2**	**0.2%**
% RA Culiseta	**0.2%**	
Trap Total	1,169	100.0%
Average # of Total Mosquitoes per Trapnight	90	
Average # of Culex per Trapnight	9	

*%RA= Percent Relative Abundance

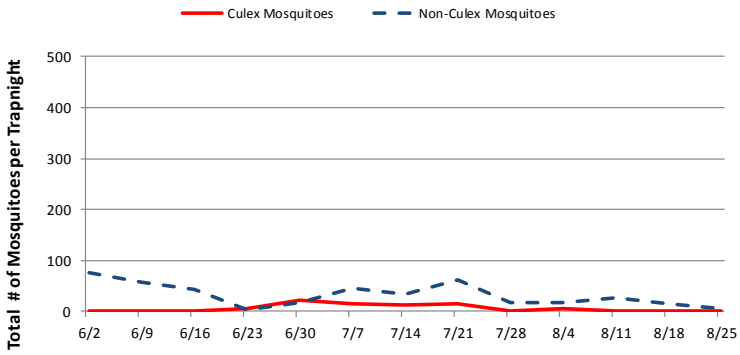


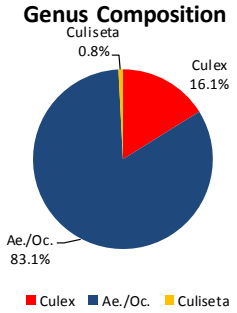


BC-36 Yellowstone

Trap ID/Trap Location	**BC-36/Yellowstone**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	5	1.0%
Culex tarsalis	76	15.1%
Total Culex	**81**	**16.1%**
% RA Culex	**16.1%**	
Aedes vexans	332	66.1%
Oc. dorsalis	12	2.4%
Oc. increpitus	46	9.2%
Oc. melanimon	17	3.4%
Oc. trivittatus	10	2.0%
Total Aedes/Ochlerotatus (Ae./Oc.)	**417**	**83.1%**
% RA Ae./Oc.	**83.1%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	4	0.8%
Total Culiseta	**4**	**0.8%**
% RA Culiseta	**0.8%**	
Trap Total	502	100.0%
Average # of Total Mosquitoes per Trapnight	39	
Average # of Culex per Trapnight	6	

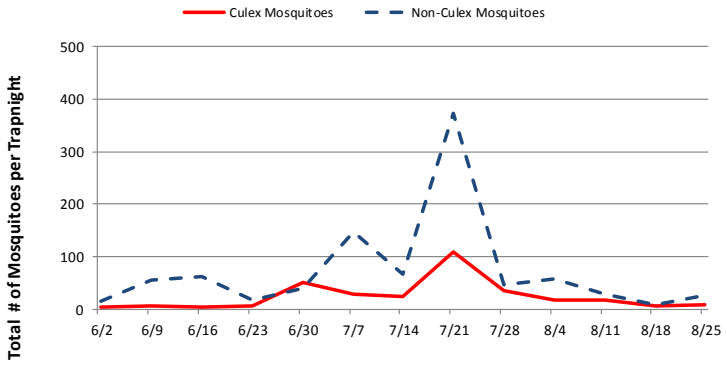
*%RA= Percent Relative Abundance

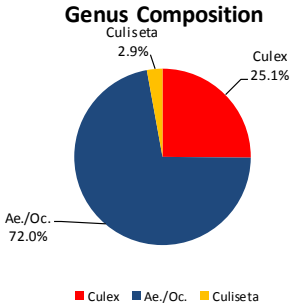




BC-37 Burch Reservoir

Trap ID/Trap Location	**BC-37/Burch Reservoir**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	101	8.0%
Culex tarsalis	216	17.1%
Total Culex	**317**	**25.1%**
% RA Culex	**25.1%**	
Aedes vexans	502	39.8%
Oc. dorsalis	7	0.6%
Oc. increpitus	2	0.2%
Oc. melanimon	7	0.6%
Oc. trivittatus	390	30.9%
Total Aedes/Ochlerotatus (Ae./Oc.)	**908**	**72.0%**
% RA Ae./Oc.	**72.0%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	36	2.9%
Total Culiseta	**36**	**2.9%**
% RA Culiseta	**2.9%**	
Trap Total	1,261	100.0%
Average # of Total Mosquitoes per Trapnight	97	
Average # of Culex per Trapnight	24	
*%RA= Percent Relative Abundance	24	

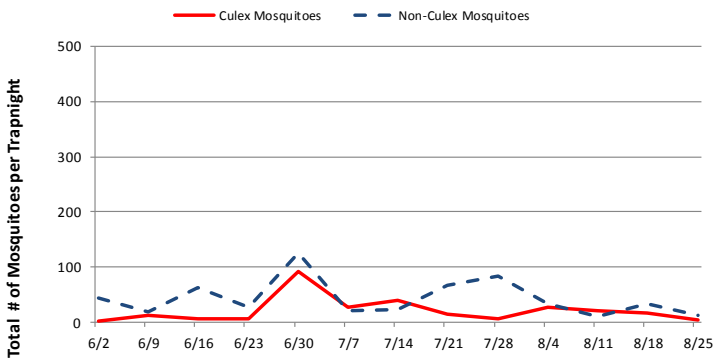


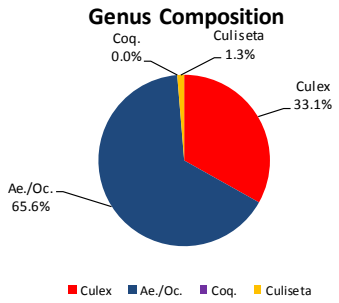


BC-38 Willow Glen- Teller Lake

Trap ID/Trap Location	**BC-38/Willow Glen- Teller Lake**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	67	7.9%
Culex tarsalis	213	25.2%
Total Culex	**280**	**33.1%**
% RA Culex	**33.1%**	
Aedes vexans	467	55.3%
Oc. dorsalis	6	0.7%
Oc. hendersoni	1	0.1%
Oc. increpitus	16	1.9%
Oc. melanimon	25	3.0%
Oc. trivittatus	39	4.6%
Total Aedes/Ochlerotatus (Ae./Oc.)	**554**	**65.6%**
% RA Ae./Oc.	**65.6%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	11	1.3%
Total Culiseta	**11**	**1.3%**
% RA Culiseta	**1.3%**	
Trap Total	845	100.0%
Average # of Total Mosquitoes per Trapnight	65	
Average # of Culex per Trapnight	22	

*%RA= Percent Relative Abundance

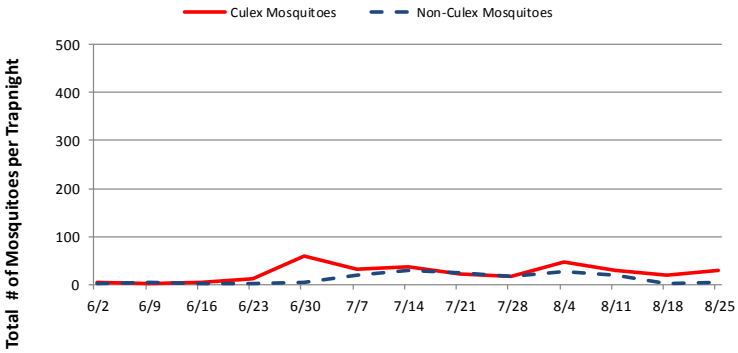


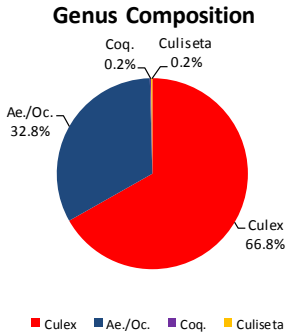


BC-39 Heatherwood

Trap ID/Trap Location	**BC-39/Heatherwood**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	85	18.1%
Culex tarsalis	229	48.7%
Total Culex	**314**	**66.8%**
% RA Culex	**66.8%**	
Aedes vexans	138	29.4%
Oc. dorsalis	2	0.4%
Oc. melanimon	12	2.6%
Oc. trivittatus	2	0.4%
Total Aedes/Ochlerotatus (Ae./Oc.)	**154**	**32.8%**
% RA Ae./Oc.	**32.8%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Coquillettidia perturbans	1	0.2%
Total Coquillettidia (Coq.)	**1**	**0.2%**
% RA Coquillettidia	**0.2%**	
Culiseta inornata	1	0.2%
Total Culiseta	**1**	**0.2%**
% RA Culiseta	**0.2%**	
Trap Total	470	100.0%
Average # of Total Mosquitoes per Trapnight	36	
Average # of Culex per Trapnight	24	

*%RA= Percent Relative Abundance

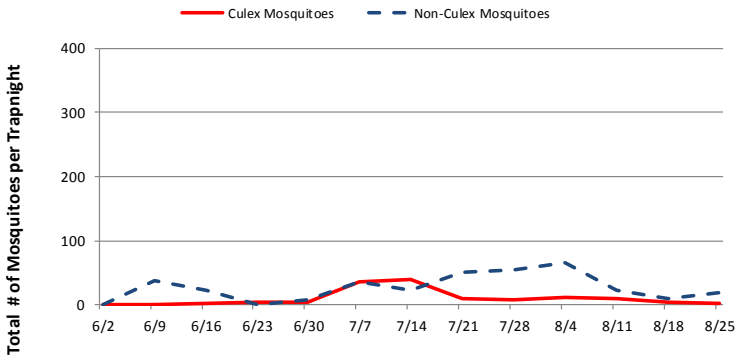


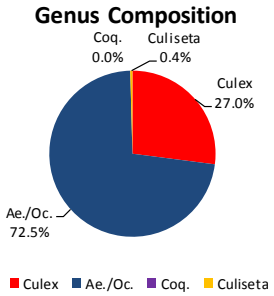


BC-40 Chance Acres

Trap ID/Trap Location	**BC-40/Chance Acres**	
Trap Type	**CDC Light**	
Total # of Trapnights	**13**	
Species	**Number**	**%RA***
Culex pipiens	10	2.1%
Culex tarsalis	119	24.9%
Total Culex	**129**	**27.0%**
% RA Culex	**27.0%**	
Aedes vexans	210	44.0%
Oc. dorsalis	37	7.8%
Oc. increpitus	1	0.2%
Oc. melanimon	12	2.5%
Oc. trivittatus	86	18.0%
Total Aedes/Ochlerotatus (Ae./Oc.)	**346**	**72.5%**
% RA Ae./Oc.	**72.5%**	
Total Anopheles	**0**	**0.0%**
% RA Anopheles	**0.0%**	
Total Coquillettidia (Coq.)	**0**	**0.0%**
% RA Coquillettidia	**0.0%**	
Culiseta inornata	2	0.4%
Total Culiseta	**2**	**0.4%**
% RA Culiseta	**0.4%**	
Trap Total	477	100.0%
Average # of Total Mosquitoes per Trapnight	37	
Average # of Culex per Trapnight	10	

*%RA= Percent Relative Abundance





APPENDIX C - 2014 ADULT CONTROL APPLICATIONS

Boulder County Mosquito Control District

2014 Season

Adult Mosquito Control Summary

Truck Mounted ULV

Area	Material	Start Time	End Time	Route Miles[1]	Spray Miles[2]	Ounces Applied[3]
Boulder Hills	Aqualuer 20-20	6/11/2014 20:54	6/11/2014 21:31	5.9	3.0	76.9
Divide Reservoir	Aqualuer 20-21	6/26/2014 20:03	6/26/2014 20:44	6.0	2.8	69.9
Park Lake	Aqualuer 20-20	7/2/2014 20:33	7/2/2014 20:54	2.8	1.9	50.7
Willow Glen and Fox Run	Aqualuer 20-20	7/2/2014 20:59	7/2/2014 21:11	1.8	1.3	32.3
Marshall Rd/Mesa Valley/Wildflower	Aqualuer 20-20	7/2/2014 21:30	7/2/2014 21:55	5.7	2.2	55.9
Divide Reservoir	Aqualuer 20-20	7/9/2014 20:39	7/9/2014 21:02	3.8	2.3	58.1
Hygiene Heights	Aqualuer 20-20	7/9/2014 21:17	7/9/2014 21:45	3.6	2.0	49.6
Boulder Hills	Aqualuer 20-20	7/9/2014 21:57	7/9/2014 22:25	6.5	3.4	85.1
Valmont and 75th	Aqualuer 20-20	7/9/2014 22:45	7/9/2014 23:05	3.7	2.4	61.4
Boulder Hills	Aqualuer 20-20	7/16/2014 20:33	7/16/2014 21:03	5.9	3.1	79.4
Brigadoon Glen/Rangeview/Oriole	Aqualuer 20-20	7/16/2014 21:15	7/16/2014 22:06	11.9	5.4	136.2
Divide Reservoir	Aqualuer 20-20	7/23/2014 20:59	7/23/2014 21:41	5.1	2.9	73.6
Hygiene Heights	Aqualuer 20-20	7/23/2014 21:58	7/23/2014 22:24	3.5	2.1	52
Fairgrounds	Aqualuer 20-20	7/23/2014 22:41	7/23/2014 23:10	3.9	2.4	59.1
Hillcrest Heights	Aqualuer 20-20	7/23/2014 23:18	7/23/2014 23:48	4.6	2.6	65.3
Red Fox Hills	Aqualuer 20-20	7/24/2014 0:08	7/24/2014 0:21	1.9	1.2	30.1
Twin Lakes	Aqualuer 20-20	7/24/2014 0:28	7/24/2014 0:58	4.2	2.7	67.9
Willows	Aqualuer 20-20	7/24/2014 1:05	7/24/2014 1:23	3.5	1.2	29.7
Brownsville/Canfield	Aqualuer 20-20	7/24/2014 1:41	7/24/2014 2:27	7.6	4.7	116.2
Divide Reservoir	Aqualuer 20-20	7/31/2014 20:30	7/31/2014 21:04	3.1	1.5	38.1
Brigadoon Glen/Rangeview/Oriole	Aqualuer 20-20	7/31/2014 23:07	8/1/2014 0:05	12.2	5.4	136.3
Brownsville/Canfield	Aqualuer 20-20	8/1/2014 0:19	8/1/2014 0:52	7.5	4.6	116.4
Divide Reservoir	Aqualuer 20-20	8/6/2014 20:21	8/6/2014 21:08	5.1	3.0	75.2
Boulder Hills	Aqualuer 20-20	8/6/2014 21:40	8/6/2014 22:19	6.5	3.4	86.2
Willows	Aqualuer 20-20	8/6/2014 22:35	8/6/2014 22:53	3.3	1.2	30
Twin Lakes	Aqualuer 20-20	8/6/2014 22:59	8/6/2014 23:36	6.4	2.6	66.4
Red Fox Hills	Aqualuer 20-20	8/6/2014 23:36	8/6/2014 23:49	2.0	1.1	28.9
Boulder Hills	Aqualuer 20-20	8/14/2014 20:49	8/14/2014 21:31	6.6	3.4	85.3
Brigadoon Glen/Rangeview/Oriole	Aqualuer 20-20	8/14/2014 21:42	8/14/2014 23:19	12.1	5.7	125.1
Brownsville/Canfield	Aqualuer 20-20	8/14/2014 23:36	8/15/2014 0:18	7.7	4.7	119.6
Fairgrounds	Aqualuer 20-20	8/20/2014 20:08	8/20/2014 20:25	4.0	2.4	59.9
Gayner Lake	Aqualuer 20-20	8/20/2014 20:38	8/20/2014 20:51	2.4	1.6	41.1
Hillcrest Heights	Aqualuer 20-20	8/20/2014 20:57	8/20/2014 21:18	4.6	2.6	65.9
			Total:	**175.4**	**92.8**	**2,323.8**
			Average:	**5.3**	**2.8**	**70.4**
			Minimum:	**1.8**	**1.1**	**28.9**
			Maximum:	**12.2**	**5.7**	**136.3**

Notes:

1. Includes entire mileage of route, including both ULV spray-on and spray-off miles; should be used when comparing 2014 data to historical data.
2. Only includes ULV spray-on mileage (excludes shutoffs, turnarounds, etc.)
3. Ounces of Aqualuer 20-20 and water applied at a 1:6.5 dilution rate (Aqualuer 20-20 to water) for an application rate of .0035 (Pounds of Permethrin a.i./Acre).

Historical BCMCD Annual Totals

Average	**508.3**
Minimum	**71.6**
Maximum	**725.2**

APPENDIX D - 2014 PROGRAM TIME EXPENDITURES BY CATEGORY

2014 PROGRAM TIME EXPENDITURES BY CATEGORY

Program Category	Approximate Hours	Percentage
Larval Surveillance & Control	10,945	91%
Adult Surveillance & Laboratory	573	5%
Adult ULV Control	168	1%
Public Education/Relations and Reporting	404	3%
Total	12,090	100%