

City of Louisville Integrated Mosquito Management Program 2018 Annual Report

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**City of Louisville
Integrated Mosquito Management Program**

2018 Annual Report

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Program Objectives

City of Louisville (Louisville) contracted Vector Disease Control International, LLC (VDCI) to operate an Integrated Mosquito Management (IMM) program in 2018. The primary objective of Louisville's IMM Program is to monitor and reduce mosquito populations through the use of environmentally sound control techniques in order to protect its residents from the threat of mosquito-borne diseases and suppress local populations of nuisance mosquitoes. VDCI prioritizes the detection and elimination of larval mosquitoes in aquatic habitats, in conjunction with the monitoring of adult mosquito populations through routine surveillance, in order to assess West Nile virus vector species abundance in the area.

Open communication is maintained by VDCI between Louisville, residents, HOAs, Property Management Companies, County and State Departments of Health & Environment, and surrounding municipalities in order to ensure that the highest level of mosquito control and epizootic response is achieved. This diligent and cooperative communication is important to the City of Louisville mosquito management program and provides significant benefit to public health throughout the entire area.

VDCI's Commitment

Vector Disease Control International is a company built on the foundations of public health, ethics, professionalism, and technical expertise. VDCI is committed to providing our customers with scientifically based, environmentally sensitive and technologically advanced Integrated Mosquito Management (IMM) programs of the highest quality. All of our employees are committed to excellence in vector control and public health and strive to improve the quality of human life in communities through public education and the control of mosquitoes and the diseases they can transmit. VDCI currently has programs across the state of Colorado, providing services for towns, cities, counties, homeowners associations, and encephalitis surveillance monitoring programs for county health departments.

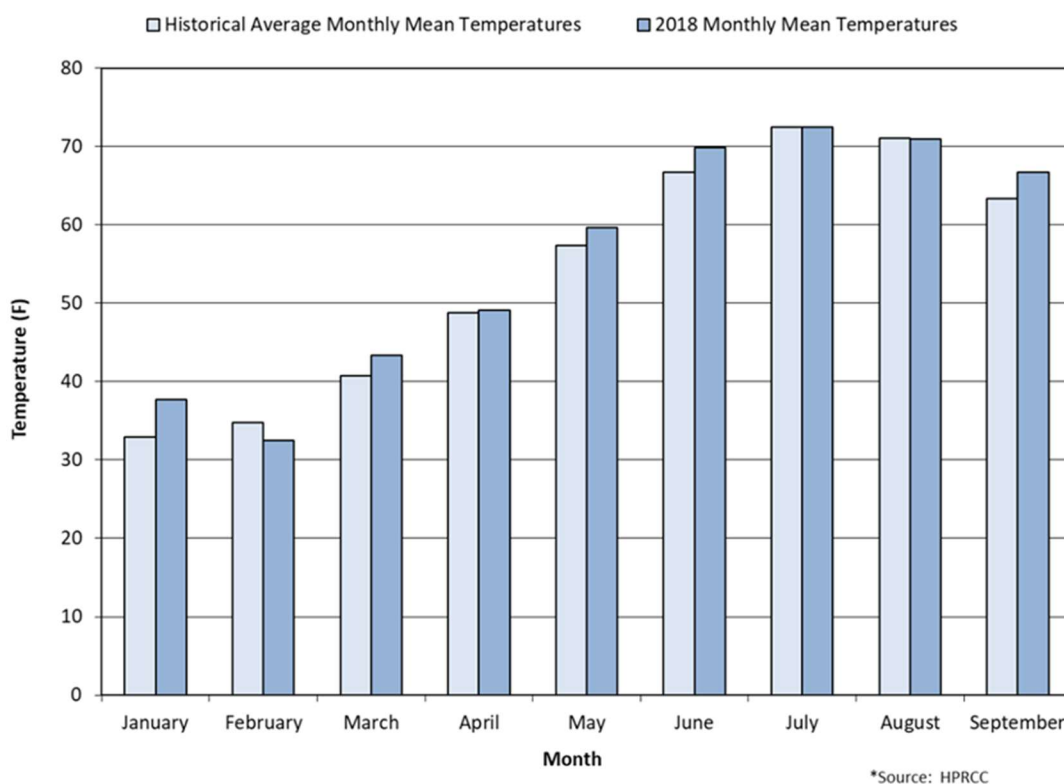
Vector Disease Control International, as the contractor for the City of Louisville, will continue to use proven scientific Integrated Mosquito Management techniques to survey and control local mosquito populations using biorational larval controls and limited low-toxicity insecticide applications. All of the methods and materials used have been reviewed and registered by the US Environmental Protection Agency, the Centers for Disease Control, the Colorado Department of Agriculture and the American Mosquito Control Association.

2018 Season Perspective and Climate Data

At VDCI we have come to expect each Colorado summer to present a unique set of temperature, precipitation, irrigation, and human interactions that combine to create new and different challenges in both mosquito control and mosquito-borne disease proliferation. The City of Louisville is located in a semi-arid environment with elevation in the project area approximately 5,335 feet above sea level. The typical mosquito season for Louisville is from late May to September. Current and historical climate data from the National Oceanic Atmospheric Administration's (NOAA) High Plains Regional Climate Center's (HPRCC) Boulder, Colorado weather station was used to monitor regional temperature and precipitation patterns throughout the season.

In 2018, every month of the mosquito season, except February, had temperatures at or above normal (**Figure 1**). The months of January, June and September experienced the highest deviation from average, +4.8, +3.2 and +3.4 degrees respectively, during the year while March and May were +2.3-2.6 degrees higher than average. April and July had mean monthly temperatures that were at or near average, while February and August were slightly below or at average. Overall, the 2018 season was approximately two (2) percent warmer than the previous year.

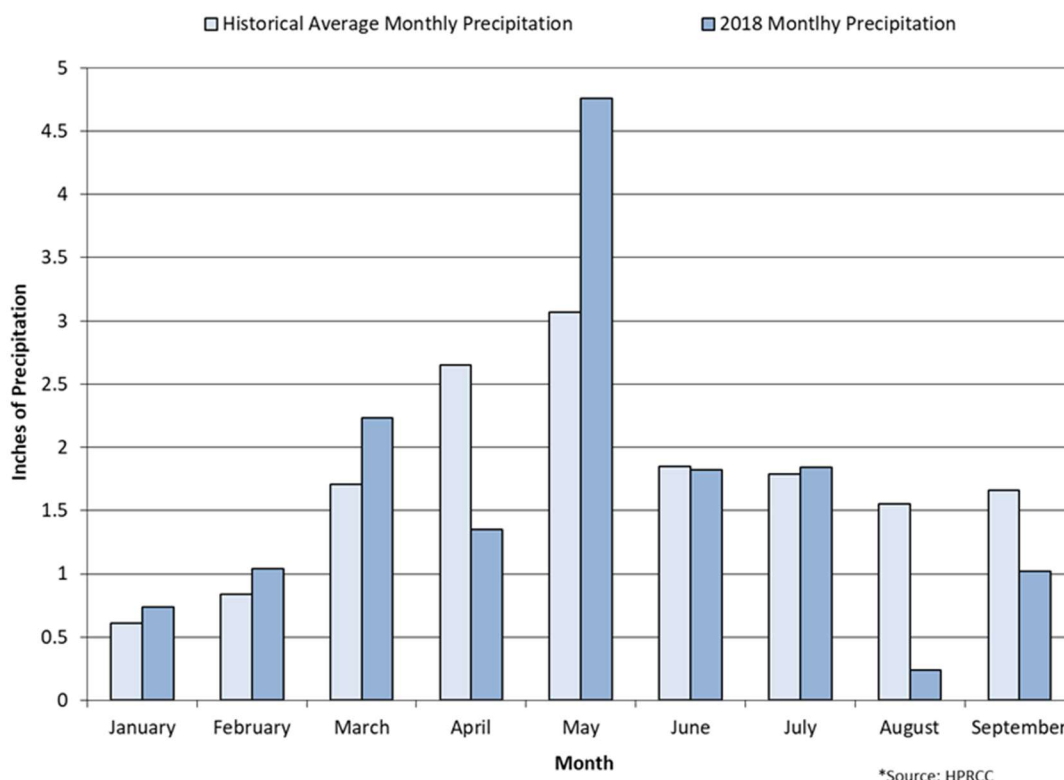
Figure 1 2018 Monthly Mean Air Temperature and Historical Averages



The historical averages for monthly mean precipitation indicate that April, May and June are usually the wettest months of the year. During 2018, the accumulated precipitation from January through September was lower than the historical average for the same period with a total of 15.04 inches (**Figure 2**). This is approximately 4.4 percent less precipitation than the historical average of 15.73 inches. The most significant variation during the mosquito season was the month of May which received 55 percent more than (4.76 inches) the average (3.07 inches) amount of precipitation, making it the wettest month

of 2018. By contrast, August received approximately 15.5 percent of its normal precipitation, making it the driest month of the mosquito season in 2018.

Figure 2 2018 Monthly Total Precipitation Data and Historical Averages*



The overall decrease in precipitation and continuous above normal temperatures during the 2018 mosquito season likely caused mosquito larvae to develop at a much faster rate which influenced both the nuisance and vector mosquito populations. While a drier than usual August, coupled with a warmer season presumably caused the elevated abundance of *Culex* species mosquitoes experienced throughout much the of the 2018 mosquito season, it also allowed for lower than average levels of West Nile virus to be detected throughout the area.

West Nile Virus Season

Since the introduction of West Nile virus to the United States in 1999, the virus has made a complete westward expansion to the West Coast. Starting in the Northeastern parts of the United States, the virus steadily spread through the South, the Midwest, the Rocky Mountain region and to the Western States. This extensive distribution is due to the ability of WNV to establish and persist in the wide variety of ecosystems present across the country. WNV has been detected in 65 different mosquito species in the U.S., though it appears that only a few *Culex* species drive epizootic and epidemic transmission (WNV Guidelines CDC 2013). Although West Nile virus has been endemic to the United States since 1999, researchers continue to seek an understanding for some of the factors which contribute to region specific spikes in vector abundance and human risk. We still do not understand why some humans develop West Nile fever while other infections develop into more serious West Nile encephalitis or West Nile meningitis cases. Additionally, physicians and researchers continue to seek answers to the variable

recovery times and occurrence of deaths that result with some infections. WNV has expanded to the point that it can now be found in all 48 contiguous states and has produced two additional, large nationwide epidemics in 2003 and 2012 (WNV Guidelines CDC 2013).

As of October 2nd, 2018, a total of 44 states and the District of Columbia have reported West Nile virus infections in people, birds, or mosquitoes in 2018 (**Figure 3**). Overall, 1,611 cases of West Nile virus disease in humans have been reported to CDC. Of these, 933 (58%) were classified as neuroinvasive disease (such as meningitis or encephalitis) and 678 (42%) were classified as non-neuroinvasive disease (**Figure 4**) and a total of 68 deaths have resulted from these infections.

Figure 3 West Nile Virus Activity by State – United States, 2018 (as of October 2nd, 2018)*

*CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2018/activitybystate2018.html>

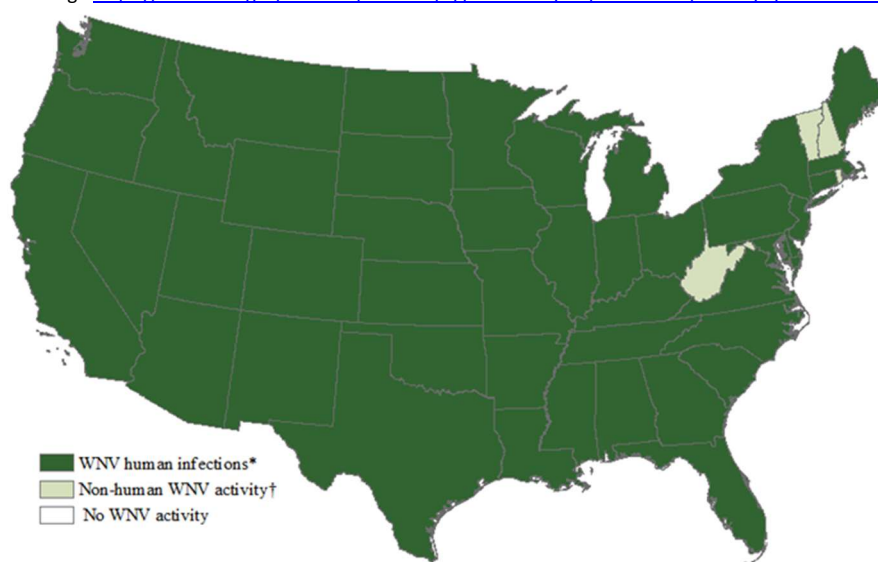
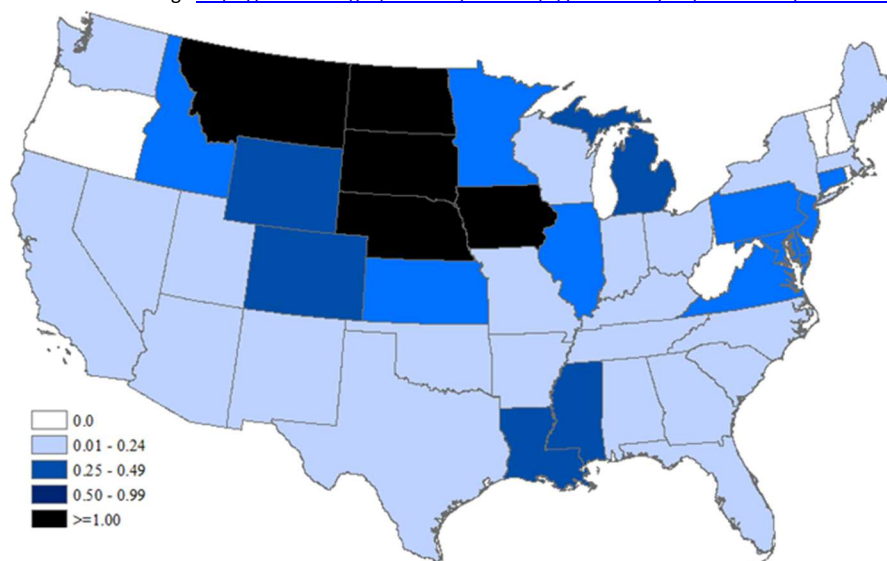


Figure 4 West Nile Virus Neuroinvasive Disease Incidence by State – United States, 2018 (as of October 2nd, 2018)*

*CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2018/incidencestate-2018.html>



This map shows the incidence of human West Nile virus neuroinvasive disease (e.g., meningitis, encephalitis, or acute flaccid paralysis) by state for 2018 with shading ranging from 0.01-0.24, 0.25-0.49, 0.50-0.99, and greater than 1.00 per 100,000 population.

Colorado 2018

As of October 5th, 2018, the Colorado Department of Health and Environment has identified 78 cases of human West Nile virus (WNV) infections in Colorado (**Figure 5**). The CDC reports only 73 cases as of October 2nd, 2018 with 4 (5%) asymptomatic blood donor, 36 (47%) neuroinvasive cases including symptoms of meningitis or encephalitis (including meningoencephalitis), and 37 (48%) non-neuroinvasive which includes cases where individuals are non-symptomatic or present with fever and other minor symptoms (**Figure 6**). There has been one death (**Figure 6**) associated with West Nile virus infections from an undisclosed location in Colorado during the 2018 season. The discrepancy between CDPHE data and CDC data is likely due to lag time in the communication between these entities.

Figure 5 Weekly WNV Human Case Count, 2002-2018 (2003 suppressed)*

*CDPHE image <https://www.colorado.gov/pacific/cdphe/west-nile-virus-data>

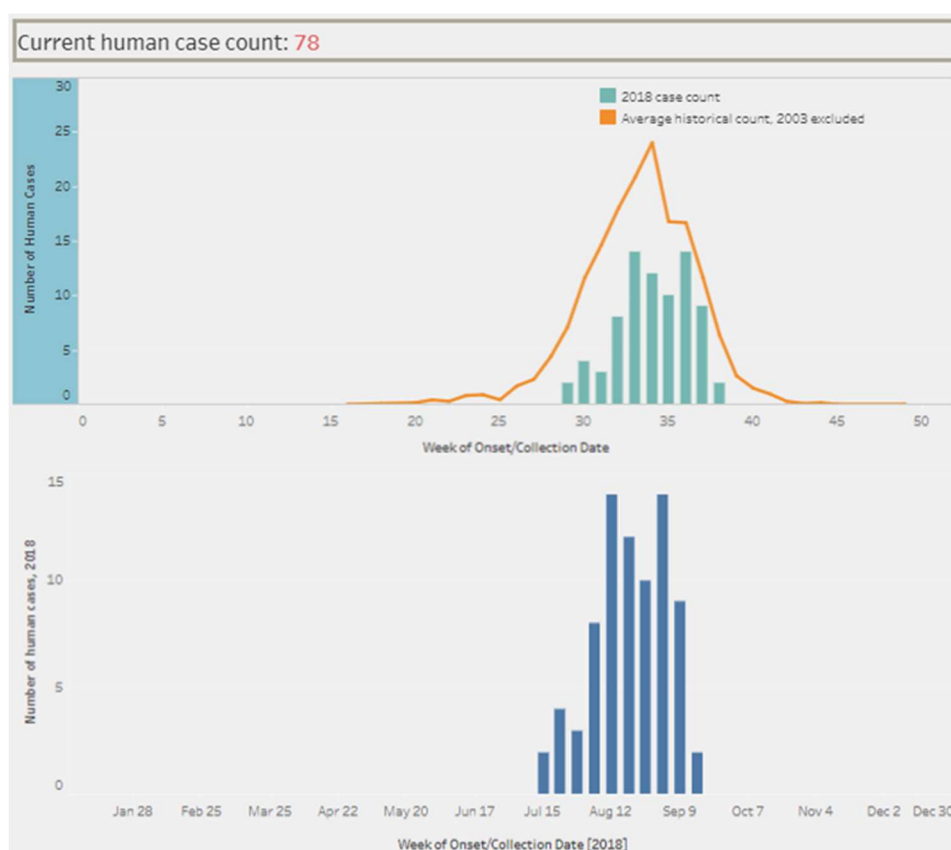


Figure 6 West Nile Virus Disease Cases and Presumptive Viremic Blood Donors by State – United States, 2018 (as of October 2nd, 2018)*

State	Neuroinvasive Disease Cases†	Non-neuroinvasive Disease Cases	Total cases	Deaths	Presumptive viremic blood donors‡
Colorado	36	37	73	1	4

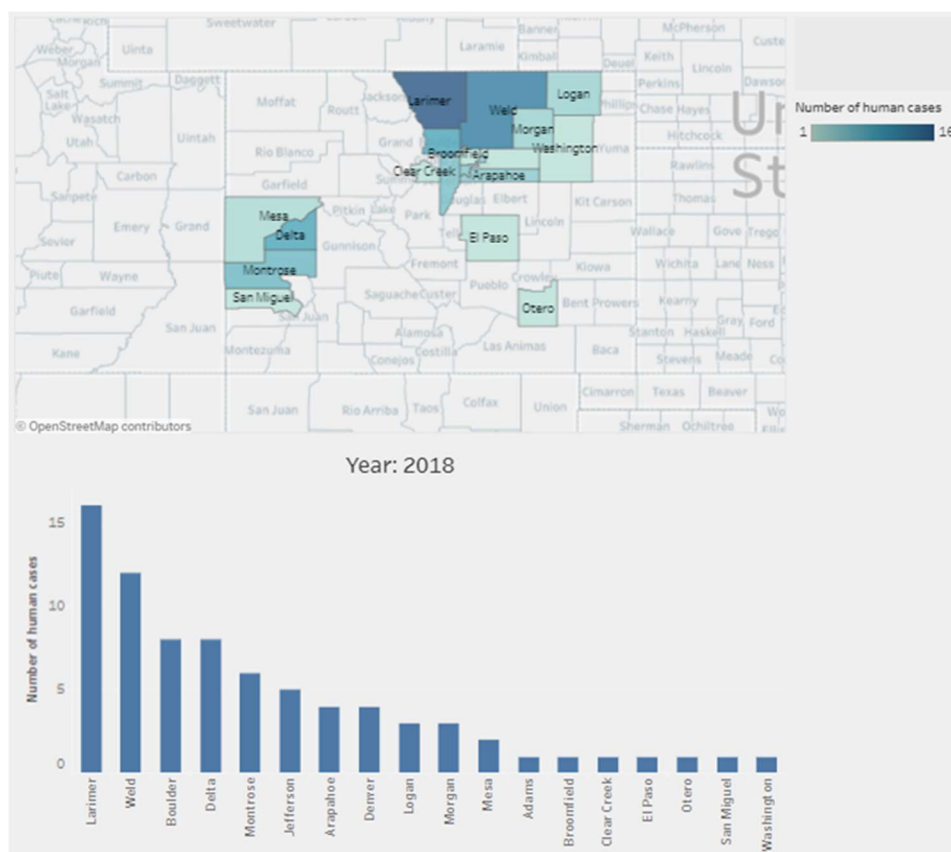
*CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2018/disease-cases-state-2018.html>

Boulder County 2018

CDPHE data currently ranks Boulder County 3rd in the number of West Nile virus human cases in the state (8 cases), while Larimer County has reported the most human cases (16) followed by Weld County with 12 (Figure 7).

Figure 7 Colorado WNV Human Cases by County, 2018*

*CDPHE image <https://www.colorado.gov/pacific/cdphe/west-nile-virus-data>



Adult mosquito surveillance data, submitted mosquito pools, and the resulting WNV infection rates were used by Boulder County Public Health (BCPH) throughout the season to calculate Vector Index (VI) levels in order to help Louisville 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 additional action to control both larval and adult mosquitoes, increase public awareness, and encourage personal protection measures.

The actual 2018 weekly Vector Index rates, as calculated by BCPH, for sentinel zones 1, 2 and 3 are illustrated below (Table 1). Due to below average WNV activity in 2018, no emergency spraying was conducted in Louisville during the 2018 mosquito season.

Table 1 Vector Index, Boulder County Sentinel Zones 1 - 3, 2018

Boulder County Vector Index 2018 ¹			
	Sentinel Zone 1 ²	Sentinel Zone 2 ³	Sentinel Zone 3 ⁴
Season Week	Vector Index	Vector Index	Vector Index
Week 21	----	----	----
Week 22	----	----	----
Week 23	----	----	----
Week 24	0.00	0.00	0.00
Week 25	0.00	0.00	0.00
Week 26	0.00	0.00	0.00
Week 27	0.00	0.00	0.00
Week 28	0.00	0.00	0.00
Week 29	0.00	0.00	0.01
Week 30	0.00	0.11	0.13
Week 31	0.01	0.00	0.48
Week 32	0.02	0.38	0.44
Week 33	0.03	0.20	0.19
Week 34	0.19	0.00	0.00
Week 35	0.00	0.00	0.00
Week 36	----	----	----
1. Reported by BCPH as of September 14, 2018			
2. City of Boulder; 3. Longmont; 4. Erie, Lafayette, Louisville, Superior			

Larval Mosquito Control

Larval mosquito control is the foundation of the City of Louisville's Mosquito Control program and can be an extremely effective way to manage mosquitoes, thereby reducing the number of potential disease vectors and annoyances associated with biting adults. Years of research and practical experience have shown that the most effective way to control mosquito populations is through an aggressive Integrated Mosquito Management (IMM) approach. This approach aims at using a variety of concepts, tools, and products to reduce mosquito populations to a tolerable level.

Pre-season larval control work involved ground truthing GIS maps, remapping areas where new development and altered landscapes occurred. VDCI began larval site inspections in many areas in May. Hiring of seasonal field technicians began in March and continued into May. VDCI's Annual Field Technician Classroom Training Day took place on May 21st with over 60 new and returning field technicians in attendance. Field training by VDCI management and veteran employees lasted through May and full time field activities were in force by early June.

In 2018 Vector Disease Control International performed 357 larval site inspections at 80 documented breeding sites throughout the City. Of these individual inspections, 241 sites (67.5%) were wet upon inspection and 88 (36.5%) were producing mosquito larvae in the City of Louisville. These inspections resulted in 86 treatments in which VDCI applied 46.8 lbs. of VectoBac G (*Bti*) and 0.5 gallons of BVA 2 larvicide oil (**Table 2; Figures 8 and 9**) to 8.1 acres of land within the City of Louisville.



By comparison, in 2017 VDCI performed 243 larval site inspections at 74 documented breeding sites throughout the City. Of these individual inspections, 121 sites (49.8%) were wet upon inspection and 45 (37.2%) were producing mosquito larvae in the City of Louisville. These inspections resulted in 45 treatments in which VDCI applied 17.9 lbs. of VectoBac G (*Bti*), 1.7 lbs. of VectoLex FG (*Bs*), and 1.8 gallons of BVA 2 larvicide oil (**Table 2 and Figure 9**) to 3.0 acres of land within the City of Louisville.

Larval mosquito control can be achieved in several ways including biological, biochemical, chemical, and mechanical means. No single larvicide product will work effectively in every habitat where mosquito larvae are found, so a variety of products and methods should be

employed. Additionally, although there are a variety of methods for reducing larval populations, some may have negative consequences that outweigh their benefits. Mechanical or physical habitat modification is a technique which VDCI uses on relatively small scale projects, as the area to be modified must be carefully reviewed.



VDCI's favored method of larval mosquito control is through the use of bacterial bio-rational products. The main product used by VDCI is a variety of bacteria (*Bacillus thuringiensis var. israeliensis*). *Bti*, as it is known, has become the cornerstone of mosquito control programs throughout the world. The benefits include its efficacy and lack of environmental impacts. When used in accordance with its label, successful control of mosquito larvae can be achieved without impact to non-target species such as other aquatic invertebrates, birds, mammals, fish, amphibians, reptiles, or humans. The label allows for the use of the

product in the majority of the habitats throughout the service area. Another bacterial product closely related to *Bti* is *Bacillus sphaericus* (*Bs*). *Bs* provides similar benefits to *Bti* while also providing residual control of certain species of mosquitoes. It is used specifically in difficult to treat areas where *Culex* larvae are the predominant species due to its limitations and high cost.

Other larval control products include the insect growth regulator methoprene (Altosid), and light mineral oils (BVA 2 larvicide oil). Methoprene is a synthetic version of a juvenile growth hormone in larval mosquitoes. The hormone prevents the normal development of larval mosquitoes into pupae and adults, eventually causing death. VDCI limits the use of chemical larvicides to areas with little biodiversity, such as road side ditches, or areas that chronically produce high mosquito populations. They are only used after a thorough assessment has been made of any habitat where their use is being considered. Mineral oil is the only product effective in controlling mosquito pupae and therefore is an essential tool when pupae are present.

Table 2 2018 Summary of Larval Control Product Applications by Type

Larval Control Product Types	2017	2018
<i>Bacillus thuringiensis israelensis (Bti)</i>		
Vectobac G (lbs) EPA Reg. #73049-10	17.9	46.8
<i>Bacillus sphaericus (Bs)</i>		
Vectolex FG (lbs) EPA Reg. #73049-20	1.7	0.0
S-Methoprene		
Altosid Briquet (oz) EPA Reg. #2724-375	0.0	0.0
Altosid XR -G (oz) EPA Reg. #2724-451	0.0	0.0
Mineral Oil		
BVA 2 Larvicide Oil (gal) EPA Reg. #70589-1	1.8	0.5

Figure 8 2018 Larval Site Inspections and Applications by Month

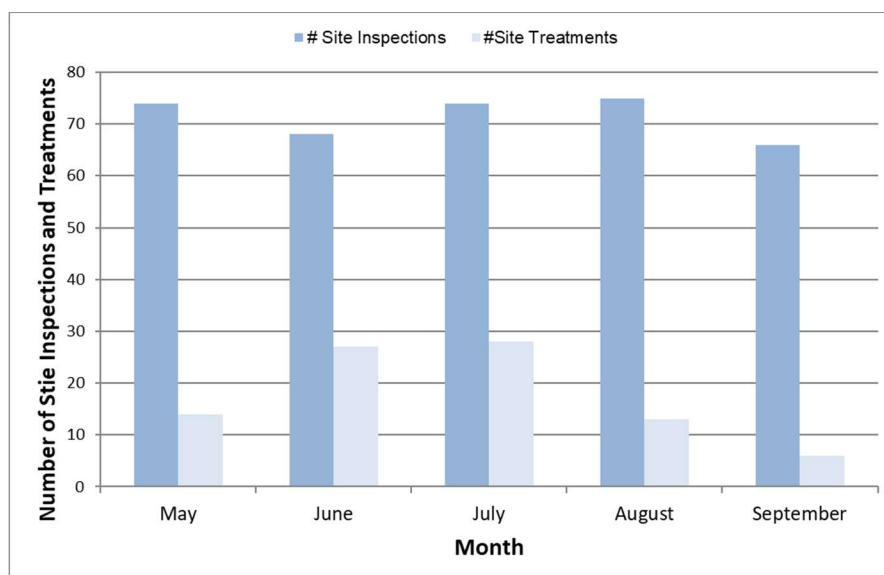


Figure 9 **Comparison of Larval Site Inspections and Treatments by Year**



VDCI Adult Mosquito Surveillance and Laboratory

Information about mosquito abundance and species diversity is essential to any IMM program. Vector Disease Control International's most commonly used adult mosquito surveillance tool is the CDC light trap which uses carbon-dioxide from dry ice as bait to attract female mosquitoes seeking a blood meal from a breathing animal. Once attracted by the CO₂, the mosquitoes are lured by a small light to a fan that pulls them into a net for collection. Traps are set overnight at carefully selected sites with abundant harborage. They are collected the following morning and returned to VDCI's laboratory, where the contents of the trap nets are counted and speciated by trained technicians.

In 2018, Vector Disease Control International monitored a statewide network of hundreds of weekly trap sites, collecting 761,858 adult mosquitoes that were counted and identified to species by the VDCI Surveillance Laboratories. While individual traps provide current seasonal information, trap data can be interpreted in the context of historical records for the same trap site if such data is available. Individual traps are also compared to other traps from around the region that were set on the same night and therefore exposed to similar weather conditions. Technicians working in the Surveillance Laboratories at Vector Disease Control International are trained to provide accurate species-level identification of both larval and adult mosquitoes.



Additionally, the VDCI Surveillance Laboratory conducts an intensive larval identification program with larval mosquito samples collected by field technicians. This information is now invaluable in targeting mosquito control efforts as we gain a greater understanding of the habitat types preferred by Colorado mosquito species and the seasonality of these habitats as sites for mosquito development.

Specimens and data collected from these traps and larval identification are used in:

-  Determining the effect of larval control efforts. Each mosquito species prefers specific types of habitats for larval development. If a trap includes large numbers, it could indicate the presence of an unknown larval habitat and, based on the species identification and known habitat preference for that species, direct field technicians as to possible sources of the mosquitoes collected.
-  Determining larval and adult mosquito species. This helps to illustrate the threat of mosquito-borne disease amplification and transmission because different mosquito species can vector different diseases to people and animals.
-  Determining where adult control efforts were necessary. While mosquito eradication is impossible, significant population reduction is achievable. In places where larval control is insufficient, such as neighborhoods where adult mosquitoes have migrated in from outside of the control area, it may be necessary to use adulticide methods, such as ULV truck fogging or barrier sprays of harborage areas. Trap counts that exceed an acceptable threshold for an area may trigger adult control measures.
-  Surveillance for Mosquito-borne Disease. Historically, VDCI efforts were targeted primarily at controlling mosquito nuisance problems with limited disease surveillance. However, since the arrival of the West Nile virus in Colorado in August of 2002, the paradigm has shifted toward disease prevention and control. Accurate species identification of the mosquitoes in the traps is important when monitoring species population trends. It also is necessary for evaluating whether a population spike represents an actual increase in disease transmission potential or only an increased nuisance level.

CITY OF LOUISVILLE ADULT SURVEILLANCE LIGHT TRAP DATA

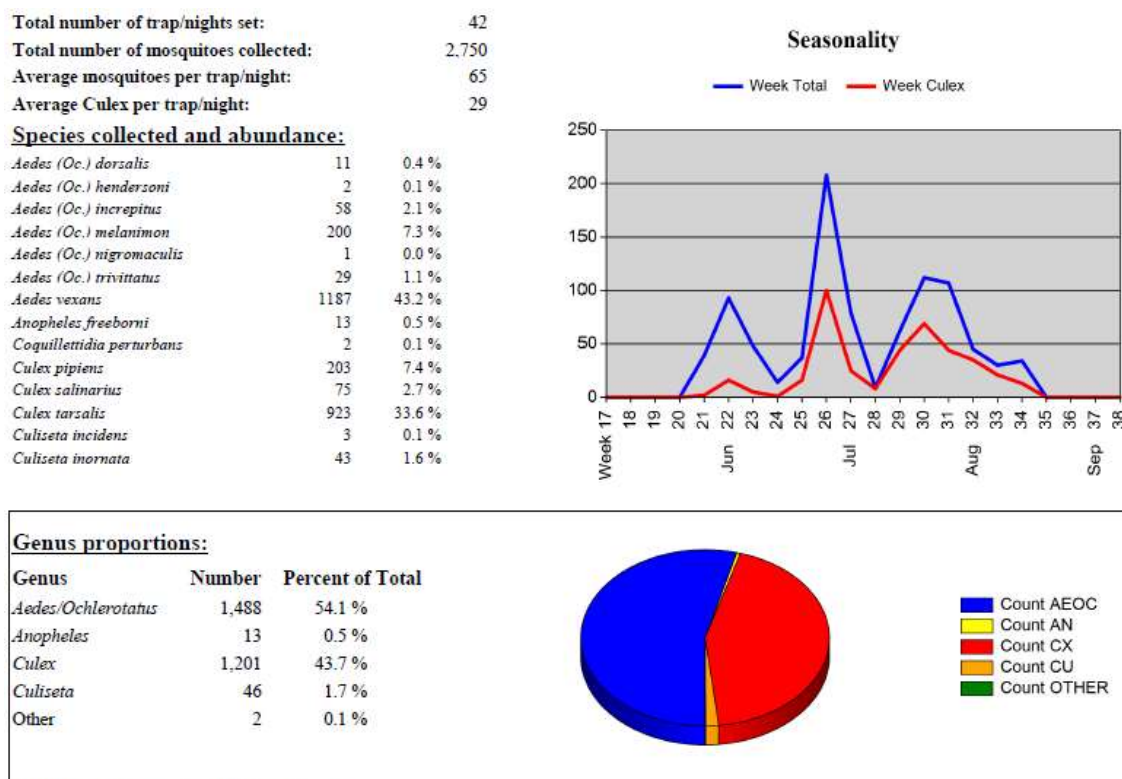
In 2018, an average of three (3) surveillance light traps monitored adult mosquito populations within the City of Louisville on a weekly basis. Surveillance trapping began May 30th and concluded on August 29th per the City of Louisville's contract and actual adult mosquito activity.

There were 42 CDC light surveillance trap nights set within City of Louisville during the 2018 season. These traps collected a total of 2,750 mosquitoes. There was an average of 65 mosquitoes caught per trap per night and an average 29 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 43.7% (1,201) *Culex spp.*, 51.1% (1,488) *Aedes/Ochlerotatus spp.*, 1.7% (46) *Culiseta spp.*, <1% (13) *Anopheles spp.*, and <1% (2) *Coquillettidia spp.* (**Figure 10**). Please refer to **Appendix A** for Louisville's Individual Light Trap Summaries.

A total of 14 species were represented in 2018 in Louisville. No exotic/introduced species (such as Asian Tiger Mosquitoes) were collected this season.

By comparison, in 2017 there were 38 CDC light surveillance trap nights set within the City. These traps collected a total of 2,444 mosquitoes. There was an average of 64 mosquitoes caught per trap per night and an average 32 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 49.1% (1,201) *Culex spp.*, 50.2% (1,228) *Aedes/Ochlerotatus spp.*, <1% (1) *Coquillettidia spp.*, and <1% (14) *Culiseta spp.*

Figure 10 2018 City of Louisville Light Trap Composite Data

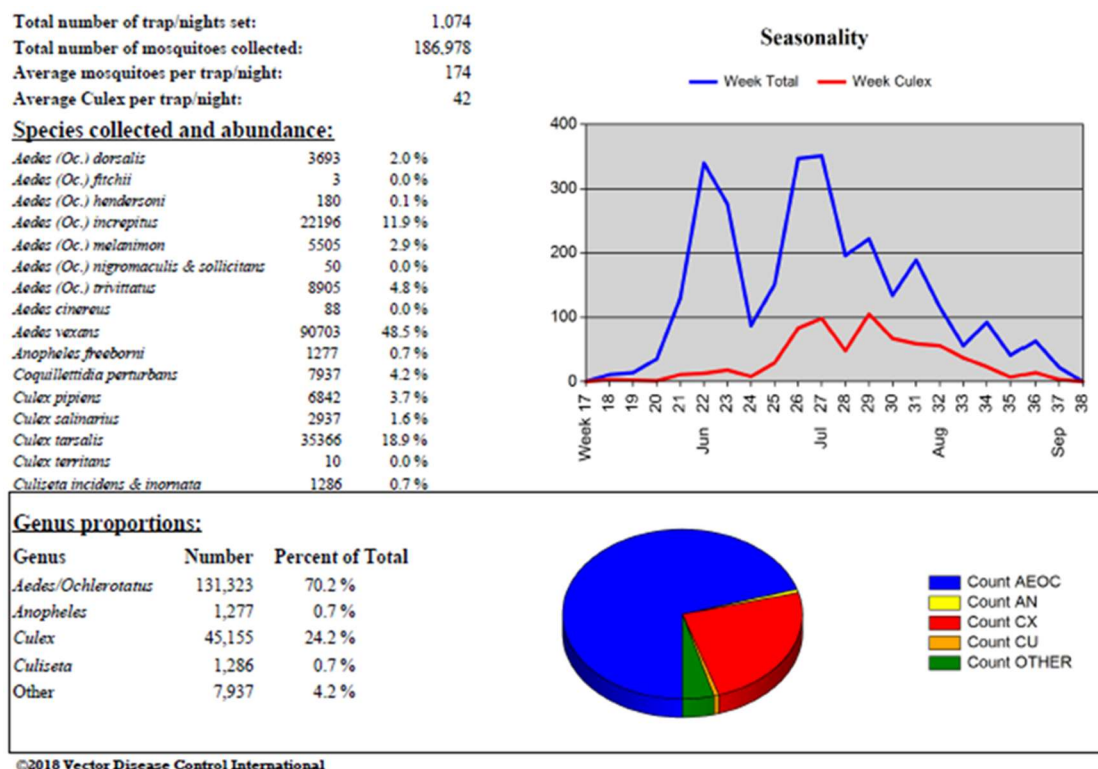


There were 1,074 CDC light surveillance trap nights set within Boulder County during the 2018 season. These traps collected a total of 186,978 mosquitoes. There was an average of 174 mosquitoes caught per trap per night and an average 42 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 24.2% (45,155) *Culex spp.*, 70.2% (131,323) *Aedes/Ochlerotatus spp.*, 4.2% (7,937) *Coquillettidia spp.*, <1% (1,277) *Anopheles spp.*, and <1% (1,286) *Culiseta spp.* (**Figure 11**).

A total of 18 species were represented in 2018 in Boulder County. No exotic/introduced species (such as Asian Tiger Mosquitoes) were collected this season.

By comparison, in 2017 there were 1,086 CDC light surveillance trap nights set within Boulder County. These traps collected a total of 164,516 mosquitoes. There was an average of 151 mosquitoes caught per trap per night and an average 50 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 33.2% (54,543) *Culex spp.*, 61.5% (101,244) *Aedes/Ochlerotatus spp.*, 3.5% (5,716) *Coquillettidia spp.*, <1% (539) *Anopheles spp.*, and 1.5% (2,474) *Culiseta spp.*

Figure 11 2018 Boulder County Light Trap Composite Data



WEST NILE VIRUS MOSQUITO SAMPLE TESTING RESULTS - BOULDER COUNTY

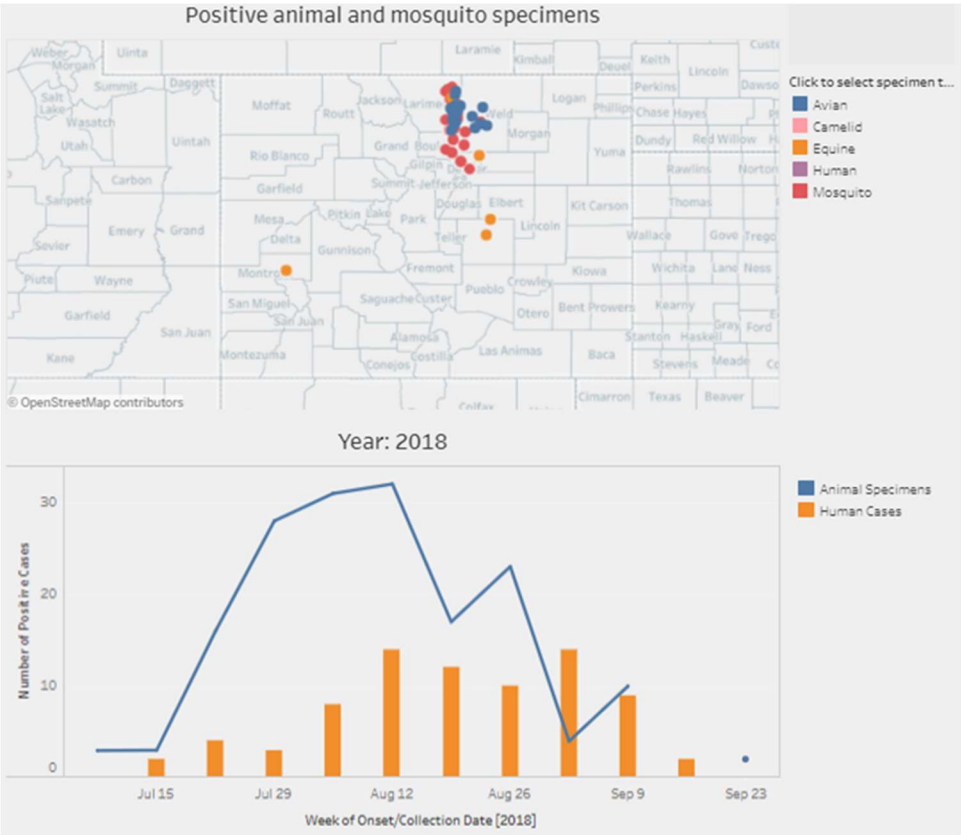
VDCI and Louisville used the adult mosquito data collected to help determine local areas of concern for public awareness and safety as well as to monitor the local vector mosquito populations. Many local health departments have moved towards mosquito-based surveillance indicators to assess the weekly risk of West Nile transmission and guide response decisions for adult mosquito control applications. The vector index and infection rate is derived by testing the mosquitoes VDCI collects for the presence of West Nile virus. This value is closely monitored by the CDPHE and local health departments to evaluate the risk posed by the vector mosquito population.

As defined in the CDC guidelines for West Nile virus surveillance, prevention and control, the vector index (VI) is an estimate of the number of West Nile virus infected mosquitoes in an area. This number can serve as a human health risk value. An operational value of 0.75, which was derived from the comparison of historical data for human infections, as well as relative abundance and infection in mosquitoes, serves as an indicator of high risk for West Nile virus transmission to humans in the corresponding area. As the value of the vector index increases there is a corresponding risk of human disease and this value can be used to offset epidemics.

Due to budget cutbacks associated with West Nile virus surveillance in recent years, the CDPHE does not have the ability to test mosquitoes from every trap set across the state. As a result, there is select testing done within three sentinel zones in Boulder County. *Culex species* mosquito samples are sent to CDPHE for WNV testing on a weekly basis as part of the state's Sentinel Encephalitis Surveillance program (**Figure 12**), which VDCI is contracted separately through BCPH to perform.

As of September 14th, 2018 CDPHE, has tested a total of 189 mosquito pools from Boulder County. Of the tested mosquito pools, 11 pools tested positive for West Nile virus from all three sentinel zones (**Appendix B**). The first Boulder County West Nile virus positive mosquito sample pools of the 2018 season were on July 23, 2018 in BCZ2 And BCZ3 (**Figure 13**).

Figure 12 **Number of Colorado Positive WNV Specimens 2018 (animal and mosquito)***
 *CDPHE image <https://www.colorado.gov/pacific/cdphe/west-nile-virus-data>

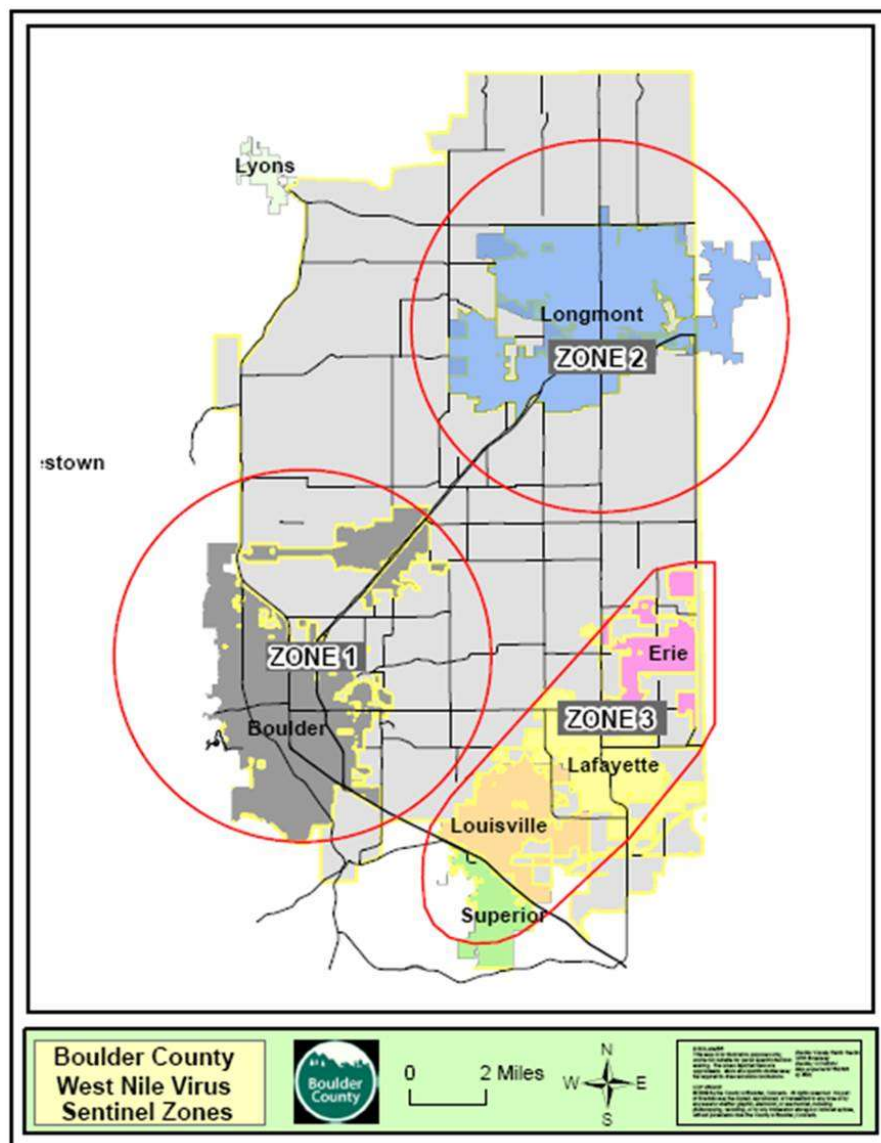


BOULDER COUNTY PUBLIC HEALTH ADULT MOSQUITO SENTINEL ZONES

The Sentinel Encephalitis Surveillance Program was funded by the Colorado Department of Public Health and Environment and Boulder County Public Health in 2018. VDCI maintained the sentinel system with five surveillance traps at permanent locations in each of three Boulder County Sentinel Zones: City of Boulder (BCZ1); City of Longmont (BCZ2); Town of Erie, City of Lafayette, City of Louisville, Town of Superior (BCZ3) (**Figure 13**). The sentinel light traps were set once a week from May 29th to September 19th.

In 2018 there were 82 sentinel surveillance trap nights set which collected 10,683 adult mosquitoes in BCZ1; 69 sentinel surveillance trap nights set which collected 10,276 adult mosquitoes in BCZ2; and 70 sentinel surveillance trap nights set which collected 9,807 adult mosquitoes in BCZ3. Please refer to **Appendix C** for a summary of species collected and abundance.

Figure 13 Boulder County Public Health Sentinel Surveillance Zone Map



ADULT MOSQUITO CONTROL

The goal of Vector Disease Control International is to provide our customers with the best options for safe, effective, modern mosquito management. The primary emphasis of Louisville's Integrated Mosquito Management Program is to control mosquitoes in the larval stage, using safe biological control products. When mosquito counts surpass nuisance thresholds of 100 mosquitoes, VDCI uses EPA and CDC approved adulticides to reduce mosquito populations. During the 2018 season a total of 54 gallons of Talstar Pro (Active Ingredient – Bifenthrin) were applied as daytime adult barrier applications (**Figures 14 and 15**). A detailed summary of adulticide applications, by neighborhood, can be found in **Appendix D**.

In 2017, a total of .7 Ultra Low Volume (ULV) miles of roads and access paths were sprayed using the adulticide Aqualuer® 20-20 (Active Ingredient – Permethrin) and a total of 71 gallons of Talstar Pro (Active Ingredient – Bifenthrin) (**Figure 15**) were applied as daytime adult barrier applications in the City of Lafayette.

VDCI uses state of the art technology, calibrated application timing, and least-toxic products to minimize non-target impacts. Adult mosquito control applications are accomplished using Ultra Low Volume (ULV) spray equipment and performed after dusk when the majority of mosquito species are most active. This type of equipment produces droplets averaging 10-25 microns in diameter and allows for a minimal amount of product to be put into the environment. These treatments take place in the evening when mosquitoes are flying in the greatest numbers and non-target insect activity (for example, day-flying pollinators like bees) is greatly reduced. Using this application technique, the overall goal of minimal environmental impact and effective adult control is achieved in the targeted area.



Figure 14 2018 Barrier Adulticide Gallons by Month

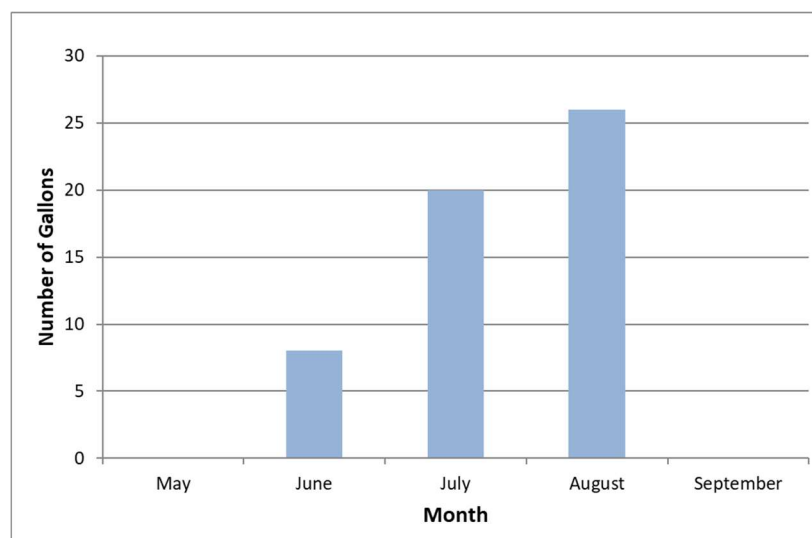
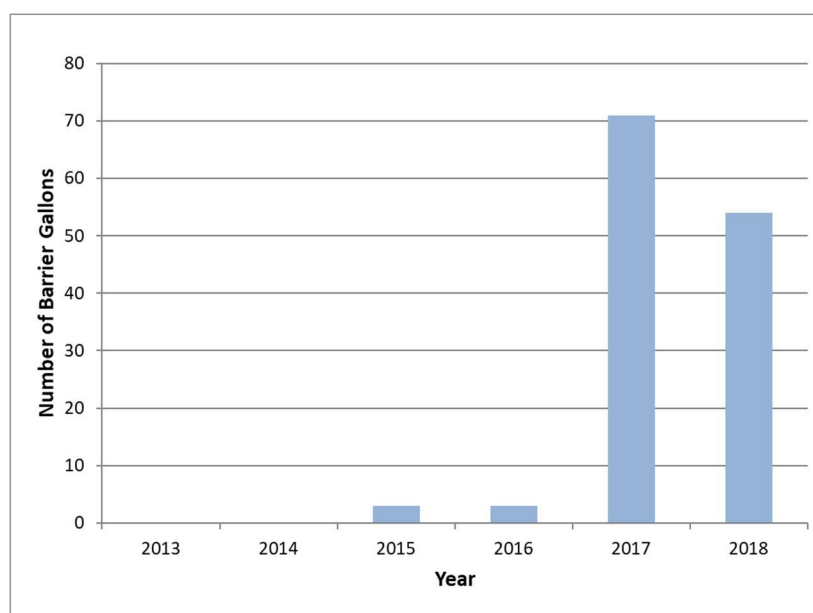


Figure 15 Comparison of Barrier Adulticide Gallons by Year



CALL NOTIFICATION & SHUTOFF SYSTEM

Both VDCI and Louisville acknowledge that adult mosquito control can be a sensitive matter to many residents; therefore a Spray Shutoff and/or Notification request option was available to the public. Residents were able to call VDCI's MosquitoLine™ or submit a website request to be notified before adult control applications were performed and/or request that the ULV sprayer be shutoff in front of their address.

At the beginning of the 2018 season, VDCI sent out 31 letters to all historical shutoff and notification households in order to establish an updated list for the 2018 season. VDCI received 2 shut off only requests, 15 shut off and notification requests, and 12 notification only requests. The 2018 season shutoff and notification list concluded with 29 households. Of these 29 requests, 4 were new shut offs and/or call notifications received via VDCI's online request form. Residents on the shut off and notification list were notified 24 hours in advance when their community was scheduled to be sprayed. VDCI used an automated message service to contact residents and listed weekly ULV spray events on VDCI's website, www.vdci.net/colorado-schedules, which utilized Google Calendar.

Public Relations and Education

VDCI is dedicated to providing strong Public Outreach and Education Programs to residents in all of our communities. Citizen complaints, inquiry, information and satisfaction surveys can aid in evaluating the effectiveness of a program. VDCI constantly looks for ways to better serve the communities we work with and encourages both the citizen and local media involvement in order to increase the effectiveness of our programs. We have clearly demonstrated that commitment and belief by proactively serving City of Louisville (and all of our contracted communities) with numerous innovative programs, activities and services.

Customer service is always a high priority for VDCI. We take pride in training each and every technician so that they have the knowledge to provide residents with the correct answers to their questions. Each field technician spends part of their day responding to resident concerns in their work area. This in-field customer service personalizes the mosquito control program, provides VDCI with local information on mosquito activity and presents a valuable opportunity to educate our residents about mosquito biology and control.

MosquitoLine™

VDCI maintains a toll-free telephone line specific to Boulder County, (888) 774-2161 and a local line (303) 466-1892 to accept calls from the public concerning:

- * Information requests about mosquito biology and source reduction of mosquito habitats
- * Information on program components, operations and monitoring
- * Seasonal West Nile virus activity
- * Personal protection options for mosquito annoyances and West Nile virus risk
- * Reports about mosquitoes and possible larval mosquito habitats
- * Requests to perform larvicide applications and/or opt-out of any adulticide spraying
- * Request notification when adulticide spraying is planned in their neighborhood
- * Request health and safety information about mosquito control operations and pesticide products used

VDCI has provided Mosquito Hotlines to the residents in communities which we are contracted to also reduce workload by municipal personnel. This enables direct communication and response by mosquito control employees to resident's concerns about West Nile virus and larval site activity and treatment. VDCI maintains a log of calls received and will summarize call activity in monthly and annual reports.

In 2018 VDCI received 8 phone calls from residents of Louisville. The majority of these calls (4) were adult mosquito complaints, 4 calls were requests for sprayer shutoffs and/or call notifications prior to spraying. No requests for habitat inspection or general information were received (**Table 3; Figures 16 and 17**).

In 2017 VDCI received 59 phone calls from residents of Louisville. 50 calls were requests for shutoff and/or call notifications prior to spraying, 5 calls were adult mosquito complaints, 3 calls were requests to have habitat inspected for mosquito larvae and one request for general information (**Figure 17**).

Table 3 2018 Mosquito Control Calls by Category

Call Category	2018	
	Number of Calls	Percentage
Adult Complaint	4	50.0%
Habitat Assessment	0	0.0%
Shutoff/Notification	2	25.0%
Notification	2	25.0%
General Info/Other	0	0.0%
Total	8	100.0%

Figure 16 2018 Mosquito Control Calls by Month

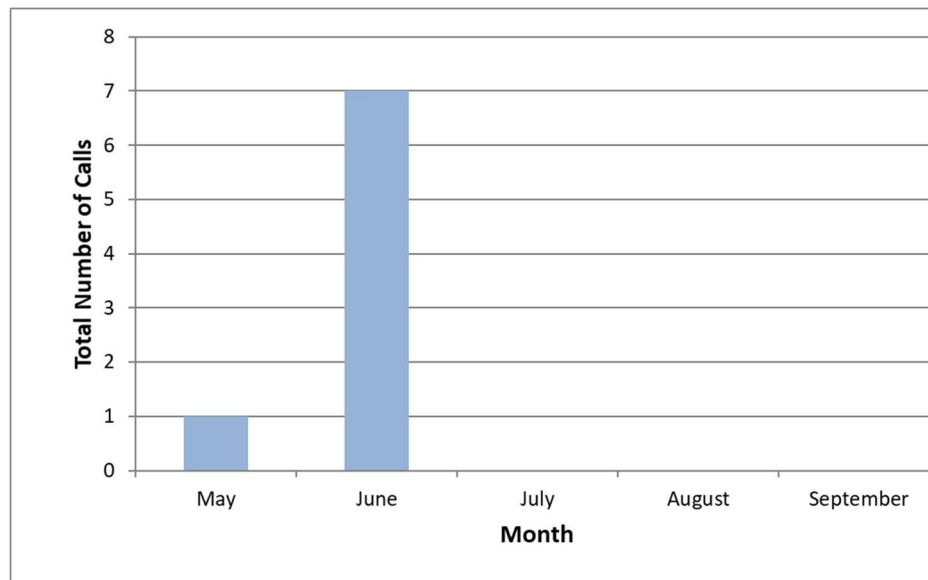
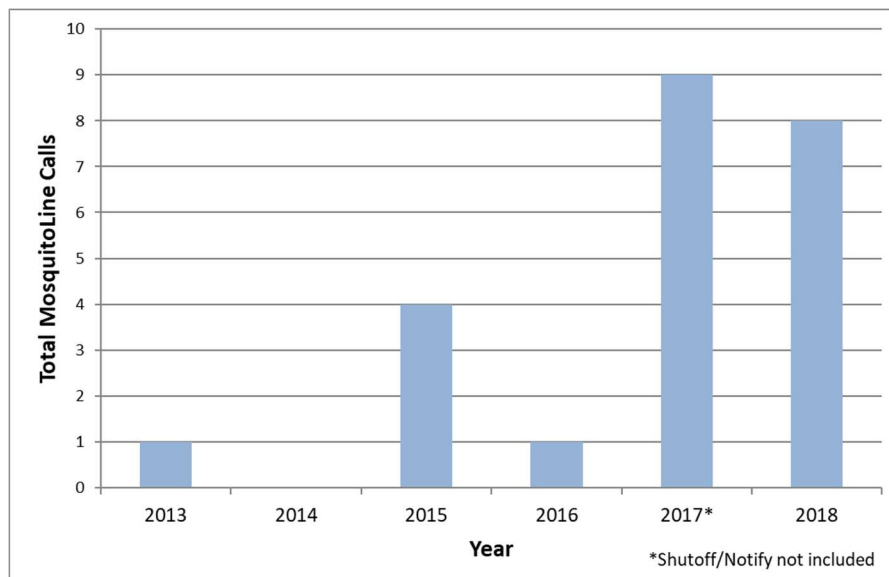


Figure 17 Comparison of Total Mosquito Control Calls by Year



Appendix A: City of Louisville Individual Light Trap Summaries

LO-01: Coal Creek Golf Course

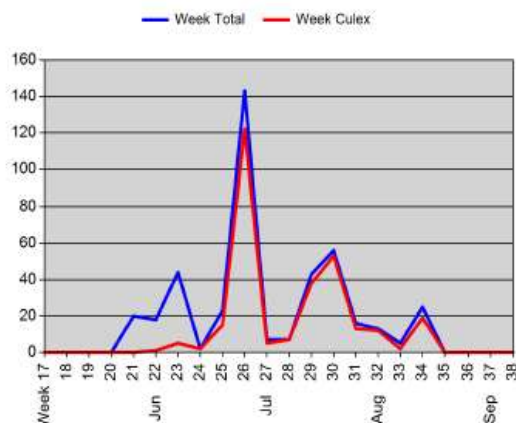
Season: 2018
 Trap Type: Light/CO2 - BCZ3 Sentinel Zone
 Location: Dillon Road at bridge over Coal Creek
 GPS: N39° 57.465', W105° 9.120'

Total number of trap/nights set: 14
 Total number of mosquitoes collected: 422
 Average mosquitoes per trap/night: 30
 Average Culex per trap/night: 21

Species collected and abundance:

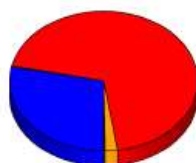
<i>Aedes (Oc.) dorsalis</i>	2	0.5 %
<i>Aedes (Oc.) inaeptus</i>	14	3.3 %
<i>Aedes (Oc.) melanimon</i>	23	5.5 %
<i>Aedes (Oc.) trivittatus</i>	6	1.4 %
<i>Aedes vexans</i>	74	17.5 %
<i>Anopheles freeborni</i>	1	0.2 %
<i>Coquillettidia perturbans</i>	1	0.2 %
<i>Culex pipiens</i>	36	8.5 %
<i>Culex salinarius</i>	1	0.2 %
<i>Culex tarsalis</i>	255	60.4 %
<i>Culiseta incidens</i>	1	0.2 %
<i>Culiseta inornata</i>	8	1.9 %

Seasonality



Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	119	28.2 %
<i>Anopheles</i>	1	0.2 %
<i>Culex</i>	292	69.2 %
<i>Culiseta</i>	9	2.1 %
Other	1	0.2 %



Count AEOC
 Count AN
 Count CX
 Count CU
 Count OTHER

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LO-04: Annette A. Brand Park

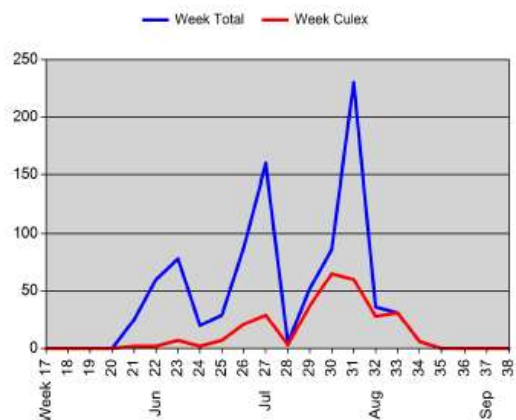
Season: 2018
 Trap Type: Light/CO2
 Location: Annette A. Brand Park at Louisville Reservoir
 GPS: N39° 59.415', W105° 9.495'

Total number of trap/nights set: 14
 Total number of mosquitoes collected: 906
 Average mosquitoes per trap/night: 65
 Average Culex per trap/night: 21

Species collected and abundance:

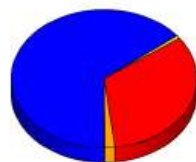
<i>Aedes (Oc.) dorsalis</i>	5	0.6 %
<i>Aedes (Oc.) hendersoni</i>	1	0.1 %
<i>Aedes (Oc.) inaeptus</i>	29	3.2 %
<i>Aedes (Oc.) melanimon</i>	48	5.3 %
<i>Aedes (Oc.) trivittatus</i>	15	1.7 %
<i>Aedes vexans</i>	485	53.5 %
<i>Anopheles freeborni</i>	6	0.7 %
<i>Coquillettidia perturbans</i>	1	0.1 %
<i>Culex pipiens</i>	55	6.1 %
<i>Culex salinarius</i>	40	4.4 %
<i>Culex tarsalis</i>	205	22.6 %
<i>Culiseta inornata</i>	16	1.8 %

Seasonality



Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	583	64.3 %
<i>Anopheles</i>	6	0.7 %
<i>Culex</i>	300	33.1 %
<i>Culiseta</i>	16	1.8 %
Other	1	0.1 %



Count AEOC
 Count AN
 Count CX
 Count CU
 Count OTHER

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LO-08: Coal Creek Trail

Season: 2018
 Trap Type: Light/CO2 - BCZ3 Sentinel Zone
 Location: Coal Creek Trailhead off Aspen Way
 GPS: N39° 58.115', W105° 8.000'

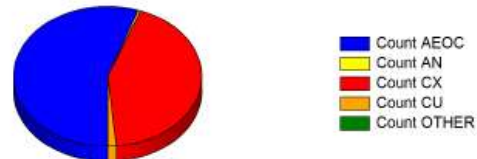
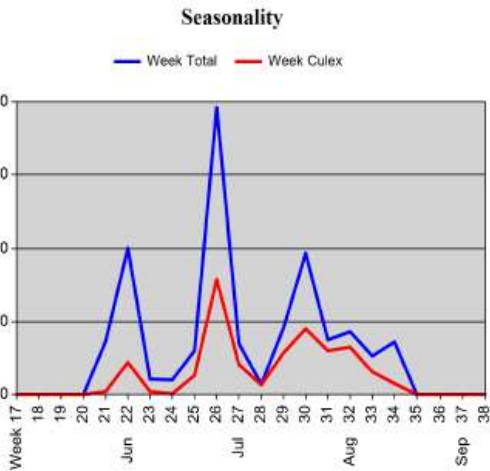
Total number of trap/nights set: 14
 Total number of mosquitoes collected: 1,422
 Average mosquitoes per trap/night: 102
 Average Culex per trap/night: 44

Species collected and abundance:

<i>Aedes (Oc.) dorsalis</i>	4	0.3 %
<i>Aedes (Oc.) hendersoni</i>	1	0.1 %
<i>Aedes (Oc.) inaeptus</i>	15	1.1 %
<i>Aedes (Oc.) melanotus</i>	129	9.1 %
<i>Aedes (Oc.) nigromaculis</i>	1	0.1 %
<i>Aedes (Oc.) trivittatus</i>	8	0.6 %
<i>Aedes vexans</i>	628	44.2 %
<i>Anopheles freeborni</i>	6	0.4 %
<i>Culex pipiens</i>	112	7.9 %
<i>Culex salinarius</i>	34	2.4 %
<i>Culex tarsalis</i>	463	32.6 %
<i>Culiseta incidens</i>	2	0.1 %
<i>Culiseta inornata</i>	19	1.3 %

Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	786	55.3 %
<i>Anopheles</i>	6	0.4 %
<i>Culex</i>	609	42.8 %
<i>Culiseta</i>	21	1.5 %
Other	0	0.0 %



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Appendix B: Adult Sample Pool Test Results for West Nile Virus Positive Locations

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Mosquito Pool Testing

Sample	Collection	Trap	Quantity	Species	Type	Notes	Results	MIR
S321117		Boulder						
	07/23/2018	LM-03	55	Culex tarsalis	LIGHT	BCZ2	POSITIVE	0.000
Total in pool							55	
S321130		Boulder						
	07/23/2018	ER-03	54	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
	07/23/2018	LO-01	10	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							64	
S321351		Boulder						
	07/30/2018	LA-11	58	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							58	
S321353		Boulder						
	07/30/2018	LO-08	65	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							65	
S321397		Boulder						
	08/06/2018	LM-17	45	Culex tarsalis	LIGHT	BCZ2	POSITIVE	0.000
	08/06/2018	LM-28	17	Culex tarsalis	LIGHT	BCZ2	POSITIVE	0.000
Total in pool							62	
S321398		Boulder						
	08/06/2018	LM-03	3	Culex pipiens	LIGHT	BCZ2	POSITIVE	0.000
	08/06/2018	LM-17	6	Culex pipiens	LIGHT	BCZ2	POSITIVE	0.000
	08/06/2018	LM-28	5	Culex pipiens	LIGHT	BCZ2	POSITIVE	0.000
	08/06/2018	LM-34	23	Culex pipiens	LIGHT	BCZ2	POSITIVE	0.000
Total in pool							37	
S321400		Boulder						
	08/06/2018	ER-03	65	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							65	
S321402		Boulder						
	08/06/2018	ER-03	10	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
	08/06/2018	LA-11	29	Culex tarsalis	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							39	
S321438		Boulder						
	08/13/2018	LM-03	65	Culex tarsalis	LIGHT	BCZ2	POSITIVE	0.000
Total in pool							65	
S321450		Boulder						
	08/13/2018	ER-03	65	Culex pipiens	LIGHT	BCZ3	POSITIVE	0.000
Total in pool							65	
S321520		Boulder						
	08/28/2018	BO-11	4	Culex tarsalis	LIGHT	BCZ1	POSITIVE	0.000
	08/28/2018	BO-22	39	Culex tarsalis	LIGHT	BCZ1	POSITIVE	0.000
	08/28/2018	BO-26	3	Culex tarsalis	LIGHT	BCZ1	POSITIVE	0.000
Total in pool							46	

CMMS - Comprehensive Mosquito Management System ©2017 Vector Disease Control International

Thursday, October 04, 2018

POOL-001

1

Sample	Collection	Trap	Quantity	Species	Type	Notes	Results	MIR
	08/28/2018	BO-26	3	Culex tarsalis	LIGHT	BCZ1	POSITIVE	0.000
Total in pool							46	

Appendix C: Boulder County Public Health Sentinel Zones 1-3 Light Trap Summaries

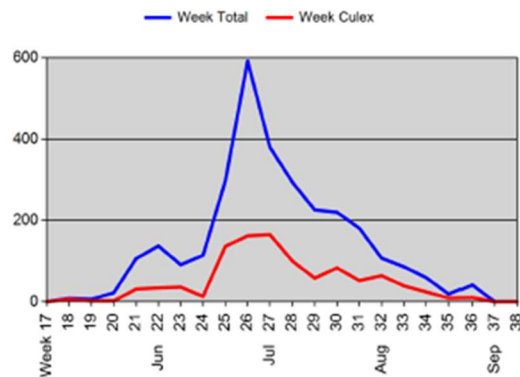
2018 BCZ1 Sentinel Zone Trap Composite Data

Total number of trap/nights set: 85
Total number of mosquitoes collected: 14,809
Average mosquitoes per trap/night: 174
Average Culex per trap/night: 60

Species collected and abundance:

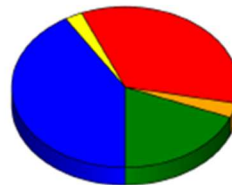
<i>Aedes (Oc.) dorsalis</i>	244	1.6 %
<i>Aedes (Oc.) hendersoni</i>	4	0.0 %
<i>Aedes (Oc.) increpitus</i>	204	1.4 %
<i>Aedes (Oc.) melanimon</i>	247	1.7 %
<i>Aedes (Oc.) nigromaculis</i>	2	0.0 %
<i>Aedes (Oc.) trivittatus</i>	322	2.2 %
<i>Aedes cinereus</i>	1	0.0 %
<i>Aedes vexans</i>	5080	34.3 %
<i>Aedes (Oc.) sollicitans</i>	1	0.0 %
<i>Anopheles freeborni</i>	371	2.5 %
<i>Coquilletidia perturbans</i>	2791	18.8 %
<i>Culex pipiens</i>	574	3.9 %
<i>Culex salinarius</i>	167	1.1 %
<i>Culex tarsalis</i>	4360	29.4 %
<i>Culex territans</i>	4	0.0 %
<i>Culiseta inornata</i>	437	3.0 %

Seasonality



Genus proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	6,105	41.2 %
<i>Anopheles</i>	371	2.5 %
<i>Culex</i>	5,105	34.5 %
<i>Culiseta</i>	437	3.0 %
Other	2,791	18.8 %



Count AEOC
Count AN
Count CX
Count CU
Count OTHER

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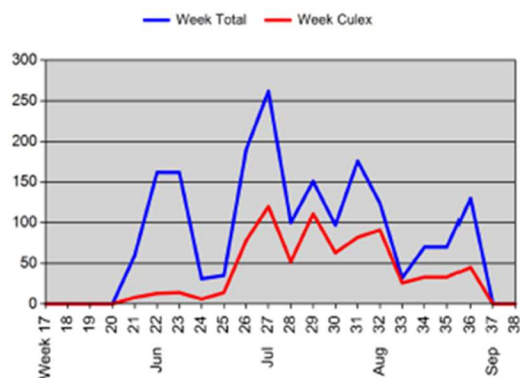
2018 BCZ2 Sentinel Zone Trap Composite Data

Total number of trap/nights set: 75
Total number of mosquitoes collected: 8,903
Average mosquitoes per trap/night: 119
Average Culex per trap/night: 50

Species collected and abundance:

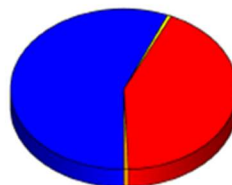
<i>Aedes (Oc.) dorsalis</i>	474	5.3 %
<i>Aedes (Oc.) increpitus</i>	50	0.6 %
<i>Aedes (Oc.) melanimon</i>	71	0.8 %
<i>Aedes (Oc.) trivittatus</i>	36	0.4 %
<i>Aedes cinereus</i>	14	0.2 %
<i>Aedes vexans</i>	4368	49.1 %
<i>Anopheles freeborni</i>	51	0.6 %
<i>Culex pipiens</i>	720	8.1 %
<i>Culex salinarius</i>	312	3.5 %
<i>Culex tarsalis</i>	2749	30.9 %
<i>Culiseta inornata</i>	58	0.7 %

Seasonality



Genus proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	5,013	56.3 %
<i>Anopheles</i>	51	0.6 %
<i>Culex</i>	3,781	42.5 %
<i>Culiseta</i>	58	0.7 %
Other	0	0.0 %



Count AEOC
Count AN
Count CX
Count CU
Count OTHER

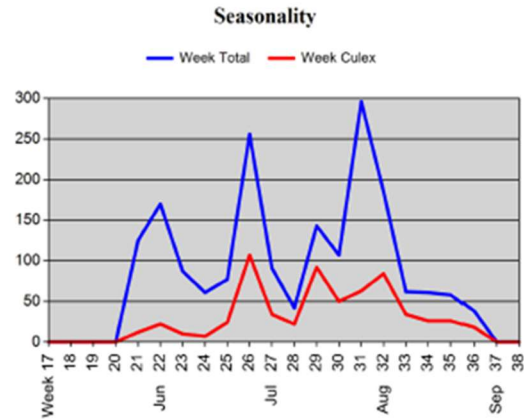
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2018 BCZ3 Sentinel Zone Trap Composite Data

Total number of trap/nights set: 73
 Total number of mosquitoes collected: 9,009
 Average mosquitoes per trap/night: 123
 Average Culex per trap/night: 41

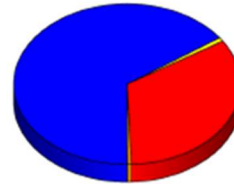
Species collected and abundance:

<i>Aedes (Oc.) dorsalis</i>	76	0.8 %
<i>Aedes (Oc.) hendersoni</i>	1	0.0 %
<i>Aedes (Oc.) inaeptus</i>	51	0.6 %
<i>Aedes (Oc.) melanomus</i>	253	2.8 %
<i>Aedes (Oc.) nigromaculis</i>	2	0.0 %
<i>Aedes (Oc.) trivittatus</i>	132	1.5 %
<i>Aedes vexans</i>	5356	59.5 %
<i>Anopheles freeborni</i>	71	0.8 %
<i>Coquillettidia perturbans</i>	5	0.1 %
<i>Culex pipiens</i>	535	5.9 %
<i>Culex salinarius</i>	137	1.5 %
<i>Culex tarsalis</i>	2345	26.0 %
<i>Culiseta incidens</i>	3	0.0 %
<i>Culiseta inornata</i>	42	0.5 %



Genus proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	5,871	65.2 %
<i>Anopheles</i>	71	0.8 %
<i>Culex</i>	3,017	33.5 %
<i>Culiseta</i>	45	0.5 %
Other	5	0.1 %



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Appendix D: City of Louisville Adulticide Application Data - Barrier



Ground Adulticide Applications

Start Date: 6/1/2018 End Date: 9/30/2018

Louisville

Month	Date	Municipality	Chemical	Mix Ratio	Trip Miles	Spray Miles	Spray Acres	Gallons Sprayed
Treatment Area Annette Brand Park Applications								
July 2018	7/12/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.1	4.0
<i>Total Talstar Pro Applied:</i>								4.0
August 2018	8/10/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.1	4.0
<i>Total Talstar Pro Applied:</i>								4.0
<i>ne Annette Brand Park Totals:</i>					0.0	0.0	0.2	8.0
Treatment Area Coal Creek GC Applications								
July 2018	7/6/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.2	8.0
<i>Total Talstar Pro Applied:</i>								8.0
August 2018	8/3/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.2	10.0
<i>Total Talstar Pro Applied:</i>								10.0
<i>Zone Coal Creek GC Totals:</i>					0.0	0.0	0.4	18.0
Treatment Area Coal Creek Trail Applications								
June 2018	6/8/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.2	8.0
<i>Total Talstar Pro Applied:</i>								8.0
July 2018	7/6/2018		Talst (279-3206)	1:128	0.0	0.0	0.2	8.0
<i>Total Talstar Pro Applied:</i>								8.0
August 2018	8/3/2018		Talstar Pro (279-3206)	1:128	0.0	0.0	0.3	12.0
<i>Total Talstar Pro Applied:</i>								12.0
<i>Zone Coal Creek Trail Totals:</i>					0.0	0.0	0.6	28.0
<i>Grand Totals:</i>					0.0	0.0	1.2	54.0