

City of Louisville Integrated Mosquito Management Program 2020 Annual Report

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**City of Louisville
Integrated Mosquito Management Program**

2020 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 2020. 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.

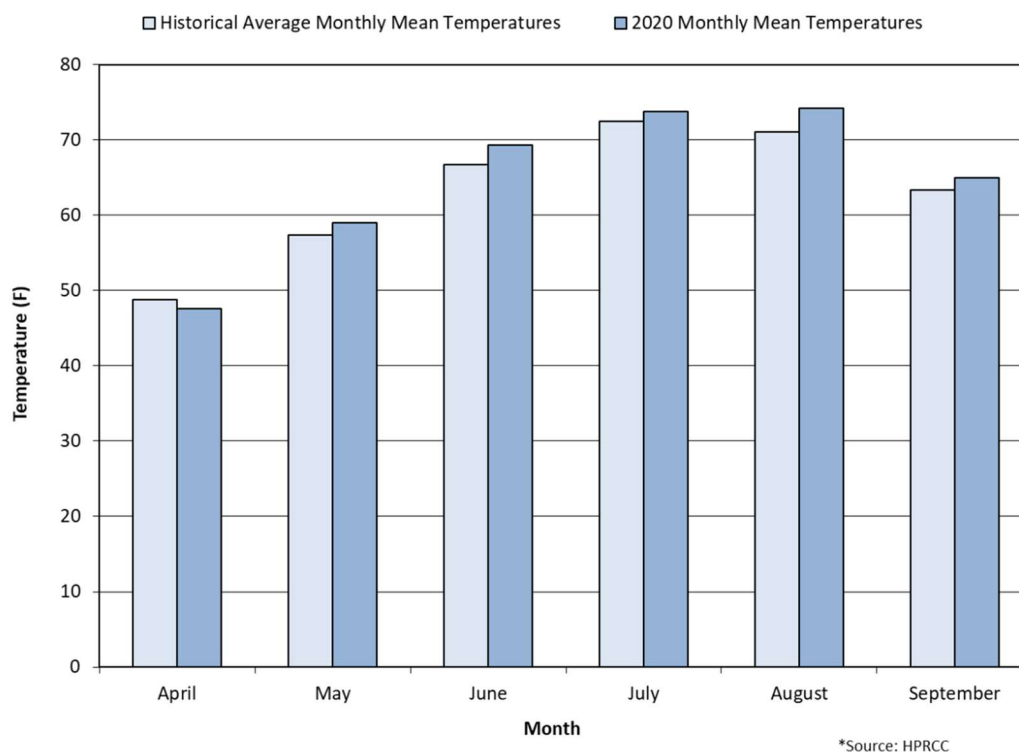
Vector Disease Control International, as the contractor for the City of Louisville, will continue to use proven scientific Integrated Mosquito Management techniques to survey and control local mosquito populations using biorational larval controls and limited low-toxicity insecticide applications. All 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.

2020 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.

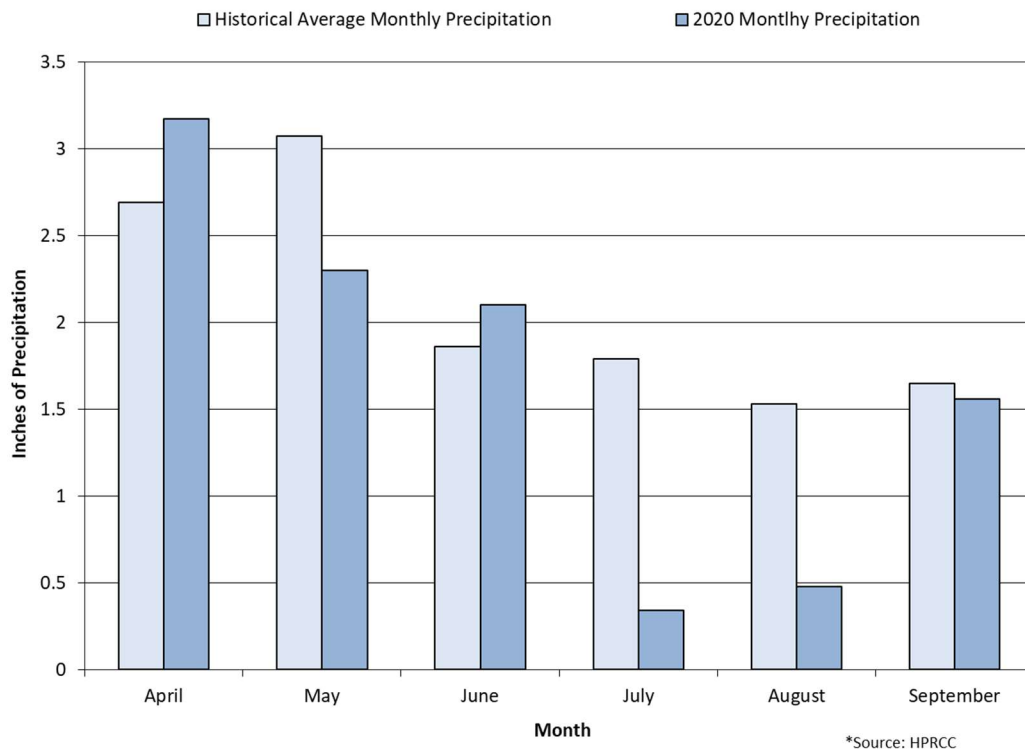
In 2020, every month of the mosquito season, except April, had temperatures above normal (**Figure 1**). The months of May, June and August experienced the highest deviation from average, +1.6, +2.6 and +3.1 degrees respectively. July had a mean monthly temperature that was near normal at only +0.3 degrees higher than average, while April was far below average at -1.2°. Overall, the 2020 season was approximately 23% warmer than an average year. The end of the season saw record high temperatures (99°) recorded on September 5th and 6th followed by record lows (32 and 30°) on September 8th and 9th, abruptly ending the mosquito season weeks earlier than normal and possibly contributing to a lower incidence of WNV at the end of the summer.

Figure 1 2020 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. The most significant variation during the 2020 mosquito season was the month of April, which received 17.8 percent more precipitation (3.17") than the average amount (2.69"), making it the wettest month of 2020. The accumulated precipitation from April through September was lower than the historical average for the same period with a total of 9.95 inches (**Figure 2**). This is approximately 21.0 percent less precipitation than the historical average of 12.59 inches. By contrast, July and August received approximately 19.0 and 31.4 percent, respectively, of normal precipitation, making both the driest months of the mosquito season in 2020. Even the early snowstorm on September 8th – 9th, with 1.4" of rain and 5.7" of snow did not make up for the unseasonably dry summer.

Figure 2 2020 Monthly Total Precipitation Data and Historical Averages*



Unusually low precipitation and overall and above normal temperatures most of the season likely influenced the lower than average nuisance and vector mosquito populations during 2020 mosquito season. A wet April presumably caused the elevated abundance of nuisance mosquitoes normally seen early in the season, however, the later hot and dry months of mid-summer contributed to lower than average levels of *Culex* species of mosquitoes and West Nile virus incidence than normally seen throughout Boulder County.

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 September 22nd, 2020, a total of 38 states have reported West Nile virus infections in people, birds, or mosquitoes in 2020 (**Figure 3**). Overall, 174 cases of West Nile virus disease in humans have been reported to CDC. This is about two thirds decrease from the number of cases reported in 2019 (627) at this time last year. Of these, 124 (71.3%) were classified as neuroinvasive disease (such as meningitis or encephalitis) and 50 (28.7%) were classified as non-neuroinvasive disease (**Figure 4**) and a total of 6 deaths have resulted from these infections.

Figure 3 West Nile Virus Activity by State – United States, 2020 (as of September 22nd, 2020)*

*CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2020/activitybystate2020.html>

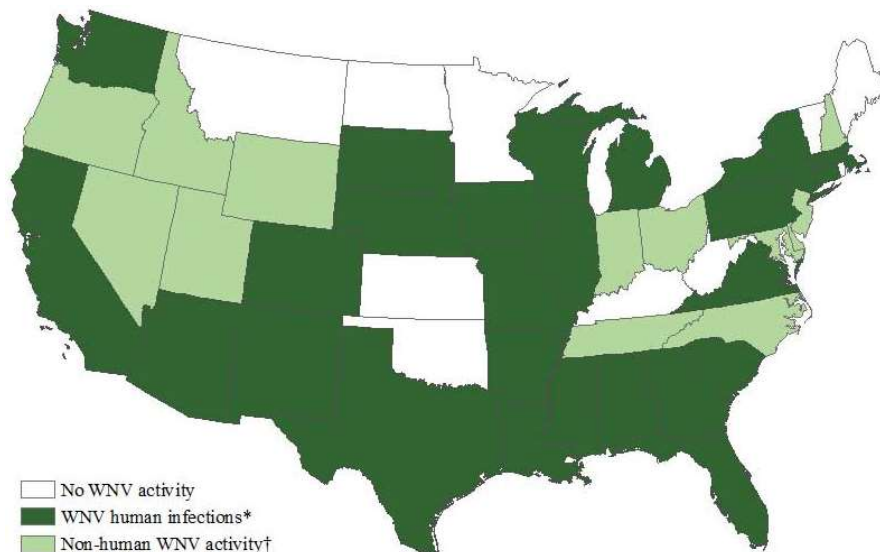
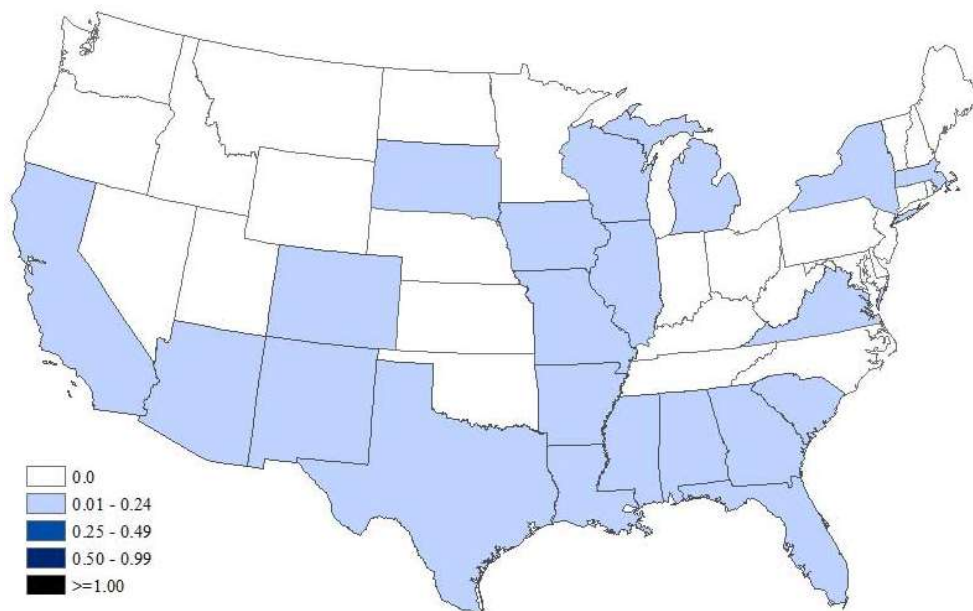


Figure 4 West Nile Virus Neuroinvasive Disease Incidence by State – United States, 2020 (as of September 22nd, 2020)* *CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2020/incidencestate-2020.html>



Colorado 2020

As of September 29th, 2020, the Colorado Department of Health and Environment has identified only 29 cases of human West Nile virus (WNV) infections in Colorado (**Figure 5**) compared to 72 cases in 2019. The CDC reports 25 cases as of September 22nd, 2020 with 6 (24%) asymptomatic blood donor, 6 (24%) neuroinvasive cases including symptoms of meningitis or encephalitis (including meningoencephalitis), and 13 (52%) non-neuroinvasive which includes cases where individuals are non-symptomatic or present with fever and other minor symptoms (**Figure 6**). There have been no deaths (**Figure 6**) associated with West Nile virus infections in Colorado during the 2020 season at this time. 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 2020 (2014-2018 Average) *

*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, 2020 (as of September 22nd, 2020)*

*CDC image <https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2020/disease-cases-state-2020.html>

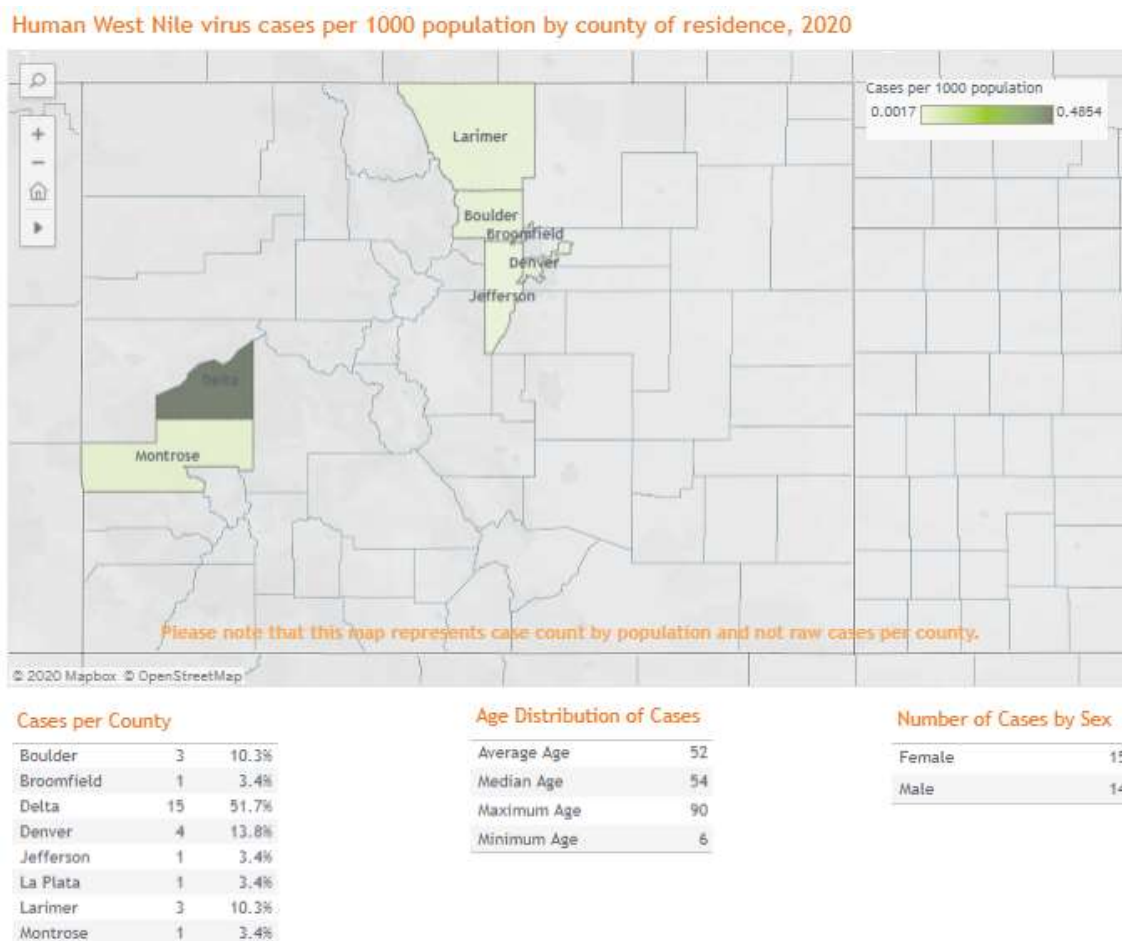
State	Neuroinvasive Disease Cases†	Non-neuroinvasive Disease Cases	Total cases	Deaths	Presumptive viremic blood donors*
Colorado	6	13	19	0	6

Boulder County 2020

CDPHE data currently shows Delta County with the most West Nile virus human cases (15) while Denver County ranks 2nd with 4 human cases followed by Boulder and Larimer Counties with 3 human cases (Figure 7).

Figure 7 Colorado WNV Human Cases by County, 2020*

*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 BCPH throughout the season to calculate Vector Index (VI) levels in order to help City of 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 2020 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 2020, no widespread emergency spraying was conducted within City of Louisville during the 2020 mosquito season.

Table 1 Vector Index, Boulder County Sentinel Zones 1 - 3, 2020

Boulder County Vector Index 2020 ¹			
	Sentinel Zone 1 ²	Sentinel Zone 2 ³	Sentinel Zone 3 ⁴
Season Week	Vector Index	Vector Index	Vector Index
Week 25 (June 14-20)	----	----	----
Week 26 (June 21-27)	----	----	----
Week 27 (June 28-July 4)	0.00	0.00	0.00
Week 28 (July 5-11)	0.00	0.00	0.00
Week 29 (July 12-18)	0.00	0.00	0.00
Week 30 (July 19-25)	0.00	0.00	0.00
Week 31 (July 26 -Aug 1)	0.00	0.00	0.00
Week 32 (August 2-8)	0.00	0.00	0.21
Week 33 (August 9-15)	0.00	0.20	0.00
Week 34 (August 16-22)	0.00	0.20	0.21
Week 35 (August 23-29)	0.00	0.15	0.00
Week 36 (Aug 30 - Sept 5)	0.00	0.00	0.00
Week 37 (Sept 6 - 12)	----	----	----
1. Reported by BCPH as of September 15, 2020			
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 the first full week in May. Hiring of seasonal field technicians began in April and continued into May. VDCI's Annual Field Technician Classroom Training Day looked different this season with Covid-19 pandemic restrictions on large gatherings. Instead, each VDCI Colorado office conducted a combination of online video training with small group field training during the week of May 18th. A large contingent of returning technicians resulted in only six newly trained field technicians for the 2020 season. Additional field training by VDCI management and veteran employees lasted through May and full-time field activities were in effect by early June.

In 2020 Vector Disease Control International performed 446 larval site inspections at 99 documented breeding sites throughout the City. Of these individual inspections, 279 sites (62.6%) were wet upon inspection and 59 (13.2%) were producing mosquito larvae in the City of Louisville. These inspections resulted in 54 applications in which VDCI applied 19.8 lbs. of VectoBac G (*Bti*), 0.01 lbs. of Vectolex FG (*Bs*) and 0.2 gallons of BVA 2 larvicide oil (**Table 2; Figures 8 and 9**) to 2.2 acres of land within the City of Louisville.

By comparison, in 2019 VDCI performed 276 larval site inspections at 80 documented breeding sites throughout the City. Of these individual inspections, 201 sites (72.8%) were wet upon inspection and 69 (33.8%) were producing mosquito larvae in the City of Louisville. These inspections resulted in 68 applications in which VDCI applied 46.8 lbs. of VectoBac G (*Bti*), 16.0 lbs. of Vectolex FG (*Bs*) and 0.6 gallons of BVA 2 larvicide oil (**Table 2 and Figure 9**) to 9.4 acres of land within the City of Louisville.



In 2018 VDCI 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 applications in which VDCI applied 46.8 lbs. of VectoBac G (*Bti*) and 0.5 gallons of BVA 2 larvicide oil (**Table 2 and Figure 9**) to 8.1 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.

Figure 8 2020 Larval Site Inspections and Applications by Month

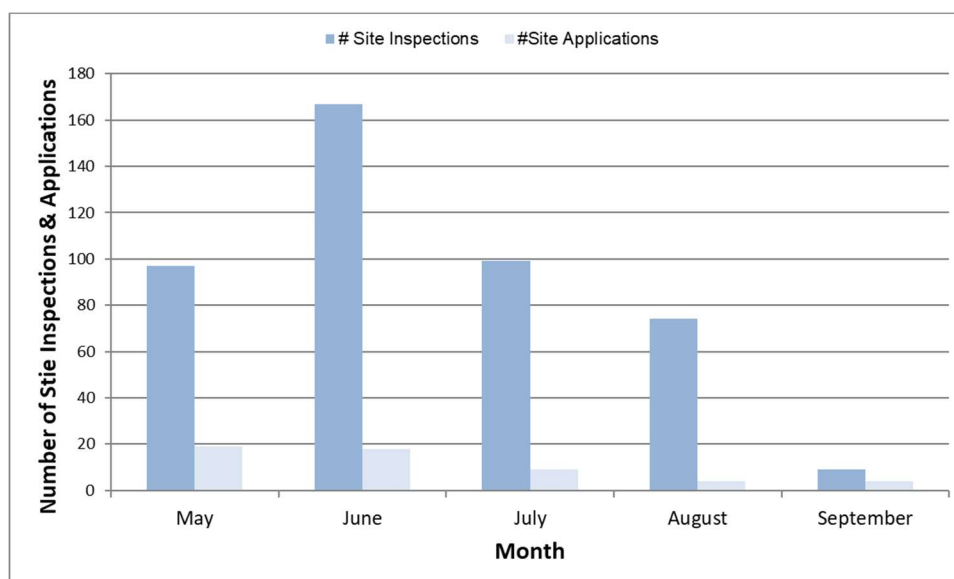


Figure 9 Comparison of Larval Site Inspections and Applications by Year

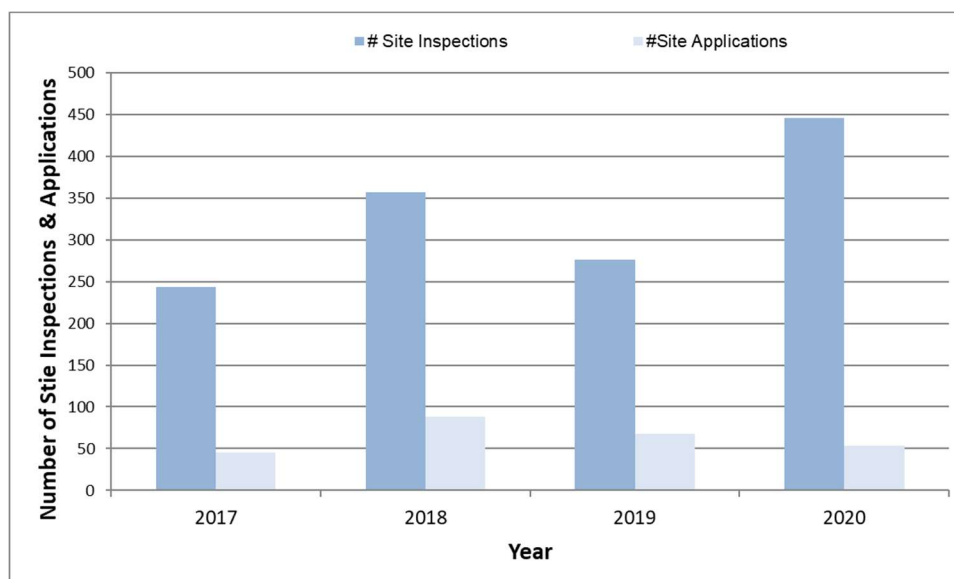


Table 2 2020 Summary of Larval Control Product Applications by Type

Larval Control Product Types	2017	2018	2019	2020
<i>Bacillus thuringiensis israelensis (Bti)</i>				
Vectobac G (lbs) EPA Reg. #73049-10	17.9	46.8	58.3	19.8
<i>Bacillus sphaericus (Bs)</i>				
Vectolex FG (lbs) EPA Reg. #73049-20	1.7	0.0	16.0	0.01
S-Methoprene				
Altosid Briquet (oz) EPA Reg. #2724-375	0.0	0.0	0.0	0.0
Altosid XRG (oz) EPA Reg. #2724-451	0.0	0.0	0.0	0.0
Mineral Oil				
BVA 2 Larvicide Oil (gal) EPA Reg. #70589-1	1.8	0.5	0.6	0.2

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 2020, Vector Disease Control International monitored a statewide network of hundreds of weekly trap sites, collecting 519,432 adult mosquitoes that were counted and identified to species by the VDCI Surveillance Laboratories compared to 873,309 in 2019. And a total of 170,328 adult mosquitoes were counted and identified in the entirety of Boulder County in 2020. 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 2020, an average of 3 surveillance light traps monitored adult mosquito populations within the City of Louisville on a weekly basis (**Figure 10**). Early season adult surveillance began with a select site (Coal Creek @ Aspen Way) the weeks of May 14th and 20th. VDCI began full surveillance (3 traps) the week of May 27th and concluded on September 15th corresponding with an unseasonal snowstorm the week prior (September 8th) and low adult mosquito activity.

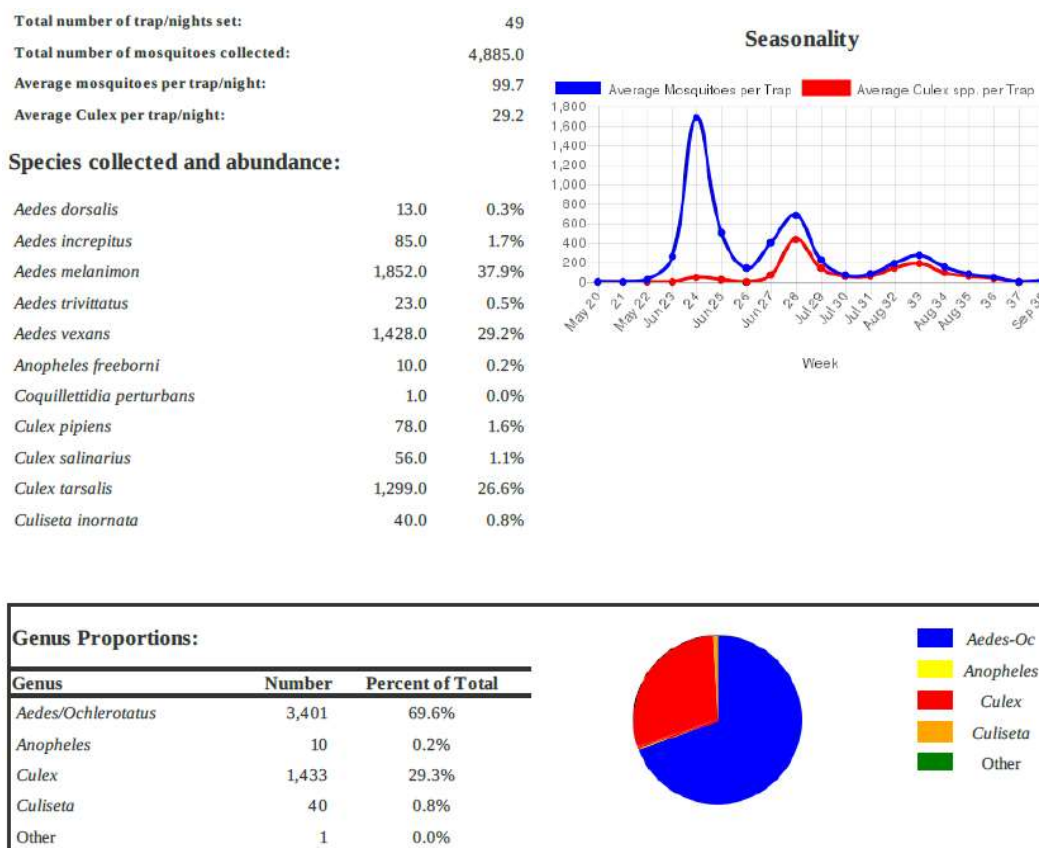
There were 49 CDC light surveillance trap nights set within City of Louisville during the 2020 season. These traps collected a total of 4,885 mosquitoes. There was an average of 99.7 mosquitoes caught per trap per night and an average 29.2 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 69.6% (3,401) *Aedes/Ochlerotatus spp.*, 0.2% (10) *Anopheles spp.*, <1% (1) *Coquillettidia spp.*, 29.3% (1,433) *Culex spp.*, and 0.8% (40) *Culiseta spp.*, (**Figure 10**). Please refer to **Appendix A** for Louisville's Individual Light Trap Summaries.

A total of 11 species were represented in 2020 in Louisville. No exotic/introduced species (such as Asian Tiger Mosquitoes) were collected this season.

By comparison, in 2019 there were 41 CDC light surveillance trap nights set within City of Louisville. These traps collected a total of 3,634 mosquitoes. There was an average of 88.6 mosquitoes caught per trap per night and an average 44.1 *Culex spp.* mosquitoes per trap per night. The composition of mosquitoes collected was 47.6% (1,731) *Aedes/Ochlerotatus spp.*, 0.1% (3) *Anopheles spp.*, 0.1% (2) *Coquillettidia spp.*, 49.8% (1,809) *Culex spp.*, and 2.4% (89) *Culiseta spp.*

In 2018 there were 42 CDC light surveillance trap nights set within the City of Louisville. 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 51.1% (1,488) *Aedes/Ochlerotatus spp.*, <1% (13) *Anopheles spp.*, <1% (2) *Coquillettidia spp.*, 43.7% (1,201) *Culex spp.*, and 1.7% (46) *Culiseta spp.*

Figure 10 2020 City of Louisville 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.

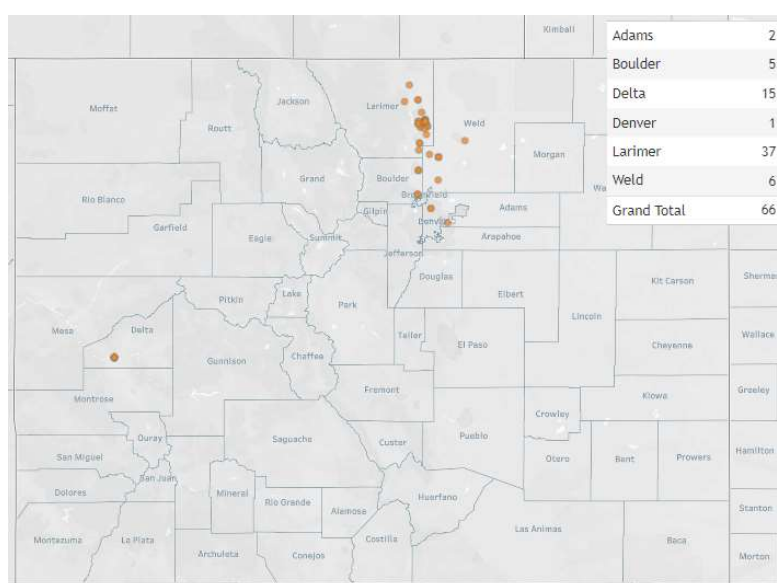
As defined in the CDC guidelines for West Nile virus surveillance, prevention and control, the vector index (VI) is an estimate of the number of West Nile virus infected mosquitoes in an area. This number can serve as a human health risk value. An operational value of 0.75, which was derived from the 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 11**), which VDCI is contracted separately through BCPH to perform.

As of September 15th, 2020, CDPHE reported 66 positive mosquito pools from Colorado Sentinel Zones. Larimer County had the most West Nile virus positive mosquito pools (37) while Delta County ranked 2nd with 15 positive pools followed by Weld and Boulder Counties with 6 and 5 respectively. The first Colorado West Nile virus positive mosquito sample pool in 2020 was the week of July 12th (week 29) in Delta County followed by Larimer County in Week 30 (**Figure 11**).

Figure 11 **Number of Colorado Positive WNV Specimens 2020***

*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 2020. 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 12**). The sentinel light traps were set once a week from June 14th (week 25) to September 14th, 2020 (week 38). WNV sentinel pool testing began June 21st (week 26) and ended August 30th (week 36) due to an unseasonably early snowstorm the following week.

As of September 15th, 2020 (week 37), CDPHE tested a total of 114 mosquito pools from Boulder County Sentinel Zones. Of the tested mosquito pools, five (5) pools tested positive for West Nile virus out of all three sentinel zones in 2020 (**Appendix B**). The first Boulder County West Nile virus positive mosquito sample pool (1) in 2020 was on August 3rd, 2020 (week 32) in BCZ3, the same week as 2019 (**Table 1; Figure 11 and 12**).

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 2020 season a total of 112 gallons of Talstar Pro or Wisdom TC (Active Ingredient – Bifenthrin) were applied as daytime adult barrier applications (**Figures 13 and 14**). A detailed summary of adulticide applications, by neighborhood, can be found in **Appendix C**.

By comparison, in 2019, a total of 140 gallons of Talstar Pro (Active Ingredient – Bifenthrin) (**Figure 14**) were applied as daytime adult barrier applications in the City of Lafayette.

In 2018, a total of 54 gallons of Talstar Pro (Active Ingredient – Bifenthrin) (**Figure 14**) 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 13 2020 Barrier Adulticide Gallons by Month

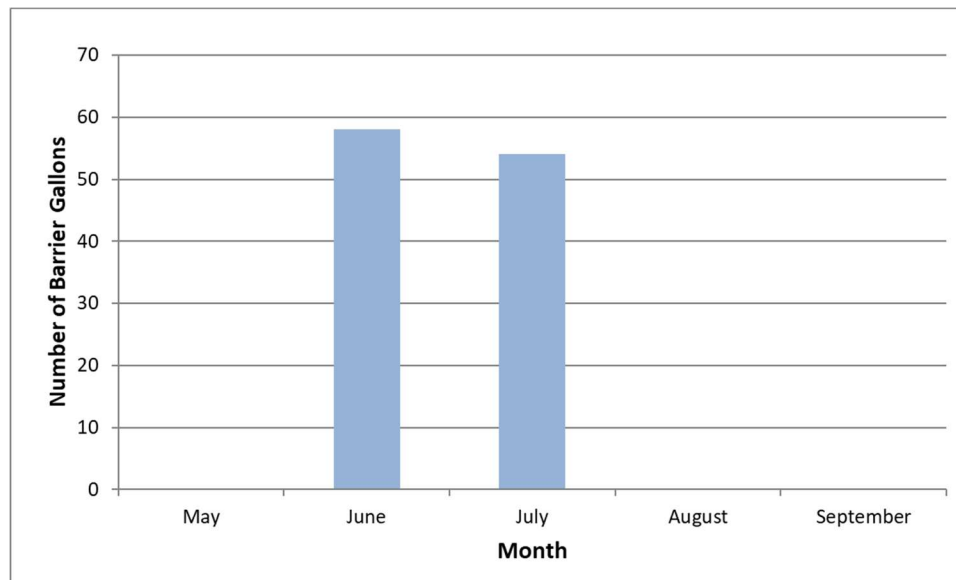
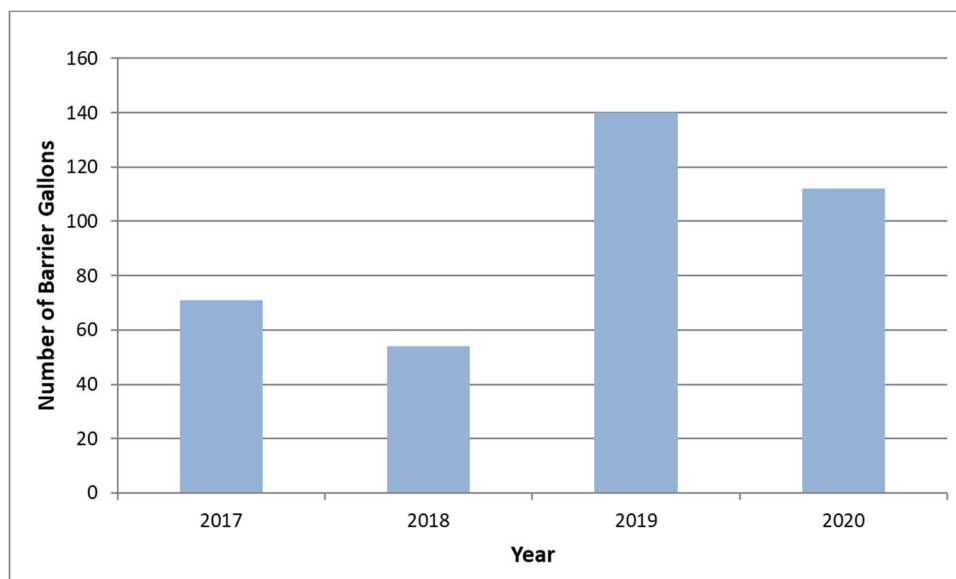


Figure 14 Comparison of Barrier Adulticide Gallons by Year



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 2020 season, VDCI sent out 5 letters to all historical shutoff and notification households to establish a current list for the 2020 season. VDCI received one (1) shut off and/or notification requests for the 2020 season via VDCI's online request form and they were not on a designated ULV adult control route. The 2020 season shutoff and notification list concluded with no households on established ULV routes. Residents on the shutoff and notification list will be notified 24 hours in advance when their community is scheduled to be fogged. VDCI uses an automated message service to contact residents and lists weekly ULV adult control operations on VDCI's website, www.vdci.net/colorado-schedules, which utilizes Google Calendar. There were no notification calls sent in 2020.

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 2020 Vector Disease Control International received approximately 10 phone calls from residents of the City of Louisville. Most of these calls (6) were for adult mosquito complaints. Of the rest, 2 calls were requests for habitat assessment, 2 calls were requests for general information or other reasons and one request for ULV adult control shut off and/or call notification (website submission) (**Table 3; Figure 15 and Figure 16**).

By comparison, in 2019 VDCI received approximately 8 phone calls from residents of the Town of Erie. No calls were received for adult mosquito annoyance. Of the rest, 1 call requested a habitat assessment and

2 calls requested general information or other information and 4 requests were for ULV adult control shut off and/or call notification (website submission) **(Figure 16)**.

In 2018 VDCI received approximately 8 phone calls from residents of the Town of Erie. Most of these calls (4) were for adult mosquito annoyance. Of the rest, no calls for habitat assessment or general information or other reasons were received. 4 requests were received for ULV adult control shut off and/or call notification (website submission) **(Figure 16)**.

Table 3 2020 Mosquito Control Calls by Category

Call Category	2020	
	Number of Calls	Percentage
Adult Complaint	6	60.0%
Habitat Assessment	2	20.0%
General Info/Other	2	20.0%
Shutoff/Notification*	0	0.0%
Notification*	0	0.0%
Total	10	100.0%
*VDCI website submission		

Figure 15 2020 Mosquito Control Calls by Month

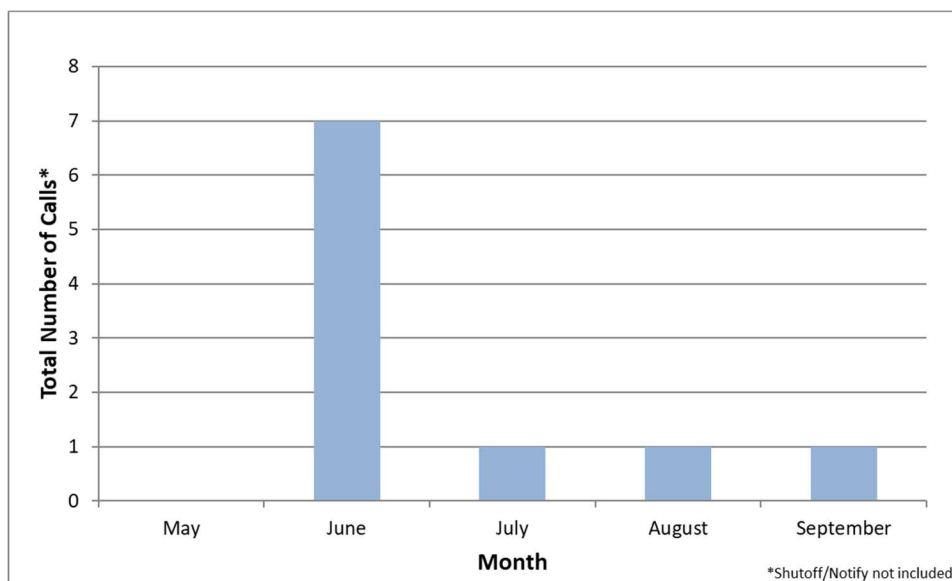
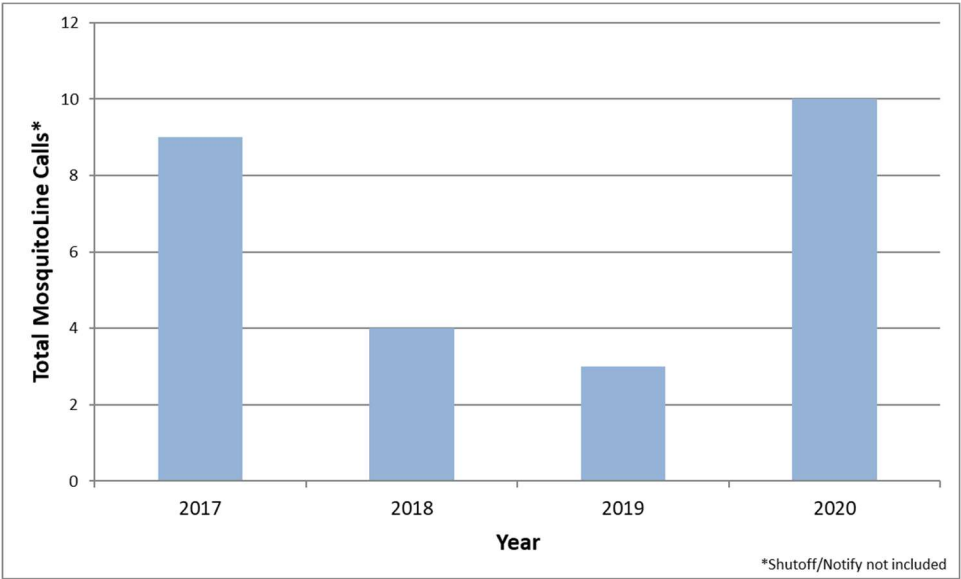


Figure 16 Comparison of Total Mosquito Control Calls by Year



Appendix A: City of Louisville Individual Light Trap Summaries

LO-01

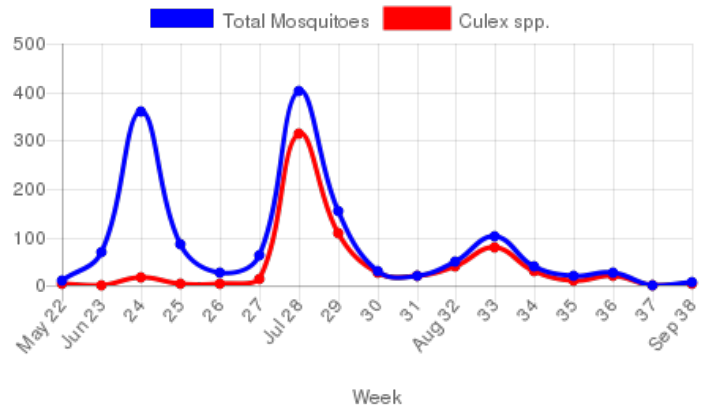
Season: 05/01/2020 - 09/18/2020
Trap Type: CDC Light Trap
Location: Louisville Coal Creek At Dillon Road
GPS: 39.957750025757214, -105.15199989080428

Total number of trap/nights set: 16.0
Total number of mosquitoes collected: 1,469.0
Average mosquitoes per trap/night: 91.8
Average Culex per trap/night: 44.1

Species collected and abundance:

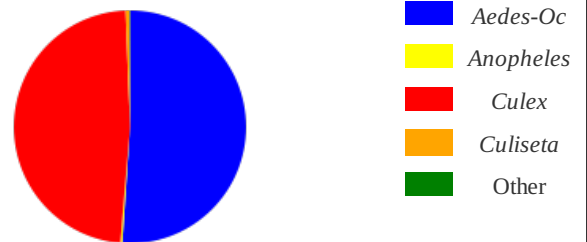
<i>Aedes dorsalis</i>	6.0	0.4%
<i>Aedes inreptus</i>	74.0	5.0%
<i>Aedes melanimon</i>	431.0	29.3%
<i>Aedes trivittatus</i>	4.0	0.3%
<i>Aedes vexans</i>	235.0	16.0%
<i>Anopheles freeborni</i>	4.0	0.3%
<i>Coquilletidia perturbans</i>	1.0	0.1%
<i>Culex pipiens</i>	34.0	2.3%
<i>Culex salinarius</i>	22.0	1.5%
<i>Culex tarsalis</i>	650.0	44.2%
<i>Culiseta inornata</i>	8.0	0.5%

Seasonality



Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	750.0	51.1%
<i>Anopheles</i>	4.0	0.3%
<i>Culex</i>	706.0	48.1%
<i>Culiseta</i>	8.0	0.5%
Other	1.0	0.1%



LO-04

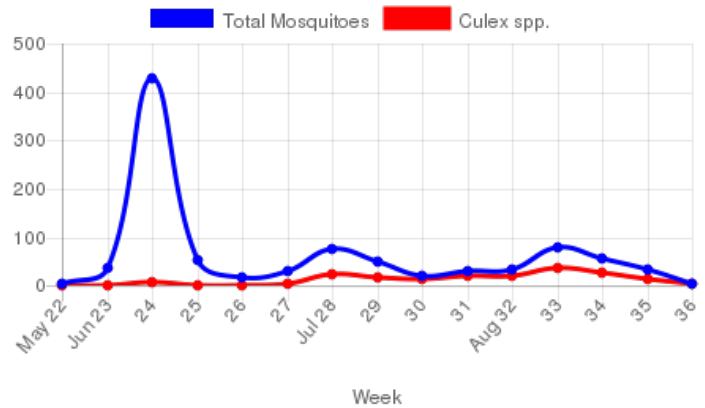
Season: 05/01/2020 - 09/18/2020
 Trap Type: CDC Light Trap
 Location: Annette A. Brand Park/Louisville Reservoir
 GPS: 39.99025, -105.15825

Total number of trap/nights set: 15.0
 Total number of mosquitoes collected: 958.0
 Average mosquitoes per trap/night: 63.9
 Average Culex per trap/night: 12.9

Species collected and abundance:

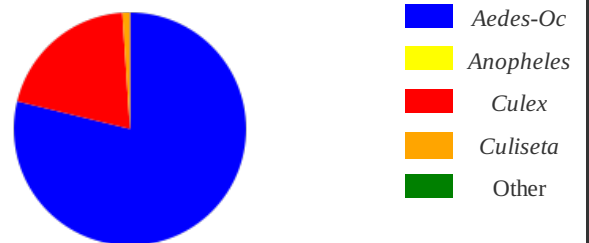
<i>Aedes increpitus</i>	11.0	1.1%
<i>Aedes melanimon</i>	10.0	1.0%
<i>Aedes trivittatus</i>	16.0	1.7%
<i>Aedes vexans</i>	718.0	74.9%
<i>Culex pipiens</i>	9.0	0.9%
<i>Culex salinarius</i>	7.0	0.7%
<i>Culex tarsalis</i>	177.0	18.5%
<i>Culiseta inornata</i>	10.0	1.0%

Seasonality



Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	755.0	78.8%
<i>Anopheles</i>	0.0	0.0%
<i>Culex</i>	193.0	20.1%
<i>Culiseta</i>	10.0	1.0%
Other	0.0	0.0%



LO-08

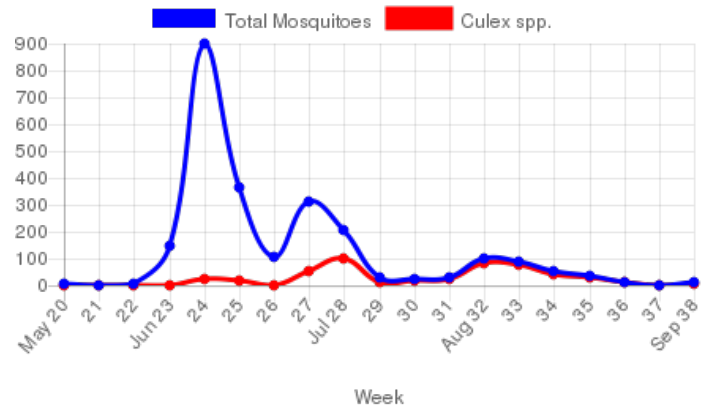
Season: 05/01/2020 - 09/18/2020
 Trap Type: CDC Light Trap
 Location: Louisville SE - Coal Creek Aspen Way
 GPS: 39.96849929260254, -105.13332769274712

Total number of trap/nights set: 18.0
 Total number of mosquitoes collected: 2,458.0
 Average mosquitoes per trap/night: 136.6
 Average Culex per trap/night: 29.7

Species collected and abundance:

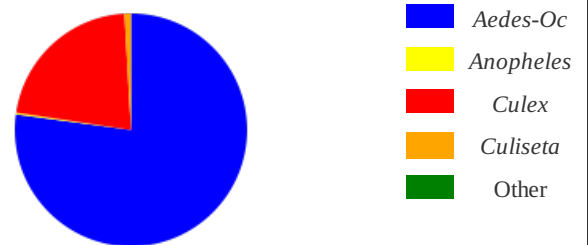
<i>Aedes dorsalis</i>	7.0	0.3%
<i>Aedes melanimon</i>	1,411.0	57.4%
<i>Aedes trivittatus</i>	3.0	0.1%
<i>Aedes vexans</i>	475.0	19.3%
<i>Anopheles freeborni</i>	6.0	0.2%
<i>Culex pipiens</i>	35.0	1.4%
<i>Culex salinarius</i>	27.0	1.1%
<i>Culex tarsalis</i>	472.0	19.2%
<i>Culiseta inornata</i>	22.0	0.9%

Seasonality



Genus Proportions:

Genus	Number	Percent of Total
<i>Aedes/Ochlerotatus</i>	1,896.0	77.1%
<i>Anopheles</i>	6.0	0.2%
<i>Culex</i>	534.0	21.7%
<i>Culiseta</i>	22.0	0.9%
Other	0.0	0.0%



*Appendix B: Adult Sample Pool Test Results for West Nile Virus
Positive Locations (BCZ3)*



Arboviral Surveillance Results

Start Date: 06/01/2020

End Date: 09/04/2020

City of Louisville

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
Treatment Area LO-01 Test Results								
LO-01	06/29/2020	CDC Light Trap	07/02/2020	S323585	<i>Culex tarsalis</i>	11	Negative	RT-PCR
LO-01	07/06/2020	CDC Light Trap	07/09/2020	S323596	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-01	07/06/2020	CDC Light Trap	07/09/2020	S323597	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-01	07/13/2020	CDC Light Trap	07/15/2020	S323613	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-01	07/20/2020	CDC Light Trap	07/21/2020	S323628	<i>Culex tarsalis</i>	25	Negative	RT-PCR
LO-01	07/27/2020	CDC Light Trap	07/28/2020	S323637	<i>Culex tarsalis</i>	19	Negative	RT-PCR
LO-01	08/03/2020	CDC Light Trap	08/04/2020	S323647	<i>Culex tarsalis</i>	39	WNV+	RT-PCR
LO-01	08/10/2020	CDC Light Trap	08/12/2020	S323662	<i>Culex tarsalis</i>	49	Negative	RT-PCR
LO-01	08/17/2020	CDC Light Trap	08/18/2020	S323672	<i>Culex tarsalis</i>	25	Negative	RT-PCR
LO-01	08/24/2020	CDC Light Trap	08/25/2020	S323680	<i>Culex tarsalis</i>	8	Negative	RT-PCR
LO-01	08/31/2020	CDC Light Trap	09/01/2020	S323683	<i>Culex tarsalis</i>	13	Negative	RT-PCR
LO-08	06/29/2020	CDC Light Trap	07/02/2020	S323585	<i>Culex tarsalis</i>	50	Negative	RT-PCR
LO-08	07/06/2020	CDC Light Trap	07/09/2020	S323598	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-08	07/13/2020	CDC Light Trap	07/15/2020	S323614	<i>Culex tarsalis</i>	15	Negative	RT-PCR
LO-08	07/20/2020	CDC Light Trap	07/21/2020	S323628	<i>Culex tarsalis</i>	18	Negative	RT-PCR
LO-08	07/27/2020	CDC Light Trap	07/28/2020	S323637	<i>Culex tarsalis</i>	21	Negative	RT-PCR

Vector Disease Control International
1320 Brookwood Drive Suite H
Little Rock, AR 72202

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
LO-08	08/03/2020	CDC Light Trap	08/04/2020	S323647	<i>Culex tarsalis</i>	9	WNV+	RT-PCR
LO-08	08/03/2020	CDC Light Trap	08/04/2020	S323648	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-08	08/10/2020	CDC Light Trap	08/12/2020	S323663	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LO-08	08/17/2020	CDC Light Trap	08/18/2020	S323672	<i>Culex tarsalis</i>	31	Negative	RT-PCR
LO-08	08/24/2020	CDC Light Trap	08/25/2020	S323680	<i>Culex tarsalis</i>	27	Negative	RT-PCR
LO-08	08/31/2020	CDC Light Trap	09/01/2020	S323683	<i>Culex tarsalis</i>	11	Negative	RT-PCR

Total Pools Tested: 22 Total Mosquitoes Tested: 761 Total Negative: 20 Total Positive: 2



Arboviral Surveillance Results

Start Date: 06/01/2020

End Date: 09/04/2020

City of Lafayette

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
Treatment Area LA-01 Test Results								
LA-11	06/29/2020	CDC Light Trap	07/02/2020	S323584	<i>Culex tarsalis</i>	29	Negative	RT-PCR
LA-11	07/06/2020	CDC Light Trap	07/09/2020	S323595	<i>Culex tarsalis</i>	45	Negative	RT-PCR
LA-11	07/13/2020	CDC Light Trap	07/15/2020	S323611	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	07/13/2020	CDC Light Trap	07/15/2020	S323612	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	07/20/2020	CDC Light Trap	07/21/2020	S323625	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	07/20/2020	CDC Light Trap	07/21/2020	S323627	<i>Culex tarsalis</i>	50	Negative	RT-PCR
LA-11	07/27/2020	CDC Light Trap	07/28/2020	S323636	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	07/27/2020	CDC Light Trap	07/28/2020	S323637	<i>Culex tarsalis</i>	12	Negative	RT-PCR
LA-11	08/03/2020	CDC Light Trap	08/04/2020	S323646	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	08/10/2020	CDC Light Trap	08/12/2020	S323660	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	08/10/2020	CDC Light Trap	08/12/2020	S323661	<i>Culex tarsalis</i>	65	Negative	RT-PCR
LA-11	08/17/2020	CDC Light Trap	08/18/2020	S323670	<i>Culex tarsalis</i>	65	WNV+	RT-PCR
LA-11	08/17/2020	CDC Light Trap	08/18/2020	S323671	<i>Culex tarsalis</i>	43	Negative	RT-PCR
LA-11	08/24/2020	CDC Light Trap	08/25/2020	S323679	<i>Culex tarsalis</i>	41	Negative	RT-PCR
LA-11	08/31/2020	CDC Light Trap	09/01/2020	S323683	<i>Culex tarsalis</i>	16	Negative	RT-PCR

Total Pools Tested: 15 Total Mosquitoes Tested: 756 Total Negative: 14 Total Positive: 1

Vector Disease Control International
1320 Brookwood Drive Suite H
Little Rock, AR 72202



Arboviral Surveillance Results

Start Date: 06/01/2020

End Date: 09/04/2020

Town of Erie

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
Treatment Area ER-01 Test Results								
ER-03	06/29/2020	CDC Light Trap	07/02/2020	S323582	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	06/29/2020	CDC Light Trap	07/02/2020	S323583	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	06/29/2020	CDC Light Trap	07/02/2020	S323584	<i>Culex tarsalis</i>	2	Negative	RT-PCR
ER-03	07/06/2020	CDC Light Trap	07/09/2020	S323594	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	07/06/2020	CDC Light Trap	07/09/2020	S323595	<i>Culex tarsalis</i>	18	Negative	RT-PCR
ER-03	07/13/2020	CDC Light Trap	07/15/2020	S323609	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	07/13/2020	CDC Light Trap	07/15/2020	S323610	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	07/20/2020	CDC Light Trap	07/21/2020	S323624	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	07/20/2020	CDC Light Trap	07/21/2020	S323626	<i>Culex tarsalis</i>	39	Negative	RT-PCR
ER-03	07/27/2020	CDC Light Trap	07/28/2020	S323634	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	07/27/2020	CDC Light Trap	07/28/2020	S323635	<i>Culex tarsalis</i>	53	Negative	RT-PCR
ER-03	08/03/2020	CDC Light Trap	08/04/2020	S323644	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/03/2020	CDC Light Trap	08/04/2020	S323645	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/10/2020	CDC Light Trap	08/12/2020	S323657	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/10/2020	CDC Light Trap	08/12/2020	S323658	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/10/2020	CDC Light Trap	08/12/2020	S323659	<i>Culex tarsalis</i>	65	Negative	RT-PCR

Vector Disease Control International
1320 Brookwood Drive Suite H
Little Rock, AR 72202

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
ER-03	08/17/2020	CDC Light Trap	08/18/2020	S323669	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/17/2020	CDC Light Trap	08/18/2020	S323671	<i>Culex tarsalis</i>	22	Negative	RT-PCR
ER-03	08/24/2020	CDC Light Trap	08/25/2020	S323677	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/24/2020	CDC Light Trap	08/25/2020	S323678	<i>Culex tarsalis</i>	65	Negative	RT-PCR
ER-03	08/31/2020	CDC Light Trap	09/01/2020	S323683	<i>Culex tarsalis</i>	10	Negative	RT-PCR
Total Pools Tested: 21 Total Mosquitoes Tested: 1119 Total Negative: 21 Total Positive: 0								



Arboviral Surveillance Results

Start Date: 06/01/2020

End Date: 09/04/2020

Town of Superior

Trap Number	Trap Date	Trap Type	Date Tested	Pool No.	Mosquito Species	Pool Size	Results	Assay
Treatment Area SU-01 Test Results								
SU-02	06/29/2020	CDC Light Trap	07/02/2020	S323585	<i>Culex tarsalis</i>	1	Negative	RT-PCR
SU-02	07/06/2020	CDC Light Trap	07/09/2020	S323599	<i>Culex tarsalis</i>	65	Negative	RT-PCR
SU-02	07/13/2020	CDC Light Trap	07/15/2020	S323614	<i>Culex tarsalis</i>	30	Negative	RT-PCR
SU-02	07/20/2020	CDC Light Trap	07/21/2020	S323628	<i>Culex tarsalis</i>	9	Negative	RT-PCR
SU-02	07/27/2020	CDC Light Trap	07/28/2020	S323637	<i>Culex tarsalis</i>	6	Negative	RT-PCR
SU-02	08/03/2020	CDC Light Trap	08/04/2020	S323647	<i>Culex tarsalis</i>	9	WNV+	RT-PCR
SU-02	08/10/2020	CDC Light Trap	08/12/2020	S323662	<i>Culex tarsalis</i>	16	Negative	RT-PCR
SU-02	08/17/2020	CDC Light Trap	08/18/2020	S323672	<i>Culex tarsalis</i>	9	Negative	RT-PCR
SU-02	08/24/2020	CDC Light Trap	08/25/2020	S323680	<i>Culex tarsalis</i>	5	Negative	RT-PCR
SU-02	08/31/2020	CDC Light Trap	09/01/2020	S323683	<i>Culex tarsalis</i>	2	Negative	RT-PCR

Total Pools Tested: 10 Total Mosquitoes Tested: 152 Total Negative: 9 Total Positive: 1

Appendix C: City of Louisville Adulticide Application Data - Barrier



Ground Adulticide Applications

Start Date: 06/01/2020

End Date: 09/30/2020

City of Louisville

Month	Date	Municipality	Chemical	Mix Ratio	Trip Miles	Spray Miles	Spray Acres	Gallons Sprayed
Annette Brand Park Applications								
June 2020	06/12/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.1	4.0
Total Talstar Pro Applied:								4.0
Coal Creek @ Aspen Way Applications								
June 2020	06/05/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.3	14.0
	06/12/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.3	14.0
	06/25/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.3	12.0
July 2020	07/02/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.4	16.0
	07/09/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.4	18.0
Total Talstar Pro Applied:								74.0
Coal Creek @ Dillon Rd Applications								

Vector Disease Control International
7230 W 118th Pl. Unit E
Broomfield, CO 80020

Month	Date	Municipality	Chemical	Mix Ratio	Trip Miles	Spray Miles	Spray Acres	Gallons Sprayed
June 2020	06/12/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.3	14.0
July 2020	07/09/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.2	10.0
	07/16/2020		Talstar Pro (279-3206)	1:128	0.0	0.0	0.2	10.0
<i>Total Talstar Pro Applied:</i>								<i>34.0</i>
<i>Coal Creek @ Dillon Rd Totals:</i>					<i>0.0</i>	<i>0.0</i>	<i>2.6</i>	<i>112.0</i>
<i>Grand Totals:</i>					<i>0.0</i>	<i>0.0</i>	<i>2.6</i>	<i>112.0</i>