Mosquito Control
Annual Report

2019
**Program Overview**

The St. Charles County Mosquito Control Program aims to reduce mosquito populations as well as decrease the risk of mosquito-borne illnesses to the citizens and visitors of the county. The program treats unincorporated St. Charles County, as well as contracted municipalities including: Augusta, Cottleville, Dardenne Prairie, Flint Hill, Lake St. Louis, Portage des Sioux, St. Paul, Weldon Spring, Weldon Spring Heights, and Wentzville. The program controls immature mosquitoes by investigating standing water, identifying breeding sites, and using biological controls and larvicides. In addition, the program responds to citizen complaints and monitors adult mosquito populations by treating areas with aerosol adulticides during the evening hours. Since the introduction of disease surveillance to the program in 2017, it has become a vital part of the program, assisting staff in monitoring West Nile virus throughout the county.

**Introduction**

West Nile virus (WNv) is an arthropod borne virus (arbovirus) transmitted via mosquitoes from infected birds to humans. However, humans are dead-end hosts, meaning if bitten by another mosquito, the disease will not spread to other humans. However, person-to-person infection can happen via blood transfusion or organ donation. Approximately 70% to 80% of people infected with WNv are asymptomatic (*Red Book, 2018*). Flu-like symptoms occur in most symptomatic hosts, and only 1% of those develop the neuroinvasive form of the virus. Even fewer cases of WNv are fatal in humans. While there is no vaccine to prevent WNv in humans, those experiencing symptoms can receive medical care.

WNv was first detected in 1939 in Uganda and was not detected in the United States until 1999 (WHO, 2017). Three years later, WNv was detected in Missouri with 168 human cases in 30 counties, St. Charles county being the third highest with 7 cases (MO DHSS, 2002). St. Charles county was only outranked by St. Louis City (56 cases) and St. Louis County (60 cases) (MO DHSS, 2002). Public health professionals have had difficulty predicting WNv trends at the local level due to high variance annually in reported cases of WNv. Due to the constant presence of WNv, St. Charles County continues to monitor species of mosquitoes known to transmit the disease.
The main vectors of WNv, *Culex pipiens* complex mosquitoes are prevalent in St. Charles County, so monitoring for the disease is even more crucial. The virus is primarily reported between July and August, especially in highly populated areas. Over 50 known mosquito species are present in Missouri.

**Mosquito Life Cycle**

Mosquitoes go through four distinct stages during their life cycle: egg, larva, pupa, and adult (Figure 1). The first three stages are aquatic, but the adult mosquito is a flying insect and therefore terrestrial. The life cycle can be complete within two weeks to many months, depending on a variety of factors such as weather conditions and the specific species.

![Mosquito Life Cycle](image)

**Figure 1:** Mosquito Life Cycle

When exposed to water, the eggs hatch. However, several species can overwinter for many months and hatch once weather conditions are favorable. After hatching, the larvae, also known as “wigglers” because of the way they move in the water, feed and develop through four instars until they become pupae. The pupae are called “tumblers” and live on the surface of the water.
During the pupal stage, feeding halts while the adult mosquito develops. Adult mosquitoes emerge within a few days and immediately search for food. Both sexes feed on plant nectar, but females must take a blood meal before they can lay their eggs. Once a female mosquito takes a blood meal, she searches for a suitable habitat, typically a container with stagnant water, to lay her eggs.

**Mosquito Control Activities**

Reducing mosquito populations is a daily task for the mosquito control staff from April to October, but many treatment activities are weather dependent. The following weather conditions play an important role while treating for mosquitoes: temperature, precipitation, and wind speed. To spray adulticides, the temperature must be at least 60 degrees Fahrenheit, little to no precipitation, and low wind speeds between 1 and 10 mph. Weather also plays a role in the abundance of mosquitoes and arbovirus activities. We receive complaints more frequently in months with favorable weather conditions for mosquito activities (Table 1).

<table>
<thead>
<tr>
<th>Month</th>
<th>Avg. Temperature (°F)</th>
<th>Avg. Precipitation (in)</th>
<th>Avg. Wind Speed (mph)</th>
<th>Mosquito Complaints (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>58.4</td>
<td>0.23</td>
<td>9.9</td>
<td>10</td>
</tr>
<tr>
<td>May</td>
<td>67.8</td>
<td>0.24</td>
<td>8.8</td>
<td>226</td>
</tr>
<tr>
<td>June</td>
<td>75.2</td>
<td>0.15</td>
<td>8</td>
<td>331</td>
</tr>
<tr>
<td>July</td>
<td>81.3</td>
<td>0.18</td>
<td>7.2</td>
<td>115</td>
</tr>
<tr>
<td>August</td>
<td>78.3</td>
<td>0.2</td>
<td>6.9</td>
<td>151</td>
</tr>
<tr>
<td>September</td>
<td>77.9</td>
<td>0.05</td>
<td>7.6</td>
<td>81</td>
</tr>
<tr>
<td>October</td>
<td>57.3</td>
<td>0.12</td>
<td>8.8</td>
<td>16</td>
</tr>
</tbody>
</table>

*Table 1: Meteorological Data vs. Nuisance Calls 2019 (National Weather Service 2019).*

Staff responded to 930 mosquito complaints and 105 larval treatments (Figure 2). While there were more adulticide complaints overall this season, more time was spent on larval treatments (Figure 3). Larval treatments are the most effective way in controlling the adult mosquito population, thus decreasing the public health risks associated with mosquitoes (EPA, 2016).
Figure 2: Comparison of Mosquito Control by Activity Type in 2019

Figure 3: Comparison of Mosquito Control Activities by Hours in 2019
The number of complaints increased from last season, however this number varies annually due to weather conditions. There was a 74% increase in the number of complaints from the 2018 season and a 34% increase from the 5-year average (Table 2).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Complaints (#)</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>Sept.</th>
<th>Oct.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>512</td>
<td>49</td>
<td>27</td>
<td>301</td>
<td>47</td>
<td>50</td>
<td>31</td>
<td>7</td>
</tr>
<tr>
<td>2011</td>
<td>198</td>
<td>1</td>
<td>37</td>
<td>61</td>
<td>47</td>
<td>37</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>2012</td>
<td>214</td>
<td>10</td>
<td>22</td>
<td>17</td>
<td>12</td>
<td>51</td>
<td>92</td>
<td>5</td>
</tr>
<tr>
<td>2013</td>
<td>409</td>
<td>0</td>
<td>48</td>
<td>137</td>
<td>85</td>
<td>94</td>
<td>36</td>
<td>9</td>
</tr>
<tr>
<td>2014</td>
<td>254</td>
<td>0</td>
<td>18</td>
<td>54</td>
<td>79</td>
<td>58</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td>2015</td>
<td>350</td>
<td>7</td>
<td>26</td>
<td>72</td>
<td>128</td>
<td>72</td>
<td>32</td>
<td>13</td>
</tr>
<tr>
<td>2016</td>
<td>716</td>
<td>28</td>
<td>82</td>
<td>125</td>
<td>161</td>
<td>180</td>
<td>110</td>
<td>28</td>
</tr>
<tr>
<td>2017</td>
<td>509</td>
<td>20</td>
<td>75</td>
<td>149</td>
<td>96</td>
<td>107</td>
<td>46</td>
<td>15</td>
</tr>
<tr>
<td>2018</td>
<td>532</td>
<td>1</td>
<td>57</td>
<td>114</td>
<td>150</td>
<td>94</td>
<td>78</td>
<td>38</td>
</tr>
<tr>
<td>2019</td>
<td>930</td>
<td>10</td>
<td>226</td>
<td>331</td>
<td>115</td>
<td>151</td>
<td>81</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 2: Annual St. Charles County Mosquito Complaint Records, 2010 – 2019.

Treating mosquito breeding sites is one of the most important steps the abatement team takes to reduce mosquito populations. The mosquito control program uses a variety of different pesticides to inhibit the growth of larval mosquitoes to ensure we are effectively controlling the population. Both liquid and granular larvicides were used for control in standing bodies of water, ditches, storm drains, and retention basins. Briquettes containing the bacterium *Bacillus thuringiensis* subspecies were also used for treatment of abandoned pools in the county. A comparison of how many times each larvicide was used, including those combining both granular and liquid, are shown below (Figure 4).
Figure 4: Comparison of Larval Treatments Completed in 2019

Adulticide treatments started in early May and continued through the first week of October during favorable weather conditions. Aerosol sprayers were calibrated to disperse 8 ounces of Kontrol per minute at 10 mph. Staff covered 954.2 miles total during 2019. Complaint points treated this season are illustrated below (Figure 5).

Figure 5: Mosquito Complaints 2019
Mosquito Surveillance

Integrated Mosquito Management (IMM) is a program designed to not only control pests, but also monitor them through different surveillance methods. For example, St. Charles County utilizes IMM by monitoring breeding grounds and the adult population, as well as monitoring the diseases local mosquitoes may carry. Another example of surveillance methods includes detecting signs of pesticide resistance in the adult mosquito population. St. Charles County makes sure to switch pesticides every few years to ensure that mosquito treatments are effective.

Disease surveillance began in 2017, a year after Zika virus was first detected in the US. Trapping begins the first week of June and continues throughout the season, weather depending. Two different traps are utilized in the program.

Gravid traps for capturing *Culex* subspecies which can carry WNv by providing a suitable environment for the eggs, thus attracting gravid females and collecting them in a storage net. BG Sentinel traps are primarily used for monitoring mosquito populations for *Aedes aegypti* and *Ae. albopictus*, carriers of Zika virus. While *Ae. aegypti* mosquitoes have not been detected in the county, it is important to continue monitoring for them since they are the primary vector of Zika virus. Female *Culex* mosquitoes collected in either trap type are tested for WNv. Gravid traps were used more often and also attracted more female *Culex* mosquitoes than the BG Sentinel traps during 2019 (Figure 6).

**Figure 6**: 2019 Mosquito Trapping Results
While St. Charles County strives to meet IMM standards by implementing surveillance efforts, not every mosquito control program can conduct disease monitoring due to the cost requirements and skills required by staff members. Surveillance conducted by the county requires the use of a test reader, the RAMP® Reader. By using the RAMP® Reader and test kits, St. Charles County mosquito control staff can get WNv results from trapped *Culex* mosquitoes the same day as collection.

Traps were used at 15 county and municipal owned parks and publicly owned grounds (Figure 7). Surveillance site selection is dependent on the following factors: close proximity to human populations, close proximity to suspected breeding sites, and the availability of resting sites and humidity. Sites also avoid direct sunlight, strong winds and fumes, and buildings with high traffic. These factors as well as the density of complaints from this season will be used to determine the 2020 season’s new trap locations.

Figure 7: St. Charles County Trap Locations 2019

Mosquito-borne diseases are distributed based on the spatial range of the vector species. As adults, vectors of WNv typically stay within 2 miles of their hatching site. Identifying breeding grounds and using traps in those areas is vital for the Mosquito Control program to identify
locations where WNv is present and continue monitoring the adult mosquito population (Figure 8).

**Figure 8**: 2019 Mosquito Complaint Density Map

Between June and October, the surveillance program ran 141 pools of 5,202 mosquitoes using the RAMP® Test. Of those pools, 12 (8.5%) tested positive and 129 (91.5%) tested negative (Figure 9).
For a pool to be considered positive, we used a RAMP® score of 100 or greater, reducing the likelihood of false positive tests. The first WNv positive pool was detected in August, however, the month with the highest number of mosquitoes trapped, as well as positive pools detected was September (Figure 10).

**Figure 9:** 2019 WNv Positive Trap Locations

**Figure 8:** Positive Number of Pools and Number of Mosquitoes Tested 2019
Using surveillance data, we determined a Minimum Infection Rate (MIR) to estimate the proportion of infected individuals in an area during a specific period. The MIR assumes that there may only be one infected individual that exists in a positive pool. The following formula was used to calculate the MIR: 
\[
MIR = \left( \frac{\text{# of positive pools}}{\text{total specimens tested}} \right) \times 1000.
\]

The 2019 MIR for St. Charles County was 2.3, a 35.9% increase from 2018. The MIR will be useful to compare with previous data and results from future surveillance, and will allow public health professionals to compare known human cases of WNV.

**Human Surveillance**

As of January 7, 2020, the U.S. Center for Diseases Control (CDC) reported 917 human cases of WNV in 43 states and the District of Columbia. This is down from 2647 reported human disease cases in 2018 (CDC, 2019).

In 2019, only four human WNV cases were reported in Missouri (DHSS, 2019). Three human cases were from St. Louis City and County and the fourth from Phelps County. In Saint Charles County, there were no confirmed or probable human cases of WNV in 2019, and the last confirmed human case occurred in 2013. All human WNV cases reported in St. Charles County for the last decade are illustrated below (Figure 9).

![Figure 9: WNV Cases (Confirmed and Probable) in St. Charles County, 10 Year Data (2010-2019)](image-url)
Community Outreach

During 2019, the Mosquito Control Program Coordinator and the Director of the Division of Environmental Health were interviewed twice by a local news station. Both interviews provided information on how to keep yourself and pets protected from mosquitoes including what residents can do around their house to reduce mosquito populations. The second interview went into more detail about WNv after flooding. The Program Coordinator also went to a couple events throughout the county and passed out brochures and single wipe packets of DEET as well as cans of DEET and Picardin. These cans were also given to local communities affected by flooding.

Summary

While no disease cases were reported in 2019, WNv is still present in St. Charles County and will likely maintain presence throughout the county in the upcoming years. Control and monitoring efforts will continue through 2020, using 2019 data to assist in determining which areas in the county and aspects of the program to focus on.

The main program goal for 2020 is increasing surveillance. To meet this goal, we will implement the following methods: identifying additional mosquito breeding grounds throughout the county, adding trap locations, and using both trap types multiple times a week. This focus on surveillance will change the direction of the program from a complaint based approach to a proactive one.

In addition to the mosquito control program, residents can do several things to protect themselves from mosquitoes. Standing water, such as dog watering bowls and drainage plates, should be dumped daily. From dusk to dawn, residents should limit their time outside. Residents should wear long pants and sleeves and an EPA approved mosquito repellent to reduce mosquito bites.

Those with questions or concerns regarding mosquito control should contact Caroline McEwen, Mosquito Control Program Coordinator, at cmcewen@sccmo.org or (636) 949-1800 ext. 6205.

