Disease Carrying Insects Program Annual Report

Presented by

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Mosquitoes, ticks and other vectors are responsible for transmitting pathogens that can result in life-changing illnesses such as West Nile virus, Lyme disease, and the Zika virus. The Health Department's Disease Carrying Insects Program was established in 2003 and works to protect county residents and visitors from vector-borne diseases. The program uses an integrated approach to monitor and manage vectors. The program continuously promotes personal protection and vector prevention methods in the community to raise awareness of these public health pests, the diseases they transmit, and what residents can do to protect themselves and their family.

Vision, Mission and Values

As part of the Health Department, the Disease Carrying Insects Program strives to help the agency meet its goals and embody the Vision, Mission and Values of the department.

West Nile Virus

The United States continued to experience the effects of West Nile virus (WNV) in 2017 with cases and deaths throughout the country. During 2017, at least 2,002 human cases with 121 deaths were reported to the Centers for Disease Control and Prevention (CDC).[1] From 1999 when the first locally-acquired cases of WNV were reported in New York through 2016, there have been 46,086 reported cases and 2,017 reported deaths in the United States.

In Fairfax County, WNV was first detected in 2000, when the virus was detected in a dead crow. In 2001, additional infected birds were detected and in 2002, the virus was found in birds, horses, mosquitoes and humans. There were 13 human cases and one death reported in Virginia in 2017. Five cases of WNV were reported in Fairfax County in 2017. From 2002 to present, there have been 176 human cases of WNV and 14 WNV-associated deaths in Virginia.

[1] 2017 provisional data obtained from CDC web site.

In that same time period, 50 human WNV cases, including four deaths, were reported in Fairfax County.

Other Mosquito-borne Diseases

The Chikungunya virus (CHIKV) and the Zika virus (ZIKAV), which are transmitted by *Aedes* mosquitoes, began circulating in the Americas in 2013 and 2015, respectively. Locally-acquired cases of both viruses have been reported in many countries in the Americas. Other travel-associated, mosquito-borne diseases routinely reported to the CDC include dengue (DENV) and malaria.

In 2016, an outbreak of ZIKAV, a mosquito-borne disease, was ongoing throughout much of the western hemisphere. Zika is of particular public health importance because it can be passed from a pregnant woman to her fetus and infection during pregnancy can cause certain birth defects. There have been 407 cases reported in the US for 2017. In 2016, 4,830 travel-associated Zika cases in the US were reported to CDC. [2] In Virginia, 6 travel-associated cases were reported in 2017 and 112 in 2016. In 2017, 114 cases of CHIKV were reported in the U.S., with four of those cases being reported from Virginia.[1] Cases of dengue are reported in the continental U.S. annually. Most reported cases of dengue are travel-related. Malaria, a parasitic disease transmitted by mosquitoes, is reported from approximately 1,500-2,000 travelers each year.

Occasionally, local mosquitoes can acquire these pathogens from infected individuals and transmit these diseases in the continental U.S. The only evidence of local mosquito transmission of the Zika virus in the continental United States so far has been in Florida and Texas. There were 224 reported cases of presumed mosquito-transmitted Zika in those two states in 2016 and 4 reported in 2017. Cases in the US have also been reported where the virus was acquired through other routes, primarily sexual transmission, in both 2016 and 2017. To date, the only evidence of local mosquito-borne transmission of CHIKV has been in Florida and Texas. Over the last several years, sporadic DENV outbreaks have been identified in Florida. Local transmission of malaria has occurred in several locations in the U.S. In the last 20 years, it has occurred twice in Virginia with a total of 4 reported cases. If there are locally-acquired cases of CHIKV, DENV, ZIKAV or malaria in the County, the Health Department will utilize guidance from the CDC and Virginia Department of Health (VDH).

Tick-borne Disease

Tick-borne diseases are the most commonly reported vector-borne diseases in the United States. Lyme disease, transmitted by the blacklegged tick is common in many areas of the United States, including Virginia. Fairfax County began tick and Lyme disease surveillance in 2005 with a small pilot program. In light of significant results from the first year of tick surveillance, the DCIP implemented an enhanced surveillance program in subsequent years.

Tick-borne diseases continue to impact public health causing serious acute illness, long-term effects and, sometimes, death. The recent and widespread encroachment of suburban sprawl into areas that were once undeveloped or farmland, and the large deer populations in these suburban communities, have increased the prevalence of disease-carrying ticks and the exposure of the human population to the disease pathogens they carry.

[2] Data obtained from CDC web site; 2017 data is provisional.

Other Disease Transmitting Insects of Public Health Importance

Other insects with the potential to transmit disease can be found throughout Fairfax County. These insects or the conditions that allow them to proliferate, could, at times, be considered public health or safety menaces.

Human Case Surveillance

West Nile virus, Lyme disease, and other vector-borne diseases are among the over 70 notifiable diseases and conditions in Virginia. The Fairfax County Health Department (FCHD) uses enhanced passive surveillance to monitor physician and laboratory reporting of these diseases.

The Health Department encourages physicians and laboratories to report cases of these illnesses by educating medical practitioners about the importance of reporting vector-borne diseases and by contacting key medical staff at hospital centers to inquire about potential cases. See Table 1 for selected reported cases.

Table 1: Reported Human Cases of Vector-borne Disease, Fairfax County

Condition	Number of Cases, Fairfax Health District	
	CY 2016	CY 2017*
Mosquito-borne Disease		
WNV (neuroinvasive and non-neuroinvasive)	0	5
Dengue**	9	3
Chikungunya**	3	2
Malaria**	27	24
Tick-borne Disease		
Lyme Disease	214	152
Ehrlichiosis/Anaplasmosis	5	9
Spotted Fever Rickettsiosis	10	19

*2017 data are provisional and subject to change.
**Travel-associated cases.

Integrated Mosquito Management

The Disease Carrying Insects Program uses Integrated Mosquito Management (IMM) principles to carry out its duties. This comprehensive program utilizes three basic strategies: surveillance, control, and public education.

Integrated Mosquito Management is a comprehensive mosquito prevention/ control strategy that utilizes all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes to reduce their numbers to tolerable levels while maintaining a quality environment. IMM does not emphasize mosquito elimination or eradication. Integrated mosquito management methods are specifically tailored to safely counter each stage of the mosquito life cycle. Prudent mosquito management practices for the control of immature mosquitoes include such methods as the use of biological controls, source reduction, water sanitation practices as well as the use of EPA-registered larvicides. When source elimination or larval control measures are not feasible or are clearly inadequate, or when faced with imminent mosquito-borne disease, application of EPA-registered adulticides by applicators trained in the special handling characteristics of these products may be needed.

Adulticide products are chosen based upon their demonstrated efficacy against species targeted for control, resistance management concerns and minimization of potential environmental impact.

IMM requires a thorough understanding of mosquitoes and their bionomics by control personnel; careful inspection and monitoring for their presence and conditions favoring their development; and prevention of oviposition and human/mosquito contact through effective public education, sanitation and facility maintenance. The Disease Carrying Insects Program strives to employ these IMM components to the extent possible, but resource availability may limit what the program will do.

All intervention measures will be driven by a demonstrated need based on surveillance data and action thresholds. IMM is knowledge-based and surveillance-driven, and when properly practiced is specifically designed to accomplish the following:

1. Protect human, animal and environmental health.
2. Promote a rational use of pesticides.
3. Reduce environmental contamination to soil, ground water, surface water, pollinators, wildlife and endangered species as a result of mosquito control activities.
4. Utilize biological controls (native, noninvasive predators) to conserve and augment other control methods.
5. Utilize source reduction (elimination, removal or reduction of larval mosquito habitats) where practical and prudent.
6. Use target-specific pesticides at the lowest effective rates to the extent possible.
7. Emphasize the proper timing of applications.
8. Minimize pesticide resistance problems.

Surveillance

Surveillance is essential to an integrated pest management program. The DCIP conducts surveillance for different vectors and some of the diseases they may carry. Surveillance is done for both adult and immature mosquitoes and for West Nile and Zika viruses. It is important to note that absolute high numbers of mosquitoes do not necessarily reflect high risk of human infection with WNV or other mosquito-borne disease. Surveillance for other vectors such as ticks is also performed.

Mosquito Surveillance: The program is anchored by a strong surveillance component that will monitor mosquito populations during the 2018 mosquito season for possible increases in vector abundance and viral activity. During the 2017 season Fairfax County continued its comprehensive mosquito surveillance program at 73 fixed, weekly collection sites (Figure 1) for a total of 4,474 trapping periods. A trap period was defined as 24 hours since some traps collected mosquitoes that were active during the day and others collected mosquitoes that were active at night. Two new trap sites were also used as part of a project at the Police Training Facility in Chantilly in 2017. They are included on the maps, overall routine collection numbers, and testing results, but not included in the trap-specific breakout graphs.

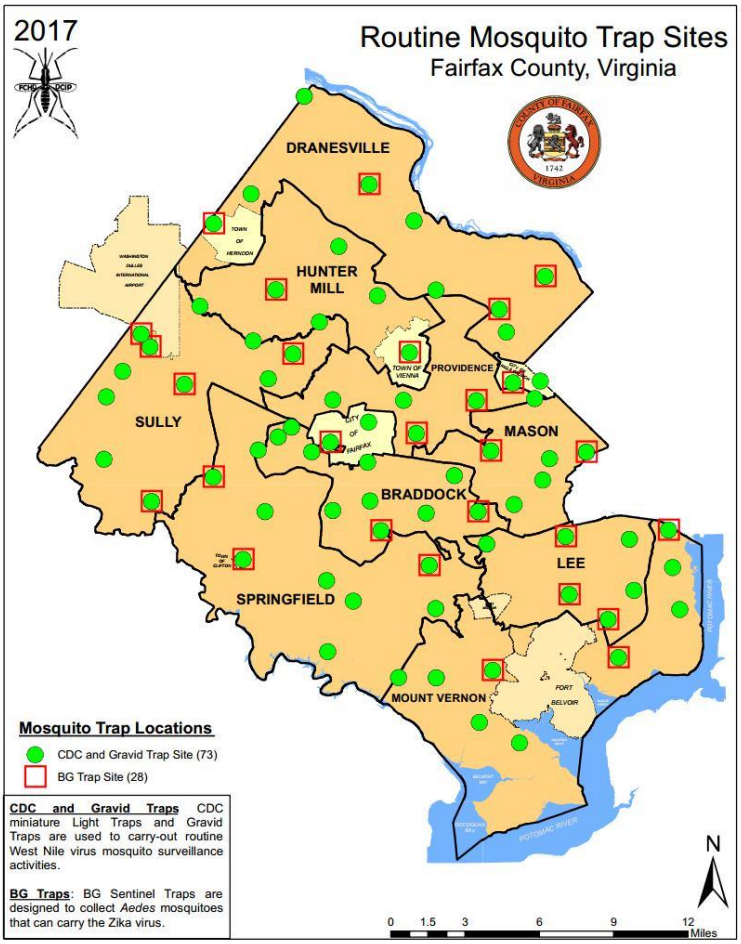

Figure 1. 2017 Routine Mosquito Trap Sites.

The program uses three types of mosquito traps to collect mosquitoes: CDC miniature light traps, gravid traps, and BG Sentinel traps. All sites had one CDC miniature light trap and one gravid trap. The number of BG Sentinel trap sites increased from 26 to 28 in 2017.

During the 2017 mosquito surveillance season, 179,557 mosquitoes identified from routine trapping activities (Figure 2). An additional 6,037 adult mosquitoes were collected through non-routine trapping.

Figure 2: Staff sorting and identifying mosquitoes (left) and mosquitoes through the microscope (right).

Figure 3: CDC Miniature Light Trap (left) and Gravid Trap (right).

The **CDC miniature light trap** (Figure 3) is a trap that collects mosquitoes that are searching for something to bite. This trap is baited with carbon dioxide (dry ice) and a small light. This trap typically collects the greatest variety of mosquitoes and 28 different species were picked up in 2017 (Figure 4). In 2017, the CDC traps were set for 1,685 trap periods and collected almost 26,000 mosquitoes.

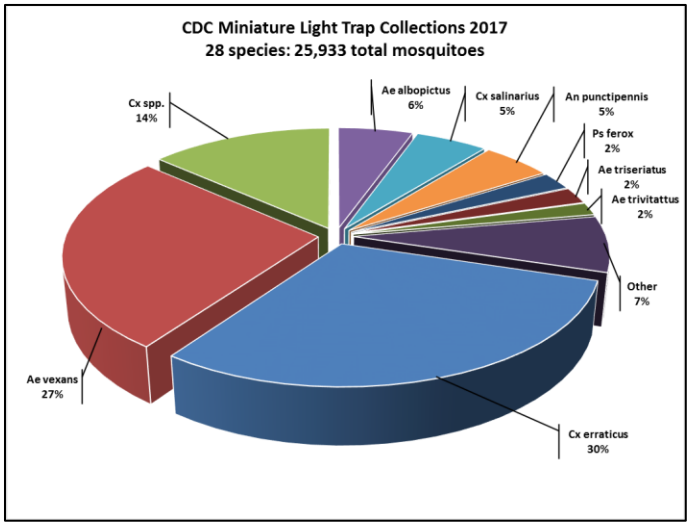

Figure 4: CDC Miniature Light Trap Collections, 2017.

The **gravid trap** (Figure 3) is a trap that collects mosquitoes that are looking for a place to lay their eggs. This trap is baited with an infusion (water, grass, straw, yeast) that is attractive to the *Culex* mosquitoes that are the primary vectors of WNV. The majority of mosquitoes collected in this trap are *Culex* species (*Culex pipiens* and *Culex restuans*) (Figure 5). In 2016, this trap was set for 1,986 trap periods and collected over 109,000 mosquitoes. Twenty-seven different species of mosquitoes were collected in the trap in 2017, but 94 percent were *Culex* species. In 2017, the population of the *Culex* mosquitoes followed the same general trend as seen in the average of the previous five years (Figure 6).

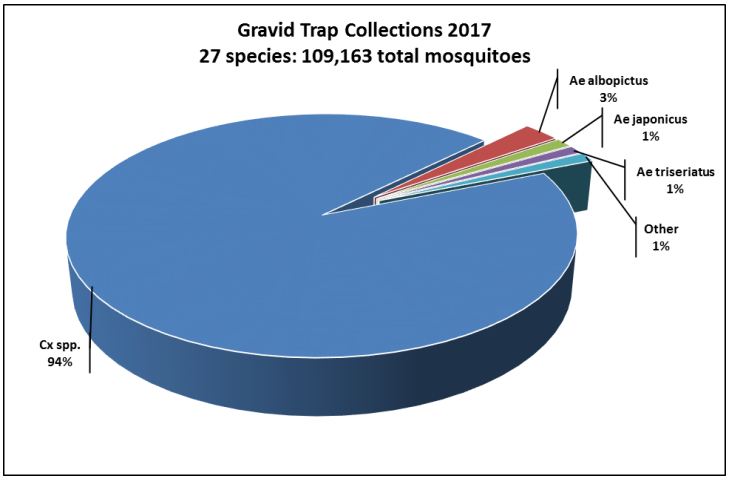

Figure 5: Gravid Trap Collections, 2017.

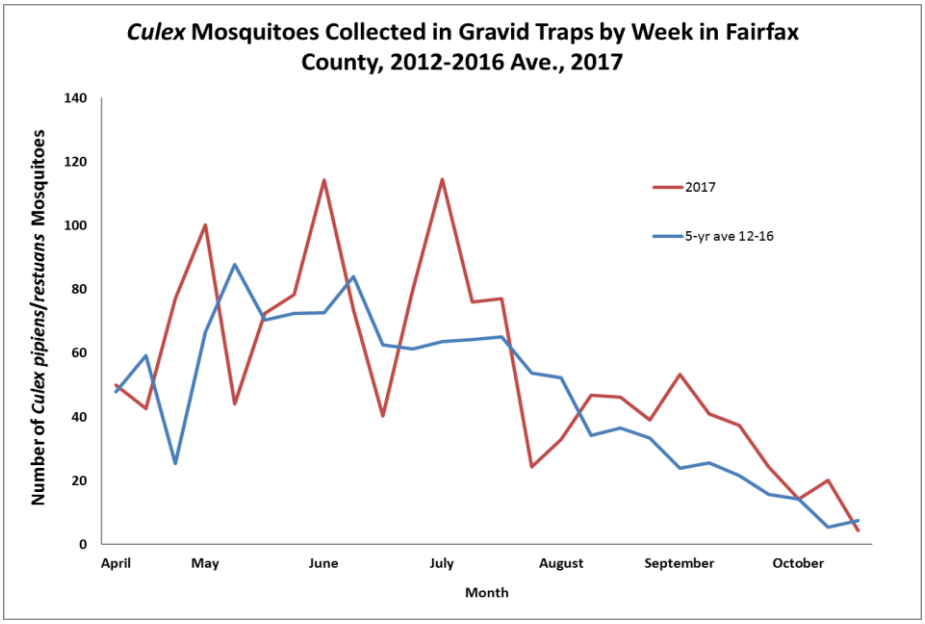

Figure 6: Average Number of Culex pipiens/restuans *collected in Gravid Traps, 5 year average and 2017.*

The **BG Sentinel trap** (Figure 7) is another trap that collects mosquitoes that are looking for something to feed on. This trap is baited with carbon dioxide (dry ice) as well as a special lure that is based on the scent of human sweat. This trap collected 25 mosquito species throughout the 2017 season, but it is most effective at collecting *Aedes albopictus* (Figure 8), a potential vector of a variety of pathogens including the Zika virus. In 2017, the trap was set for 665 trap periods at the fixed mosquito trap sites and collected over 26,500 mosquitoes. Although *Aedes albopictus* followed the same trends seen in the previous five years, the average number of mosquitoes per trap was generally lower than the average throughout the season (Figure 9).

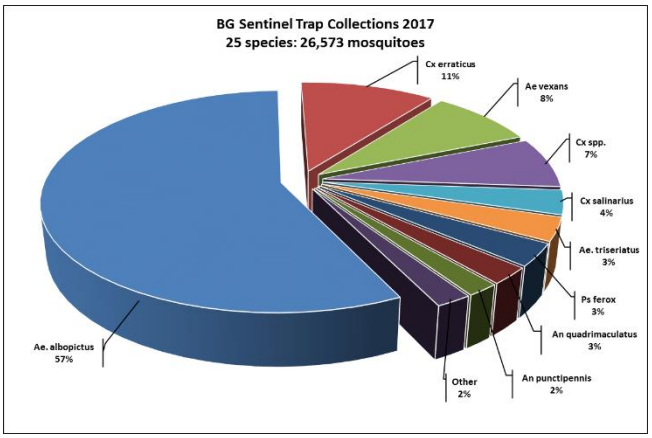

Figure 8: BG Sentinel Trap Collections, 2017.

Figure 7: BG Sentinel Trap.

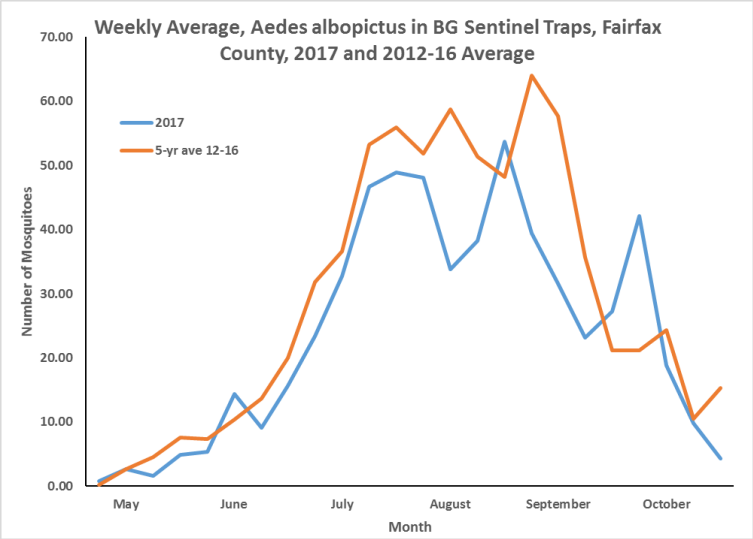

Figure 9: Average Number of Aedes albopictus *Collected in BG Sentinel Traps, 2017 and 5-year average.*

Mosquito Testing. In the 2017 mosquito season, 160,381 mosquitoes were tested in 5,085 pools. These pools included mosquitoes collected outside of normal routine surveillance activities. There were 307 positive WNV pools. Positive mosquitoes were found in many parts of the county (Figure 10). During 2016, 121,025 mosquitoes were tested in 4,074 routine pools, of which 46 were positive. In 2017, *Culex* species of mosquitoes (*Culex pipiens* and *Culex restuans*) tested positive for West Nile virus as well as *Aedes albopictus*, *Aedes vexans*, and

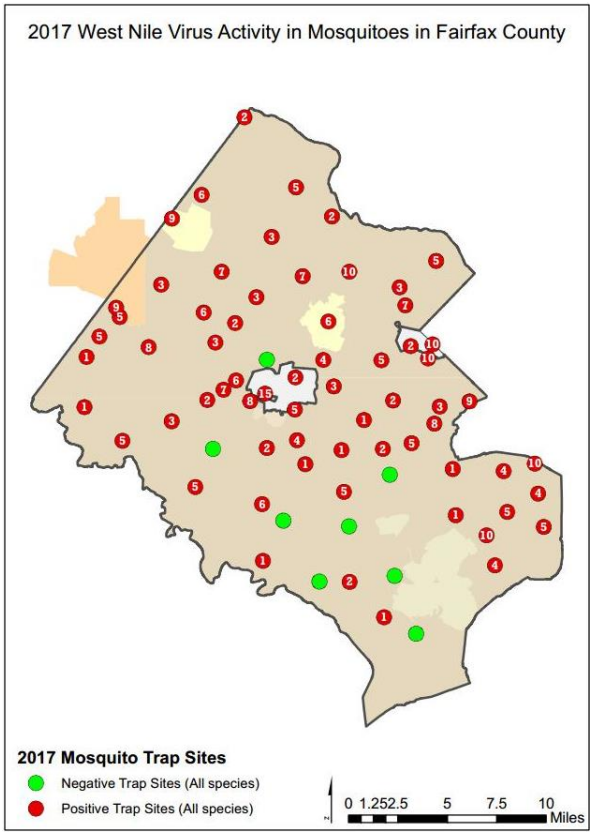

Figure 10: Map of WNV-positive Mosquito Trap Sites, 2017.

Culex salinarius. In previous years, two other species have also tested positive for WNV in the County.

Most of the mosquitoes tested were *Culex* species (*pipiens* or *restuans*) collected in gravid traps. Most of the positive mosquito pools were *Culex* species from the gravid trap. The first WNV-positive mosquitoes of 2017 were *Culex* species collected in a gravid trap early June. The infection rate of *Culex* species tested from gravid traps was calculated. The peak infection rate (maximum likelihood estimate: MLE) in 2017 came in mid-September when the MLE was calculated at 11.82 mosquitoes per 1,000. The last positive mosquitoes were collected in early October (Figure 11). The infection rate followed the general trend seen in previous years.

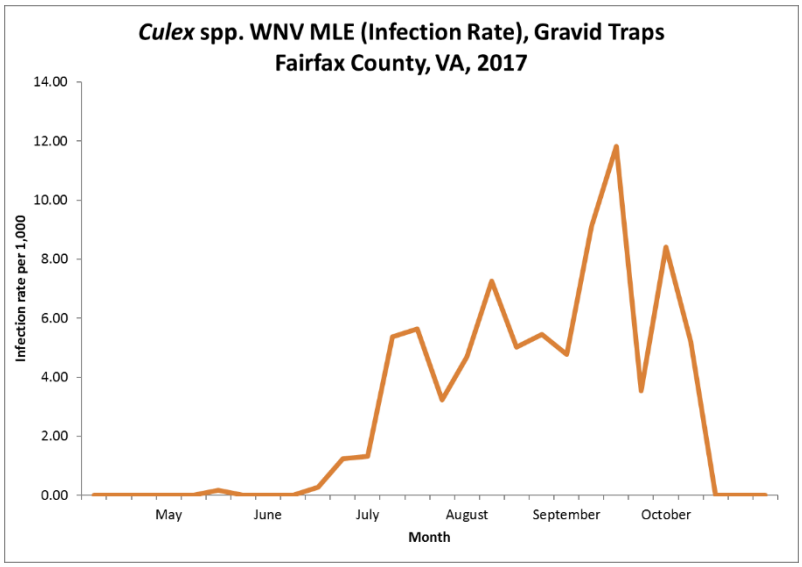

Figure 11: West Nile Virus Infection Rate (Maximum Likelihood Estimate) in Culex *species collected in Gravid Traps, 2017.*

A subset of the mosquito pools submitted (33,868 *Aedes albopictus* mosquitoes in 966 pools) was also tested for Zika virus. No mosquito pools were positive for Zika virus.

Tick Surveillance: In 2017, 8,350 ticks (including 441 blacklegged ticks) were collected throughout the year using various techniques including carbon dioxide-baited traps, tick drags, tick flags, collecting off harvested deer and collections from vet clinics. The majority of the ticks collected are from the tick drags (n=4,001) and the carbon dioxide-baited tick traps (n=3,630). The lone star tick *Amblyomma americanum* was the most abundant tick collected (Figure 12).

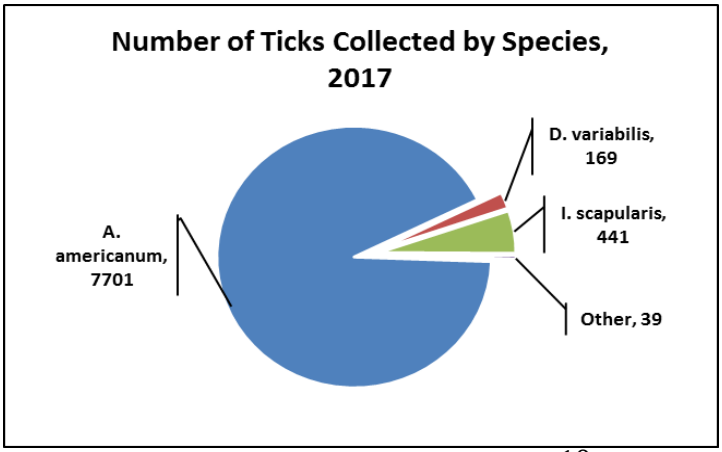

Figure 12: Number of Ticks Collected, 2017.

Tick testing for Lyme disease was made available at the Health Department Laboratory in 2016. Blacklegged ticks from 2017 (n=146) have been submitted for testing. Eight of the 77 blacklegged ticks tested (11%) from 2016 were positive for the Lyme disease bacteria. Ticks that have been feeding are not submitted for testing per protocol as the vertebrate blood in the ticks may interfere with the testing. As in previous years, tick surveillance and the tick identification service will be conducted by existing staff in the DCIP and will follow previously-established protocols.

Control

Mosquito control is a component of an integrated management program. Routine and non-routine control decisions take a variety of factors into consideration including mosquito species, presence of mosquito-borne disease, proximity to people, mosquito tolerance, weather patterns, environment, non-target impacts, health and safety, mosquito habitat, and accessibility for surveillance and treatment. Pesticide applications are made according to the label. Federal and state regulatory guidance is adhered to.

Larval Control: In 2016, the program embarked on a project to evaluate county-maintained stormwater dry ponds and their mosquito production. This activity continued in 2017. From April through October, six staff (three teams of two) checked 1,341 individual storm water sites throughout the county and performed 8,411 inspections (e.g, Figure 13). Of those inspections, over 2,500 had water that could be sampled for mosquitoes. There were over 930 inspections where mosquito larvae were collected; 588 had enough larvae to meet the treatment threshold (3 larvae per dip or sample with a minimum of 3 dips). A total of 667 treatments were made with either Natular G, Natular G30, or Cocobear. All applications were made by certified pesticide applicators or registered technicians and were made according to label guidelines.

Figure 13: Staff inspecting and treating a storm water pond.

Using GIS, staff made maps of each site and divided all the sites up within their respective magisterial district for the 2017 season. This helped improve field staff efficiency . Staff continue to work on streamlining and improving the efficiency of the inspection program by leveraging technical resources, such as GIS.

A contractor provided minimal stormwater inspection service during the month of May until the contract expired.

Adult Control: Adult mosquito control is not routinely performed by the Health Department. While source reduction and the application of larvicides are the principal and most effective interventions to reduce mosquito populations, situations may arise in which infected adult mosquitoes are present in significant numbers and pose a threat to human health. In these

situations, judicious application of adulticides to control mosquito populations will be added to all other mosquito control activities as an additional measure to reduce vector populations.

Guidelines from CDC state that adulticiding based on surveillance data is an extremely important part of any integrated mosquito management program and should be used when there is significant risk of human illness. Under exceptional circumstances, the Health Department may apply insecticides to control adult mosquitoes, and in these instances, the application will target those mosquitoes which potentially transmit disease to humans.

The Health Department has the ability to apply pesticides for adult mosquitoes should the public health need arise. The program has increased its capacity to respond to a mosquito-borne public health event by purchasing additional equipment to include backpack sprayers (Figure 14), a truck-mounted ultra-low volume (ULV) sprayer (Figure 15), and a backpack ULV sprayer. Synthetic pyrethroids or other insecticides may be used to control adult mosquitoes. All applications of pesticides will be performed by certified applicators according to the label. In 2016, utilizing guidance from the Virginia Department of Health, three targeted applications were made with a backpack sprayer. Previously, targeted barrier applications had also been made in 2005, 2006, and 2007. In 2017, nine pesticide applications were made to control adult mosquitoes. Treatments were made using a truck-mounted ULV, backpack blower, or backpack ULV. AquaZenivex E20 or Flit 10EC were used to control adult mosquitoes.

Figure14: Application with a backpack sprayer.

Figure 15: Ultra-low volume sprayer mounted in the back of a pick-up truck.

Community Outreach and Education

Figure 16: Pictures from different outreach activities.

Fairfax County will continue to emphasize personal protection measures from mosquito bites, mosquito-borne disease, and mosquito prevention and control. This is done through distribution of informational materials, media interviews, advertising, Web pages, presentations, community events (Figure 16), and collaborations with community groups and homeowners associations. In 2018, the program will also

continue its tick outreach activities as originally requested by the BOS.

The 13th 18-month "Fight the Bite" calendar was produced in 2016. The calendar was once again distributed to fourth graders in all Fairfax County Public Schools prior to the end of the school year. Other materials were updated in 2017 including the Zika fact sheet in multiple languages. (See Figure 17 for examples of outreach material.) The calendar, storybooks, and other materials were distributed at various events and venues throughout the County, including libraries, recreation centers and other County offices.

Figure 17: Some examples of outreach material.

The demand for educational material, especially information on mosquitoes and the Zika virus, was still high in 2017. In addition to the demand for materials, the Disease Carrying Insects Program worked with other Health Department staff to develop a presentation that was translated into Spanish and Chinese and presented many times by Health Department Outreach staff. DCIP staff attended multiple events giving approximately 41 educational and safety presentations and participating in 28 other community-based events such as health fairs, Celebrate Fairfax, Fall for Fairfax KidsFest, and SpringFest.

The program will continue to work with the Health Department's Communications Office, Community Outreach Team and Epidemiology Division to develop messaging and provide messaging to all communities within the County.

Service Requests: The FCHD continued to promote source reduction (elimination of mosquito breeding sites) in 2017 through the outreach campaign. The Asian tiger mosquito (*Aedes albopictus*) was the source of the majority of mosquito-related complaints received in 2016. This mosquito, which generally lays its eggs in and develops in containers (Figure 18), is an

Figure 18: Some of the container breeding sites found on service requests.

aggressive, persistent biter that can be found in large numbers around residences. Several factors contributed to the presence of *Aedes albopictus* around these homes; however, the presence of black corrugated pipes at the end of the downspouts from the roof gutters, even when placed underground, seemed to be a frequent source of the problem. Most of these corrugated pipes do not drain adequately and they retain water throughout the season, thus providing great mosquito breeding habitat. This mosquito is also a potential vector of the Chikungunya and Zika viruses. During 109 site visits and inspections, the Disease Carrying Insects Program (DCIP) educated property owners and managers about the benefits of eliminating breeding sites and/or provided Mosquito Dunks®.

Tick Identification Service: The Health Department's tick identification service encourages County residents to bring their ticks to the Health Department to help raise awareness of Lyme disease and provide information on ticks and tick-borne diseases. In 2017, 281 specimens were brought to the Health Department for identification. Of these, 257 were ticks: 182 Lone Star ticks (*Amblyomma americanum*), 42 blacklegged ticks (*Ixodes scapularis*), 32 American Dog ticks (*Dermacentor variabilis*) and 1 Gulf Coast tick (*Amblyomma maculatum*) were brought to the tick identification service.

Emergency Preparedness and Response Activities

In 2016, the World Health Organization declared Zika virus to be a "Public Health Emergency of International Concern" due to the ongoing epidemic and concern about Zika's relationship to birth defects including microcephaly. The CDC and VDH continuously provided guidance before and throughout the 2016-17 mosquito seasons. The Fairfax County Health Department's Incident Command System (ICS) was active from March through October both years as staff worked together to develop a response plan and educate and engage the community and stakeholders. The Disease Carrying Insects Program worked together with other Fairfax County Health Department staff to help prepare for any potential local, mosquito-borne ZIKAV transmission.

The Communicable Disease and Epidemiology section of the Health Department performed human case investigations and coordinated human testing. The Health Department Laboratory also helped with human testing coordination. Environmental investigations and mosquito-related activities were performed by DCIP staff. These activities included site visits, education and outreach, source reduction, vector surveillance and vector abatement activities. The Health Department Laboratory performed mosquito testing for ZIKAV.

The Division of Environmental Health has taken additional steps to increase preparedness within the agency by moving forward with a plan to have all Environmental Health staff become certified pesticide applicators. By the end of 2017, 26 Environmental Health staff were Certified Pesticide Applicators with the Virginia Department of Agriculture and Consumer Services. The remaining Environmental Health staff will be certified in 2018.

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In 2018, the program will continue perform vector surveillance, community outreach and public education, and mosquito control, primarily through proactive larviciding. We encourage the community to do their part by tipping and tossing standing water to prevent mosquitoes and by preventing mosquito and tick bites. A healthier community begins with you!