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# Chesapeake Mosquito Control Commission

# Annual Report
# 2017

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January 26, 2018

TO: Citizens of the City of Chesapeake, VA

FROM: Dreda A. Symonds, Director

SUBJECT: 2017 Chesapeake Mosquito Control Commission (CMCC) Annual Report

We have continued the two-section format of the annual report this year. For readers who need background information on our organization, mosquito biology and mosquito control practices, please begin with Section 1. General Information on Mosquitoes & Mosquito Control in the City of Chesapeake. For those who have a basic understanding of mosquito control, please feel free to start with Section 2. Chesapeake Mosquito Control Commission Overview of 2017.

Here are some highlights of the 2017 Overview:

- Highly unusual weather conditions beginning in the fall of 2016 and continuing through spring of 2017 resulted in record numbers of certain mosquito species.
- The largest percentage of service requests occurred in May and June and seemed to be in response to just one or two of these species.
- Although the incidence of Zika virus in Virginia has decreased dramatically, the mosquito that can transmit it (the Asian tiger) continues to be a major nuisance to our citizens.
- West Nile virus, a disease transmitted by the common brown house mosquito, exhibited higher than normal activity in 2017. Conversely, eastern equine encephalitis activity was unusually low.
- The commission realized a 53% increase in treatment of immature mosquito habitats (larviciding) with no additional labor hours by utilizing, electronic mapping, using more sustained-release products, and pre-treating problem areas.
- The commission remained fiscally responsible by keeping expenditures below revenues by $220,125 for FY 2017.

We continue to pledge our commitment to protecting the public's health and comfort. By making mosquito control decisions based on both scientific data and citizen input, we will make the biggest impact on problem species while minimizing side effects on the environment.

*Dreda A. Symonds*, Director
Chesapeake Mosquito Control Commission

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# SECTION 1.

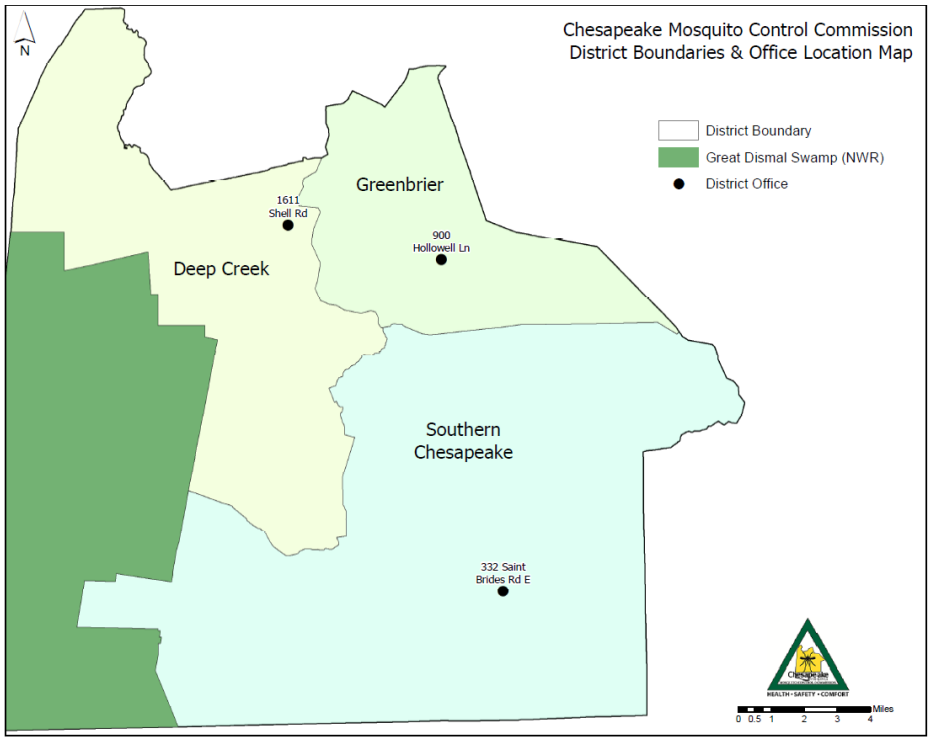
# GENERAL INFORMATION ON MOSQUITOES & MOSQUITO CONTROL IN THE CITY OF CHESAPEAKE

# *Mission and organization*

The mission of the Chesapeake Mosquito Control Commission is to protect the health and welfare of the citizens and visitors of Chesapeake by controlling mosquito populations and mosquito-borne diseases. Our philosophy is to use integrated pest management (IPM) practices, with an ecologically sensitive approach. By employing several different control techniques and the safest, most effective pesticides for target species, we strive to achieve our goals with minimal disruption to people or the environment.

The Chesapeake Mosquito Control Board of Commissioners consists of six volunteer members appointed by the Chesapeake City Council, and a designee of the Virginia State Health Commissioner who serves as Commission Chair. The commissioners' role is oversight of the operating budget and the overall mosquito control program. Details of the operation and day-to-day financial decisions are the responsibility of the Director.

The Commission consists of three working districts: Deep Creek, Greenbrier and Southern Chesapeake. Administration headquarters and the biology laboratory are located at the Deep Creek office.



# *History of mosquito control in Chesapeake*

Following is the sequence of events leading to the creation of five independent mosquito control districts in what is now the City of Chesapeake, Virginia, and their eventual consolidation into one operation. Each of the five commissions originally operated independently and were individually funded by special taxes levied specifically for mosquito control.

*May, 1948* - The Norfolk County Board of Supervisors created ***Deep Creek*** Mosquito Control Commission, which served that district only.

*November, 1949* – The City of ***South Norfolk*** Council voted in favor of creating their own mosquito control district.

*July, 1954* - Norfolk County Board of Supervisors recognized the need for mosquito control in ***Western Branch*** and that district was formed.

*November, 1956* - A desire for mosquito control in ***Washington Borough*** resulted in a vote for a commission covering that district of Norfolk County.

*January, 1963* - Norfolk County and the City of South Norfolk merged to become the ***City of Chesapeake.***

*October, 1965* - Chesapeake City Council passed an ordinance forming the ***Great Bridge*** Mosquito Control Commission.

*September, 2002* – The boundaries of the Great Bridge district were expanded to include the entire southern region of the city not previously included in mosquito control activities. This increased the service delivery area significantly.

*January, 2003* – The five independent mosquito control commissions consolidated to become the ***Chesapeake Mosquito Control Commission***.

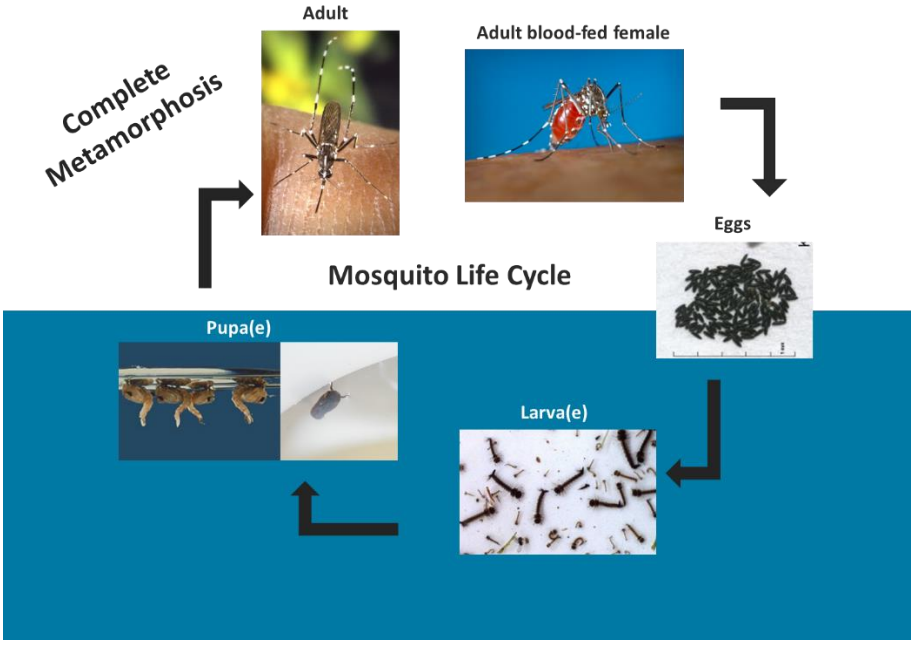
# *Mosquito biology*

Mosquitoes are a huge group of insects that differ significantly from species to species. One of the biggest misconceptions about mosquitoes is that they are all the same, all "bad", and can be controlled using a few basic techniques. Nothing could be further from the truth: there are 2,700 species of mosquitoes worldwide (60 of these reside in Virginia). Each species is unique in its appearance, behavior and habitat. Considering mosquitoes as a group is akin to considering water birds – one species is as different from another as a goose is from a penguin.

As different as they are, all mosquitoes have one thing in common - their life cycle (Figure 1, pg. 4) and its dependence on stagnant water. Mosquitoes undergo complete metamorphosis, i.e., they pass through four successive stages of development: egg, larva, pupa and adult. Depending on the species and environmental conditions, the life cycle can take from 3 days to 2 years, but averages ten to fourteen days during the season. The fact that the first three stages of a mosquitos' lifecycle occurs in stagnant water focuses many control efforts at this source.

Upon emergence, almost all adult female mosquitoes will seek a blood meal. Only female mosquitoes bite, because they require proteins from blood for the development of eggs. Male mosquitoes feed on plant juices or flower nectar and do not take blood meals. The adult females of some species lay their eggs in masses or "rafts" on the surface of the water. Other species lay eggs in depressions that will later be flooded, or in containers that will catch and hold rainwater. After two days these eggs are ready to hatch but if not flooded, can withstand drying for months. Heavy rains and flooding can produce huge mosquito populations in short periods.

**Figure 1. The mosquito life cycle.**




## *The impact of mosquitoes on health and welfare*

*"Of all disease-transmitting insects, the mosquito is the greatest menace…" (World Health Organization).* Certain species of mosquitoes can pick up and transmit some very devastating diseases that have significant impacts on human and animal health and the economic well-being of our region. Not only do these diseases sometimes result in death, the long-term suffering and medical costs imposed upon survivors are significant.

Several local mosquito species transmit West Nile virus (WNV) and eastern equine encephalitis (EEE), neurological diseases that are endemic in southeast Virginia. Newly discovered mosquito-borne diseases such as Chikungunya and Zika virus have very recently emerged in the western hemisphere. These are readily spread by one of our most common and bothersome suburban species, the Asian tiger mosquito. Although malaria is no longer endemic in our area, mosquito species that can transmit the disease are common in Chesapeake. Figure 2 (pg. 5) lists some common mosquito species in Chesapeake and the diseases they can transmit to humans and domestic animals.

**Figure 2. Some common mosquito species in southeast Virginia and the diseases they can transmit (from "Mosquitoes of the Southeastern United States", Nathan D. Burkett-Cadena)**

| Scientific Name | Common Name | Diseases potentially transmitted |
|---|---|---|
| **Aedes albopictus* | Asian Tiger mosquito | CHIK. ZIKA |
| **Aedes canadensis* | Spring woodland pool mosquito | EEE, LAC, JCV |
| *Aedes sollicitans* | Golden salt marsh mosquito | EEE, DHW |
| *Aedes triseriatus* | Eastern tree hole mosquito | LAC |
| **Aedes vexans* | Common floodwater mosquito | EEE, WNV, DHW |
| *Anopheles mosquitoes (4 species)* | Freshwater marsh mosquito | MAL |
| **Coquillittidia perturbans* | Cattail mosquito | EEE |
| **Culex pipiens* | Northern house mosquito | WNV, EEE, SLE, DHW |
| **Culex restuans* | Spotted brown house mosquito | WNV, EEE |
| *Culex salinarius* | Salt-marsh Culex | WNV, EEE, SLE |
| *Culiseta melanura* | Dusky encephalitis mosquito | EEE, WNV |
| | | |

CHK – Chikungunya
DHW – Dog Heartworms
EEE - Eastern equine encephalitis
JCV – Jamestown Canyon virus
LAC – La Crosse encephalitis
MAL – Malaria
SLE – Saint Louis encephalitis
WNV – West Nile virus
ZIKA – Zika virus

* Important nuisance species in Chesapeake

Note that many of the mosquitoes listed above are characterized as "nuisance" species. There are many additional species in Chesapeake that cause considerable pain and irritation to humans and domestic animals, especially when they emerge in large numbers. The discomfort and annoyance inflicted by these mosquitoes can cause major economic impact, especially in recreational areas and places where mosquito problems can result in depreciation of real estate values. Finally, huge mosquito broods can make storm clean-up and recovery efforts very difficult or impossible.

## *Modern mosquito control in Chesapeake*

The basic philosophy of Chesapeake Mosquito Control Commission is an integrated pest management (IPM) approach. IPM requires the use of several different techniques and types of pesticides to control problem mosquito populations. Using IPM with various methods and materials accomplishes many goals:

1. It acknowledges that mosquito species differ dramatically in habitat, host preference (animals they will bite) and behavior, and require different monitoring and control techniques.

2. It emphasizes source reduction (eliminating mosquito egg-laying sites) which is a longer-term control strategy and does not involve pesticides. Source reduction involves many methods, from public education about artificial containers to drainage maintenance.

3. It increases the types of both natural and synthetic pesticides used to reduce the possibility of pesticide resistance. Different pesticides work in diverse ways in the mosquitoes' bodies. They are less likely to become resistant to any one class of pesticide if there are multiple effects on their biological systems.

4. It places priority on controlling immature stages (larvae & pupae) to reduce mosquito numbers before they become adults.

5. It is the safest system for humans and the environment and has the biggest impact on the target species.

6. It saves money by making pesticide applications dependent on surveillance data, rather than on a set schedule.

## *Integrated Pest Management (IPM) techniques*

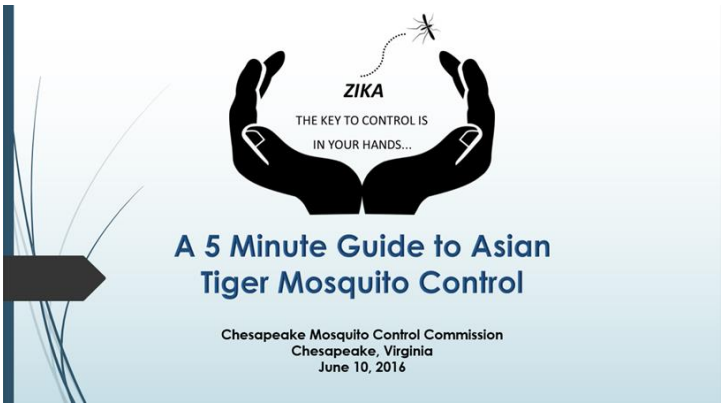
**A. Public Education**

The mosquito species responsible for the most service requests in the City of Chesapeake is the Asian tiger mosquito. This species lives in close association with humans, lays eggs in small containers that catch and hold rainwater, and is active during the day when people are most likely to be exposed. In addition, the Asian tiger mosquito is the local mosquito species capable of transmitting Zika virus. Educating the public on the role their own property plays in the development of these mosquitoes empowers them to eliminate breeding sites before adult infestation becomes a problem. It also alerts them to favorable harborage for adult mosquitoes (tall grass, overgrown shrubbery, ivy, etc.). It advises the best and safest methods of using insect repellants and (if desired) pesticide application. Finally, it alerts the public in the event of heightened mosquito-borne disease activity. Public education efforts are illustrated in figure 3 (pg. 7) and include the following:

1. Seasonal personalized inspections in response to service requests
2. Special presentations or assemblies for public schools
3. Outreach programs for civic and special interest groups
4. Participation at public events, such as fairs and career days
5. Maintenance of a web site link and a telephone hotline
6. Press releases (in conjunction with the Chesapeake Health Department)

7. Appearances in various local media

**Figure 3. Live and online forms of public education.**




**B. Source Reduction**

In addition to the elimination of container breeding sites mentioned above, the commission performs drainage maintenance of mosquito control ditches in the late fall, winter and early spring seasons (figure 4, pg. 7). In most instances, this will improve drainage and eliminate stagnant water breeding sites. Sometimes crews will clear ditches or paths although the grade may not be great enough for proper drainage. This provides clear access to areas that may later be treated for immature mosquitoes, a process called larviciding.

**Figure 4. Drainage maintenance.**

**C. Larviciding**

The optimal time to control mosquitoes is when they are in the aquatic immature stages. They are more concentrated in a smaller area, making them easier to find and treat. They also have not yet emerged as biting females or become a source of nuisance and disease transmission. If treated with certain pesticides, they also survive long enough in the aquatic habitat to provide food for some predaceous animals.

Larvicides are available in several different formulations, and may be applied by ground crews or aerial systems (figure 5, pg. 8-9). All pesticide applicators have extensive training and certification through the state of Virginia as either registered technicians or certified pesticide applicators in the Public Health category.

One of the larvicides employed by the commission is a bacterial spore that only targets mosquito and black fly larvae and is very selective in its action. Another mimics the insects natural growth hormones and does not complete its action until the larva reaches a certain stage of development. Yet another type of pesticide is more useful for late stage larvae and pupae that are not susceptible to the other larvicides. The modes of action of all three pesticides are very different, a fact which makes development of resistance to all of them very unlikely.

**Figure 5. Some larviciding techniques.**

**D. Adulticiding**

If the pesticide applicators cannot detect or reach larvae for treatment before they emerge, it is sometimes necessary to spray for adult mosquitoes. This process is called adulticiding or ULV (Ultra Low Volume) treatment. ULV treatments are usually accomplished by ground application (figure 6, pg. 10), but can be applied aerially when emergencies exist. Although there are not as many basic types of adulticides available, the commission uses at least two different types to avoid development of resistance. Adulticides (and larvicides) are extensively tested for toxicity levels, carcinogenic properties, environmental impacts and safety to non-target organisms. All mosquito control pesticides must be registered through the Environmental Protection Agency and, when used according to label instructions, have a very high level of safety.

**Figure 6. Ground Adulticiding.**

**E. Surveillance**

Surveillance of mosquito populations and mosquito-borne disease activity drives all pesticide application decisions. Monitoring mosquito populations can be as simple as identifying biting Asian tiger mosquitoes during a service request or dipping stagnant water in search of mosquito larvae. However, the commission also has a sophisticated monitoring program designed to provide data on the populations of many different mosquito species and the activity of EEE, WNV and Zika virus. The biology laboratory carries out this program, employing several different types of mosquito traps (figure 7, pg. 11). These devices have various designs and use different attractants to trap the many different mosquito species in Chesapeake. Depending on the species, technical personnel may test some of the mosquitoes for the presence of EEE and WNV using a dipstick type test (Figure 8, pg. 12).

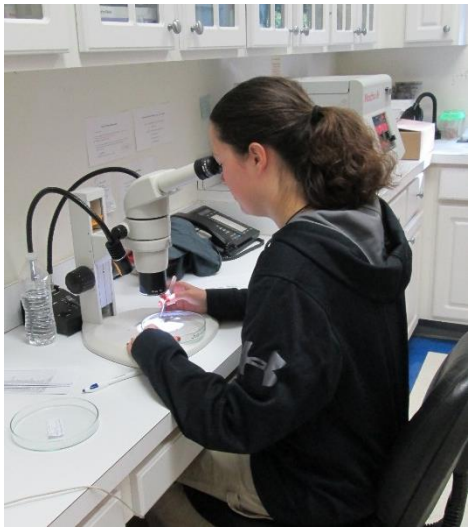
**Figure 7. Mosquito traps.**

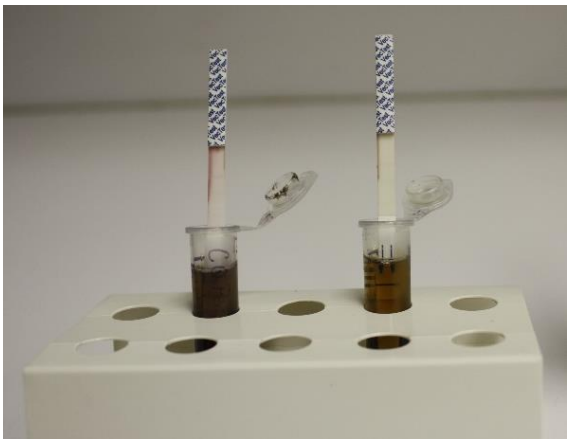
CO2 baited **CDC** miniature light trap

CO2 and special lure baited **BG** sentinel trap

**Gravid** trap baited with water imitating an egg-laying site

**Figure 8. Identifying and sorting mosquitoes for disease testing.**





The other main technique for monitoring disease activity is the sentinel chicken program. Small groups of chickens are placed strategically throughout the city where they may be exposed to biting mosquitoes. Both EEE and WNV depend on circulation through the wild bird population, and as the diseases amplify, the chickens are often infected. This does not harm the chickens in any way – they quickly produce antibodies to the viruses and there is no ill effect. By taking a very small sample of the chickens' blood (figure 9, pg. 12) and submitting it to the state laboratory, technicians can detect the antibodies very quickly, the public can be notified of heightened disease activity, and control measures can be implemented.

**Figure 9. Collecting a small blood sample for detection of mosquito-borne disease antibodies.**

More than any other factor, mosquito populations and disease activity are dependent on weather conditions. The biology laboratory records daily weather data, including temperatures, rainfall and wind speed / direction, from different sources including weather stations at Deep Creek and Southern Chesapeake (figure 10, pg. 13). This information is used to predict problems with certain species and direct control efforts. It is also essential in planning aerial larvicide and ground adulticide treatments.

**Figure 10. Weather station equipment.**

**F. Data management & Geographic Information System (GIS)**

All information, from requests for service to mosquito trap numbers and work accomplishments, is stored in various databases and can be retrieved at any time for analysis. Mosquito populations, and in turn the mosquito control work performed, are very dependent on topographic features, especially low-lying areas with accumulated water. The GIS Analyst maintains all pertinent information on these features, as well as human population densities, pesticide-sensitive sites, property boundaries, vegetative types, location of mosquito control ditches, and surveillance sites. Data on trap catches, work accomplished, location of disease positives, and other information is mapped daily to assist in data analysis and work planning (example, figures 11 & 12, pg. 14).

**Figure 11. Map of pesticide application.**

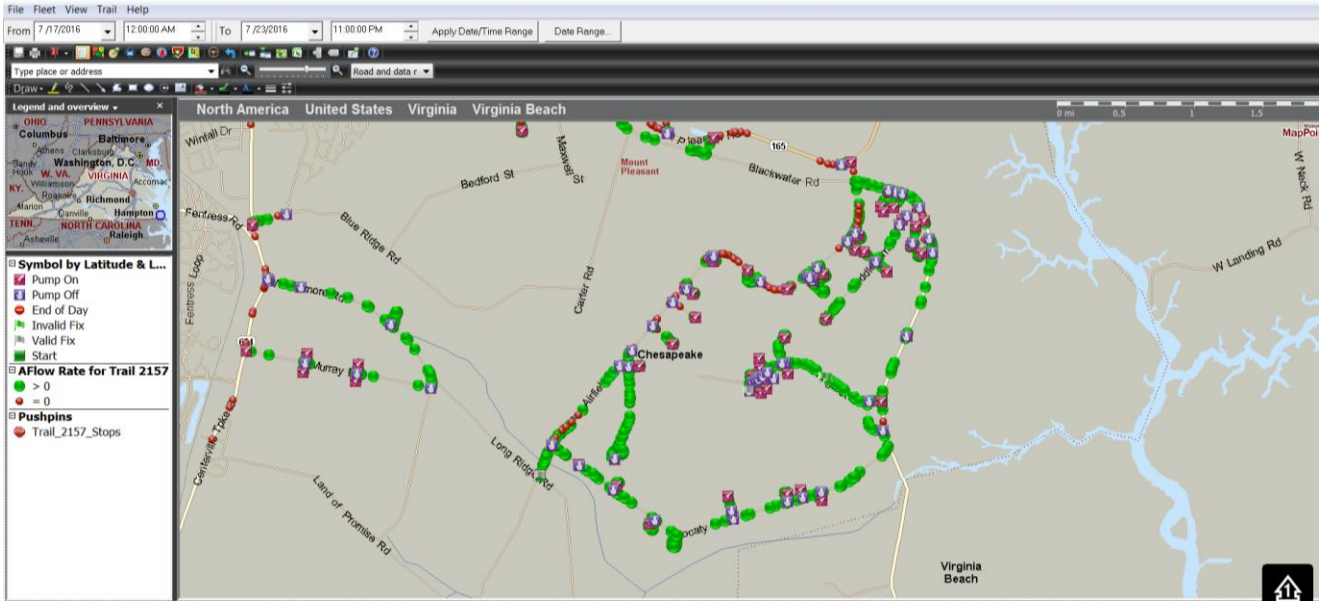
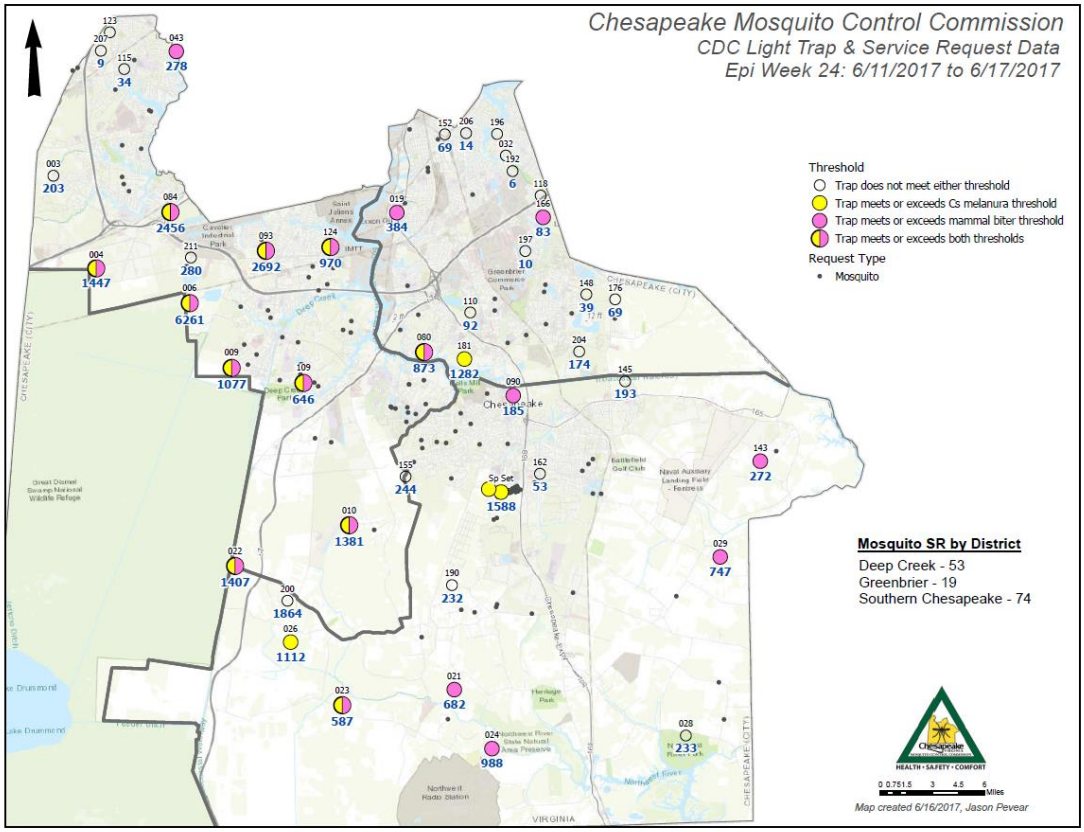



**Figure 12. Representative map of mosquito trap counts and citizen service requests.**



# SECTION 2.

# CHESAPEAKE MOSQUITO CONTRTOL COMMISSION

# OVERVIEW of 2017

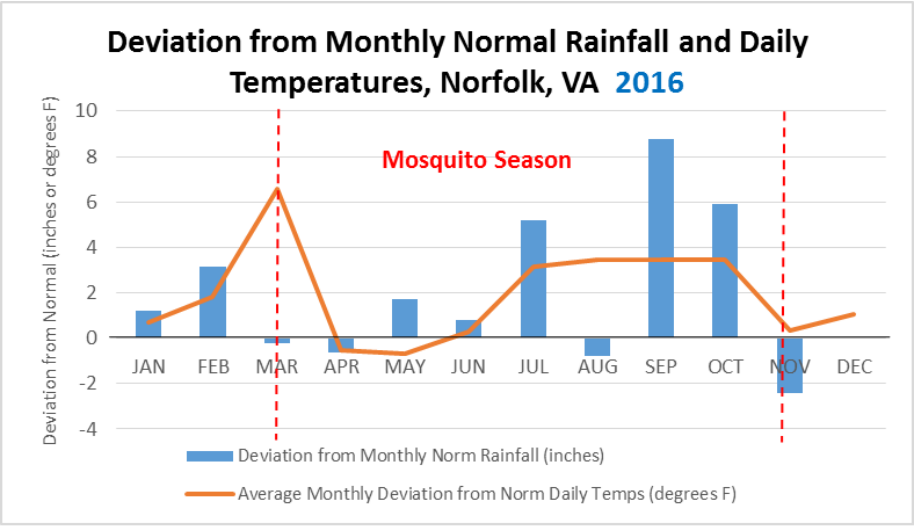
# I. ANALYSIS OF THE MOSQUITO SEASON

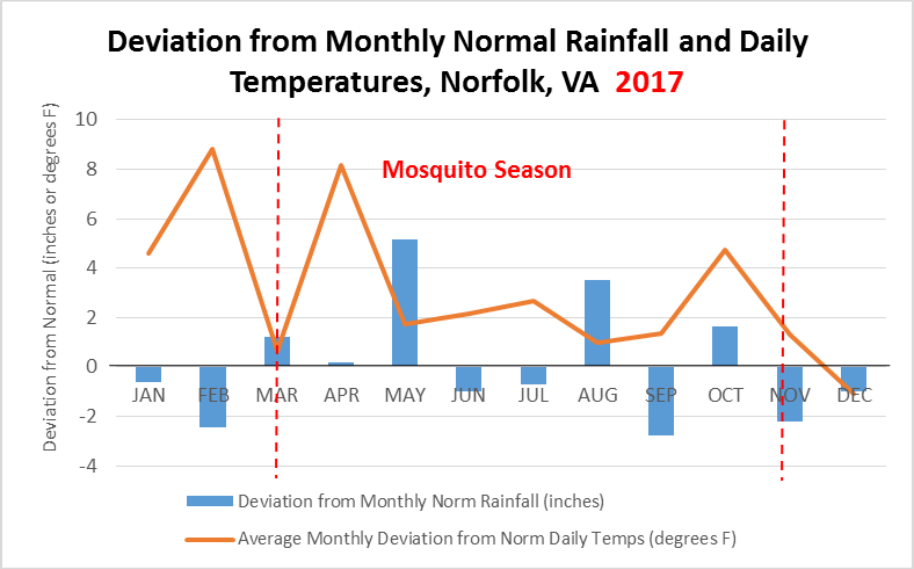
## *Weather conditions, mosquito populations & arboviral disease activity*

### A. General observations

Figure 1 (pg. 1), illustrates the deviation from normal weather conditions recorded at Norfolk International Airport in 2016 and 2017. The 2016 mosquito season was very wet and warm, especially during the months of September and October. It was during these months that Chesapeake experienced an extreme rainfall event, followed 2 ½ weeks later by Hurricane Mathew. The effects of these weather events manifested in problems with certain species during 2016, and then continued with other species into 2017.

**Figure 1. Deviation from normal weather conditions, Norfolk International Airport, 2016 & 2017.**

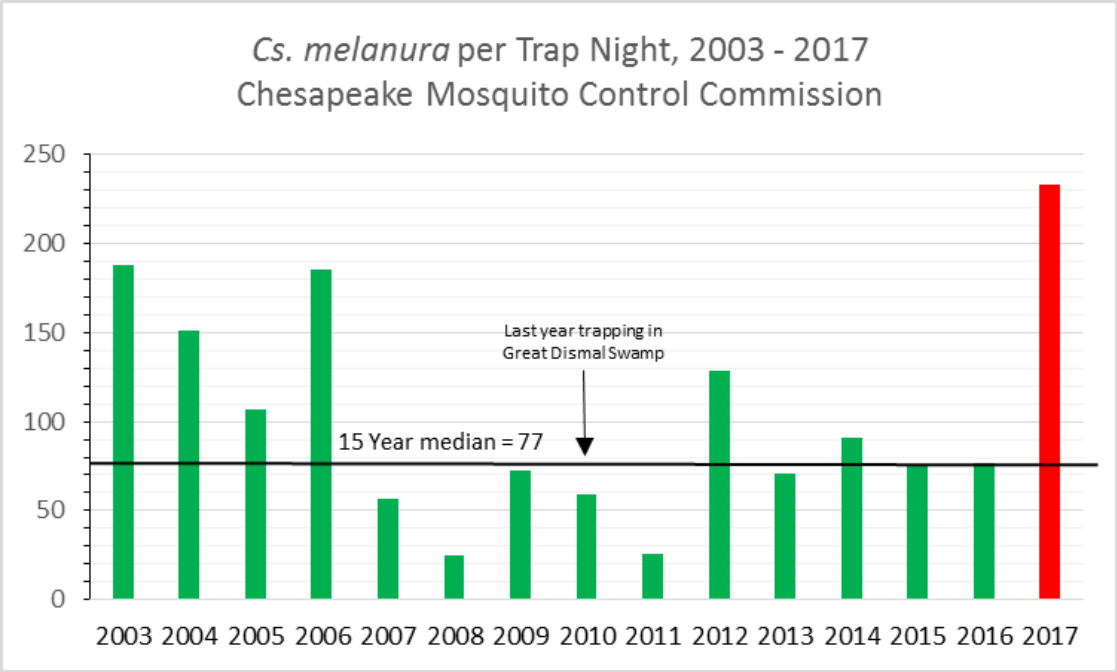


**B. Species specific observations**

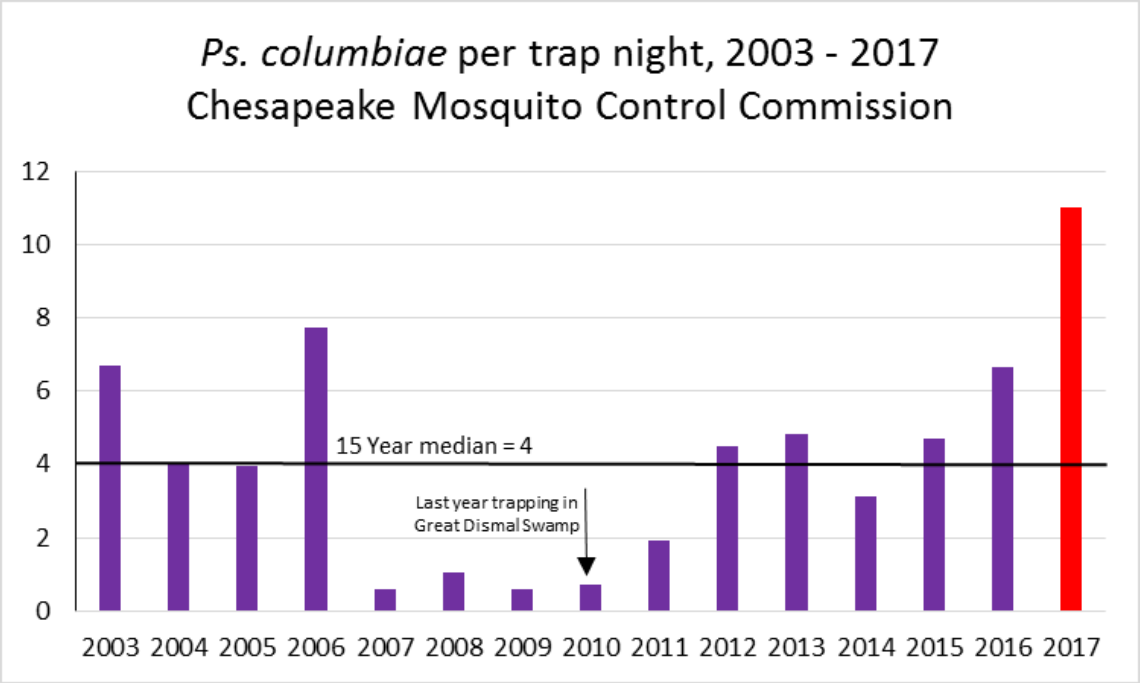
Flooding of the Great Dismal Swamp and other wooded areas in 2016 multiplied breeding sites for *Cs. melanura* (EEE) mosquitoes, which developed in the millions as larvae throughout the warm winter. *Cs. melanura* reached its highest trap counts in 15 years (figure 2, pg. 2) and was largely responsible for historically high trap catches. In fact, ***Cs. melanura comprised 71% of the record breaking 365,311*** total female mosquitoes trapped in 2017.

**Figure 2. Total female *Cs. melanura* per trap night, 2003 to 2017.**



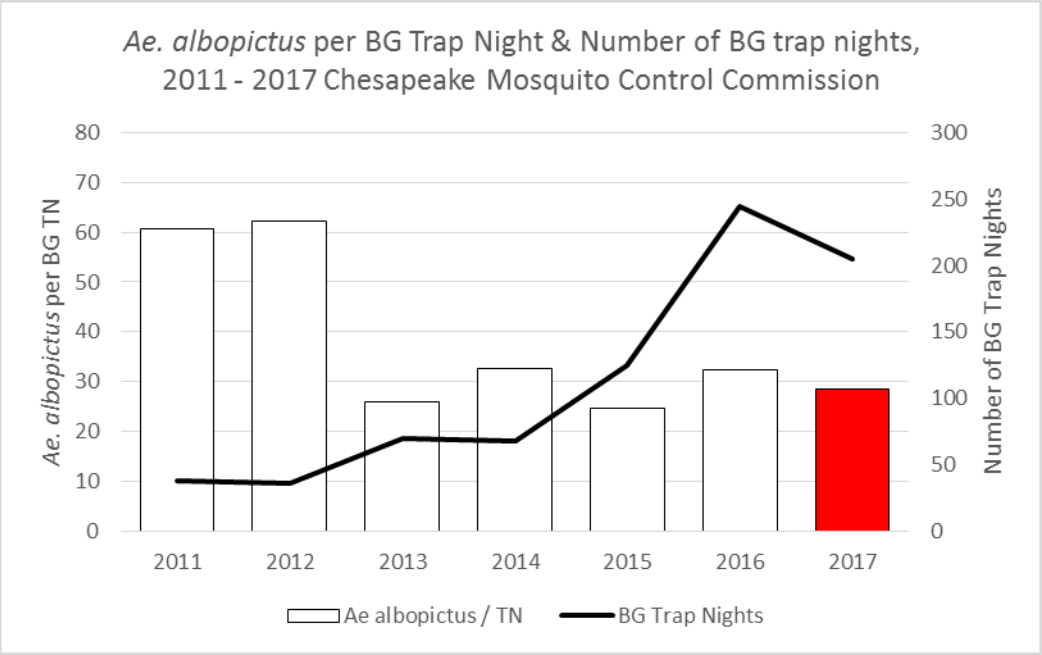
*Ps. columbiae*, an extreme nuisance species, also took advantage of the flooding in 2016 and left unusually large quantities of eggs to survive the winter. These mosquitoes emerged en masse when flooded by heavy rainfall in May, and became a significant annoyance to our citizens for several weeks. The number of ***Ps. columbiae per trap night in 2017 was the greatest in the past 15 years*** (see figure 3, pg. 3). Other species also benefitted from late 2016 season weather conditions and became challenges in 2017, but none as dramatically as *Cs. melanura* and *Ps. columbiae*.

**Figure 3. *Ps. columbiae* per trap night, Chesapeake, VA, 2003 – 2017**



Catches of *Ae. albopictus* (Asian tiger mosquitoes) were moderate this season and were not as large as 2016 catches (figure 4, pg. 4). It must be noted that surveillance for this species has been heightened in the past 3 years, with more BG traps deployed (black line in figure 4) to specifically attract *Ae. albopictus*. This species has a short flight range and problems are often localized, making a correlation between trap catches and actual service request numbers difficult.

**Figure 4. *Ae. albopictus* per BG trap night and number of BG trap nights, 2011 – 2017.**



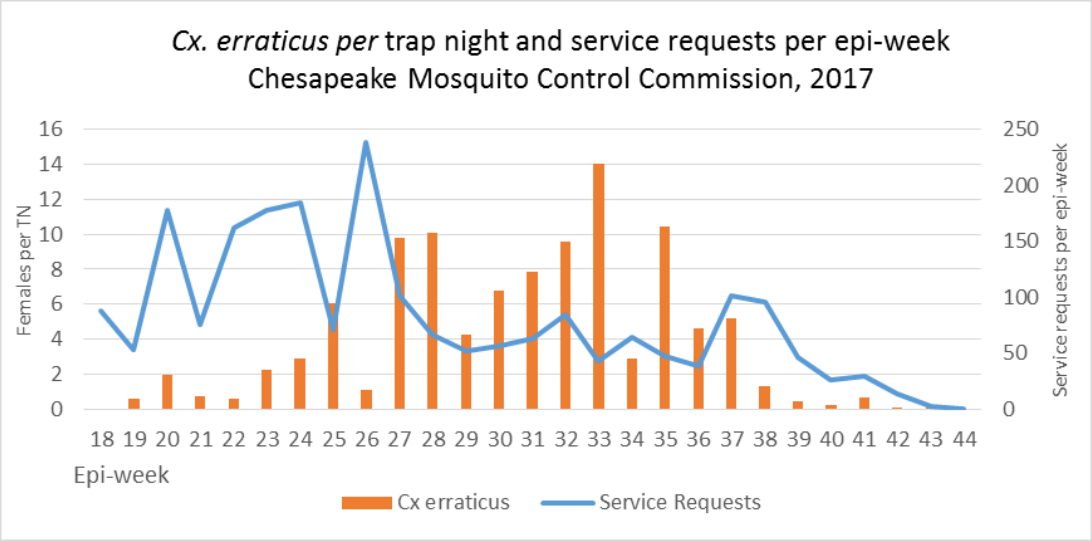

One factor that benefits rapid *Ae. albopictus* development is warm temperatures, of which Chesapeake had plenty in 2017. Although deviation from normal rainfall was not as extreme during the 2017 mosquito season, deviation from normal average daily ***temperature was above normal during every month of the year except December*** (see gold line in 2017, figure 1, pg. 1).

Figure 5 (pg. 5) contains a detailed comparison of most of the species trapped and identified by our biology lab staff during 2016 and 2017. The pink bars indicate significant increases in numbers throughout 2017 and the green bars indicate significant decreases. The overall predominance of green reflects a ***less severe season in 2017 than 2016***. The main exceptions to this rule are the numbers of *Cs. melanura* and *Ps. columbiae*, which were discussed previously. *Cx. erraticus* numbers increased significantly in 2017, but they do not appear to be correlated with a big increase in public annoyance as measured by mosquito service requests (figure 6, pg. 6).

**Figure 5. Comparison of most mosquito species (females) trapped in 2016 and 2017.**

| | **2016 Total Catch** | ***Per Trap Night*** | **2017 Total Catch** | ***Per Trap Night*** | ***% Increase / Decrease per Trap Night*** | **Reason for concern when higher (red)** |
|---|---|---|---|---|---|---|
| **Trap Nights (TN)** | **1,096** | | **1,113** | | ***2%*** | |
| Ae albopictus | 7,900 | 7 | 5,843 | 5 | -26% | Extreme nuisance / Zika vector |
| Ae vexans | 4,429 | 4 | 4,906 | 4 | 11% | Nuisance / bridge vector |
| *An crucians/bradleyi* | 22,924 | *21* | 24,432 | *22* | 7% | |
| *An punctipennis* | 2,162 | *2* | 2,179 | *2* | 1% | |
| *An quadrimaculatus* | 1,573 | *1* | 1,692 | *2* | 8% | |
| Cq pertubans | 21,361 | 19 | 6,988 | 6 | -67% | Nuisance / bridge vector |
| Cs melanura | 83,998 | 77 | 259,033 | 233 | 208% | EEE Primary vector |
| Cx erraticus | 2,326 | 2 | 4,383 | 4 | 88% | EEE Bridge vector |
| *Cx pipiens* | 7,630 | *7* | 7,023 | *6* | -8% | |
| *Cx restuans* | 624 | *1* | 254 | *0* | -59% | |
| *Cx salinarius* | 35,059 | *32* | 13,604 | *12* | -61% | |
| *Cx territans* | 100 | *0* | 232 | *0* | 132% | |
| Oc atlanticus | 8,000 | 7 | 4,654 | 4 | -42% | Extreme nuisance |
| Oc canadensis | 20,312 | 19 | 6,526 | 6 | -68% | Nuisance / bridge vector |
| Oc infirmatus | 4,547 | 4 | 1,623 | 1 | -64% | Extreme nuisance |
| Oc solicitans | 110 | 0 | 38 | 0 | -65% | |
| *Oc taeniorhynchus* | 13 | *0* | 23 | *0* | 77% | |
| Oc triseriatus | 253 | 0 | 111 | 0 | -56% | Nuisance / bridge vector |
| *Or signifera* | 31 | *0* | 39 | *0* | 26% | |
| *Ps ciliata* | 153 | *0* | 187 | *0* | 22% | |
| Ps columbiae | 7,283 | 7 | 12,286 | 11 | 69% | Extreme nuisance |
| Ps ferox | 18,285 | 17 | 8,754 | 8 | -52% | Extreme nuisance |
| *Ps howardii* | 214 | *0* | 114 | *0* | -47% | |
| *Ur sapphirina* | 169 | *0* | 323 | *0* | 91% | |
| Total Males | 4941 | *5* | 3,710 | *3* | *-25%* | |
| **Total Females** | 249,456 | ***228*** | 365,247 | ***333*** | ***46%*** | |
| | | | | | | |
| | ***2016*** | | ***2017*** | | | |
| BG Trap Nights | 244 | | 206 | | -16% | |
| *Ae albopictus* | 7,900 | *32* | 5,843 | *28* | ***-12%*** | |
| | | | | | | |
| Gravid Trap Nights | 102 | | 135 | | 32% | |
| *Cx pipiens* | 7,090 | *70* | 7,023 | *52* | ***-25%*** | |

**Figure 6. *Cx. erraticus* per trap night and service requests per epi-week, 2017.**




Although their numbers were down significantly from 2016 post-hurricane levels, *Ps. ferox* were still present in relative abundance early in the 2017 season. Their totals were well above the 15 year median (figure 7, pg 6) and apparently more than the public will tolerate. Along with *Ps. columbiae*, they were partially responsible for the high service request levels during May and June when we received 51% of the total mosquito service requests for the entire year (figure 8, pg 7).

**Figure 7. *Ps. ferox* catches per trap night, 2003 – 2017.**

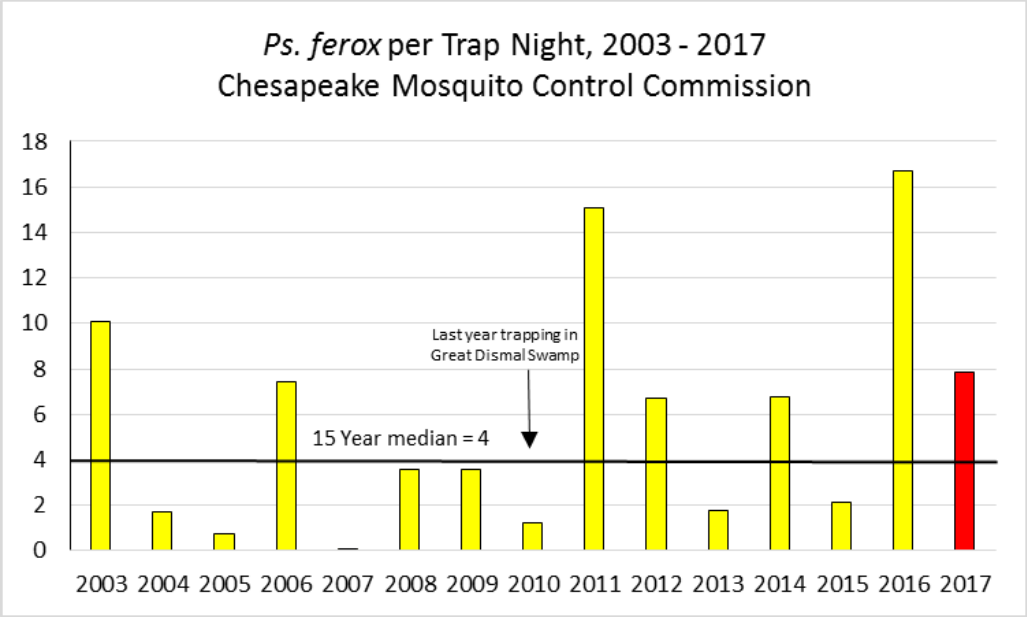
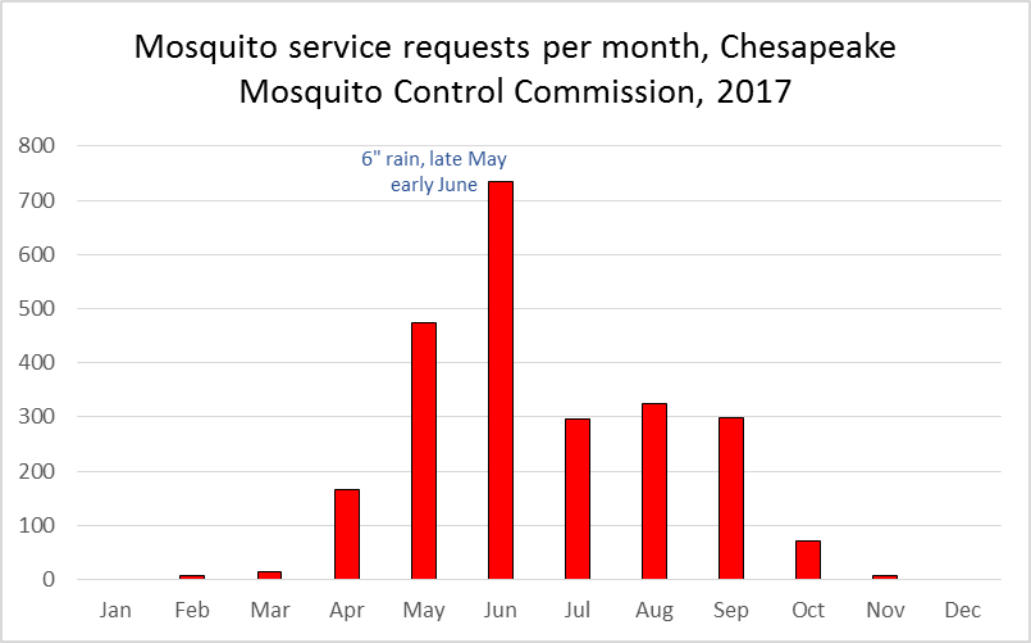


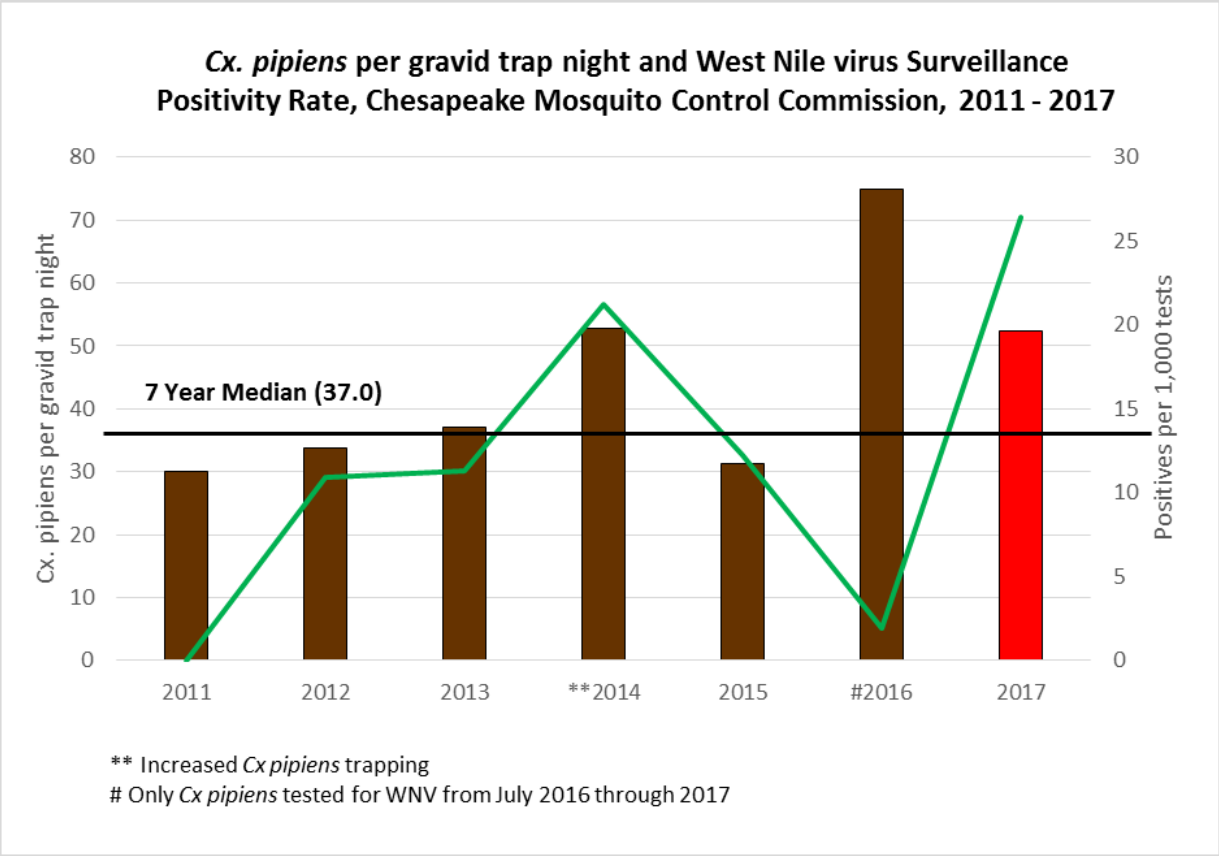
**Figure 8. Mosquito service requests per month, 2017.**



**C. Arboviral (mosquito-borne) disease activity**

***1) West Nile Virus (WNV)*** - Although *Cx. pipiens* populations were lower than last season, the number of WNV positive events was higher (green line, figure 9, pg. 8). In fact, the ***2017 WNV positivity rate per 1,000 samples tested was the highest in the past 10 years***. WNV mosquito pool testing was limited to *Cx pipiens* beginning in July 2016, and this may have skewed positivity calculations in 2017. However, trap catches of this species were significantly higher last season, so it appears that abundance of primary vectors alone did not influence arboviral activity as it normally does. It is possible that extremely high temperatures in April (the same month when many nestling birds are present) affected the spread and growth of the disease.

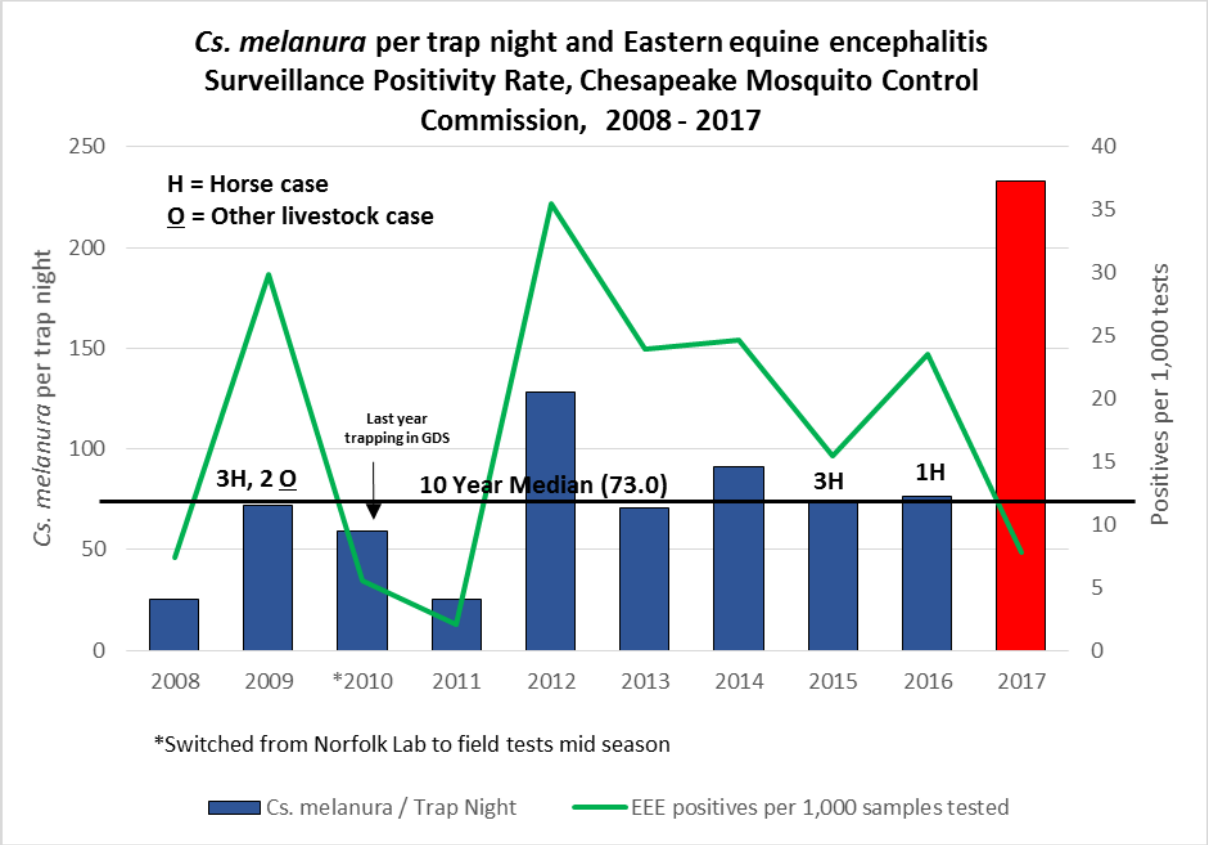
**Figure 9. *Cx pipiens* gravid trap catches and WNV positivity rates.**




***2) Eastern equine encephalitis (EEE)*** – The warm April / high positivity theory does not explain the ***low (EEE) activity in 2017***. With extremely high numbers of *Cs. melanura* and very warm summer temperatures, activity should have been very high. However, the positivity chart

in figure 10 (pg. 9) indicates a 2017 season with very low activity. There is no clear explanation for this phenomenon. It does, however, highlight ***the importance of testing for arboviral disease activity, rather than just depending on primary vector population counts***, to determine arboviral risk to humans.

**Figure 10. *Cs. melanura* trap catches and EEE positivity rates.**




***3) Zika Virus*** - The incidence of imported human Zika cases in Virginia dropped dramatically from ***108 in 2016 to 6 in 2017*** (cases reported through ArboNET, Centers for Disease Control). Activity of the Governor's Zika task force decreased during 2017 in conjunction with the low presence of Zika in Virginia. However, protocols are still in place should a human case require action from local mosquito control districts.

During 2017, the federal government still provided funding for pesticide resistance testing through Virginia Tech. Chesapeake Mosquito Control Commission continues to submit *Ae. albopictus* eggs for this testing program (figure 11, pg. 10) and will be performing our own bottle bioassays in 2018.

**Figure 11. Collecting Asian tiger mosquito eggs from an ovitrap for pesticide resistance testing.**

# II. OPERATIONS

## *Work & service request report*

### A. Drainage maintenance

Figure 1 (pg. 11) illustrates work accomplished during calendar years 2016 and 2017 and the percent increase or decrease per category. Note the decrease in drainage maintenance production and hours in 2017. This is partially due to the fact that one facet of ground larviciding (blocking) began earlier in 2017.

**Figure. 1. Work report comparison, calendar years 2016 – 2017.**

| Work Report Comparison | 2016 | 2017 | % Increase / Decrease |
|---|---|---|---|
| **Field Personnel - Total FTE's** | **22.60** | **22.02** | **-3%** |
| **Drainage Maintenance** | | | |
| Bush - Mach (acres) | 42 | 35 | -17% |
| Cleaning (miles) | 39 | 34 | -13% |
| Refuse Removed (tons) | 54 | 56 | 4% |
| **Total Drainage Maintenance Hrs.** | **10,554** | **8,906** | **-16%** |
| | | | |
| **Pesticide Application & Inspections** | | | |
| **Ground Larvicidng (week-acres)* | 10,330 | 15,824 | **53%** |
| # of Backyard Inspections | # not available | 4,932 | N/A |
| # of Backyard ULV Treatments (Asian tiger problems) | 1,810 | 1,702 | -6% |
| Ground ULV (acres truck-mounted + UTV+ backyard) | 329,204 | 335,126 | 2% |
| **Total Ground Pesticide Application Hrs.** | **23,316.74** | **21,446.70** | **-8%** |
| **Aerial Larviciding (week-acres)* | 7,066 | 7,824 | **11%** |
| | | | |
| **Service Requests (dependent on environmental conditions)** | | | |
| Mosquitoes | 3,328 | 2,390 | -28% |
| Drainage | 153 | 103 | -33% |
| Property Release | 40 | 21 | -48% |
| Special Event Treatment | 450 | 357 | -21% |
| Other | 210 | 146 | -30% |
| **TOTAL** | **4,181** | **3,017** | **-28%** |
| | | | |
| **Biology Lab - Total FTE's** | **3.20** | **3.20** | **0%** |
| **Biology** | | | |
| Total Mosquito Traps Set | 1,096 | 1,113 | 2% |
| Total Female Mosquitoes | 249,473 | 365,311 | **46%** |
| Total mosquito pools tested for disease | 898 | 1,098 | 22% |
| Total Chicken Samples | 287 | 320 | 11% |
| | | | |
| **Education / Outreach (includes Director)** | | | |
| Schools | 22 | 16 | |
| Outreach Activities/ Training | 29 | 8 | |
| Total Education / Outreach | **51** | **24** | **-53%** |
| | | | |
| **Week-acres - New measure that takes into account sustained-release formulations.* | | | |
| *= Number of weeks of control X Acres treated* | | | |

**B. Ground larviciding**

Blocking targets *Oc. canadensis* and other early spring species. It employs a 150-day sustained-release growth regulator that will continue to control other species later into the season. Expanding the blocking program and catch basin (30-day) treatment programs have been two factors increasing our ground larviciding coverage.

However, an even greater element is the new special larvicide project program. This program involves identification, measurement and pre-treatment of large problem areas using the City of Chesapeake's electronic mapping program (ConnectExplorer). Our experienced field crews worked together to define the areas most prone to mosquito breeding, map, and treat them with sustained-release granules via utility terrain vehicles (UTV's) (figure 2, pg. 12). Our GIS Analyst created a database to house information on these sites and create a schedule for treatment. Through this group effort, ***we added 1,628 physical acres to our ground larviciding program, and expanded the control time 3 to 6 weeks***, depending on the type of granule used.

Overall, blocking, catch basin treatments, and special larvicide projects were responsible for ***increasing ground larvicide treatment by 53% in 2017*** (figure 1, pg. 11).

**Figure 2. Field technicians working with ConnectExplorer and one of our UTV's to treat problem areas.**

**C. Backyard inspections and treatments**

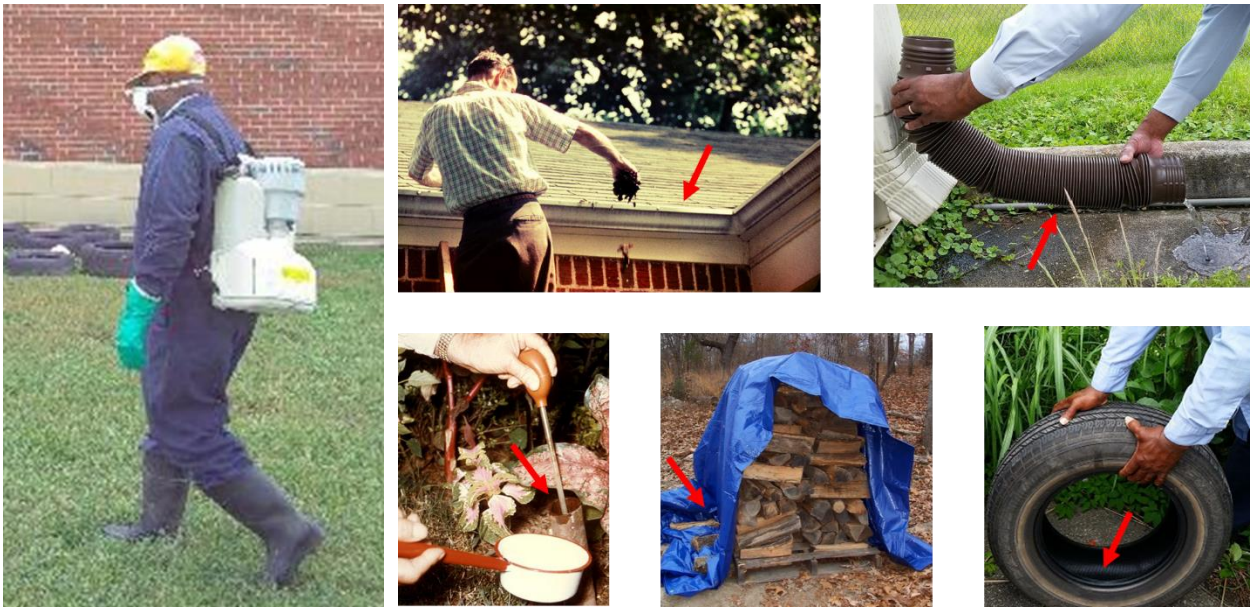
Asian tiger mosquitoes (*Ae. albopictus* – figure 3, pg. 13*)* are an invasive species that live in close association with humans and breed in artificial containers that catch and hold

rainwater. They are especially hard to control, as these sites are not normally accessible to mosquito control efforts.

**Figure 3. Asian tiger mosquito (*Aedes albopictus*).**

Backyard inspections and treatments are the most effective means of control (figure 4, pg. 13), but take considerable time and labor. However, the importance of this nuisance and potential disease vector makes the effort necessary. ***Field technicians inspected 4,932 properties and treated 1,702 individual yards in 2017 (figure 1, pg. 11).***

**Figure 4. An inspector treating adult Asian tiger mosquitoes and examples of egg-laying sites.**



Please note that the ***ultimate responsibility for source control of Asian tigers resides with our residents***. The best way to avoid excessive populations of this species is to eliminate all water from containers (figure 4, pg. 13) diligently every week. Citizens should also note that the ultra-low volume (ULV) treatment our field technicians employ only eliminates adult mosquitoes that it contacts. ***This adulticide has none of the residual effect of the formulations applied by many private pest control companies.***

**D. Adulticiding (nighttime spray operation)**

The Commission also employs ultra-low volume (ULV) technology in all its nighttime pesticide application trucks (figure 5, pg. 14) and UTV's. We periodically calibrate the flow rate and measure droplet size to ensure applications that are effective on mosquitoes but safe to non-target organisms. In 2017, we modified all our truck-mounted ULV machines to accommodate water-based pesticides, making this program more environmentally friendly.

**Figure 5. A supervisor measuring water-based pesticide into a truck-mounted ULV machine.**

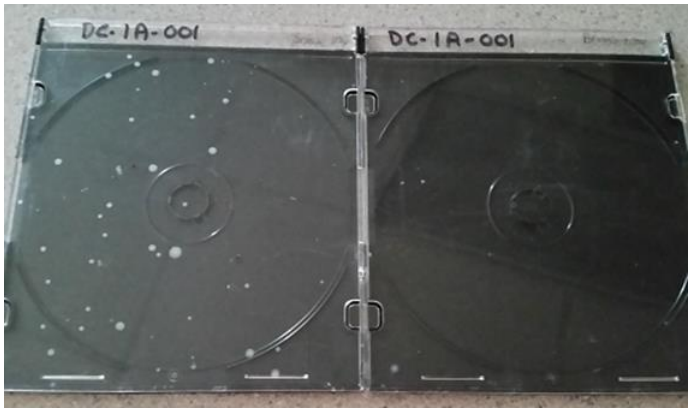
The decision of when and where to spray is made daily throughout the mosquito season. The decision is based on service requests, positive arboviral activity, and trapped mosquito number thresholds. ***The total acres treated via ground ULV in 2017 was 335,126***, slightly more than the acreage treated in 2016 (figure 1, pg. 11).

**E. Biology Laboratory**

As stated in the analysis of the mosquito season, mosquito trap catches were extremely high in 2017 and lab personnel were faced with the challenge of identifying, sorting and testing thousands of mosquitoes per day. Fortunately, we were able to employ 3 temporary interns who all had previous experience and who, along with our experienced Biologist II and Biology Technician, handled the work load very well. ***Lab personnel were able to set and retrieve 2% more traps, process 46% more mosquitoes, test 22% more mosquito pools, and collect and process 11% more sentinel chicken samples in 2017 than in 2016 (see figure 1, pg. 11).*** The ovitrap program to collect *Ae. albopictus* eggs for pesticide resistance testing was also continued from last seaosn. Outreach efforts decreased in 2017 due to the diminishing public concern with Zika virus, but important school functions and special interest groups were addressed.

The biology laboratory was engaged in extensive surveillance of key larval breeding sites early in the year (figure 6, pg. 15). The purpose was to access the effectiveness of both the liquid and granule aerial larvicide programs. Our GIS Analyst created a database for this project and lab personnel collected valuable information both pre and post treatment.

**Figure 6. Larval site survey and indicators of liquid larvicide canopy penetration.**

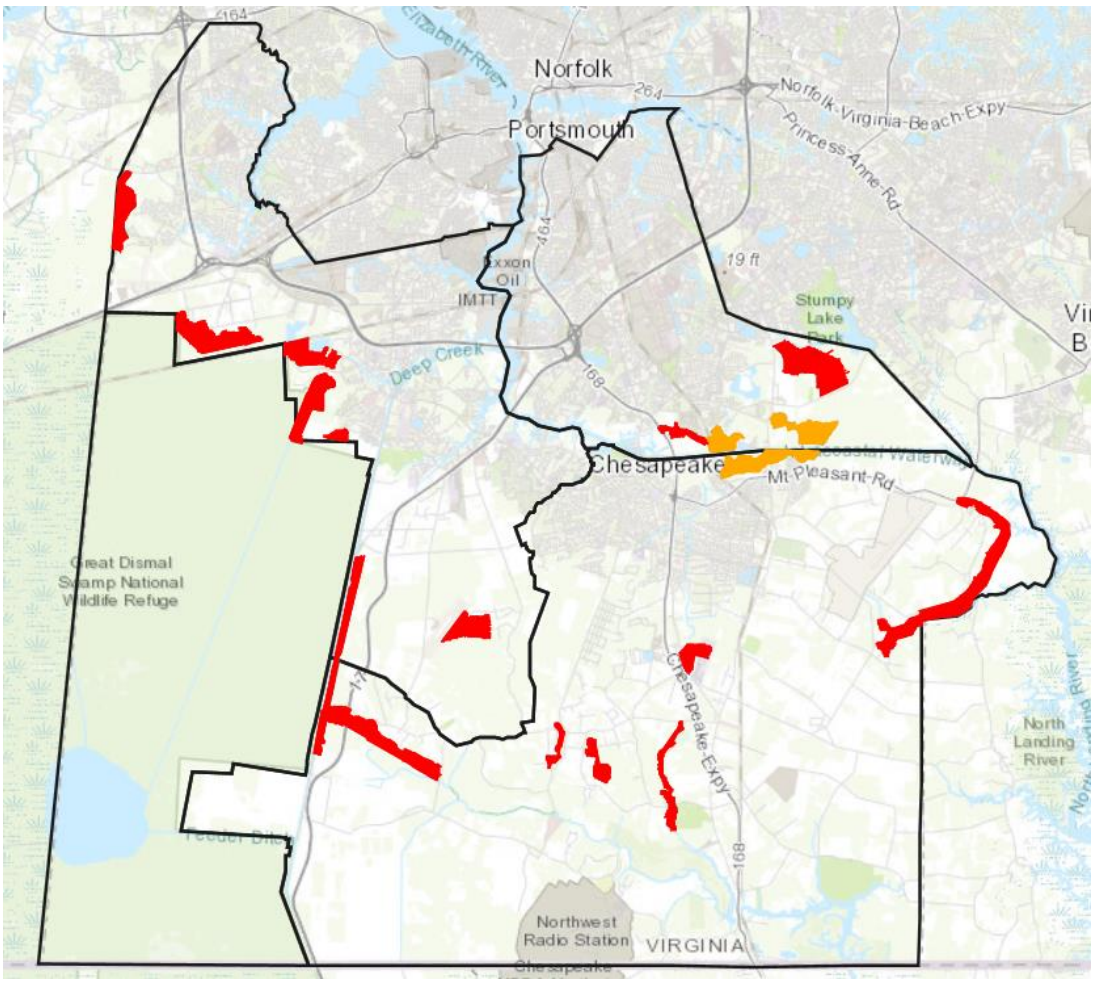



# *Aerial larvicide application*

Kritter Crop-dusting performed the aerial larvicide application from March 6 – 9, 2017. A map of the treatment zones is pictured in figure 7, page 16. The red areas indicate treatment with a liquid mixture of B.t.i. (a bacterial spore) and Altosid (an insect growth regulator) and comprise 5,163 of the total acres treated. The species targeted was the spring woodland pool mosquitoes, *Oc. canadensis*. Zones colored gold were treated with longer-lasting granular Altosid formulations. These applications were made in marshy areas where *Cq. perturbans*

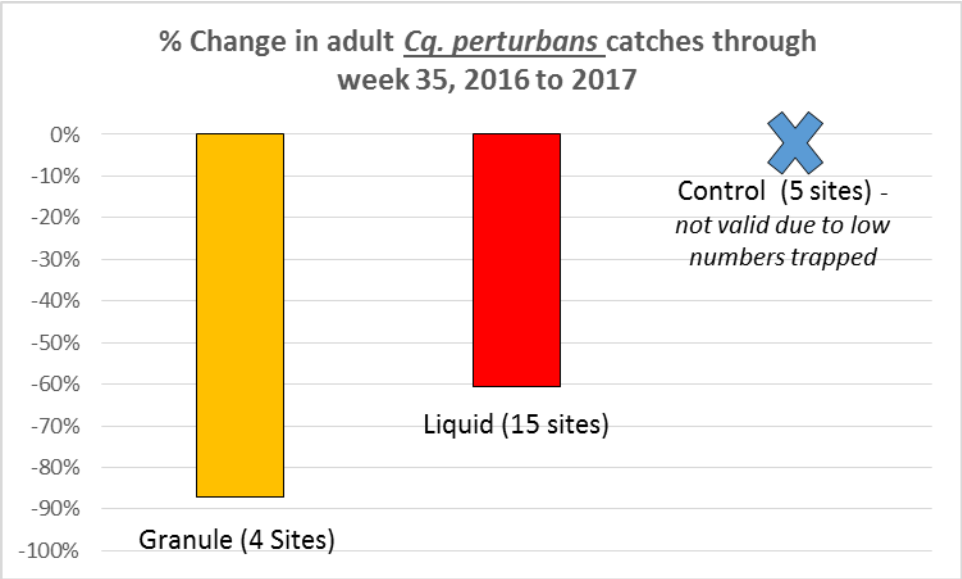
develop. There is some evidence that suggests granular treatments may be more effective against this species. Therefore, more emphasis was placed on it in 2017. However, as explained below, efficacy results of the aerial larvicide were inconclusive.

**Figure 7. Aerial larvicide treatment zones, 2017. Liquid larvicide applications are red – granule applications are gold.**




At first glance of post-treatment surveillance data, there appears to be a great decrease in adult *Cq. perturbans* trapped near granule treatment zones (87% - figure 8, pg. 17). However, a significant decrease (61%) also occurred near liquid treatment zones that did <u>not</u> target this species. It is impossible to determine whether the granule treatment truly affected this species significantly, or whether it is just going through ***natural population fluctuations***. Discussions with neighboring mosquito control districts have confirmed the fact that there <u>has</u> been a region-wide decrease in *Cq. perturbans* populations for the past 2 years.

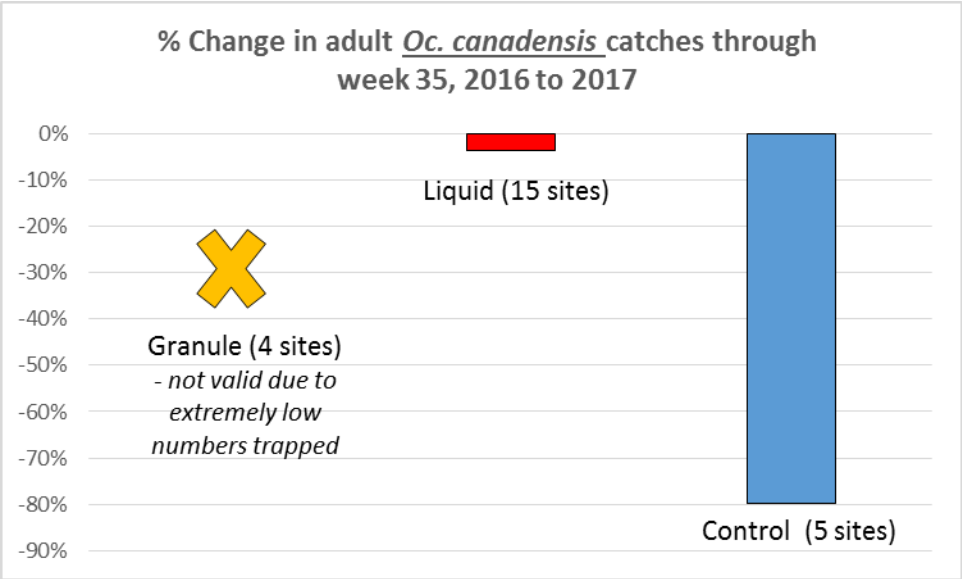
**Figure 8. Percent change in *Cq. perturbans* (granule target species) from 2016 to 2017 near granule treatment zones, liquid treatment zones and control zones (no treatment nearby).**




The alarming emergence of spring woodland pool mosquitoes (*Oc. canadensis*) after Hurricane Mathew in October of 2016 increased the risk of another large emergence in spring of 2017. This species is the target for aerial liquid larvicide treatment, and treatment zones were increased to assure that breeding sites within range of more human populated areas were covered. Extremely high daily temperatures during January and February (5$^{o}$F and 9$^{o}$F deviations from norm, consecutively) resulted in very rapid larval development, so treatment was planned earlier than in the past. Post-treatment surveillance indicated that the liquid had reached the sites (see the spotted cases in figure 6, pg. 15), but the sites had dried and shrunk considerably by the time they were treated.

There was significant rainfall in March about 10 days post-treatment. This flooded more eggs and more larvae hatched. Subsequent larval surveillance indicated that a later brood developed. There was no residual effect from the liquid larvicide and the treatment was not effective at this later date. Numbers of *Oc. canadensis* decreased more at control sites where there was no treatment than at liquid treatment zones (figure 9, pg. 18). This series of events illustrates that ***the number of factors involved in planning and executing a spring aerial liquid larvicide program make success elusive.*** Unreliable weather conditions, the uncertainty of granule treatment effectiveness, and current financial constraints dictate that we reduce the aerial larviciding program in 2018 and remove funding for the program from the budget thereafter.

**Figure 9. Percent change in *Oc. canadensis* (liquid target species) from 2016 to 2017 near granule treatment zones, liquid treatment zones and control zones (no treatment nearby).**




# *Goals & Challenges for 2018*

**A. Arboviral diseases**

The threat of **Zika** virus decreased significantly in 2017 (***6 human cases of Zika in Virginia in 2017 vs. 108 in 2016***), but the policies and procedures initiated through the Governor's Zika task force are still in place should the disease return in force. We will remain diligent and participate in any surveillance and testing programs offered through the state. We will also continue to work closely with the Chesapeake Department of Health to educate the public and respond quickly, with enhanced mosquito control efforts, to areas near any documented human cases.

Heightened **West Nile virus** activity during the 2017 season was unexpected, but was a phenomenon experienced throughout the state***. In Virginia, there were 13 human cases (the 16-year median is 6 cases per year), 1 death and 4 blood donors with the disease.*** We will soon be working with the City of Chesapeake Public Utilities and HRSD to enhance surveillance at sewerage pumping stations. Once we have identified all stations that may be breeding sites for the WNV primary vector, we will initiate periodic treatments to reduce the problem.

The historically high number of **eastern equine encephalitis** primary vectors in 2017 prompted us to intensify ULV efforts early in the season. When it was clear that the EEE infection rate was very low, we increased our action threshold, thereby reducing truck-mounted ULV operations and conserving resources. It is uncertain how the high primary vector

population in 2017 will affect EEE activity in 2018, but we will continue both mosquito pool and sentinel chicken tests to monitor and respond to problems.

**B. Environmental stewardship**

The conversion of our truck-mounted ULV machines to water-based (vs. oil-based) pesticides is complete. We are studying the combination of a different water-based pesticide and a new hand-held ULV unit for backyard treatments. Fiscal Administration and Customer Service continue our efforts to "keep it green" by converting most records from paper to electronic files. Finally, we continue to support the Chesapeake Animal Services while recycling by donating aluminum cans and newspapers.

**C. Records management & computer technology**

A cooperative effort between our GIS Analyst and Pesticide, Facilities and Fleet Supervisor has resulted in a database to replace the antiquated pesticide inventory spreadsheet. Their partnership has also produced a fleet maintenance and repair database that will help us schedule maintenance, identify common repairs, maintain parts inventories, budget, and determine vehicle replacement schedules. Finally, our field personnel will continue to use electronic mapping to identify, measure and plan pre-treatments, increasing treatment week/acres and decreasing the impact of large rain events.

**D. Biology laboratory**

We hope to expand the tasks performed by the Biology Lab staff to include more structured and routine larval surveillance, specialized projects, and pesticide resistance testing.

# III. FINANCIAL REPORT

**CITY OF CHESAPEAKE, VIRGINIA**
**2015 COMPREHENSIVE ANNUAL FINANCIAL REPORT *Schedule T-2***
Statement of Revenues, Expenditures, and Changes in Fund Balance
Chesapeake Mosquito Control Commission
Year Ended June 30, 2017

| | |
|---|---|
| **REVENUES** | |
| Property taxes* | $ 4,211,543 |
| Investment income | 10,432 |
| Other | 174,271 |
| Total revenues | 4,396,246 |
| | |
| **EXPENDITURES** | |
| Other salaries and wages | 1,885,727 |
| Other fringe benefits | 771,084 |
| Other repairs and supplies | 850,448 |
| Insurance premiums | 239,990 |
| Capital outlay | 69,813 |
| Other | 359,059 |
| Total expenditures | 4,176,121 |
| **Excess of revenues over expenditures** | 220,125 |
| **Fund balance – beginning** | **$ 3,584,009** |
| **Fund balance – ending** | **$ 3,804,134** |

**Reconciliation to Change in Net Assets:**

Governmental funds report capital outlay as expenditures. However, when reporting net assets, the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense.

| | |
|---|---|
| Net change in fund balance | $ 220,125 |
| Pension expense | 348,191 |
| Depreciation expense | (147,252) |
| Loss on disposal | (112,392) |
| Capital outlay expenditures | 69,813 |
| | |
| **Change in Net Position** | $ 378,485 |

**The City finances the operations of the Commission through incremental property taxes of $.01 per $100 of assessed value for real estate properties and $.08 per $100 of assessed value for personal property.*