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Chesapeake Mosquito Control Commission

Annual Report
2018

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HEALTH • SAFETY • COMFORT

February 19, 2019

TO: Citizens of the City of Chesapeake, VA

FROM: Dreda A. Symonds, Director

SUBJECT: 2018 Chesapeake Mosquito Control Commission (CMCC) Annual Report

We continue the two-section format of the annual report. 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 2018.

Here are some highlights of the 2018 Overview:

- There were a record number of human West Nile virus (WNV) cases in Virginia in 2018 (48 cases). Two of these patients reside in the City of Chesapeake, and were our first ever locally acquired cases.
- Heavy rainfall during the mosquito season resulted in multiple large broods of nuisance mosquito species. Although these species do not transmit disease, they were the impetus behind many citizen requests.
- Our biology laboratory began the first of many years of pesticide resistance tests for local mosquito populations. This testing is necessary to access the effectiveness of our pesticides and guide our future control strategies.
- The commission remained fiscally responsible by keeping expenditures below revenues by $706,205 for FY 2018.

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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*(*NOTE: The financial overview covers fiscal year 2017-2018, while the rest of this report covers calendar year 2018 to encompass one mosquito season.)*

SECTION 1.

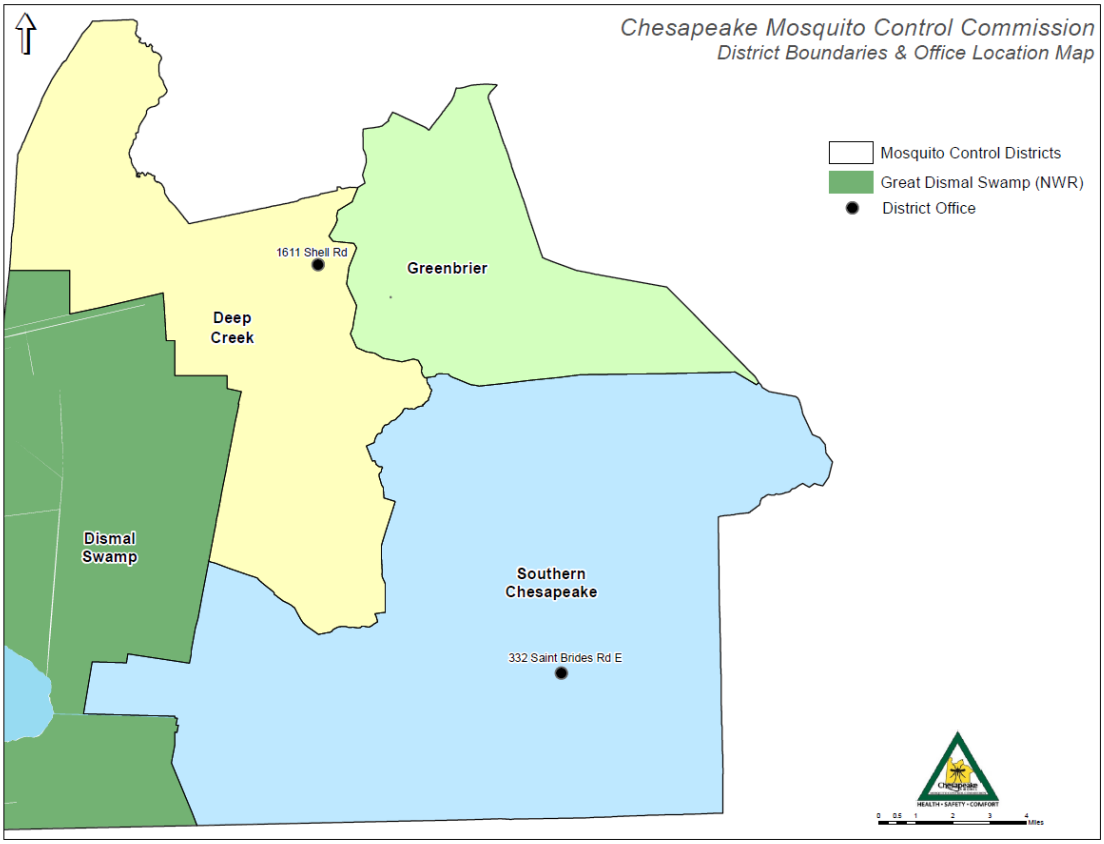
GENERAL INFORMATION ON MOSQUITOES & MOSQUITO CONTROL IN THE CITY OF CHESAPEAKE

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. The administrative headquarters, garage, and the biology laboratory are located at the Deep Creek / Greenbrier facility at 1611 Shell Rd.



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***.

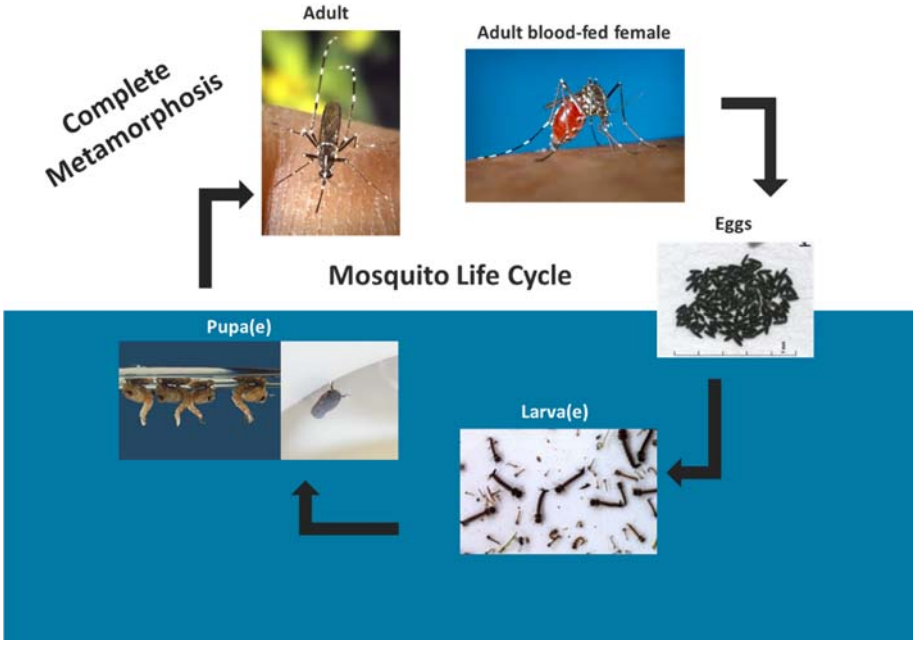
Mosquito biology

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 3,500 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 usually responsible for the most service requests in the City of Chesapeake is the Asian tiger mosquito (figure 3, p. 6). This invasive species lives in close association with humans, lays eggs in small containers that catch and hold rainwater (e.g., figure 4, p. 7), and is active during the day when people are most likely to be exposed. They are particularly hard to control, as their breeding and adult resting sites are not normally accessible to conventional control efforts. In addition, the Asian tiger mosquito is capable of transmitting certain mosquito-borne diseases.

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

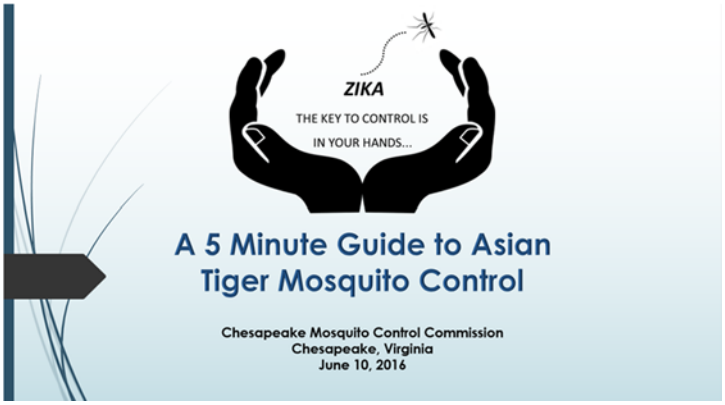
Figure 4. Examples of Asian tiger mosquito egg-laying sites.

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 5 (pg. 8) 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 an auto-notification service of night-time sprays
6. Press releases (in conjunction with the Chesapeake Health Department)
7. Appearances in various local media

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 dump all water from containers diligently every week. Citizens should also note that our ultra-low volume (ULV) backyard spray treatments only eliminate adult mosquitoes that it contacts. ***This pesticide has none of the residual effect of the formulations applied by many private pest control companies.***

Figure 5. Live and online forms of public education.



B. Source Reduction

As another type of source reduction, the commission performs drainage maintenance of mosquito control ditches in the late fall, winter and early spring seasons (figure 6, pg. 8). 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 6. 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 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 7, pg. 9-10). 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 7. Some larviciding techniques.

D. Adulticiding

If 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 8, pg. 11), 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 8. 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 and WNV. The biology laboratory carries out this program, employing several different types of mosquito traps (figure 9, pg. 12). 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 10, pg. 13).

Figure 9. 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 10. 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 11, pg. 13) 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 11. Collecting a small blood sample to detect 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 12, pg. 14). This information is used to predict problems with certain species and direct control efforts. It is also essential in planning pesticide applications.

Figure 12. 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 13 & 14, pg. 15).

Figure 13. Map of pesticide application.

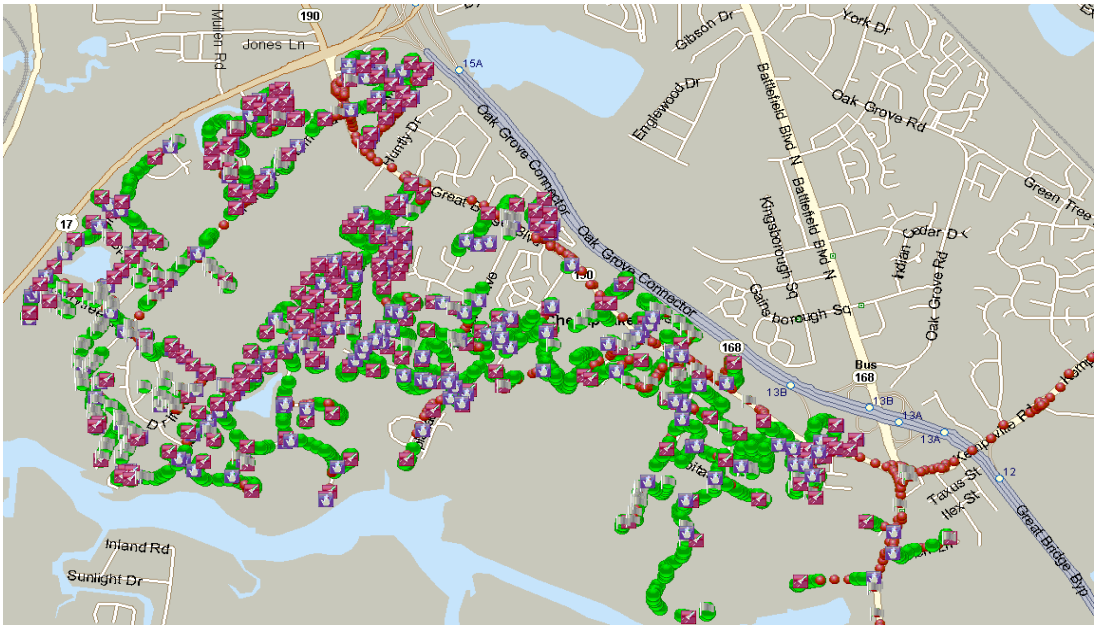
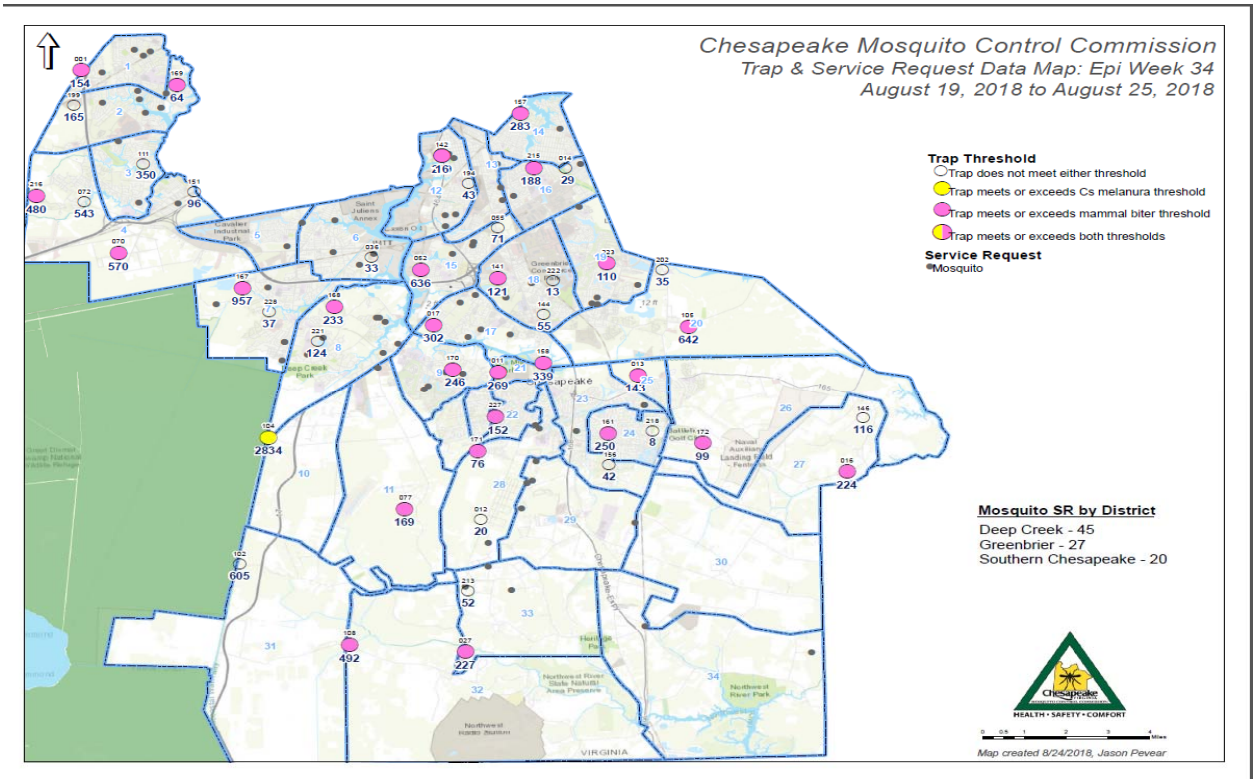


Figure 14. Representative map of mosquito trap counts and citizen service requests.



SECTION 2.

CHESAPEAKE MOSQUITO CONTRTOL COMMISSION

OVERVIEW of 2018

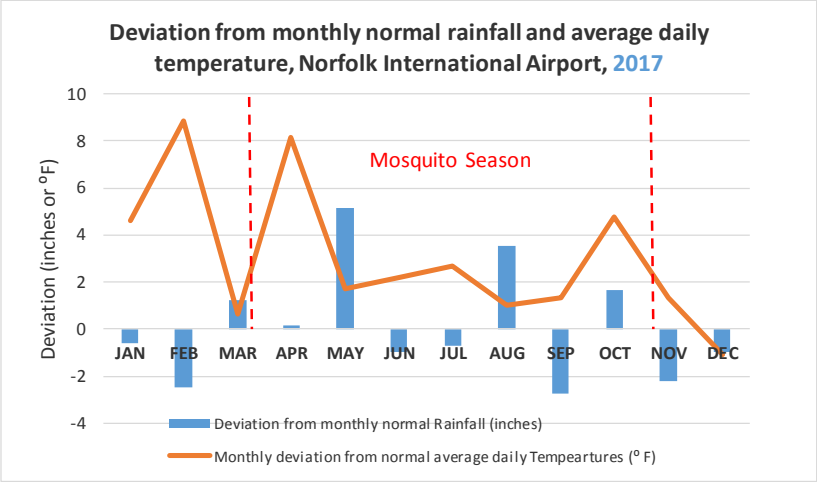
I. ANALYSIS OF THE MOSQUITO SEASON

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 2017 and 2018. Both years favored mosquito development during the mosquito season, but deviations from normal conditions were more pronounced during 2018. Heavy rainfall in the period of May through August contributed to proliferation of both nuisance mosquitoes and West Nile virus vectors.

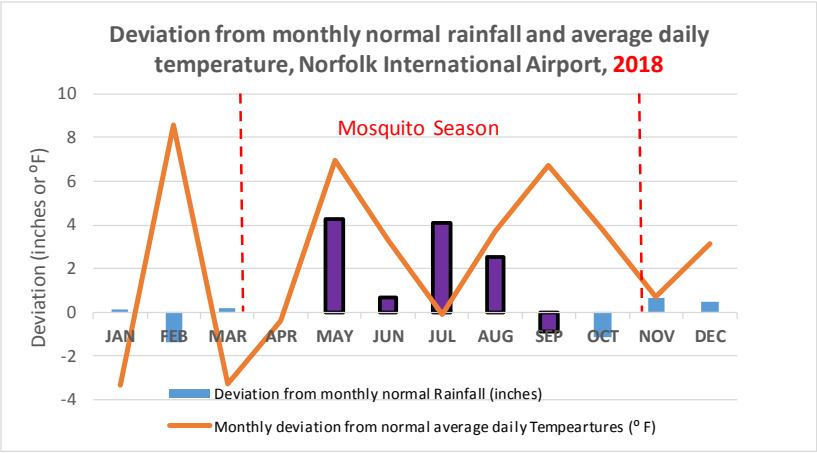
Figure 1. Deviation from normal weather conditions, Norfolk International Airport, 2017 & 2018.



Average deviation from normal during Mosquito Season

2017 Rainfall = .86 inches

2017 Ave. Daily Temp = 3.12 °



Average deviation from normal during Mosquito Season

2018 Rainfall = 1.36 inches

2018 Ave. Daily Temp = 3.42 °

2018 Ave. Daily Temp from May - Sep 4.1 ° F

Most Critical months of the 2018 Season		% of Total weeks May - Sep
Total weeks from **May through September** =	22	
# of weeks with no rainfall =	2	9%
# of weeks with recordable rainfall =	20	91%
# of weeks with >1" rainfall =	13	59%

Although the total number of mosquitoes (species of interest) trapped was 49% lower this season than last, this was largely due to the record numbers of *Cs. melanura* trapped in 2017. Although this species is the primary vector of EEE, it rarely bites mammals, and its activity does not result in service requests from citizens. Many of the nuisance species were more prevalent in 2018 than 2017. This, plus the fact that the primary WNV vector was more numerous, created a more severe mosquito season. Taking *Cs. melanura* out of the totals of both seasons results in an overall increase (19%) in mosquito populations in 2018 (see figure 2, p. 2).

Figure 2. Comparison of catches of species of interest, 2017 vs 2018.

2017 / 2018 Catch Comparisons - Species of Interest	2017 Total Catch	*Per Trap Night*	2018 Total Catch	*Per Trap Night*	*% Increase / Decrease per Trap Night*	Reason for concern when higher (red)
Ae albopictus	5,882	29	8,107	40	41%	Nuisance / WNV bridge vector
Ae vexans	4,920	6	2,322	3	-53%	
An crucians/bradleyi	24,452	*31*	15,557	*20*	-36%	
An punctipennis	2,194	*3*	1,634	*2*	-25%	
An quadrimaculatus	1,694	*2*	4,914	*6*	192%	Nuisance at night
Cq pertubans	6,990	9	15,112	19	117%	Nuisance / EEE bridge vector
Cs melanura	259,198	333	69,105	89	-73%	
Cx erraticus	4,397	*6*	8,910	*11*	104%	EEE bridge vector
Cx pipiens	7,038	*53*	19,914	*70*	33%	WNV Primary & bridge vector
Cx restuans	254	*2*	206	*1*	-62%	
Cx salinarius	13,682	*18*	20,360	*26*	50%	Nuisance / bridge vector
Cx territans	232	0	114	0	-51%	
Oc atlanticus	4,664	6	7,262	9	57%	Extreme nuisance
Oc canadensis	6,526	8	3,889	5	-40%	
Oc infirmatus	1,627	2	1,826	2	13%	
Oc solicitans	39	*0*	15	*0*	-61%	
Oc taeniorhynchus	23	0	16	0	-30%	
Oc triseriatus	111	*0*	125	*0*	13%	
Or signifera	39	*0*	51	*0*	31%	
Ps ciliata	187	0	157	0	-16%	
Ps columbiae	12,503	16	13,771	18	11%	Extreme nuisance
Ps ferox	8769	*11*	16901	22	94%	Extreme nuisance
Ps howardii	126	*0*	101	*0*	-19%	
Ur sapphirina	323	*0*	1,257	*2*	291%	
Total Males	3,722	3	4,603	4	*10%*	
Total Females	**365,870**	***327***	**211,626**	***168***	***-49%***	
Total Females *minus Cs. melanura*	**106,672**	**95**	**142,521**	**113**	***19%***	

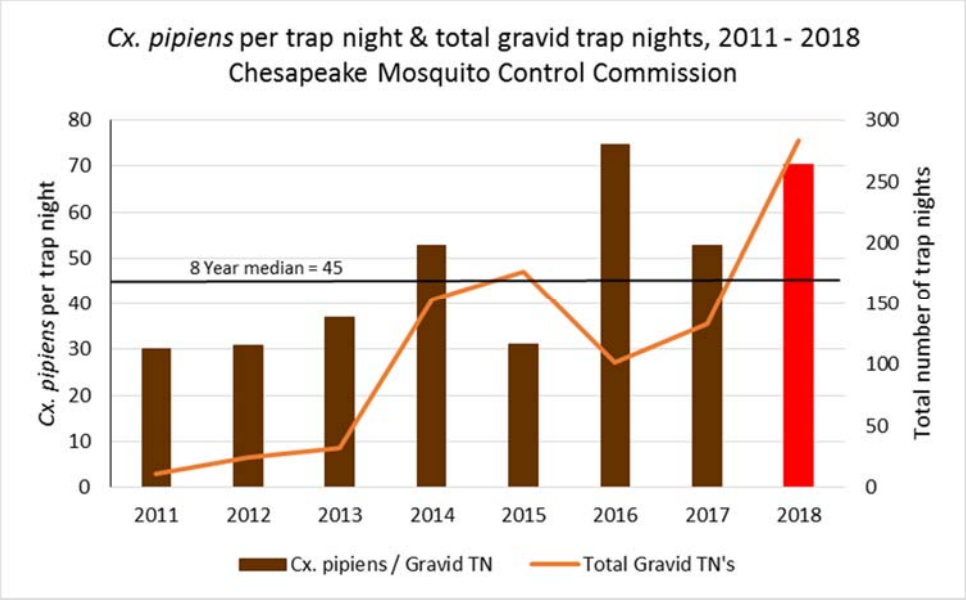
Number of Trap Nights	***2017***		***2018***
CDC trap nights	779		775
BG Sentinel trap nights	206		201
Gravid trap nights	133		283
Total Trap Nights	**1,118**		**1,259**

B. Specific observations

1. West Nile virus (WNV) mosquitoes

Cx. pipiens, both the primary and bridge vector of West Nile virus, were more plentiful this season, indicated by higher gravid trap numbers beginning earlier in the summer than normal. Figure 3 (p. 3) illustrates the number of *Cx. pipiens* per gravid trap night caught from 2011 to 2018. Although the number per trap night was slightly higher in 2016, this may be the result of fewer traps, placed only at the most productive sites. The number of traps set in 2018 was 2.77 times higher than 2016. Though the females per trap night was lower, actual populations may have been higher in 2018.

Figure 3. *Cx. pipiens* (WNV mosquitoes) per trap night and total number of trap nights, 2011-2018



2. Nuisance mosquito species

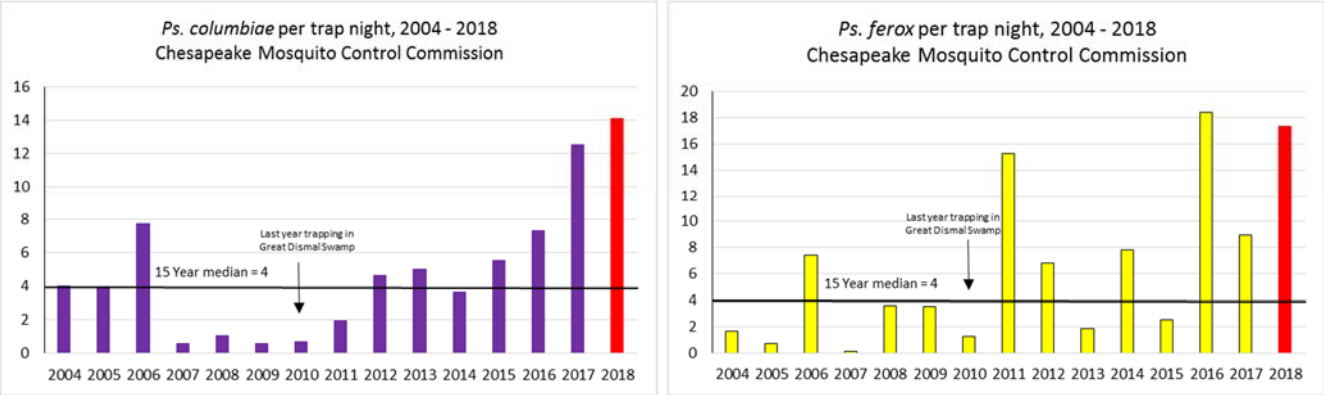
As figure 2 (p. 2) illustrates, at least seven species of nuisance mosquitoes were more numerous in 2018 than in 2017. Most of these species take advantage of either containers with rainwater, or floodwaters resulting from rainfall, to breed. It is not surprising that they flourished in 2018, as rainfall from May through September was plentiful. As noted in figure 1 (p. 1), there was measurable rainfall during 91% of the weeks during this critical period. Moreover, 59% of the weeks in this period experienced over 1 inch of rainfall and only 9% had no rain at all.

a) *Psorophora* species

These mosquitoes are short-lived and do not transmit disease, but emerge after heavy rains and are a source of extreme nuisance due to their very large populations and aggressive nature. *Ps. columbiae* develops in temporary pools in open areas, such as farm fields. Figure 4 (p. 4) illustrates catches of this species for the past 15 years. High populations in 2017 left more eggs

to overwinter, then hatch and develop in 2018, a problem exacerbated by weather conditions discussed previously.

Figure 4. *Psorophora* mosquitoes per trap night, 2004 – 2018.

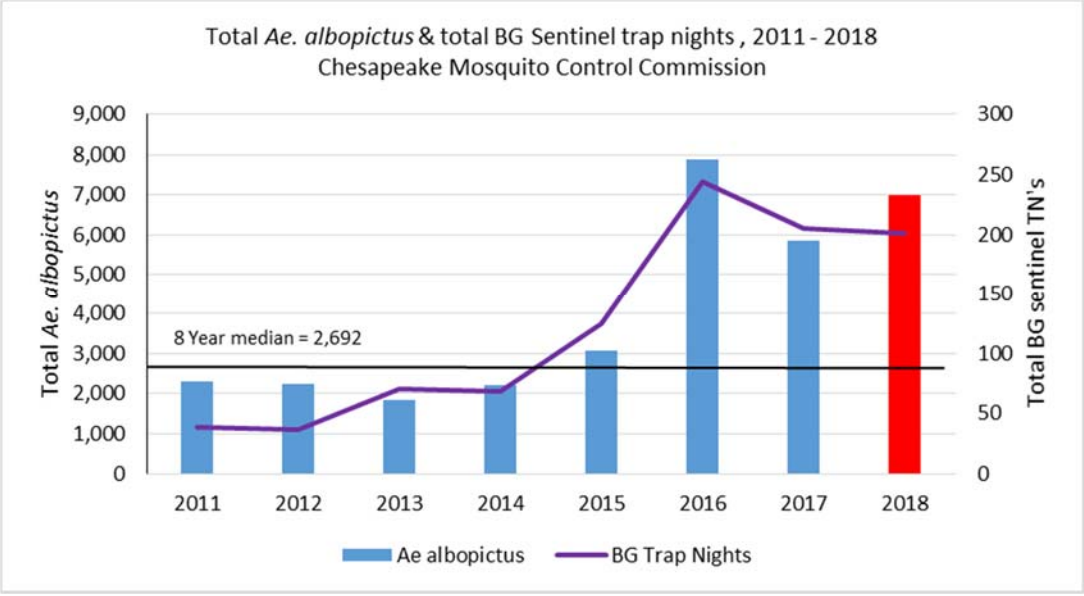


Ps. ferox (figure 4, p. 4) is limited to woodland habitats and is often associated with *Oc. atlanticus*, which shares its breeding sites.

b) *Aedes albopictus* (Asian tiger mosquitoes)

Catches of *Ae. albopictus* (Asian tiger mosquitoes) were moderate this season, but were larger than 2017 catches (figure 2, pg. 2). It must be noted that surveillance for this species has been heightened in the past 3 years, with more BG traps deployed to specifically attract *Ae. albopictus*. For this reason, it is more appropriate to look at total catches and total number of trap nights (figure 5, p. 4) rather than catches per trap night.

Figure 5. Total *Ae. albopictus* and total number of BG trap nights, 2011 – 2018.

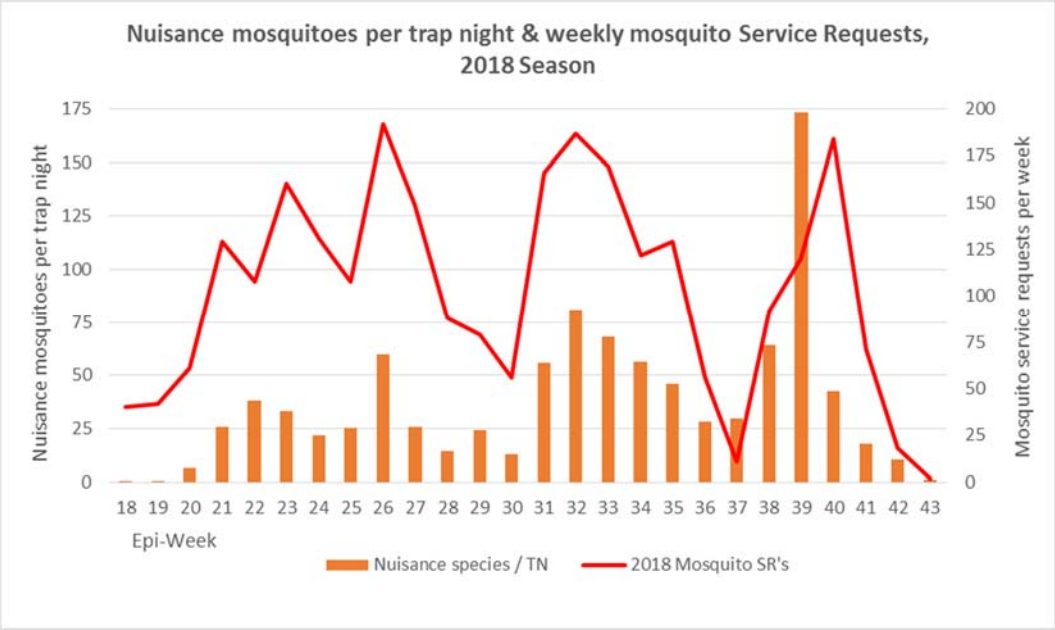


One factor that benefits rapid *Ae. albopictus* development is warm temperatures, of which Chesapeake had plenty in 2018. Deviation from normal average daily temperatures averaged 4.1°F during the critical months of May through September (figure 1, p. 1).

c) Citizen reaction to nuisance species

Our response to mosquito problems varies depending on the species. However, service requests always increase with the rise of certain mosquitoes, especially the nuisance group discussed above. Note the correlation between the catches of these species and mosquito service requests illustrated in figure 6 (p. 5). Psorophora mosquito larvae develop very quickly, making their flooded breeding sites difficult to locate and larvicide prior to their emergence.

Figure 6. Weekly nuisance mosquito abundance vs. citizen service requests, 2018.

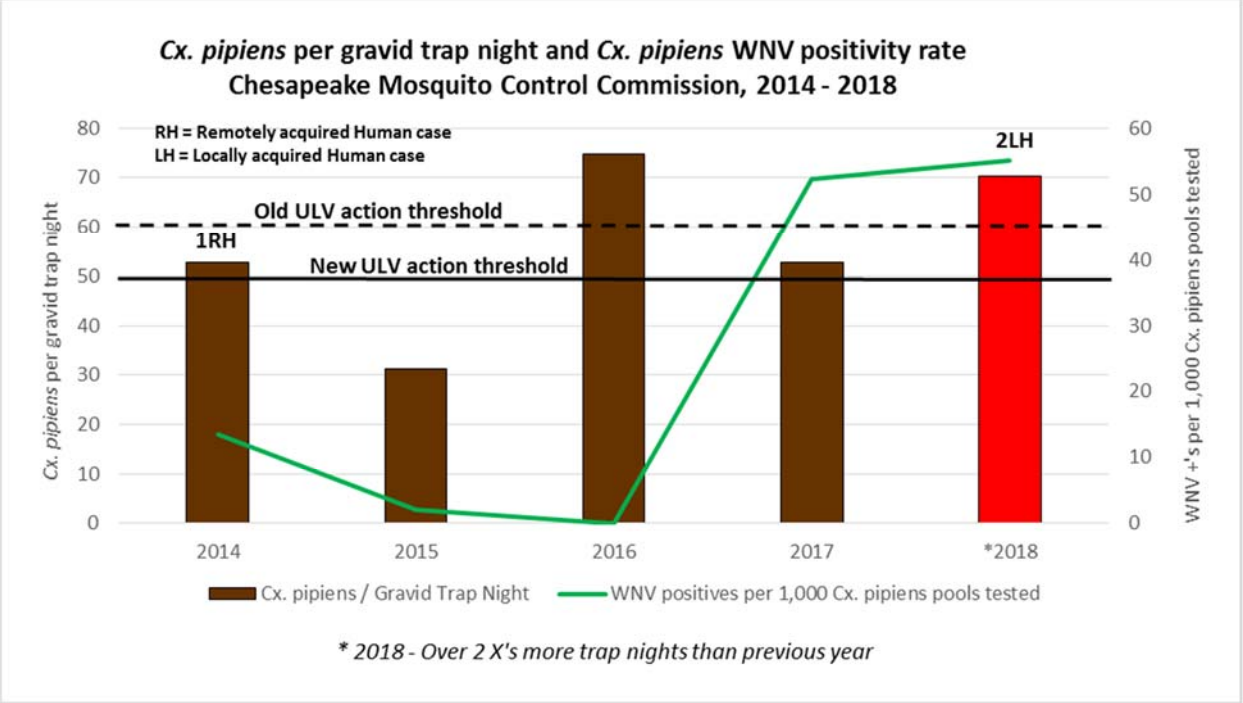


C. Arboviral (mosquito-borne) disease activity

1. *West Nile Virus (WNV)*

WNV activity reached historic highs in Virginia and all along the eastern seaboard during 2018. Figure 7 (p. 6) illustrates catches of the primary vector (*Cx. pipiens*) in Chesapeake from 2014 to 2018, and the WNV positivity rate of those mosquitoes tested. Although gravid trapping did not become routine in Chesapeake until 2014, it is clear that 2018 was a very active year for WNV. A high WNV positivity rate combined with greater than normal populations of the primary vector created optimal conditions for human infection. In fact, two Chesapeake residents with no recent travel history contracted the disease somewhere in the Hampton Roads area. Historic data analysis suggests that we may be more effective combating this disease if we lower our ULV action threshold for *Cx. pipiens* (see figure 7, p. 6).

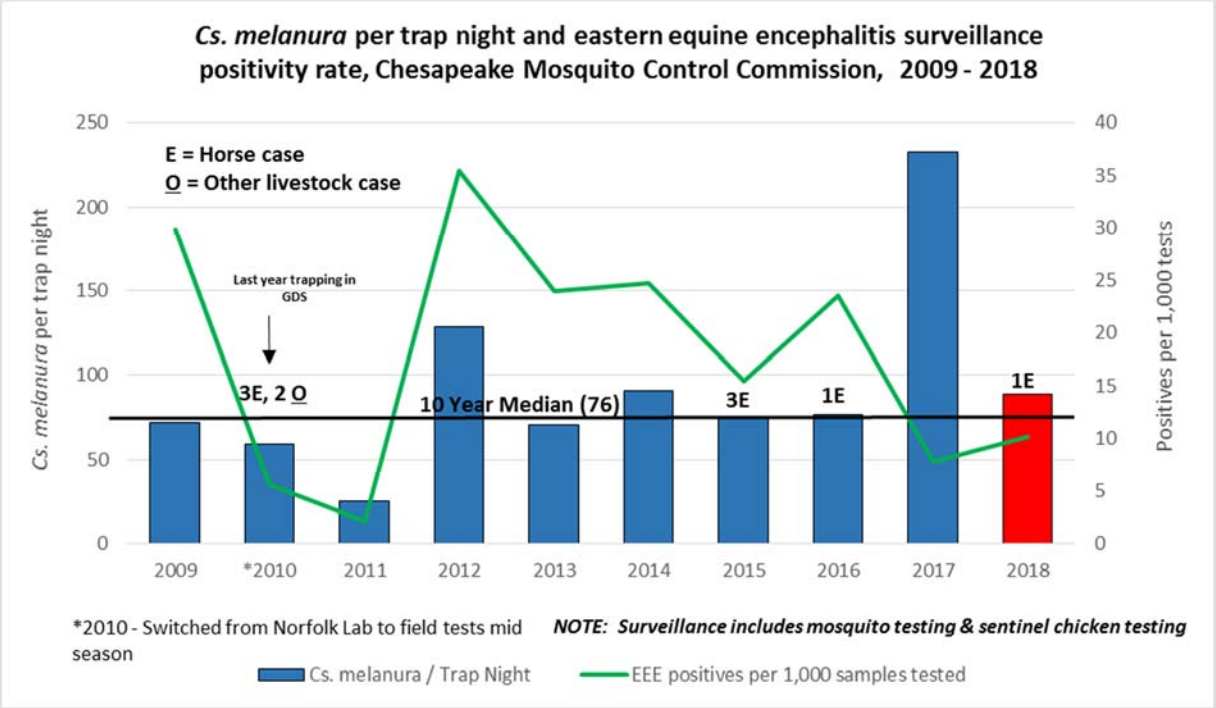
Figure 7. *Cx pipiens* gravid trap catches and WNV positivity rates.



2. *Eastern equine encephalitis (EEE)* – Figure 8 (p. 7) illustrates the relationship between catches of the primary vector (*Cs. melanura*) and the EEE positivity rates of samples tested over the past 10 years. 2018 was not a year of high *Cs. melanura* catches or EEE activity and risk of infection in mammals was minimal (1 case in an unvaccinated horse). Although larger catches per season tended to also have higher positivity rates, this has not been the case over the past two years. It is remains important to test both sentinel chickens and *Cs. melanura*

mosquito pools for EEE, rather than relying solely on mosquito numbers to determine risk of infection.

Figure 8. *Cs. melanura* trap catches and EEE positivity rates, 2009 – 2018



II. OPERATIONS

Accomplishments, work reports & service requests

A. Biology Laboratory

1. Surveillance

Figure 1 (p. 8) contains details of the Biology Laboratory work report, 2017 vs 2018. We held the Biology Technician position open throughout the year in anticipation of reassessment of labor needs and a possible reclassification. We converted a field technician position to a FT Biologist I position, which was filled late in December of 2017. The resulting employee compliment for the 2018 mosquito season was 1 FT Biologist II, 1 FT Biologist I, and 3 part-time seasonal student interns.

Figure 1. Biology Laboratory work report, 2017 & 2018.

Biology Lab	2017	2018	% Increase / Decrease
Total FTE's	**3.20**	**3.50**	**9%**
Total Mosquito Traps Set	1,113	1,259	13%
Total Female Mosquitoes	365,311	211,669	-42%
Total mosquito pools tested	1,098	1,146	4%
Total Chicken Samples	320	420	31%
*Total Larval surveys	140	102	-27%
Total pesticide resistance tests	0	26	
Special projects			
Human WNV response	0	2	
Biting fly trap	0	3	
Education / Outreach (includes Director)			
School sessions	24	23	
Outreach Activities	8	*7*	
**Training		*9*	
Total Education / Outreach	**32**	**39**	**22%**

** More aerial treatment sites to monitor in 2017*

***included in outreach in 2017*

2. Pesticide resistance testing

i. Importance

Mosquito populations will become resistant to a particular pesticide (or class of pesticides) if exposed too often for too many years. It is very important to rotate pesticides periodically to interrupt this process and avoid resistance problems. It is also important to test different species of concern for pesticide resistance on a routine basis, to assure that the pesticides used are working properly and to guide future pesticide purchases.

ii. Bottle bioassays

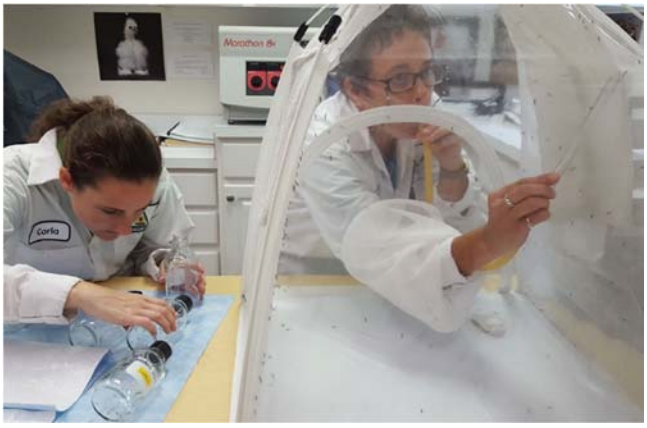
One of the best testing processes is a bottle bioassay, whereby adult mosquitoes are exposed to extremely small amounts of technical grade pesticide to see how long they survive. The process is complex, involving collection of mosquito eggs, rearing mosquitoes to adults and keeping them alive and healthy, accurately measuring and mixing pesticides, exposing several groups of mosquitoes to the pesticides, timing the survival period, and analyzing the results.

The continued spread of Zika virus into the Americas in 2017 prompted the Centers for Disease Prevention & Control to promote a standard bottle bioassay process to assess pesticide resistance of local mosquito populations. Our biologists attended CDC-sponsored training and acquired all the materials and stock pesticides we need to test the mosquitoes in our City.

iii. *Culex pipiens* & *Aedes albopictus* – Chesapeake MCC Biology Lab

Figure 2 (p. 9) shows our biologists collecting *Culex* egg rafts, and aspirating mosquitoes and checking the treated bottles for mosquito mortality. *Cx. pipiens* and *Ae. albopictus* larvae were hatched in trays, and the adults kept in bio-domes to provide healthy specimens for testing. These species are of greatest concern and are also the easiest to collect and rear. Eggs were collected from different sites to compare susceptibility of populations from different areas of the city.

Figure 2. Egg raft collection and pesticide resistance testing in the CMCC Biology Laboratory



Some of the results of the bottle bioassays are listed in figure 3 (p. 10). Susceptibility of different populations of mosquitoes varies by site location and species, and ranges from susceptible to resistant. Resistance tests must be continued for a number of years to clarify trends. The biology lab will perform many more tests in the years to come with both wild-caught and laboratory raised mosquitoes to assure that we are using the most effective products against our local populations.

Figure 3. A portion of the results of CMCC's bottle bioassay pesticide resistance tests.

Site	Urban/Suburban/ Rural/Industrial	Household Income	Home Density	Species Tested	Pesticide Active Ingredient	Results
1	Urban	Lower	Higher	*Cx. pipiens*	Etofenprox	Possibility of resistance
					Pyretrhum	Resistant
2	Suburban	Higher	Lower	*Cx. pipiens*	Etofenprox	Resistant
					Permethrin	Possibility of resistance
3	Rural / Industrial			*Cx. pipiens*	Etofenprox	Possibility of resistance
					Permethrin	Possibility of resistance
4	Urban	Lower	Higher	*Ae. albopictus*	Permethrin	Susceptible
					Etofenprox	Susceptible
5	Suburban	Higher	Lower	*Ae. albopictus*	Permethrin	Susceptible
					Etofenprox	Resistant
6	Suburban	Higher	Lower	*Ae. albopictus*	Permethrin	Resistant
					Etofenprox	Susceptible

Pesticide most-often applied for control efforts

iv. *Ae. albopictus* testing – Virginia Tech results

Gravid egg papers collected by the biology lab were submitted to Virginia Tech in a cooperative effort with other Virginia mosquito control districts. The Entomology Department at Virginia Tech hatched many of the eggs, reared the *Ae. albopictus* larvae, and performed bottle bioassays on pesticides chosen by the state entomologist. Our eggs were collected from different locations but, unfortunately, the Virginia Tech lab combined mosquitoes from different sites. We are not able to pinpoint some of the areas where resistance may be developing, but we do know that the mosquitoes in Group 1 (figure 4, p. 10) were collected from three sites in the Greenbrier section of the city.

Figure 4. A portion of the results of Virginia Tech's bottle bioassay pesticide resistance tests.

Site	Species Tested	Pesticide Active Ingredient	Results
Group 1	*Ae. albopictus*	Permethrin	Resistant
(3 collection sites, Greenbrier)		Etofenprox	Susceptible
		Deltamethrin	Resistant
Group 2	*Ae. albopictus*	Permethrin	Possibility of resistance
(6 collection sites, scattered)		Etofenprox	Susceptible
		Deltamethrin	Susceptible

Pesticide most-often applied for control efforts

B. Control Operations

1. Drainage maintenance

Figure 5 (pg. 11) illustrates control work accomplished during calendar years 2017 and 2018 and the percent increase or decrease per category. Note the decrease in drainage maintenance production and hours in 2018. This is partially due to the unusually high number of hours lost to inclement weather during the months when we performed drainage maintenance in 2018. During this period, we logged 17 % more hours to inclement weather in 2018 than 2017.

Figure. 5. Control operations work report comparison, calendar years 2017 - 2018.

Control Operations Work Report Comparison	2017	2018	% Increase / Decrease
Field Personnel - Total FTE's	**22.02**	**21.52**	**-2%**
Drainage Maintenance			
Bush - Mach (acres)	35	25	-29%
Cleaning (miles)	34	24	-29%
Refuse Removed (tons)	56	32	-43%
Total Drainage Maintenance Hrs.	**8,906**	**6,395**	**-28%**
Time lost to Inclement weather (Jan-Mar & Nov - Dec)	2,990	3,497	17%
Pesticide Application			
**Ground Larvicidng (week-acres)*	12,455	12,712	**2%**
# of Backyard ULV Treatments (Asian tiger problems)	1,702	2,214	30%
Ground ULV (acres truck-mounted + UTV+ backyard)	335,126	674,221	101%
Total Ground Pesticide Application Hrs.	**21,447**	**21,210**	**-1%**
**Aerial Larviciding (week-acres)*	7,824	1,076	**-86%**

Service Requests (dependent on environmental conditions)			
Mosquitoes	2,390	2,601	9%
Drainage	103	77	-25%
Property Release	21	64	205%
Special Event Treatment	357	135	-62%
Other	146	115	-21%
TOTAL	**3,017**	**2,992**	**-1%**

**Week-acres = number of Weeks of larval control X Acres treated*

2. Ground larviciding

Ground larviciding encompasses application of 150-day and 30-day sustained release pesticides, application of various types of granules via hand or through blowers through special projects, and application of liquid larvicides to road-side ditches from our jeeps.

Frequent rains and rapid development of the Psorophora species discussed on pp. 3-4 made it very difficult to reach larval sites before mosquito emergence. Although week-acres treated increased 2% in 2018, much of this was due to expansion of the early season 150-day blocking program. We were short two field techs for most of the mosquito season and it was impossible to keep up with all the standing water.

3. Ground adulticiding (spraying)

It is for this reason that we placed a heavy emphasis on adulticiding in 2018, including truck-mounted (figure 6, p. 12) and UTV-mounted ULV applications. Note the 101% increase in acres treated in this category (figure 5, p. 11).

Figure 6. A supervisor measuring water-based pesticide into a truck-mounted ULV machine.

4. Chesapeake Alert

We implemented a new service for the citizens of Chesapeake in 2018. Chesapeake Alert is an automatic notification system that will send an e-mail, text or voice message to any resident who wants to know when we plan truck-mounted ULV applications in their neighborhood. The system is accessible by registering on the City of Chesapeake website (http://www.cityofchesapeake.net/page2108.aspx) and choosing mosquito spraying.

5. Backyard inspections and treatments

Backyard inspections and handheld ULV treatments are the most effective means of control for *Ae. albopictus* (figure 7, pg. 13), but take considerable time and labor. The higher than normal populations of *Ae. albopictus* (noted on p. 4 of the Analysis of the Mosquito Season) were partially responsible for the 9% increase in mosquito service requests this season and entirely responsible for the 30% increase in backyard ULV treatments noted in figure 5, p. 11.

Figure 7. Backyard inspections and handheld ULV application.

Goals & Challenges for 2019

A. Arboviral diseases

West Nile virus activity during the 2018 season was the highest in Virginia since 2002 when recording began***. There were 48 human cases in the Commonwealth in 2018 (the 16-year average is 13 cases per year).*** For the first time, two Chesapeake residents acquired the disease locally (somewhere in the Hampton Roads area). In response to these cases, we worked with the Health Department to minimize the risk to other local residents. Our surveillance, larviciding and adulticiding efforts were all focused on the primary vector species, and intensified in areas around the patients' residences.

We will stock specialized larvicides and adulticides next season to aid in any future spikes of WNV activity. Although WNV is now endemic in our region, the regular cyclical pattern of activity exhibited by many endemic diseases does not yet seem to be established. If winter conditions are mild, many more gravid female mosquitoes will survive and may increase the risk of another bad season in 2019.

B. Floodwater nuisance species

Although they are not a disease threat, many of the floodwater mosquito species common in our city are a significant nuisance to our citizens after heavy rainfall and hot conditions. Huge broods of mosquitoes are the result of our inability to reach and treat the breeding sites of these species. This problem may be exacerbated in the future by increasing encroachment of development into the rural areas of our city.

We will be exploring the use of our Buffalo turbine to reach some of the flooded breeding sites with larvicides. We will also research the feasibility of using a drone to locate and treat some of these sites.

C. Pesticide resistance studies

We will continue bottle bioassays to assess the susceptibility of our local populations to mosquito adulticides. There are only two broad classes of adulticides still available, and we must rotate products periodically to assure that those we use are still effective. The bottle bioassays, in addition to larvicide studies, will determine our future pesticide purchases and overall approach to mosquito control.

Financial Overview

(NOTE: The financial overview covers fiscal year 2017-2018, while the rest of this report covers calendar year 2018 to encompass one mosquito season.)

CITY OF CHESAPEAKE, VIRGINIA
2018 COMPREHENSIVE ANNUAL FINANCIAL REPORT *Schedule T-2*
Statement of Revenues, Expenditures, and Changes in Fund Balance
Chesapeake Mosquito Control Commission
Year Ended June 30, 2018

REVENUES	
Property taxes*	$ 4,420,306
Investment income	33,317
Other	206,191
Total revenues	4,659,814
EXPENDITURES	
Other salaries and wages	1,696,531
Other fringe benefits	756,776
Other repairs and supplies	844,358
Insurance premiums	236,611
Capital outlay	65,812
Other	353,521
Total expenditures	3,953,609
Excess of revenues over expenditures	706,205
Net change in fund balance	**706,205**
Fund balance – beginning	**$ 3,804,134**
Fund balance – ending	**$ 4,510,339**

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	$ 706,205
Pension expense	280,106
OPEB expense	54,568
Depreciation expense	(140,522)
Capital outlay expenditures	65,812
Change in Net Position	$ 966,169

**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.*