Chesapeake Mosquito Control Commission Information Handbook

General History, Mosquito and Mosquito-borne Disease Management Strategies

(Revised February 20, 2020)

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TO: Citizens of the City of Chesapeake, VA

FROM: Dreda A. Symonds, Director

SUBJECT: Chesapeake Mosquito Control Commission Information Handbook

The following handbook is a guide to the history of the Chesapeake Mosquito Control Commission and as an outline of the basic methods of mosquito and mosquito-borne disease control employed by the Commission. Mosquito biology remains relatively unchanged, but deviations in species abundance, mosquito-borne disease activity and susceptibility to different pesticides do occur. Control strategies are modified as needed in response to new developments in control techniques, and changes in environmental and economic conditions, which influence any particular season.

We suggest that the public study this handbook before reading our annual report. It will provide the basic background necessary to understand and evaluate the seasonal mosquito abundance, mosquito-borne disease activity, and our operational response. We welcome public inquiries and input, and always strive to provide the most effective, economical and environmentally sound mosquito control to the citizens and visitors of the City of Chesapeake.

Dreda A. Symonds, Director
Chesapeake Mosquito Control Commission

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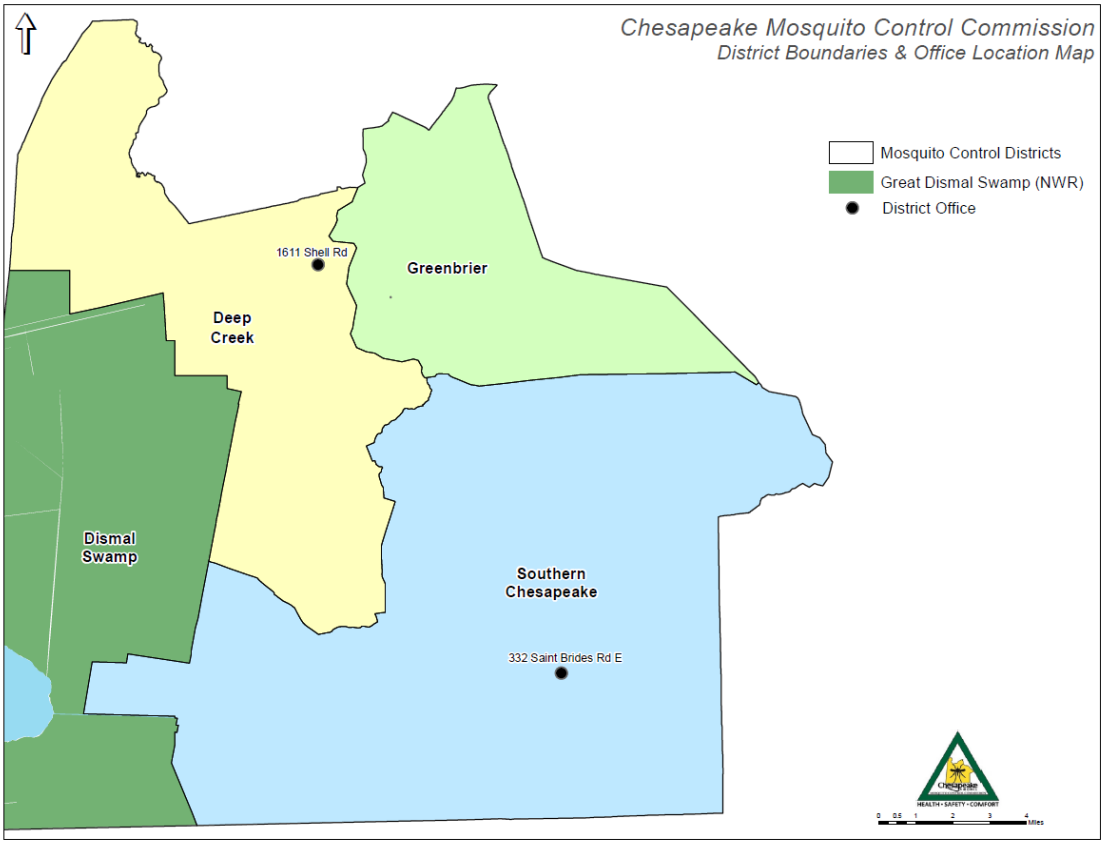
Mission and Organization

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 Board oversees 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, Deep Creek and Greenbrier Districts are located at 1611 Shell Rd. The Southern Chesapeake District is located at 332 St. Brides Road, East.



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 and formed the in ***Western Branch*** 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 – A consolidation team appointed by Chesapeake City Council approved the expansion of service boundaries to include the entire southern region of the City (not previously covered by 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*** with three districts to cover the entire City: Southern Chesapeake, Greenbrier and Deep Creek.

April 2019 – The new facility at 1611 Shell Rd. was completed. This facility includes improved garage facilities, improved pesticide storage and more secure equipment storage. It places Administration, Greenbrier district headquarters, Deep Creek district headquarters and the Biology laboratory at the same address, increasing efficiency and saving money.

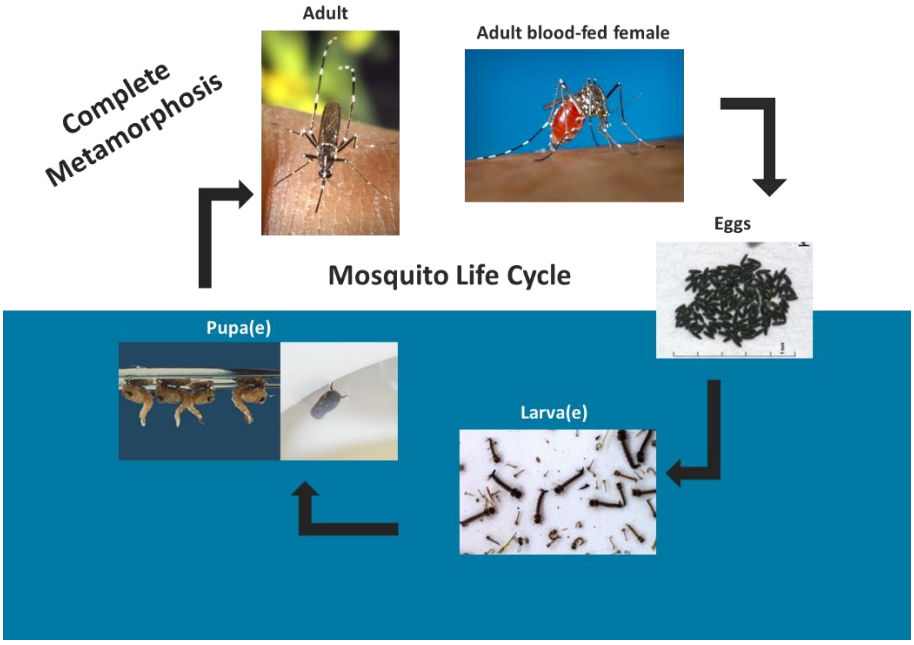
Mosquito Biology

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 mosquito's 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…" [1]. Certain species of mosquitoes can pick up and transmit some very devastating diseases, which 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 (p. 5) lists some common mosquito species in Chesapeake and the diseases they can transmit to humans and domestic animals.

[1] ***Executive Summary- The World Health Report 1996 (p. 5).***

Figure 2. Some common mosquito species in southeast Virginia and the diseases they can transmit. [2]

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. Additionally, huge mosquito broods can make storm clean-up and recovery efforts very difficult or impossible.

[2] ***Burkett-Cadena, N. (2013) University of Alabama Press***

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 and 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. 7). This invasive species lives in close association with humans, lays eggs in small containers which 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*).

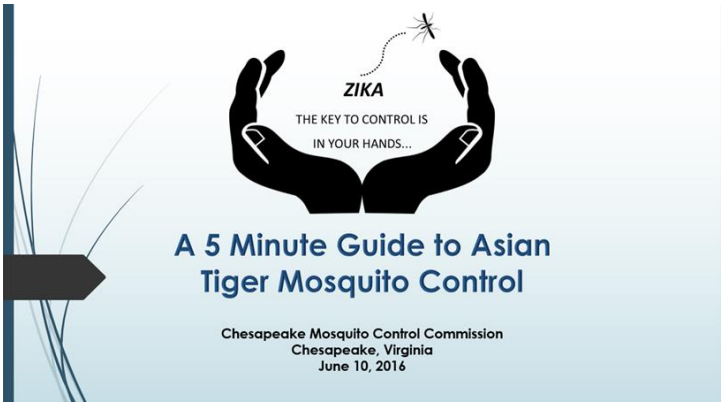
Figure 4. Examples of Asian tiger mosquito egg-laying sites.

Educating the public on the role their own property plays in the development of these mosquitoes and 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 citizens***. The best way to avoid excessive populations of this species is to diligently dump all water from containers every week. Citizens should also note that our ultra-low volume (ULV) backyard spray treatments only eliminate adult mosquitoes which they contact. ***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. 9). 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. 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 insect's 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. 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. 14) 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. 15). 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.

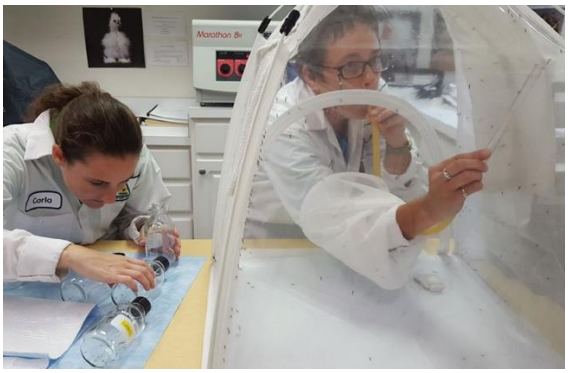
F. Pesticide efficacy testing

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.

Figure 13. Collecting mosquito eggs and rearing mosquitoes for pesticide tests.

Another important function of the biology laboratory is to perform these pesticide efficacy tests. Many of the tests involve raising colonies from mosquito eggs collected in the field and raised at our facility (Figure 13, p. 15). The immature or adult mosquitoes are exposed to label specified concentrations of the pesticides and mortality is measured over time to indicate the effectiveness of the pesticide against our local mosquito populations. Figure 14 (p. 16) illustrates a bottle bioassay test for adult mosquitoes and a test of sustained-release larvicides for immature mosquitoes.

Figure 14. Two types of pesticide efficacy tests.



G. 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. 16-17).

Figure 13. Map of pesticide application.

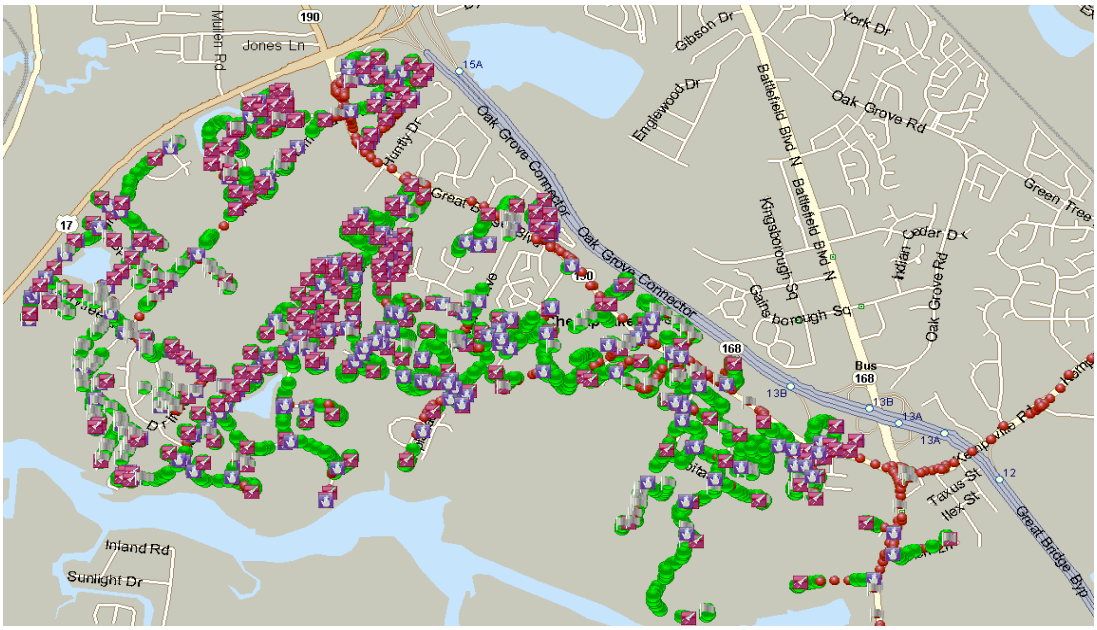
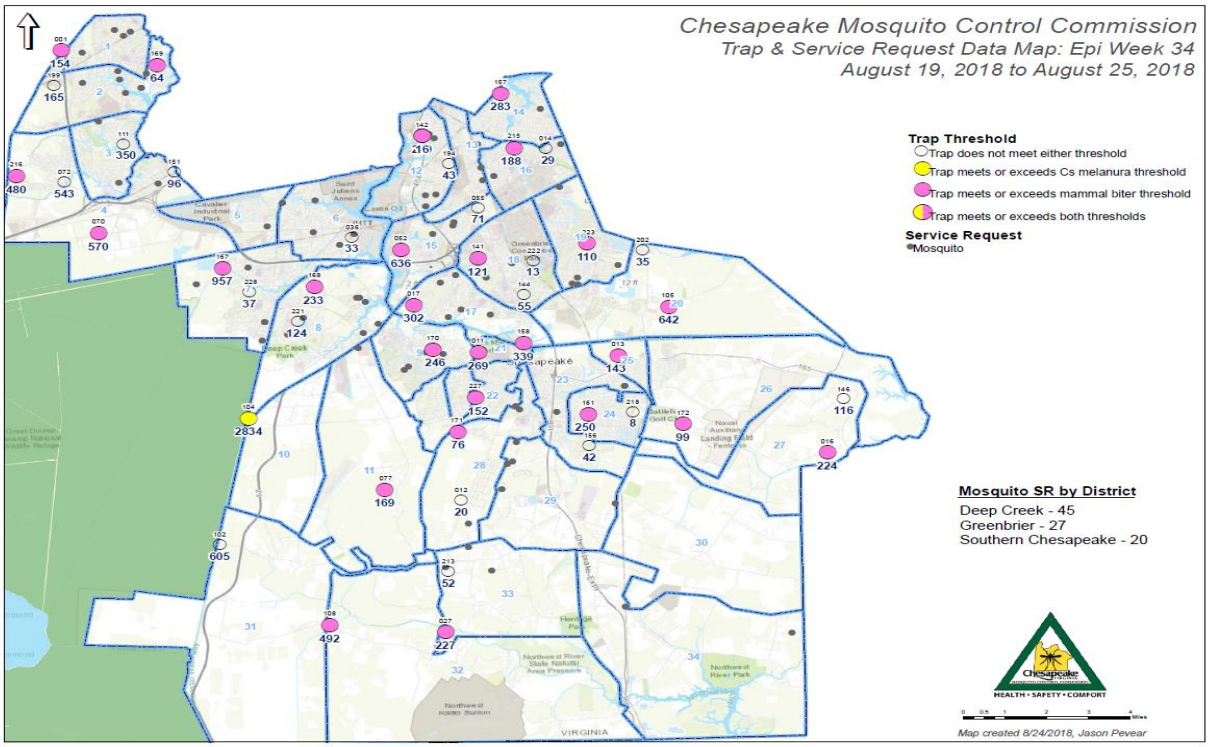



Figure 14. Representative map of mosquito trap counts and citizen service requests.