MOSQUITO SURVEILLANCE 2023

GEORGIA DEPARTMENT OF PUBLIC HEALTH, ENVIRONMENTAL HEALTH

Mosquito Surveillance 2023

Limited mosquito surveillance programs occur in many Georgia counties (http://www.gamosquito.org/resources/GA_Mosquito_Control_Programs2017.pdf), but most counties with mosquito control programs conduct control activities without appropriate mosquito surveillance.   Data obtained from mosquito surveillance activities are important to guide vector control operations by identifying vector species, providing an estimate of vector species abundance, and by indicating geographic areas where humans and animals are at greatest risk of exposure to WNV or other arboviruses.

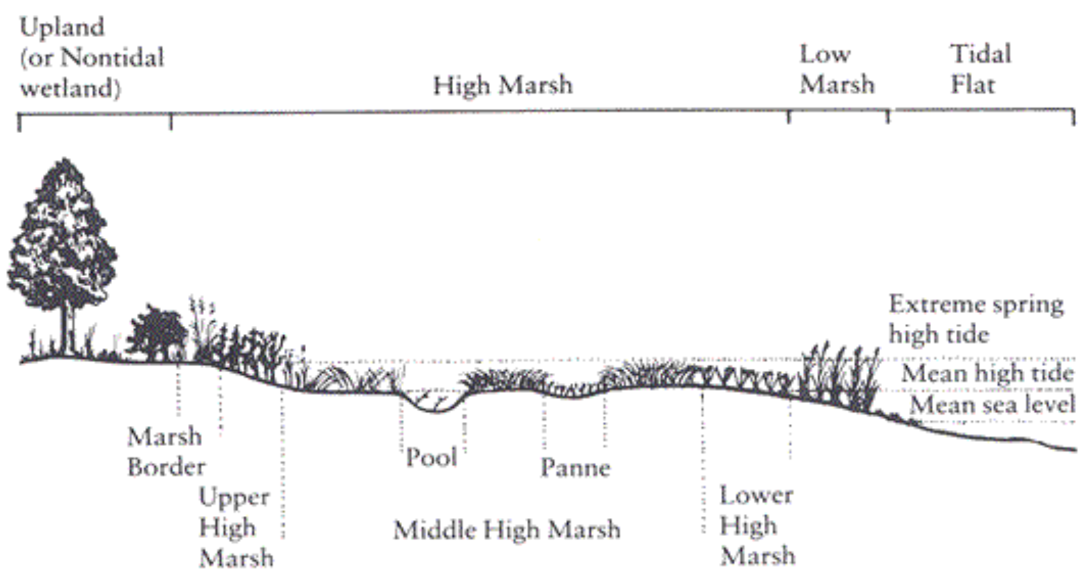
Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700 000 deaths annually. Vector-borne diseases can be caused by either parasites, bacteria, or viruses.

Malaria is a parasitic infection transmitted by Anopheline mosquitoes. It causes an estimated 219 million cases globally, and it results in more than 400,000 deaths every year. Most of the deaths occur in children under the age of 5 years.

Dengue is the most prevalent viral infection transmitted by *Aedes* mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths occurring every year.

Other viral diseases transmitted by vectors include Chikungunya, Zika, yellow fever, West Nile Virus, and Japanese Encephalitis (transmitted by mosquitoes) and Rocky Mountain spotted fever, Powassan, Lyme, Anaplasmosis, Ehrlichiosis, Powassan virus, babesiosis, and tularemia (transmitted by ticks).

Many of vector-borne diseases are preventable, through protective measures and community mobilization. Although our surveillance team has continued to be diminished by funding cuts, our goals for the 2024 mosquito surveillance season included doing some level of mosquito surveillance in as many counties in Georgia as possible, assisting mosquito control programs with surveillance where possible, and providing local outreach for mosquito complaints. We also planned to continue to do pesticide resistance testing in a few areas of Georgia. The accomplishment of these goals allows the Georgia Department of Public Health to be better prepared for dealing with endemic mosquito-borne disease issues, and for dealing with the next mosquito-borne disease to emerge. The data we collect provides information on changing risks for arboviral disease transmission that Public Health can use to provide educational messages and mosquito control can use to support control decisions. We accomplish these goals with the assistance of our colleagues and collaborators.



FLOODWATER AND PERMANENT WATER MOSQUITO BREEDING SITES

Integrated Mosquito Management

Controlling mosquitoes reduces the nuisance factor and protects public health. The best way to control mosquitoes is by utilizing a wide variety of control methods known as Integrated Mosquito Management (IMM). The first part of IMM is trapping and surveillance, which is used to quantify the number~~s~~, species, and location of mosquitoes.

What does mosquito control do to protect the public's health? In Georgia, there are approximately 60 different mosquito species. Each species of mosquito has a different flight range, host preference, larval habitat, and potential for carrying and transmitting infectious disease. Any mosquito that bites or annoys people can be considered a health problem, but in Georgia the definition includes mosquitoes that carry infectious diseases like WNV, LaCrosse Encephalitis (LAC), and Eastern Equine Encephalitis (EEE), as well as those can transmit new and emerging viruses like CHIK and ZIKV.

What are the techniques of an Integrated Mosquito Management (IMM) program that serve to eliminate the mosquito? If your county has mosquito control, it is usually located in the Public Works Department, but it may be in Public Health/Environmental Health, or it could be a stand-alone agency. The first response to a mosquito complaint is to send an inspector to find the source of the mosquitoes. Source reduction, also known as physical control, is an important part of IMM. This involves finding and eliminating potential mosquito breeding areas and is typically the most effective and economical of the various techniques used to control mosquitoes. Mosquitoes need water for their eggs to hatch and for the larvae to survive until adulthood. In areas around a home these sources may be anything that can retain water, including birdbaths, unscreened swimming pools, and old tires. Breeding areas also include hollow stemmed plants like bromeliads. The inspector should educate the homeowner about keeping these items clean and dry, or rinsing them periodically with fresh water.

If the source is a new pond or other permanent-water area that cannot or should not be drained, the inspector may elect to stock it with small, non-descript mosquito-eating fish called *Gambusia*. Using the mosquito's natural predator to reduce populations is a method of biological control.

Another technique is called larviciding. Larviciding, as the name implies, kills mosquito larvae and pupae using a variety of products, both chemical and biological. This prevents the metamorphosis of the larvae into the flying, biting pests that we know and hate. Larvicide treatments can be applied by ground or air to standing water depending on the size of the area. Different types of larvicides include chemical pesticides that are absorbed or ingested by the larvae, surface control agents that suffocate the pupae, insect growth regulators, and microbial larvicides. Larvicides commonly used in Georgia include microbial larvicides and insect growth regulators (IGRs). The microbial larvicide consists of two species of the Bacillus bacterium (Bti and *B sphaericus*), that are toxic when ingested by mosquito and black fly larvae. Methoprene, an IGR, prevents mosquito larvae from molting to the adult stage.

Once adult mosquitoes are on the wing, the only way to control them is to use an adulticide. Using truck-mounted sprayers or aircraft, a condensed plume of ultralow volume (ULV) insecticide is released into the air, which spreads out with the prevailing wind. When the pesticide droplets contact flying mosquitoes, it kills them. Mosquito control may also use a barrier spray to provide the homeowner some temporary relief. This is also one method of controlling day biting mosquitoes. A barrier spray is a coating of pesticide droplets sprayed onto foliage surrounding an area that has been inundated by mosquitoes. This will kill mosquitoes landing in the foliage, and it repels them. It adheres to the underside of the foliage, depriving them of their resting places. Another technique, thermal fogging, can be used to control day biting mosquitoes or to control mosquitoes in areas where vegetation is so dense that ULV does not penetrate. The amount of chemical used is designed to be target specific, in that it kills mosquitoes without harming anything else. Since most mosquitoes do not fly during the daytime, adulticiding is done at dusk and beyond, and the hours just before dawn, when mosquito activity is at its peak. Additionally, spraying pesticides by ULV machines during the heat of the day is wasteful as the pesticide droplets rise and never interact with the mosquitoes, and so is wasted.

It is impossible to completely eradicate the mosquito, so the focus should be on controlling mosquito populations to reduce the nuisance factor and protect public health by using all aspects of Integrated Mosquito Management. It is important to remind homeowners that they can also play a role in mosquito control, especially where organized mosquito control is not present. Surveillance can be used to determine if the mosquito is *Aedes albopictus*, the Asian tiger mosquito, or some other species. By standing out in the yard during the day and waiting to see if a small black and silver mosquito comes to bite your legs, it is possible to determine if this species is present. This is the most common nuisance species in Georgia, and~~,~~ unless there have been heavy rains recently or the area is along the coast, the mosquito most likely to come and bite during the day. Why is knowing the species important? This species is a container breeder and does not fly very far from where it lays its eggs. Source reduction is the best means of control. This includes picking up anything that holds water, emptying it, and disposing of it correctly; refilling bird baths and animal water bowls at least once a week; raking big leaves, such as magnolia leaves, that can hold water; and cleaning gutters, will help reduce the populations of this species and other container breeding species. Additionally, pools need to be maintained properly as “green” pools breed large numbers of mosquitoes, including the WNV vector. Homeowners can also buy larvicide, both Bti (mosquito dunks) and methoprene (mosquito torpedoes). This can be applied to standing water to control mosquitoes by killing larvae. As with any pesticide, it is important to follow the label instructions explicitly, to protect the environment and non-targets, and to reduce or eliminate pesticide resistance issues.

Finally, it is important to wear repellent outside when mosquitoes are biting. Information about the various types of recommended repellents can be found at https://dph.georgia.gov/environmental-health/insects-and-diseases.

The 4 overlapping aims of mosquito control are to:

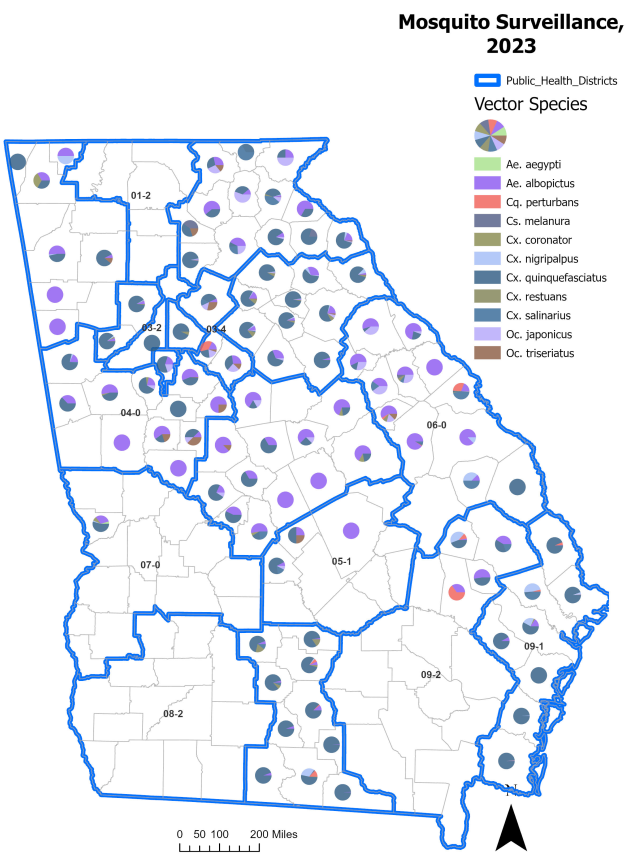
- Keep mosquito populations at acceptable densities
- Prevent mosquito bites
- Minimize mosquito-vertebrate contact
- Reduce the longevity of female mosquitoes

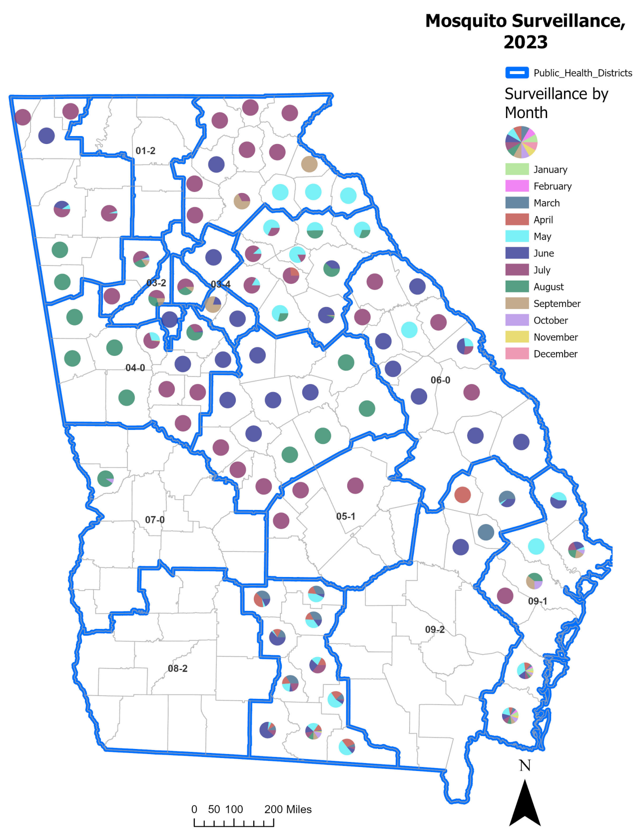
This last aim is of vital importance when dealing with container breeding mosquitoes. Oviposition site choice in container breeders tends to be cryptic, making it difficult to find and larvicide sufficient breeding sites to reduce mosquito populations. Additionally, the container breeding species tend to emerge asynchronously, with small numbers emerging daily, making the use of adulticides to reduce populations difficult. However, adulticiding will kill off the older mosquitoes, which are the most likely to have picked up virus while blood feeding, so this technique is most likely to reduce the risk of arboviral disease transmission. Several studies reported in the European Centre for Disease Prevention and Control (ECDC) Technical Report, show that vector control practices and strategies against West Nile virus indicated that aerial ULV adulticiding reduced the number of human cases within the treatment sites compared to the untreated sites, and that the odds of infection after spraying were six times higher in the untreated areas compared to the treated ones. Also, with larviciding of catch basins only, a > 90% reduction in larvae/pupae was recorded. However, no significant reduction was observed in adult *Culex* spp populations collected resting in catch basins indicating that larval control alone did not lead to meaningful reductions in adult mosquito populations and WNV prevalence. Finally, while larvicide applications reduced pupal abundance and the prevalence of host-seeking adults, there was no detectable impact on entomological risk metrics for WNV. This was likely because mosquitoes in the treatment areas were significantly younger than those in the control area; younger mosquitoes are less likely to have blood fed, so less likely to have picked up virus.

Overview

Currently, surveillance is done by the 2 entomologists at the State level and the District-level programs in 1-1, 2-0, 3-1, 3-2 (Bug Busters), 3-5, 6-0, and 8-1 and 10-0. We worked with Columbus, GA Environmental Health in Muscogee County and Fayette County Environmental Health to collect data in those two counties. We also collaborated with Chatham County Mosquito Control, Liberty County-Hinesville Mosquito Control, Mosquito Control Services (Glynn and Camden counties), and Valdosta State University (Lowndes County). We were fortunate to have a few interns and volunteers who assisted with mosquito surveillance in various areas throughout the State.

The maps used in this document were all created in March 2024. They depict the month(s) in which surveillance was done in each county and the presence or absence of the important vector species *Aedes aegypti*, *Ae albopictus*, *Coquillettidia perturbans*, *Culiseta melanura*, *Culex coronator*, *Cx nigripalpus*, *Cx quinquefasciatus*, *Cx restuans*, *Cx salinarius*, *Ochlerotatus japonicus,* and *Oc triseriatus*. All species trapped are listed in a table for each District by county.





Surveillance

Adult mosquito monitoring is a necessary component of surveillance activities and is directed toward identifying where adults are most numerous. This information drives response to service requests and helps determine whether interventions (source reduction, larviciding, and/or adulticiding) are effective.

There are a variety of different mosquito traps, but generally two different types of traps are used. One type, a gravid trap, selectively attracts container- breeding mosquitoes that have had a blood meal and are looking for a place to lay eggs. The other type, a light trap, attracts mosquitoes looking for a blood meal. Recently, a third type of trap, the BG-Sentinel trap, has been used in areas where exotic arbovirus cases have been detected. This trap is very specific for the Zika (ZIKV), Chikungunya (CHIK), and Dengue (DEN) vectors, *Ae aegypti* and *Ae albopictus*. With all three traps, as the mosquito gets close, it gets suctioned into the trap by a small fan. Mosquitoes caught in these traps are counted and identified. They may also be pooled according to date, species, and location and sent to a lab for testing.

Surveillance and mosquito identification were done by the two GDPH entomologists, by District or County Environmental Health Specialists (EHS), by local mosquito control, and by a variety of other collaborators.

GRAVID TRAP

This trap selectively attracts container-breeding mosquitoes that lay eggs in stagnant, organically rich water. These mosquitoes will have had at least one blood meal, so may possibly have picked up an infected blood meal if there are arbovirus-positive enzootic hosts in the area.

LIGHT TRAP

Light traps attract mosquitoes looking for a blood meal. The attractants used are light and CO_2, in the form of dry ice or as compressed gas in canisters. These traps are useful for providing information about the mosquito species found in the area under surveillance. Because they attract mosquitoes looking for a blood meal that may have just emerged and never had a blood meal previously, the likelihood of finding virus in these mosquitoes is much reduced.

BG SENTINEL TRAP

What makes the BG-S trap different? It:

- Mimics convection currents created by a human body
- Employs attractive visual cues
- Releases artificial skin emanations through a large surface area
- Can be used without CO2 to specifically capture selected mosquito species

Used in combination with the BG-Lure, a dispenser which releases a combination of non-toxic substances that are also found on human skin (ammonia, lactic acid, and caproic acid), the BG-Sentinel trap is especially attractive for the yellow fever (or ZIKV) mosquito, *Aedes aegypti*, the Asian tiger mosquito, *Aedes albopictus*, the southern house mosquito, *Culex quinquefasciatus*, and selected other species.

With the addition of carbon dioxide, the BG-Sentinel trap is an excellent surveillance tool for mosquitoes in general.

MOSQUITO BREEDING HABITAT TYPES

There are two general categories within which mosquito breeding habitats exist: natural mosquito breeding habitats and man-made mosquito breeding habitats. Female mosquitoes lay their eggs either on water or on soils that are periodically flooded. These breeding areas can be found in habitats that exist naturally, such as within a pond or flood plain; or in habitats that have been created by humans, such as bird baths, water-filled tires, or catch basins. Mosquitoes can breed in a wide variety of locations, and the discussion below provides a description of the general types of habitats where mosquitoes are known to breed.

NATURAL MOSQUITO BREEDING HABITATS

Temporary Woodland Pools:

Shallow, temporary pools are common in woodland areas during the spring and wet summers in low lying areas or in small depressions where a variety of mosquito species will breed, most commonly *Ochlerotatus canadensis* and *Aedes vexans*. These mosquitoes lay their eggs along the edges of the pool, and when rainwater or melting snow fills these pools, the larvae hatch.

Freshwater Ponds:

The larvae of Anopheles are found primarily in small ponds among the emergent vegetation. Ponds clogged with vegetation can breed large numbers of mosquitoes by providing large amounts of organic matter for feeding and by providing shelter from fish and other aquatic predators.

Streams and Floodplains:

Streams with running water rarely produce mosquitoes. However, mosquitoes need to be near water to lay their eggs. *Aedes* and *Culex* species are two genera that can sometimes be found in isolated pockets adjacent to streams or within floodplain areas that undergo only periodic flooding.

Tree Holes and Other Natural Containers:

Tree holes and other natural containers, such as pitcher plants or water trapped in or on plant leaves, can also serve as breeding habitats for mosquitoes, such as *Ochlerotatus triseriatus*. Frequent rainfalls maintain standing water within these types of microhabitats and can breed mosquitoes throughout the summer.

Freshwater Marshes and Swamps:

Mosquitoes, such as *Coquillettidia perturbans*, breed in freshwater marshes and swamps consisting of emergent vegetation. These types of habitats can occur in both woodland and open field habitats. Larvae attach themselves to the stems and roots of the vegetation to obtain oxygen, and do not need to swim up and down in the water column to feed or breathe. Due to this adaptation, larvae can avoid exposure to predatory fish.

MAN-MADE MOSQUITO BREEDING HABITATS

Stormwater/Wastewater Detention:

A catch basin typically includes a curb inlet where storm water enters the basin to capture sediment, debris, and associated pollutants. These catch basins provide breeding habitat for urban mosquito species, such as *Culex quinquefasciatus*. Moisture and organic debris captured within the catch basin provide habitat for growing larvae. Detention/retention basins that perform similar functions for other types of wastewaters, such as waste treatment settlement ponds, provide a similar type of breeding habitat to that of the storm water catch basin.

Roadside Ditches:

Roadside ditches are the suitable habitat for many species of Culex mosquitoes. The larvae of *Culex quinquefasciatus* and *Culex restuans*, for example, can survive in waters with high organic content. Culex mosquitoes will lay their eggs directly on the water's surface; therefore, ditches that hold water for extended periods of time can breed large numbers of mosquitoes.

Artificial Containers:

Artificial containers such as tires, bottles, buckets, and birdbaths can provide an excellent mosquito-breeding habitat free from predation. Saucers placed under flowerpots to hold water provide a habitat for mosquito larva, as well as causing root rot in the plant. Many tree-hole mosquitoes have learned to adapt to using these man-made mosquito nurseries. *Aedes albopictus*, our most common pest species, also breeds readily in these artificial containers. An abundance of organic debris, which also collect in these containers, allows for the proliferation of mosquitoes.

Control – A Message for the Public

The mosquitoes of most importance to public health in Georgia are *Culex quinquefasciatus*, the Southern house mosquito, and *Aedes albopictus*, the Asian tiger mosquito. Both species lay eggs in such artificial containers as birdbaths, gutters, tires, flowerpots, and any other container that holds water for at least a week. The Southern house mosquito prefers organically polluted water for laying its eggs, and bites at dusk. It feeds primarily on birds, but will bite mammals, and is our primary vector for WNV. The Asian tiger mosquito, a daytime biter, prefers cleaner water for laying its eggs. It feeds primarily on mammals. *Aedes albopictus* is a potential vector for WNV in Georgia and can be a vector for DEN, ZIKV, and CHIK.

The best way to control these species is to dump out or treat standing water, treat catch basins with larvicide, and to cut back heavy vegetation where the mosquito will rest when not out biting. These mosquitoes will shelter in abandoned houses or sheds. Thermal fogging or barrier spray around these structures can help to reduce resting and overwintering mosquitoes. Two larvicides are available to the public for treating standing water, Mosquito Torpedoes (Methoprene) and Mosquito Dunks (Bti). Both are available online, from home goods or hardware stores, and occasionally from large chain pet stores. Hand-held foggers can also be used to reduce biting populations of mosquitoes, but this solution is temporary and needs to be followed up with good source reduction (removing breeding sites) and larviciding.

Mosquitoes and Trap Types, 2023

Species	**BGS**	**CDC**	**Exit**	**Gravid**	**Other**	**TOTAL**
Ae. aegypti		8				8
Ae. albopictus	53	1180		532		1765
Ae. albopictus (male)		5		3		8
Ae. vexans		561		148	8	717
Aedes/Ochlerotatus spp.		18		23		41
An. barberi		1				1
An. crucians		497		14		511
An. crucians (male)		2				2
An. punctipennis		175		6		181
An. quadrimaculatus		51		7		58
Anopheles spp.		4		2		6
Cq. perturbans		4575	2	586		5163
Cs. melanura		1015	66	62		1143
Culex spp.		81		3387		3468
Culex spp. (male)		93		39		132
Culiseta spp.		29		1		30
Cx. coronator	11	44		5		60
Cx. erraticus		2558	6	50		2614
Cx. nigripalpus		6141	82	7704		13927
Cx. quinquefasciatus	39	1666		143805		145510
Cx. restuans		29		1595		1624
Cx. salinarius		1342		211		1553
Cx. territans		3		25		28
Ma. titillans		368		225		593
Mansonia spp.		41				41
Oc. atlanticus		418	3	1		422
Oc. canadensis		42				42
Oc. dupreei		16				16
Oc. fulvus pallens		8		1		9
Oc. infirmatus		219	13	2		234
Oc. japonicus		29		128		157
Oc. sollicitans		49				49
Oc. taeniorhynchus		489		11		500
Oc. triseriatus	3	40		44		87

MOSQUITO SURVEILLANCE 2023

Species	**BGS**	**CDC**	**Exit**	**Gravid**	**Other**	**TOTAL**
Oc. triseriatus (male)				2		2
Oc. trivittatus		1				1
Or. signifera				3		3
Ps. ciliata		27		1		28
Ps. columbiae		104		2		106
Ps. ferox		469		5		474
Ps. horrida		920		20		940
Ps. howardii		27				27
Ps. howardii (male)		1				1
Psorophora spp. (male)		2				2
Tx. rutilus	2			1		3
unknown		144		30		174
Ur. sapphirina		82		1		83

AEDES AEGYPTI

NOTE: Is it *Aedes*, or is it *Ochlerotatus*?

Ochlerotatus had been originally established as a genus in 1891. It became an aedine subgenus in the 1930s. In 2000, John Reinert and his colleagues elevated the subgenus *Ochlerotatus* back to a genus based upon microscopic differences in the male genitalia between it and other subgenera of *Aedes*. However, in 2005 the *Journal of Medical Entomology* and the Entomological Society of America decided to put *Ochlerotatus* back to subgenera level (https://academic.oup.com/jme/article/42/4/511/910895?login=true). After a contentious worldwide debate regarding the effect the taxonomic changes would have on names established over decades of work in scientific, government, and lay communities, many scientists (including those at the CDC), and others affected by the change, espoused the continued use of the previously established names. So, for the time being, everything is *Aedes* again.

HOWEVER, since the GDPH mosquito surveillance database was established after *Ochlerotatus* was elevated to genus status, we appreciate you continuing to use *Ochlerotatus* to make data access easier.

Aedes

- *Ae. aegypti*
- *Ae. albopictus*
- *Ae. cinerius*
- *Ae. vexans*

Ochlerotatus

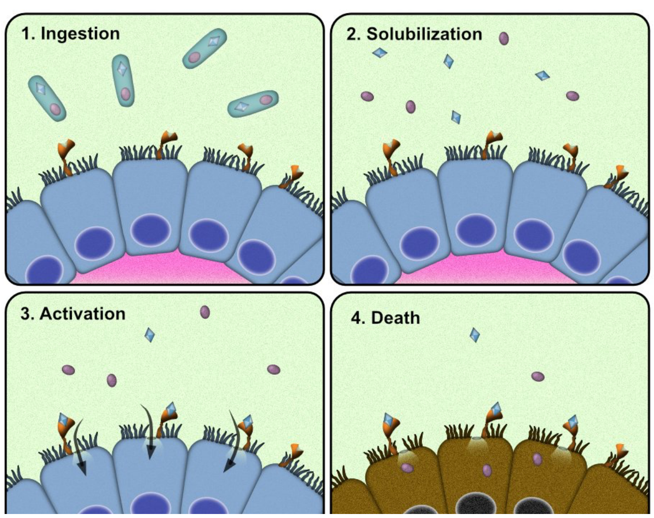
- *Oc. atlanticus/tormentor*
- *Oc. atropalpus*
- *Oc. canadensis*
- *Oc. dupreei*
- *Oc. fulvus pallens*
- *Oc. hendersoni*
- *Oc. infirmatus*
- *Oc. japonicus*
- *Oc. mathesoni*
- *Oc. mitchellae*
- *Oc. sollicitans*
- *Oc. sticticus*
- *Oc. taeniorhynchus*
- *Oc. thibaulti*
- *Oc. triseriatus*
- *Oc. trivittatus*

Data by District

District 1-1

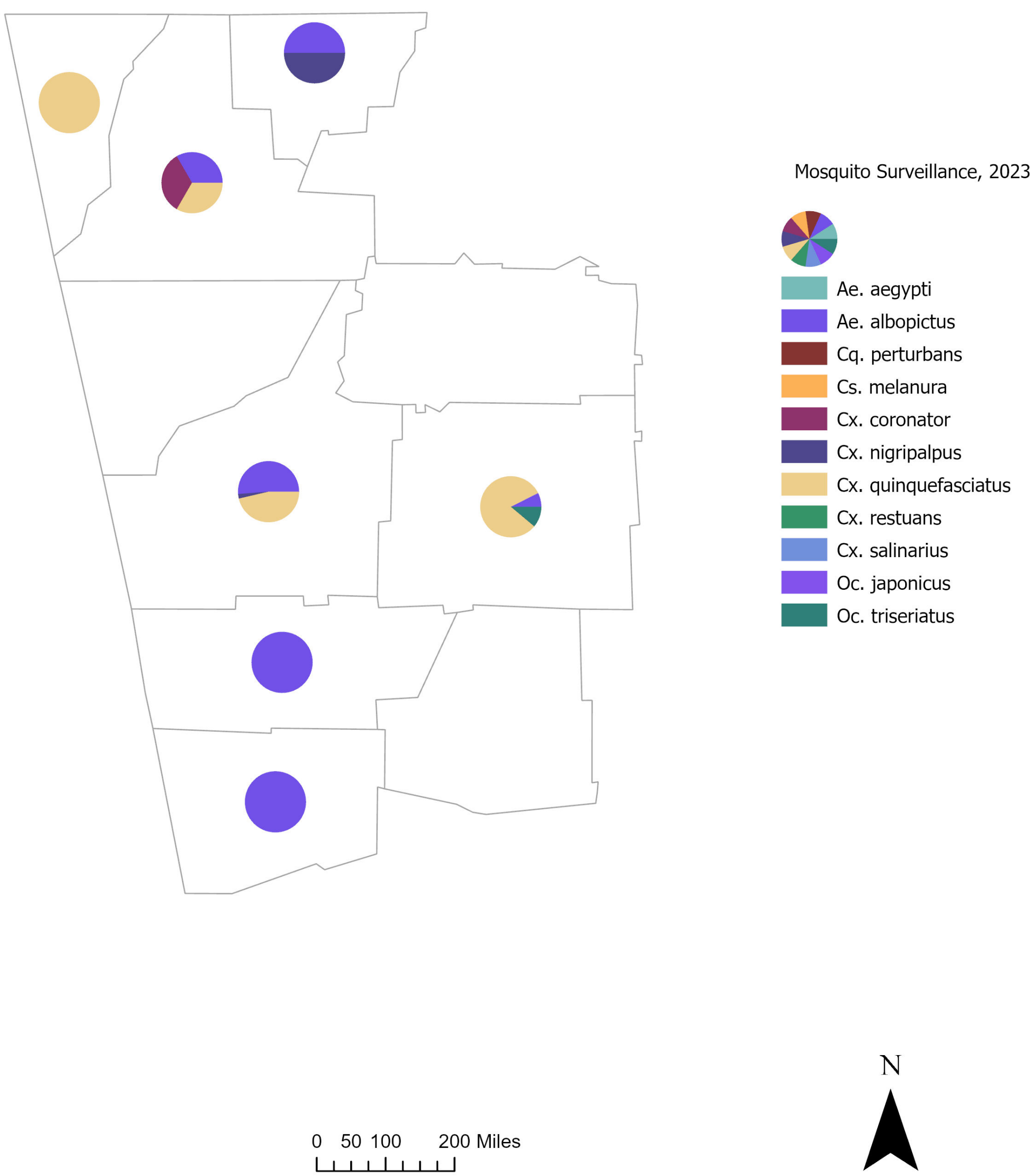
Surveillance in District 1-1 was done by local EHS. Surveillance was done from the end of May through the beginning of August over 14 trap nights.

District 1-1		trap type	
County	**Species**	**CDC**	**Gravid**
Bartow	*Ae. albopictus*	2	
	Cx. quinquefasciatus		22
	Oc. triseriatus		3
Catoosa	*Ae. albopictus*	3	
	Cx. nigripalpus		3
Dade	*Cx. quinquefasciatus*	1	
Walker	*Ae. albopictus*	1	
	Cx. coronator	1	
	Cx. quinquefasciatus	1	
Floyd	*Ae. albopictus*	3	18
	Cx. nigripalpus	1	
	Cx. quinquefasciatus	12	7
Haralson	*Ae. albopictus*		1
Polk	*Ae. albopictus*		7



HOW BTI KILLS THE MOSQUITO LARVA

District 1-1


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

MOSQUITO SURVEILLANCE 2023

District 1-2

No surveillance was done in District 1-2 in 2023.

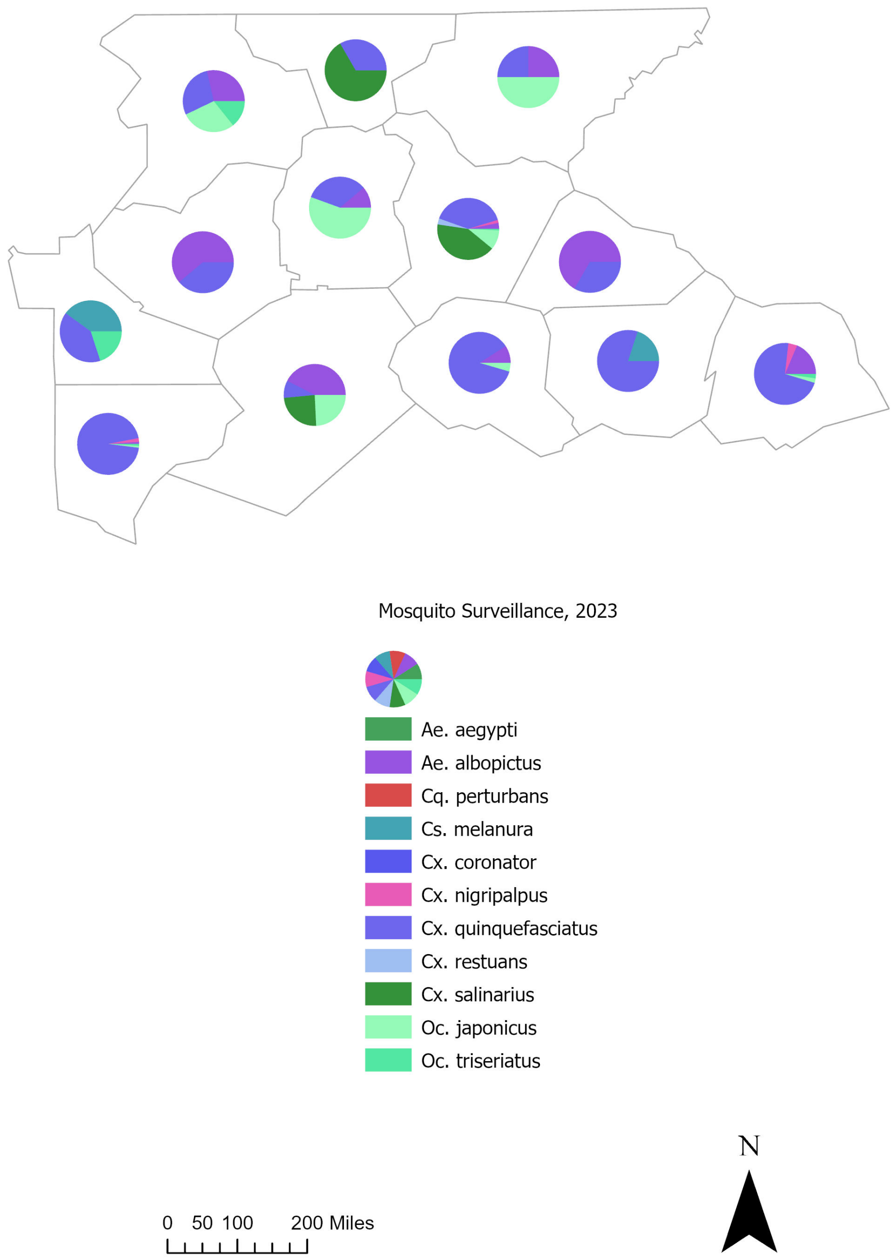
District 2-0

Surveillance in District 2-0 was done by local EHS. Surveillance was done from May-September over 14 trap nights.

District 2-0		trap type	
County	***Species***	**CDC**	**gravid**
Banks	*Ae. albopictus*	1	3
	Cx. quinquefasciatus		38
	Oc. japonicus		2
Dawson	*Cs. melanura*	2	
	Cx. quinquefasciatus	2	
	Oc. triseriatus	1	
Forsyth	*Ae. albopictus*	1	
	Cx. nigripalpus	2	
	Cx. quinquefasciatus	64	31
	Oc. japonicus		1
	Oc. triseriatus		1
Franklin	*Cs. melanura*		2
	Cx. quinquefasciatus		8
Habersham	*Ae. albopictus*	2	2
	Cx. nigripalpus	2	
	Cx. quinquefasciatus		51
	Cx. restuans	4	
	Cx. salinarius		53
	Oc. japonicus		13
	Oc. triseriatus		1
Hall	*Ae. albopictus*	10	4
	Cx. quinquefasciatus		3
	Cx. salinarius	8	
	Oc. japonicus	7	1

District 2-0		trap type	
County	***Species***	**CDC**	**gravid**
Hart	*Ae. albopictus*	8	
	Cx. nigripalpus		2
	Cx. quinquefasciatus		31
	Oc. japonicus		1
	Oc. triseriatus		1
Lumpkin	*Ae. albopictus*	2	9
	Cx. quinquefasciatus		7
Rabun	*Ae. albopictus*	1	4
	Cx. quinquefasciatus		5
	Oc. japonicus	1	9
Stephens	*Ae. albopictus*	1	9
	Cx. quinquefasciatus		5
Towns	*Cx. quinquefasciatus*		1
	Cx. salinarius		2
Union	*Ae. albopictus*		2
	Cx. quinquefasciatus		2
	Oc. japonicus	1	1
	Oc. triseriatus	1	
White	*Ae. albopictus*		1
	Cx. quinquefasciatus		3
	Oc. japonicus		5

District 2-0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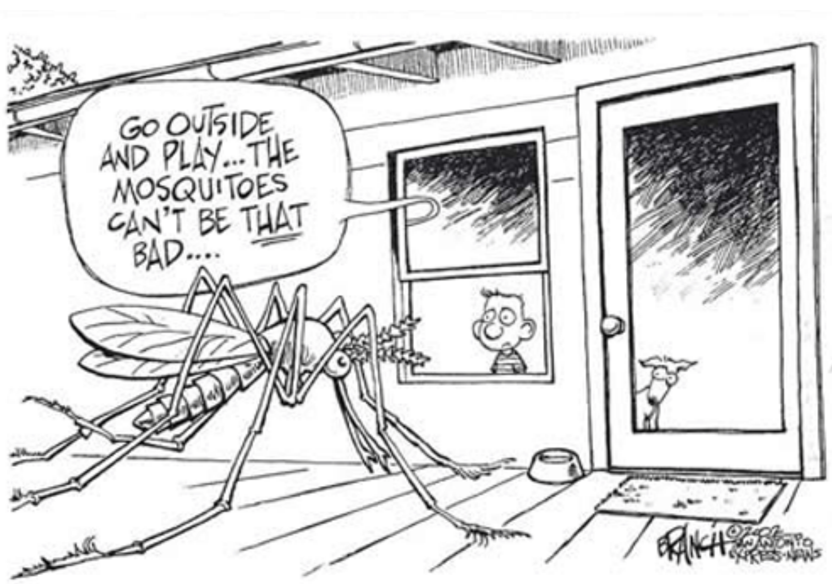
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
N
0 50 100 200 Miles

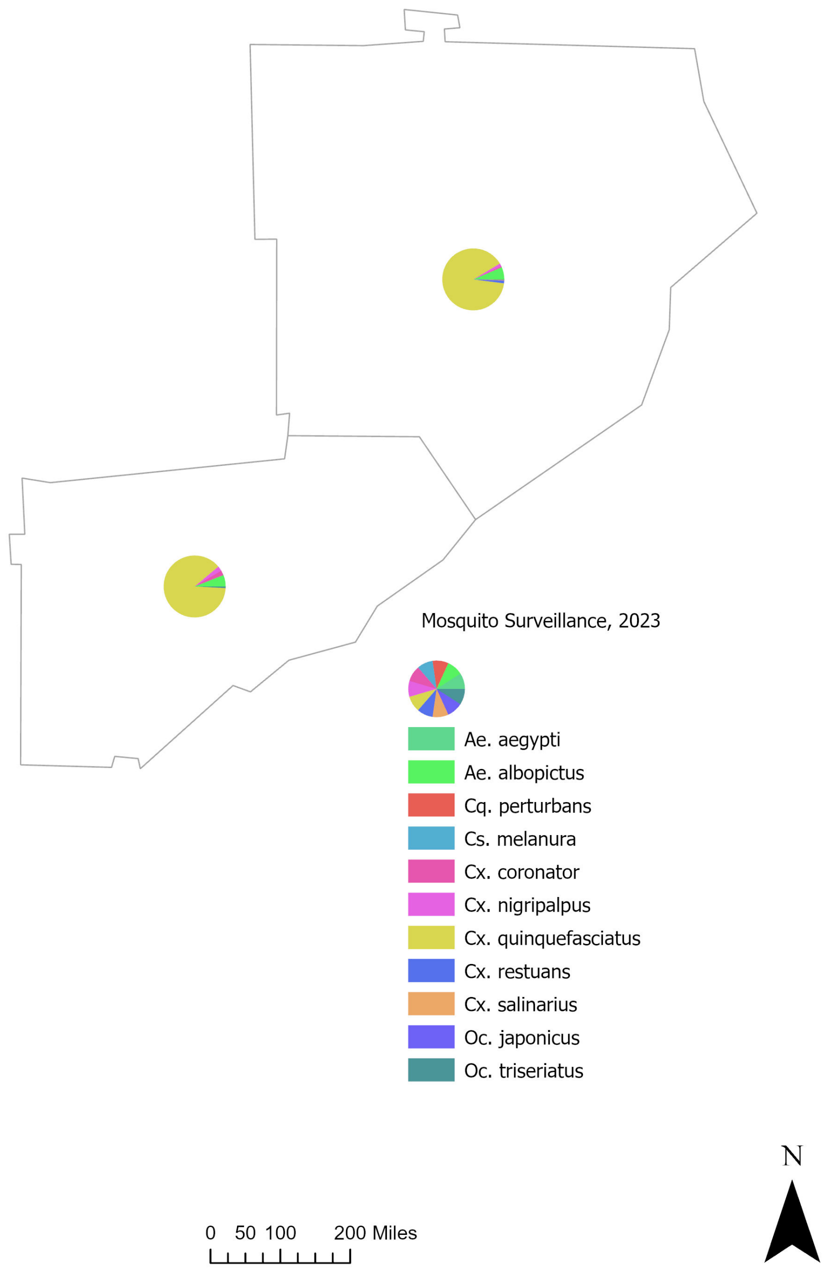
District 3-1

District 3-1		trap type	
County	**Species**	**CDC**	**gravid**
Cobb	*Ae. albopictus*	69	9
	Cx. coronator	5	2
	Cx. nigripalpus	1	18
	Cx. quinquefasciatus	74	1014
	Cx. restuans		18
	Cx. salinarius		4
	Oc. triseriatus	1	2
Douglas	*Ae. albopictus*	5	2
	Cx. coronator		3
	Cx. nigripalpus		3
	Cx. quinquefasciatus	29	74
	Oc. triseriatus	1	

Surveillance in District 3-1 was done by the EHS mosquito technician and the DPH entomologists. Surveillance was done from May-October over 40 trap nights.



District 3-1

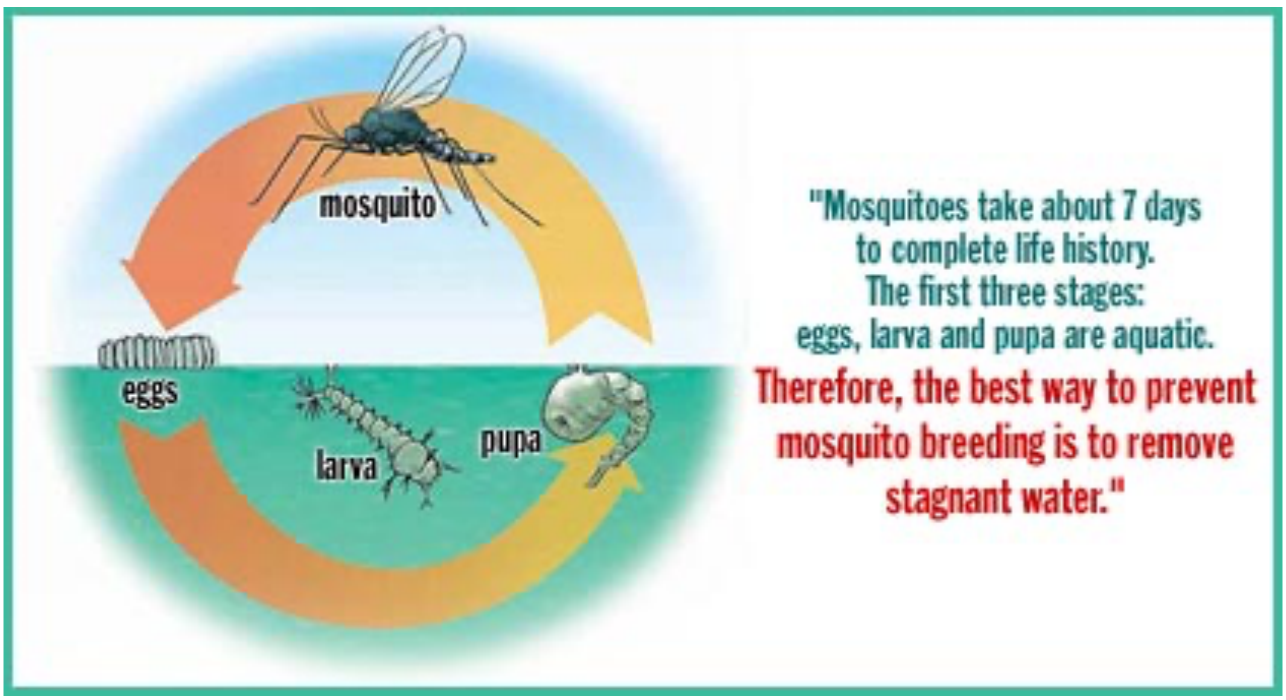

Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

MOSQUITO SURVEILLANCE 2023

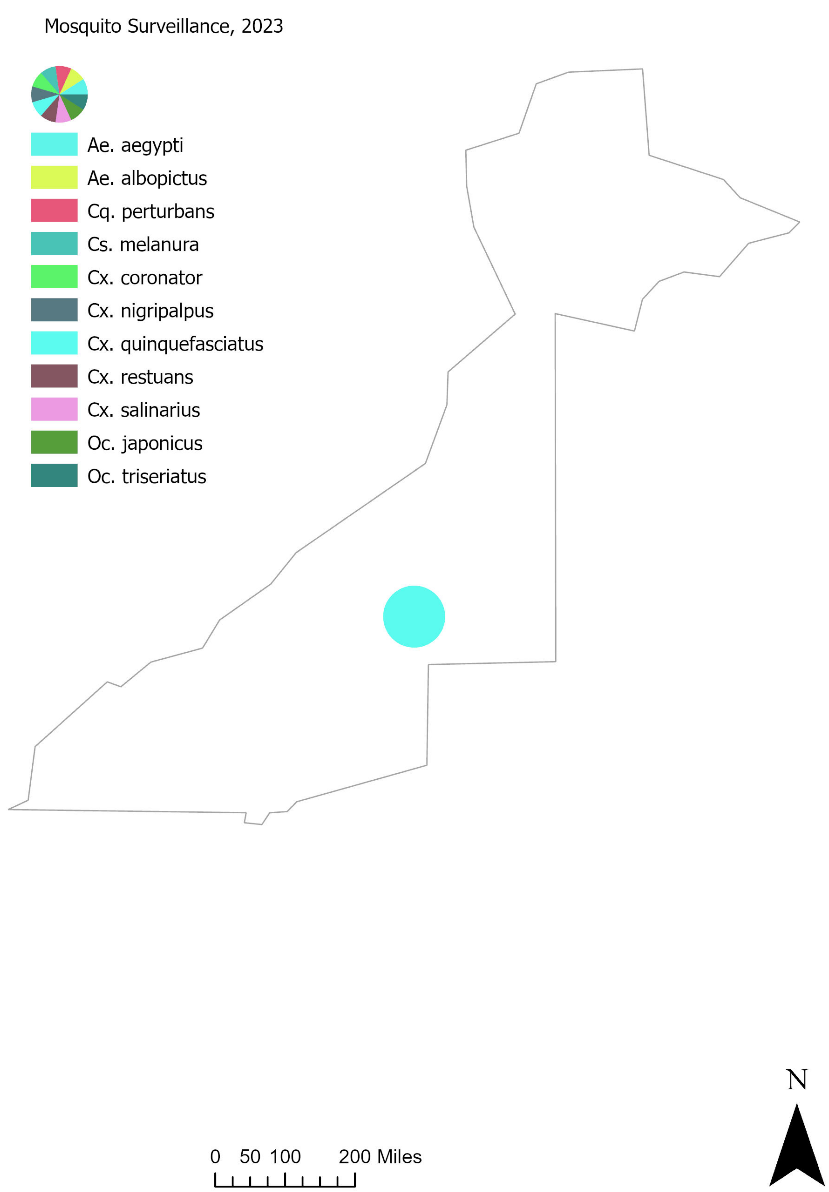
District 3-2

Surveillance in District 3-2 was done by Bug Busters, a pesticide company that contracted with the District to do mosquito surveillance and control. Surveillance was done from July-September over 156 trap nights. Only mosquitoes tested for virus were shared.

District 3-2		trap types	
County	**Species**	**CDC**	**Gravid**
Fulton	*Cx. quinquefasciatus*	270	4670



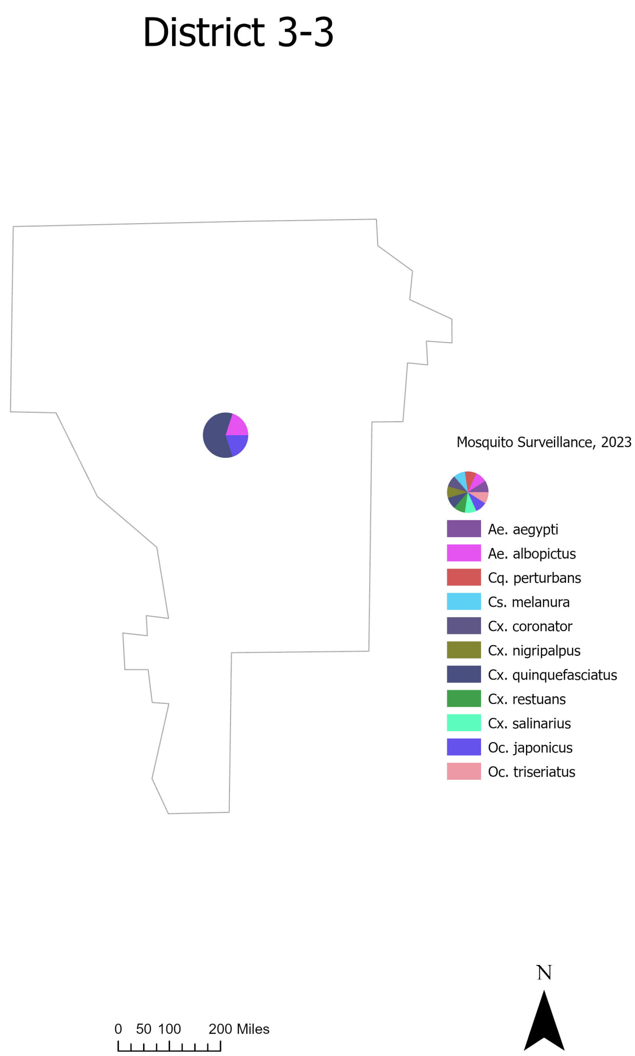
District 3-2


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

District 3-3

Surveillance in District 3-3 was done by the DPH entomologists. Surveillance was done in June over 1 trap night.

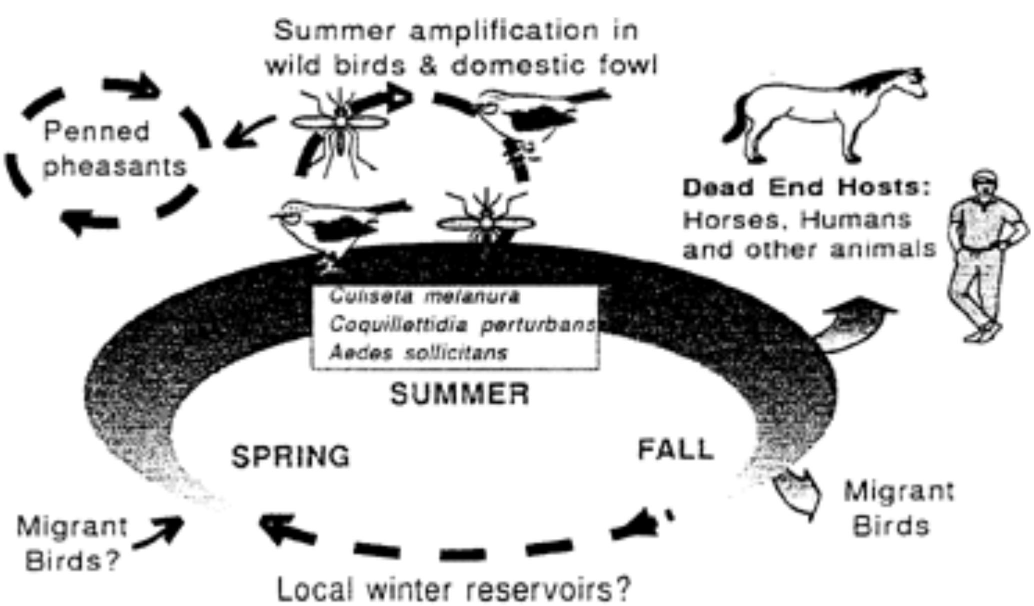
District 3-3		trap type
County	**Species**	**Gravid**
Clayton	*Ae. albopictus*	1
	Cx. quinquefasciatus	3
	Oc. japonicus	1



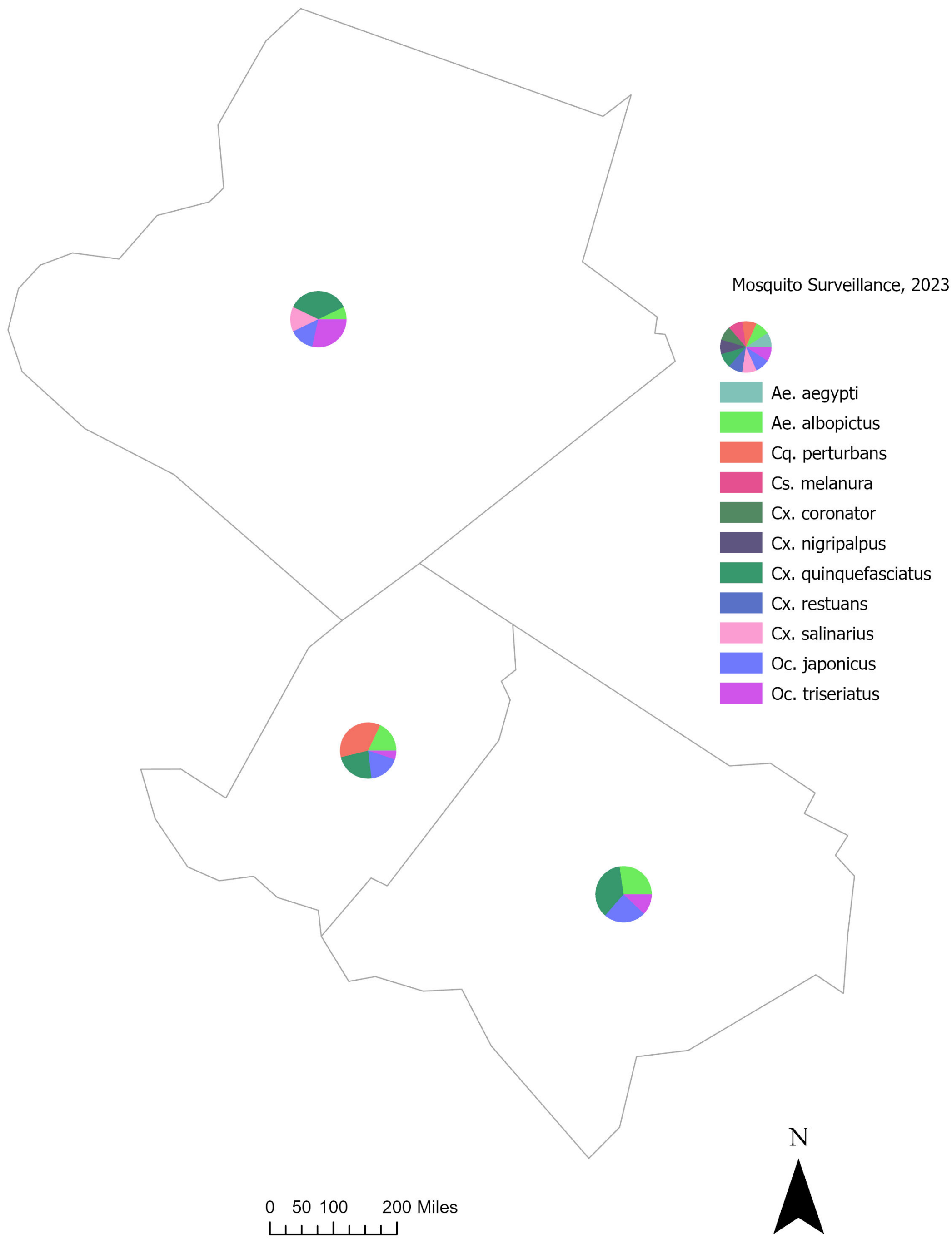
District 3-4

Surveillance in District 3-4 was done by the DPH entomologists. Surveillance was done in August and September over 7 trap nights.

District 3-4		trap type	
County	**Species**	**CDC**	**gravid**
Gwinnett	*Ae. albopictus*	1	
	Cx. quinquefasciatus		5
	Cx. salinarius	2	
	Oc. japonicus	1	1
	Oc. triseriatus	2	2
Newton	*Ae. albopictus*		9
	Cx. quinquefasciatus		12
	Oc. japonicus		8
	Oc. triseriatus		4
Rockdale	*Ae. albopictus*	2	5
	Cx. quinquefasciatus	4	5
	Oc. japonicus		7
	Oc. triseriatus	1	1



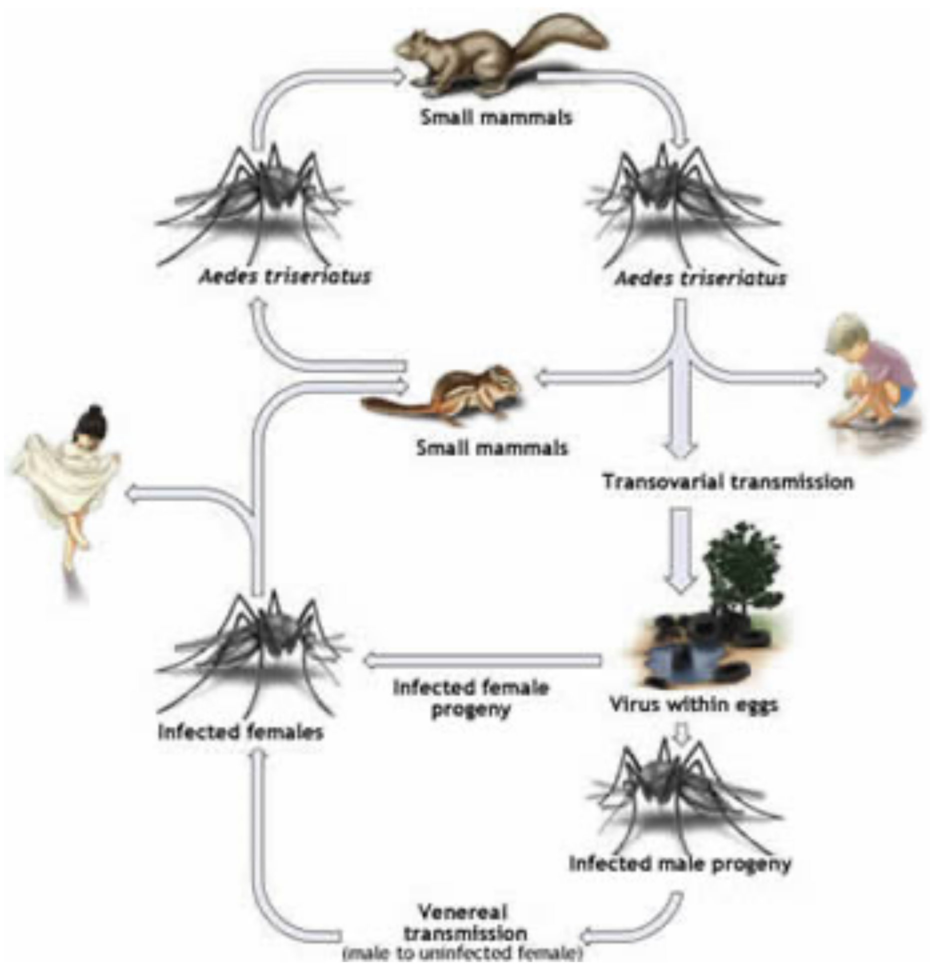
District 3-4


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
N
0 50 100 200 Miles

District 3-5

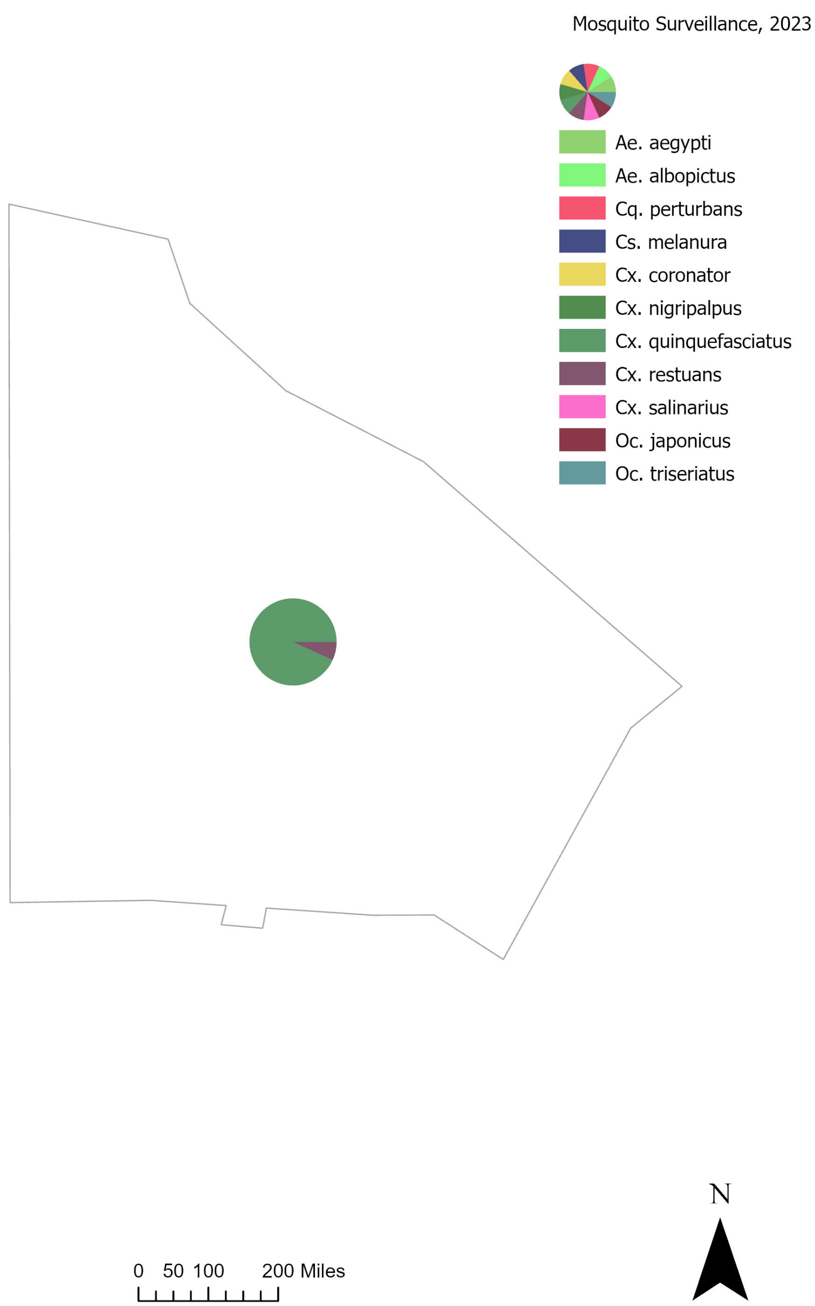
District 3-5		trap type
County	**Species**	**Gravid**
DeKalb	*Cx. quinquefasciatus*	11886
	Cx. restuans	864

Surveillance in District 3-5 was done by interns in the County Environmental Health program. Surveillance was done from July - September over 221 trap nights. Data from tested mosquitoes were shared with the DPH.



LACROSSE ENCEPHALITIS TRANSMISSION CYCLE

District 3-5

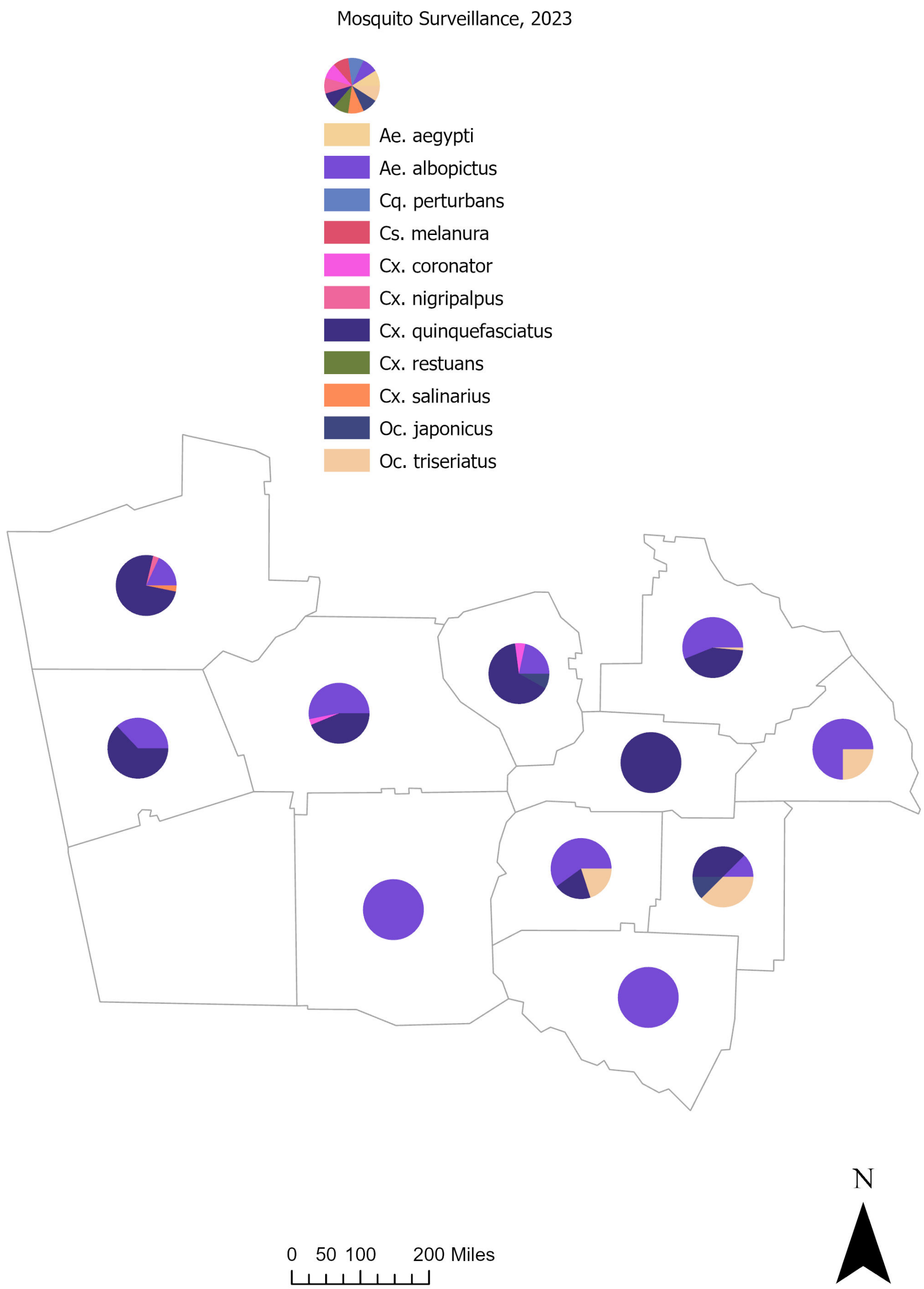

Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

District 4-0

Surveillance in District 4-0 was done by the DPH entomologists. Surveillance was done in May – August and in November over 20 trap nights.

District 4-0		trap type		
County	**Species**	**BGS**	**CDC**	**Gravid**
Butts	*Ae. albopictus*			3
	Oc. triseriatus			1
Lamar	*Ae. albopictus*			1
	Cx. quinquefasciatus		3	
	Oc. japonicus			1
	Oc. triseriatus		1	2
Meriwether	*Ae. albopictus*			3
Pike	*Ae. albopictus*		2	1
	Cx. quinquefasciatus			1
	Oc. triseriatus		1	
Upson	*Ae. albopictus*		19	
Fayette	*Ae. albopictus*		6	2
	Cx. coronator		2	
	Cx. quinquefasciatus		6	18
	Oc. japonicus			3
Henry	*Ae. albopictus*	36		1
	Cx. quinquefasciatus	28		
	Oc. triseriatus	1		
Spalding	*Cx. quinquefasciatus*			5
Carroll	*Ae. albopictus*		12	5
	Cx. nigripalpus		3	
	Cx. quinquefasciatus		14	57
	Cx. salinarius			3
Heard	*Ae. albopictus*		8	2
	Cx. quinquefasciatus			17
Coweta	*Ae. albopictus*		27	7
	Cx. coronator		2	
	Cx. quinquefasciatus		8	20

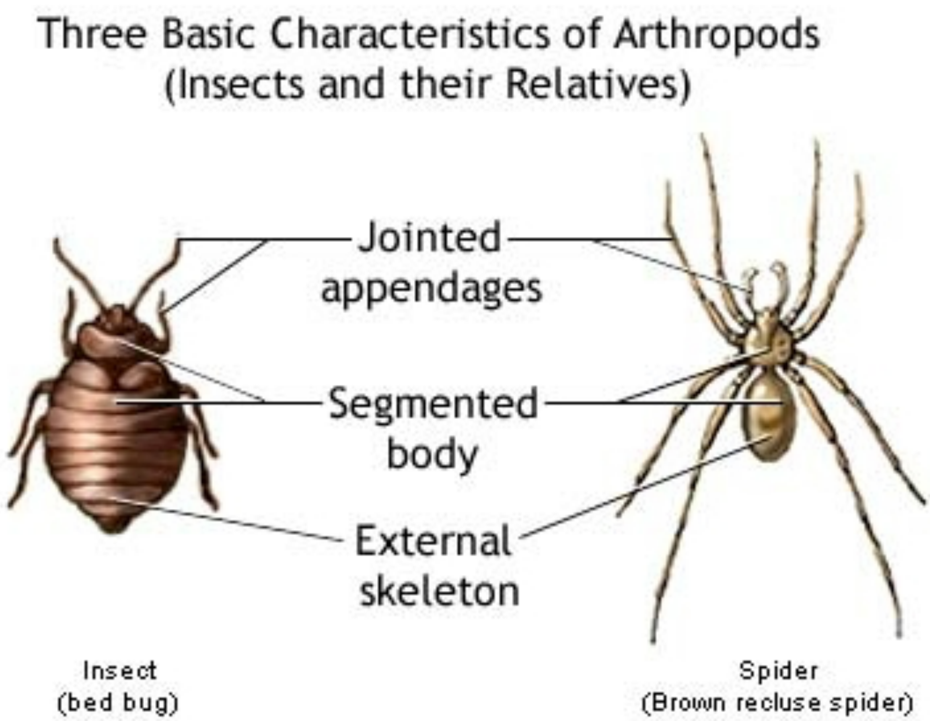
District 4-0


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

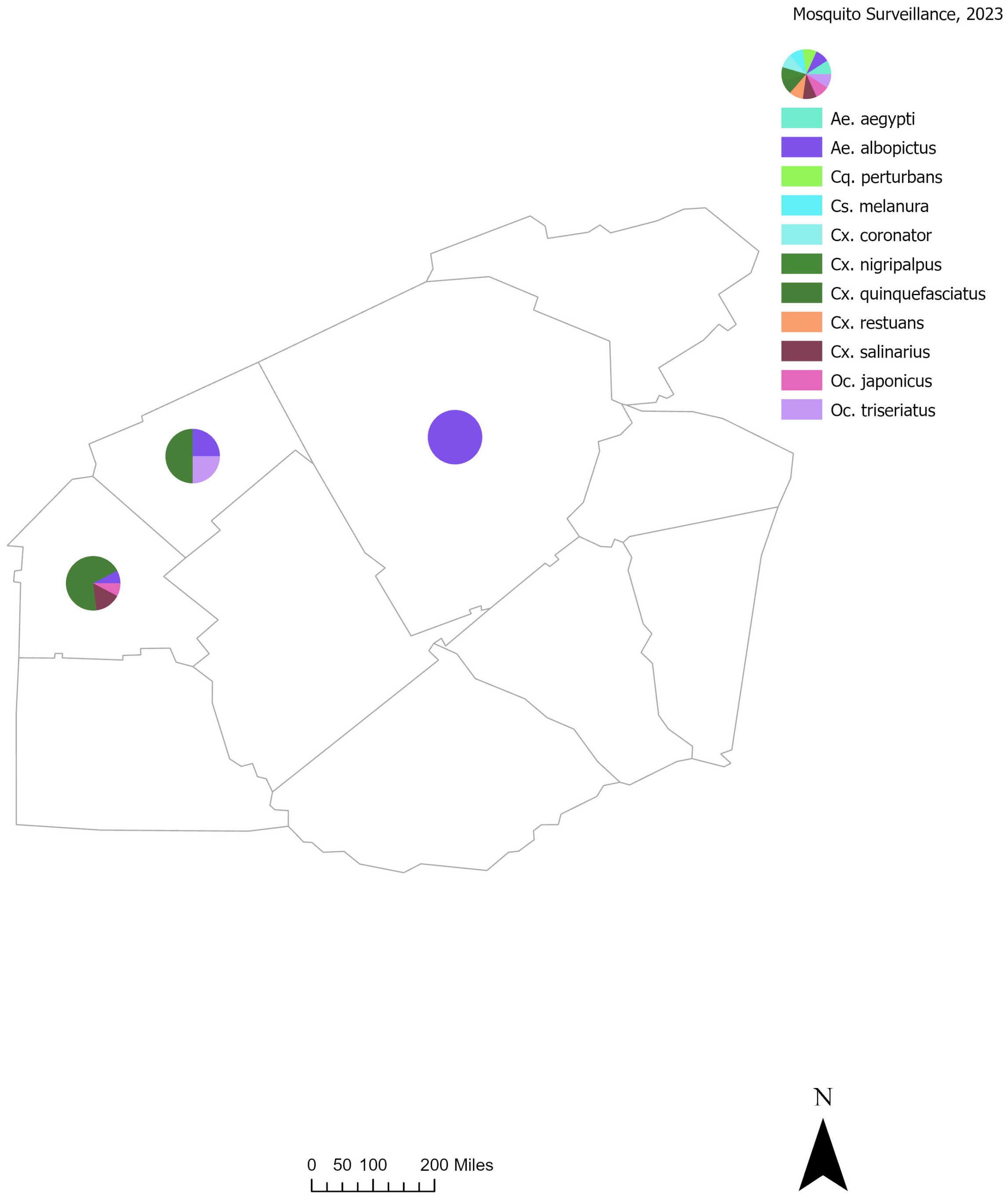
District 5-1

Surveillance in District 5-1 was done by the DPH entomologists in July over 3 trap nights.

District 5-1		trap type	
County	**Species**	**CDC**	**gravid**
Bleckley	*Ae. albopictus*	1	1
	Cx. quinquefasciatus	1	3
	Oc. triseriatus		2
Laurens	*Ae. albopictus*		1
Pulaski	*Ae. albopictus*		1
	Cx. quinquefasciatus		9
	Cx. salinarius	2	
	Oc. japonicus		1



District 5-1

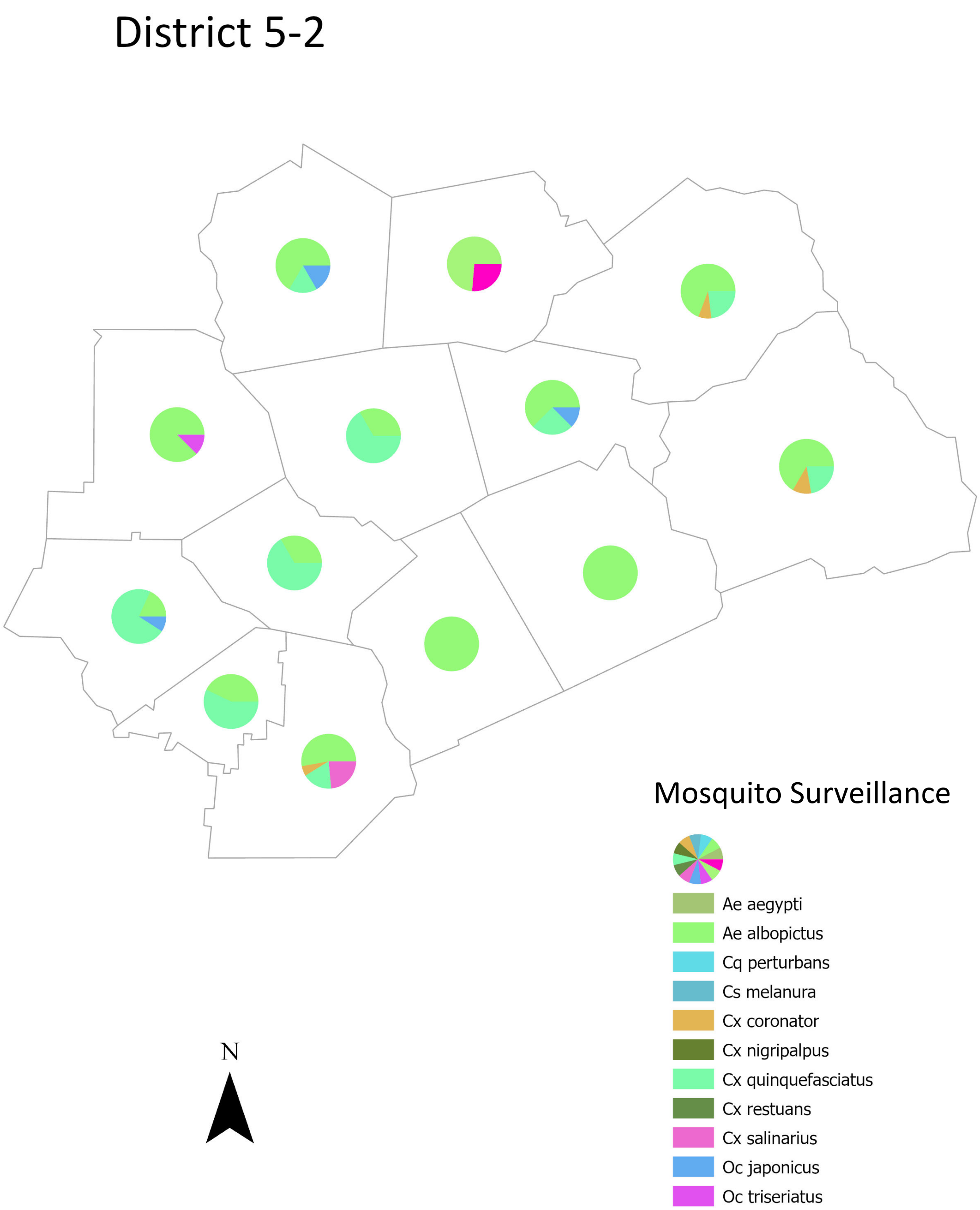

Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

District 5-2

Surveillance in District 5-2 was done by the DPH entomologists in June - August over 12 trap nights.

District 5-2		trap type	
County	**Species**	**CDC**	**gravid**
Peach	*Ae. albopictus*	1	2
	Cx. quinquefasciatus	1	3
Monroe	*Ae. albopictus*	2	5
	Oc. triseriatus		1
Bibb	*Ae. albopictus*		1
	Cx. quinquefasciatus		2
Jones	*Ae. albopictus*		1
	Cx. quinquefasciatus		2
Baldwin	*Ae. albopictus*	2	3
	Cx. quinquefasciatus		2
	Oc. japonicus		1
Putnam	*Ae. albopictus*	7	7
	Oc. triseriatus	5	

District 5-2		trap type	
County	***Species***	**CDC**	**gravid**
Jasper	*Ae. albopictus*		4
	Cx. quinquefasciatus		1
	Oc. japonicus		1
Houston	*Ae. albopictus*	9	
	Cx. coronator	1	
	Cx. quinquefasciatus	2	1
	Cx. salinarius	4	
Crawford	*Ae. albopictus*		2
	Cx. quinquefasciatus		8
	Oc. japonicus		1
Washington	*Ae. albopictus*	3	3
	Cx. coronator	1	
	Cx. quinquefasciatus	1	1
Wilkinson	*Ae. albopictus*	2	1
Hancock	*Ae. albopictus*	5	4
	Cx. coronator	1	
	Cx. quinquefasciatus		3
Twiggs	*Ae. albopictus*		1

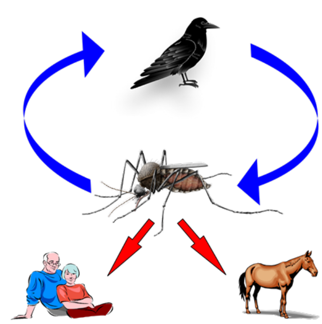

District 5-2
Mosquito Surveillance
Ae aegypti
Ae albopictus
Cq perturbans
Cs melanura
Cx coronator
Cx nigripalpus
Cx quinquefasciatus
Cx restuans
Cx salinarius
Oc japonicus
Oc triseriatus
N

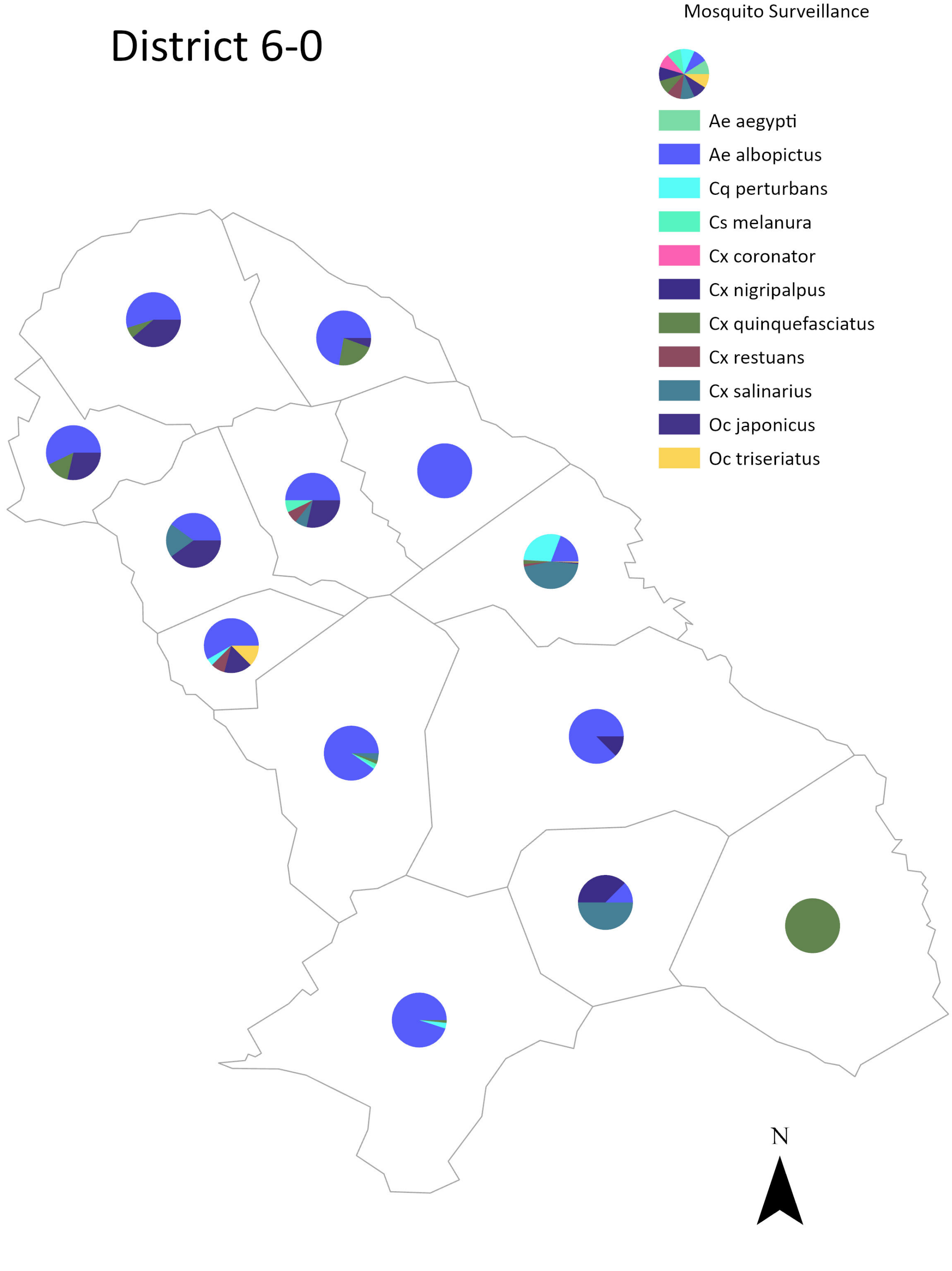
District 6-0

Surveillance in District 6-0 was done by the Richmond County Mosquito Control program. Surveillance was done from May-July over 121 trap nights.

District 6-0		trap type	
County	***Species***	**CDC**	**gravid**
Burke	*Ae. albopictus*	4	3
	Cx. nigripalpus	1	
Glascock	*Ae. albopictus*	14	
	Cx. restuans		2
	Oc. japonicus		4
	Oc. triseriatus		3
Jefferson	*Ae. albopictus*	80	4
	Cs. melanura	2	
	Cx. quinquefasciatus		2
	Cx. salinarius	3	1
Jenkins	*Ae. albopictus*		1
	Cx. nigripalpus	3	
	Cx. salinarius	4	
McDuffie	*Ae. albopictus*	7	
	Cs. melanura	1	
	Cx. restuans	1	
	Cx. salinarius	1	
	Oc. japonicus		4
Richmond	*Ae. albopictus*	443	61
	Cs. melanura	2	1
	Cx. coronator	4	
	Cx. nigripalpus	2	1
	Cx. quinquefasciatus	14	43
	Cx. restuans	2	39
	Cx. salinarius	1175	15
	Oc. japonicus	3	19
	Oc. triseriatus	10	8

District 6-0		trap types	
County	***Species***	**CDC**	**gravid**
Screven	*Cx. quinquefasciatus*	1	
Taliaferro	*Ae. albopictus*	2	2
	Cx. quinquefasciatus		1
	Oc. japonicus	1	1
Wilkes	*Ae. albopictus*	4	13
	Cx. quinquefasciatus		2
	Oc. japonicus		12
Warren	*Ae. albopictus*	1	1
	Cx. salinarius	1	
	Oc. japonicus		2
Lincoln	*Ae. albopictus*	7	6
	Cx. quinquefasciatus		4
	Oc. japonicus		1
Columbia	*Ae. albopictus*	21	6
Emanuel	*Ae. albopictus*	55	2
	Cx. quinquefasciatus	1	

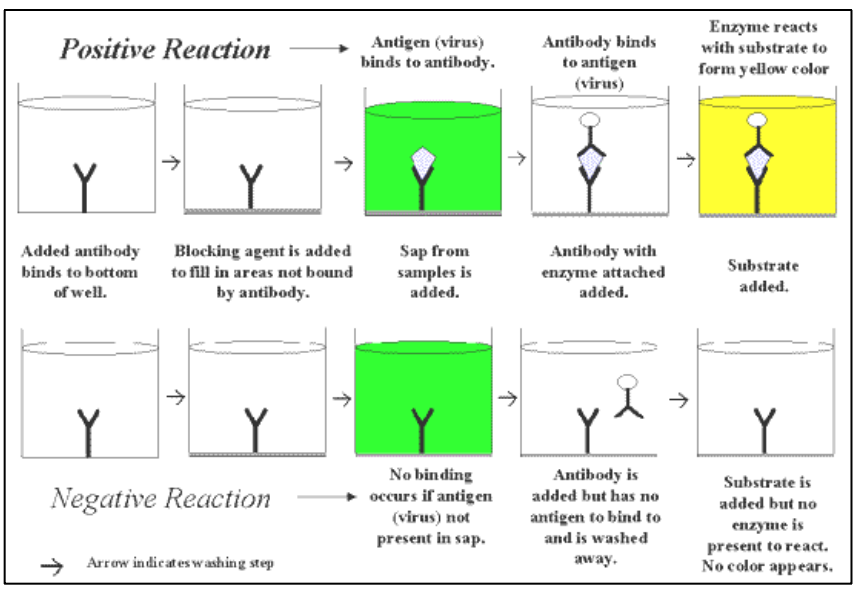



District 6-0
Mosquito Surveillance
Ae aegypti
Ae albopictus
Cq perturbans
Cs melanura
Cx coronator
Cx nigripalpus
Cx quinquefasciatus
Cx restuans
Cx salinarius
Oc japonicus
Oc triseriatus
N

District 7-0

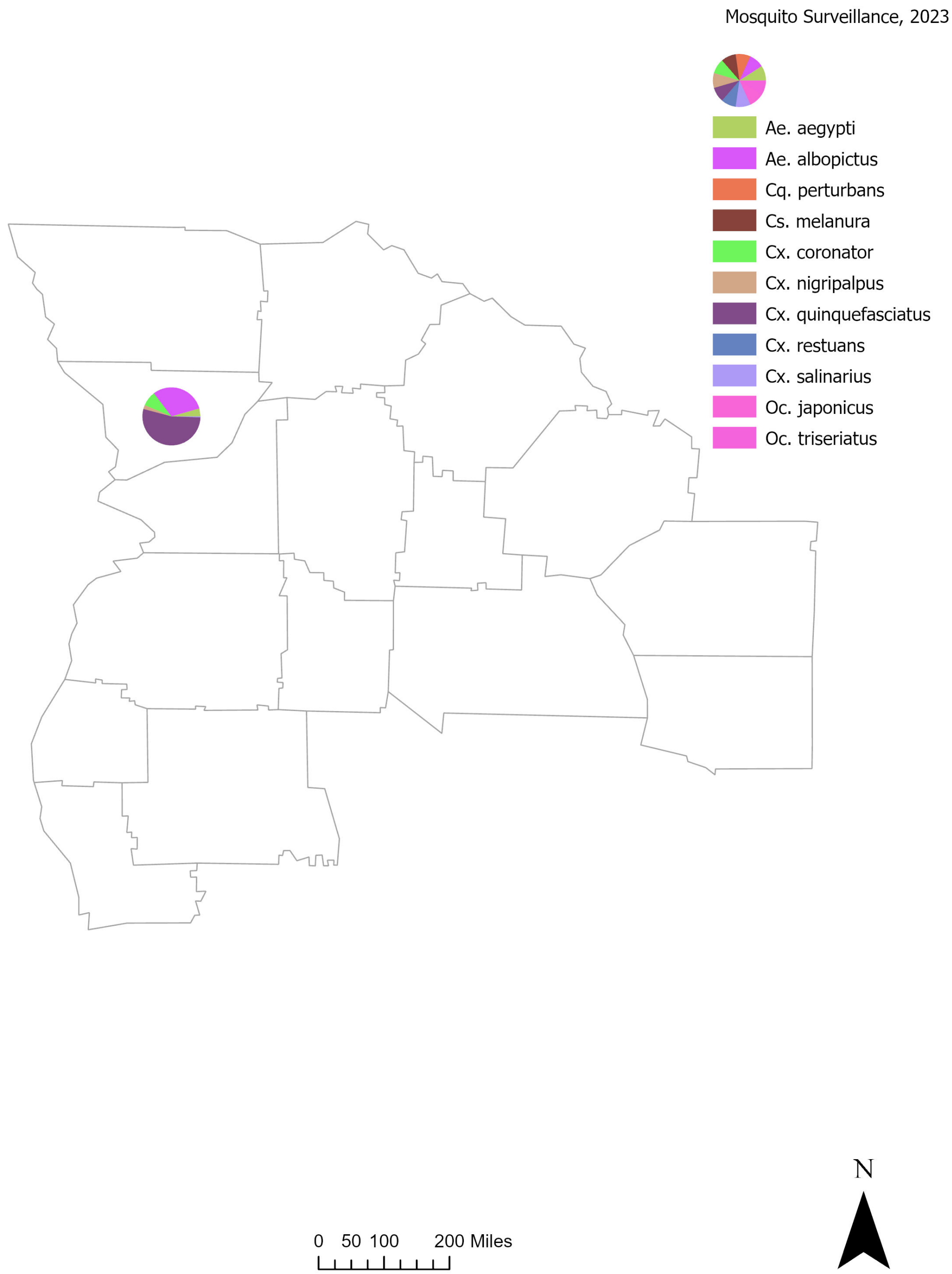
Surveillance in District 7-0 was done by the DPH entomologists. Surveillance was done in August and October over 8 trap nights.

District 7-0		trap type	
County	***Species***	**CDC**	**Gravid**
Muscogee	*Ae. aegypti*	8	
	Ae. albopictus	48	8
	Cx. coronator	15	
	Cx. nigripalpus	4	
	Cx. quinquefasciatus	94	3
	Cx. salinarius	1	



ELISA

District 7-0


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

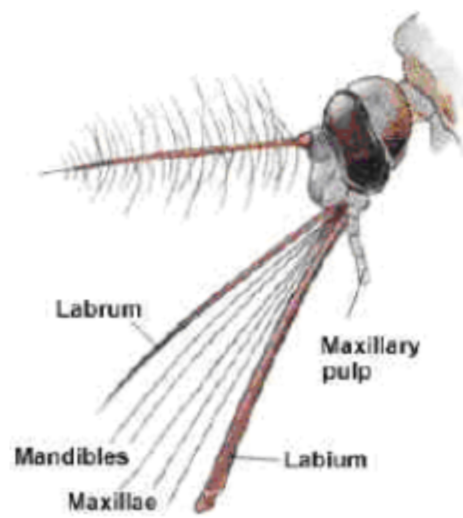
MOSQUITO SURVEILLANCE 2023

District 8-1

Surveillance in District 8-1 was done by the local EHS and students from Valdosta State University. Surveillance was done from March-November over 742 trap nights.

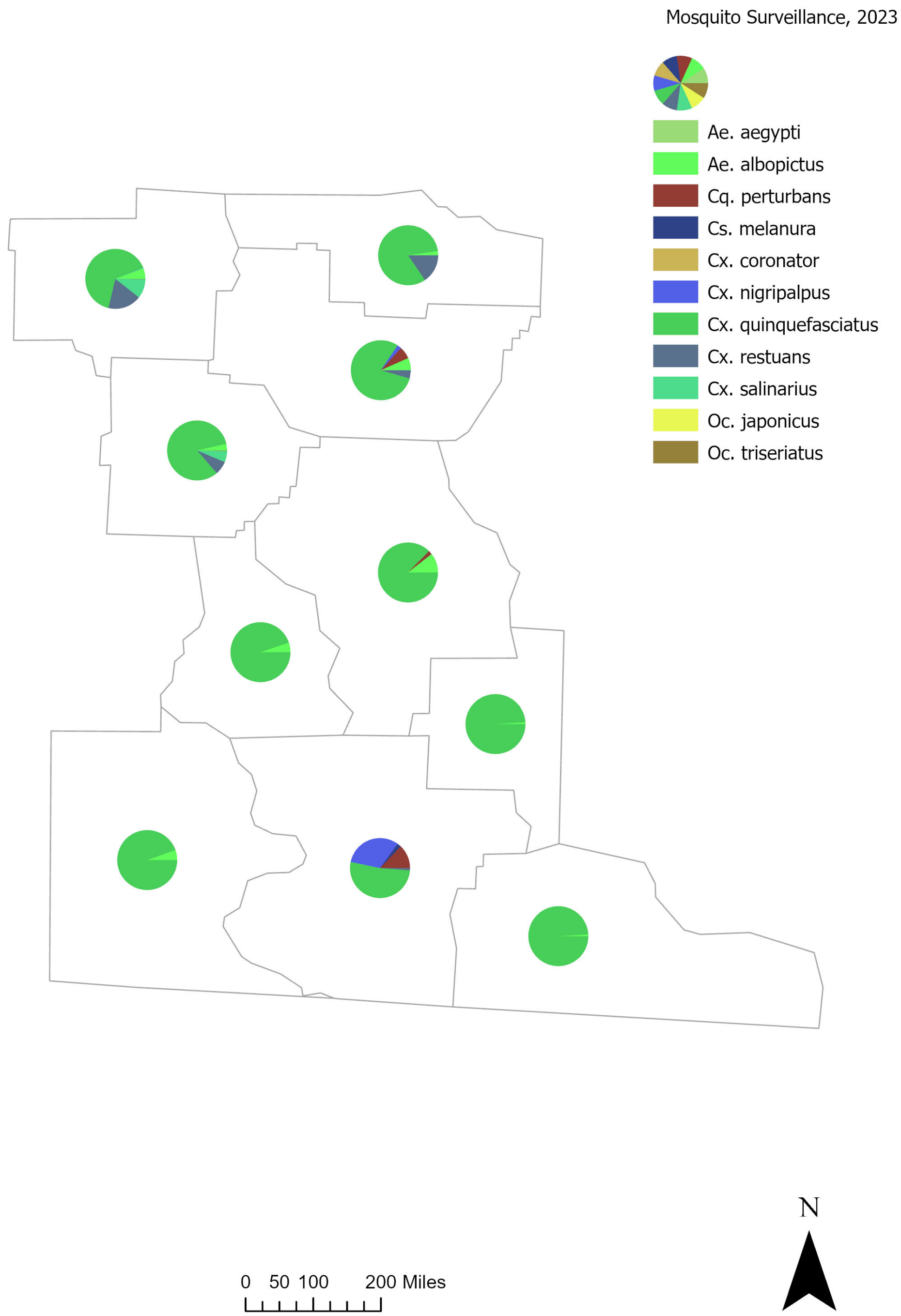
District 8-1		trap type	
County	***Species***	**CDC**	**Gravid**
Ben Hill	*Ae. albopictus*		1
	Cx. quinquefasciatus		37
	Cx. restuans		7
Berrien	*Ae. albopictus*		15
	Cx. quinquefasciatus		124
Brooks	*Ae. albopictus*		6
	Cx. quinquefasciatus		104
Cook	*Ae. albopictus*		12
	Cx. quinquefasciatus		219
Echols	*Ae. albopictus*		3
	Cx. quinquefasciatus		337
Irwin	*Ae. albopictus*		3
	Cx. nigripalpus		1
	Cx. quinquefasciatus		36
	Cx. restuans		2
Lanier	*Ae. albopictus*		3
	Cx. quinquefasciatus		297
Lowndes	*Cs. melanura*	596	57
	Cx. nigripalpus	5640	4199
	Cx. quinquefasciatus	525	15624
	Cx. restuans	6	376
	Cx. salinarius		1
Tift	*Ae. albopictus*		27
	Cx. quinquefasciatus		624
	Cx. restuans		55
	Cx. salinarius		46
	Oc. triseriatus		2

District 8-1		trap type	
County	***Species***	**CDC**	**gravid**
Turner	*Ae. albopictus*		38
	Cx. nigripalpus		1
	Cx. quinquefasciatus		418
	Cx. restuans		116
	Cx. salinarius		67
	Oc. triseriatus		1



Mosquito

District 8-1


Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

District 8-2

No surveillance was done in District 8-2 in 2023.

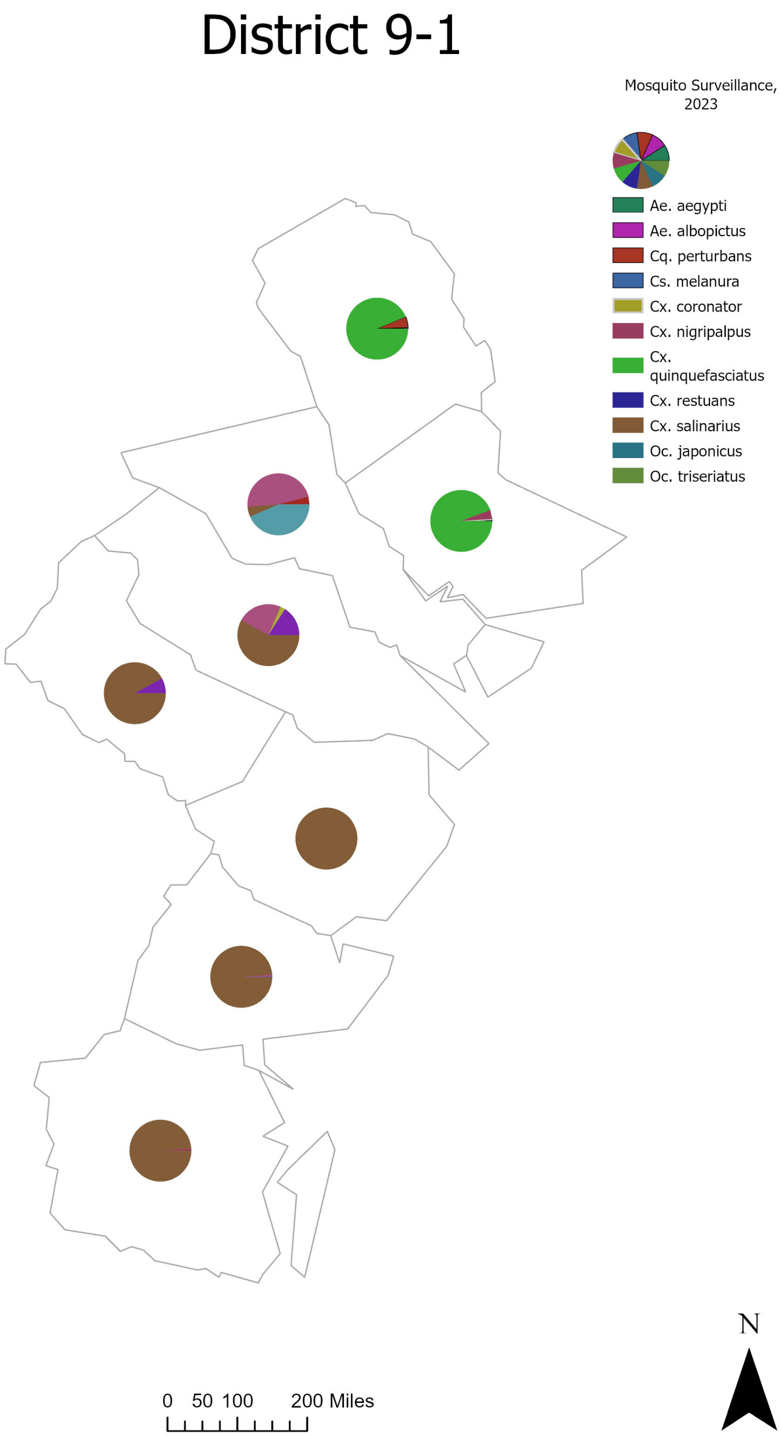
District 9-1

Surveillance in District 9-1 was done by Hinesville Public Works (Liberty County), Mosquito Control Services (Glynn & Camden counties), and Chatham County Mosquito Control programs. Surveillance was done from January-November over 2092 trap nights.

District 9-1		trap type			
County	***Species***	**BGS**	**CDC**	**Exit**	**Gravid**
Bryan	*Cx. nigripalpus*		33		3
	Cx. quinquefasciatus		4		
	Cx. salinarius		33		
Camden	*Ae. albopictus*		4		
	Cx. nigripalpus		50		
	Cx. quinquefasciatus		17		11241
	Cx. salinarius		14		
Chatham	*Ae. albopictus*	17			
	Cs. melanura		412	66	2
	Cx. coronator	11			
	Cx. nigripalpus		103	82	3400
	Cx. quinquefasciatus	11	10		71638
	Cx. restuans				14
	Cx. salinarius		35		
	Oc. triseriatus	2	9		3
Effingham	*Ae. albopictus*		1		
	Cx. quinquefasciatus		38		156
Glynn	*Ae. albopictus*		27		47
	Cx. nigripalpus		138		26
	Cx. quinquefasciatus		58		22446
	Cx. salinarius		18		8

District 9-1		Trap Types			
County	***Species***	**BGS**	**CDC**	**Exit**	**Gravid**
Liberty	*Ae. albopictus*		68		
	Cx. coronator		11		
	Cx. nigripalpus		100		
	Cx. quinquefasciatus		16		231
Long	*Ae. albopictus*		8		
	Cx. quinquefasciatus				93
McIntosh	*Cx. quinquefasciatus*				4

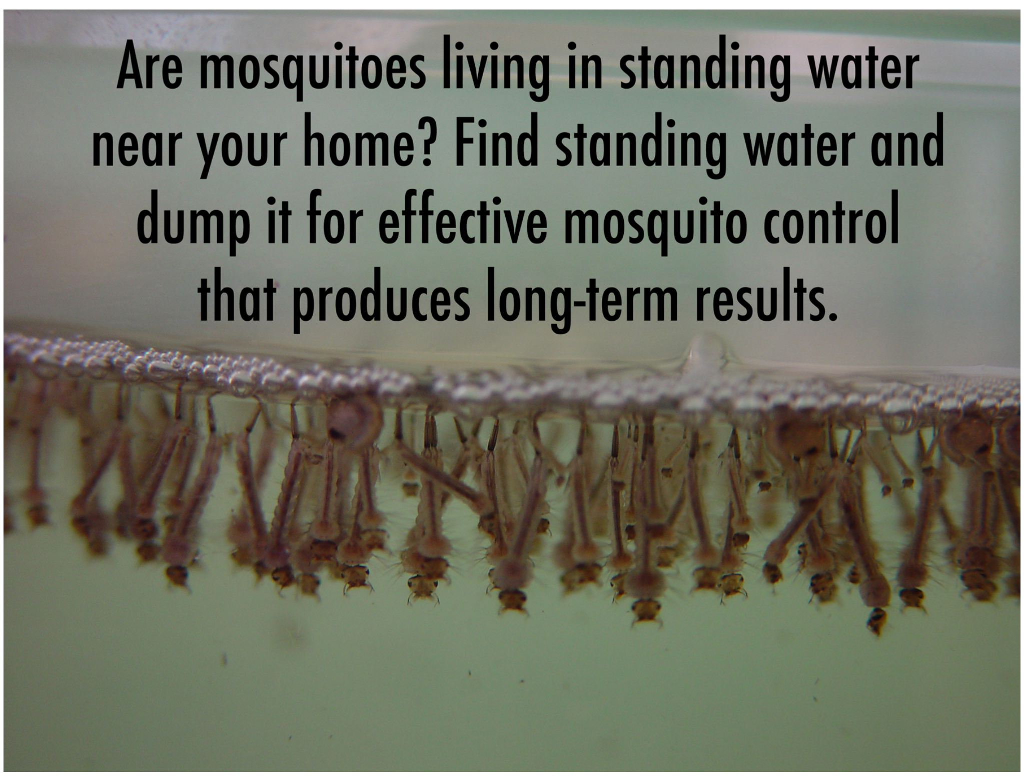
REITER-CUMMINGS GRAVID TRAP

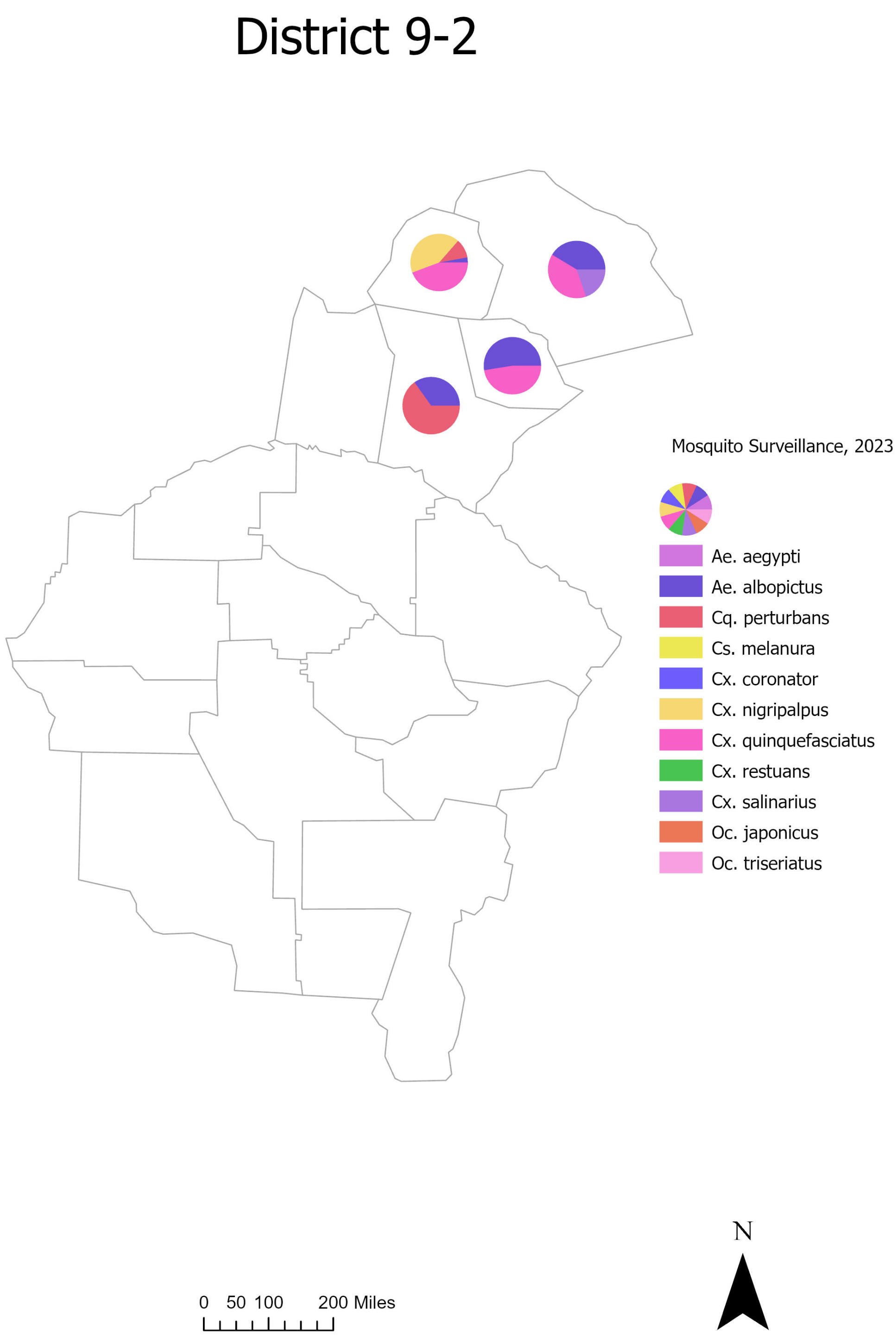

District 9-1
Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
N
0 50 100 200 Miles

District 9-2

Surveillance in District 9-2 was done by a volunteer from the Health District. Surveillance was done from March-June over 10 trap nights.

District 9-2		trap type	
County	***Species***	**CDC**	**Gravid**
Bulloch	*Ae. albopictus*	67	19
	Cx. quinquefasciatus	66	15
	Cx. salinarius	41	
Candler	*Ae. albopictus*	4	
	Cx. nigripalpus	48	11
	Cx. quinquefasciatus	56	6
Evans	*Ae. albopictus*	22	9
	Cx. quinquefasciatus	23	5
Tattnall	*Ae. albopictus*	15	




District 9-2
Mosquito Surveillance, 2023
Ae. aegypti
Ae. albopictus
Cq. perturbans
Cs. melanura
Cx. coronator
Cx. nigripalpus
Cx. quinquefasciatus
Cx. restuans
Cx. salinarius
Oc. japonicus
Oc. triseriatus
0 50 100 200 Miles
N

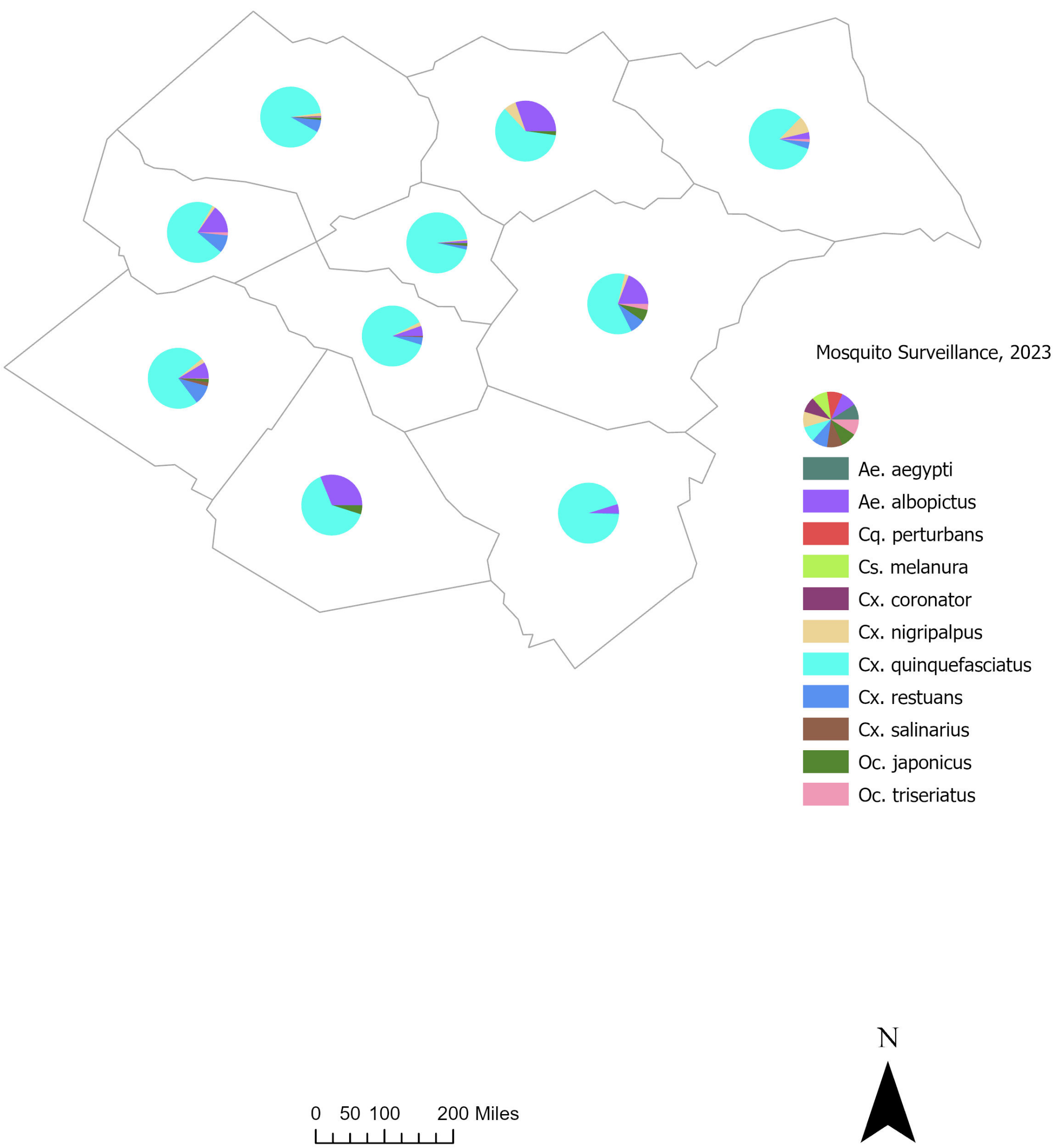
District 10-0

Surveillance in District 10-0 was done by an intern from SECVBD and a volunteer entomologist from UGA. Surveillance was done from April-September over 40 trap nights.

District 10-0		trap types	
County	**Species**	**CDC**	**Gravid**
Clarke	*Ae. albopictus*	3	3
	Cx. coronator	1	
	Cx. quinquefasciatus	1	8
	Oc. japonicus		1
Elbert	*Ae. albopictus*	15	3
	Cx. quinquefasciatus	46	2
Greene	*Ae. albopictus*		1
	Cx. quinquefasciatus	2	3
Jackson	*Ae. albopictus*	6	4
	Cx. nigripalpus	3	
	Cx. quinquefasciatus	17	7
Madison	*Ae. albopictus*	33	8
	Cx. quinquefasciatus		4
	Oc. triseriatus	1	
Morgan	*Ae. albopictus*	1	
Oconee	*Ae. albopictus*	20	1
	Cx. quinquefasciatus	14	13
	Oc. triseriatus	1	
Oglethorpe	*Ae. albopictus*	1	
	Cx. coronator	14	
	Cx. nigripalpus	3	1
	Cx. quinquefasciatus	24	7

District 10-0		trap type	
County	**Species**	**CDC**	**Gravid**
Barrow	*Ae. albopictus*	6	13
	Cx. nigripalpus		2
	Cx. quinquefasciatus	11	79
	Cx. restuans		12
	Oc. triseriatus	2	
Walton	*Ae. albopictus*	3	26
	Cx. nigripalpus	3	5
	Cx. quinquefasciatus	9	239
	Cx. restuans		35
	Cx. salinarius		7
	Oc. japonicus		6
	Oc. triseriatus		1

District 10-0

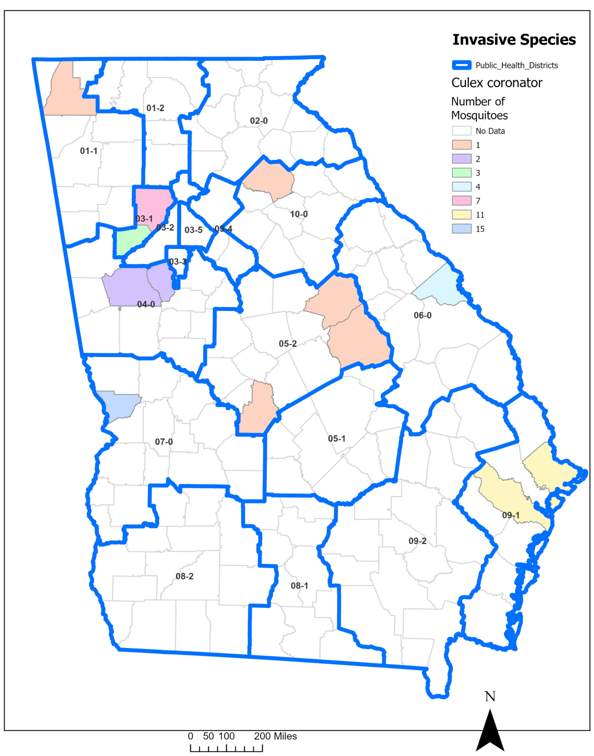


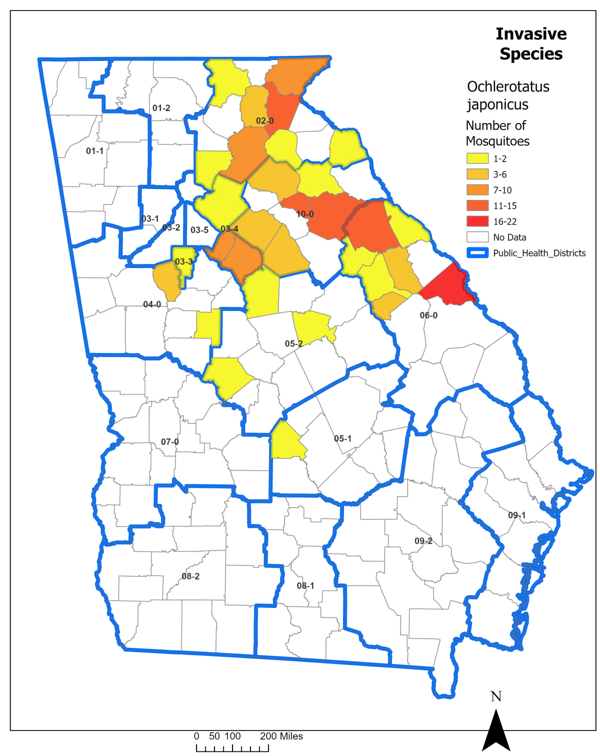
Invasive Mosquito Species

One of the benefits of mosquito surveillance is determining where mosquito species are found. This is especially important for vector species and for invasive species which may become involved in arboviral disease cycles.

Culex coronator was first detected in Georgia in 2006. It was found initially in counties below the Fall line. Mosquito surveillance done in 2017 - 2020 has shown that this species can now be found in most regions of Georgia. It is important to monitor *Cx. coronator* as it has the potential to be involved in the WNV cycle.

Ochlerotatus japonicus was first detected in Georgia in 2002. This species lays its eggs in rock pools, so was initially found only above the Fall line. Mosquito surveillance done in 2017 - 2020 has shown that this species can now be found in most regions of Georgia. It is important to monitor *Oc. japonicus* as it has the potential to be involved in the WNV cycle.





Invasive Species, 2023

Pesticide Resistance Testing

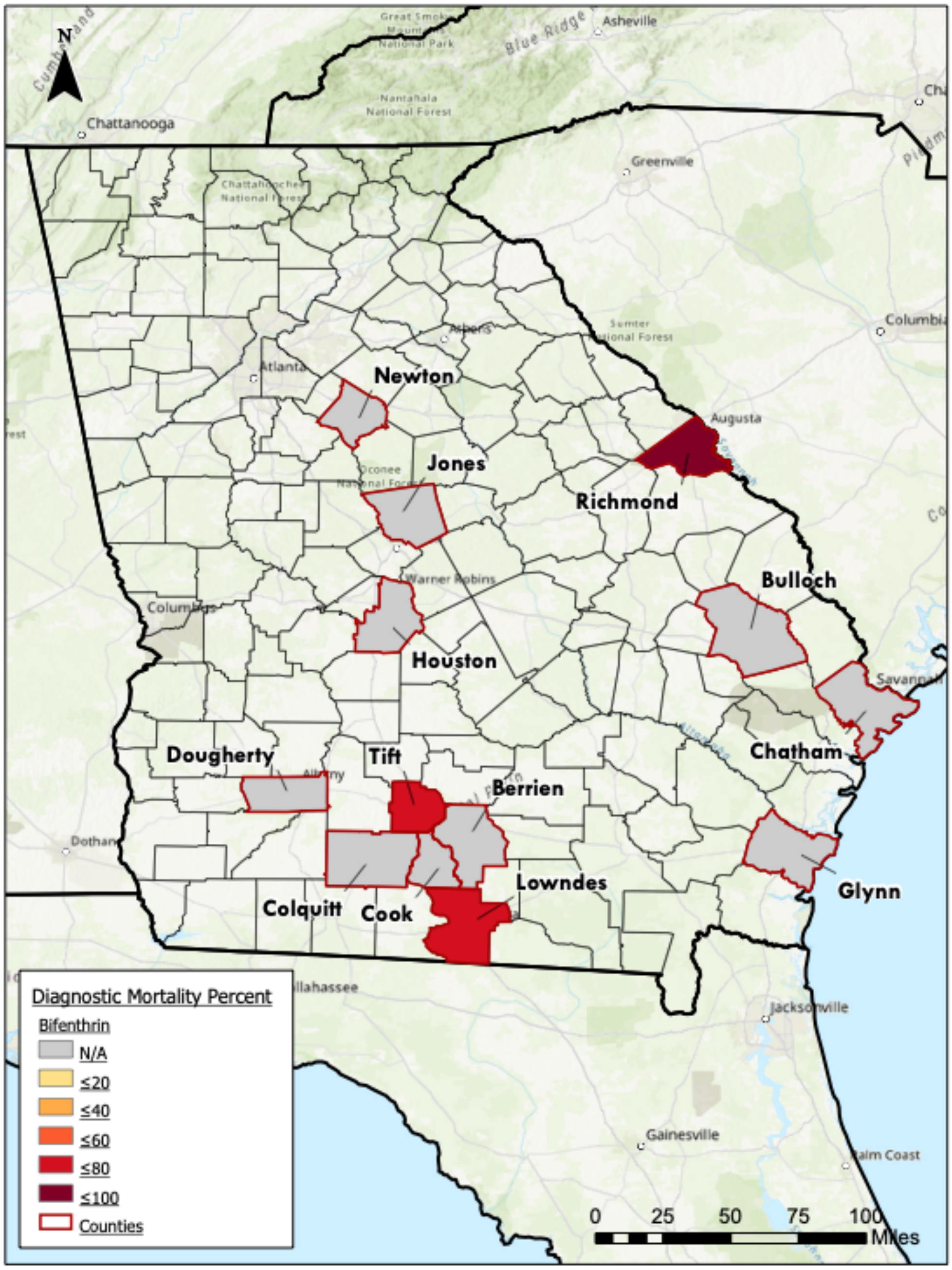
As we continue to see arboviral diseases such as La Crosse Encephalitis, St. Louis Encephalitis, Eastern Equine Encephalitis, and West Nile Virus in Georgia in 2023, mosquito control methods are critical. Pesticide resistance has been found to be a component for ineffective mosquito control. There is a lack of insecticide resistance studies conducted statewide in Georgia and minimal knowledge of which pesticides mosquitoes are resistant to.

The state entomologists and regional entomologist are tasked to conduct insecticide resistance testing in all high-risk urban regions of Georgia. Mosquito egg collections were initially performed by Vector Surveillance coordinators. Environmental Health Specialists are now assisting with egg collections. Mosquito egg collection training can be provided to all who assist with this endeavor.

Resistance testing is performed using the CDC Bottle Bioassay procedure and the chemicals that were provided in the CDC Bottle Bioassay kits. Preliminary data from several central and southern counties showed *Ae albopictus* to be exhibiting varied levels of resistance to permethrin and deltamethrin but were susceptible at varied levels to bifenthrin and deltamethrin used along with the synergist, PBO. *Culex quinquefasciatus* showed varied levels of resistance to permethrin, lambda cyhalothrin, and deltamethrin; they were susceptible to malathion.

With the implementation of the first statewide pesticide resistance testing program, a clearer picture of the type of mosquitoes and their resistance to specific pesticides commonly used in Georgia will be determined. This information enables DPH to advise and train current mosquito control operators in using the most effective and cost-efficient pesticide for their target-mosquito. The statewide pesticide resistance testing program is a major component in reducing the exposure of mosquito-borne disease risk to the public.

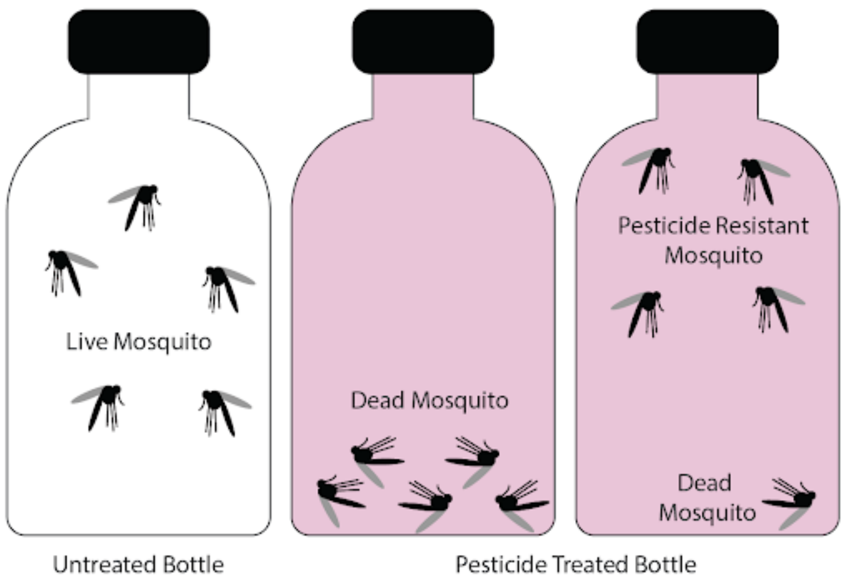
The map below shows resistance to bifenthrin in Georgia. Bifenthrin is an insecticide in the pyrethroid family. It is used as a barrier spray for mosquito control, most often by commercial applicators although Richmond County Mosquito Control Program does apply barrier spray in downtown Augusta to primarily control *Aedes albopictus*.

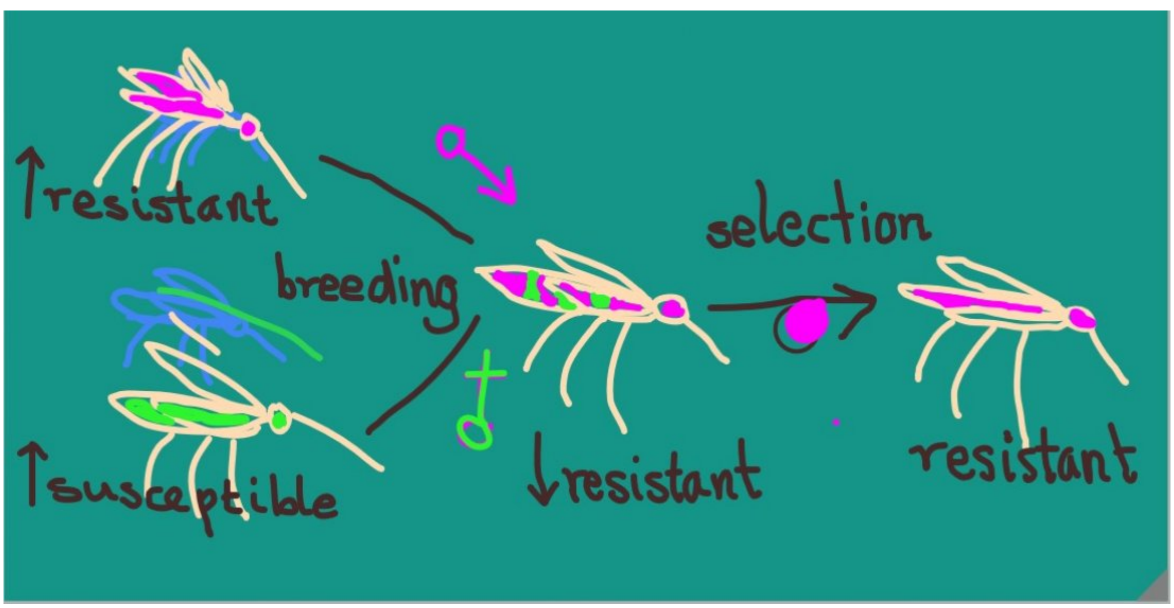


MAP OF MOSQUITO RESISTANCE TO BIFENTHRIN, GEORGIA

Resources

- http://www.gamosquito.org/publications.htm
- http://cdcsercoevbd-flgateway.org/
- https://www.cdc.gov/parasites/education_training/lab/bottlebioassay.html
- https://www.researchgate.net/publication/230625904_The_possible_role_of_entomological_surveillance_in_mosquito-borne_disease_prevention





MOSQUITO SURVEILLANCE 2023

Conclusions

In 2023, despite limited funding, mosquito surveillance was done in 101 of Georgia's 159 counties.

Year	# counties doing surveillance	% of counties
2001	2	1.3%
2002	11	6.9%
2003	26	16.4%
2004	56	35.2%
2005	55	34.6%
2006	28	17.6%
2007	28	17.6%
2008	28	17.6%
2009	26	16.4%
2010	22	13.8%
2011	19	11.9%
2012	12	7.5%
2013	13	8.2%
2014	15	9.4%
2015	13	8.2%
2016	60	37.7%
2017	159	100.0%
2018	159	100.0%
2019	159	100.0%
2020	142	89.3%
2021	103	64.8%
2022	79	49.7%
2023	101	63.5%

MOSQUITO SURVEILLANCE 2023

Surveillance was done in areas of highest risk of vector-borne diseases, but in many counties, surveillance was non-existent or limited. Surveillance was unfortunately lacking completely in 2 Health Districts (1-2 & 8-2). This level of surveillance was only possible through the combined effort of State, District, and County Environmental Health, as well as assistance from several other agencies, including mosquito control, contracted services, interns, and volunteers.

Our goals for the 2024 mosquito surveillance season continue to be:

- Doing some level of mosquito surveillance in every county in Georgia
- Doing targeted surveillance in areas where *Ae aegypti* were found in the 1950s
- Providing continued training to Environmental Health Specialists
- Support local outreach for mosquito complaints and arboviral disease cases
- Continued testing for adulticide resistance, especially in high-risk areas of Georgia
- Beginning testing for larvicide resistance in localized areas
- Spatial analysis of pesticide resistance in Georgia

The accomplishment of these goals will allow the Georgia Department of Public Health to be better prepared for the next mosquito-borne disease to emerge. However, these goals are not attainable without sustainable funding.

Acknowledgements

I would like to thank everyone who assisted with this mosquito surveillance project, at the State, District, and County Public Health levels, as well as the mosquito control programs, interns, and others who contributed data.

District Map