Bay County Mosquito Control • 2017 ANNUAL REPORT

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PROGRAM BACKGROUND

Bay County Mosquito Control (BCMC) is a community-wide public health program that began operations in 1977 in conjunction with Saginaw County as the Saginaw-Bay Mosquito Control Commission after an outbreak of St. Louis encephalitis occurred in Michigan. To better serve their residents, the counties each began their own operations in 1985.

As one of the divisions of the Bay County Environmental Affairs and Community Development Department, the Mosquito Control program seeks to protect the health and quality of life of residents and visitors from potential disease and the annoyance caused by the bite of mosquitoes. We acknowledge the importance of serving the public by providing mosquito control services without producing adverse impacts on the environment; therefore, our goal for mosquito "control" is not elimination of the insect, but rather an Integrated Mosquito Management (IMM) approach using a variety of methods designed to prevent and reduce the number of mosquitoes so they no longer unfavorably affect the health and quality of life of Bay County residents.

Using nationally verified scientific mosquito management and control strategies, IMM methods include education on repellents and skin protection to reduce biting occurrences, source reduction through ancillary habitat management, (i.e., spare tire collection, dumping containers, and covering pools), biological surveillance, disease surveillance, and finally, field operations using larval and adulticide source control.

Bay County is one of four Michigan counties providing a comprehensive mosquito control program and efficiencies are realized through collaboration in a Mid-Michigan Technical Advisory Committee (TAC), composed of local and state professionals. The TAC meets annually to review program operations for Bay, Midland and Tuscola County mosquito control programs and allows for interagency cooperation and cost savings, particularly as the three counties bid jointly on bulk insecticide orders to keep costs as low as possible.

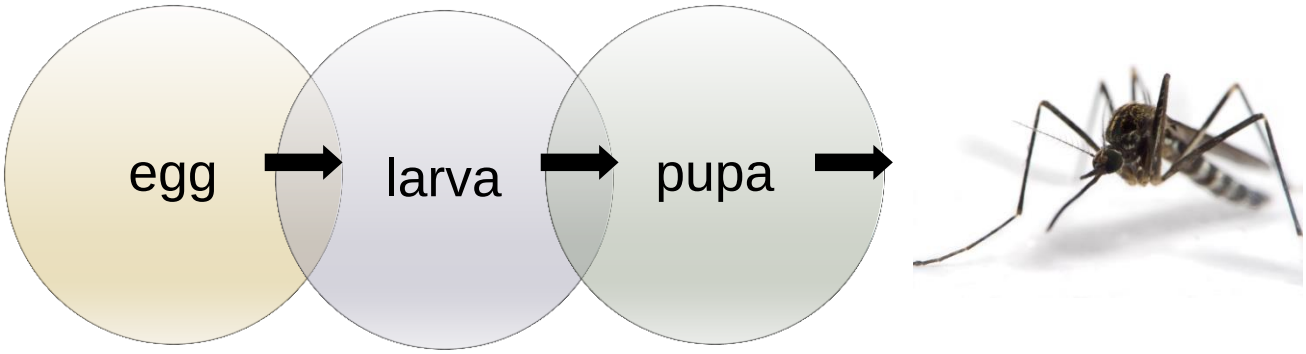
BCMC provides services to the 106,000 residents living in an area covering 443 square miles. The Mosquito Control program is funded by a voter-approved millage, which routinely has received overwhelming voter approval of 84%. After 28 years, the 0.45 mill tax levy was increased for the first time in 2016 to 0.55 mills for eight years.

MOSQUITO BIOLOGY AND LIFE CYCLE

Mosquitoes are aquatic insects that undergo a complete metamorphosis involving four distinct stages—egg, larva, pupa, adult—throughout their life cycle. Female mosquitoes can develop several hundred eggs with each blood meal and lay them in or around water. The eggs are laid (where standing water accumulates after rain or flooding) either singly or attached to one another to form an egg raft that floats on the water's surface.

Once eggs hatch, larvae emerge, wriggling through the water. The larvae are filter feeders that eat voraciously and outgrow their skin. Larvae undergo four stages or instars before they change into pupae, which happens about one week after the eggs initially hatch. Pupae do not feed and are often found at the surface of water (like larvae) where they breathe. Inside the pupa's protective shell, the mosquito transforms into the winged adult. Eclosion is the emergence of the adult mosquito from the pupal case. These newly-emerged adults use the cast skin for support until their wings and body dry, at which time they fly away. The whole life cycle is typically a quick process, taking about a week to complete. Once the eggs hatch, the time required to complete the life cycle is dependent on temperature—the warmer the water, the more quickly a mosquito develops.

After mating, females seek out an animal upon which to feed and this blood provides protein to develop eggs. Males do not bite, but do have sucking mouthparts to obtain plant nectar as a source of energy; females do this as well. Next, females search for an aquatic habitat or moist ground to deposit eggs. Although there are exceptions to the rule, most adult mosquitoes live for a period of four to eight weeks.



SPRING LARVAL SURVEILLANCE

As a result of spring flooding due to rainfall or snowmelt, the potential exists each year for significant spring mosquito larval development in the woodland areas of Bay County. Spring aerial treatment utilizing three fixed wing aircraft was conducted when larvae reached the second or third instar growth stage. Monitoring larval development was critical for timely application of *Bti* (*Bacillus thuringiensis israelensis*), a bacterium eaten by larvae that caused mortality within 48 hours. The *Bti* could be used as a food source by other aquatic organisms occupying the same woodland pool habitats.

Surveillance was an essential part of the spring mosquito control program. Mosquito larval surveillance began in early-March with first instars observed in woodland pools on March 9th. The most notable feature of the woodlots at that time was that water levels were well-below average compared to a typical year. Rainfall for March was 2.8 inches although an inch of that total fell during the last day and half of the month. When coupled with the wet April (5.89 inches of rain recorded), plenty of water was present to cause mosquito hatch for the 2017 aerial treatment program. A cold snap from March 20-23 and again from March 28-31 caused larval development to slow, but rebounded when temperatures averaged 8 degrees above normal from April 8-19. Woodland pools were set and larvae counted beginning April 10 when both first and second instar larvae were noted.

Pre-treatment larval counts were taken between one and four days before aerial treatment in forty woodlots with post counts following within five days after treatment. Aerial calibration took place on April 17 with treatment beginning immediately and lasting eight days until April 25. Two of those days were non-treatment days due to wind and rain. Three fixed wing aircraft were calibrated to deliver 3 pounds of VectoBac® G *Bti* per acre and a high level of larval mortality was achieved with the VectoBac product.

Post counts indicated an overall average 91.2% corrected larval mortality (Table 1), which indicates favorable control was accomplished at the 3-pound per acre dosage. Most woodlots had excellent *Bti* coverage and, as usual, where there was *Bti*, there were either no mosquito larvae found or only dead larvae floating throughout the water column. In some woodlots with lower mortality, there was light *Bti* coverage due to the wind's influence on granular product placement. In others, a long, shallow pool had *Bti* on one end with little on the other. When the water is shallow, the bacteria may not be able to circulate throughout the water column as effectively, leading to lower mortality values. *Bti* continues to be one of the most important tools in Bay County's IMM control program, as it offers high mortality with little environmental impact at an affordable cost.

Quality control of the spring aerial campaign was accomplished with the help of three full-time and two seasonal staff members. Staff walked through 33 treated woodlots over the course of the program in order to determine both the average number of *Bti* granules per

square foot, which helped confirm the dosage rate, and locate possible skips or misses occurring with the aerial application.

Bio-ecological monitoring was conducted before and after treatments. Frogs, tadpoles, seed shrimp, fairy shrimp, water fleas, copepods, and caddisflies that were observed in the woodland water habitats before treatment were found in large numbers after treatment, as well.

Mosquito pupae were first seen on April 19 and adult emergence of spring *Aedes* mosquitoes from seasonally flooded woodlots took place from May 1-10, earlier than the historical average. Thankfully, though adult mosquitoes were on the wing early, the nightly temperatures were low enough that adult mosquito activity was limited until early June.

Spring woodland pool

Table 1 – Spring Treat Larval Mortality

Bay County Mosquito Control Spring Treatment 2017 3 lb/acre VectoBac® G *Bti* Evaluation			
	Larval Count		
Location	**Pre**	**Post**	**Mortality**
Bangor 4 - Bangor Oil Well	0.95	0	100%
Bangor 33 - Bangor and Zimmer	0.8	0.075	90.6%
Beaver 4 - 1576 Cottage Grove	2.02	0.14	93.1%
Beaver 5 - Carter and Cottage Grove	1.26	0.04	96.8%
Beaver 9 - 1585 Cottage Grove	1.48	0.02	98.6%
Beaver 18 - 1200 Flajole	0.633	0	100%
Beaver 24 - Beaver Township Park	0.7	0	100%
Frankenlust 2 - 6505 Four Mile	3.26	0.02	99.4%
Frankenlust 3 - Delta by Automotive Bldg.	1.44	0.22	84.7%
Frankenlust 3 - Mackinaw Road	1.36	0.12	91.2%
Frankenlust 7 - 259 Amelith Road	2.125	0.26	87.8%
Fraser 6 - Townline 16 by 7 Mile Rd.	1.05	0.2	81%
Fraser 11 - Camp Fishtales	0.78	0.18	76.9%
Fraser 11 - Deer Acres	1.208	0.32	73.5%
Fraser 15 - Fraser Twp. Firebarn	1.25	0.025	98%
Fraser 22 - Fraser Twp. Hall	0.9	0.02	97.8%
Garfield 9 - 11 Mile N. of Erickson	1.46	0.04	97.3%
Garfield 10 - Garfield Twp. Park	1.04	0.26	75%
Garfield 15 - Methodist Church	2.075	0.06	97.1%
Garfield 26 - Crump Fox Club	2	0.2	90%
Kawkawlin 2 - 2080 LeBourdais Rd.	3.4	0	100%
Kawkawlin 30 - White Birch Village	0.8	0	100%
Monitor 9 - 1306 Wheeler	0.6	0.05	91.7%
Monitor 20 - Fraser and N. Union	1.47	0	100%
Monitor 23 - Rocking Horse Ranch	0.74	0.1	86.5%
Monitor 28 - Mackinaw Road Tech Park	0.62	0.04	93.5%
Monitor 34 - Fremont Cemetery	0.583	0.04	93.1%
Mt. Forest 9 - Sand Rd. Road Commission	1.12	0	100%
Mt. Forest 17 - Carter N. of Cody-Estey	3.74	0.28	92.5%
Mt. Forest 21 - Daycare	1.32	0.04	97%
Mt. Forest 21 - Mt. Forest Hall	0.78	0	100%
Mt. Forest 21 - Mt. Forest Firebarn	1.89	0.14	92.6%
Mt. Forest 30 - Pinconning and County Line	4.07	0.2	95.1%
Pinconning 23 - K C Hall Water Street	1.96	0.52	73.5%
Pinconning 30E - Pinconning County Park	0.8	0.02	97.5%
Portsmouth 35 - R&R Ready Mix	0.67	0.1	85.1%
Williams 19 - Victoria Woods Trailer Park	0.567	0.133	76.5%
Williams 20 - Forest School/Daycare	0.96	0	100%
Williams 21 - Forest Edge	0.633	0.22	65.2%
Williams 30 - Rockwell and Salzburg	1.08	0	100%
CONTROL 6505 Four Mile	3.26	3.04	6.7%
CONTROL Fremont Cemetery	0.583	0.56	3.9%
AVERAGE TREATED MORTALITY			**91.7%**
AVERAGE TREATED MORTALITY (Corrected)			**91.2%**

SUMMER LARVAL SURVEILLANCE

Mosquito larval activity was monitored throughout the season and considered a key component to an IMM program. Surveillance was designed to monitor mosquitoes county-wide to determine distribution, density, and species composition and it is a combined effort conducted by larviciding crews, field supervisors, and biology personnel.

Staff conducted routine surveillance of probable mosquito breeding sites using a standard pint-sized dipper. Stagnant water sites included ditches, catch basins, flooded fields, woodlots, and tires. Roadside ditch larval site inspections, termed sequential sampling, occurred weekly throughout the county with larval samples collected and identified to determine the need for control. One hundred thirty-three larval samples representing ten species were identified; the majority was *Culex pipiens, Culex restuans, Aedes vexans*, and *Aedes japonicus,* the latter found primarily in tires and containers.

Quality control continued to be an essential function for biology technicians. Habitats that were recently treated were re-checked to ensure control materials were properly applied and effective. Quality control efforts began with surveys of woodlots in April to assure proper treatment and continued through the summer as technicians checked recently-treated habitats. Tires, ornamental ponds, ditches, and retention ponds were some of the habitats that were checked within a few days of treatment to make sure the product was performing correctly; no non-target impacts were noted.

CATCH BASINS: To assess the activity and mortality of *Culex* mosquitoes in city and suburban catch basins, biology staff randomly inspected 20-40 basins on nine occasions. The basins are a perfect habitat, providing *Culex* mosquitoes with organically-rich standing water and decomposing leaf litter that provides a bacterial food source. Basin surveillance on May 31 showed that 40% of wet basins checked were breeding with both larvae and pupae. This prompted the initial treatment on June 5 using VectoLex® FG and Natular™ XRT, two products with naturally-occurring active ingredients. In order to determine efficacy and longevity of the control materials, basins were inspected often. Based on past experience, VectoLex is expected to provide control for about four weeks while Natular is expected to provide season-long control. However, twelve days after the initial treatment, heavy June rains began with a 3-4” rain event on June 17 followed by 0.5-1.2” of rain on June 20, 0.25-1.2” on June 22, and 3-5” on June 26. Published results from other mosquito districts have shown that a two-inch rain event can flush product from the basins.

Catch basin surveillance in early July showed spotty results. Many treated and control basins appeared to have either been flushed of larvae and/or product showing no activity whatsoever or a resurgence of larvae. A second VectoLex catch basin treatment of the VectoLex-marked basins occurred on July 11 with post-checks beginning July 21. Nearly 45% of these basins were heavily breeding one month later prompting the third and final

treatment in mid-August. Catch basins receiving the Natular XRT treatment in early June showed 16% breeding on July 3, 30% breeding on July 21, and by August 11 half of the basins had showed some breeding activity with larger-stage larvae. Again, perhaps the rain events occurring in June caused product flushing and loss of control. Surveillance will continue next summer to evaluate product efficacy.

AEDES JAPONICUS

Aedes japonicus is a container-breeding mosquito species native to Asian countries. It was first discovered in Bay County in 2005 in its adult form, but began to crop up in larval samples in 2006. The following two figures show how this invasive species now occupies several habitats including artificial containers (Figure 1) and tires (Figure 2) as it competes with native species. Technicians have also sampled *Ae. japonicus* larvae to a lesser extent in ornamental ponds, cross country drains, tree holes, roadside ditches, and ponds.

Staff continue to provide control efforts as well as habitat reduction (i.e. tire drives) to inhibit this species. It is thought to serve as a "bridge" vector in transmission of West Nile and perhaps other mosquito-borne viruses in North America.

Figure 1 – Artificial Container Species, 2017

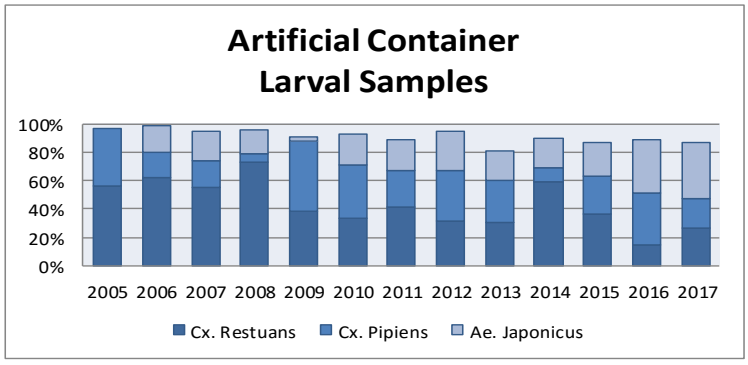
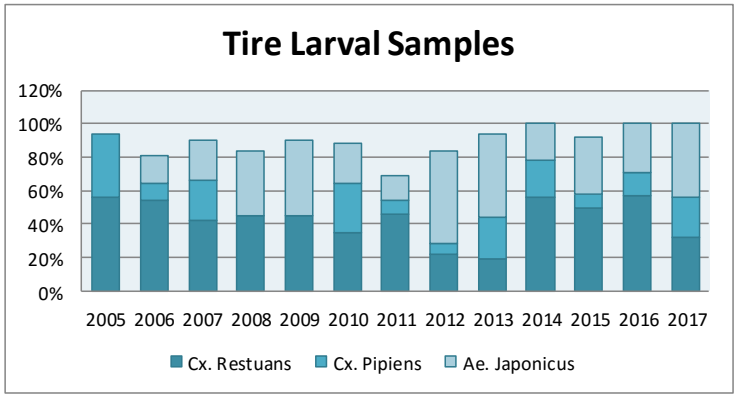


Figure 2 – Tire Species, 2017



NEW JERSEY LIGHT TRAPS (NJLT)

As in previous years, BCMC completed regular mosquito trapping throughout the season. Trapping data is critical to the mosquito management program as it helps recognize mosquito numbers, species, location, and potential disease threats. One of the main tools utilized for adult surveillance is the NJLT. From mid-May through mid-September, adult mosquitoes were collected in 14 traps placed throughout the county in backyards with little or no competing light source. Samples were gathered three times each week, followed by counting and species identification. The total capture was 25,769 (Table 2), twice the number collected in 2016 and 70% more than the historical average of 15,041. Heavy rains in late June caused a significant floodwater mosquito hatch that lasted through July with nuisance mosquitoes spiking July 12 and causing much anxiety among Bay County residents.

Table 2 - New Jersey Light Trap Data, 2017

2017 LIGHT TRAP DATA						
Species	**May**	**June**	**July**	**August**	**September**	**TOTAL**
Aedes canadensis	15	12	97			124
Aedes cinereus		1	7			8
Aedes implicatus			9			9
Aedes intrudens	2	3	51	5		61
Aedes japonicus		2	12	6	2	22
Aedes provocans			4			4
Aedes sticticus		4	24	2		30
Aedes stim/fitchii	36	26	122			184
Aedes triseriatus		6	28	5		39
Aedes trivittatus	4	8	302	26		340
Aedes vexans	51	832	14793	851	81	16608
Anopheles perplexens	5		6	3	9	23
Anopheles punctipennis	13	62	261	147	14	497
Anopheles quadrimaculatus	15	350	923	727	127	2142
Anopheles walkeri	10	149	242	98	16	515
Culiseta inornata/morsitans	16	4	4	2	2	28
Coquillettidia perturbans		1220	1620	87	1	2928
Culex restuans	107	251	426	247	51	1082
Culex pipiens		73	370	322	87	852
Culex erraticus					2	2
Culex territans		2	49	40	11	102
Psorophora ciliata			7			7
Psorophora ferox			44	4		48
Uranotaenia sapphirina		2	36	19	5	62
Damaged	5	9	29	8	1	52
TOTAL FEMALES	**279**	**3016**	**19466**	**2599**	**409**	**25769**
TOTAL MALES	236	1278	4424	1448	212	7560
Historical Female Totals (35 yrs)	**377**	**4141**	**5440**	**3923**	**1160**	**15041**

Twenty-four species were collected during the 2017 season with the most predominant species being *Aedes vexans*, ranking first numerically, representing 64% of the total. This floodwater mosquito usually ranks first because it hatches in great numbers after heavy rains flood ditches, fields, and woodlots. The second most abundant species was *Coquillettidia perturbans*, the cattail marsh mosquito, with 2,928 females collected representing 11% of the catch. In a typical year, *perturbans* would account for 9% of the total. Lastly, four *Anopheles* species (*quadrimaculatus*, *walkeri*, *punctipennis*, and *perplexens*) represented 12% of the total catch, collectively.

Figure 3 shows a 22-year historical view of light trap collections with the average number collected in a given year represented by the solid red line (15,041). Total number of females collected in 2017 was well-above average and the season ranked the fourth heaviest mosquito year in a 35-year history. Typically, total number of females corresponds with the amount of rainfall received and this year our heaviest rains came in mid-to-late June. Figure 4 (page 11) shows mosquito species collected per trap night throughout the summer. In 2017, there was only one major hatch of summer floodwater *Aedes* with the peak occurring on July 12, which followed the heavy June rains by about two weeks. *Anopheles* species showed two minor spikes in early July and August and were mostly confined to areas along the Saginaw Bay.

Figure 3 - New Jersey Light Trap Historical Data

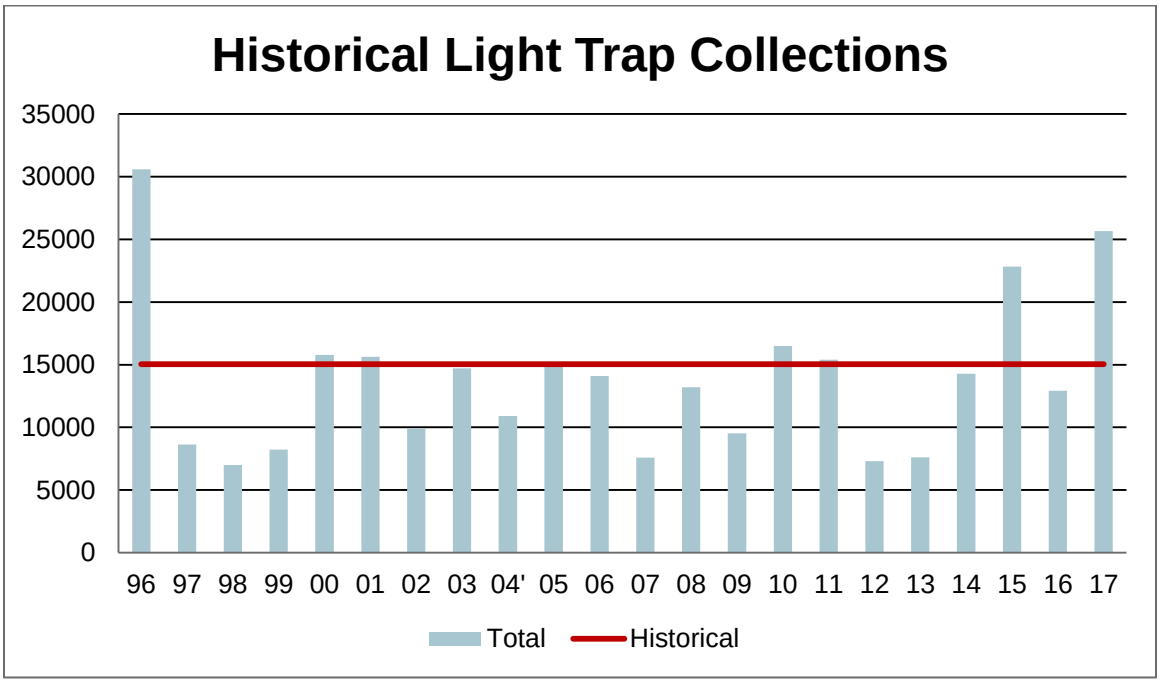
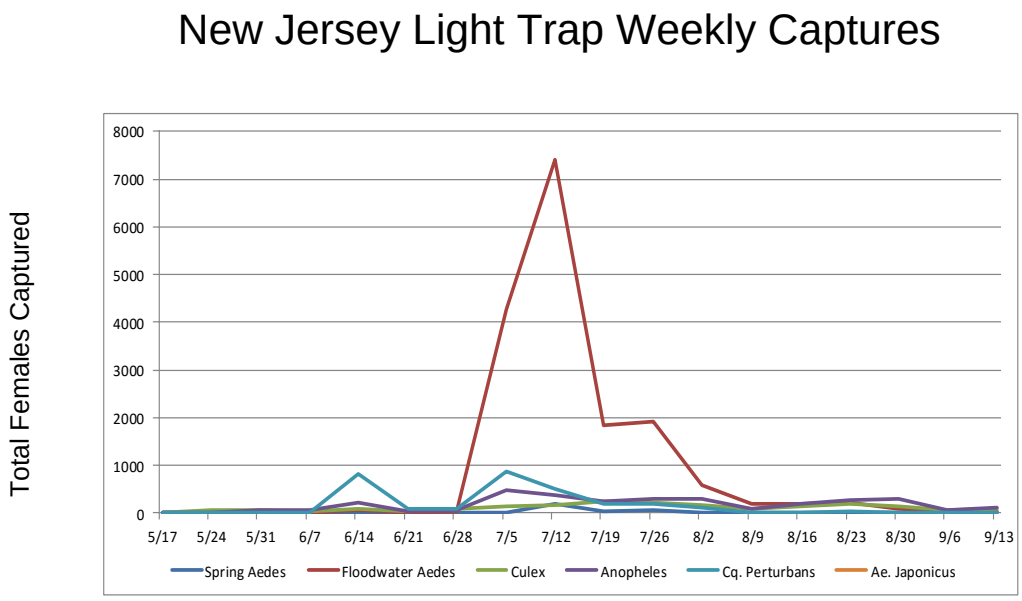


Figure 4 - New Jersey Light Trap Weekly Data, 2017



Unsorted light trap collection (left) with male and female mosquitoes sorted (right)

CDC TRAPS

CDC Traps are another mechanical trap utilized in BCMC's adult surveillance program. The CDC Trap attracts blood-seeking female mosquitoes with the use of dry ice (carbon dioxide) as bait. Traps are placed overnight within woodlots, summer festival grounds, treatment sites, and residential properties. Usually the traps hold diverse species and larger mosquito numbers compared to New Jersey Light Traps. Traps are also used to assess homeowner complaints, gather mosquito-borne disease information, and record changes in abundance of mosquitoes before and after control operations. These traps are quite good at sampling most of the district's individual mosquito species, each one being slightly different from the other due to breeding site preferences, biting habits, flight range, and ability to transmit disease.

The total number of mosquitoes captured in 287 CDC traps this year was 53,576 (Table 3-page 14). Heavy June rains brought on a large influx of floodwater species, namely *Aedes vexans, Ae. trivittatus, and Ae. sticticus*, together claiming the top-ranking spot for total females collected (44%), as they do in most years. Also ranking high this year was the cattail marsh mosquito, *Coquillettidia perturbans,* representing 35% of the total catch. Historically, *Cq. perturbans* numbers are elevated about once every three years, but their counts have been higher than average and they've been coming on earlier for the last two years.

Twenty-four species in seven genera were collected and identified, averaging 187 females per trap, up considerably from 2016 when there were 74 females per trap. The average number of females in 2015 and 2014 was 188 and 191, respectively. This year we continued to trap twice weekly, placing 20 traps total each week. Some traps were placed in previously-sampled locations while others were placed based on dead bird reports, mosquito complaints, or other indicators of possible virus or nuisance risk.

Studies have shown that more *Culex* mosquitoes can be collected when a CDC trap is suspended in the tree canopy compared to traps placed at ground level. To aid in disease surveillance efforts, CDC traps were elevated on five occasions to collect additional *Culex* mosquitoes that feed on birds as they roost in tree canopies. In every case, *Culex* dominated the species captured in elevated traps; on average 76% of the species collected were *Culex*.

Table 3 - CDC Trap Data, 2017

2017 CDC TRAP DATA						
Species	**May**	**June**	**July**	**August**	**September**	**TOTAL**
Aedes atropalpus						0
Aedes canadensis	83	127	1234	7		1451
Aedes cinereus	7	4	5	47		63
Aedes dorsalis						0
Aedes implicatus			3	1	2	6
Aedes intrudens		15	226	10		251
Aedes japonicus			1			1
Aedes provocans		1				1
Aedes sticticus		79	219	7		305
Aedes stim/fitchii	73	54	84	3		214
Aedes triseriatus		5	15	32	3	55
Aedes trivittatus	36	144	7584	207	20	7991
Aedes vexans	99	3006	9629	2123	353	15210
Anopheles perplexens		6	1	3		10
Anopheles punctipennis	27	89	135	71	1	323
Anopheles quadrimaculatus	29	347	700	728	15	1819
Anopheles walkeri	26	625	857	209	18	1735
Culiseta inornata	4	1				5
Culiseta morsitans						0
Coquillettidia perturbans		10357	6837	1344	58	18596
Culex restuans	107	46	291	565	50	1059
Culex pipiens	1	808	44	438	13	1304
Culex tarsalis		1		2		3
Culex territans			3		2	5
Psorophora ciliata			2	2		4
Psorophora ferox			3055	52		3107
Uranotaenia sapphirina					2	2
Damaged	4	4	38	8	2	56
Total	**496**	**15719**	**30963**	**5859**	**539**	**53576**

BG SENTINEL 2 TRAP

The BG Sentinel 2 Trap was introduced into the surveillance program during 2016. It is equipped with a BG-Lure that releases a combination of substances found on human skin, such as ammonia, lactic acid and caproic acid. The trap also has a black body and white lid, thus relying on visual cues from mosquitoes to hone in on the trap. After years of research, the trap is designed to be especially effective in collecting *Aedes aegypti* and *Aedes albopictus* mosquitoes, Zika virus vectors. Carbon dioxide can also be added to the trap, but BCMC does not equip the traps in that fashion. Traps were not utilized in 2017, but will be implemented into the 2018 program plan to monitor for the potential introduction of these two species in Bay County.

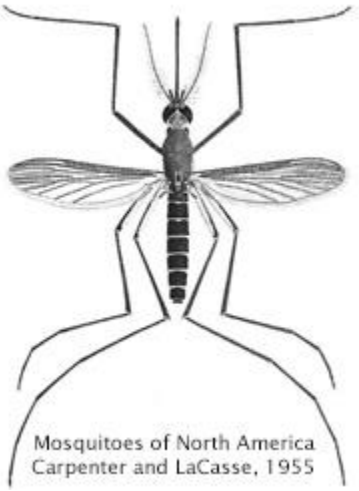
SPECIES FOCUS – CULEX ERRATICUS VS. CULEX TERRITANS

Culex erraticus is a small, dark brown, multiple-generation species that is known to breed in grassy shallow margins of ponds and marshes. It is frequently associated with larvae of *Anopheles quadrimaculatus*; the same can be said of *Culex territans*. As a larva, ***erraticus'*** siphon or breathing tube is very long, thin, and marked by five pairs of hair tufts (again, not unlike *Culex territans* which makes them difficult to tell apart as larvae). Adults look similar to common *Culex* found in Michigan, but are a richer brown color and their long proboscis is slightly swollen at the end. Research shows that *Culex erraticus* adult females may attack man at night in outdoor situations, but that they seem to prefer the blood of birds, large mammals, reptiles and amphibians. Furthermore, the species does not fly far from its breeding ground after emergence.

Distribution maps for *Cx. erraticus* show it occupying areas in the southeastern U.S. from Virginia to Texas and as far north as southern Minnesota. In Michigan the maps show the species along the southern border; however it has been found as recently as 2016 in Midland County and BCMC found 2 adults in NJLTs this year.

According to the CDC, *Cx. erraticus* have tested positively for Eastern Equine encephalitis (EEE), St. Louis encephalitis (SLE), and West Nile virus (WNV), but have only been found to be competent vectors of EEE and don't seem to effectively spread the other viruses they have been infected with.

Winter is passed as a hibernating adult, which seems to hold true in Michigan's colder climate for other *Culex* species as well.



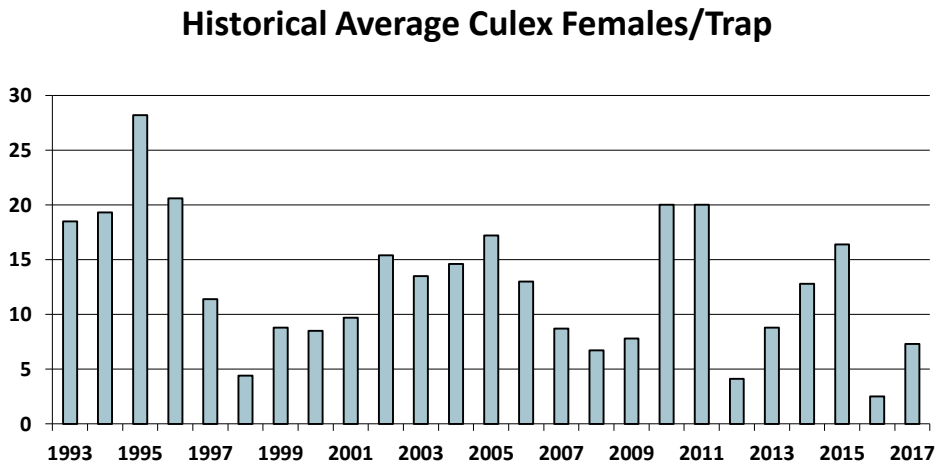
Culex erraticus

GRAVID TRAPS

Two *Culex* species, namely *Cx. pipiens* and *Cx. restuans*, are considered the main vectors of West Nile virus in Bay County. The abundance of these species is closely monitored and is used in the risk assessment for West Nile virus transmission. Gravid traps offer another method to collect female mosquitoes, primarily these *Culex* species that have taken a blood meal and are searching for a suitable place to lay eggs (oviposit). This trap is selective for blood-fed female *Culex* mosquitoes; therefore, the traps provide a good means for early West Nile virus (WNV) detection. A solution containing water, brewer's yeast, whey, and guinea pig pellets is allowed to ferment for about a week before it's poured into a plastic tub, over top of which sits the gravid trap. This organically-rich water is the attractant to gravid (egg-bearing) females.

Gravid trap placement ran from June through September with 68 traps capturing 1,309 mosquitoes (494 *Culex* species, 50 *Ae. vexans*, 10 *Ae. japonicus*, 5 *An.quadrimaculatus, 4 An. punctipennis, 2 Cq. perturbans, 1 Ae. trivittatus, 1 Cx. territans, 1 Ae. triseriatus, and 741* males). Traps were placed in a variety of locations, including the immediate area of WNV activity. *Culex* mosquitoes collected in gravid traps were grouped together and submitted to Michigan State University (MSU) for WNV-detection. Figure 5 shows a historical view of the average number of *Culex* mosquitoes collected per gravid trap. Collections from 2017 increased substantially from the 2016 numbers, with an average of 7.3 female *Culex* mosquitoes per trap; however most of the females came from a sewage lagoon on a single trap night in mid-July.

Figure 5 – Historical Average *Culex* species per Gravid Trap, 2017



BG-GAT LETHAL OVITRAPS

BG-GAT (Biogents® Gravid *Aedes* Trap) is a lethal ovitrap that offers an ideal larval site for *Aedes aegypti* and *Aedes albopictus*, attracting them for oviposition and then preventing the adults from escaping with vegetable oil-coated trap lids. The adults die inside the traps before any further feeding so therefore they cannot continue to spread disease.

Gravid mosquitoes are attracted to the black and white colored trap. The black plastic base is filled with standing water and is equipped with a drain hole. The translucent lid has a mesh screen on its bottom that acts as a barrier between mosquitoes and the water. Adults entering through the funnel-shaped lid are essentially trapped and will be found dead on the barrier screen. To kill adult mosquitoes, vegetable oil is sprayed on the inner wall of the translucent chamber. The oil becomes deposited on the wings of the adult mosquito making flight impossible.

Studies have shown traps like these to be effective in reducing densities of *Aedes* mosquitoes and the likelihood of disease outbreaks. In some communities, deployment of these traps has been done in conjunction with additional source reduction efforts so the ovitraps are even more attractive to gravid mosquitoes.

Eight BG-GAT traps were placed in the field, filled with stink water, and checked weekly for eight weeks from mid-August to the end of September. Traps were placed in wooded sites that offered some protection from the rain although little rain fell during the evaluation period. While we do have some *Aedes* species present in Bay County that may be likely to utilize a lethal ovitrap (i.e., *Aedes japonicus*), none were collected from the traps. We theorized that *Culex* mosquitoes might be collected; however, no *Culex* were collected either.

DISEASE SURVEILLANCE

Since the inception of BCMC's program, efforts have been targeted at controlling known disease vectors as well as nuisance mosquito species. While reducing annoyance and improving quality of life are important, the primary goal of our program has always been to reduce mosquito numbers in order to decrease the risk of disease transmission. Since WNV came on the scene in 2001, our efforts at disease prevention and public education have taken on a bigger role.

St. Louis encephalitis, Eastern Equine encephalitis, LaCrosse encephalitis, West Nile virus, and dog heartworm are all mosquito-borne pathogens found in Michigan. Captured mosquitoes are submitted to MSU's Microbiology and Molecular Genetics Department to be analyzed for several of these disease agents. West Nile virus was the only pathogen detected this season.

Mosquitoes are submitted in "pools", which are groups of up to 50 mosquitoes of the same species collected from one of various traps that are then placed in a vial and tested for mosquito-borne disease. Four hundred seventy-two (472) pools containing 15,202 females representing a variety of species were tested with the following results:

- *Coquillettidia perturbans* (303 pools/11,748 females/no positives)
- C*ulex restuans*/*pipiens* (169 pools/3,454 females/**16 WNV-positives**)

A positive pool indicates local mosquitoes are infected with West Nile virus and are capable of transmission to humans and other hosts. The positive pools were collected from adult surveillance traps – **9 *Culex***, 352 S. Trumbull Light Trap (LT), 7/17/17; **30 *Culex***, Bay City Mall Gravid Trap (GT), 8/4/17; **16 *Culex***, 1600 Grant LT, 8/4/17; **17 *Culex***, Schumann Road CDC Trap (CDC), 8/9/17; **8 *Culex***, Pine and 22nd CDC, 8/11/17; **10 *Culex***, 8 Mile and Ott CDC, 8/11/17; **50 *Culex***, Baxman and Fisher CDC, 8/11/17; **2 *Culex* pools** (50 and 38 females), River and McGraw CDC, 8/11/17; **8 *Culex***, Mackinaw and U.S. 10 CDC, 8/16/17; **2 *Culex* pools** (50 and 26 females), Ed Golson Park CDC, 8/18/17; **44 *Culex***, Kawkawlin Twp. Park CDC, 8/18/17; **16 *Culex***, Spruce Ridge LT, 8/25/17; **50 *Culex***, Second St. Pinconning LT, 8/25/17; **8 *Culex***, Wilder and 4 Mile CDC, 8/25/17.

Mosquito surveillance data are useful in tracking virus activity. The minimum infection rate (MIR) is a calculation of the number of infected mosquitoes per 1,000 of a particular species. The higher the MIR, the more elevated the level of viral activity and the greater the chance for human infections. A MIR of 4 or above indicates a high level of viral activity. The MIR for *Culex* mosquitoes at BCMC in 2017 was 0.46; for *Coquillettidia perturbans* the MIR was 0. The MIR for *Culex* in 2016 was 0.16.

The Avian Surveillance program was established in 2001 by the Michigan Department of Community Health in collaboration with local health agencies. Bay County citizens report dead birds as one method of WNV surveillance. A total of 75 phone calls reporting dead birds throughout

the community were received with 87 dead birds reported, most of which were American Crows (52), Blue Jays (8), and blackbirds (Common Grackles/European Starlings) (14). Other species reported were House Finches (7), American Robins (3), Herring Gull (1), and Other (2). Dead bird reporting and testing typically produce the earliest evidence of WNV activity in the county each season.

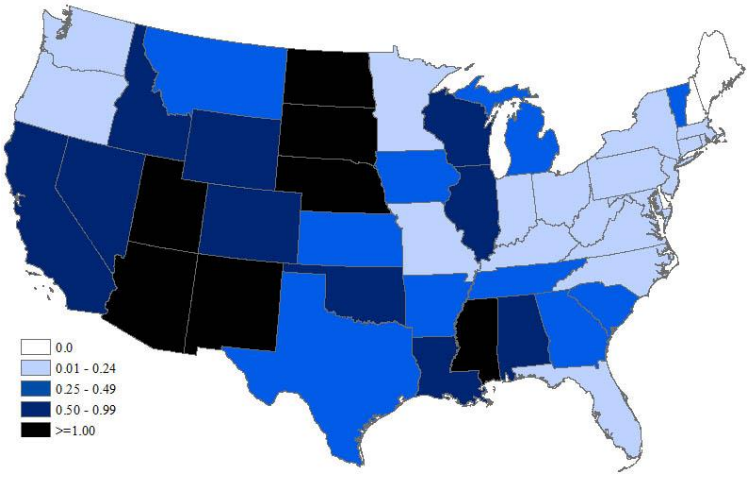
All dead bird sightings were logged onto Michigan's Emerging Diseases website www.michigan.gov/emergingdiseases. After initial screening by staff, only 33 crows or jays were suitable for testing (using the WNV Vector Test™ kit) and **22 tested positive**. Most of the WNV-positive birds were located in a cluster around the more urban areas of the County (page 45). Tracking WNV risk geospatially allows for targeted mosquito surveillance and control efforts. Compared to 2016, disease activity increased significantly for Bay County.

While there was a high number of positive mosquitoes and birds, the statewide human case count was average for the year. Statewide, there were 39 human cases with one fatality, which includes 8 asymptomatic blood donors (Table 4, as of November 28, 2017). Bay County was home to one of the blood donors. Human cases were clustered around Detroit-metro and Grand Rapids-metro areas. As of November 28, the CDC has reported a total of 47 states and the District of Columbia with 1,921 West Nile virus human cases and 115 deaths. Forty-six percent of the cases were reported from five states (California – 483, Texas–127, Arizona – 108, Illinois – 86, and South Dakota-73) (see Figure 6).

Table 4 – Michigan's WNV Human Cases

Year	Total Cases	Fatalities	Year	Total Cases	Fatalities
2017	39	1	2009	0	0
2016	43	2	2008	17	0
2015	18	2	2007	13	2
2014	2	0	2006	55	7
2013	36	2	2005	62	4
2012	202	17	2004	16	0
2011	33	2	2003	19	2
2010	29	3	2002	614	51

Figure 6 – WNV Neuroinvasive Disease Incidence by State, as of November 28, 2017



ZIKA VIRUS AND MOSQUITO SURVEILLANCE

Invasive mosquito species are becoming an increasing concern for mosquito control districts. *Aedes aegypti* (yellow fever mosquito) and *Aedes albopictus* (Asian tiger mosquito) are undergoing range expansion in the United States. These mosquito species are container breeders that often make use of man-made containers such as tires, tarps, and trash for breeding. These species are aggressive human biters and are often found in close proximity to humans and are known vectors of several important human viruses, such as: Yellow fever, Dengue, Chikungunya, and Zika. BCMC has a surveillance program in place for these invasive species, but none have been detected in Bay County. *Aedes albopictus* has been identified as close as Livonia, MI in August, 2017.

Zika virus first appeared in the Western Hemisphere in Brazil in 2015 and spread rapidly throughout Central America. Zika is spread mostly by the bite of an infected *Aedes aegypti* or *Aedes albopictus* mosquito. On February 1, 2016, the World Health Organization declared Zika a public health emergency and the CDC warned pregnant women against traveling to countries with large-scale Zika infections.

Zika can be passed from a pregnant woman to her fetus, which can cause birth defects such as microcephaly. There is currently no vaccine for Zika and while it has not been found in Michigan, local mosquito-borne Zika virus transmission has been reported in Florida and Texas. In the United States from January 1, 2017-November 29, 2017, there were 362 Zika virus disease cases reported – 356 in travelers returning from affected area (7 in Michigan), 2 cases acquired through presumed local mosquito-borne transmission (one in Florida and one in Texas), and 4 cases acquired through sexual transmission.

WEATHER

The relationship between weather and mosquito activity is especially important in an IMM approach to mosquito control. Monitoring both rainfall and temperature are paramount in estimating mosquito larval and adult activity. Flooding rain creates ideal breeding conditions for mosquitoes, but what also matters is how long the water remains on the ground after a storm. Average rainfall for Bay County from May 1 through September 30, 2017 was 17.02 inches-0.94 inches above the average of 16.08 (Figure 7). However, most of that total fell during the week of June 17-23 when nearly 9 inches was recorded with portions of Bay County seeing significant flooding.

Winter 2016-17 averaged warmer than average from November 2016 through February 2017. In fact, February 2017 experienced an average mean temperature of 33.6 degrees or 9 degrees above normal. The most noteworthy weather phenomena during the 2017 season were the heavy rains of June followed by near-drought conditions from July-September.

Figure 8 (page 22) shows the average weekly rainfall amounts that were measured in a rain gauge network placed throughout the county from May to October. Rain events that drop over an inch of rain are typically sufficient to cause a new hatch of summer floodwater mosquitoes. There were four such rain events that occurred, although some were affiliated with the same hatch due to how closely they occurred. The most significant rain event occurred in later June (9.1") and this was felt throughout the county. Heavy mosquito counts and complaint calls followed two weeks later.

Table 5 (page 22) lists weather data occurring in Bay County from Nov. 2016-Oct. 2017 and the monthly departures from normal for temperature and rainfall.

Figure 7 – Bay County Total Rainfall May 1 – September 30, 2017 (Observed vs. Historical)

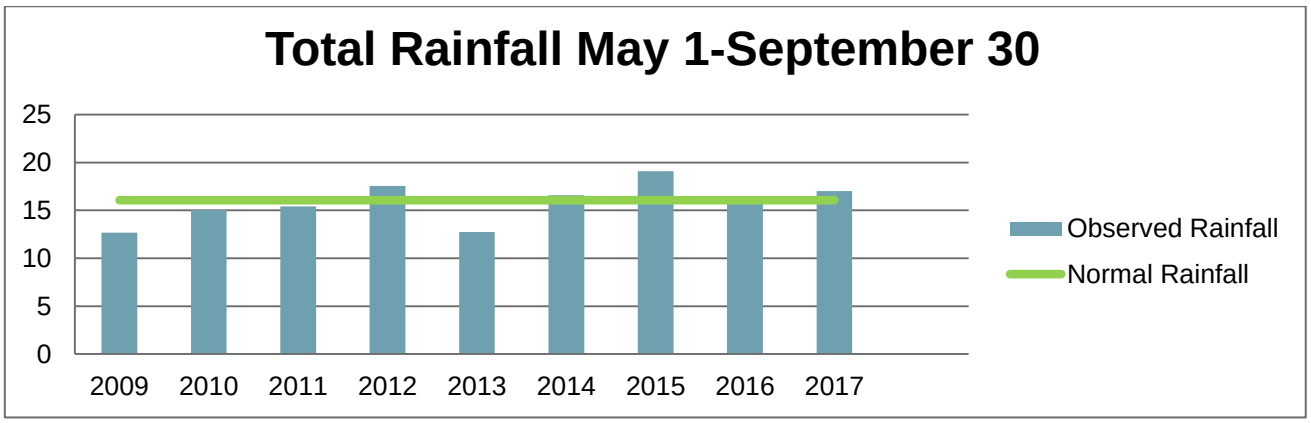


Figure 8 – Average Weekly Rainfall, 2017

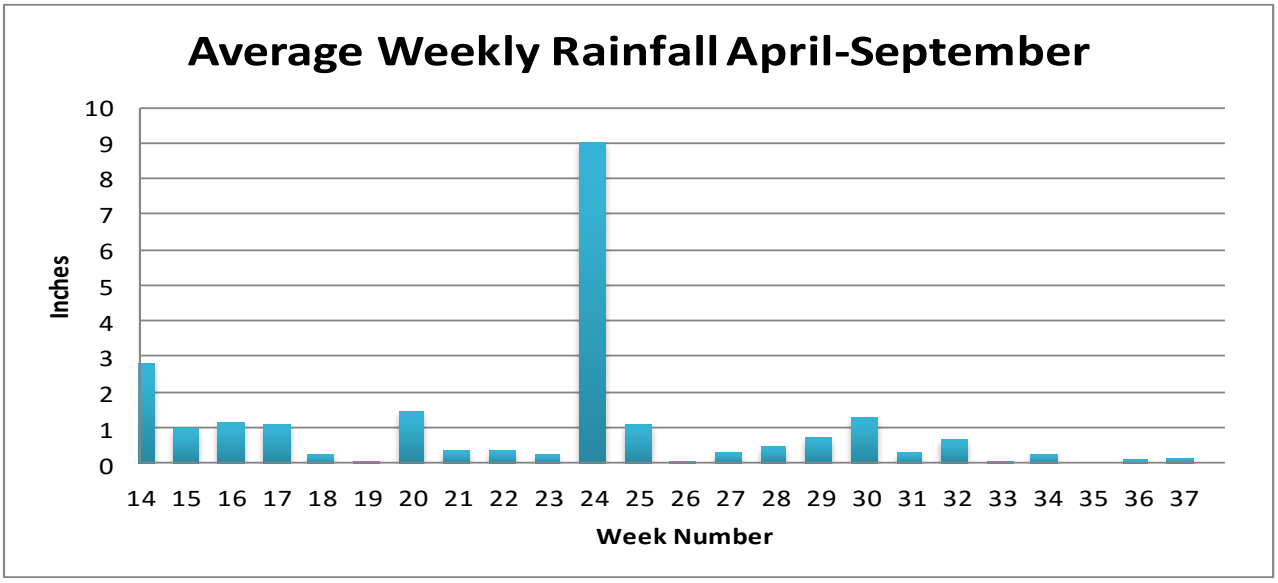


Table 5 – Rainfall and Temperature Data, 2017

Month	Normal Rainfall	2016/17 Rainfall	Departure from Normal	Normal Mean Temp.	2016/17 Mean Temp	Departure from Normal
November '16	2.7"	1.88"	-0.82"	38.5˚	45.4˚	+6.9˚
December '16	1.86"	1.37"	-0.49"	27.3˚	27.1˚	-0.2˚
January	1.71"	2.54"	+0.83"	22.2˚	27.9˚	+5.7˚
February	1.61"	1.97"	+0.36"	24.5˚	33.6˚	+9.1˚
March	2.06"	2.80"	+0.74"	33.7˚	32.9˚	-0.8˚
April	2.89"	5.89"	+3.00"	46.1˚	50.8˚	+4.7˚
May	3.38"	2.06"	-1.32"	57.3˚	56.8˚	-0.5˚
June	2.98"	10.76"	+7.78"	67.2˚	68.9˚	+1.7˚
July	2.58"	1.48"	-1.10"	71˚	72.0˚	+1.0˚
August	3.31"	2.28"	-1.03"	68.8˚	67.9˚	-0.9˚
September	3.83"	0.44"	-3.39"	61.3˚	65.6˚	+4.3˚
October	2.63"	4.45"	1.82"	49.7˚	55.9˚	+6.2˚

SPRING AERIAL LARVICIDING

Aerial larviciding of seasonally flooded woodlots signals the beginning of the mosquito control season and approximately 50,000 acres were treated throughout Bay County. Historically, treatment begins in mid-April, but the actual date is dictated by larval development and weather.

The spring aerial campaign began on April 17 and lasted eight days until April 25; there were two non-treatment days due to wind and rain, but the project was completed in a timely manner. The operation targets larvae before they reach the adult, biting stage. The aerial program has gone on for over three decades in the Great Lakes Bay Region and remains the best way to dramatically decrease numbers of spring *Aedes* mosquitoes. The preferred control method uses a bacterial product known as *Bti* (*Bacillus thuringiensis israelensis*) applied to seasonally flooded woodlots to control mosquito larvae.

Earl's Spray Service, Inc. of Wheeler, Michigan used three aircraft to apply *Bti* to 49,834 woodland acres in the following townships: Bangor (5,360 acres), Beaver (6,089), Frankenlust (1,332), Fraser (4,965), Garfield (6,049), Gibson (1,398), Hampton (2,068), Kawkawlin (2,147), Merritt (621), Monitor (3,140), Mt. Forest (5,459), Pinconning (6,571), Portsmouth (944), and Williams (3,691).

Calibration, loading, and fueling of the fixed wing aircraft took place at James Clements Airport in Bay City. Sites were treated with VectoBac® *G 5/8 mesh Bti* corncob granules at a dosage rate of 3 pounds per acre.

Pilot Jake Baker during spring aerial treatment

SPRING GROUND TREATMENT

Three full-time staff helped with aerial quality control, conducting post-treatment surveys in 33 woodlots to assess *Bti* application. After the completion of the aerial treatment program,

several more technicians were brought on board to begin inspections and subsequent ground treatment to manage the larvae or pupae. Field technicians began to treat woodland pools with larvicide oils or *Bti*, concentrating on smaller woodlots not feasibly treated by aircraft. Ground crews concentrate on sensitive woodlots such as those near eagles' nests, no spray zones, and towers. In the past few years, heavily vegetated woodlots previously treated by ground crews have been re-assigned to the aerial application to increase efficiency.

Table 6 lists the number of acres treated by foot crews and material used in smaller tracts of woodlots during the 2017 spring season. Just over 200 acres received larval treatment by ground crews to control the emergence of pestiferous spring *Aedes* mosquitoes. The crews checked 248 sites, dipping each one, to determine the need for treatment. A total of 179 sites were treated; untreated sites were either dry or were wet with no larval activity. A total of 7.16 lbs. *Bti*, 17 *Bti* Briquets, 120.38 lbs. Provect 1%, and 176.421 gal. BVA2 larvicide oil were dispensed at a dosage rate of five pounds/acre, one briquet/100 square feet, 5 pounds/acre, and one gallon/acre, respectively.

Pupae were first noted on April 19, but were found en masse on April 27. Significant emergence of spring *Aedes* adults occurred May 1-10. Adult emergence initiated adulticiding, control of adult mosquitoes through fogging operations.

Table 6 – Spring Ground Treatment, 2017

Township	**Acres Treated**	**BVA2 (gal)**	**Provect 1% (lbs)**	***Bti* (lbs)**	***Bti* Briquets (each)**
Bangor	1.55	0.99		2.78	
Bay City East	0.25	0.24			6
Bay City West	0.23		1.16		
Essexville	0.03		0.16		
Frankenlust	0.31		1.54		
Garfield	10.63	10.63			
Gibson	56.81	54.145	12.06	1.24	9
Hampton	10.95	10.84	0.23	0.34	
Kawkawlin	0.93	0.65	1.4		
Monitor	0.02		0.08		
Mt. Forest	77.29	74.517	11.1	2.74	2
Pinconning	36.72	18.569	90.74		
Portsmouth	2.30	2.21	0.41	0.06	
Williams	3.93	3.63	1.5		
TOTAL	**201.95**	**176.421**	**120.38**	**7.16**	**17**

SUMMER LARVICIDING

Bay County residents enjoy spending time outdoors during summertime, but the presence of mosquitoes can interfere with outdoor recreation. We try hard, therefore, to reduce mosquito numbers so residents can enjoy Michigan's all-too-short summer while also reducing vector mosquitoes.

Our comprehensive mosquito control program focuses on routine surveillance and control of potential breeding sites to prevent adults from emerging. The program involves MDARD-certified technicians applying insecticides to stagnant water throughout the county and/or dumping water from man-made containers (i.e., buckets, pails) that act as breeding habitats. During the breeding season, a team of 18 technicians inspect habitats guided by a database of known breeding sites, citizen complaints, and high trap numbers. Homeowners are notified of property inspections either in person or through the use of a door hanger.

Efforts directed at larval control are accomplished by using bacterial, chemical, or sanitary (source reduction component – to eliminate the breeding source) methods. The district uses several natural bacterial products for control of larval mosquitoes. These include VectoBac®G (*Bti*), *Bti* Briquets™, VectoLex® FG (*Bacillus sphaericus*) and Natular® XRT and 2EC (*Saccharopolyspora spinosa*). Chemical insecticides routinely used include temephos (Allpro® ProVect 1G and Allpro® ProVect 4E Larvicide), alcohol-based monomolecular surface film (Agnique® MMF) and petroleum-based oil (BVA2 Mosquito Larvicide Oil). The Agnique® MMF was used near the Saginaw Bay beachfront as well as sensitive wetland areas.

Larval Sites: The total number of breeding sites changes each year as new sites are added to the database and others are deleted. A total of 19,115 larval site inspections were conducted this season; only 7.6% (1,447) of those required treatment with a larvicide material. Some of these sites were permanent breeding habitats while others were temporary and included ditches, containers, fields, woodlots, tires, idle pools, ornamental ponds, and Saginaw Bay beachfront. Larvae are sampled by quickly skimming the water's surface with a dipper; some are collected and returned to the lab for identification. Technicians also control mosquitoes by dumping water from buckets, pails and other man-made containers (source reduction) on a regular basis. This is the preferred method to eliminate mosquitoes from breeding in containers.

Events: In addition to surveillance and control in neighborhoods throughout the county, special attention is given to summertime outdoor recreational events, such as the Auburn Cornfest, Munger Potato Festival, and River of Time, to name a few. According to the Bay Area Convention and Visitors Bureau, over a half million people attend these types of festivals, which contribute significantly to local economies. Residents participate in a variety of outdoor activities including gardening, biking, walking, golfing, and barbecuing. As activities like these grow in popularity, more and more people spend time outdoors and BCMC strives to control mosquito larvae and pupae to prevent the emergence of large adult mosquito populations. It is always BCMC's goal to decrease mosquito populations to decrease mosquito annoyance and disease threats.

Ditch Treatments: Bay County's topography is very flat and most roadways are flanked by ditches that divert water from the county's 1,400 linear miles of roads. Many ditches breed mosquitoes because they hold water for extended periods of time. Culverts are often dug deeper than the ditch itself so even if a ditch dries, areas near the driveway culverts often still hold water. So attention is given to monitoring mosquito activity in ditches throughout the county. In fact, surveys are made by lab personnel once each week. Most problems with breeding occur after major rainfall events, which stimulate mosquito eggs to hatch.

This year, ditch trucks logged 3,297 miles treated, which was 35% less than the historical average (Figure 9) as a result of less significant rain events. After the major June rains, the remainder of the summer was quite dry. Control materials dispensed included 2,077.5 gallons of Natular 2EC mix (12.125 gallons of Natular 2EC concentrate), 5 gallons of BVA2, and 11 gallons of VectoLex WDG mix. Figure 10 portrays product usage for each township. Most of the treatment (42%) occurred in Beaver, Williams, Mt. Forest, and Fraser Townships with 445, 369, 335, and 247 miles treated, respectively.

Figure 9 – Historical Ditch Truck Miles

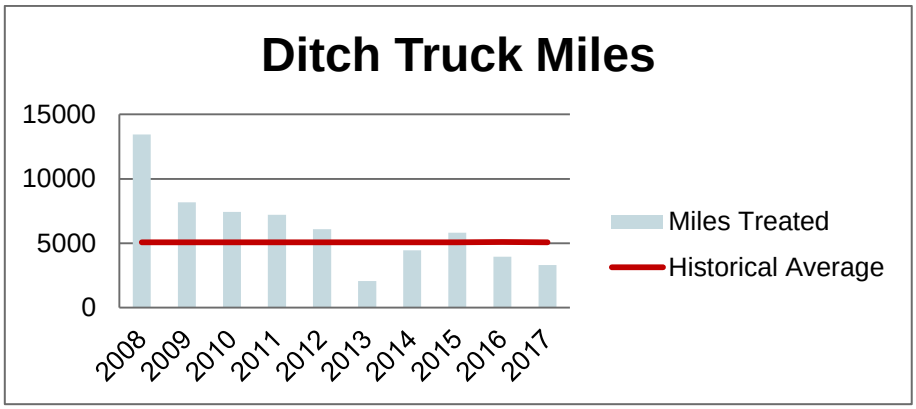
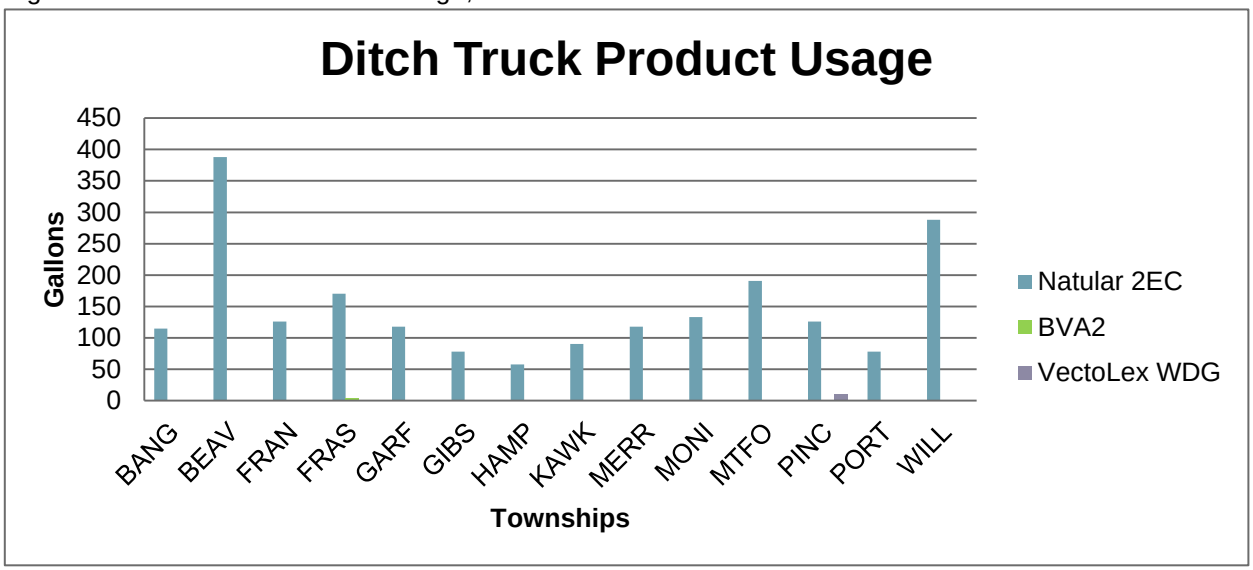


Figure 10 – Ditch Truck Product Usage, 2017



Catch Basins: Treatment of catch basins, or storm drains, will control *Culex restuans* and *Culex pipiens* mosquitoes, known vectors of both St. Louis encephalitis and West Nile virus. These species are not considered nuisance mosquitoes, as they feed primarily on birds; however, controlling disease vectors is extremely important in our efforts to decrease disease potential and maintain public health.

Catch basins may be found along streets, in parking lots, and sometimes in backyards. Staff monitored mosquito breeding in catch basins and treated a total of 30,382 individual habitats. Figure 11 shows the total number of catch basins treated for each township. The bulk of treatment took place in Bay City, Monitor, Bangor, and Hampton Townships, which are the most urban areas of the county and, therefore, areas with the most catch basins. Treatments reduce vector mosquitoes during late summer, the period of time of greatest disease risk to humans.

Catch basins were primarily treated with either Natular® XRT (5,706 individual tablets), VectoLex® FG bacterial larvicide (693.61 pounds), or VectoLex WSP (776 packets). However, there were also 100 packets of Natular T30 and 2.52 gallons of BVA2 dispensed in catch basins. Basins in BCE, BCW, and Essexville, were all treated three times with VectoLex, with the first treatment commencing in early June. Basins treated with Natular XRT received a second treatment with VectoLex FG due to lower control which was most likely due to heavy June rains washing away/diluting the product. Figure 12 shows the amount of product applied to catch basins in each township or city for the three main products dispensed.

Figure 11-Total Catch Basins Treated Per Township, 2017

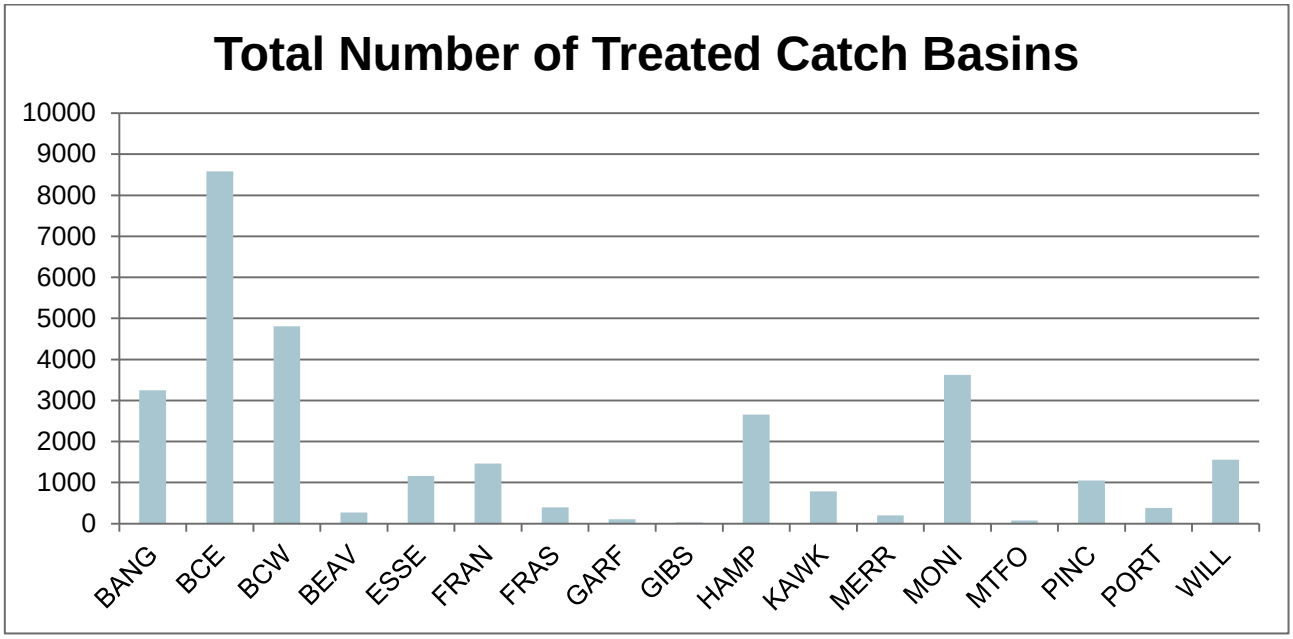
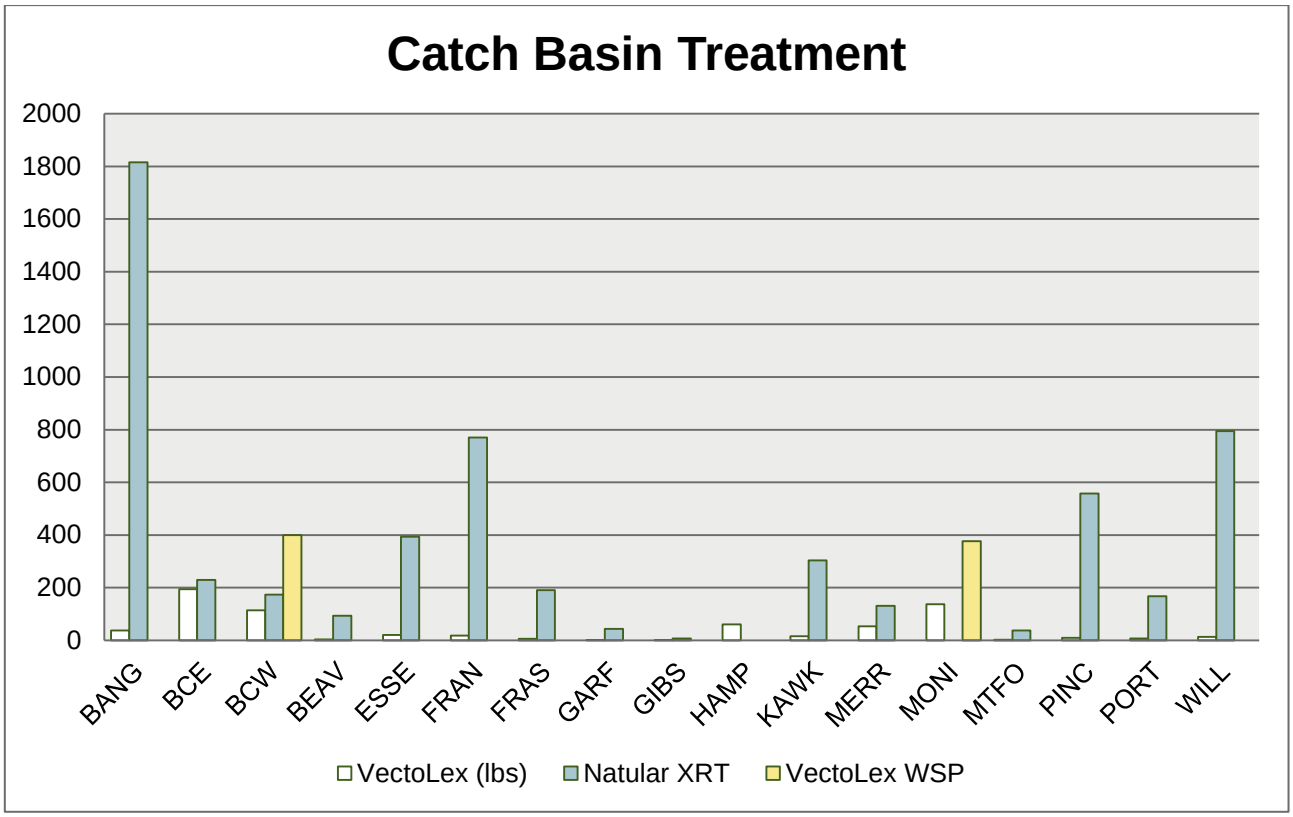


Figure 12 – Catch Basin Treatment Data, 2017



Retention & Detention Ponds: Bay County is home to approximately 140 retention ponds or detention basins that are designed to manage storm water runoff to prevent flooding. Retention ponds usually include a permanent pool of water in their design, while a detention pond holds storm water for a limited time or until the water either percolates or evaporates, which returns the area to its normally-dry state.

All mosquitoes need water to complete their life cycle, but some species live in permanent and semi-permanent waters while others live in temporary waters. Permanent and semi-permanent waters are found in retention ponds, where it's present except during drought periods. Pools of water that accumulate in low-lying areas during and immediately following a flood, like those seen in detention basins, are examples of temporary waters and these waters can produce large populations of floodwater mosquito species. Mosquitoes need a minimum of four consecutive days of stagnant water for larvae to grow to adulthood.

Floodwater mosquitoes are usually the first to appear in detention ponds, but *Culex* and *Anopheles* mosquitoes can also be found. Certified technicians surveyed the ponds making 314 individual visits throughout the summer, 89% of which did not result in treatment. This is a trend often seen in "search and destroy" operations.

When conducting surveys and/or larviciding of these ponds, technicians utilized aerial maps that detailed the location and size of each pond. This gave technicians a way to quickly locate the ponds allowing for more efficient surveillance and treatment.

Sewage Lagoons: Sewage lagoons are a prolific source of mosquitoes, especially *Culex* mosquitoes that prefer permanent, polluted, highly organic water in which to lay eggs. Surface and emergent vegetation along a lagoon's shoreline provide both shelter and food for the developing larvae. This is where most mosquito breeding occurs – in a zone about 10 feet wide from the shoreline outward. Populations of mosquito larvae and pupae in lagoons may become high from time to time in spite of the best prevention efforts, but treatment will quickly bring an infestation under control.

One sewage lagoon was monitored 17 times this season—White Birch Village Mobile Home Park sewage lagoon — resulting in 14 treatments. In order to treat sewage lagoons, a Michigan DEQ Water Treatment Additive permit was obtained.

Search and Destroy: Through data gathered during field surveillance, BCMC technicians conduct daily mosquito surveillance in a variety of habitats in a procedure known as Search and Destroy. This simply means that technicians search for and control immature mosquitoes in various breeding habitats, such as those listed below. In the case of man-made containers, staff will educate and enlist the help of homeowners who are encouraged to dump water from containers or cover them to reduce mosquito breeding.

Man-Made Habitats
• Artificial Containers • Idle Pools • Rain Barrels • Catch Basins • Ornamental Ponds • Ponds • Retention/Detention Ponds • Sewage Lagoons • Tires

Natural Habitats
• Flood Plains • Flooded Fields • Roadside Ditches • Cross Country Drains • Flooded Woodlots

It is important to select the appropriate control material/formulation based on what life stage is encountered in the water habitat. Timing of the application is also crucial as is dosage rate. Technicians leave door hangers when they encounter tires, reminding citizens about the residential scrap tire drives and the need to recycle tires.

In addition to the materials used in Table 7, 18 gallons of CocoBear oil were dispensed in Gibson and Kawkawlin Townships and 9 gallons of Natular 2EC was dispensed in Garfield, Gibson, Kawkawlin, Merritt, and Pinconning Townships.

Table 7 – Larvicides Dispensed During Search and Destroy Operations, 2017

Twp.	Agnique	Briquets	Bti*	BVA2	Natular XRT	Provect 1G	Provect 4E	VectoLex
BANG	0.17	67.5	125.7	28.7	8	8.4	0	1.8
BCE	0	42	29.5	7.6	0	4.7	0.3	1.2
BCW	0	7.5	27.1	34.9	11	4.2	0.1	0.5
BEAV	0.17	8.5	9.9	18.4	0	2.6	0	0.4
ESSE	0	2	5.7	1.3	0	0.1	0	0.6
FRAN	0	16	34.7	5.6	0	0.7	0	0.8
FRAS	0	64.5	41.3	8.6	22	15.7	0.9	0.2
GARF	1.06	28	3.6	2.6	2	0.3	0.04	0
GIBS	0	66	1.5	37.3	1.5	1.9	0	0
HAMP	3.14	9.9	690.1	9.9	0	0.1	0.06	0.9
KAWK	0.17	27.5	15.4	32.4	2.8	9.5	6.3	0.02
MERR	0	9.3	12.9	3.2	2	0.4	0	0.05
MONI	3.93	44.4	106.6	48.4	29	0.9	1.3	2.9
MTFO	0.49	18.5	0.4	10.3	0	2.3	1.1	0.06
PINC	10.97	82	8.8	19.8	2	2.6	0.8	0.1
PORT	0	8.5	49.5	6.1	0	1	0	0.4
WILL	5.44	17	21.2	30.9	0	1.1	1.4	1.3
TOTALS	**25.54**	**519.1**	**1183.9**	**306**	**80.3**	**56.5**	**12.3**	**11.23**

*Bti totals include VectoBac and Sustain brands

Field Technicians Adam Ramseyer and Jim Hughes prepare to treat a mosquito-breeding habitat using Hudson® pressure sprayers

ADULTICIDING

While larval control is the preferred method of treatment, it is virtually impossible to find and treat all breeding sites, so adulticiding (fogging to kill adult mosquitoes in flight) is also a part of the control program. Mosquito numbers vary between seasons and a major contributing factor to this is the amount of rainfall received. While it is not possible to eliminate mosquitoes, it is important to take measures to reduce the risk of being bitten by nuisance or infected mosquitoes. Adult mosquito activity will increase following periods of heavy rains that cause new mosquito broods to hatch.

Fogging adult mosquitoes includes the use of both gas-powered and electric Ultra Low Volume (ULV) machines that allow a relatively small amount of material to be dispensed from the spray unit. Truck-mounted units are fitted with flow control monitors that can adjust the flow rate of the insecticide pump based on truck speed. Label recommendations are strictly followed to assure proper dosage rate and droplet size during application. To accomplish the latter, droplet measurements are taken several times throughout the season. This year, droplet characterization took place on May 8 and August 4 using a newly-purchased DC-IV droplet measuring device where a probe is inserted into the fog to measure droplet diameters.

Resistance is monitored through bottle bioassays to determine the response of adult mosquitoes to a given insecticide. The bottles are coated with insecticide, adult mosquitoes are added to treated and un-treated bottles, and mortality is measured, which essentially detects possible resistance. We remain vigilant of resistance to pesticides, which may threaten the efficacy of our current control programs and allow the potential for new and re-emerging vector-borne diseases. Three resistance tests run in 2017 showed no resistance to the permethrin products used at BCMC.

Supervisor Ken Misiak exposes the DC-IV probe to the adulticide fog to measure droplet size

When weather conditions are conducive to fogging (temperatures above 50°F and winds below 10 mph), nine certified technicians treat cities and townships that have either the highest mosquito populations or noted disease activity. This year saw the routine use of the permethrin products Evoluer™ 4-4 ULV and Masterline® Kontrol 4-4. Mosquitoes must come in contact with the droplets in order for the insecticide to be effective so adulticiding activities take place after sunset when most mosquito species are active and bees have returned to their hives.

For management purposes, Bay County utilizes route maps during adulticiding operations. These road maps of each township show the most efficient route to follow when adulticiding so all roads are treated without skips or re-treatment during a nightly operation. The maps also highlight addresses of medical and no spray residences. Medical residences, of which there are 77 (a 7% increase from 2016), are homes that qualify to be a part of our Medical Needs Program because at least one resident is allergic to mosquito bites or has verifiable medical needs. The medical condition must be confirmed by a medical doctor. No spray residences are homes that prefer not to be treated for mosquitoes; there were 93 in 2017.

During the 2017 season, the “Long Driveway Program” continued. This program is designed to treat inhabited properties that sit a considerable distance off the main road and do not receive adequate adult mosquito control during normal fogging operations. One hundred forty-two such addresses were placed on route maps to be fogged during routine sweeps, an increase of 19% from 2016.

Table 8 (page 34) reveals that 19,858 miles were treated during adulticiding operations and 5,472.2 gallons of control materials were dispensed, the majority being Masterline® Kontrol 4-4 (3,841.1 gallons). Compared to 2016, this is 1,036 more gallons of control materials and 2% fewer miles treated, likely due to an increased dosage rate utilized throughout the month of July when mosquito numbers were at their peak.

Table 8 – Adulticiding Treatment, 2017

Adulticiding Treatment Totals			
Township	**Kontrol 4-4 (gallons)**	**Evoluer™ 4-4 ULV (gallons)**	**Miles Treated**
Bangor	389.3	167.5	2011.4
Bay City East	123.2	60.1	605.7
Bay City West	104.2	34.8	461.2
Beaver	235.7	72.8	1078.7
Essexville	33.8	15.3	174.6
Frankenlust	143.3	81.5	803.2
Fraser	307.9	89.3	1446.6
Garfield	187.6	74.5	977.8
Gibson	170.9	75.1	913.8
Hampton	318.7	150.7	1813.5
Kawkawlin	295.2	151.7	1670.2
Merritt	143.5	59.2	679.9
Monitor	437.6	198.7	2306.9
Mt. Forest	204.4	99.0	1081.4
Pinconning	292.6	117.1	1464.8
Portsmouth	164.6	71.9	860.6
Williams	288.6	111.9	1507.7
Total	**3841.1**	**1631.1**	**19858**

POLLINATOR RESPONSE PLAN

As part of the national strategy to reduce the losses of honey bees and other pollinators, Michigan has developed a managed pollinator protection plan (MP3) that is designed to improve and protect the health of pollinators in Michigan by reducing the risk of pesticide exposure, while recognizing that pesticides are important tools for crop, property, and human health protection.

As a community-wide public health program, Bay County Mosquito Control recognizes the importance and protection of pollinators and their role in both native plant pollination as well as agriculture, which is a large part of the Great Lakes Bay Region's economy. BCMC remains diligent in providing an Integrated Mosquito Management program that focuses on mosquito-borne disease prevention as well as quality of life while incorporating strategies to reduce pollinator risk.

The MP3 plan is a non-regulatory document that provides guidance and flexibility to growers, pesticide users, beekeepers, and other stakeholders and encourages best management practices that apply to beekeepers, growers, and pesticide applicators. BCMC follows the Michigan Mosquito Control Association's Mosquito Control and Pollinator Protection Best Management Practices as outlined below:

Best Management Practices

The following best management practices are employed by BCMC to help reduce the risk of control efforts on pollinators:

- Use of larvicide products primarily - target larval stage mosquitoes in standing water, which offers little to no risk to pollinators
- Source reduction – drain standing water when possible to eliminate mosquito larvae
- Minimize pesticide exposure by following Integrated Mosquito Management (IMM) principles and following pesticide label directions
- Ultra Low Volume (ULV) adult mosquito management that applies small amounts of material effective for small insects such as mosquitoes
- Timing of pesticide applications - ULV applications occur after sunset when honey bees and other pollinators are not foraging
- Avoid direct application of spray to flowering plants
- Monitor wind speed so insecticide off-target drift does not occur
- Communication - maintain open and frequent communication with bee keepers to help avoid unwanted impacts on pollinators
- Work with any bee keepers who would like to set up "no spray" status
- Watch MDARD's Drift Watch website for hive locations

SERVICE CALLS

Service calls represent a combination of phone calls received from Bay County residents requesting service as well as service for Specials, Medical Needs residents, and Long Driveways. Office staff entered and technicians responded to 4,838 adult mosquito service requests received during the 2017 season. There were 3,979 entries for either regular service requests for adulticide treatment due to nuisance mosquitoes, Specials, Medicals, or Long Drives, while the remaining 859 were event requests where residents called for backyard spray requests. The event requests were highest in June and July, corresponding to graduation season, which is a trend we see most years. The actual number of individual phone calls received numbered 1,808. Figure 13 represents a historical profile of adulticide service. Office staff also logged 1,070 calls reporting standing water with potential mosquito breeding (Figure 14). Regardless of the type of service request, all were responded to in a professional, courteous, and prompt fashion.

Figure 13 – Historical Number of Adulticiding Requests from Bay County Citizens

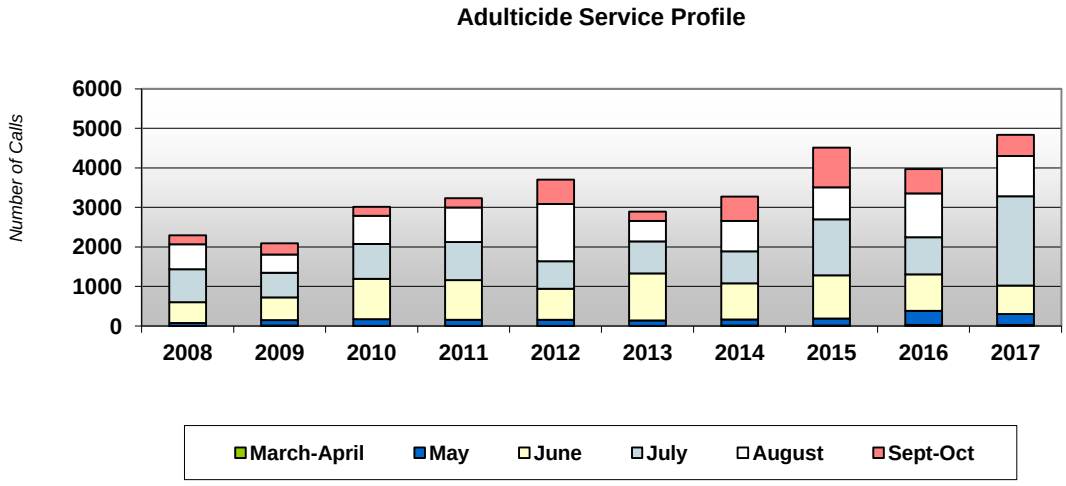
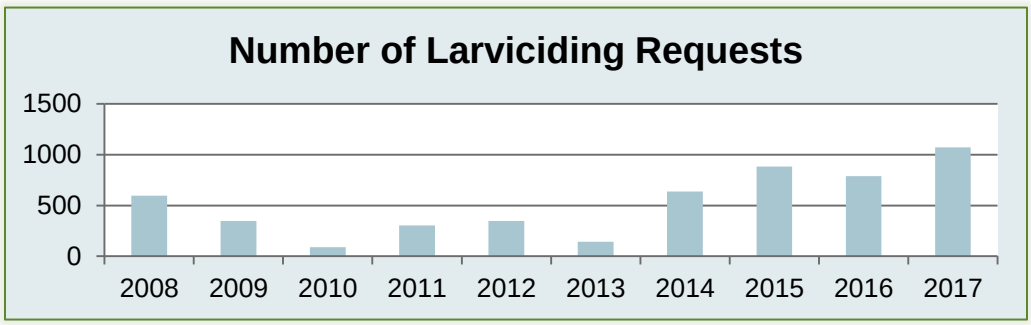


Figure 14 – Historical Larviciding Requests from Bay County Citizens



VEHICLE MAINTENANCE AND MILEAGE

Bay County Mosquito Control's state-certified mechanic maintains the 33-vehicle fleet as well as four Bay County Animal Control vehicles, several Veterans Affairs vehicles and a Gypsy Moth vehicle, which are billed for parts and labor. Besides vehicles, the shop maintains forklifts, ULV foggers, ditch truck sprayers, and various types of equipment. From time to time, specialized equipment is designed and fabricated.

During the 2017 season, as Figure 15 shows, 155,282 miles were driven, which is much below the 26-year average of 182,260 miles, but represents 12% more miles driven than in 2016. Seven new four-wheel drive trucks and two new ULV machines were purchased this season. Vehicle and equipment maintenance included the following:

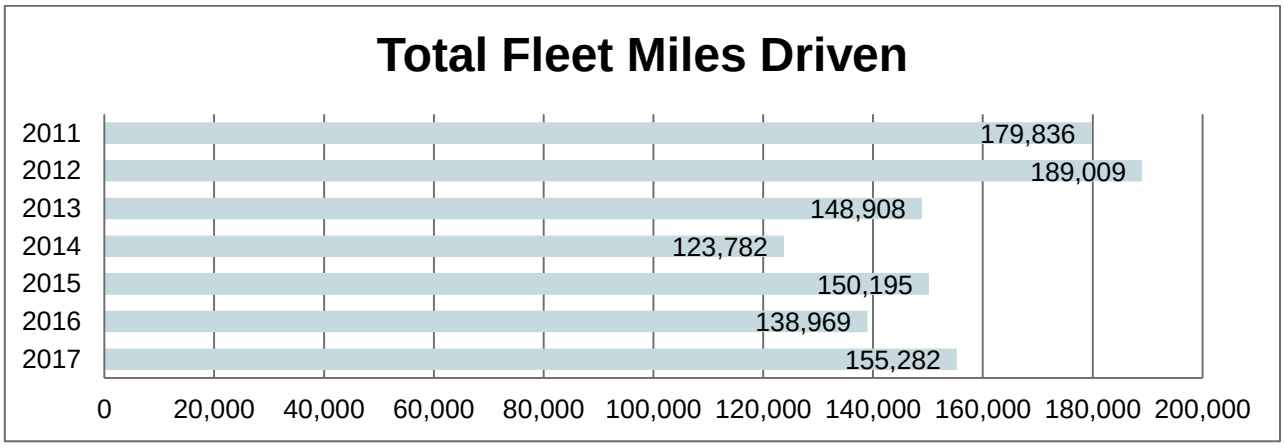
Vehicle Repairs

- Brake systems - 10
- Fuel systems - 12
- Front end repairs - 16
- Truck oil changes - 52
- Electrical systems - 31
- Drive lines - 7
- New tires - 32
- Used tire repair - 12

Equipment Repairs

- ULV oil changes - 18
- ULV repairs - 21
- Ditch trucks - 11
- Hudson® sprayers - 41
- Spreaders - 7
- CDC Traps - 4
- New Jersey Light Traps - 7
- Gravid Traps - 2

Figure 15 – Historical Vehicle Mileage



FLEET TRACKING

Velocity Systems, LLC of Big Rapids, MI continued implementing a fleet tracking system in 2017. Ten MqTrack™ systems were installed in nine ULV trucks and one ditch truck during the 2016 season, although not everything functioned properly. In 2017, 10 additional tracking systems were installed in larviciding vehicles with the intention to have everything completely operational for the 2017 season. Unfortunately, there were still some modules of the system that did not function properly during the 2017 season. Velocity Systems has been notified of our on-going issues and is working to improve the system for the 2018 season.

The MqTrack™ system monitors and maps application positioning, collects detailed application rate measurements, and produces informative, statistical reports of coverage areas. The system uses an on-board computer and GPS to track position and rate information as application operations are performed. Reports are presented in detail over aerial maps and live tracking is provided for up-to-the-minute location of vehicles and progress monitoring.

SCRAP TIRE DRIVES

Scrap tire drives are one method of source reduction, the removal or elimination of breeding sources that currently are or have the potential to breed mosquitoes. Two community tire drives were held this season. The first was held on June 3 at the BCMC field station and staff recycled 1,868 tires; an additional 995 tires were recycled during the second late-summer tire drive on August 5.

In 2017, BCMC applied for and received a Scrap Tire Cleanup Grant for up to $6,000 from the Michigan Department of Environmental Quality. The purpose of the grant was to assist property owners and local units of government with the proper removal of abandoned scrap tires and scrap tires at collection sites. The goal of the program was to use available funding to maximize reduction of the public health and environmental concerns associated with scrap tire collection sites, while improving the urban renewal and economic development opportunities.

Semi-trailers were filled at the drop-off location; trailers were then hauled back to Environmental Rubber Recycling where tires were recycled at the Flint facility. Tires were ground into chips and shipped to Michigan power plants to be burned as tire-derived fuel.

EDUCATION AND OUTREACH

The District's outreach program educates and informs the public about mosquito and West Nile virus prevention methods through presentations, advertising, and media coverage. Presentations are provided to school classrooms and local community groups designed to discuss life cycle, habitats, surveillance, control methods and mosquito-borne diseases. A great deal of education takes place every day through hundreds of personal contacts in the field and calls to the office. Periodic interviews by newspaper, television, and radio allow discussion of news affecting the public, such as spring aerial treatment, summer programs, homeowner property inspections for water elimination, West Nile encephalitis, and scrap tire drives. Press releases are also issued, as needed, if a mosquito-borne disease is detected in the county. Staff training is also held on a regular basis to update staff on various topics including safety, disease activity, and policies and procedures. Brochures and handouts are developed and distributed at various locations and BCMC's website is updated regularly.

We participated in a variety of community events throughout the year where an educational booth was set up that included brochures, live mosquitoes, bug boxes, mosquito repellent distribution, and staff present to answer questions on activities and services. This year we participated in the Bay City Farmer's Market, Consumers Energy Family Day, Bay County Fair open house, YMCA summer camp, and the Townships of northern Bay County meeting.

MEMBERSHIP/CERTIFICATION/MEETINGS

Membership in professional organizations remains vital in accessing updated and new information and maintaining good working relationships with peers. Membership with the non-profit Michigan Mosquito Control Association (MMCA), American Mosquito Control Association (AMCA), and The Entomological Society of America (ESA) are maintained. All are beneficial due to conferences, publications, networking, and legislative advocacy.

All staff members maintain certification with the Michigan Department of Agriculture and Rural Development (MDARD) in both the Core and 7F (Mosquito Control) categories. In addition to two training sessions that were held May 12 and June 12 with new and returning technicians in attendance, MDARD certification testing was offered at the field station for the first time. A presentation was also provided by Kevin Kern, MDARD, on June 13 discussing pesticide use investigations, road check inspections, and question/answer.

Full-time staff members were also present for MMCA's 31st annual meeting at The DoubleTree, Port Huron on February 1-2, 2017 and the MMCA 2017 Mosquito Control Training Session October 23, 2017 in Bay City, both of which offered continuing education credits. Staff attended the State of the Community Luncheon at Bay Valley Resort on February 23, the Saginaw Valley Beekeepers meeting on March 7, State of the Bay Conference in Bay City on September 27, and a public informational phragmites boat tour on September 29, 2017 highlighting the success of Bay County's Environmental Affairs and Community Development work treating invasive phragmites along the shoreline. Staff listened to several webinars offered by the AMCA, ESA, Centers for Disease Control and Prevention, National Academies of Sciences, Engineering and Medicine, and Zingerman's. Seminars included the following: The Shifting Landscape for Accelerating Speed to Market of Globally Recommended Vector Control Products (3-27-17), Keys to Effective Mosquito Control This Summer (4-6-17), Spatial Repellents for Vector Management: How Do These Things Work? (6-13-17), Communicating with the Public about Pesticides and Risk (8-9-17).

BCMC's program plan was reviewed and approved in January by MDARD as part of our Comprehensive Community Outreach as mandated in Regulation 637. The Technical Advisory Committee (TAC) annual meeting was held March 1, 2017 where the 2016 annual report and 2017 program plan were presented for review and approval.

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

To comply with state and federal regulations on storm water runoff from urban and suburban areas, many communities have implemented new programs to reduce the adverse impact of storm water runoff on streams, rivers, lakes, and estuaries. Compliance at BCMC is achieved by following the MI Department of Environmental Quality's Storm Water Pollution Prevention Plan (SWPPP) that began in July of 2010.

According to permit guidelines, in addition to routine monthly inspections, comprehensive inspections are completed once every six months by a certified storm water operator. The overall objective is to ensure continued use of Best Management Practices (BMPs) and good housekeeping practices as defined by the MDNR. Any leaks, spills or other exposure of significant materials shall be addressed immediately to achieve compliance with permit standards. Additionally, it is imperative to identify any potential sources of storm water contamination and reduce that potential by the greatest extent possible. In June 2016, Justin Krick and Robert Kline were granted a continuance of their Storm Water Industrial Site Operator certifications.

The areas inspected in 2017 included the chemical storage, cold storage, wash bay, garage, and parking lot. Four indoor and three outdoor catch basins were also monitored. Minor vehicle leaks were the main issue observed during inspections. These were cleaned up with Floor-Dry™ granular absorbent or soap, water, and paper towel.

NPDES

Water quality protection has been a long-standing concern in Michigan and an effort to protect Michigan's water resources began early in the twentieth century, with the enactment of the Michigan Water Resources Commission Act (Act 245) in 1929.

The NPDES permit process was initiated by The Federal Water Pollution Control Act amendments of 1972. The purpose of the program is to control the discharge of pollutants into surface waters by imposing effluent limitations to protect the environment. Authority to administer this program was delegated to Michigan by the Environmental Protection Agency (EPA) in October of 1973. Thus, Michigan was one of the first states to be authorized to carry out this program. Currently, authority for NPDES permit issuance rests with the Michigan Department of Environmental Quality (MDEQ).

The MDEQ has issued BCMC a Certificate of Coverage (COC) under the National Pollution Discharge Elimination System (NPDES) General Permit No. MIG030004. The COC authorizes BCMC to discharge biological pesticides and pesticide residues resulting from the application of chemical pesticides to control mosquito and other flying insect pests, in, over, or near to surface waters of the State of Michigan. The original permit expired February 1, 2017, but was reissued until February 1, 2022. This year was the fifth year BCMC was mandated to file a NPDES Annual Report, which was completed and submitted on November 20, 2017 via the MIWaters website. The annual report was approved on December 1, 2017.

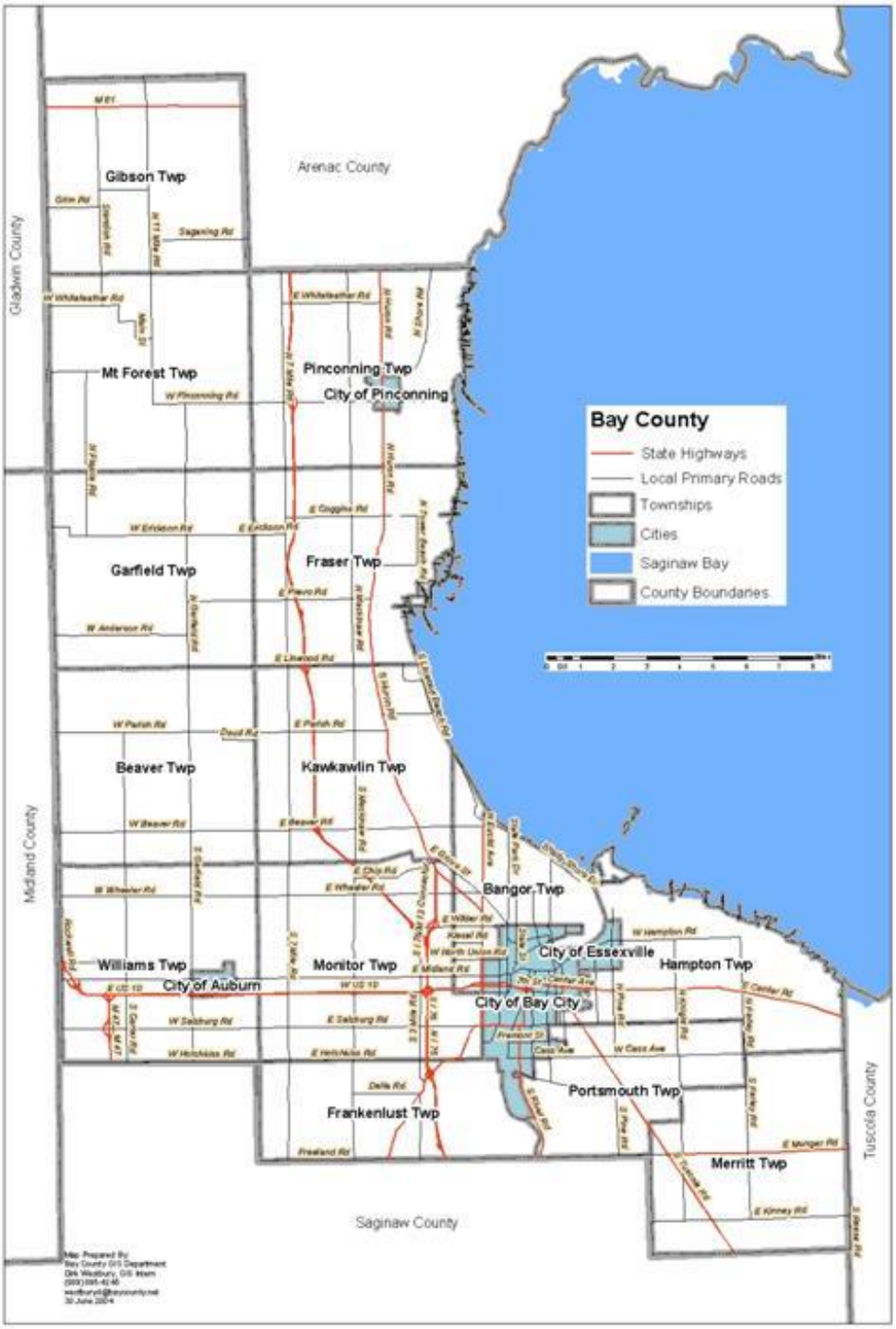
The issuance of an NPDES permit or certificate of coverage does not authorize violation of any federal, state or local laws or regulations, nor does it prevent the necessity of obtaining such permits, including any other DEQ permits, or approvals from other units of government as may be required by law.

Table 9 – Control Material List, 2017

Control Materials

Trade Name	Application Rate	Active Ingredient Dosage
AllPro® ProVect 1G	10 lb/acre	0.1 lb temephos/acre
AllPro® Provect 4E	1.5 fl oz/acre	0.048 lb temephos/acre
Agnique® MMF	0.2-1 gal/acre	0.2-1 gal alcohol-based surface film/acre
BVA2 Mosquito Larvicide Oil	1-3 gal/acre	0.987-2.96 gal petroleum distillates/acre
Bactimos Bti Briquets™	1briquet/100 sq ft	7000 *Aedes aegypti (AA*) Bti ITU/mg
VectoBac® G	3-5 lb/acre	0.273-4555 billion Bti ITU/acre
VectoLex® FG	5-80 lb/acre	0.115-1.84 billion BsITU/acre
VectoLex® WSP	1 pouch/50 sq ft	0.023 Billion BsITU/lb
Natular™ 2EC	1.1-2.8 fl oz/acre	0.018-0.045 lb spinosad/acre
Natular™ T30	1-4 tablets/100 sq ft	8.33% spinosad
Natural™ XRT	1 tablet/CB	6.25% spinosad/tablet
AllPro® Sustain MBG	5-10 lb/acre	0.91-1.82 billion Bti ITU/acre
Masterline® Kontrol 4-4	0.67 fl oz/acre	0.00175 lb permethrin/acre 0.00175 lb PBO/acre
Evoluer™ 4-4 ULV	0.78 fl oz/acre	0.00175 lb permethrin/acre 0.00175 lb PBO/acre

BAY COUNTY MAP



BAY COUNTY 2017 WNV-POSITIVE BIRDS