
# annual report 2016

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## ORGANIZATIONAL HISTORY

Bay County Mosquito Control (BCMC) began operations within the organizational structure of the Bay County Health Department and under the auspices of the Bay County Executive in January of 1985. The program commenced in 1977 as a bi-county district, Saginaw-Bay Mosquito Control Commission, after an outbreak of St. Louis encephalitis occurred in Michigan and seeks to protect the health and quality of life of county residents from disease and annoyance caused by mosquitoes.

Mosquito "control" does not mean elimination, but rather involves Integrated Pest Management (IPM) methods designed to reduce the number of mosquitoes so they no longer unfavorably affect the health and quality of life of Bay County residents. BCMC provides a variety of services to the 109,000 residents living in an area covering 443 square miles. As one of the divisions of the Environmental Affairs and Community Development Department, we acknowledge the importance of serving the public by providing services without producing adverse impacts on the environment. The program consists of field operations, biological surveillance, disease surveillance, and education.

Bay County is one of four Michigan counties with formal, comprehensive mosquito control programs. A Technical Advisory Committee (TAC), composed of local and state professionals, annually reviews program operations for BCMC, Midland County Mosquito Control, Tuscola County Mosquito Abatement, and APM Mosquito Control. Involvement in the TAC allows for interagency cooperation on many levels, but particularly with the coordination of insecticide bids as the three county mosquito districts mentioned above bid jointly to keep costs as low as possible.

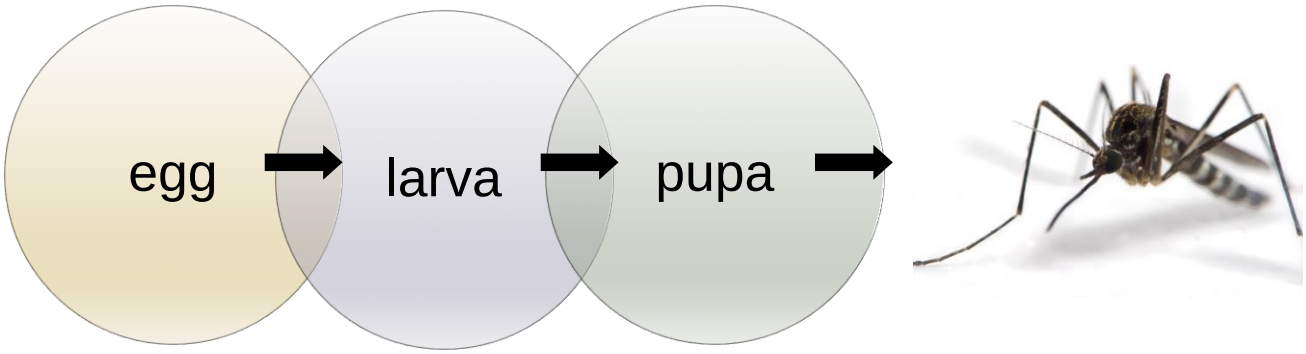
Funding is received from a special millage for the control and abatement of mosquitoes and diseases borne by mosquitoes. After 28 years, the 0.45 mill tax levy was increased to 0.55 mills on November 8, 2016 for eight years. Voters in Bay County approved the millage increase with an overwhelming approval rating of 84%.

## 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 was conducted when larvae reached the second or third instar growth stage. Monitoring larval development was critical in order to have a 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 mid-March with first instars observed in woodland pools on March 15th. The most notable feature of the woodlots at that time was that water levels were average to slightly above-average compared to a typical year. Only 0.31 inches of rain fell during April so these woodland pools began to dry down throughout the month. We initiated setting woodland pools and counting larvae on March 29 when both first and second instar larvae were noted. A cold snap from April 1-10 (temperatures ranging between 29.4-36.9˚F) caused larval development to slow and the aerial start date to be pushed back a week until April 12.

Pre-treatment larval counts were taken between one and four days before treatment in 42 woodlots and post counts followed within four days after treatment. Aerial calibration took place on April 12 with treatment beginning immediately and lasting six days until April 17. Three fixed wing aircraft were calibrated to deliver 3 pounds of *Bti* per acre. Two brands of *Bti* were utilized this spring, with most acreage treated with VectoBac® G *Bti*. About 1,300 acres were treated using the AquaBac® 200G *Bti*. Complete larval mortality was achieved with both products.

Quality control of the spring aerial campaign was accomplished with the help of three full-time staff who walked through 41 treated woodlots over the course of the program 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.

Post counts (Table 1) indicated an average 91.4% larval mortality at the 3-pound per acre dosage. Granular *Bti* can certainly achieve 100% mortality, but that level of control is not always feasible when the product is applied aerially at 120 mph. However, 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. Frogs, tadpoles, seed shrimp, fairy shrimp, water fleas, copepods, and caddisflies were observed both before and after treatment. Pupae were first seen on April 22 and adult emergence of spring *Aedes* mosquitoes from seasonally flooded woodlots took place from May 7-21, which was on track with the historical average.

Table 1 – Spring Treat Larval Mortality

| Bay County Mosquito Control Spring Treatment 2016<br>3 lb/acre VectoBac® G *Bti* Evaluation* | | | |
|---|---|---|---|
| | Larval Count | | |
| **Location** | **Pre** | **Post** | **Mortality** |
| Bangor 4 - Bangor Oil Well | 1.03 | 0 | 100% |
| Bangor 33 - Bangor and Zimmer | 0.4 | 0.08 | 80% |
| Beaver 4 - 1576 Cottage Grove | 1.9 | 0.06 | 96.8% |
| Beaver 5 - Carter and Cottage Grove | 1.96 | 0.7 | 64.3% |
| Beaver 9 - 1585 Cottage Grove | 4.82 | 0.54 | 88.8% |
| Frankenlust 2 - Four Mile and Delta | 1.24 | 0.12 | 90.3% |
| Frankenlust 3 - Delta by Automotive Bldg. | 1.24 | 0.16 | 87.1% |
| Frankenlust 3 - Mackinaw Road | 0.72 | 0.04 | 94.4% |
| Frankenlust 7 - 259 Amelith Road | 1.32 | 0 | 100% |
| Fraser 6 - Townline 16 by 7 Mile Rd. | 1.82 | 0.02 | 98.9% |
| Fraser 11 - Camp Fishtales | 0.62 | 0.28 | 54.8% |
| Fraser 11 - Deer Acres | 0.9 | 0.18 | 80% |
| Fraser 15 - Fraser Twp. Firebarn | 0.83 | 0.05 | 94% |
| Fraser 22 - Fraser Twp. Hall | 0.76 | 0 | 100% |
| Garfield 9 - 11 Mile N. of Erickson | 0.88 | 0.02 | 97.7% |
| Garfield 10 - Garfield Twp. Park | 1.68 | 0.04 | 97.6% |
| Garfield 15 - Methodist Church | 0.73 | 0 | 100% |
| Garfield 26 - Crump Fox Club | 2.5 | 0.54 | 78.4% |
| Kawkawlin 2 - 2080 LeBourdais Rd. | 3.24 | 0.58 | 82.1% |
| Kawkawlin 30 - White Birch Village | 1.16 | 0.22 | 81% |
| Monitor 9 - 1306 Wheeler | 2.26 | 0.58 | 74.3% |
| Monitor 20 - Fraser and N. Union | 1.17 | 0.03 | 97.4% |
| Monitor 23 - Rocking Horse Ranch | 1.2 | 0.2 | 83.3% |
| Monitor 28 - Mackinaw Road Tech Park | 1.02 | 0.04 | 96.1% |
| Monitor 34 - Fremont Cemetery | 0.84 | 0 | 100% |
| Mt. Forest 9 - Sand Rd. Road Commission | 1.04 | 0.02 | 98.1% |
| Mt. Forest 17 - Carter N. of Cody-Estey | 1.44 | 0.08 | 94.4% |
| Mt. Forest 21 - Daycare | 2.54 | 0 | 100% |
| Mt. Forest 21 - Mt. Forest Hall | 1.48 | 0.02 | 98.6% |
| Mt. Forest 21 - Mt. Forest Firebarn | 1.22 | 0.26 | 78.7% |
| Mt. Forest 30 - Pinconning and County Line | 2.92 | 0.06 | 97.9% |
| Pinconning 23 - K C Hall Water Street | 1.16 | 0.2 | 82.8% |
| Pinconning 30E - Pinconning County Park | 1.38 | 0.02 | 98.6% |
| Portsmouth 35 - R&R Ready Mix | 1 | 0 | 100% |
| Williams 7 - Reder Landscaping | 0.77 | 0 | 100% |
| Williams 16 - Carter and N. Union | 1.72 | 0.04 | 97.7% |
| Williams 19 - Victoria Woods Trailer Park | 0.65 | 0 | 100% |
| Williams 20 - Forest School/Daycare | 1.08 | 0.06 | 94.4% |
| Williams 21 - Forest Edge | 1.02 | 0.02 | 98% |
| Williams 30 - Rockwell and Salzburg | 0.6 | 0 | 100% |
| CONTROL Mt. Forest 30 Pinconning and County Line | 2.92 | 4.14 | 0% |
| CONTROL Mt. Forest Daycare Mt. Forest 21 | 2.54 | 3.62 | 0% |
| **AVERAGE TREATED MORTALITY** | | | **91.4%** |
| * Will 7 and 30 treated with AquaBac® 200G | | | |

## SUMMER LARVAL SURVEILLANCE

Surveillance is the key component of an Integrated Pest Management (IPM) program and there are two main types — larval and adult — designed to monitor mosquitoes county-wide to determine distribution, density, and species composition. Surveillance 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. Eighty larval samples representing ten species were identified; the majority was *Culex pipiens, Culex restuans,* and *Aedes japonicus,* the newest mosquito species to Bay County, which was found breeding primarily in tires and containers.

To assess the activity of *Culex* mosquitoes in city and suburban catch basins, biology staff randomly inspected 30-50 basins on seven 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 June 1 showed that 17% of wet basins checked were breeding with both larvae and pupae. This prompted the initial treatment (commencing June 3) using VectoLex® FG and Natular™ XRT. In order to determine efficacy and longevity of the control materials, basins were inspected every three-four weeks. We expect VectoLex to provide control for about four weeks while Natular is expected to provide season-long control.

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 treatment product was performing correctly; no non-target impacts were noted.

## *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 the production of *Ae. japonicus*.

Figure 1 – Artificial Container Species, 2016

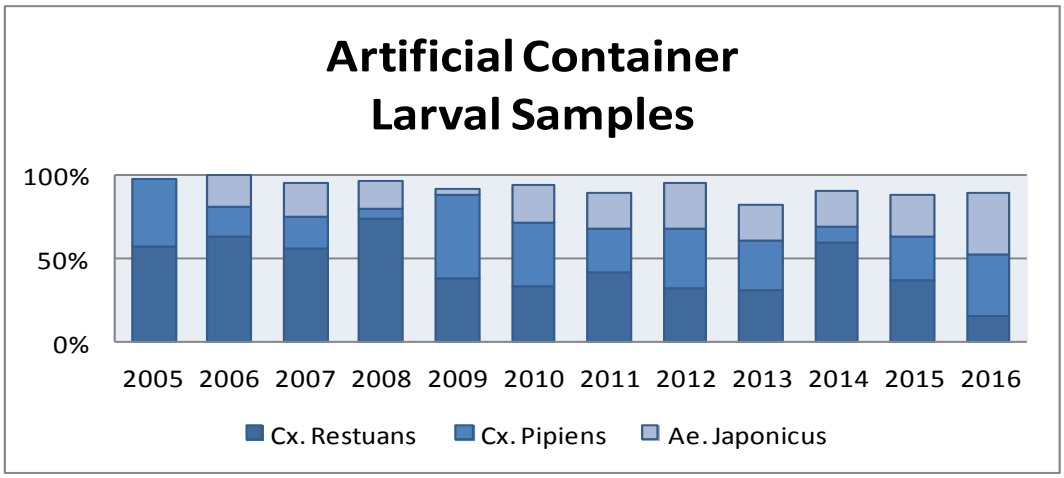
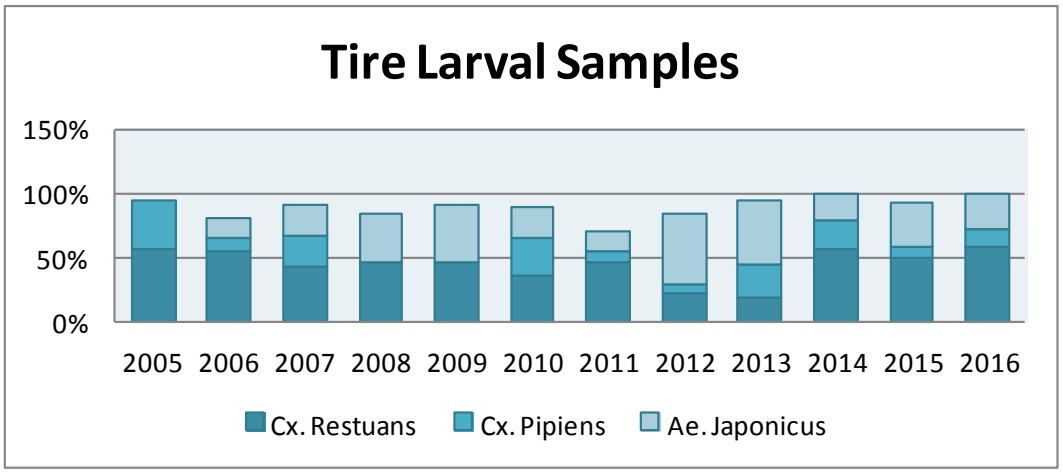



Figure 2 – Tire Species, 2016



## 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 12,932 (Table 2), 43% fewer than the number collected in 2015 and 12% less than the historical average of 14,726. Heavy rains in mid-to-late August caused a significant floodwater mosquito hatch at the end of the treatment season. Mosquito numbers spiked in September (as they did in September 2015) causing a mosquito nuisance for Bay County residents.

Table 2 - New Jersey Light Trap Data, 2016

**2016 LIGHT TRAP DATA**

| Species | May | June | July | August | September | TOTAL |
|---|---|---|---|---|---|---|
| Aedes canadensis | 9 | 0 | 0 | 0 | 0 | 9 |
| Aedes cinereus | 1 | 2 | 0 | 0 | 0 | 3 |
| Aedes implicatus | 1 | 0 | 0 | 0 | 0 | 1 |
| Aedes intrudens | 1 | 1 | 1 | 0 | 7 | 10 |
| Aedes japonicus | 0 | 1 | 8 | 2 | 2 | 13 |
| Aedes provocans | 1 | 0 | 0 | 0 | 0 | 1 |
| Aedes sticticus | 0 | 0 | 0 | 2 | 0 | 2 |
| Aedes stim/fitchii | 28 | 28 | 3 | 0 | 0 | 59 |
| Aedes triseriatus | 0 | 0 | 0 | 3 | 5 | 8 |
| Aedes trivittatus | 1 | 0 | 1 | 4 | 3 | 9 |
| Aedes vexans | 10 | 30 | 349 | 1122 | 2863 | 4374 |
| Anopheles perplexens | 0 | 2 | 7 | 7 | 8 | 24 |
| Anopheles punctipennis | 19 | 29 | 79 | 41 | 64 | 232 |
| Anopheles quadrimaculatus | 12 | 227 | 1022 | 1174 | 287 | 2722 |
| Anopheles walkeri | 46 | 73 | 78 | 44 | 140 | 381 |
| Culiseta inornata/morsitans | 3 | 1 | 0 | 2 | 0 | 6 |
| Coquillettidia perturbans | 0 | 1619 | 2278 | 188 | 13 | 4098 |
| Culex restuans | 19 | 67 | 108 | 45 | 2 | 241 |
| Culex pipiens | 0 | 35 | 114 | 246 | 163 | 558 |
| Culex tarsalis | 1 | 0 | 0 | 0 | 0 | 1 |
| Culex territans | 0 | 3 | 7 | 21 | 16 | 47 |
| Psorophora ciliata | 0 | 0 | 0 | 0 | 1 | 1 |
| Psorophora ferox | 0 | 0 | 0 | 0 | 1 | 1 |
| Uranotaenia sapphirina | 0 | 0 | 39 | 56 | 9 | 104 |
| Damaged | 3 | 6 | 8 | 7 | 3 | 27 |
| **TOTAL FEMALES** | **155** | **2124** | **4102** | **2964** | **3587** | **12932** |
| TOTAL MALES | 118 | 1088 | 690 | 1282 | 746 | 11749 |
| **Historical Female Totals (34 yrs)** | **380** | **4174** | **5028** | **3962** | **1182** | **14726** |

Twenty-four species were collected during the 2016 season with the most predominant species being *Aedes vexans.* Although they ranked first numerically, it was by a much smaller percentage than typically seen – they represented about a third 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 4,098 females collected and representing 32% of the catch. In a typical year, *perturbans* would only account for 9% of the total showing how populations of *perturbans* were much-elevated in 2016. Lastly, four *Anopheles* species (*quadrimaculatus*, *walkeri*, *punctipennis*, and *perplexens*) represented 26% of the total catch.

Figure 3 shows a 21-year historical view of light trap collections with the average number collected in a given year represented by the solid black line (14,726). Total number of females collected in 2016 fell 12% below the average. Typically, total number of females corresponds with the amount of rainfall received and this year our heaviest rains came in mid-to-late August. Figure 4 (page 11) shows mosquito species collected per trap night throughout the summer. In 2016, there was only one major hatch of summer floodwater *Aedes* with the peak occurring on September 6, which followed a major rain event by about two weeks. Of note, the population of *Cq. perturbans* was much higher than average, with populations increasing by June 21 and lasting until mid-July. *Anopheles* species showed three minor spikes in early July, August, and September and were mostly confined to areas along the Saginaw Bay.

Figure 3 - New Jersey Light Trap Historical Data

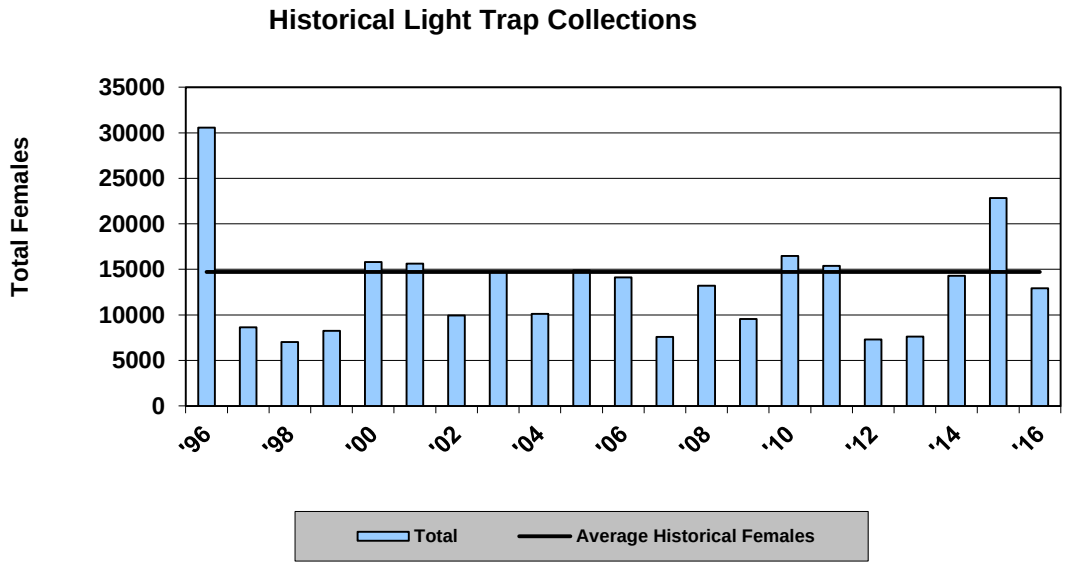
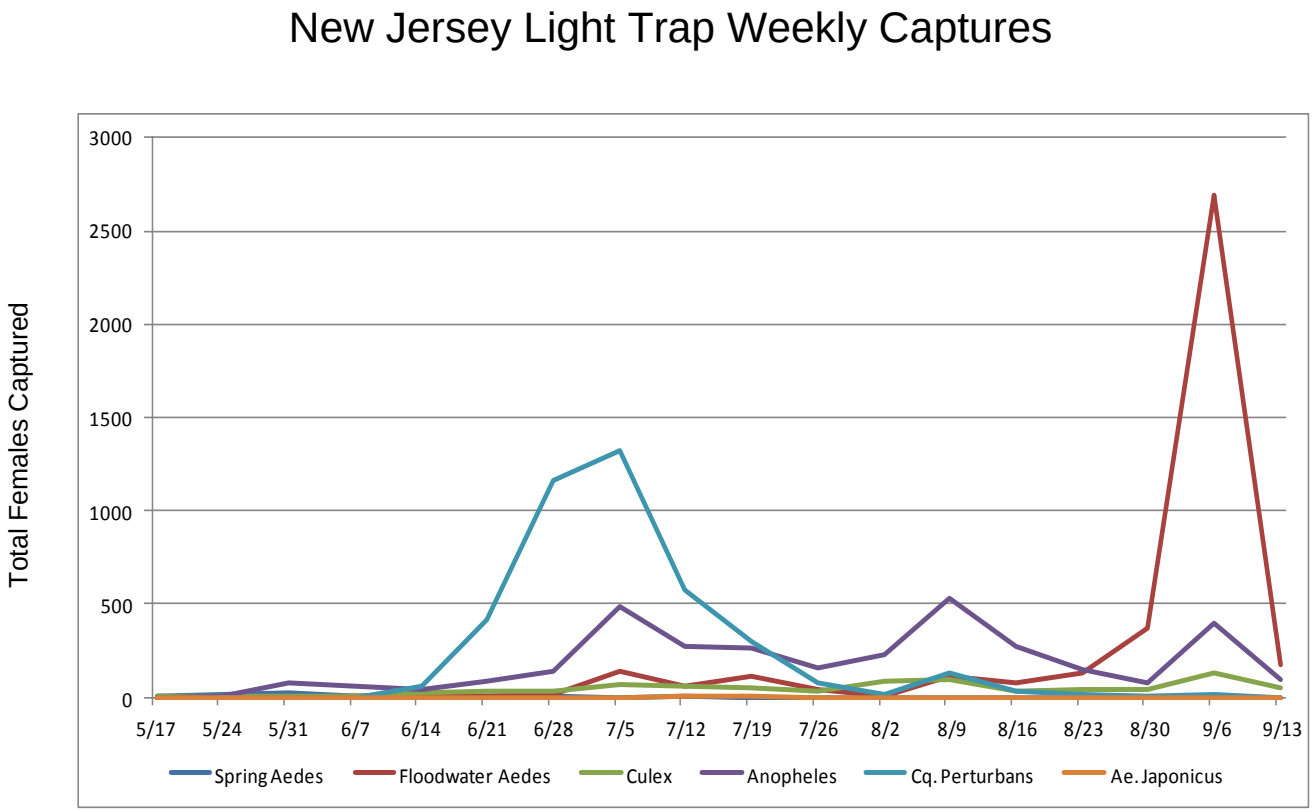


Figure 4 - New Jersey Light Trap Weekly Data, 2016




Unsorted (left) and sorted (right)
light trap collection

## 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 personal residences. 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 where they prefer to breed, their biting habits, flight range, and ability to transmit disease.

The total number of mosquitoes captured in 298 CDC traps this year was 22,089 (Table 3-page 13). Due to dry conditions prevailing throughout the summer, the main floodwater species, *Ae. vexans,* did not claim the top-ranking spot for total females collected, as it does in most years. Rather the cattail marsh mosquito, *Coquillettidia perturbans,* ranked first representing (52%) of the total catch. Summer floodwater species, *vexans* and *Aedes trivittatus*, together ranked second representing 27% while *Anopheles* species comprised 9% of the total catch. Most of the floodwater species were collected in September following the heavy rains that fell in mid-to-late August.

Only twenty species in six genera were collected and identified, averaging 74 females per trap, down considerably from 2015 when there were 188 females per trap. The average number of females in 2014 and 2013 was 191 and 78, respectively. This year we continued to trap twice weekly, placing 20 traps total each week. Some traps sampled the same locations while others were placed based on dead bird reports, mosquito complaints, or other indicators of possible virus or nuisance risk.

Mosquitoes from CDC Traps, like New Jersey Light Traps, were tested for mosquito-borne viruses in batches of between 5-50 individuals of a particular species sampled from one location. Two WNV-positive pools were detected from mosquitoes collected in CDC Traps.

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. On five occasions (July 21, July 28, August 4, 18, and 30), CDC traps were elevated in woodlots to collect additional *Culex* mosquitoes (that feed on birds as they are roosting in tree canopies) to aid in disease surveillance efforts. In every case, *Culex* dominated the species captured in elevated traps; on average 68% of the species collected were *Culex*.

Table 3 - CDC Trap Data, 2016

| 2016 CDC TRAP DATA | | | | | | |
|---|---|---|---|---|---|---|
| **Species** | **May** | **June** | **July** | **August** | **September** | **TOTAL** |
| Aedes atropalpus | 0 | 1 | 0 | 0 | 0 | 1 |
| Aedes canadensis | 27 | 347 | 7 | 0 | 0 | 381 |
| Aedes cinereus | 0 | 4 | 0 | 0 | 0 | 4 |
| Aedes dorsalis | 0 | 0 | 0 | 0 | 0 | 0 |
| Aedes implicatus | 3 | 0 | 0 | 0 | 0 | 3 |
| Aedes intrudens | 9 | 17 | 12 | 2 | 0 | 40 |
| Aedes japonicus | 0 | 2 | 1 | 2 | 0 | 5 |
| Aedes provocans | 1 | 14 | 0 | 0 | 0 | 15 |
| Aedes sticticus | 0 | 0 | 0 | 0 | 0 | 0 |
| Aedes stim/fitchii | 725 | 242 | 9 | 0 | 0 | 976 |
| Aedes triseriatus | 0 | 1 | 2 | 18 | 25 | 46 |
| Aedes trivittatus | 0 | 72 | 249 | 18 | 94 | 433 |
| Aedes vexans | 43 | 377 | 741 | 642 | 3658 | 5461 |
| Anopheles perplexens | 0 | 2 | 1 | 0 | 0 | 3 |
| Anopheles punctipennis | 8 | 29 | 32 | 0 | 2 | 71 |
| Anopheles quadrimaculatus | 8 | 232 | 797 | 369 | 96 | 1502 |
| Anopheles walkeri | 119 | 73 | 74 | 91 | 17 | 374 |
| Culiseta inornata | 0 | 0 | 0 | 0 | 0 | 0 |
| Culiseta morsitans | 0 | 0 | 0 | 0 | 0 | 0 |
| Coquillettidia perturbans | 3 | 3772 | 7319 | 387 | 30 | 11511 |
| Culex restuans | 6 | 48 | 94 | 38 | 16 | 202 |
| Culex pipiens | 0 | 37 | 179 | 440 | 281 | 937 |
| Culex tarsalis | 0 | 0 | 0 | 0 | 0 | 0 |
| Culex territans | 0 | 0 | 0 | 0 | 0 | 0 |
| Psorophora ciliata | 0 | 0 | 0 | 0 | 0 | 0 |
| Psorophora ferox | 0 | 0 | 0 | 12 | 7 | 19 |
| Uranotaenia sapphirina | 0 | 0 | 1 | 0 | 0 | 1 |
| Damaged | 4 | 14 | 39 | 38 | 9 | 104 |
| **Total** | **956** | **5284** | **9557** | **2057** | **4235** | **22089** |

## 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 did not equip traps in that fashion. Traps were placed overnight in a variety of locations for 8 weeks with only two *Culex restuans* females collected during that time. Next year we will continue utilizing the traps and keep them running continuously for a few days' time, replacing batteries daily.

## *SPECIES FOCUS – COQUILLETTIDIA PERTURBANS*

*Coquillettidia perturbans* is a single-generation summer species that first appears as a biting adult as early as late-May, but typically not until mid-June. Its numbers increase through July and peak around the Independence Day holiday. *Perturbans* is a unique mosquito in its ecology, or how it interacts with its environment, in that as both a larva and pupa, the mosquito attaches itself with a modified siphon to the roots or submerged stems of plants (such as the cattail) where it remains throughout development. The larva or pupa gets oxygen from the plant, thus never surfacing to get oxygen from the air/water interface as other species do. The winter is passed as an immature or mature larva and the adult emerges the next summer.

This season the adult *Cq. perturbans* population saw a huge spike compared to the past 15-20 years with 4,098 and 11,511 females captured from New Jersey Light Traps and CDC Traps, respectively. In fact, most of our complaint calls came from areas of the county that were being affected by this species. The females bite principally at night, being most active during the early part of the night. The adults are strong fliers with a flight range of up to 5 miles.

A description of this species that helps with identification includes the following notable features - adults have a dark proboscis with a broad ring of pale scales in the center; nearly every leg section is dark and speckled with white scales as well as rings of white scales at the joints; wings have broad, dark and white scales.

Female Cq. perturbans

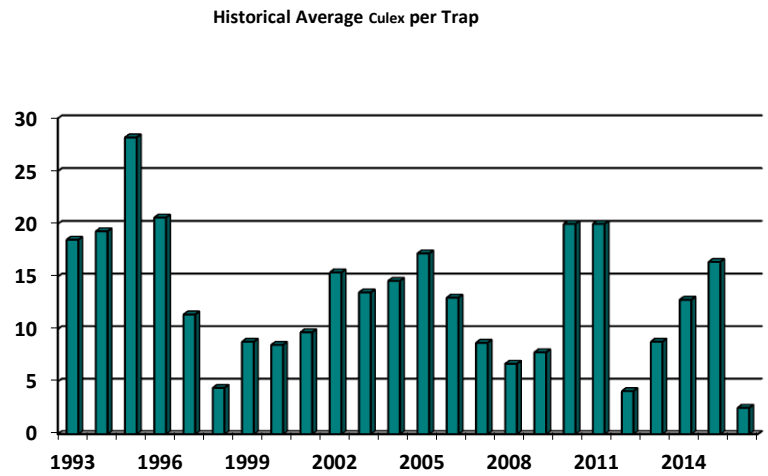
## GRAVID TRAPS

Gravid traps offer another method to collect female mosquitoes, primarily *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 56 traps capturing 195 mosquitoes (138 *Culex* species, 24 *Ae. japonicus*, 4 *An.quadrimaculatus,* 1 *Ae. vexans,* 1 *Ur.sapphirina, and* 27 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 perspective of the average number of *Culex* mosquitoes collected per gravid trap. Collections from 2016 decreased substantially from the 2015 numbers, with an average of 2.5 female *Culex* mosquitoes per trap.

There were no West Nile virus-positive pools collected from Gravid Traps this season.

Figure 5 – Historical Average *Culex* species per Gravid Trap, 2016




## 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. 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 eight (408) pools containing 12,750 females representing a variety of species were tested with the following results:

- *Coquillettidia perturbans* (312 pools/11,243 females/no positives)
- C*ulex restuans*/*pipiens* (96 pools/1,507 females/**2 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 CDC Traps – one placed on Park Street in Auburn (8/25/16; 10 *Culex* mosquitoes) and one placed at the Monitor Township Tech Park at U.S. 10 and Mackinaw (9/14/16; 27 *Culex* mosquitoes).

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 2016 was 0.16; for *Coquillettidia perturbans* the MIR was 0. The MIR for *Culex* in 2015 was 0.04.

BCMC was notified in mid-summer by the Michigan Department of Health and Human Services that two **grackles** from Bay County tested positive for WNV. Notification was received in mid-October of a **wild turkey** collected from Beaver Township on September 21 testing **WNV-positive** at the MDNR Wildlife Disease Laboratory. Finally, in early November a **Great-Horned Owl** from Monitor Township and an **Eastern Fox Squirrel** from Bay City tested **WNV-positive.**

The dead bird surveillance program was established in 2001 by the Michigan Department of Community Health in collaboration with local health agencies. We rely on Bay County citizens reporting dead birds as one method of WNV surveillance. This year we received 37 phone calls

reporting dead birds throughout the community, which decreased from last year's 47 calls. In 2016, 43 dead birds were reported, most of which were American Crows (17), Blue Jays (9), and blackbirds (Common Grackles/European Starlings) (6). Other species reported were House Sparrows (5), American Robins (5), and Red-tailed Hawks (1).

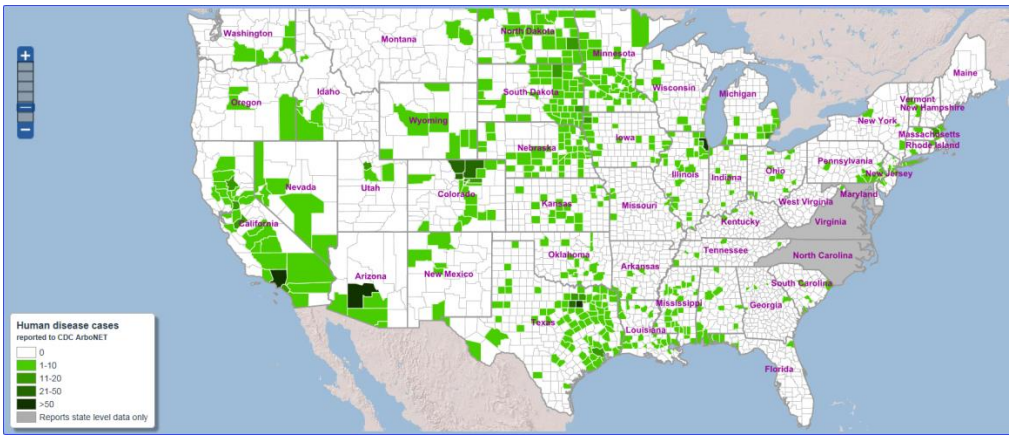
All dead bird sightings were logged onto Michigan's Emerging Diseases website www.michigan.gov/emergingdiseases. After initial screening by staff, a total of 9 crows or jays were tested (using the WNV Vector Test™ kit) to determine infection rates; **2 tested positive**. Birds that tested positive for WNV were collected from the east side of Bay City and Essexville; locations were about one-half mile apart. Compared to 2015, disease activity decreased slightly for Bay County.

Statewide, there were 42 human cases compared to 18 last year (Table 4, as of December 14, 2016). Human cases were clustered around Detroit-metro and Grand Rapids-metro areas and the two fatalities reported were from Berrien County and the City of Detroit. As of December 21, 2016, a total of 46 states and the District of Columbia have reported 2016 West Nile virus infections in people, birds, or mosquitoes. Overall, 1,853 human WNV cases with 90 deaths have been reported to CDC. Fifty-seven percent of the cases were reported from five states (Texas–337, California-276, Illinois-150, South Dakota-151, and Colorado-148) (Figure 6).

Table 4 – Michigan's WNV Human Cases

| Year | Total Cases | Fatalities | Year | Total Cases | Fatalities |
|---|---|---|---|---|---|
| 2016 | 42 | 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 |
| 2009 | 0 | 0 | | | |

Figure 6 – WNV Human Disease Cases, as of December 21, 2016



## ZIKA VIRUS

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, neither of which has been found in Michigan. 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.

### WHAT YOU NEED TO KNOW

(Source – http://www.cdc.gov/zika)

1. *Zika primarily spreads through infected mosquitoes. You can also get Zika through sex. Many areas in the U.S. have the type of mosquitoes that can spread Zika virus. These mosquitoes are aggressive daytime biters, but can also bite at night. Zika can be passed through sex from a person who has Zika to his or her sex partners.*
2. *The best way to prevent Zika is to prevent mosquito bites. Use EPA-registered insect repellent. Wear long-sleeved shirts and long pants, stay in places with air conditioning or window and door screens, and remove standing water around your home.*
3. *Zika is linked to birth defects and infection during pregnancy can cause a serious birth defect called microcephaly that is a sign of incomplete brain development. Doctors have also found other problems in pregnancies and among fetuses and infants infected with Zika virus before birth. If you are pregnant and have a partner who lives in or has traveled to an area with Zika, do not have sex, or use condoms the right way, every time, during your pregnancy.*
4. *Pregnant women should not travel to areas with Zika, but if you must, talk to your healthcare provider first and strictly follow steps to prevent mosquito bites.*
5. *Returning travelers infected with Zika can spread the virus through mosquito bites. An infected mosquito can then spread the virus to other people.*

## WEATHER

The relationship between weather and mosquito activity is especially important in an IPM 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, 2016 was 15.76 inches-0.32 inches below the average of 16.08 (Figure 8).

Winter 2015-16 was warmer than average from November 2015 through March 2016. In fact, December 2015 experienced the warmest mean, average low, and average high temperatures on record with a mean temperature nearly 12 degrees above the normal. In the course of the last year for the Great Lakes Bay Region, only April 2016 had temperatures fall below the normal mean by 2.6 degrees; other recorded monthly temperatures were above normal.

Figure 9 (page 20) shows the average 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 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 events occurred in mid-August (5.3") and early-September (1.3") with the heaviest rains occurring in Mt. Forest Township with 7.2" and Auburn with 6.2". In both cases, mosquito counts and complaint calls followed two weeks later.

Table 5 (page 20) lists weather data occurring in Bay County from Nov. 2015-Oct. 2016 and the monthly departures from normal for temperature and rainfall.

Figure 8 – Bay County Total Rainfall May 1 – September 30 (Observed vs. Historical), 2016

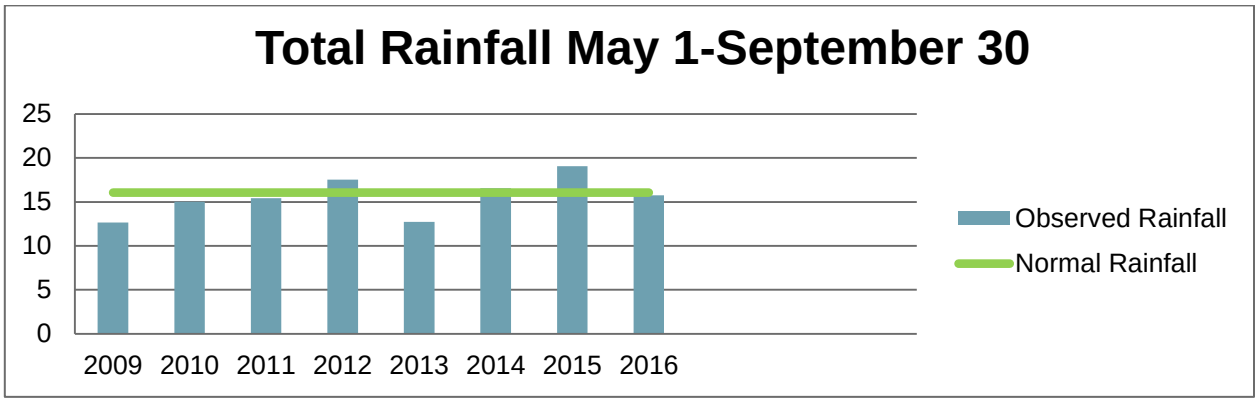


Figure 9 – Average Weekly Rainfall, 2016

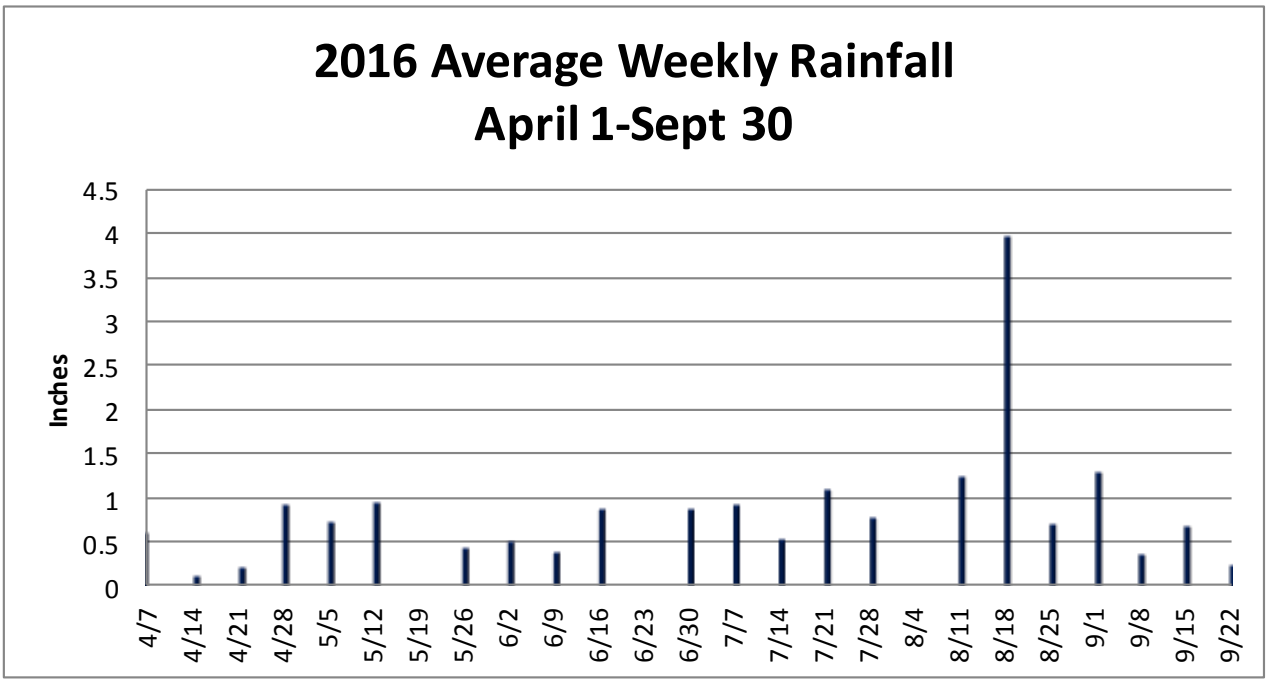



Table 5 – Rainfall and Temperature Data, 2016

| Month | Normal Rainfall | 2015/16 Rainfall | Departure from Normal | Normal Mean Temp. | 2015/16 Mean Temp | Departure from Normal |
|---|---|---|---|---|---|---|
| November '15 | 2.7" | 1.45" | -1.25" | 38.5˚ | 45.6˚ | +7.1˚ |
| December '15 | 1.86" | 3.1" | +1.24" | 27.3˚ | 39.1˚ | +11.8˚ |
| January | 1.71" | 2.04" | +0.33" | 22.2˚ | 26.7˚ | +4.5˚ |
| February | 1.61" | 1.88" | +0.27" | 24.5˚ | 29.2˚ | +4.7˚ |
| March | 2.06" | 3.98" | +1.92" | 33.7˚ | 39.4˚ | +5.7˚ |
| April | 2.89" | 1.83" | -1.06" | 46.1˚ | 43.5˚ | -2.6˚ |
| May | 3.38" | 2.11" | -1.27" | 57.3˚ | 60.3˚ | +3.0˚ |
| June | 2.98" | 1.77" | -1.21" | 67.2˚ | 68.4˚ | +1.2˚ |
| July | 2.58" | 3.43" | +0.85" | 71˚ | 73.4˚ | +2.4˚ |
| August | 3.31" | 5.88" | +2.57" | 68.8˚ | 73.4˚ | +4.6˚ |
| September | 3.83" | 2.57" | -1.26" | 61.3˚ | 65.6˚ | +4.3˚ |
| October | 2.63" | 2.39" | -0.24" | 49.7˚ | 54.0˚ | +4.3˚ |

## SPRING AERIAL LARVICIDING

Aerial larviciding of seasonally flooded woodlots signals the beginning of our mosquito control season and approximately 49,000 acres were treated throughout Bay County. Historically, treatment begins in mid-April, but the actual date is dictated by larval development and weather. Mean temperatures for March were almost 6 degrees above normal with rainfall twice as heavy as normal. April, on the other hand, saw below-average temperatures and rainfall.

The spring aerial campaign began on April 12 and lasted six days until April 17; good treatment conditions prevailed and we were able to complete the spring operation 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 48,567 woodland acres in the following townships: Bangor (4,336 acres), Beaver (5,981), Frankenlust (1,089), Fraser (5,215), Garfield (6,020), Gibson (1,461), Hampton (1,796), Kawkawlin (2,318), Merritt (478), Monitor (2,676), Mt. Forest (6,537), Pinconning (6,131), Portsmouth (713), and Williams (3,816).

Calibration, loading, and fueling of the fixed wing aircraft took place at Barstow Airport in Midland. Sites were treated with VectoBac® *G 5/8 mesh Bti* corncob granules at a dosage rate of 3 pounds per acre. This was the third season BCMC treated all aerial acres at the 3 pound rate, compared to the 4-5 pound rates used previously. This provided a more expansive treatment area while still achieving a high mortality rate.

Pilot Jake Baker during spring aerial treatment

## SPRING GROUND TREATMENT

Three full-time staff helped with aerial quality control, conducting post-treatment surveys in 41 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 treatable 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 2016 spring season. Just over 130 acres received larval treatment by ground crews to control the emergence of pestiferous spring *Aedes* mosquitoes. The crews checked 423 sites, dipping each one, to determine the need for treatment. A total of 113 sites were treated; untreated sites were either dry or were wet with no larval activity. A total of 8.22 pounds of *Bti*, 9 *Bti* Briquets, 1.695 ounces of Agnique, and 127.73 gallons of BVA2 larvicide oil were dispensed at a dosage rate of five pounds/acre, one briquet/100 square feet, one gallon/acre, one gallon/acre, respectively.

Pupae were first noted on April 22, but were found en masse on May 5. Significant emergence of spring *Aedes* adults occurred May 7-15. Adult emergence initiated adulticiding, control of adult mosquitoes through fogging operations.

Table 6 – Spring Ground Treatment, 2016

| Township | Acres Treated | BVA2 (gallons) | Agnique (ounces) | *Bti* (pounds) | Bti Briquets (number) |
|---|---|---|---|---|---|
| Bangor | 0.41 | 0.38 | | 0.1 | |
| Bay City East | 0.16 | 0.16 | | | |
| Essexville | 0.40 | 0.40 | | | |
| Frankenlust | 5.09 | 5.09 | | | |
| Fraser | 0.44 | 0.44 | | | |
| Garfield | 30.77 | 30.765 | 1.2 | | |
| Gibson | 43.9 | 42.04 | | 5.82 | 4 |
| Hampton | 0.1 | 0.1 | | | 5 |
| Kawkawlin | 2.14 | 2.14 | | | |
| Merritt | 0.56 | 0.56 | | | |
| Monitor | 0 | 0 | | | |
| Mt. Forest | 26.1 | 25.405 | 0.132 | 1.9 | |
| Pinconning | 6.99 | 6.99 | 0.363 | | |
| Portsmouth | 12.6 | 12.6 | | | |
| Williams | 0.79 | 0.66 | | 0.4 | |
| **TOTAL** | **130.45** | **127.73** | **1.695** | **8.22** | **9** |

## 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 16 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 Abate® 4-E), 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 12,616 larval site inspections were conducted this season; only 10% (1,274) 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 3,948 miles treated, which is 23% less than the historical average (Figure 10) as a result of less significant rain events compared to 2015. Control materials dispensed included 1,704 gallons of Abate 4E mix (6.7 gallons of Abate 4E concentrate) and 207.5 gallons of Natular 2EC mix (1.36 gallons of Natular 2EC concentrate). Figure 11 portrays product usage for each township. Most of the treatment occurred in Monitor, Williams, Pinconning, and Beaver Townships with 681, 608, 328, and 316 miles treated, respectively. As a combined total for these four townships, 1,933 miles were treated or 49% of the total.

Figure 10 – Historical Ditch Truck Miles

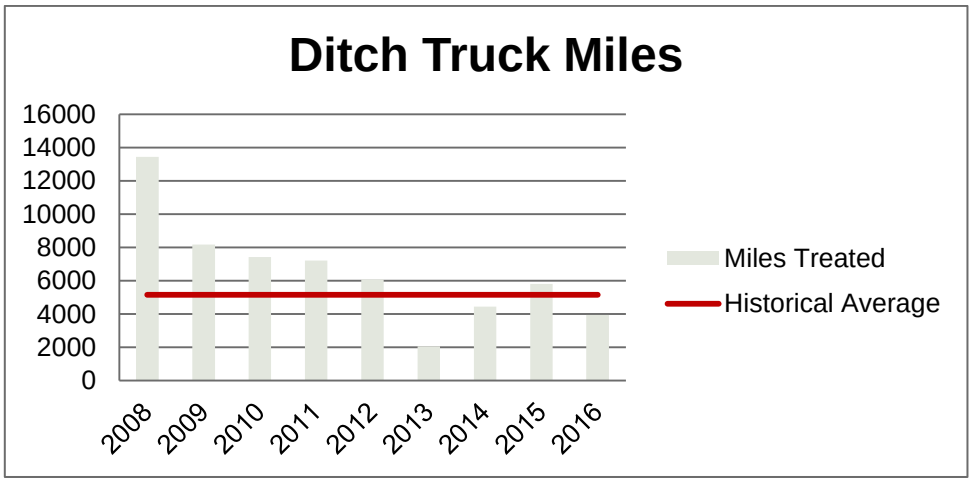
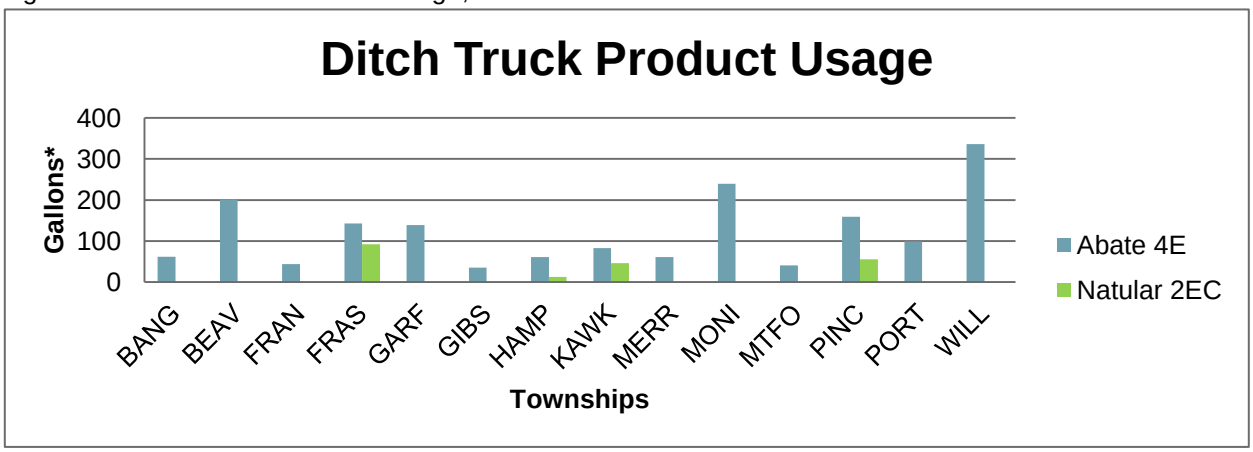



Figure 11 – Ditch Truck Product Usage, 2016




*Unit of measure is gallons of final mix for Abate 4E and Natular 2EC.

**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 27,723 individual habitats. Figure 12 shows the total number of catch basins treated for each township. The bulk of treatment took place in Bay City, Hampton Township, Monitor Township, and Essexville, 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 (4,840 individual tablets) or VectoLex® FG bacterial larvicide (680.03 pounds). 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 single treatment during the 2016 season. Figure 13 shows the amount of product applied to catch basins in each township or city.

Figure 12-Total Catch Basins Treated Per Township, 2016

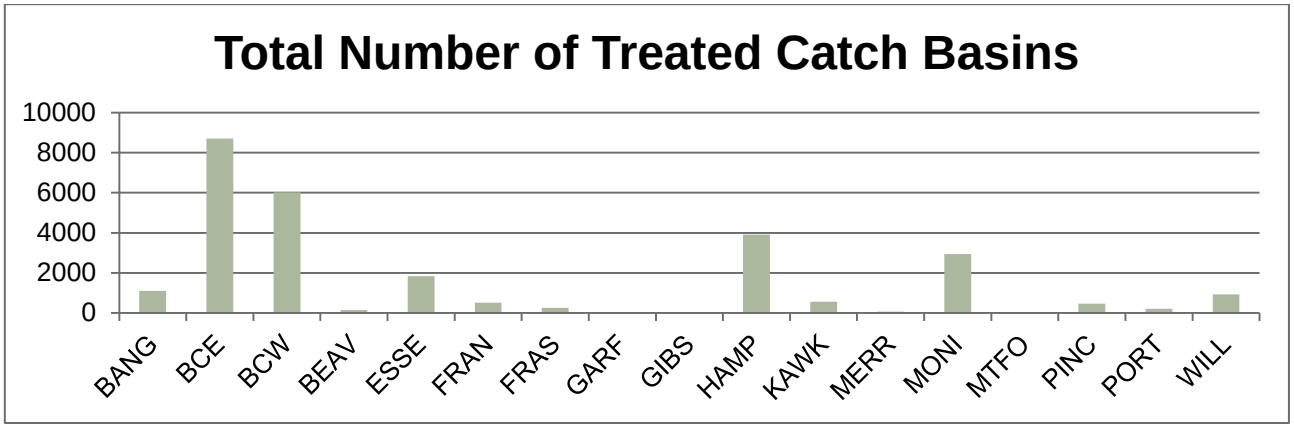
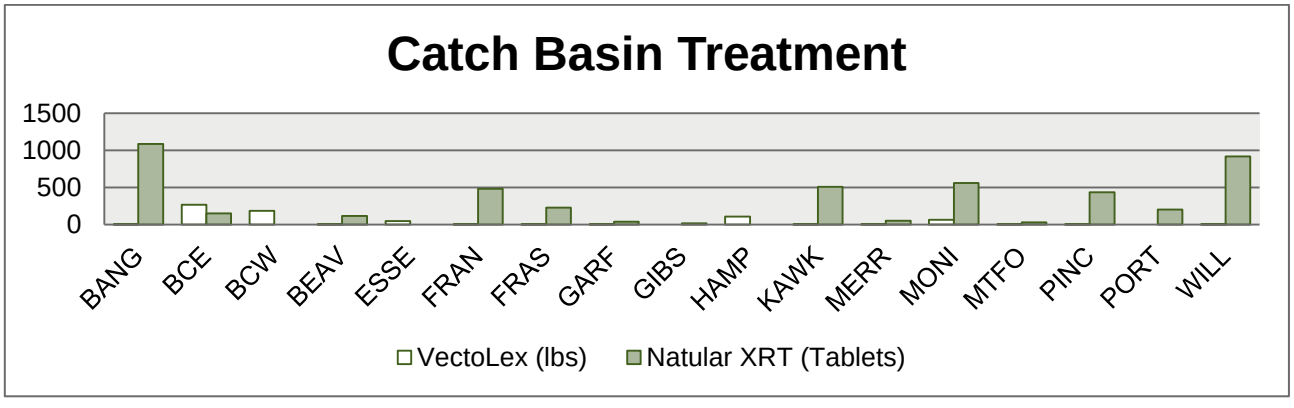



Figure 13 – Catch Basin Treatment Data, 2016



**Retention & Detention Ponds:** Bay County is home to approximately 150 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 400 individual visits throughout the summer, 86% 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.

Two sewage lagoons were monitored 23 times this season—White Birch Village Mobile Home Park and Pinconning McDonalds— resulting in 18 treatments, all of which were done at White Birch Village. In order to treat sewage lagoons, a Michigan DEQ Water Treatment Additive form was first approved.

**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 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.

Table 7 – Larvicides Dispensed During Search and Destroy Operations, 2016

| Twp. | AB4E | Agnique | Briquets | Bti | BVA2 | Provect | VectoLex |
|---|---|---|---|---|---|---|---|
| BANG | 29.22 | 1.45 | 61.5 | 41.326 | 10.081 | 2.06 | 3.13 |
| BCE | 14.586 | 0.165 | 22 | 5.37 | 0.73 | 0 | 4.95 |
| BCW | 20.168 | 1.065 | 20 | 16.618 | 15.02 | 1.1 | 1.32 |
| BEAV | 5.39 | 0.85 | 1 | 37.07 | 0.32 | 0 | 7.77 |
| ESSE | 0 | 0.2 | 1 | 0.957 | 0 | 0 | 0 |
| FRAN | 0.68 | 0 | 16 | 26.54 | 1.76 | 2.06 | 1.966 |
| FRAS | 5.73 | 1.947 | 20.25 | 22.57 | 3.954 | 0 | 0 |
| GARF | 0.36 | 0.363 | 10 | 0.61 | 1.399 | 0 | 1.09 |
| GIBS | 0.96 | 0 | 27.5 | 0.24 | 36.69 | 0 | 0 |
| HAMP | 26.84 | 2.033 | 25 | 49.226 | 6.43 | 0 | 5.84 |
| KAWK | 11.26 | 1.7 | 21.5 | 6.6 | 13.626 | 0 | 2.332 |
| MERR | 22.44 | 0.066 | 28.5 | 3.55 | 0.23 | 0 | 0.36 |
| MONI | 16.6 | 0.561 | 73 | 422.696 | 25.56 | 5.37 | 7.567 |
| MTFO | 4.8 | 0.033 | 31 | 1.96 | 2 | 1.8 | 0 |
| PINC | 15.68 | 3.171 | 54.5 | 25.054 | 1.17 | 0.82 | 0.143 |
| PORT | 17.711 | 0.165 | 22 | 10.27 | 0.95 | 0.17 | 18.56 |
| WILL | 44.77 | 0.401 | 21 | 69.916 | 11.438 | 0 | 4.13 |
| **TOTALS** | **237.195** | **14.17** | **455.75** | **740.573** | **131.358** | **13.38** | **59.158** |

## 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 Ultra Low Volume (ULV) equipment that allows a relatively small amount of material to be dispensed from the spray unit. Application rates are adhered to by using GPS units with SmartFlow® technology in each truck. Label recommendations are strictly followed to assure proper dosage rates and droplet sizes during adulticide applications. To accomplish the latter, droplet measurements are taken several times throughout the season. This year, droplet characterization took place May 3 and August 1 using the Teflon® slide method to measure aerosol droplets. The Biology Department also runs 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. Three tests run in 2016 showed no resistance to the permethrin products used at BCMC.

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 72 (a 6% increase from 2015), 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 87 in 2016.

During the 2016 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 nineteen such addresses were placed on route maps to be fogged during routine sweeps, an increase of 3% from 2015.

Table 8 reveals that 20,327 miles were logged during adulticiding operations and 4,435.47 gallons of control materials were dispensed, with the majority being Evoluer™ 4-4 ULV (3,202.28 gallons). Compared to 2015, this is 344 more gallons of control materials and 4% more miles treated, likely due to the addition of a ninth nighttime driver.

Table 8 – Adulticiding Treatment, 2016

| Adulticiding Treatment Totals | | | |
|---|---|---|---|
| **Township** | **Kontrol 4-4 (gallons)** | **Evoluer™ 4-4 ULV (gallons)** | **Miles Treated** |
| Bangor | 114.68 | 286.54 | 1912.68 |
| Bay City East | 26.20 | 84.55 | 532.04 |
| Bay City West | 17.15 | 56.90 | 353.51 |
| Beaver | 87.16 | 201.49 | 1320.85 |
| Essexville | 6.21 | 15.00 | 111.51 |
| Frankenlust | 44.96 | 161.03 | 952.60 |
| Fraser | 89.88 | 205.64 | 1327.59 |
| Garfield | 61.99 | 154.65 | 999.50 |
| Gibson | 64.55 | 132.05 | 918.85 |
| Hampton | 89.20 | 269.41 | 1603.70 |
| Kawkawlin | 79.01 | 234.11 | 1403.10 |
| Merritt | 61.15 | 188.63 | 1151.89 |
| Monitor | 134.67 | 458.92 | 2586.33 |
| Mt. Forest | 82.70 | 112.46 | 901.80 |
| Pinconning | 78.74 | 187.18 | 1226.12 |
| Portsmouth | 70.62 | 174.47 | 1138.07 |
| Williams | 124.32 | 279.25 | 1887.03 |
| **Total** | **1233.19** | **3202.28** | **20327.17** |

## 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 3,971 adult mosquito service requests received during the 2016 season. There were 3,239 entries for either regular service requests for adulticide treatment due to nuisance mosquitoes, Specials, Medicals, or Long Drives, while the remaining 732 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. Figure 14 represents a historical profile of adulticide service. Office staff also logged 789 calls reporting standing water with potential mosquito breeding (Figure 15). Regardless of the type of service request, all were responded to in a professional, courteous, and prompt fashion.

Figure 14 – Historical Number of Adulticiding Requests from Bay County Citizens

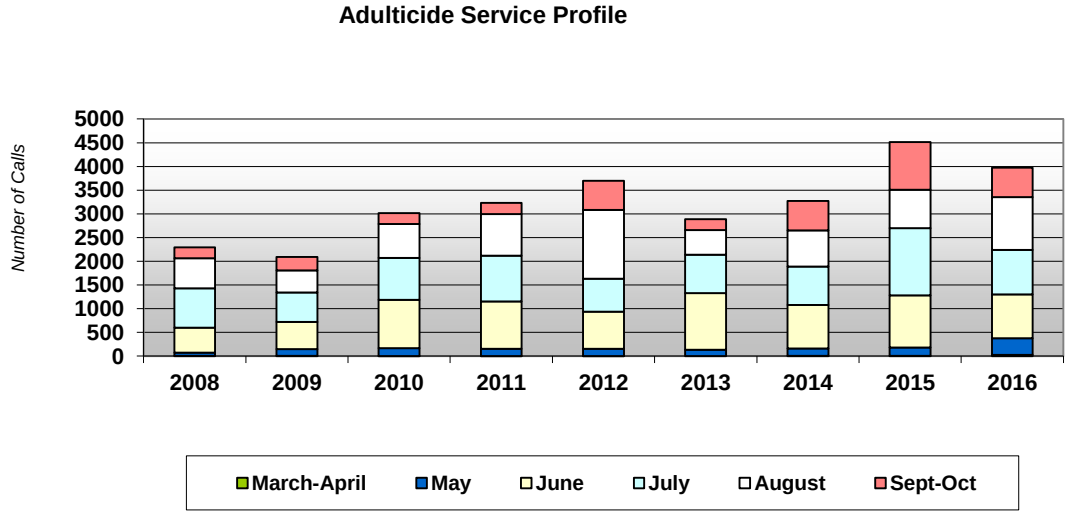
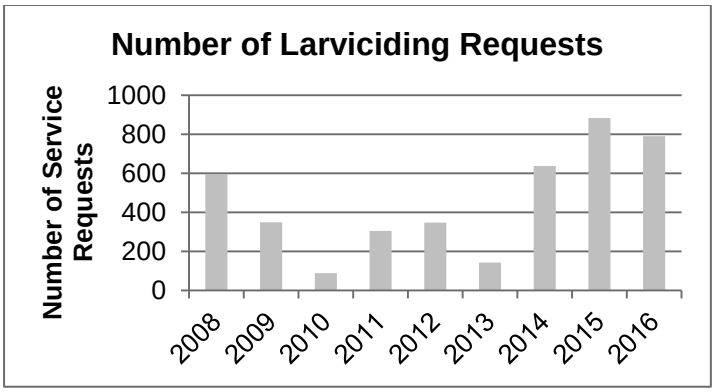


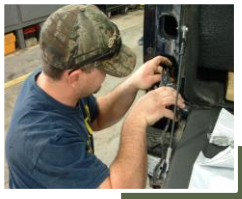

Figure 15 – Historical Larviciding Requests from Bay County Citizens



## 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 2016 season, as Figure 16 shows, 138,969 miles were driven, which is much below the 25-year average of 183,339 miles and represents 8% fewer miles driven than in 2015. Vehicle and equipment maintenance included the following:



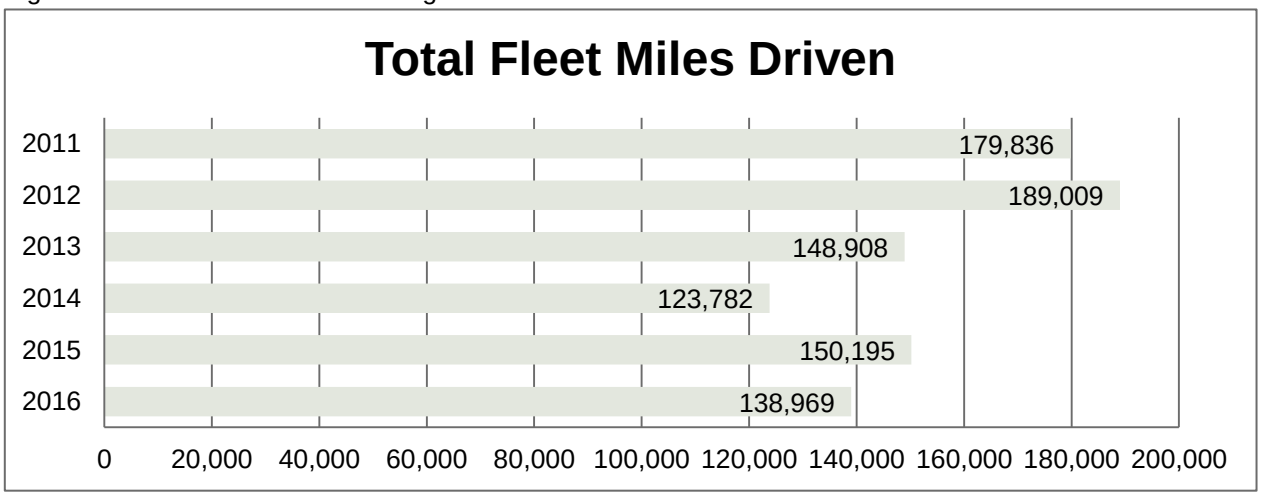
### Vehicle Repairs

- Brake systems - 14
- Fuel systems - 7
- Front end repairs - 28
- Truck oil changes - 54
- Electrical systems - 42
- Drive lines - 4
- New tires - 24
- Used tire repair - 8

### Equipment Repairs

- ULV oil changes - 24
- ULV repairs - 46
- Ditch trucks - 15
- Hudson® sprayers - 37
- Spreaders - 4
- CDC Traps - 10
- New Jersey Light Traps - 8
- Gravid Traps - 4

Figure 16 – Historical Vehicle Mileage



## FLEET TRACKING

Velocity Systems, LLC of Big Rapids, MI continued implementing a fleet tracking system in 2016. Ten MqTrack™ systems were installed in nine ULV trucks and one ditch truck with the intention of running the units beginning in the 2016 season, although not everything functioned properly. Velocity should have everything completely operational for the 2017 season.

The MqTrack™ system provides guidance throughout the application process, handles automatic no-spray control, monitors and maps application positioning, collects detailed rate and volume 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.

Phase 2 (2017 and beyond) involves purchasing 10 more GPS units for larviciding vehicles as well as tablets and software installed in all trucks. The tablets will be used by staff to load work orders, locate treatment sites, and enter treatment data.

## 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 4 at the BCMC field station and staff recycled 1,009 tires; an additional 483 tires were recycled during the second late-summer tire drive on August 14.

In 2016, 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

Efforts are made to inform and educate Bay County residents about mosquito 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. Presentations are also given to various groups, including middle and elementary schools. Brochures and handouts are developed and distributed at various locations and BCMC's website is updated regularly.

## 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 13 and June 6 with new and returning technicians in attendance, two staff meetings were scheduled during the summer for the entire BCMC staff. Full-time staff members were also present for MMCA's 30th annual meeting at Weber's Inn, Ann Arbor on February 2-3, 2016 and the MMCA 2016 Mosquito Control Training Session October 24, 2016 in Bay City, both of which offered continuing education credits. 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: Open Book Management (1-13-16), Research Priorities to Inform Public Health and Medical Practice for Domestic Zika virus: A Workshop (2-16-16), Zika virus (2-18-16), Everyone Seems to Have a Better Mosquito Trap: Making Sense of Mosquito Trapping (2-23-16), Preventing Zika in the U.S. (3-3-16), Zika virus (3-4-16), Four Ways to Enhance Your Relationship With Time (3-9-16), Local Health Departments – Preparing and Preventing Zika (3-23-16), Mosquito Control:

IPM Techniques (3-29-16), Vectors and Public Health Pests Virtual Conference (4-13-16), Zika Workshop (5-4-16), Managing Mosquitoes and Other Problem Pests (6-28-16).

BCMC's program plan was reviewed and approved in January by the MDARD as part of our Comprehensive Community Outreach as mandated in Regulation 637. The Technical Advisory Committee (TAC) annual meeting was held March 9, 2016 where the 2015 annual report and 2016 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 a 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 2016 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

The Michigan Department of Environmental Quality 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 permit expires February 1, 2017; BCMC re-

applied for the permit in August 2016. This year was the fourth year BCMC was mandated to file a NPDES Annual Report, which was completed and submitted on November 23, 2016 via the newly-created MIWaters website.

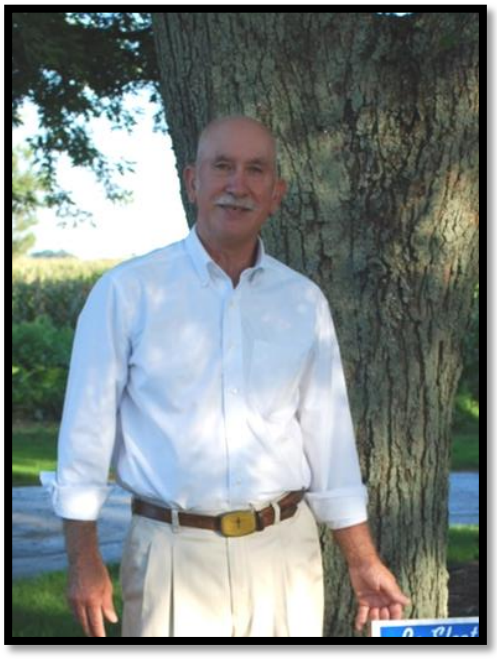
Table 9 – Control Material List, 2016

| 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 Bs ITU/acre |
| **Natular™ 2EC** | 1.1-2.8 fl oz/acre | 0.018-0.045 lb spinosad/acre |
| **Natular™ XRT** | 1 tablet/CB | 6.25% spinosad/tablet |
| **Masterline® Kontrol 4-4** | 0.67 fl oz/acre | 0.00175 lb permethrin/acre<br>0.00175 lb PBO/acre |
| **Evoluer™ 4-4 ULV** | 0.78 fl oz/acre | 0.00175 lb permethrin/acre<br>0.00175 lb PBO/acre |

## TOM PUTT'S RETIREMENT

After a 31-year tenure as Director of Bay County Mosquito Control, Tom Putt announced his retirement on October 21, 2016. Tom has been a key figure in mosquito control in Michigan since he was called to public service in 1977, beginning his mosquito control career working for the Saginaw Bay Mosquito Control Commission as a Field Technician and then Foreman. On January 1, 1985 he began his long and memorable career as Director of Bay County Mosquito Control, dedicating himself to serving the residents of Bay County, then, for a total of 40 years. Under his direction, two new field stations were completed. Bay County Mosquito Control's newest field station was constructed with three separate buildings – office, garage/wash bay/cold storage, and chemical storage. It was always Tom's dream to build an up-to-date facility that would truly accommodate our needs and meet MDARD regulations and that dream became reality in 2003. With his guidance, the residents of Bay County overwhelmingly supported the millage-based program he directed, most recently with an 84% approval rating.

Tom has been an outstanding member of the Michigan Mosquito Control Association and received the prestigious H. Don Newson Distinguished Service Award in 1996. He also served as MMCA President in 1992, 2000, 2004, and 2006 and served on many MMCA committees (too numerous to mention). Tom has served as a Williams Township Trustee for 12 years and was re-elected in November 2016 for another 4-year term.



After his long, active, and exemplary service to Bay County, Tom will now have the opportunity to spend quality, uninterrupted time with his supportive wife Mary Anne, his two sons John (Ashley) and Patrick (Crystal), and, especially, his three grandsons Dane, Luke, and Jack. Tom also now has extra time to devote to his love of agriculture and you can be sure you'll see him out in the fields in the spring and fall.

The Bay County Mosquito Control staff praise Tom for his long and successful service to the field of mosquito control and recognize his retirement represents a major transition. He likes to call it re-focusing rather than retirement, but either way we hope he enjoys a long, well-deserved and healthy departure from the mosquito control community pursuing other activities.

# BAY COUNTY


Arenac County
Gladwin County
Midland County
Saginaw County
Tuscola County
Gibson Twp
Mt Forest Twp
Pinconning Twp
City of Pinconning
Garfield Twp
Fraser Twp
Beaver Twp
Kawkawlin Twp
Bangor Twp
City of Essexville
Hampton Twp
Williams Twp
City of Auburn
Monitor Twp
City of Bay City
Portsmouth Twp
Frankenlust Twp
Merritt Twp
Bay County
State Highways
Local Primary Roads
Townships
Cities
Saginaw Bay
County Boundaries