73rd Annual Report

Mosquito Control for a Safe and Quality Environment

1947 - 2019

February 18, 2020

Mr. Mark Stutler, Director

Toledo Area Sanitary District

5015 Stickney Avenue

Toledo, Ohio 43612

Mr. Mark Stutler:

In compliance with Section 6115, paragraph 14 of the Ohio Revised Code, I hereby submit the Annual Report for 2019. This 73rd Annual Report of the Toledo Area Sanitary District (TASD) contains the financial report for 2019 and a budget for 2020. It also summarizes the District's operations, field activities, and achievements over the past year.

The District provides an efficient, economical, and environmentally conscious program for the residents of Lucas County. The techniques, insecticides, and equipment used by the District are among the most widely recommended and accepted in the industry. As a result, the TASD has been influential in educating and recommending sound best management practices throughout the state of Ohio and into neighboring states.

The tremendous assistance and support we continue to receive from you and the Advisory Committee is greatly appreciated. Going forward, we will continue to do our best to fulfill our mission and provide the citizens of Lucas County with mosquito control for a safe and quality environment.

Respectfully submitted,

Paul R. Bauman

General Manager

Contents

Staff & Advisory Committee

Executive Committee

Director.....Mark A. Stutler

Secretary-Treasurer.....Russell R. Miller

General Manager.....Paul R. Bauman

Full-Time Employees

Bradley Betz.....Field Supervisor

Mike Bruce.....Garage & Facilities Specialist

Myles Caryer.....Larviciding Chief Supervisor

Lisa Diehl.....Office Manager/Bookkeeper

Arianna Johansen.....Office Clerk/Asst. Bookkeeper

Darnea Merrell.....Larviciding Chief Supervisor

Doug Nabors.....Field Supervisor

Mark Nye.....Field Supervisor

Justin Rist.....Water Management Chief Supervisor

Hunter Sanner.....Field Supervisor

Bob Sattler.....Operations/Substation Manager

Bob Schramm.....Field Supervisor

Dr. Jennifer Shimola.....Education & Research Coordinator

Thomas Shultz.....Field Supervisor

Jacob Sublett.....Biologist & GIS Specialist

Cory Taylor.....Field Supervisor

Ben White.....Fogging Chief Supervisor

Shannon Wilson.....Field Supervisor

2019 Seasonal Employees

Melvin Augustyniak.....Night Fogging

Tom Bauman.....Night Fogging

Kathryn Clapsaddle.....Lab Technician

Derek Frey.....Night Fogging

Frank Fulkerson.....Lab Technician

Kellie McConeghy.....Night Fogging

Avery Miller.....Lab Technician

David Pruss.....Night Fogging

Kurt Susdorf.....Night Fogging

Joshua White.....Night Fogging

Advisory Committee & Consultants

Dr. Gary F. Bennett.....Professor Emeritus of Biochemical Engineering, University of Toledo

Jennifer Gottschalk.....Supervisor, Toledo-Lucas County Health Department

Michael K. Hart.....Public Information - Consultant

David G. Huey.....Retired Director, Toledo Area Sanitary District

Dr. Donald R. Knepper.....Doctor of Veterinary Medicine

Thomas Kovacik.....Kovacik Consulting

Jennie Lambert.....Principal, Rehman

Russell R. Miller.....Legal Counsel - Consultant

Dr. Daniel Pavuk.....Lecturer of Biological Sciences, Bowling Green State University

Dr. Randall J. Ruch.....Associate Professor of Biochemistry & Cancer Biology, UT College of Medicine

Amy K. Stone.....Extension Educator, Ohio State University Extension - Lucas County

Konni Sutfield.....Retired Supervisor, Toledo-Lucas County Health Department

Dr. R. Travis Taylor.....Assistant Professor of Medical Microbiology & Immunology, UT College of Medicine

History, Organization, & Funding

The District's wrecker

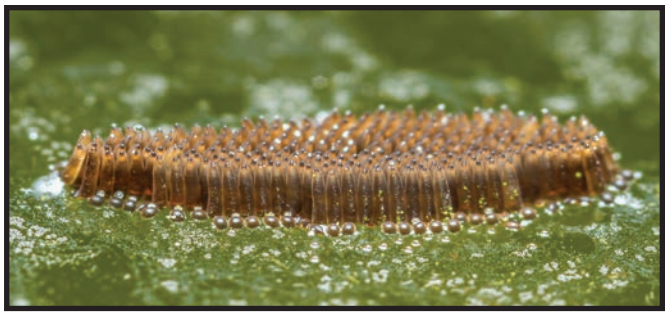
Under authority of the Sanitary District Act of Ohio, the Toledo Area Sanitary District (TASD) was established September 27, 1945, by the Common Pleas Court of Lucas County. Residents from the Village of Ottawa Hills petitioned to the Court for the establishment of the District for the abatement and control of mosquitoes. TASD was organized and formulated in 1946, with actual mosquito control operations beginning in 1947.

TASD employees add water from a hydrant to a mix for a product.

In accordance with the statute, responsibility for policy determination for the TASD resides with the Director, who is appointed by the Common Pleas Court. The Secretary-Treasurer and General Manager for the District are appointed by the Director. Although not required or provided for in the statutes, a volunteer citizen Advisory Committee is assembled by the TASD Executive Committee (Director, Secretary-Treasurer, and General Manager).

Funding for the TASD is provided through a special assessment levied upon property holders within Lucas County. For 2019, eligible properties were assessed at a rate of 0.34 mills, which equates to approximately $11.90 per $100,000.00 of taxable property value.

Mosquito Biology



Eggs are laid one at a time and can be attached together to form "rafts" which float on the surface of water. The female mosquito will seek out semi-permanent water sources to deposit these egg rafts, such as catch basins or water gardens. Other mosquitoes that do not make egg rafts will deposit their eggs on damp soil or inside artificial containers, waiting for rain to flood the area or fill the containers, exposing the eggs to water for hatching. Most eggs hatch into larvae within 48 hours; others might withstand subzero winters before hatching. Exposure to water is a necessary part of their habitat. The egg is the part of the mosquito lifecycle primarily responsible for survival through winter.

Larvae live in water and come to the surface to breathe. Larvae shed (molt) their skins four times, growing larger after each molt. Most larvae have siphon tubes for breathing and hang upside down from the water surface. Some larvae do not have a siphon and lie parallel to the water surface to get a supply of oxygen through a breathing opening. A few other species of larvae attach to plants to obtain their air supply. The larvae feed on microorganisms and organic matter in the water. During the fourth molt, larvae change into pupae. Depending on environmental conditions, larvae can develop into pupae in as little as four days.

Pupae are a resting, non-feeding, development stage; however, pupae are mobile and respond to light changes by moving (tumbling) with a flip of their tails (abdomen) towards the water bottom or protective areas. This is the stage when the mosquito changes into an adult. This process is similar to the metamorphosis seen in butterflies when the butterfly develops, while in the cocoon stage, from a caterpillar into a butterfly. In most mosquito species this takes about two days in the summer. When development is complete, the pupal skin splits and the adult mosquito will emerge. Pupae do not feed, but still must breathe air at the water's surface.

The newly emerged **adult** rests on the surface of the water for a short time to allow itself to dry and all its body parts to harden. The wings have to spread out and dry properly before it can fly. Blood

feeding and mating do not occur for a couple of days after the adults emerge. Only females feed on blood and the primary food source for both males and females is sugar. Not all species of mosquito feed on people; some prefer other animals such as birds, amphibians, or reptiles. Flight ranges also vary greatly, from under one mile to 10-20 miles per day from a breeding location. The lifespan of a female adult mosquito can last several months. This is the lifecycle stage that is a pest to humans and can potentially spread disease.

Mosquito Breeding Habitats

Mosquitoes require water to complete their lifecycle and can breed in a variety of aquatic habitats. Listed below are some of the different types of breeding habitats the TASD routinely monitors and treats for developing mosquitoes.

Permanent water sources (wetlands, marshes, retention ponds, etc.)

Coquillettidia spp., *Anopheles* spp., and *Culex* spp. routinely breed and emerge from these types of habitats. These mosquitoes can be an extreme nuisance for humans, as well as potentially being involved in the transmission of diseases such as malaria, Eastern Equine Encephalitis (EEE), and West Nile Virus (WNV).

Semi-permanent & temporary water sources (ditches, floodwater, vernal pools, etc.)

These types of habitats produce the most pestiferous and numerous mosquitoes in Lucas County. Spring *Aedes* spp. mosquitoes emerge from vernal pools and can live through the entire summer. Summer floodwaters produce large numbers of *Aedes vexans* mosquitoes that fly long distances and readily feed on people throughout the season.

Natural containers (tree holes, rock pools, gravel, etc.)

These small, cryptic, water-holding locations can be very difficult to locate and treat, but can produce numerous mosquitoes. *Aedes triseriatus*, the tree-hole mosquito and vector of La Crosse encephalitis, can commonly be found in these locations. *Aedes japonicus* is another mosquito that breeds in these natural locations.

Man-made containers (tires, swimming pools, ornamental water gardens, catch basins, etc.)

These types of man-made containers can be found throughout areas where people live. They provide a perfect habitat for numerous species of mosquitoes to develop. Many mosquitoes of concern for disease transmission breed in these types of habitats.

Integrated Mosquito Management (IMM)

The TASD practices, promotes, and firmly believes in using *integrated mosquito management* (IMM) techniques for its operations. Using IMM philosophies means that the District approaches the task of mosquito control from a holistic perspective, seeking to prevent and control mosquito populations at every possible level of their development.

The IMM approach employed by the TASD focuses on surveillance, mapping, breeding source reduction, larval mosquito control, adult mosquito control, and education/community outreach. No single phase of the IMM approach is more important than another. Each aspect of this approach is integral to reducing and controlling mosquito populations in the most efficient and environmentally conscious manner possible.

IMM: Education

Educating the citizens of Lucas County about how to protect themselves from mosquito bites and disease transmission, as well as how to identify and eliminate mosquito breeding sources around the home and in the community, is vital to the mission of the TASD. In 2019, the District expanded its public educational curriculum and reach.

Public Education

Public education in vector control aims to reduce vector abundance and disease transmission through awareness. TASD developed three mosquito management curricula for school-age citizens that provide information on mosquito breeding habitat and vector-borne disease. These programs were presented at five classrooms and two community events, directly impacting approximately 330 students in Lucas County.

Dr. Jennifer Shimola, Education and Research Coordinator, helps students at Anthony Wayne High School identify mosquitoes' breeding sources.

TASD continues to have educators available upon request for formal presentations to community groups. In 2019, TASD visited the Maumee Garden Club's Spring Forum, the Golden Emblems retirement group, OSU Extension's Lunch and Learn, and the Maumee Valley Beekeepers Association in order to inform citizens about mosquito biology and to promote services offered by TASD.

A kindergarten class makes mosquitoes out of construction paper and pipe cleaners.

Professional Development

Jacob Sublett, Biologist, gives a presentation in the District's new education room, which was funded by a grant from NAACHO.

TASD was the recipient of the National Association of County and City Health Officials' (NACCHO) Vector Control Collaborative grant in 2019. TASD acquired educational equipment and developed an on-site classroom with the awarded funds. In return, TASD mentored Hancock Public Health on mosquito surveillance and insecticide resistance testing to improve Hancock County's vector control program. The classroom and microscopes funded by this grant were used for an insecticide resistance monitoring workshop hosted by the Ohio Mosquito and Vector Control Association (OMVCA), the Ohio Department of Health (ODH), and the Midwest Center of Excellence in Vector-Borne Disease.

TASD assisted in the planning and execution of the OMVCA's annual conference, which had approximately 100 attendees. All TASD employees attended this event to advance their understanding of current mosquito control practices and to fulfill requirements of their pesticide applicator licenses.

TASD employees continued their education by attending the Michigan Mosquito Control Association's and American Mosquito Control Association's annual conferences.

Media, Social Media, & Website

During 2019, TASD was the subject of 13 local news stories. The TASD Facebook page was used to inform citizens about TASD operations and services as well as current information on mosquito-borne diseases, tick management, and personal protection, with an average reach of 350 people per post. TASD expanded the educational materials available on its website to include tick-borne disease control and travel-associated vector-borne disease.

IMM: Water Management/Source Reduction

The removal or modification of potential mosquito breeding habitats is a basic component to a good mosquito control program. TASD staff is routinely involved in small-scale mosquito breeding source reduction efforts on a daily basis. Activities such as emptying a bucket, dumping out a container, or removing a used scrap tire can make a big difference in reducing local mosquito populations.

Anything left to accumulate water can become a breeding ground for mosquitoes.

A unique component of the integrated TASD program is the large-scale water management projects conducted during the fall and winter. These projects can generally be described as cleaning ditches or removing blockages in local waterways and drain paths that are meant to keep water flowing properly and reduce springtime flooding that creates mosquito breeding habitats. The TASD works with individual homeowners, land managers, and the Lucas County Engineer's office to identify areas in need. A large multi-year project to clear Drennan Ditch was continued in the fall of 2019. APPENDIX, Figure 1 shows the progress that has been made.

TASD removes debris that was causing water to collect and breed mosquitoes.

IMM: Surveillance

Surveillance is the backbone of an integrated mosquito management program. It involves determining a need to conduct control operations, gathering the information necessary to prioritize control treatment plans, and providing the efficacy data for the evaluation of those control operations. The TASD routinely relies on citizen surveillance reports and data collected through a network of various surveillance traps to provide the information necessary for successful mosquito control operations.

In 2019, from May 20th through October 3rd, adult mosquito populations were monitored using 26 stationary New Jersey Light Traps, placed throughout Lucas County (APPENDIX, Figure 2) and sampled four days a week. The mosquito collections were identified to species in the lab by trained personnel. The survey data was used to estimate relative population densities of individual mosquito species, suggesting which areas within Lucas County needed increased control efforts. The TASD Laboratory Staff identified 18,429 adult female mosquitoes from light traps in 2019 (APPENDIX, Table 2).

A gravid trap is used for mosquito surveillance.

West Nile Virus (WNV) prevalence in the mosquito population was monitored from over 55 different locations within the county using gravid mosquito traps. A combination of stationary locations and rotating gravid trap locations were used to collect female mosquitoes that could have potentially acquired WNV after taking a blood meal from a WNV infected bird. During the 2019 season, 34,486 gravid female mosquitoes, grouped into 1,342 pools, were tested for WNV infection. Fifty-nine of the mosquito pools submitted by TASD tested positive for WNV. These results were analyzed and mapped to determine areas of increased risk for human transmission of WNV, shaping control decisions designed to break the virus's transmission cycle.

IMM: Larval Control (Larviciding)

Aside from removing a potential breeding source altogether, larval mosquito control (larviciding) is the most effective method of control used by the District. Thousands of potential mosquito breeding sites are routinely checked by District personnel each season.

A jar of mosquito larvae

For the 2019 season, the first larvae of the year were observed on March 20th. Larviciding control operations began on April 1st and continued until October 28th. This uncharacteristically late start to larviciding operations was dictated by slow mosquito development, presumably linked to below-average late winter and early spring temperatures. Throughout the season there was a large reliance upon the use of biological larviciding products. These products can be collectively referred to as "biopesticides" and are very specific and effective in their target and control of larval mosquitoes.

For the first time in its history of use by the District, VectoMax® was the most heavily used larvicide product (12,614 pounds). With combined active ingredients of 4.5% *Bacillus thuringiensis israelensis* (Bti) and 2.7% *Bacillus sphaericus* (Bs), this biopesticide can provide residual larval control for up to four weeks. The product was used as a replacement for Skeeter Abate®, a chemical-based larval control product that is no longer being manufactured. Small remaining stock of Skeeter Abate at the District was exhausted in early 2019 and the product will no longer be used going forward.

In 2019, TASD was also granted access to conduct larviciding in predetermined areas of the state nature preserves managed by the Ohio Department of Natural Resources. This new approval allowed large areas of Louis Campbell Preserve to be treated with VectoMax, resulting in a great reduction of nuisance mosquitoes in that preserve and the surrounding areas.

Other biopesticides used in 2019 include Aquabac 200G® (2.86% *Bacillus thuringiensis israelensis*) and Natular G30® (2.5% Spinosad). A complete listing of all the larval control products used during the 2019 season can be found in the APPENDIX, Table 1.

IMM: Adult Control (Adulticiding)

An adult mosquito feeding on a human.

The method of mosquito control most familiar to the public is ground adulticiding. Truck-mounted units treat during dusk or dawn as part of nighttime control efforts; this is referred to as fogging. Adulticiding is conducted when environmental conditions are favorable and when the target mosquitoes are most active. This important part of an Integrated Mosquito Management program is designed to kill adult mosquitoes in flight at the time of the application, with no residual control. TASD uses ultra-low volume (ULV) technology that disperses approximately one tablespoon of public health insecticide per acre in droplets that are approximately 20 microns in size. This equates to 1.25 tablespoons of liquid applied to an area approximately the size of a football field, in droplets that are small enough to fit five or six across the width of a human hair.

The US Environmental Protection Agency (EPA) and the Centers for Disease Control (CDC) have asserted in a joint statement regarding mosquito control activities that adult mosquito control products applied with ULV technology do not pose any unreasonable risk to humans or the environment.

A TASD fogging truck

The first adult mosquitoes hatched in the field during 2019 were observed on April 23rd. Adulticiding treatments began during the evening of May 24th and continued through the night of October 1st. Over 366,000 acres were treated during adulticiding operations throughout the course of the year.

To manage against insecticide resistance in the mosquitoes, control products were used just below mid-label application rate and rotated throughout the season.

A complete listing of all the adulticiding products used during the 2019 season can be found in the APPENDIX, Table 1.

IMM: Mapping & Technology

Throughout 2019, the District has continued to create, use, and invest in ideas, technologies, and equipment to strengthen its various programs, including nighttime fogging, larval control, and citizen engagement.

The greatest technological changes were made to the fogging program. TASD shifted all of its 2019 fogging records to an electronic format using ULV Windows, a GPS and recordkeeping software made by Frontier Precision. TASD also began trialing a truck-mounted weather station at the opening of the adult control season. This station records meteorological data such as temperature, wind speed, and wind direction. Without the weather station, this information must be recorded manually by the driver before they begin fogging; automating this process saves time and eliminates the potential for human error. These data are then displayed within the ULV Windows mobile software inside the truck, giving the fogging technician the information they need to ensure applications are optimized. In addition to being extremely useful for recordkeeping and label compliance, the weather station provides invaluable information for evaluating the efficacy of an adult control application.

Advancements in encouraging citizen engagement continued in 2019. TASD expanded its citizen science applications with a tick reporting app that allows community members to share photos of ticks and where they were found. Additionally, the launch of the Long Driveway Treatment Program warranted the creation of an online application form that would allow personnel to review driveways submitted by residents for consideration. Once an application was accepted, TASD employees could add the approved driveway to the preexisting service map route and upload it to the ULV Windows software. With the creation of the online application form and the ease of integrating driveways into the existing route on the GPS software, citizens were able to get their driveways included into this program in an efficient and timely manner, with almost all driveway applications being completed without any staff member ever leaving the office.

The successful integration of GPS-enabled tablets into the fogging program prompted the District to invest in equipping all of its larval control technicians with tablets as well. These tablets will allow technicians to create paperless daily inventory and larval product usage reports, draw in breeding locations, and update previously marked breeding locations, as well as help technicians navigate to any area of concern with turn-by-turn directions. While the software and technology needed to provide the aforementioned capabilities is still being implemented, TASD is excited to start the trialing process at the beginning of the 2020 mosquito season.

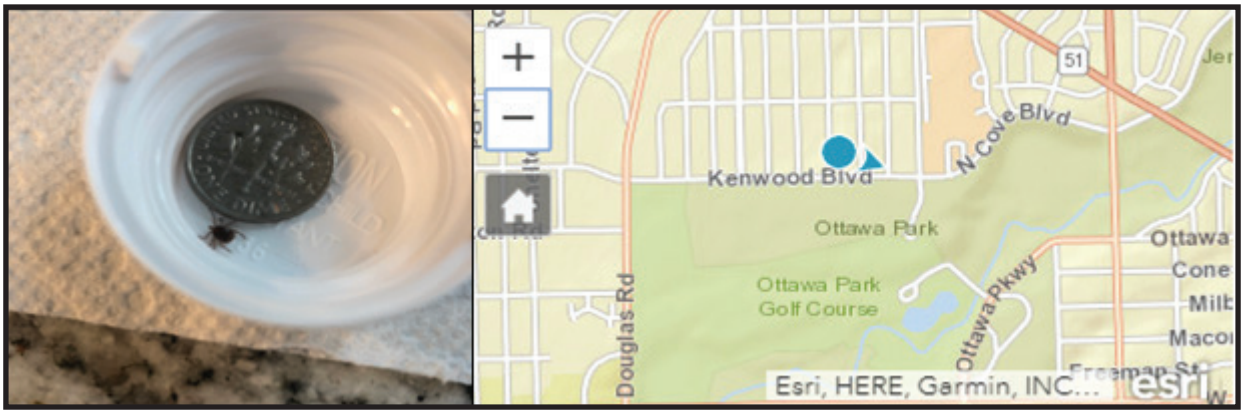


Photo and location of a tick submitted through TASD's citizen tick reporter app.

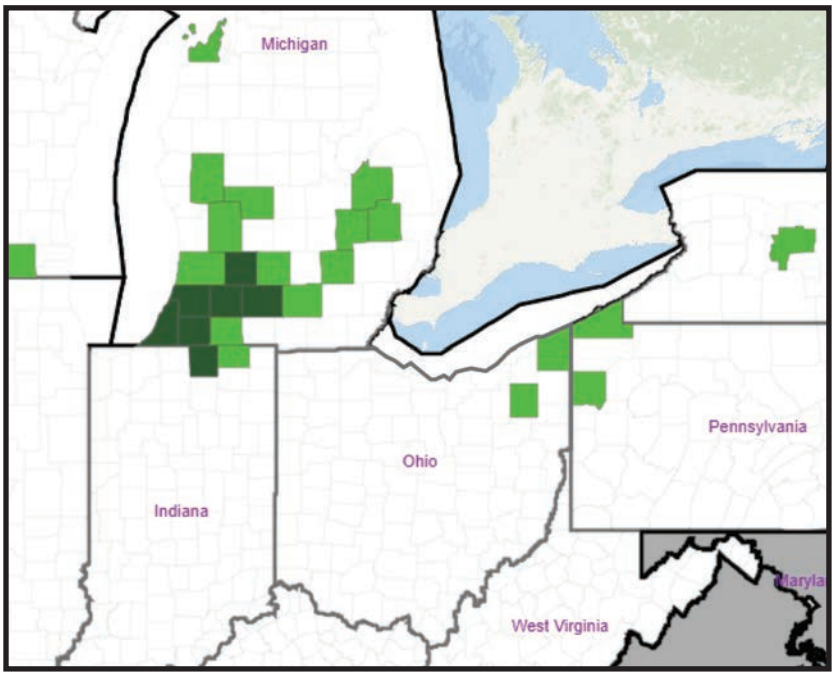
Current Affairs & Mosquito-Borne Disease

West Nile Virus continues to be the mosquito-borne disease of primary concern to citizens of Lucas County. A total of three human cases of West Nile Virus (WNV) were reported in Ohio in 2019, with one case diagnosed in a Lucas County resident. Targeted night-fogging applications conducted by TASD after the identification of WNV-positive mosquito pools were successful at reducing mosquito populations and protecting citizens from infection. The TASD WNV mosquito testing was conducted by the Ohio Department of Health.

Culex pipiens is the primary vector of West Nile Virus to humans.

Nationwide in 2019, 44 states and the District of Columbia reported a cumulative total of 885 human cases of WNV, including 47 fatalities. Leading states for WNV cases included California (196), Arizona (173), and Colorado (120).

Although overshadowed by West Nile Virus, other arboviruses also occur in Ohio (see table below). St. Louis Encephalitis Virus (SLE), Jamestown Canyon Virus (JCV), and La Crosse Virus (LAC) have all been found in Ohio in the past. From 2009-2018, Ohio had 208 of the 679 cases of LAC diagnosed throughout the nation. In 2019, LAC activity was high in Ohio again with 24 cases, but there were no human cases diagnosed in Lucas County residents. TASD maintains an active surveillance and control program for arboviruses and their primary mosquito vector species. Mosquitoes are routinely tested for the presence of virus. *Aedes triseriatus*, the vector of LAC, is controlled through nighttime fogging applications and the elimination and treatment of breeding tree holes and man-made containers. Traditional breeding locations for *Culex*



The counties colored in dark green are those that had human cases of EEE in 2019; the ones in light green are those that reported non-human infections.

pipiens, the primary vector of WNV to humans, are routinely monitored and treated when standing water is present.

Eastern Equine Encephalitis (EEE) gained national attention in 2019 due to an epidemic in human cases. Thirty-six human cases were reported to the CDC as of December 2019, compared to five cases in 2018. More locally, Michigan reported ten cases on or near the state's southern border; Ohio only had equine cases. Although the total number of EEE cases was much smaller than WNV, the implications of contracting the disease are cause for concern and action. According to the CDC, approximately one third of all people with EEE die from the disease. Death usually occurs 2 to 10 days after onset of symptoms, but can occur much later. Of those who recover, many are left with debilitating and progressive mental and physical ailments, which can range from minimal brain dysfunction to severe intellectual impairment, personality disorders, seizures, paralysis, and cranial nerve dysfunction. Many patients with these severe lasting impacts die within a few years. With this in mind, the Michigan Department of Health & Human Services conducted aerial treatment for adult female mosquitoes in 14 counties that were deemed "high risk".

The EEE virus is primarily maintained in a bird/mosquito cycle between *Culiseta melanura* mosquitoes and birds. A bridge vector that will feed on both birds and other mammals is required to transmit the virus from birds to animals and people. The primary bridge vector in Lucas County is *Coquillettidia perturbans*, the cattail mosquito. With news of the increase in cases in southern Michigan, TASD increased the surveillance for and control of the *Cq. perturbans* mosquito. Fortunately, Lucas County did not report either human or equine cases of the EEE virus.

2019 Mosquito-Borne Disease Statistics, as of Dec. 2019		
	National	**Ohio**
Chikungunya	98 cases (imported)	10 cases
Dengue	852 (imported); 13 (local)	8 cases (imported)
Eastern Equine Encephalitis	36 cases (10 in MI)	none
Malaria	avg. 1500-2000 cases/yr. (imported)	56 cases (imported)
St. Louis Encephalitis	13 cases	none
Zika Virus	13 cases (imported)	none

Research & Development

The TASD's goal is to continually improve its services to Lucas County citizens by seeking out partnership opportunities with other entities and through the continued advancement of operational procedures and product use.

Typically, the District has relied upon Skeeter Abate in floodwater sites that are difficult to access. With the discontinued availability of this product, the efficacy of an alternative residual larvicide, VectoMax, was evaluated in 2019. Mosquito larval abundance was monitored weekly from mid-April to June following treatment with VectoMax. VectoMax-treated sites had significantly fewer larvae than untreated sites, an effect that persisted for an average of four weeks. After treatment, first instar larvae were only detected in 2% of samples; this suggests that rebreeding did not occur later in the season. Floodwater drained shortly after the study was concluded. Therefore, VectoMax was successful in providing season-long control of spring floodwater mosquitoes in 2019. However, these results may depend on environmental factors and, as such, VectoMax efficacy will continue to be evaluated.

The District used liquid larvicide treatments for the first time in 2019. Liquid larvicide provides control for small, hard-to-find containers that are abundant in urban and suburban areas. Mosquito larval mortality was monitored in field-collected containers to evaluate treatment efficacy. Larval mortality was 20% and 47% greater in treated containers compared to untreated containers for the first and second trial, respectively (APPENDIX, Figure 5). Samples placed in dense foliage had lower mortality than open locations. Some treatment sites had poor efficacy in multiple samples, though the distance from the treated road did not predict larval mortality. While mortality was higher in treated sites, manipulating the treatment setup (wind speed, machine type) could result in a more effective treatment. The District plans to continue evaluating liquid larvicide efficacy during the 2020 season and beyond.

Left: The District trials its new liquid larviciding machine. Right: A researcher counts living and dead larvae in a container that has been treated with liquid larvicide.

TASD established a partnership with the Toledo Zoo's local conservation effort, Wild Toledo. This collaborative study is evaluating the abundance and diversity of non-target insects in urban prairies following mosquito adulticide treatment. Each adulticide treatment location is sampled for one day prior to application and five days following application. Insects from 2019 are currently being identified (190 samples). Both collection and identification will continue in 2020.

The District also contributed to multi-agency research studies executed by the Walker lab at Michigan State University. The research evaluates insecticide resistance and genetic background of the primary West Nile Virus vector, *Culex pipiens*. While this work is ongoing, results suggest that our local mosquito population retains localized insecticide resistance to chlorpyrifos. These results emphasize the importance of continuing product rotation in Lucas County. Additionally, the local *Cx. pipiens* population contains genes from multiple subspecies of *Cx. pipiens*. Given that these subspecies are known to vary in virus competency, host preference, and insecticide susceptibility, these data could inform control decisions in the future. TASD also provided Michigan State University *Aedes* spp. and *Anopheles* spp. mosquitoes to be tested for Jamestown Canyon virus as well as blood-fed *Culex* spp. mosquitoes for genetic analysis.

Insect samples collected through the cooperative research project with the Toledo Zoo.

Environmental Sustainability

Everyone recognizes that mosquitoes are a nuisance, but few realize the magnitude of the health threat and economic impact they present. Mosquito eradication is not possible. Nevertheless, much can be done to control these pests without harming humans, wildlife, or the environment. All of the products used by the TASD have been approved for mosquito control by the United States Environmental Protection Agency (USEPA) and the Ohio Department of Agriculture (ODA), posing little to no risk to human health, other organisms, or the environment. The public health insecticides used during mosquito control operations are readily biodegradable and do not accumulate in the food chain or leave harmful residues on plants or other surfaces. These products have not been implicated in the contamination of well water or public waterways. TASD operations are covered by the general NPDES permit for Ohio, under the Clean Water Act.

As an individual partner, under the auspices of the American Mosquito Control Association, in the Environmental Protection Agency's Pesticide Environmental Stewardship Program, the District is committed to embracing sound environmental stewardship practices in its operation whenever possible. "Green" initiatives that were started in 2017 continued to progress. The on-site native pollinator habitat flourished in its second year of growth. In 2019, the District registered its first apiary with the Ohio Department of Agriculture. This honeybee colony will contribute to the health of the on-site native plant prairie and provide the opportunity to promote pollinator protection and health to the public through various educational efforts.

Capital improvements to the District office were made to increase energy efficiency, such as improved insulation, the installation of new energy efficient furnace and air conditioning units, and the continued installation of replacement windows. Plans remain in place to continue efficiency improvements to the building into 2020 and beyond.

In 2019, the TASD expanded its scrap tire recycling program that was started in 2017. Through this program, TASD employees collected and removed 5,222 discarded scrap tires from the environment. This was the largest number of tires recycled in the three year history of the program. This program provides lasting mosquito control by removing a known breeding source. It also has direct environmental benefits that come along with the removal of these illegally dumped tires. Employees actively search for these scrap tires throughout the county, collect them, remove any water and breeding mosquitoes, and stack them for proper recycling.

2019 Financial Report & 2020 Budget

	2019 FINANCIAL REPORT	2020 BUDGET
FUNDS ON HAND		
Petty Cash	$ 100.00	$ 100.00
Cash Book Balance	841,311.77	1,314,498.59
TOTAL FUNDS ON HAND	$ 841,411.77	$ 1,314,598.59
RECEIPTS		
Maintenance Assessments (Gross)	$ 2,886,839.08	$ 2,700,000.00
Grants	15,968.81	0.00
Interest Earned on Investments	4,003.79	2,000.00
Sale of Equipment & Supplies	13,211.50	0.00
Sale of Scrap	82.00	0.00
Adjustments and Refunds	33,831.49	0.00
TOTAL	$ 2,953,936.67	$ 2,702,000.00
TOTAL RECEIPTS & BALANCES	$ 3,795,348.44	$ 4,016,598.59
EXPENDITURES		
OFFICE & ADMINISTRATION		
Wages - Permanent	$ 303,605.31	$ 360,000.00
Wages - Temporary	17,789.75	50,000.00
Equipment	9,290.26	12,000.00
Utilities & Communications	21,829.26	35,000.00
Professional Services	43,251.95	200,000.00
Pension & Employee Insurance	608,604.55	750,000.00
General Insurance	88,412.00	130,000.00
Travel & Conference	14,360.31	20,000.00
Supplies	10,147.42	22,000.00
Education & Research	14,783.74	20,000.00
R.E. Improv., Maint. & Rental	38,169.36	355,000.00
Assessment Roll & Taxes	10,257.45	75,000.00
Workers' Comp. & State Auditor	14,139.00	40,000.00
Adjustments	0.00	0.00
TOTAL	$ 1,194,640.36	$ 2,069,000.00
FIELD PROGRAM		
Wages - Permanent	$ 787,422.68	$ 790,000.00
Wages - Temporary	43,368.10	110,000.00
Vehicles & Equipment	108,834.54	240,000.00
Larvicides & Insecticides	265,137.12	325,000.00
Fuel & Lubricants	29,113.68	45,000.00
Equipment Maintenance & Shop	14,408.77	30,000.00
Field Supplies & Hand Tools	22,472.47	33,000.00
Miscellaneous & Contingencies	370.00	2,000.00
Drainage Equipment Maintenance	3,895.63	20,000.00
Special Projects	1,748.77	0.00
Vehicle & Equipment Rental	0.00	0.00
Environmental Sustainability	9,337.73	12,000.00
TOTAL	$ 1,286,109.49	$ 1,607,000.00
TOTAL EXPENDITURES	$ 2,480,749.85	$ 3,676,000.00
BALANCE	$ 1,314,598.59	$ 340,598.59

LISA DIEHL
OFFICE MANAGER/BOOKKEEPER

Appendix

Table 1. TASD Product Use Summary (2019)

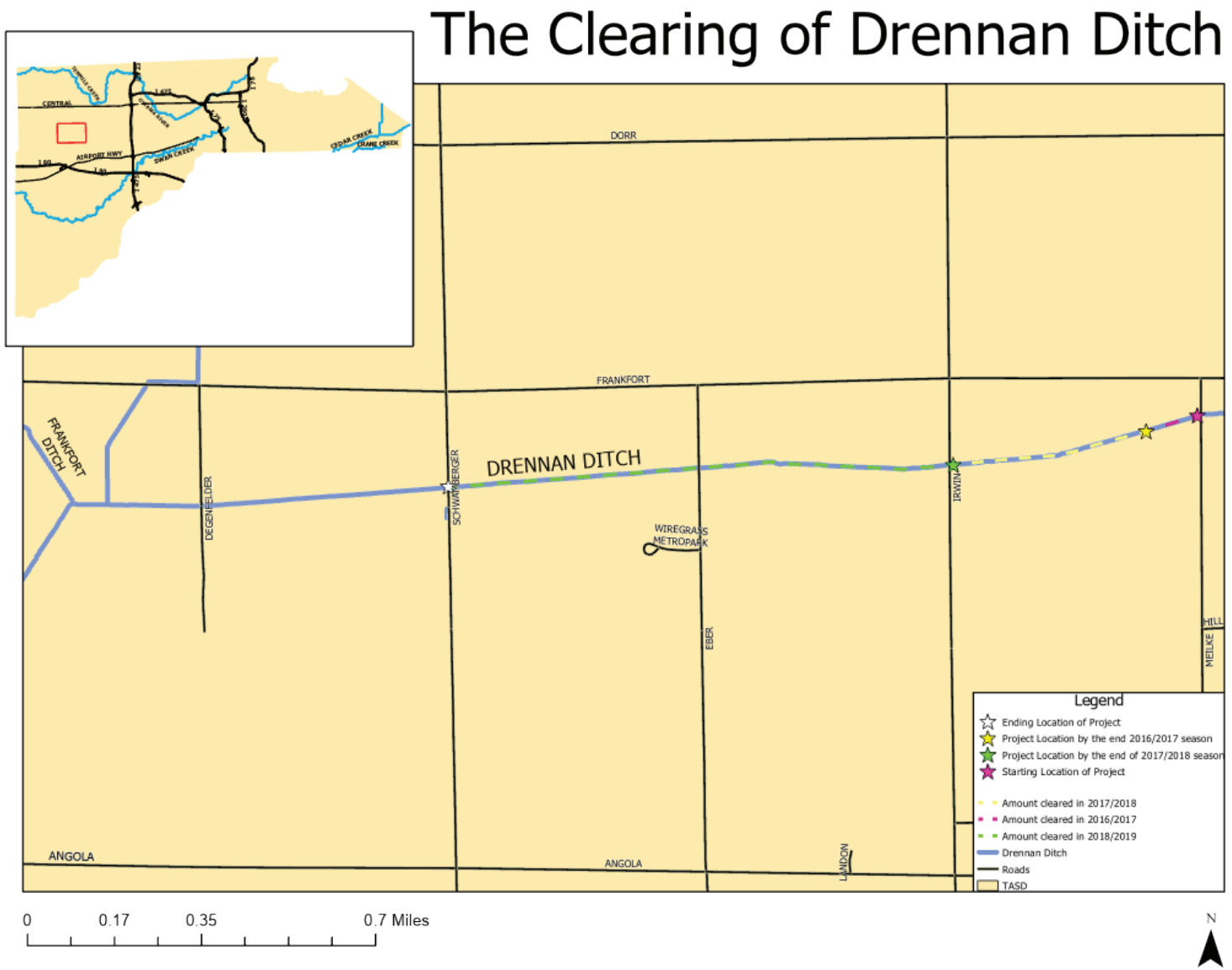
Product	Use Pattern	Amount Used
Anvil 2+2®	Dawn fogging applications	7 gallons
BioMist 3+15®	Night fogging applications	548 gallons
Duet®	Night fogging: disease response	315 gallons
Pursuit 4-4®	Night fogging applications	1,186 gallons
ULV Mosquito Master 412®	Night fogging: product rotation and resistance management	11 gallons
Zenivex E4®	Night fogging applications	401 gallons
Abate 5% Tire Treatment®	Tire larval control	476 lbs.
Altosid SBGII®	Catch basin treatments	70 pounds
Aquabac 200G®	Temporary floodwater treatment	7,528 lbs.
BVA 2®	Pupal and late fourth instar larval control	1,305 gallons
FourStar Bti CRG®	Catch basin treatments and containers	789 lbs.
Natular G30®	Catch basin treatments and containers	1,240 lbs.
Natular G30 WSP®	Catch basin trial use	6 pouches
Natular XRT®	Abandoned swimming pools and larger “containers”	85 tablets
Skeeter Abate Pellets®	Persistent floodwater with season-long accessibility concerns	267 lbs.
Vectobac WDG®	Wide Area Larviciding System (WALS) - liquid larvicide	97 lbs.
VectoLex FG®	Catch basin treatments and semi-permanent floodwater	2,413 lbs.
VectoMax FG®	Spring floodwater applications	12,614 lbs.

Appendix

Table 2. New Jersey Light Trap Collections (2019)

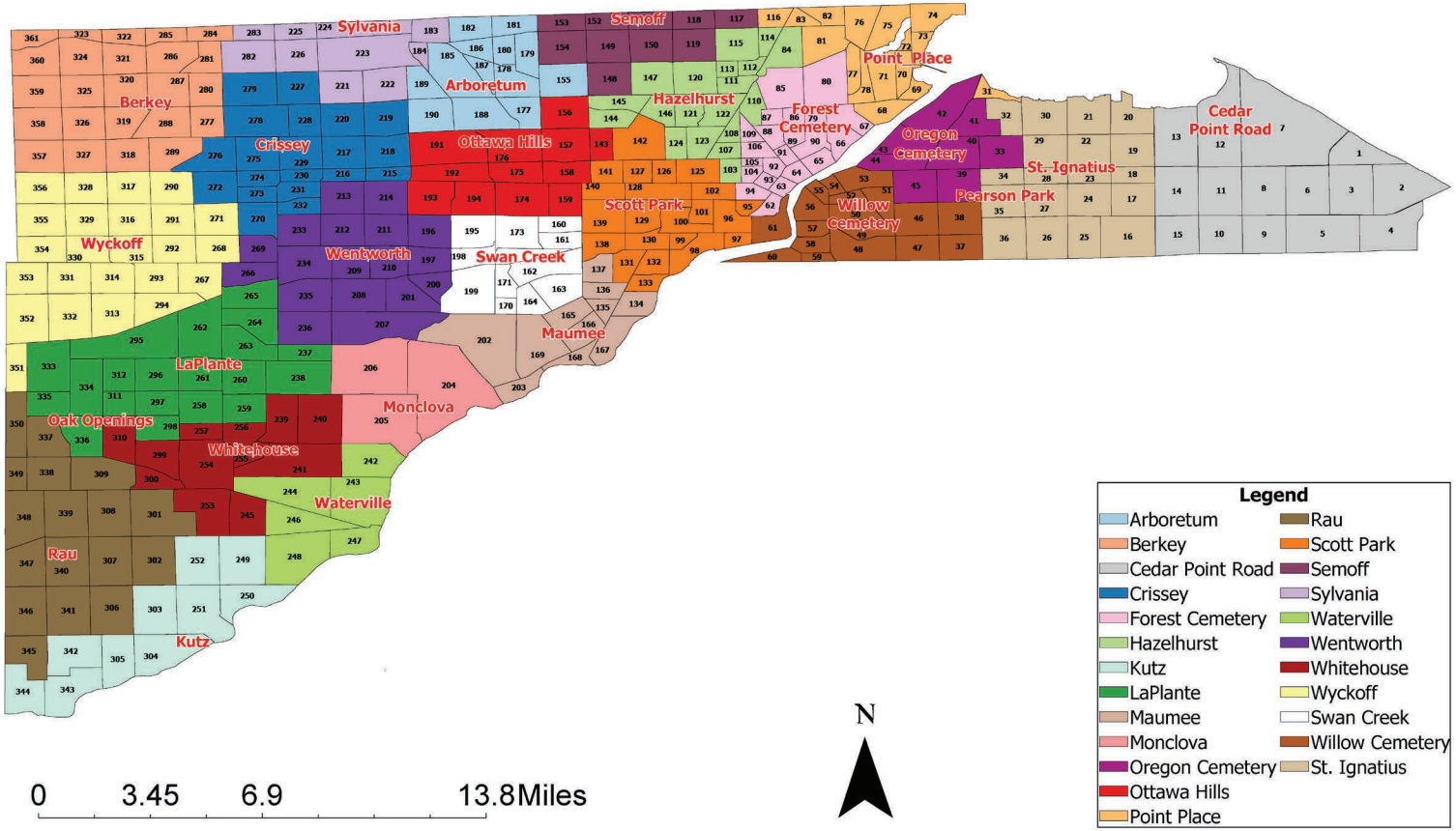
	May		June				July					August				September				Oct.							
Weeks:	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**							
Mosquito species																					**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Totals**
Ae. canadensis	9	8	15	9	10	7	2	2	0	1	0	0	0	0	0	0	0	0	0	0	17	41	5	0	0	0	**63**
Ae. cinereus	0	1	2	2	2	0	0	0	0	0	0	0	0	0	0	2	3	0	1	0	1	6	0	0	6	0	**13**
Ae. grossbecki	22	31	28	29	5	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	53	68	4	0	0	0	**125**
Ae. japonicus	0	15	1	1	8	4	3	0	1	1	5	3	6	4	3	5	8	24	5	8	15	14	10	16	42	8	**105**
Ae. sollicitans	2	0	0	0	0	0	0	0	3	1	1	0	8	0	7	25	2	0	0	0	2	0	5	15	27	0	**49**
Ae. sticticus	118	69	42	14	24	11	2	10	11	6	4	1	0	12	2	22	49	25	0	3	187	91	33	15	96	3	**425**
Ae. stimulans	15	21	14	21	8	19	4	5	0	0	0	0	0	1	1	0	0	0	0	0	36	62	9	2	0	0	**109**
Ae. triseriatus	0	12	0	0	1	1	1	2	0	0	1	1	0	2	3	2	4	0	0	0	12	2	4	6	6	0	**30**
Ae. trivittatus	1	14	7	2	0	1	3	5	5	1	2	2	2	2	1	46	50	9	5	0	15	10	16	7	110	0	**158**
Ae. vexans	363	485	297	260	464	1585	361	382	509	208	192	204	106	132	412	428	1566	279	79	76	848	2606	1652	854	2352	76	**8388**
An. barberi	0	0	0	8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8	0	1	0	0	**9**
An. perplexans	9	1	6	3	5	12	3	1	5	2	1	5	2	6	10	18	18	4	4	1	10	26	12	23	44	1	**116**
An. punctipennis	18	14	29	9	11	28	10	9	6	15	11	21	15	23	22	31	50	17	2	4	32	77	51	81	100	4	**345**
An. quadrimaculatis	2	2	3	9	20	41	11	15	5	34	19	41	20	79	145	29	43	19	27	17	4	73	84	285	118	17	**581**
An. walkeri	11	9	4	123	56	175	64	36	57	30	7	29	11	25	5	1	16	15	7	0	20	358	194	70	39	0	**681**
Cq. perturbans	0	0	0	13	167	582	126	68	202	72	16	48	53	107	29	10	15	1	1	0	0	762	484	237	27	0	**1510**
Cx. erraticus	1	1	0	3	1	3	0	1	0	2	5	18	23	30	81	34	54	49	23	39	2	7	8	152	160	39	**368**
Cx. pipiens	45	47	120	129	105	244	54	127	73	102	108	123	77	152	241	125	456	284	194	472	92	598	464	593	1059	472	**3278**
Cx. restuans	135	278	463	254	133	85	12	3	0	2	1	0	0	7	3	1	0	3	1	1	413	935	18	10	5	1	**1382**
Cx. territans	2	11	12	12	15	11	3	3	3	4	10	17	7	29	21	10	39	25	3	7	13	50	23	74	77	7	**244**
Cs. inornata	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	1	0	2	0	1	0	**4**
Or. signifera	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	**2**
Ps. ciliata	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**2**
Ps. ferox	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	2	2	1	0	0	0	0	1	4	5	0	**10**
Ur. sapphirina	1	1	1	2	1	9	2	5	6	13	8	62	25	91	51	41	78	24	5	6	2	13	34	229	148	6	**432**
Total Female	**755**	**1020**	**1044**	**903**	**1036**	**2825**	**664**	**675**	**889**	**494**	**393**	**575**	**355**	**704**	**1041**	**832**	**2453**	**780**	**357**	**634**	**1775**	**5808**	**3115**	**2675**	**4422**	**634**	**18429**
Total Male	**558**	**589**	**1154**	**1537**	**581**	**1028**	**383**	**358**	**166**	**214**	**244**	**285**	**178**	**257**	**683**	**769**	**1200**	**445**	**556**	**1125**	**1147**	**5808**	**3115**	**2675**	**5056**	**1125**	**18926**

Figure 1.


The Clearing of Drennan Ditch
DORR
FRANKFORT
ANGOLA
ANGOLA
DRENNAN DITCH
FRANKFORT DITCH
DEGENFELDER
SCHWAMBERGER
WIREGRASS METROPARK
EBER
IRWIN
LANDON
MELKE
CENTRAL
AIRPORT HWY
SWAN CREEK
CEDAR CREEK
CRANE CREEK
Legend
Ending Location of Project
Project Location by the end 2016/2017 season
Project Location by the end of 2017/2018 season
Starting Location of Project
Amount cleared in 2017/2018
Amount cleared in 2016/2017
Amount cleared in 2018/2019
Drennan Ditch
Roads
TASD
0
0.17
0.35
0.7 Miles
N

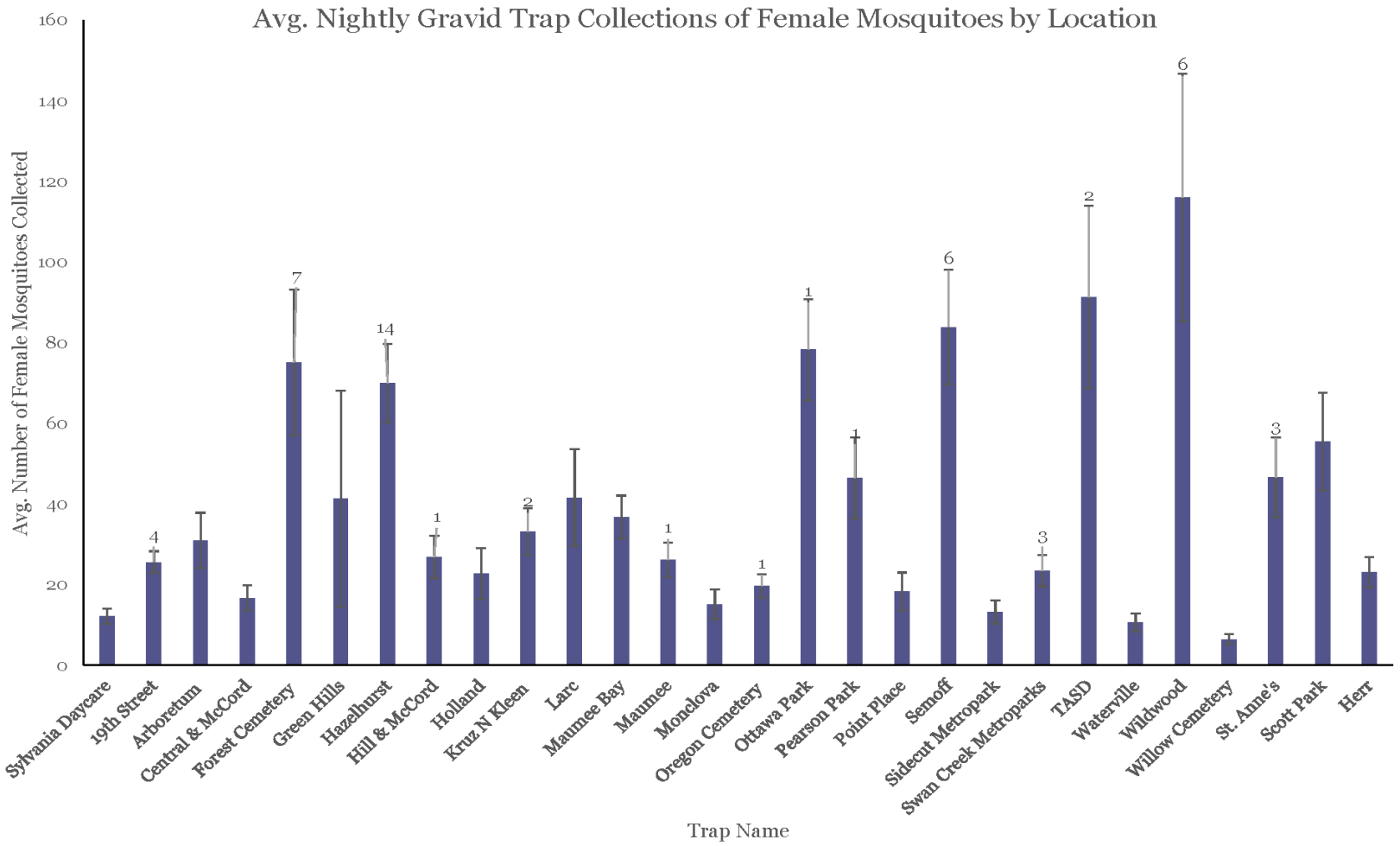
Appendix

Figure 2. New Jersey Light Trap Locations and Associated TASD Service Maps (2019)



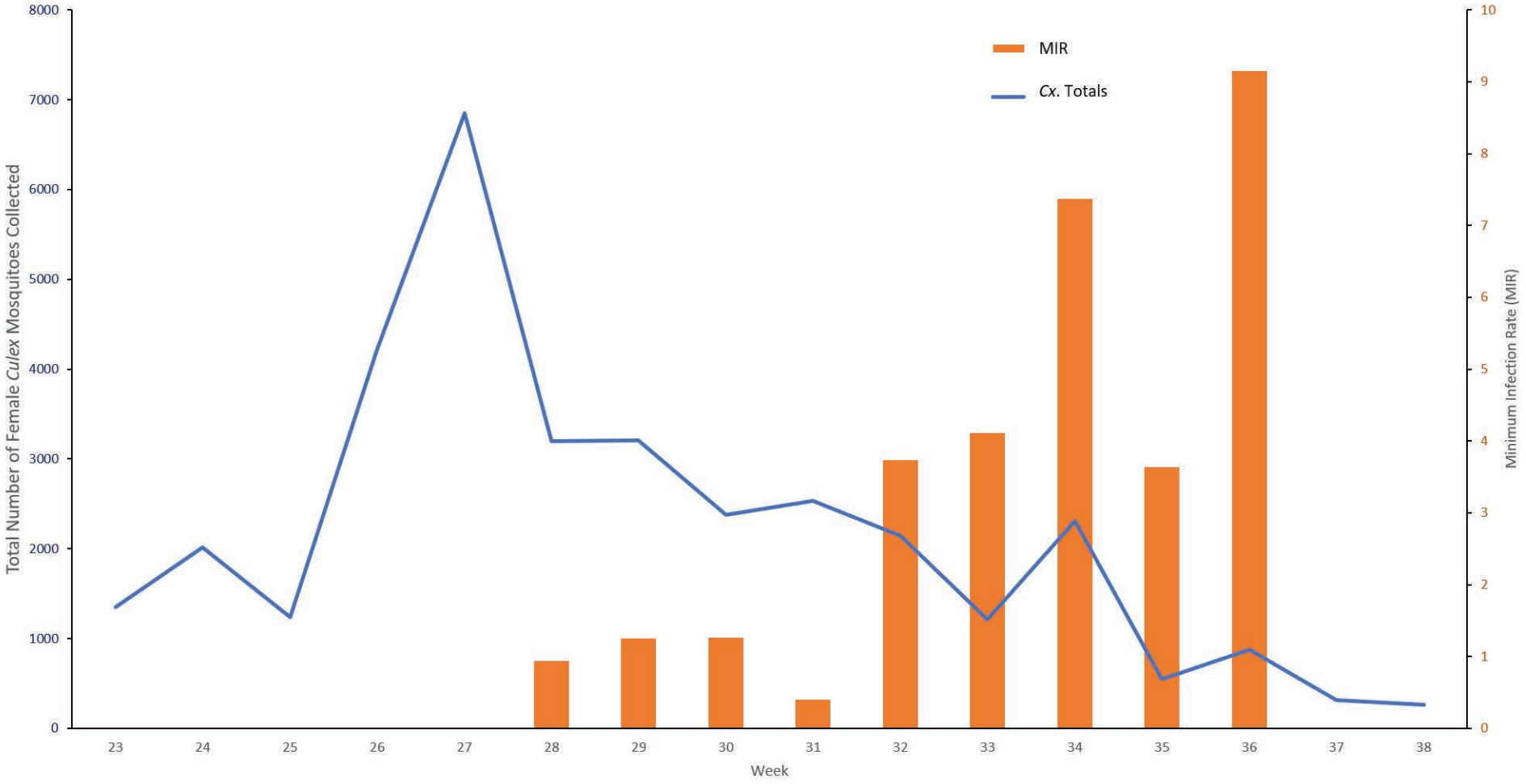
Appendix

Figure 3.



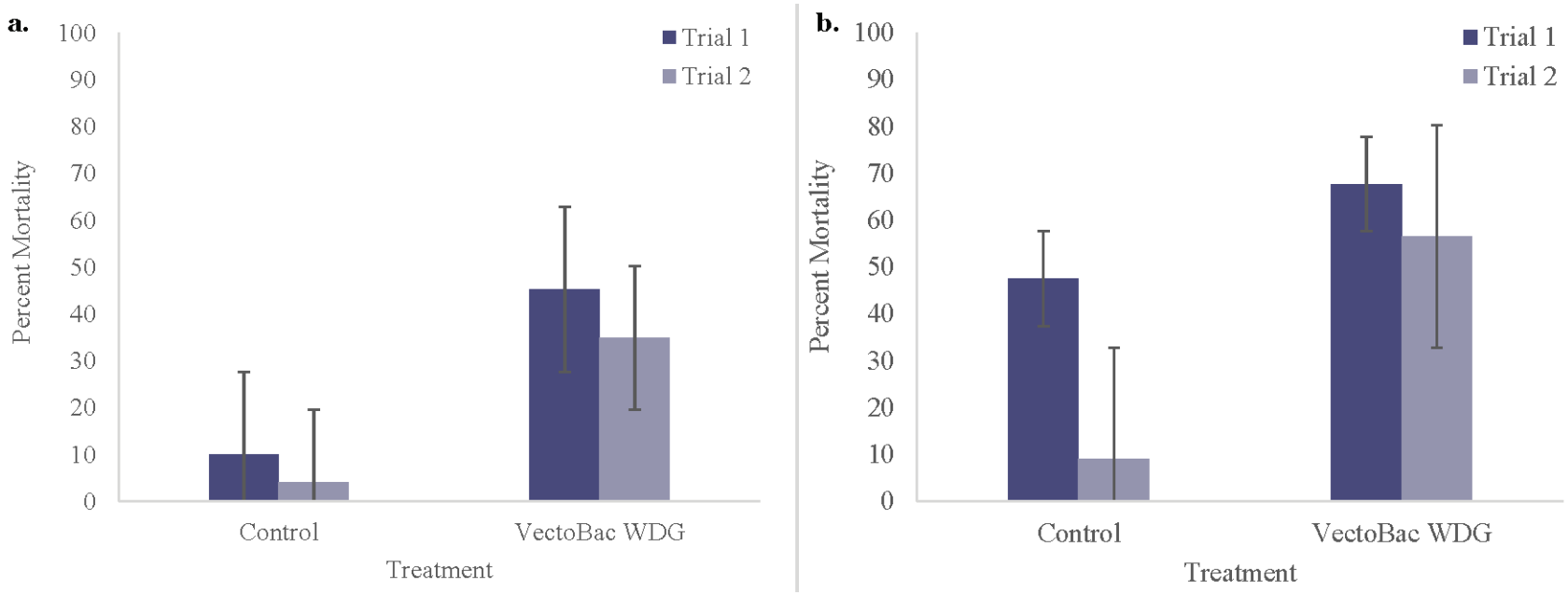
Appendix

Figure 4. Weekly *Culex* Collections and Minimum West Nile Virus Infection Rates (2019)



Appendix

Figure 5. Control mortality from liquid larviciding bioassay: Control mortality of larvae in field-collected bioassay jars differed between treatments at 24 hours (a) and 48 hours (b) during both trials. Error bars represent standard error.



Notes