The Delta Vector Control District Annual Report

2019

Dear Residents,

This is the 2019 annual report for Delta Vector Control District, serving northwestern Tulare County. We are pleased to compile this report for your viewing, showing the work that was completed in the 2019 season and presenting issues and plans for improvement in the coming years.

It is a pleasure to be of service to you. Delta Vector Control District strives to be the finest and most responsive governmental organization you have ever encountered. Our employees are well trained, professional, and caring. As an organization, we are committed to providing effective, courteous, and timely service to you. We are problem solvers, willing to work hard to address and solve any vector problem you may be experiencing. The District prides itself on its consistent and dedicated work, while continuously attempting to improve existing programs and develop new ones. This year has brought a variety of new accomplishments and new challenges.

The 2019 mosquito season saw the continuation of our expanded surveillance trap sets across the District and a dramatic increase of the invasive *Aedes aegypti* mosquito. New techniques were evaluated to control these invasive mosquitoes. Lessons learned from 2019 will translate into a new and improved plan in 2020. We hope for an increase in public involvement to help control this invasive species.

Our public education and outreach program also saw continued improvements in 2019, leading to increased public awareness of the District's role and the services that we offer. We celebrated this accomplishment with an increase in service requests, the likes of which the District hasn't seen ever.

We look forward to the challenges and successes we will face in the future and thank you for standing with us to make northwestern Tulare County a safer and healthier place to live, work, and raise a family.

Sincerely,

Michael W. Alburn

District Manager


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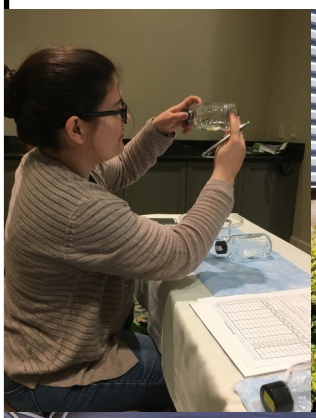
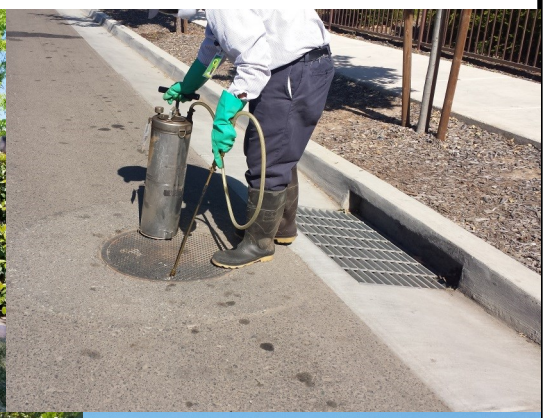









About the District

Delta Vector Control District (DVCD) is an independent special district covering 712 square miles of northwestern Tulare County. As an independent special district, DVCD is not part of the Tulare Country governmental system and is responsible directly to the people that it serves. The District prides itself on being accountable, accessible and efficient in conducting vector control activities. DVCD is governed by a Board of Trustees, each trustee appointed by one of the incorporated cities or for the county at large within the District's boundaries. Board members may serve multiple terms and are highly dedicated to this community service. Board meetings are held at 7:00 pm on the second Wednesday of each month at 1737 West Houston Avenue, Visalia, in the boardroom of the Lourenco Laboratory, and members of the public are welcome to attend.

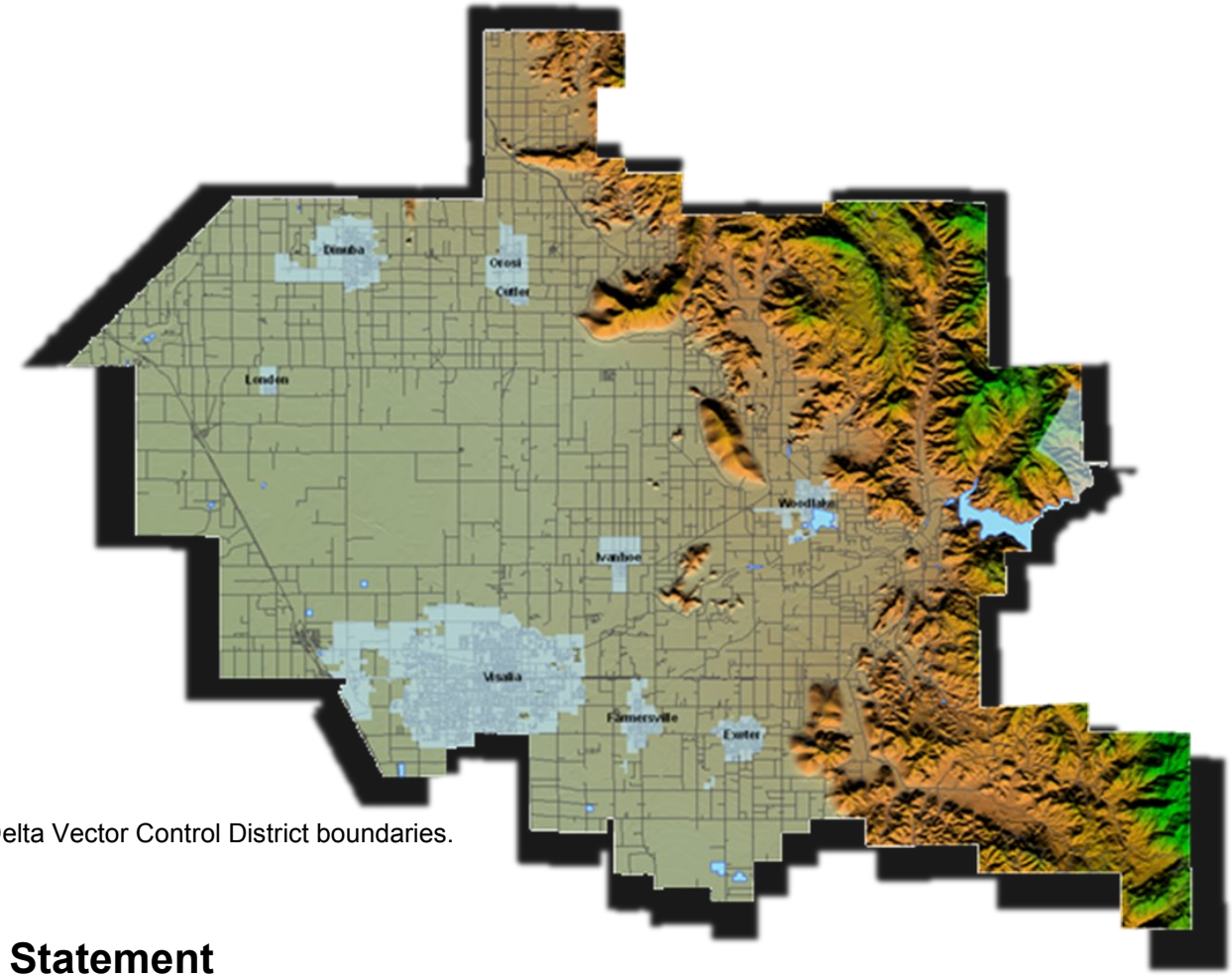


Figure 1. Delta Vector Control District boundaries.

Vision Statement

The Delta Vector Control District will be the authority for vector control and vector-borne disease prevention in Tulare County.

Mission Statement

> *"The Delta Vector Control District is committed to protecting the public's health from vector-borne disease and discomfort by delivering exceptional services which preserve and enhance the quality of life and desirability of the area in order to make Tulare County a safe place in which to live, work and raise a family."*

Goals

- Provide continual surveillance of mosquitoes to determine the threat of disease transmission and annoyance levels.
- Use safe integrated pest management methods to keep mosquito populations suppressed.
- Promote cooperation and communication with property owners, residents, social and political groups, and governmental agencies.

Integrated Vector Management

The goal of Delta Vector Control District is, always, to minimize disease risk to residents and decrease nuisance level from vectors. This is accomplished by utilizing Integrated Vector Management (IVM) which is an ecosystem-based strategy that relies on a combination of techniques including public outreach, vector surveillance, biological control, physical control, and chemical control. This allows us to minimize the risk to human health, nontarget organisms, and the environment, while targeting the organisms capable of transmitting disease or being a nuisance. At Delta, staff are cross-trained as part of the IVM program so that they can easily resolve all vector problems they come across.

To help ensure the District is using best management practices, full time staff must achieve and maintain Vector Control Technician Certification through the California Department of Public Health (CDPH). To be fully certified, staff must pass four exams covering the categories of Pesticide Application and Safety, Mosquito Biology and Control, Arthropods of Public Health Significance, and Vertebrates of Public Health Importance. Once the exams are successfully passed, certification must be maintained through Continuing Education, which takes place over two-year cycles. Continuing Education is made up of both live units and webinars across all four knowledge areas. At the end of 2019, all staff members retained their certification status. Additionally, three seasonal employees received and maintained the first two certifications at the end of the mosquito season.

The District also works with several organizations to ensure compliance with local, state and federal regulations. Delta Vector Control District complies with the Clean Water Act by following the regulations of our National Pollutant Discharge Elimination System (NPDES) permit and filing all appropriate reports. The District is covered by a Memorandum of Understanding (MOU) between CDPH and the California Department of Fish and Wildlife (CDFW) regarding carcass pickup for West Nile Virus (WNV) testing. The District maintains an additional MOU with the CDFW regarding source reduction efforts in riparian areas and weed control around dairy lagoons to protect nesting birds. Pesticide reports are also generated monthly and given to the Agricultural Commissioner.

2019 Board of Trustees

President
Greg Gomez: City of Farmersville, first appointed Feb, 2017, current term ending Dec 31, 2021

Secretary
Belen Gomez: City of Woodlake, first appointed Oct, 2003, current term ending Dec 31, 2020

General Trustees
Larry Roberts: City of Dinuba, first appointed Jan, 2011, current term ending Dec 31, 2020
Rosemary Hellwig: City of Exeter, first appointed Feb, 2011, current term ending Dec 31, 2021
Kevin Caskey: County at Large, first appointed March, 2016, current term ending Dec 31, 2020
Michael Cavanaugh: City of Visalia, first appointed March, 2018, current term ending Dec 31, 2021
Linda Guttierrez: County at Large, first appointed May, 2018, current term ending Dec 31, 2021

2019 Staff

Administration
Michael W. Alburn, *District Manager*
Sheri Davis, *Administrative Assistant*
Mark Dynge, *Systems Administrator*

Laboratory
Mir Bear-Johnson, MS, *Scientific Program Manager*
Jesse Erandio, *Biologist & Microbiologist*
Crystal Grippin, MSPH, *Biologist & Public Education Outreach Officer*
Mark Nakata, *Biologist & Biological Control Supervisor*
Seasonal Staff: (2) *Laboratory Intern I &* (7) *Laboratory Technician I*

Operations
Paul D. Jobe, *Superintendent*
Darin Dula, *Foreman & Mechanic*
Rick Alvarez, *Supervisor of House Mosquito Program*
Paul Harlien, *Vector Control Technician III-Mechanic*
Tim Christian, *Vector Control Technician III-Mechanic*
Bryan Ruiz, *Vector Control Technician III*
Ryan Toney, *Vector Control Technician III*
Jorge Lopez, *Vector Control Technician II*
Sergio Tovar, *Vector Control Technician II*
Seasonal Staff: (9) *Vector Control Technician I*

Employment Opportunities

The District currently employs 15 full time staff year round and anywhere from 15 to 20 additional seasonal staff to help from March to October, when the most mosquitoes are present and active. Seasonal staff must be over eighteen years of age, have a valid CA drivers license, and be able to pass a pre-employment physical. If you, or someone you know, is interested in a position at the District, please check the employment tab on the website. All submitted applications will be kept on record for one year.

2019 Chain of Command

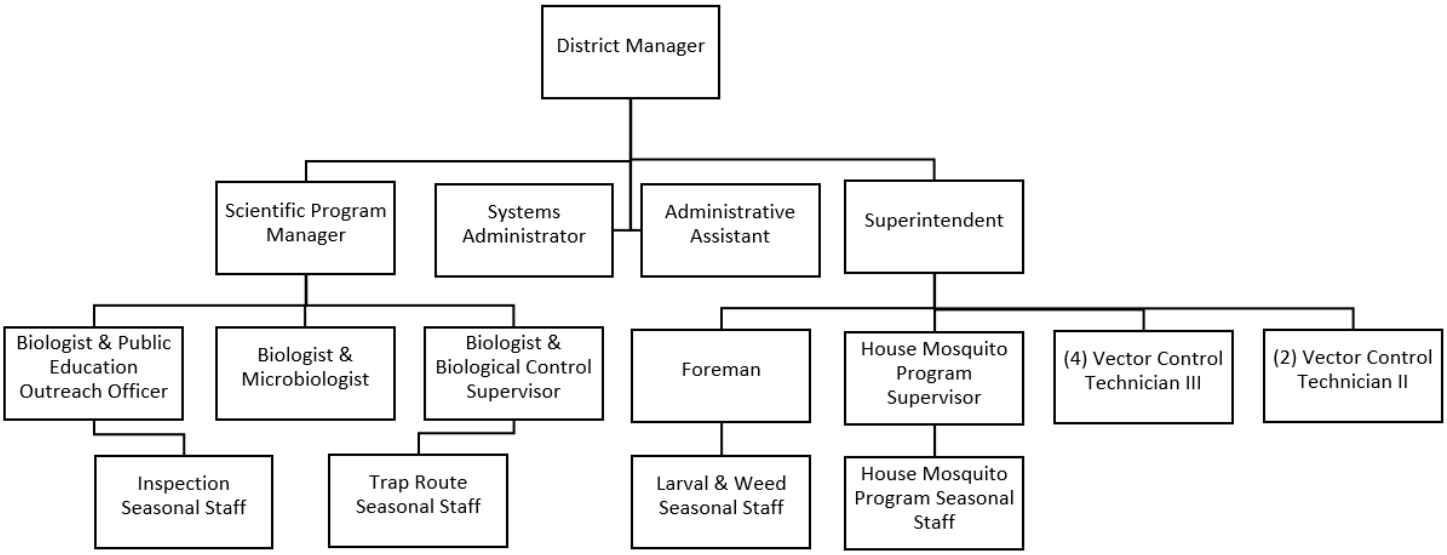


Figure 2: 2019 Chain of Command for Delta Vector Control District.

Professional Associations

Delta Vector Control District is a member of several professional associations that promote knowledge, research and new discoveries in the fields of mosquito and vector control and surveillance. DVCD is one of 64 agencies that are members of the Mosquito and Vector Control Association of California (MVCAC), and one of nearly 1,500 members of the American Mosquito Control Association (AMCA). DVCD is a member of the Society for Vector Ecology (SOVE), an international organization that focuses on vectors across the globe. The District is also a member of the California Special District Association (CSDA), which promotes good governance and improved professional development, advocacy, and other services for all types of independent special districts. Through MVCAC and AMCA the District is also involved in and kept aware of newer initiatives, programs, and networks, such as the Vector-Borne Disease Network (VBDN) and Pacific Southwest Center of Excellence in Vector-borne Diseases (PacVec). The following is a list of District employees who have participated in regional, statewide or national organizations:

- Mir Bear-Johnson: MVCAC Vector and Vectorborne Disease Committee, AMCA Young Professional, CSDA Special District Administrator Program Study Group member, Tulare County Health Emergency Coalition member
- Mark Dynge: MVCAC Information Technology Committee
- Jesse Erandio: MVCAC Laboratory Technologies Committee, AMCA Young Professional
- Crystal Grippin: AMCA Young Professional
- Mark Nakata: MVCAC Integrated Vector Management Committee, AMCA Young Professional

History

In 1904, the first recorded mosquito control efforts in California were under the direction of UC professors and focused on salt-marsh mosquitoes in the San Francisco Bay marshlands. By 1908 malaria was devastating the Central Valley, which led to the adoption of the “Mosquito Abatement Act” across California in 1915. This act has since been incorporated into the California Health and Safety Code, Division 3, which forms the basis for the creation, governing powers, and functions of Mosquito and Vector Abatement and Control Districts today.

Delta Mosquito Abatement District was founded in 1922, covering 16 square miles – which at the time was the entire city of Visalia and some adjacent suburban areas. The District was formed in large part due to the efforts of the Visalia Woman’s Civic Club to eliminate malaria, the most prominent disease of the time.

From 1922 to 1973, the District underwent some significant changes. Between 1922 and 1958, Delta Mosquito Abatement District annexed a total of six additional land expanses into the service area, ending with 712 square miles, the same area covered today. In 1946, headquarters were moved to its present-day location on Houston Avenue. The last improvement came in the form of a name change in 1973 to “Delta Vector Control District” to better reflect the services provided by the District.

In 2011, work began on a new laboratory facility to aid efforts to minimize disease risk. Another building is in the planning stage to be added to house the expanding laboratory program and assist with biological control efforts.

Vectors of Concern

The main vector of concern within the district is mosquitoes. Mosquitoes are a type of fly in the taxonomic order of *Diptera* and family *Culicidae*. These insects are no bigger than a half inch with each species having unique characteristics and adaptations based on their preferred environmental conditions.

All mosquitoes undergo the same four stage life cycle: egg, larva, pupa, and adult. The first three stages of the life cycle are sometimes referred to as the immature stages. Mosquito eggs, laid on or next to water, hatch into larvae which must remain in water to stay alive. Larvae, sometimes called wigglers, consume nutrients from the water. After undergoing four molts, or instars, larvae molt into pupae. Pupae, sometimes called tumblers, are a non-eating aquatic life stage after which the adult mosquito emerges. The entire mosquito life cycle, from egg to adult mosquito, can take as little as 5-7 days depending on environmental conditions.

Adult mosquito lifespan varies, depending on conditions and species, averaging approximately one month. While adult male mosquitoes drink nectar exclusively, female mosquitoes require a blood meal as a source of protein to produce eggs and continue the life cycle. Thus, only female mosquitoes are capable of being vectors for disease.

Culex quinquefasciatus, *Culex tarsalis*, and *Culex stigmatosoma* are considered the main vectors of West Nile virus (WNV), St. Louis encephalitis virus (SLEV), and Western equine encephalitis virus (WEEV) within the District. *Culex* species, generally, prefer to bite at dawn or dusk and preferentially feed on birds, although they will bite humans opportunistically or when abundance is very high. *Culex* are usually active from March until November, depending on the temperatures during the year. Most overwinter as adults, finding warmer structures in which to remain dormant, but they may be observed during winter months when disturbed by human activity.

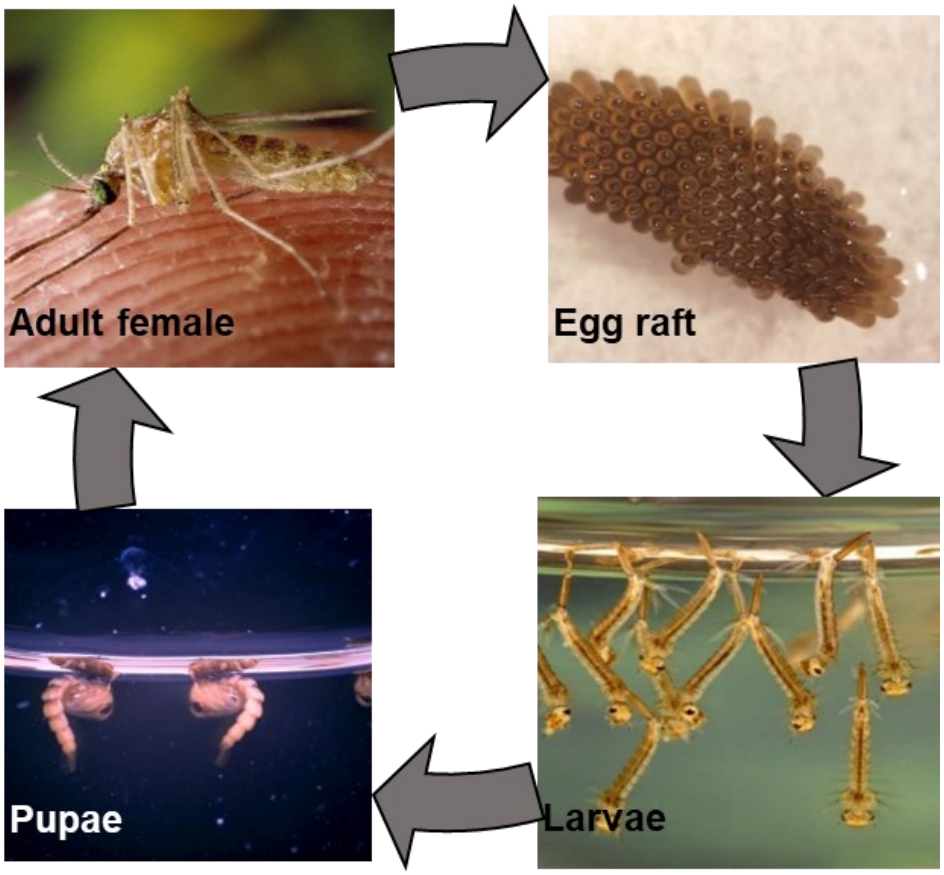
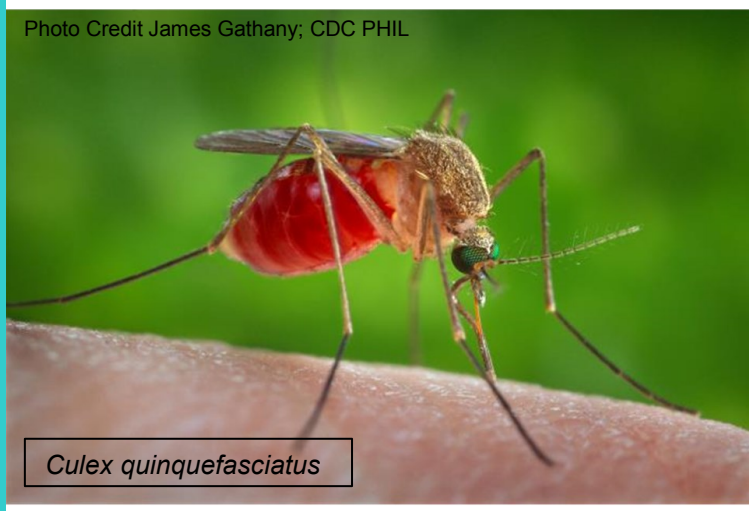


Figure 3. Mosquito life cycle (*Culex quinquefasciatus*).

Photos credit James Gathany & CDC PHIL

The southern house mosquito, *Culex quinquefasciatus*, is a brown or tan mosquito which prefers to breed in stagnant water that is rich with organic compounds, and therefore usually has an unpleasant odor. These mosquitoes are most often found breeding in unmaintained swimming pools, catch basins, dairy pits, or stagnant irrigation puddles.



Culex quinquefasciatus

The western encephalitis mosquito, *Culex tarsalis*, is a brown mosquito with a distinctive median white band on its proboscis, chevrons on the underside of its abdomen, and striped legs. This mosquito can be found in water sources that are similar to, but cleaner than, those of *Cx. quinquefasciatus*. While *Cx. tarsalis* is most often found in fresh irrigation water, this mosquito can also be found breeding alongside *Cx. quinquefasciatus* in suburban swimming pools.

Culex tarsalis

The foul water mosquito, or *Culex stigmatosoma*, is also a brown mosquito with a distinctive median white band on its proboscis, striped legs, and white triangles on the underside of its abdomen. Without a microscope it is very difficult to differentiate *Cx. stigmatosoma* from *Cx. tarsalis*. As its nickname implies, this species prefers much more polluted waters than either of the other *Culex* species. This mosquito is most often found breeding in dairy pits, sewer farms, and other areas with extremely stinky water.

The tule mosquito, or *Culex erythrothorax*, is a less capable vector of WNV, SLEV, and WEEV and is usually found in lower numbers throughout the District. This mosquito has an orange-brown thorax and breeds predominately in water sources with tule, which is a type of plant also known as bulrushes. Unlike most other *Culex* species, *Cx. erythrothorax* overwinter as fourth instar larvae.

The District is also home to native *Anopheles* and *Culiseta* species, as well as both native and invasive *Aedes* species. Of these, the native *Anopheles* and invasive *Aedes* species are capable of transmitting diseases to humans. However, currently none of these diseases are endemic within the District.

Anopheles species

The three most common species of *Anopheles* in the District are *Anopheles freeborni*, *Anopheles franciscanus*, and *Anopheles punctipennis*. Although not currently a disease threat in California, malaria can be transmitted by these mosquitoes. They tend to be most active after dusk and into the early evening hours. These mosquitoes tend to be slightly larger than *Culex* species and will feed preferentially on mammals, including humans. While they will readily enter

homes to feed, they will not breed indoors. *Anopheles* species usually breed in algae-rich water and may be present in algae pockets along slow-moving rivers or streams. Although these species are not currently disease threats, they are aggressive biters and can be a large nuisance threat in warmer months when they are active.

Culiseta species are unlike the other mosquitoes in that they can be active in the winter. Some species are primarily active in the winter or early fall and other species are active year-round. *Culiseta* mosquitoes are the largest comparatively and prefer to feed on mammals at dawn and dusk. They are less aggressive than the *Anopheles* or *Aedes* species but are still considered a nuisance species. *Culiseta incidens*, *Culiseta inornata*, and *Culiseta particeps* are all found both in traps and breeding alongside *Culex* species in a variety of water habitats throughout the District.

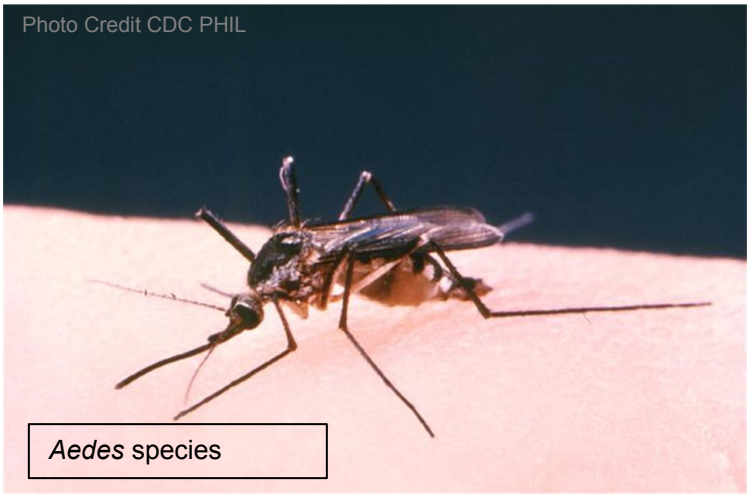


Photo Credit CDC PHIL

Aedes species

There are several native *Aedes* species within the District, including *Aedes melanimon*, *Aedes nigromaculis*, *Aedes vexans* and *Aedes sierrensis*. These mosquitoes prefer to bite mammals and tend to be aggressive day biting mosquitoes, although they will bite into dusk when the opportunity presents itself. Out of these four species, all but *Ae. sierrensis* are considered floodwater mosquitoes, which means they lay their eggs on ground which will later flood. In this District, flooding is usually a result of irrigation or watering crops and pastures. Large quantities of these mosquitoes may hatch off at the same time, leading to impressive volumes of mosquitoes if not controlled properly.

Ae. sierrensis mosquitoes, or western tree hole mosquitoes, can transmit canine heartworm. As the nickname implies, this mosquito is most often found breeding in tree holes, which may be difficult to find and treat.

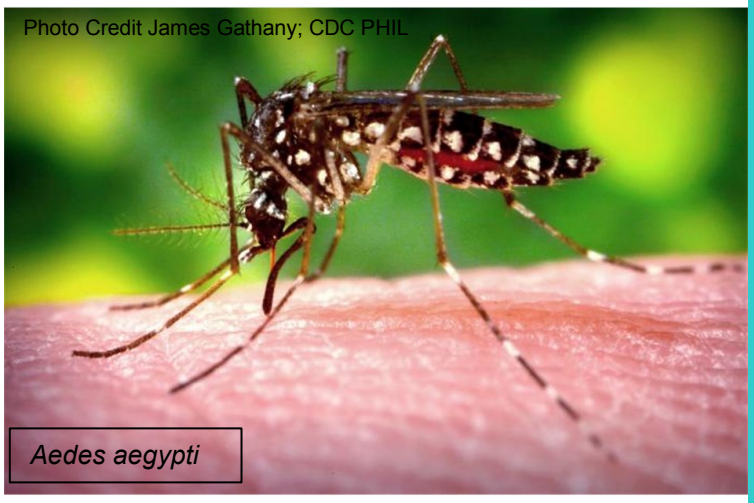


Photo Credit James Gathany; CDC PHIL

Aedes aegypti

Tulare County also houses the invasive yellow fever mosquito, *Aedes aegypti*. This mosquito has been found throughout the District and is an extremely aggressive day biting mosquito. Unlike the other species which prefer any type of mammal, *Ae. aegypti* prefer to feed on humans and can even breed inside homes when given the opportunity. These mosquitoes are known as 'container breeders' due to their preference for man-made containers over floodwater or tree holes. They have been found in pots, plant trays, bromeliads, animal watering dishes, tarps, tires, bird baths, decorative figurines, fountains, vases, toys, yard drains, rain water containers, ash trays, trash, watering cans, and more. While *Ae. aegypti* prefer small, cryptic fresh water sources, they have also been found in foul water sources when fresher water was not as readily available. Their eggs are resistant to desiccation and cling to the sides of containers, allowing people to unwittingly move them throughout the District. Although not inherently infected with any disease, this species is a public health concern due to its ability to transmit yellow fever, dengue, chikungunya, and Zika.

Although the main concern of the District is mosquitoes and the diseases that they are capable of carrying, the District does also work with other vectors as well as non-vector pest species. Ticks are rarely reported and are not considered a serious health threat within the District, but are still a potential public health concern and caution is always advised.

Ticks are bloodsucking ectoparasites, feeding off of reptiles, birds, mammals, and occasionally amphibians. Like mosquitoes, ticks go through different life stages before becoming adults. Unlike mosquitoes, ticks don't require water sources to develop and all of the forms look similar, with the larval stage only having six legs instead of the eight of the nymph and adult stages. Ticks can be less than a millimeter up to 30 millimeters long. Ticks may prefer different blood meal options at different stages of their lifecycle.

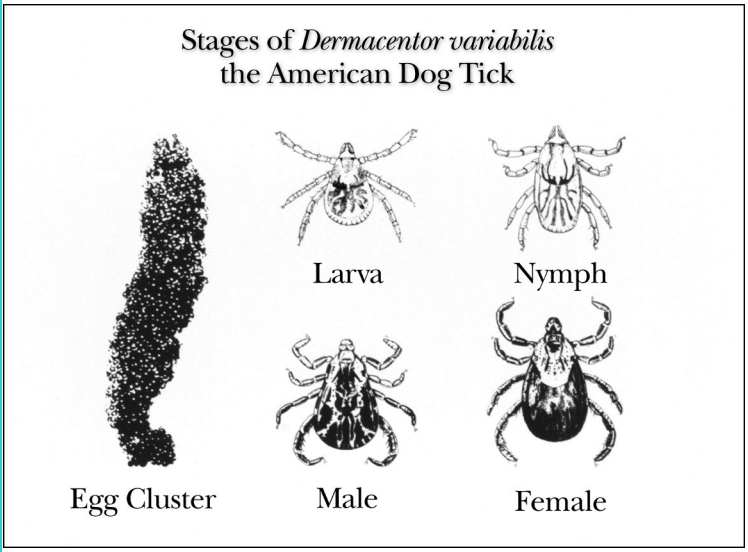


Figure 4: Growth stages of the American dog tick. Photo credit to CDC, 1973.

Tick bites can cause skin disorders, otoacariasis, tick paralysis, and allergic reactions as well as potentially transmit bacterial, viral, and protozoan pathogens. In California there are nearly 50 different kinds of ticks, of which six are considered to be of public health significance. Within Tulare County, there are four ticks of public health importance: the American dog tick, the Pacific Coast tick, the brown dog tick, and the Western black legged tick.

The brown dog tick is predominately an ectoparasite of dogs, but is capable of transmitting Rocky Mountain spotted fever (RMSF). The Western black legged tick, which has only rarely been reported within the District, is known for producing dermatoses, or skin diseases, in susceptible individuals and is also capable of transmitting anaplasmosis and Lyme disease. The American dog tick is capable of transmitting tularemia and RMSF. The pacific coast tick is also capable of transmitting RMSF.

Lyme disease is the most common tick-borne disease in the US and symptoms include fever, headache, fatigue, and a bulls-eye skin rash. Untreated Lyme disease can be very serious. Rocky Mountain spotted fever is a bacterial infection that can cause vomiting, sudden high fevers, headaches, abdominal pain, rash, and muscle aches and can be very serious. Anaplasmosis is also a bacterial infection that can cause fever, headache, chills and muscle aches. Tularemia is an infectious disease that causes fevers, skin ulcers and enlarged lymph nodes, or potentially pneumonia or a throat infection.

Residents who spend time outdoors, specifically in heavily wooded areas, should use an EPA-registered insect repellent, ideally one recommended for both ticks and mosquitoes. People should check themselves and their pets for ticks after returning indoors so that any ticks can be removed as soon as possible. If a tick has bitten in, it should be removed by applying a fine-tipped pair of tweezers where it is stuck in the skin and pulling straight up with steady even pressure. The bite area should be cleaned with rubbing alcohol or soap and monitored for signs of infection. If still intact, the tick can be stored in a zip lock bag, or other container, inside a freezer for later identification. The District can be called so that the tick can be identified to species. DVCD staff can also flag for ticks, identify ticks to species, and facilitate shipping samples to CDPH for disease testing, depending on the species.

Surveillance

Source Surveillance

Untreated or neglected swimming pools are a major source of suburban breeding for *Culex quinquefasciatus* mosquitoes within the District and can vary greatly year to year. As such, a flight is contracted out every spring to take aerial photos of the District. These photos are used to compile a list of green swimming pools or other large unmaintained bodies of water that are potential breeding sources. This list, as well as reports of green pools throughout the year, is given to the House Mosquito Program to check and control as needed.

In 2018, Delta Vector Control District implemented an unmanned aircraft system (UAS) program to augment its mosquito control efforts through aerial photography of green swimming pools. For the UAS program, a certified remote pilot flies a Phantom 4 Pro quadcopter to identify new potential breeding sources in areas with high trap counts. The remote pilot in command, or flight supervisor, is certified by the Federal Aviation Administration (FAA) to operate small UAS, or drones, under the 14 Code of Federal Regulations Part 107.

On August 23, 2019, the UAS program was implemented in northern western Visalia, on a corn field, following a trap that collected 1,043 mosquitoes, with no known untreated source in the area. The three-hour drone operation immediately identified 10 potential mosquito breeding sources for field technicians to monitor. The District will continue to optimize its UAS program to provide quick and cost-efficient methods to support public health.

Mosquito and Vector Surveillance

Vector Surveillance is an essential component of any IVM program and falls under the duties of the District's laboratory staff, who are dedicated to ensuring the reliability and timeliness of results. The District's trapping surveillance program consists of the Native Mosquito Surveillance Program and the Invasive Mosquito Surveillance Program, each of which consists of a series of fixed-location traps surveyed on a weekly basis with an additional rotation of strategic traps set weekly as needed. Mosquitoes capable of transmitting West Nile Virus (WNV), St. Louis Encephalitis Virus (SLEV), or Western Equine Encephalitis Virus (WEEV) are sampled from both surveillance programs and tested for disease, with the laboratory providing test results the next workday after initial collection.

The Native Mosquito Surveillance Program used two types of traps in 2019, the gravid trap and the encephalitis virus surveillance (EVS) trap, while the Invasive Mosquito Surveillance Program used Biogents Sentinel (BGs) traps.

With these traps, the District collected over 160,000 mosquitoes during 6,918 trap nights from fixed and strategic locations. All mosquitoes were identified to species and counted by laboratory staff. Female mosquitoes of any species capable of transmitting WNV, WEEV, or SLEV from the same trap were placed in tubes, ten to fifty female mosquitoes per tube, and these samples were tested for virus.

Areas with high abundance or disease were reported to the operations staff to help guide their control efforts and ensure that no breeding locations had been overlooked.

Traps

The gravid trap is used for the fixed-location component of the Native Mosquito Surveillance Program. This trap predominately attracts female *Culex quinquefasciatus* who are looking for a water source to oviposit, or lay eggs. Alfalfa and yeast water is placed in the tray of the water in order to attract the mosquitoes.

Gravid Trap


EVS Trap

The EVS trap, predominately catches host-seeking female mosquitoes who are attracted to carbon dioxide emitted from the dry ice that is used as bait. The EVS trap is mostly used in the Native Mosquito Surveillance Program as strategic trap sets, although it is sometimes used in response to specific service requests. This trap targets mosquitoes that bite birds or larger mammals due to its placement on a pole that is three to five feet off the ground.

The BGs trap predominately attracts host-seeking female mosquitoes, as well, using a chemical lure and carbon dioxide, produced by the reaction of sugar and yeast in water, as bait. This trap is located on the ground and is most likely to catch the invasive *Aedes aegypti* mosquito. There are two versions of this trap. This trap is mostly used in the Invasive Mosquito Surveillance Program, as both the routed trap sets and strategic trap sets.


BGS 1 Trap


BGS 2 Trap

Native Mosquito Surveillance Program

Delta Vector Control District has been conducting mosquito surveillance in Visalia, Exeter, Farmersville, Dinuba, Woodlake, Ivanhoe, and Cutler-Orosi since the areas were incorporated into the District.

After the emergence of WNV in the region, trapping changed to focus on mosquitoes that vectored WNV and on their breeding sources. From 2004 to 2012, WNV trapping focused on vectors in mainly rural environments. However, in 2013, surveillance efforts shifted to include suburban environments, using semi-structured gravid trap site configurations to guide the trap locations. These configurations consisted of fixed gravid trapping sites within a mile section of suburban area, surveyed on a two-week rotation, coupled with weekly random or information-driven trapping events.

In 2016, the surveillance program increased to 172 fixed gravid trapping sites, one trap within each quarter mile of suburban area surveyed on a weekly basis, with the weekly random or information driven EVS trapping events still taking place. In 2019 the Surveillance Program changed its name from the West Nile Virus Surveillance Program to the Native Mosquito Surveillance Program to better reflect the full scope of the program.

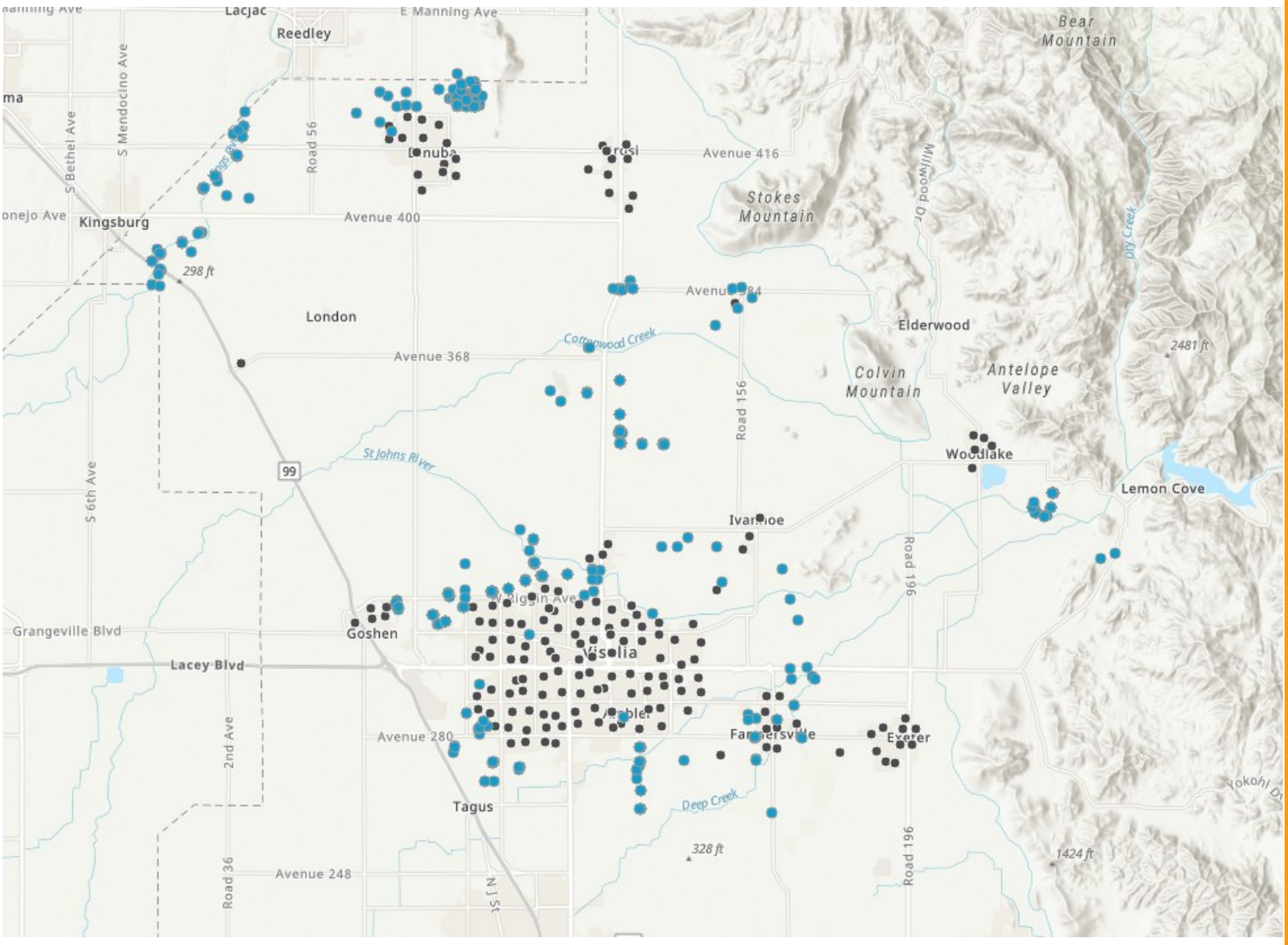


Figure 5. Locations of the 4,892 traps set from April to October for the Native Mosquito Surveillance Program.

Fixed Location Gravid Trapping Survey

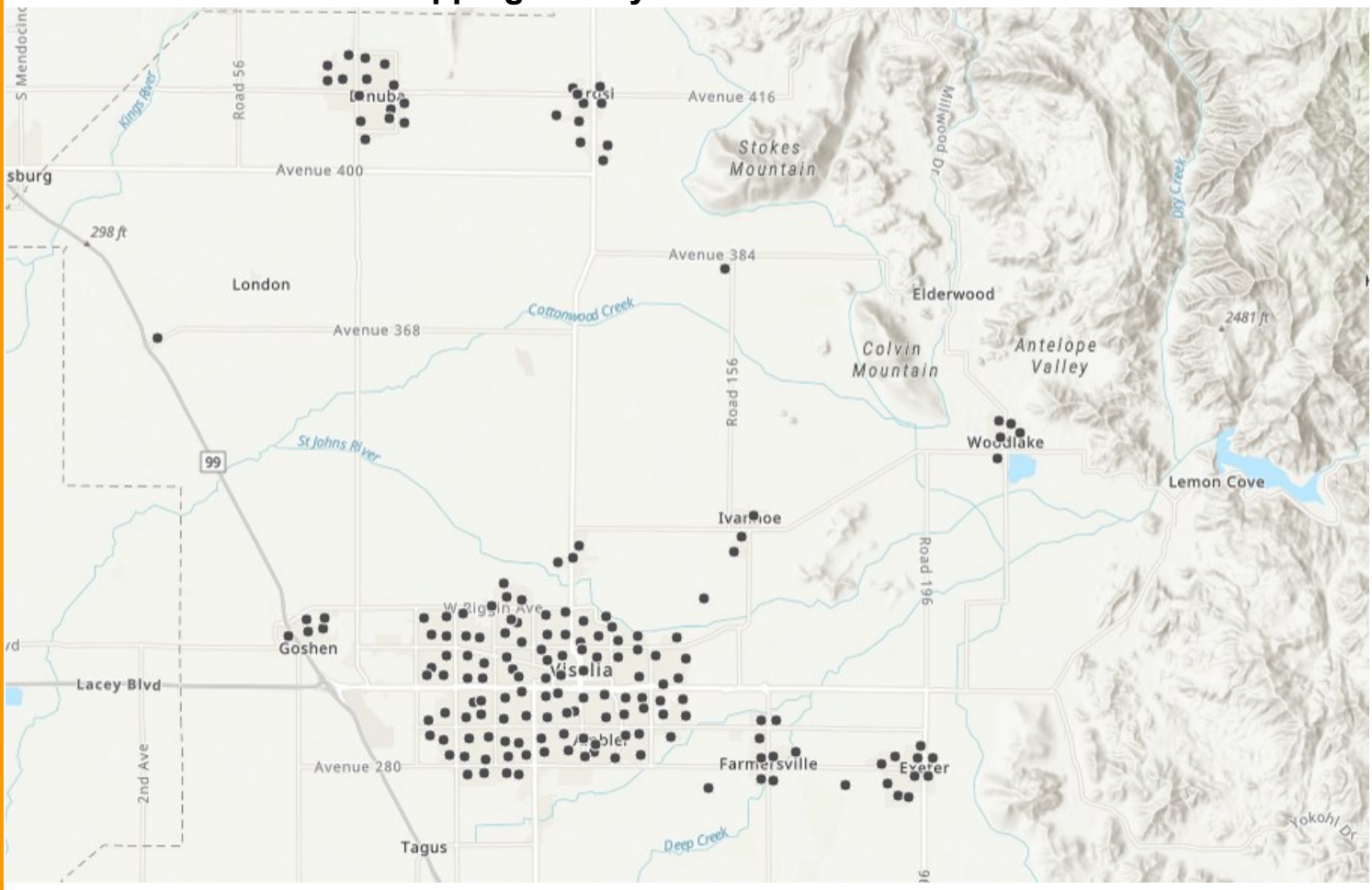


Figure 6. Locations of the 172 gravid traps set from April 2nd to October 4th for the Native Mosquito Surveillance Program

In the 2019 surveillance season, fixed gravid traps operated weekly from April 2nd through October 4th. Traps were set one per quarter mile of suburban area. During this trapping period, 67,907 adult mosquitoes were collected with seven species represented.

Species	Abundance
Culex quinquefasciatus	64,974
Culex stigmatosoma	1,295
Aedes aegypti	950
Culex tarsalis	596
Culiseta incidens	82
Anopheles freeborni	6
Culiseta inornata	4

Table 1. Abundance of mosquito species collected from gravid traps in 2019.

The infusion used in gravid traps is specifically designed to attract *Culex quinquefasciatus* and as such they are preferentially trapped, making up 95.68% of the caught mosquitoes.

City	Average number of mosquitoes per gravid trap per trap-night
Cutler-Orosi	8.14
Dinuba	13.16
Exeter	6.57
Farmersville	10.78
Goshen	10.81
Ivanhoe	6.17
Visalia	9.01
Woodlake	8.08

Table 2. The average number of mosquitoes collected per trap-night from gravid trap in each city within the District in 2019.

Average numbers of mosquitoes collected per trap-night from gravid traps is calculated for comparison between cities within the District. In 2019 the average number of mosquitoes collected

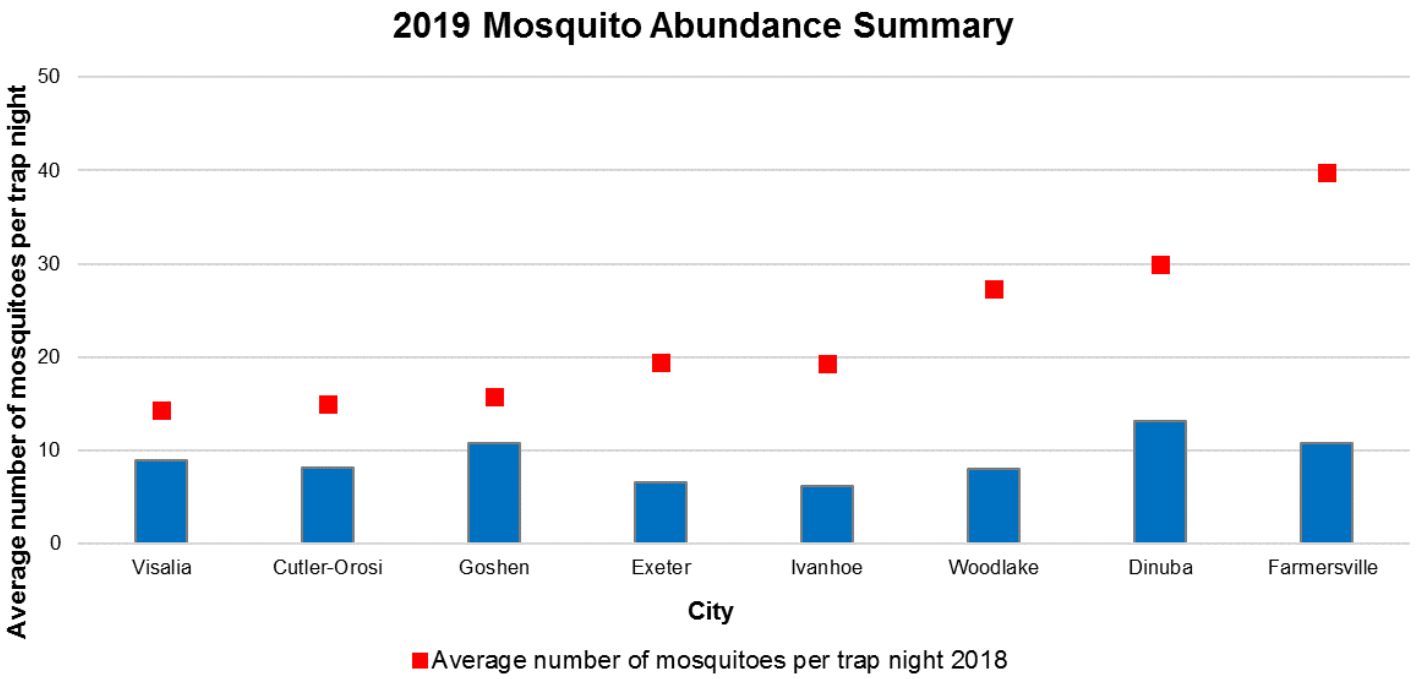


Figure 7. Average number of mosquitoes collected per trap night in each city within the District from gravid traps in 2019 compared to 2018.

in gravid traps per trap-night was 9.09, a significant decrease from 2018 when the average number was 22.60. In 2019, Dinuba had the highest average with 13.16 and Ivanhoe had the lowest with 6.17. In 2018, Farmersville had the highest average with 39.73 and Visalia the lowest with 14.32.

Temperatures fluctuated in 2019, effecting the gravid trap averages, but overall the trend is similar to that shown in 2018.

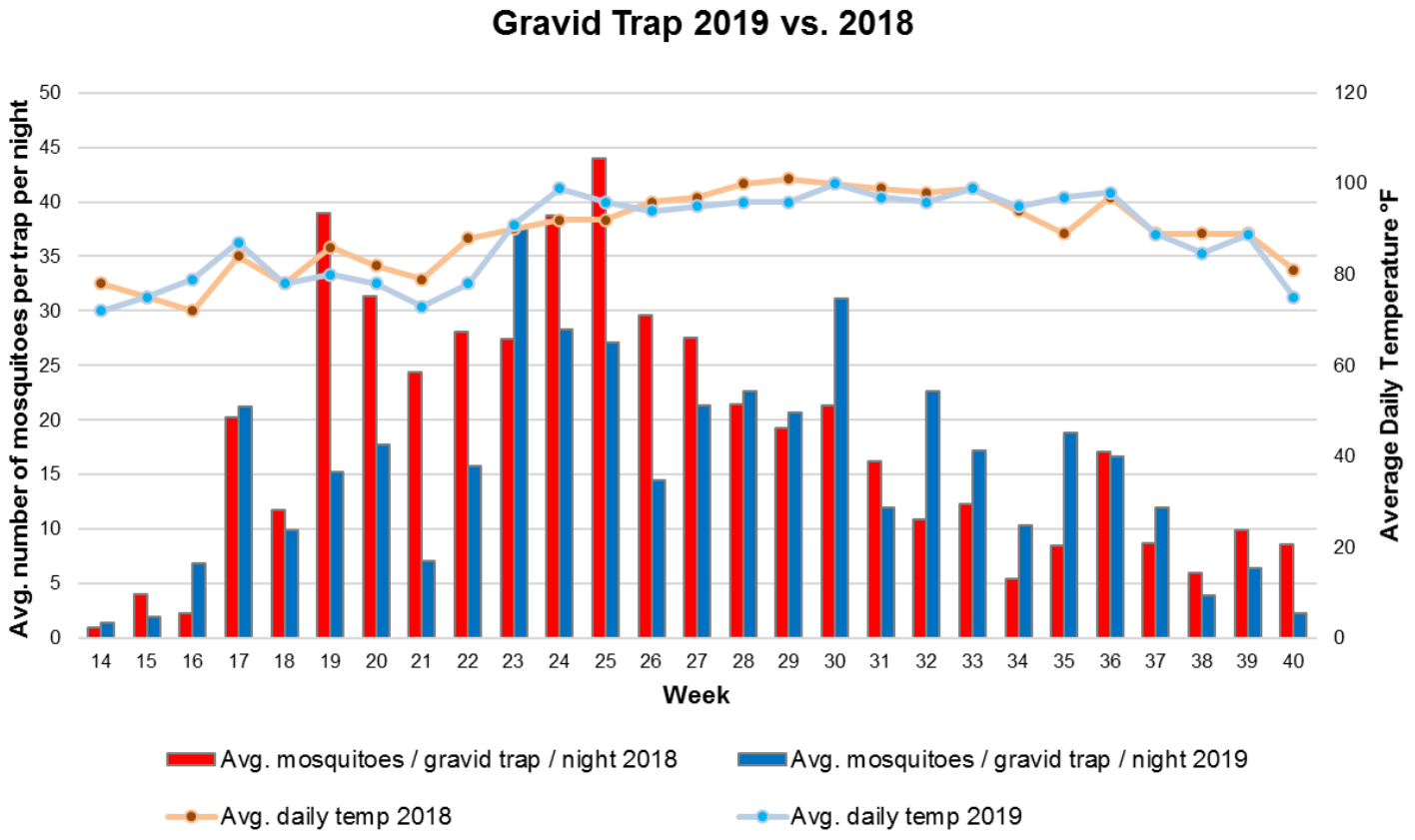


Figure 8. Average number of mosquitoes collected per trap, per night, by disease week. Data from 2018 and 2019 are represented, as are the average daily temperatures for those years.

Encephalitis Virus Surveillance Strategic Trapping Survey

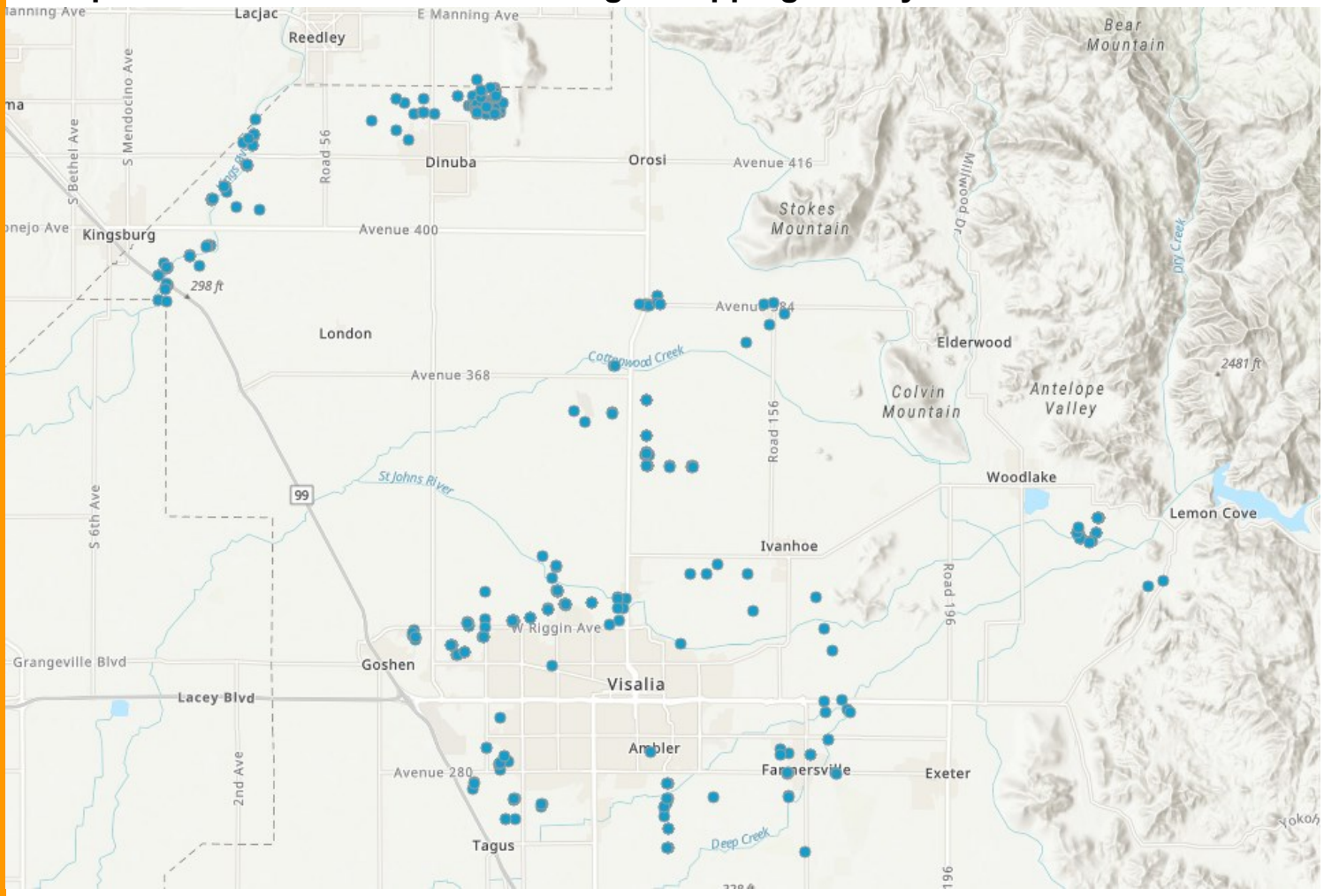


Figure 9. Placement of the EVS trap sets throughout the District in 2019

In 2019, 509 Encephalitis Virus Surveillance (EVS) traps were set in the District, significantly more traps than the 393 set in the 2018 season. During the collection period, 45,554 mosquitoes were trapped with fifteen different mosquito species represented. The highest single trap count within the District was 1,175 mosquitoes collected northwest of Visalia.

The EVS traps collected significantly higher numbers of *Culex quinquefasciatus* in 2019 compared to 2018. This was likely due to the continued high counts coming from agricultural sources northwest of Visalia. This species represented 68.44% of all collections in 2019 versus 38.35% of all collections in 2018.

Species	Abundance	Percentage of collection
Culex quinquefasciatus	31,177	68.44%
Culex tarsalis	6,692	14.69%
Culex erythrothorax	3,666	8.05%
Culex stigmatosoma	2,054	4.51%
Anopheles freeborni	1,018	2.23%
Aedes vexans	561	1.23%
Anopheles franciscanus	87	0.19%
Culiseta particeps	86	0.19%
Anopheles punctipennis	55	0.12%
Aedes nigromaculis	47	0.10%
Aedes aegypti	35	0.08%
Culiseta incidens	35	0.08%
Aedes sierrensis	26	0.06%
Culiseta inornata	13	0.03%
Aedes melanimon	2	0.004%

Table 3. Total abundance and percentage of total collection of each mosquito species collected from EVS traps in 2019.

Invasive Mosquito Surveillance Program

With the rediscovery of *Aedes aegypti* in 2017, first in Visalia followed by Farmersville and Exeter, the District decided to implement another surveillance program to better monitor this invasive mosquito. In 2018, the Invasive Mosquito Surveillance program changed to its current iteration, although at the time it was called the Invasive *Aedes* Surveillance Program. The program consists of 60 fixed-location BG traps set weekly, one per square mile of suburban area, with an additional 20-25 strategic BG traps per week to better identify possible breeding sources or to follow up on a service request. Unlike the native species of mosquitoes which prefer larger bodies of water, or more obvious ones such as unmaintained swimming pools, the *Ae. aegypti* mosquito prefers small cryptic locations, which makes finding the breeding sources increasingly difficult.

Fixed Location BG Trapping Survey

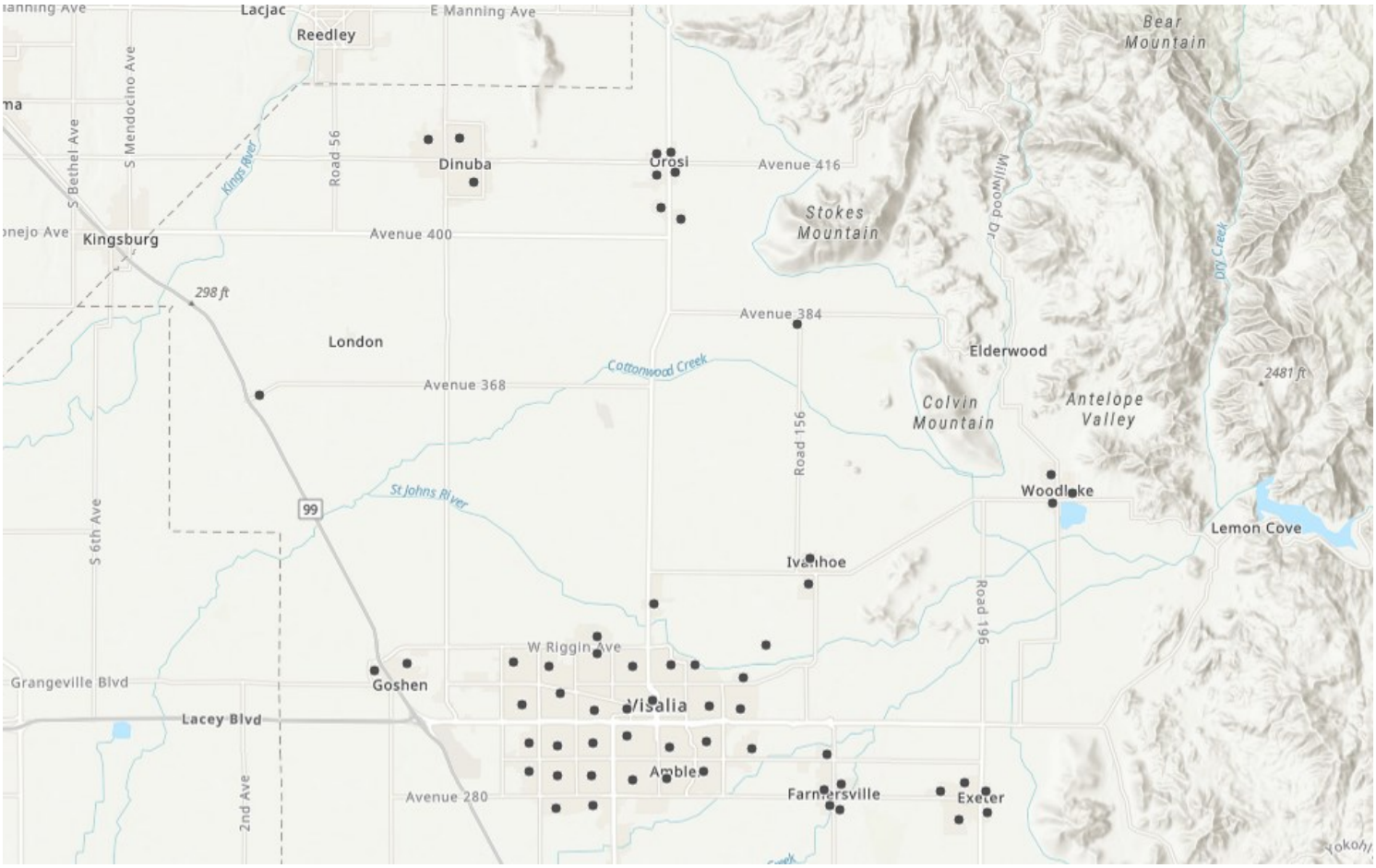


Figure 10. Placement of the 60 BG traps in fixed sites used from April 15th to October 4th, 2019.

During the 2019 surveillance season, 60 BG traps operated weekly from April 15th through October 4th at fixed trap locations, equaling a total of 1,418 trap sets. During the trapping period, 31,521 adult mosquitoes were collected with 11 species represented. Despite BGs being the gold-standard for trapping *Aedes aegypti*, 62.56% of the mosquitoes caught were *Culex quinquefasciatus* with 28.21% being *Ae. aegypti*. This was a massive increase for the number of *Ae. aegypti*, however, as in 2018 they only made up 4.01% of the total collections from routed BG traps. Additionally the high numbers of *Cx. quinquefasciatus* were not unexpected as they are still the most abundant mosquito within the District.

Species	Abundance
Culex quinquefasciatus	19,718
Aedes aegypti	8,893
Culex tarsalis	2,381
Culex stigmatosoma	492
Culiseta incidens	20
Anopheles freeborni	10
Aedes nigromaculis	3
Aedes sierrensis	1
Anopheles franciscanus	1
Culex erythrothorax	1
Culiseta inornata	1

Table 4. Abundance of mosquito species collected in fixed BG traps in 2019.

Species	Abundance
Culex quinquefasciatus	9,284
Aedes aegypti	4,472
Culex tarsalis	1,071
Culex stigmatosoma	118
Anopheles freeborni	13
Culiseta incidens	10
Aedes vexans	3
Culiseta inornata	2
Aedes nigromaculis	1
Aedes melanimon	1

Table 5. Abundance of mosquito species collected in strategic BG traps in 2019.

Strategic Location BG Trapping Survey

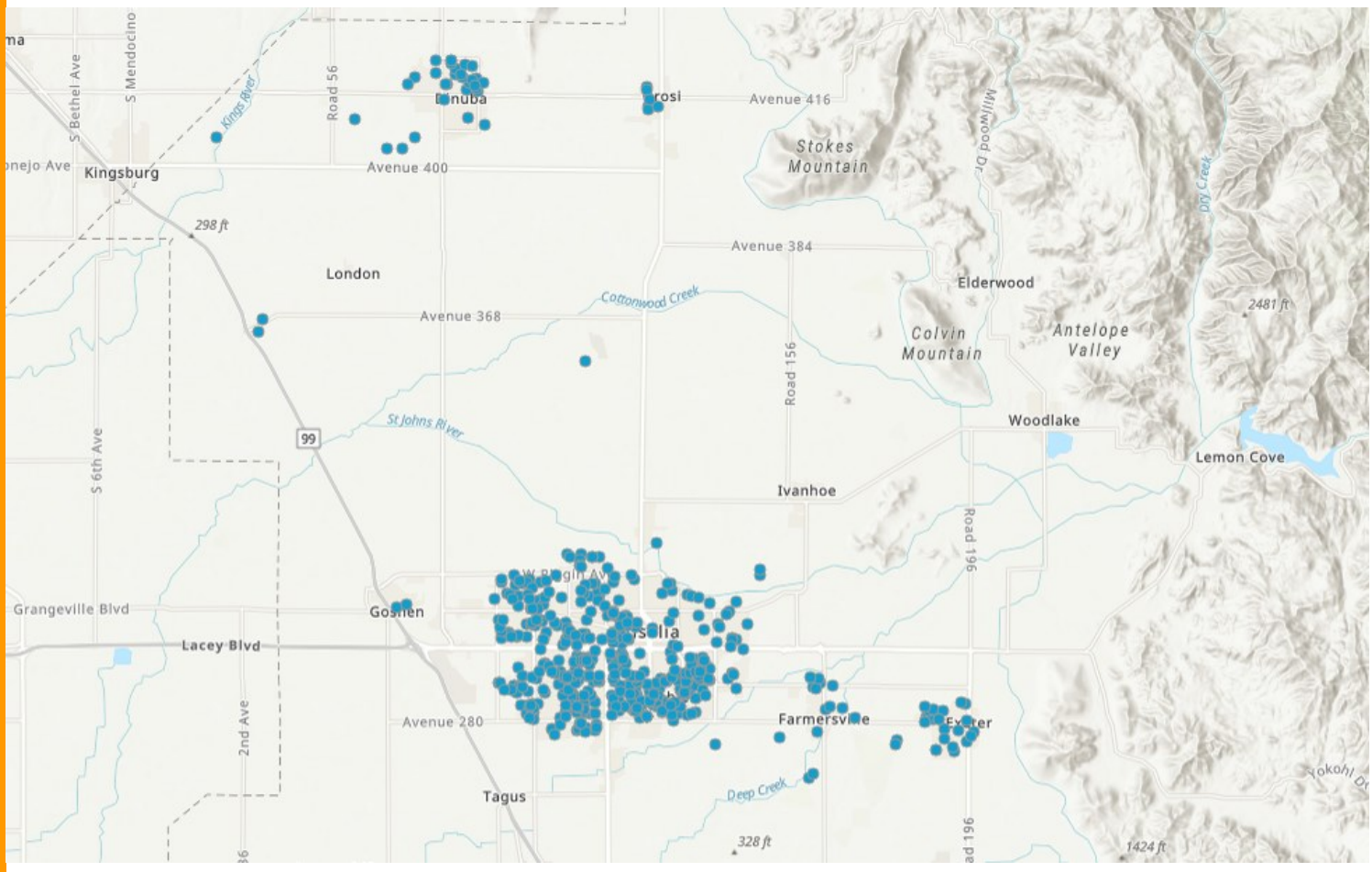


Figure 11. Placement of the BG strategic trap sets throughout the District in 2019.

From April 8th through November 12th, 608 strategic BGs were set. During the trapping period, 14,975 adult mosquitoes were collected with 10 species represented.

The invasive *Ae. aegypti* mosquito made up a slightly larger percentage of the collections for strategic trap sets, 29.86% of the entire collection, compared to the 28.21% from the routed traps. This was significantly higher than

2018 when *Ae. aegypti* made up only 11.57% of the total collection. *Cx. quinquefasciatus*, again, made up most of the collection at 62.00% of the entire collection.

Aedes aegypti from All Traps:

A total of 14,391 adult *Ae. aegypti* were collected from all trap types. Per trap type, 93.2% of all collections were from BG traps, 6.6% from Gravid traps, and 0.2% from EVS traps. The first *Ae. aegypti* adult of 2019 was collected April 4th from Visalia from a routed gravid trap. The first *Ae. aegypti* larvae sample of 2019 was collected January 3rd from lucky bamboo found inside a business in Visalia. The highest *Ae. aegypti* trap count for a single trap night was 144 mosquitoes, 47 females and 97 males, from Visalia, collected with a strategic BG.

Over seventy-four percent of all *Ae. aegypti* were collected in Visalia, with Exeter being the next most abundant city at 8.16% of the collection.

In total, 2,026 BG trap sets were utilized during the 2019 surveillance season, an increase from the 1,624 BG trap sets from 2018.

City	Total number *Aedes aegypti* from all traps	Percentage of *Aedes aegypti*
Visalia	10,788	74.96%
Exeter	1,174	8.16%
Dinuba	928	6.45%
Farmersville	767	5.33%
Cutler-Orosi	497	3.45%
Ivanhoe	95	0.66%
Goshen	46	0.32%
Woodlake	43	0.30%
Traver	40	0.28%
Sultana	2	0.01%

Table 6. Total number of *Aedes aegypti* mosquitoes collected per city from all traps in 2018.

In addition to routed and strategic adult surveillance, door-to-door yard inspections were conducted following high trap counts or service requests to collect immature specimens. The surveillance program found specimens from across the district.

Aedes aegypti Inspections and Door-to-Door Education

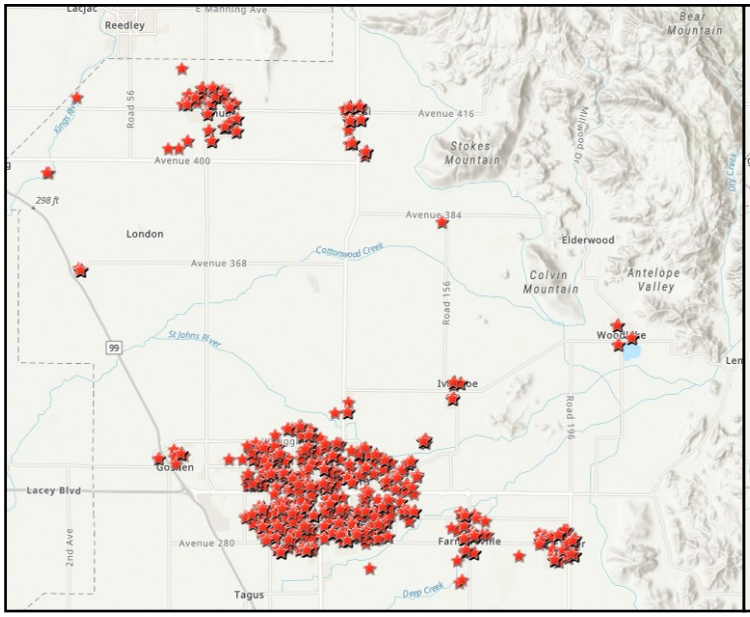


Figure 12. Locations where traps caught *Aedes aegypti* in the District in 2019 (red stars).

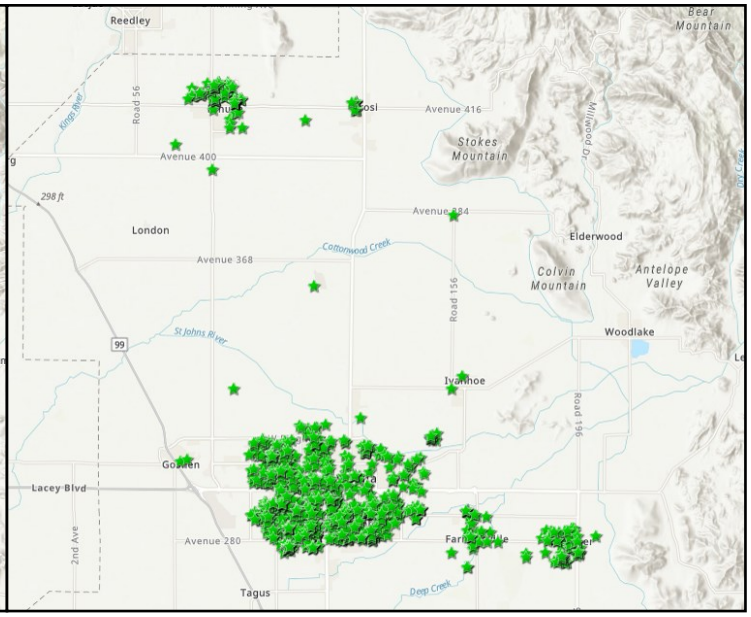


Figure 13. Locations where inspections were conducted for *Aedes aegypti* in the District in 2019 (green stars).

The maps of where *Ae. aegypti* were caught and where inspections took place are not identical, since service requests often generated an inspection independent of trap count, but low trap counts did not always generate an inspection.

In 2019, a total of 1,919 inspections were completed on 1,633 unique properties. Unique, or individual properties, refer to the count of different addresses that were inspected, while multiple inspections may have taken place for the same address, giving the increased total number. This is a dramatic increase from 2018 when 934 total inspections were completed on 730 individual properties.

City	Individual properties	Total inspections	Percentage breeding
Visalia	1,340	1,550	24.78%
Dinuba	128	154	19.53%
Exeter	108	131	26.85%
Farmersville	40	58	35.00%
Cutler-Orosi	13	18	38.46%
Ivanhoe	1	2	100.00%
Goshen	2	2	0.00%
Seville	1	1	0.00%
Total	**1,633**	**1,916**	**24.86%**

Table 7. The number of individual properties and total inspections that were completed per city in 2019 to look for the *Aedes aegypti* mosquito. Individual properties refer to single locations that were inspected at least once, whereas total inspection considers the reinspection(s) that may have taken place on an individual property. Breeding refers to individual properties found breeding.

Inspections were conducted in the outdoor areas of residences or businesses where a service request was made or surrounding a high trap count. Inspections were conducted predominately by lab staff, with samples being taken when breeding was found, and breeding sources being eliminated where possible. Active and potential breeding sources were pointed out to residents who were then educated on control methods to prevent future breeding. Active breeding sources refer to items where breeding was found during the inspection. Potential breeding sources refer to items which were not currently breeding mosquitoes, but would be capable of breeding mosquitoes in the future. Paperwork was left with the resident as well, providing more information, contact information and specific recommendations for their situation.

District-wide, 25% of properties were breeding *Aedes aegypti* mosquitoes. Of the 407 properties where breeding was found, 48.9% of breeding sources were eliminated during the initial inspection while 34.9% corrected or maintained their problematic sources after the initial inspection. However, 8.1% required two inspections and 8.1% required three or more inspections before the source was controlled.

During yard inspections, the top three potential breeding sources found on properties were miscellaneous containers, plant trays, and pet water dishes. Miscellaneous containers included watering cans, buckets, cups, vases, and other similar items (Figure 14). Of these sources, *Ae. aegypti* breeding was found most often in other sources, fountains, plant trays, and drains. Other sources include items such as wheelbarrows, neglected hot tubs, old household appliances, bathtubs, leaking irrigation control valve boxes, rocks, and flooded areas from leaks or over watering (Figure 15). These items were drained and scrubbed out when possible, removed when possible, and potentially treated with product if they couldn't be drained or removed.

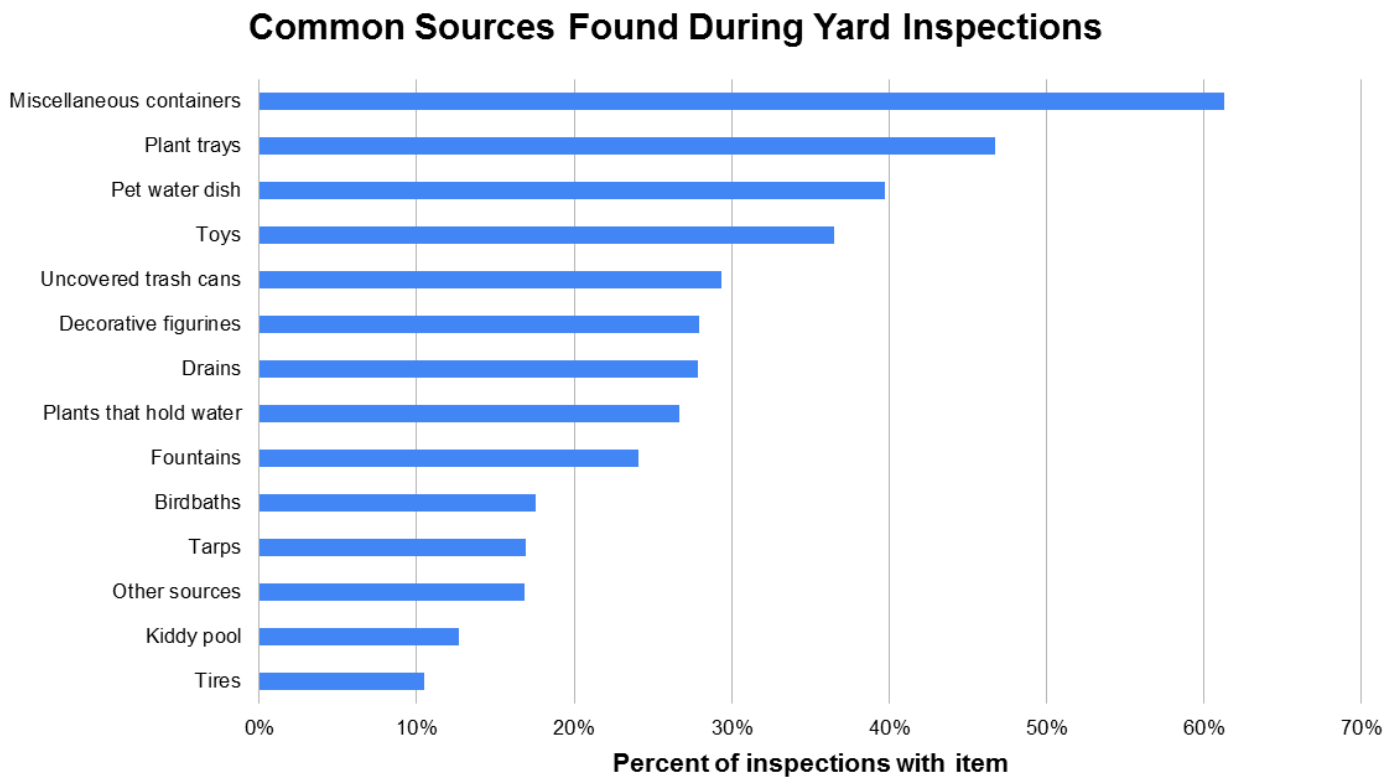


Figure 14. Common sources found during yard inspections in 2019.

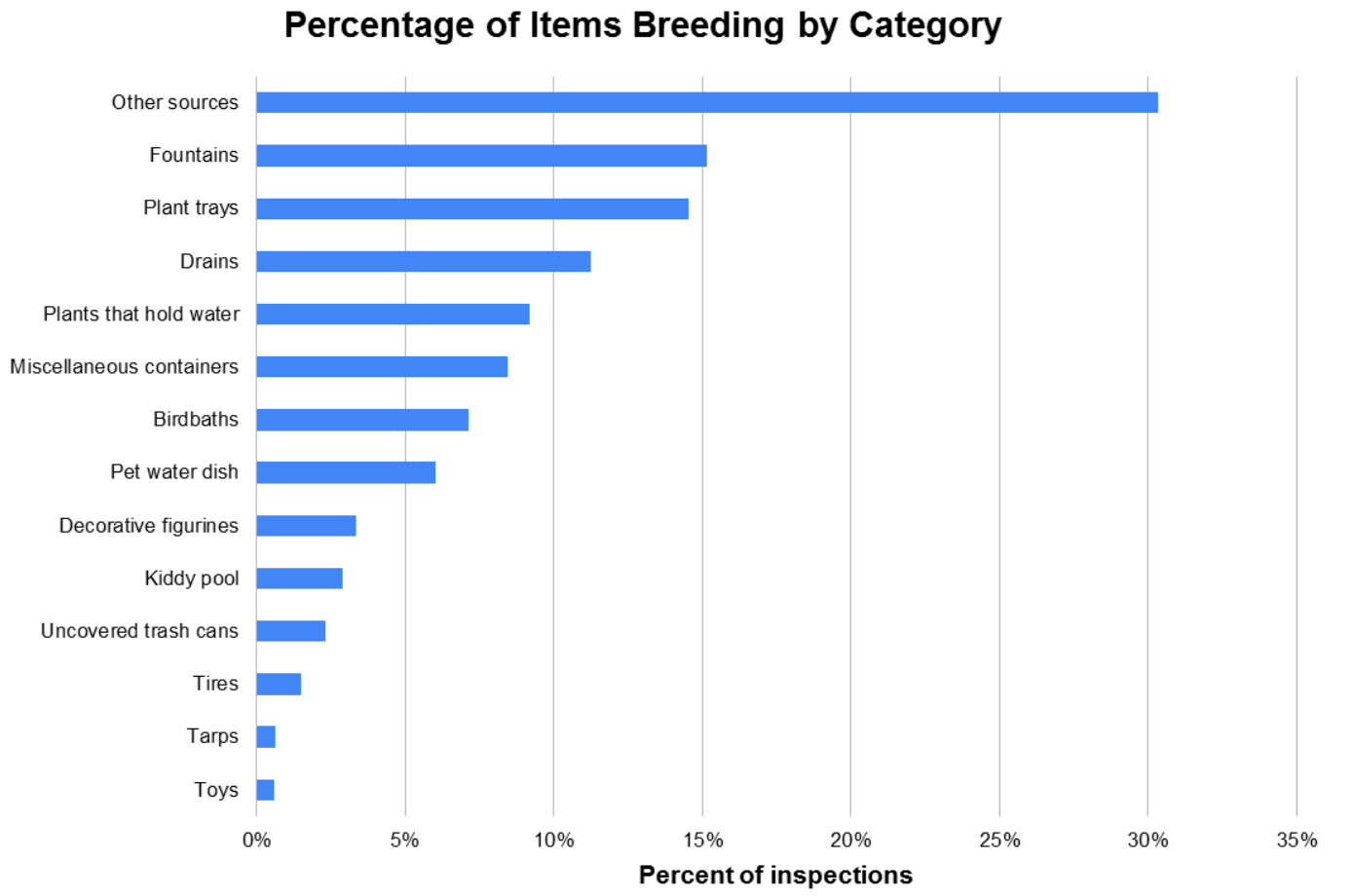


Figure 15. Percentage of items breeding by category in 2019.

Disease Testing

In 2012, following completion of the new laboratory facility, the District began on-site testing of mosquito specimens and dead birds for virus, allowing a quicker turnaround time from trapping to knowledge of disease presence, which helps to better guide the control program. Initially, only West Nile Virus (WNV) test results were reported to the California Department of Public Health (CDPH) but the program is now capable of testing and reporting WNV, St. Louis Encephalitis (SLEV), and Western Equine Encephalitis (WEEV).

Every year, the District maintains these testing capabilities by passing the annual proficiency panel implemented by CDPH and distributed by the Davis Arbovirus Research and Training (DART) Lab.

In the future, the laboratory hopes to be able to test for other arboviruses such as Zika, dengue, and chikungunya.

2019 Proficiency Panel

The proficiency panel was ordered and successfully passed in April, before the beginning of the 2019 season, allowing the District to report all the positive mosquito samples to CDPH.

The 2019 panel included two known positive samples and six unknown samples, consisting of unknown quantities of inactivated viruses and mosquito slurry. The unknown samples and 10-fold serial dilutions of the known samples were tested using RNA extraction and Real-Time Polymerase Chain Reaction methods. Finding resultant cyclic threshold (Ct) scores that were consistent with the values found by DART indicated a passing result.

In 2019, thirteen districts participated in the proficiency panel. The following charts show the finalized results compiled by DART for all participating agencies. Delta is abbreviated as DLTA.

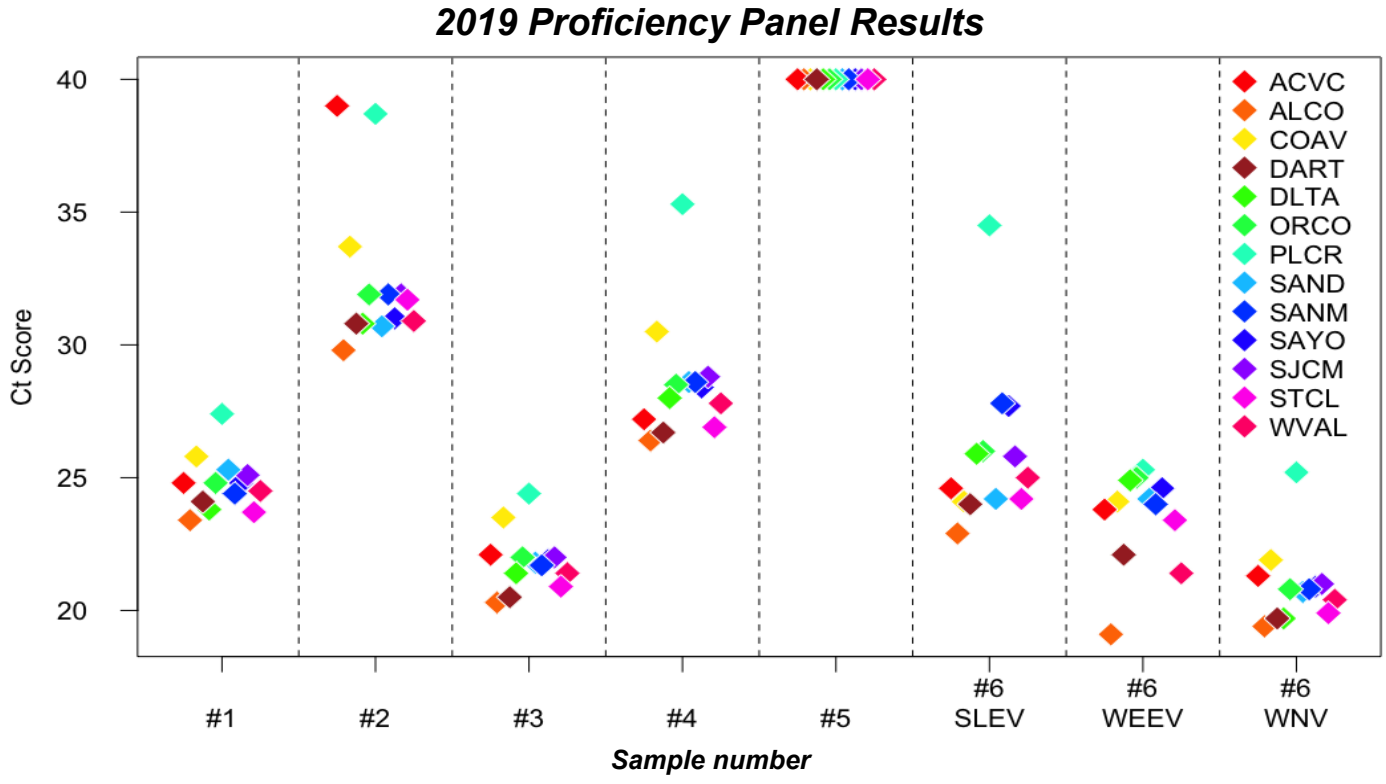


Figure 16. Cyclic threshold scores for the unknown simulated mosquito pools. Each color represents an agency, and values of 40 indicate negative test results. Unknown sample #6 was infected with WNV, SLEV, and WEEV.

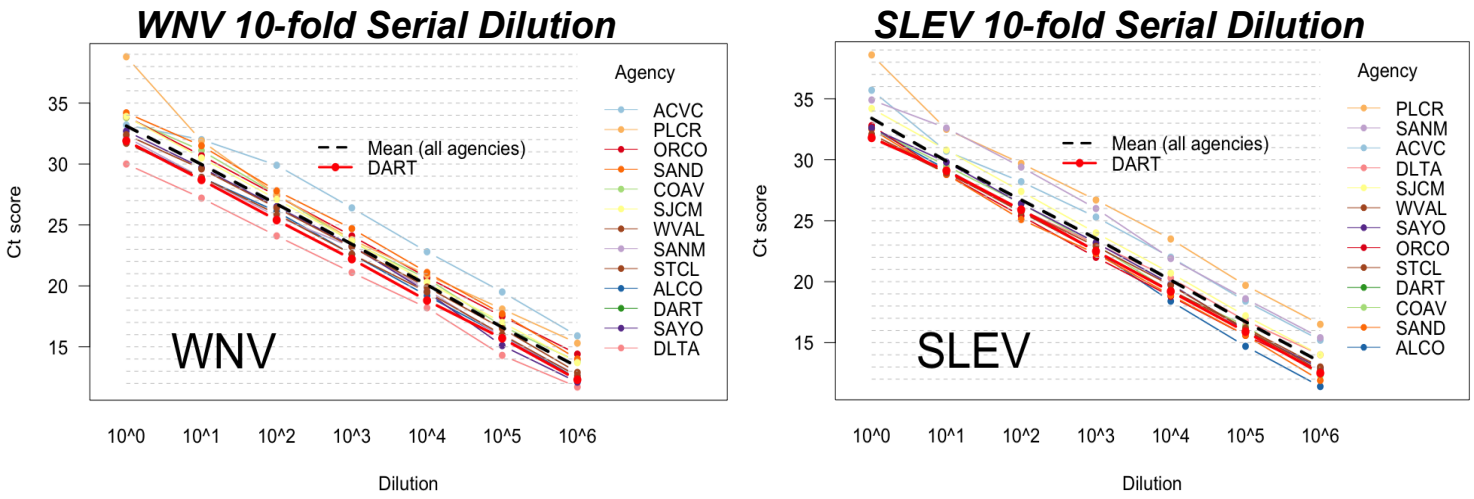


Figure 17. Cyclic threshold (Ct) scores for the 10-fold dilution series for WNV and SLEV. Lines show variation in Ct scores and slopes for individual agencies.

Dead Birds Reports

Humans and mammals are not a reservoir host of WNV, SLEV, or WEEV and cannot transmit any of these diseases to a mosquito if bitten. Birds, however, can be reservoir hosts to all three viruses, and can also die from these diseases, specifically WNV. As such, dead bird carcasses that are reported to the District or to CDPH through their WNV and dead bird call center, are collected by technicians and tested alongside mosquito pools during the season. If mosquito numbers are low in an area, a dead bird carcass may be the only indication available to the District that there is WNV within that area. Delta tests and reports all testable dead birds and encourages members of the public to report any dead birds they see.

In 2019, 114 dead birds were reported to the District. Of those, 27 were considered testable. Dead bird carcasses are only considered testable if they have died within the past forty-eight hours, have no obvious physical trauma that led to death, and are of an accepted species for testing. Of the 27 tested birds, 16 tested positive for WNV. Comparatively, in 2018, only 39 bird carcasses were reported to the district, only ten of those were considered testable, and none of those ten tested positive for disease.

Mosquito Sample Virus Detections

Mosquito samples are made up of 10-50 female mosquitoes of any of the four *Culex* species which can transmit these viruses. If a location had sufficient mosquitoes to create multiple samples, all samples were tested. The laboratory tested 3,792 mosquito samples for WNV, SLEV and WEEV in 2019. There were 792 confirmed WNV positive samples and 89 confirmed SLEV positive samples. Comparatively, in 2018, the laboratory tested 3,836 mosquito samples, with 65 samples testing positive for WNV, and 138 samples testing positive for SLEV. Sample testing began a month earlier in 2018 than in 2019, although no positive samples were detected during that month.

WNV positives increased significantly from 2018 to 2019, while SLEV positives decreased slightly. There were no positive WEEV detentions in either 2019 or 2018.

2017-2019 WNV and SLEV Positive Mosquito Samples			
Disease	**2019**	**2018**	**2017**
WNV	776	65	575
SLEV	89	138	30

Table 8. Total number of WNV and SLEV detections during the mosquito season from 2017-2019.

The first WNV positive sample was collected on May 15th, from west Visalia, and the last WNV positive sample was collected on September 27th also from west Visalia in 2019. In 2018 the first WNV positive sample was collected on June 20th from north Exeter

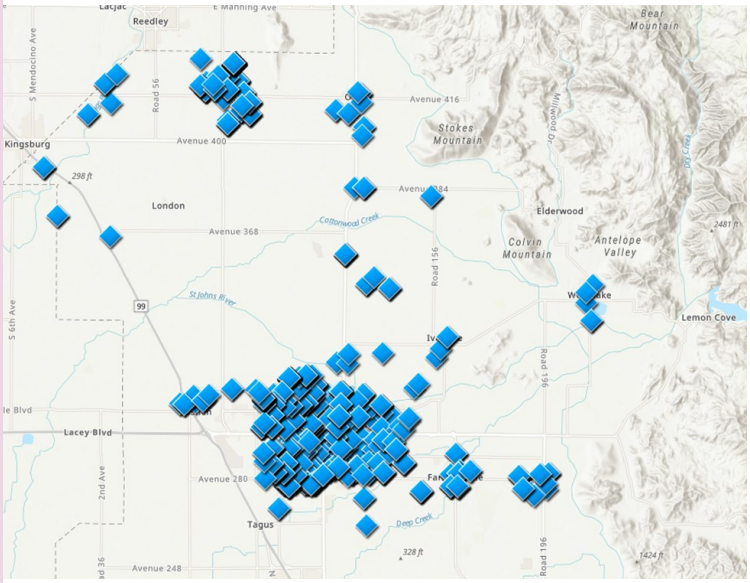


Figure 18. A map of the District where at least one mosquito pool tested positive for WNV in 2019.

The 2019 season overall had an increase in WNV detections in comparison to the previous years.

In addition, the first positive sample for WNV was seen in week 20 of 2019 which was five weeks earlier than in 2018.

Historically, the earliest a positive sample for WNV has been detected by the district had been week 17 in 2015. The most common week for initial detection, on the other hand, is week 23. So while WNV was detected earlier in 2019 than in 2018, it was not detected abnormally early.

That being said, the percent of samples that tested positive for disease did reach a record peak, with over 50% of samples testing positive in week 32. In 2018, positives only reached about 10% in week 35.

The District-wide infection rate (IR) for WNV was 6.92 in 2019, a drastic increase from 0.5919 in 2018. The IR is a measurement of the risk of an infection within a population. Our IR is calculated by dividing the number of positive mosquito pools by the total number of mosquitoes tested. A higher IR indicates an increased risk for humans as well as mosquitoes. IR's varied from community to community within the District, with Visalia experiencing the highest IR at 9.32 and Woodlake experiencing the lowest IR with 1.75.

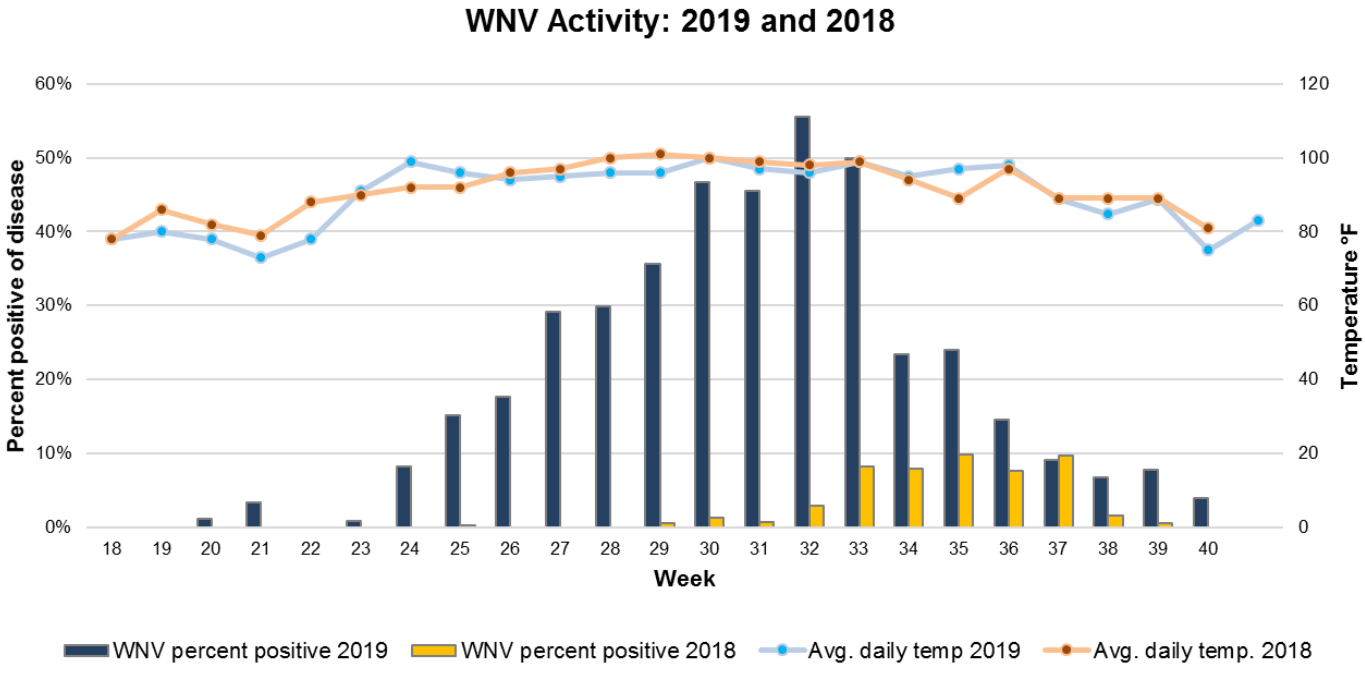


Figure 19. The West Nile virus (WNV) positive percentage of tested mosquito pools from 2018 and 2019 by disease week, with the average daily temperatures included for comparison.

2019 WNV and SLEV Community Infection Rates						
City	WNV IR	SLEV IR	Number of Samples	WNV Positives	SLEV Positives	Number of mosquitoes tested
Cutler-Orosi	4.26	0.00	117	12	0	2,819
Dinuba	6.39	0.14	230	45	1	7,044
Exeter	5.86	0.00	117	16	0	2,731
Farmersville	7.69	0.48	150	32	2	4,159
Goshen	8.13	1.63	26	5	1	615
Ivanhoe	6.44	0.00	38	5	0	776
Visalia	9.32	0.75	1,653	411	33	44,096
Woodlake	1.75	0.00	92	4	0	2,286
Rural Areas	5.16	1.09	1,369	246	52	47,676
Total District	**6.92**	**0.79**	**3,792**	**776**	**89**	**112,202**

Table 9. The season long infection rate (IR) for WNV and SLEV from each community within the District in 2019.

In 2019, the first SLEV positive sample was collected on May 24th from southwest Visalia and the last SLEV positive sample was detected in the rural area to the southwest of the city of Visalia on October 8th. In 2018, however, the first SLEV positive sample was collected on June 4th from southeast Visalia and the last on September 27th from northern Dinuba.

SLEV positive mosquito samples were collected from Dinuba, Goshen, Farmersville, and Visalia in 2019. There was a decrease in the number of samples collected in comparison to the previous year. This is reflected by the District-wide IR of 1.41 in 2018 and only 0.79 in 2019.

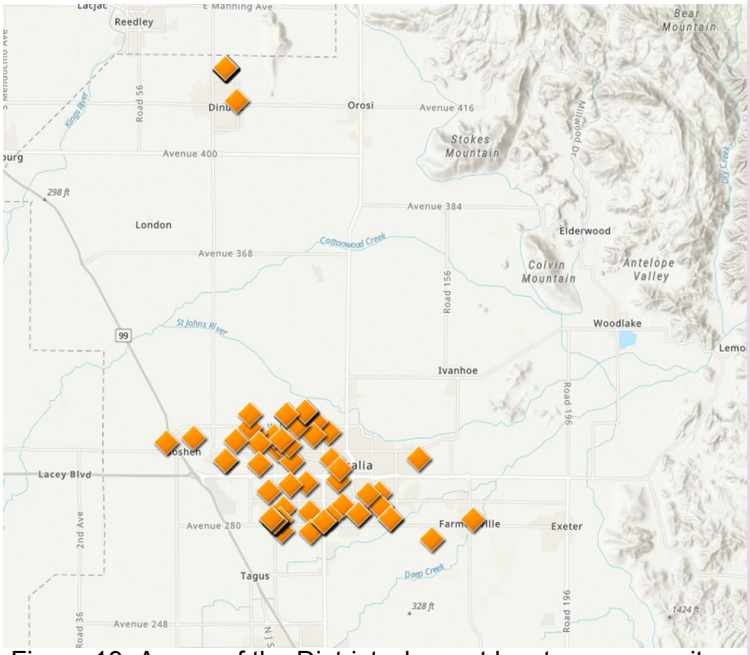


Figure 19. A map of the District where at least one mosquito pool tested positive for SLEV in 2019.

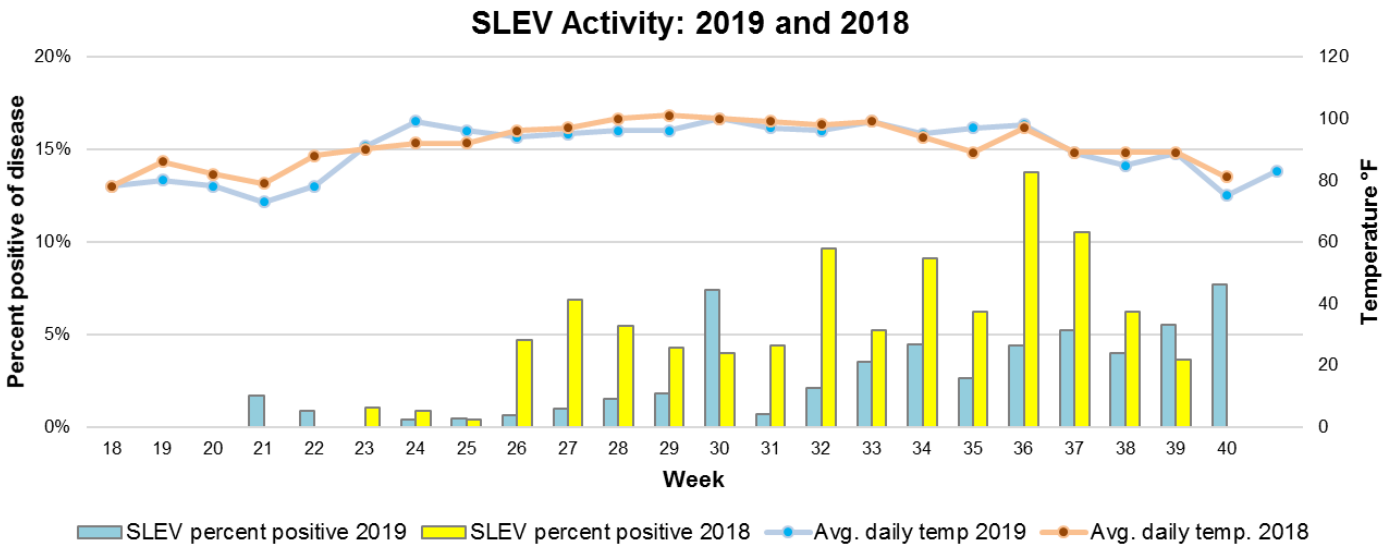


Figure 20. The St. Louis Encephalitis (SLEV) positive percentage of tested mosquito pools from 2018 and 2019 by disease week, with the average daily temperatures included for comparison.

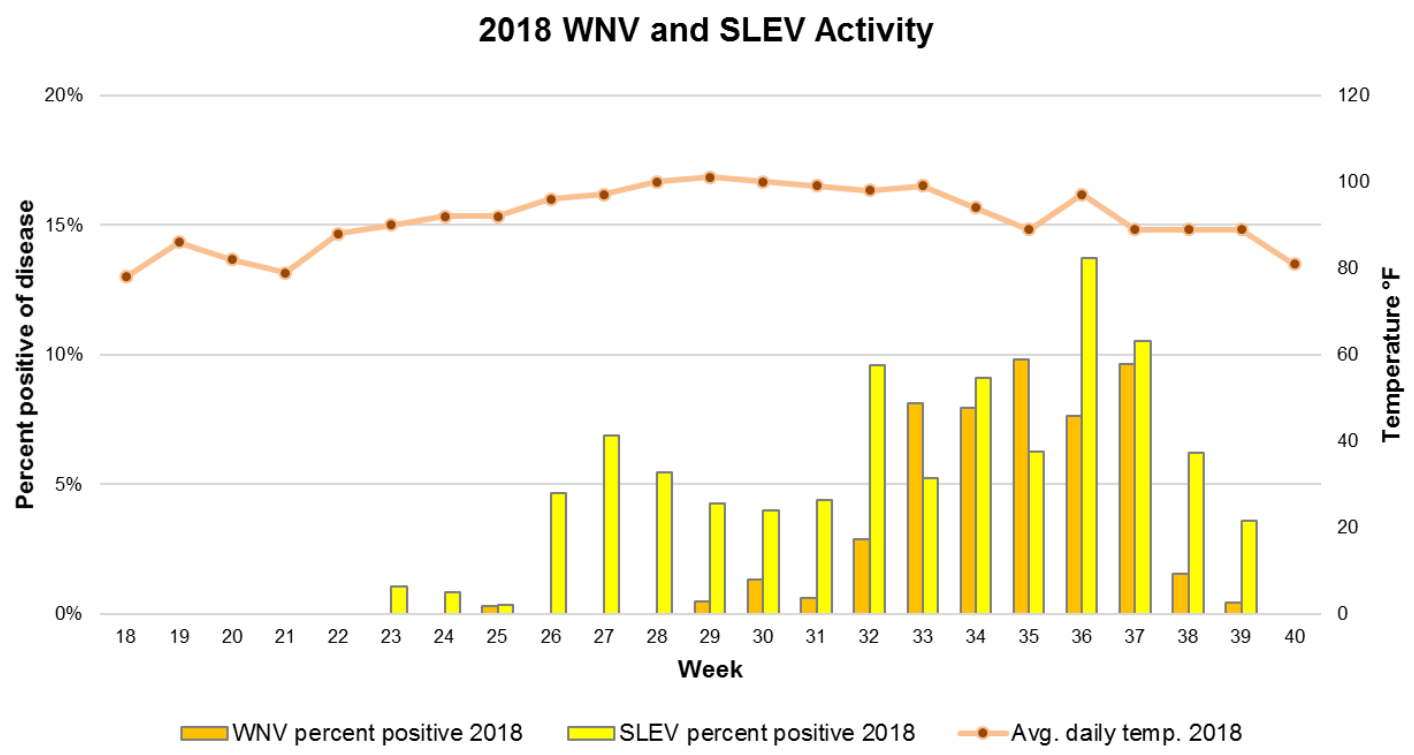


Figure 21. Comparison of positive pools for WNV and SLEV in 2018. Average daily temperature from 2018 is included for reference.

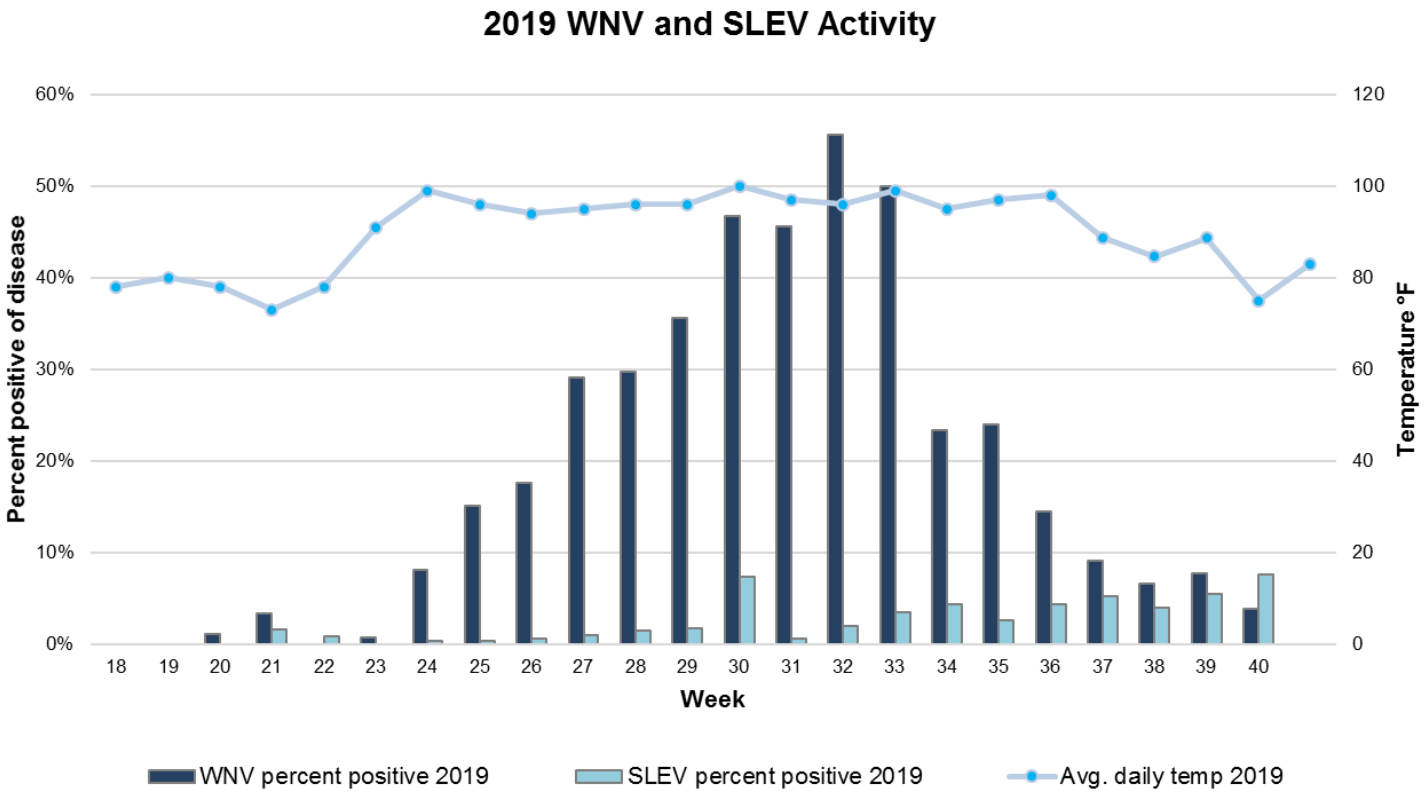


Figure 22. Comparison of positive pools for WNV and SLEV in 2019. Average daily temperature from 2019 is included for reference.

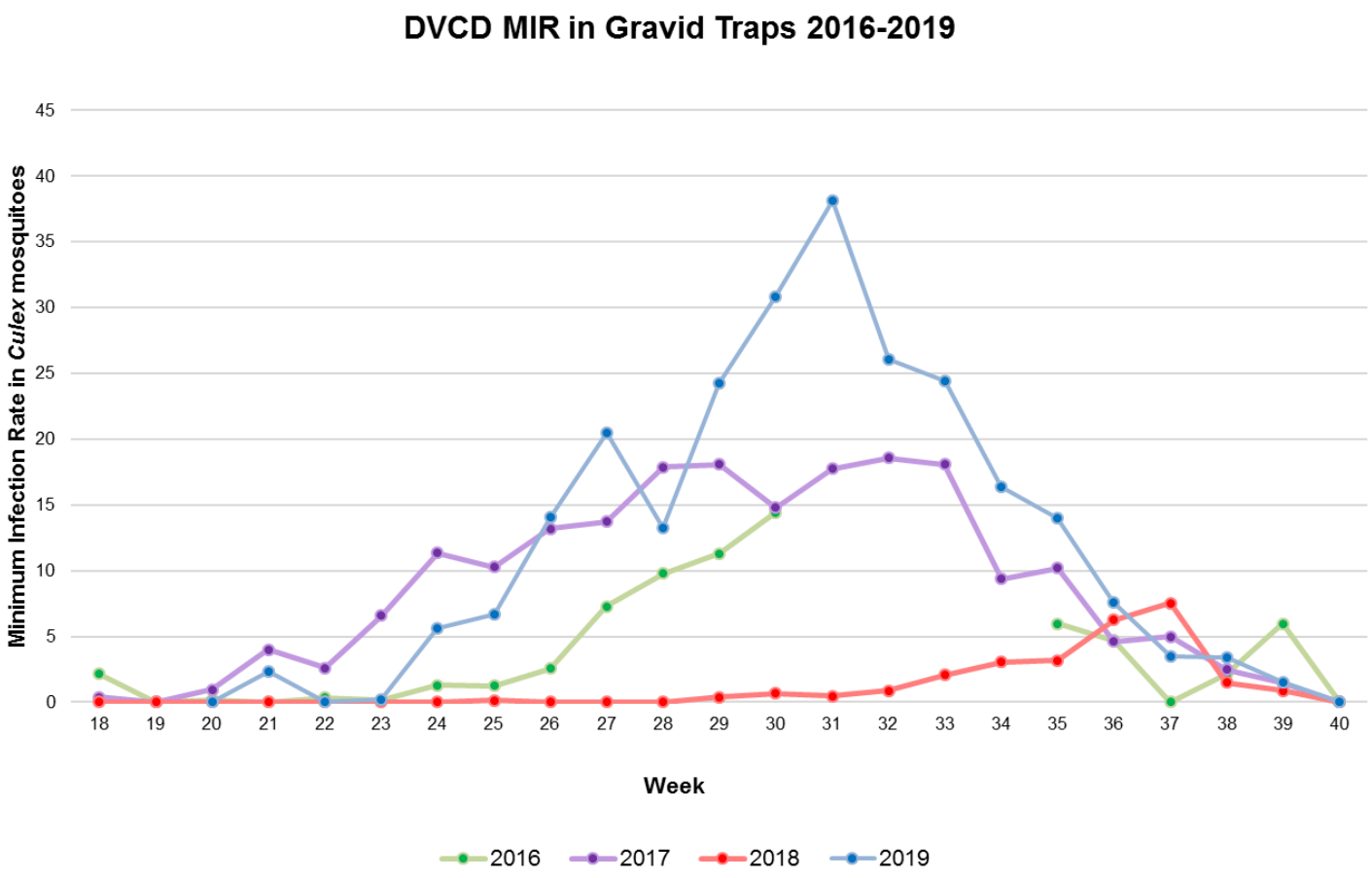


Figure 23. Minimum infection rate (MIR) in gravid traps from within Delta Vector Control District's borders for the years 2016-2019. Note that due to circumstances the MIR is not available for weeks 31-34 in 2016.

Human Cases

The Tulare County Health and Human Services Agency (HHSA) reported 13 human cases of WNV within District boundaries in 2019. Of those cases, seven were diagnosed with neuroinvasive WNV and the other six had non-neuroinvasive disease, also known as West Nile fever. Comparatively, there was only one human case of WNV within the District in 2018. There were no human cases of SLEV or WEEV reported in either 2019 or 2018. Human cases of mosquito-borne diseases are reported to the District to help guide control efforts and are reported in compliance with the Health Insurance Portability and Accountability Act (HIPAA), lacking personal identification information.

Other Viruses

Although the District is not currently capable of testing for mosquito-borne viruses other than WNV, SLEV, and WEEV, there is still a protocol in place if any other virus did emerge within our population. Any human case of a mosquito-borne disease within the county is reported by the Tulare County HHSA to the District, whether the case was acquired locally or while traveling. This is especially important for diseases that can be transmitted from an infected person to a mosquito and then to another person, which include malaria, dengue, chikungunya, yellow fever, and Zika.

In 2019, the District was not notified of any human case for any other viruses within District boundaries. In the event of a human case, the District will begin surveillance and control efforts, including collecting mosquito samples and sending them to DART for disease testing.

In 2020, the District hopes to be able to complete in house testing for dengue, chikungunya and Zika.

Control

Biological Control

Biological control refers to any control effort in which a natural predator, parasite or pathogen is used to target the vector. At Delta Vector Control District, *Gambusia affinis*, or the mosquitofish, is the preferred biological control agent to lower immature mosquito populations.

Mosquitofish are an effective predator of mosquito larvae and are a great alternative to chemical control. However, they are not a native fish to California and thus cannot be released in any waterway that connects to waters of the US or where native species may be present. As such, these fish are mainly used in holding basins, ornamental ponds, fountains, unmaintained pools, watering troughs, and water reservoirs, throughout the District. Mosquitofish readily adapt to their environment, multiply quickly, and can consume massive numbers of mosquito larvae. These fish are small, with adult females usually measuring less than 2.5 inches and adult males under 1.5 inches. They vary in color, depending on their immediate environment, from a light silver to a darker olive green.

The District currently utilizes three runways and two nursery tanks to treat and hold fish. In the winter, the runways are emptied for cleaning and maintenance, while the remaining fish are deposited in holding basins and ponds throughout the District. In spring, fish traps are set in the basins and ponds to repopulate the District's mosquitofish supply. Before being distributed, the fish are tested and, if possible, treated for flukes and other parasites that they may be carrying.

It is becoming increasingly difficult to stock the mosquitofish runways with the amount of fish necessary for efficient control. In 2019, only two fish sources could be used to stock the runways due to the high density of parasites found in the fish from all other sources. With the demand for mosquitofish increasing every year, a more reliable fish management system is needed.

The solution is to start breeding mosquitofish as many other vector control districts already do. This will alleviate the stress of finding fishing sources in the field and allows for additional control over the quantity and quality of available mosquitofish. This will directly benefit the District since an adequate stock of healthy mosquitofish will be ready to distribute year-round to treat mosquito sources. The building process for this fish facility is currently ongoing and is expected to be completed by 2020.

In 2019, 142 requests were made to treat hundreds of water sources with mosquitofish. Homeowner requests for mosquitofish nearly doubled from 2018, with 82 requests being made to treat private water sources in 2019. Technicians

distributed fish to 60 locations in 2019, which is close to the 59 locations distributed to in 2018. Fish were stocked in irrigation ponds, troughs, ornamental ponds, fountains, pools, various backyard sources that hold water, school education programs, flood control basins, and sloughs. Over 2,700 mosquitofish were distributed throughout the District to treat water sources, both big and small, to combat both invasive and native immature mosquitoes.

Mosquitofish are free to the public within the District and can either be picked up at the Houston Avenue facility or taken to the homeowner at their request. The District is looking forward to being able to breed mosquitofish in the future and cutdown on the delay in distributing mosquitofish in coming years.

Physical Control

Physical control is conducted year-round and refers to environment management to eliminate or reduce mosquito breeding habitats. During winter and early spring in 2019, technicians worked on path maintenance to improve site access for treatments later in the season. They also cleared brush and weeds along creeks, dairy ponds, drain ditches, and other aquatic sources throughout the District to reduce stagnant water pools. Throughout the year, field technicians also check for any blockages water which may create shallow pools or otherwise stagnant water that can breed mosquitoes.

The District houses seventy-five dairy and waste water lagoon sites. Of those fifty-four (72%) have opted in for the Weed Program. In 2019, those fifty-four sites were treated a total of 812 times with herbicides to control plant growth that would have facilitated the breeding of mosquitoes. Some of those sites were later treated to control mosquito larvae, while others simply required ongoing weed control to prevent mosquito breeding.

Additionally, physical control is used during the season in the form of draining pools and fountains. Because of water restrictions, many homeowners are unable to drain their pools or water features when they become unable to maintain them. In these situations, the District will attempt to help the resident receive a waiver to empty their water source to stop mosquito breeding. In 2019, the District did not help drain any pools, but did help drain less than 100 smaller water features.

Given the small cryptic breeding sites of the invasive *Aedes aegypti*, and its high resistance to most adulticides, physical control is the most effective means to limit breeding. In 2019, laboratory staff would often make small physical alterations to yards to limit existing or potential breeding sources during inspections. This most often consisted of removing, overturning, or filling plant trays with sand or dirt as well as assisting homeowners in draining fountains and birdbaths. Laboratory staff also cleared debris and rubbish stuck in front of drainage pipes that had caused water to pool and become heavy breeding sources.

Chemical Control

Chemical control is used by the District when biological or physical control is not feasible, with a focus on larvicides first and adulticides only if larvicides do not work or disease risks are elevated. Larvicides target immature mosquitoes while they reside in aquatic habitats whereas adulticides are intended to reduce adult mosquito populations. Any product used by the District has been registered with the California Environmental Protection Agency and is applied with strict adherence to the pesticide label instructions. Products may be applied weekly to annually, depending on a variety of factors including but not limited to water temperature, mosquito species, organic content, instar stage, and presence of predators.

Larvicides

The District prefers to use larvicides when possible, as preventing the existence of adults eliminates them as both a disease threat and a nuisance. In 2019, there were a total of 6,870 larvicide applications performed by the District. Larvicides used by the District fall into the categories of biorationals, insect growth regulators, and surface films.

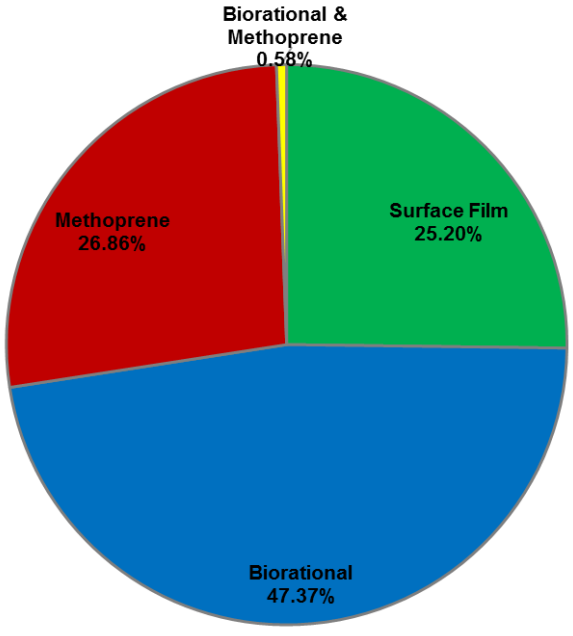


Figure 24: Percentage of types of larvicide used for applications made in 2019.

Biorational products are products derived from natural sources and include Bti (*Bacillus thuringiensis israelensis*), Bs (*Bacillus sphaericus*), and Spinosad. Bti, an Organic Materials Review Institute (OMRI) rated larvicide, is a bacterium that damages the gut lining when ingested by mosquito larvae, leading to death. Bs, like Bti, is a bacterium that leads to the death of mosquito larva once ingested. Both Bti and Bs have a very low toxicity to non-target organisms. Spinosad, produced by soil bacteria, acts on the nervous system of mosquito larvae but is slightly more toxic to aquatic larval stages of other species. Resistance to biorational products is lower than that of other chemical control methods, and as such these are the products used most often by the District. In 2019, 2,931 applications were made with these chemicals, making up 47.37% of all larvicidal treatments.

Insect growth regulators act as synthetic hormones, disrupting the ability of larvae to pupate into adults. Methoprene-based products are used by the District when necessary. These larvicides were used a total of 1,674 times, making up 26.86% of the larvicidal applications.

Products containing both biorational products and methoprene were only used 40 times, or 0.58% of the larvicidal applications. This combination is used when risk of resistance is high, there are no pupae present, and extended control is required.

Surface films are the only chemical control method that target both larval and pupal stages of mosquitoes. Pupal stages of mosquitoes do not eat and as such are not controlled by most larvicides. Alcohol and oil-based products inhibit the ability of both pupae and larvae to rest at water surfaces to breath and results in suffocation of immature mosquitoes. Surface films can interfere with other forms of aquatic life and application must be done carefully. A total of 1,513, or 25.20% of all larvicidal applications in 2019 were made with surface films.

Larvicide applications were made to a number of different types of sources, most of which fall under six main categories: agricultural, irrigation, private property, public domain, commercial, and natural.

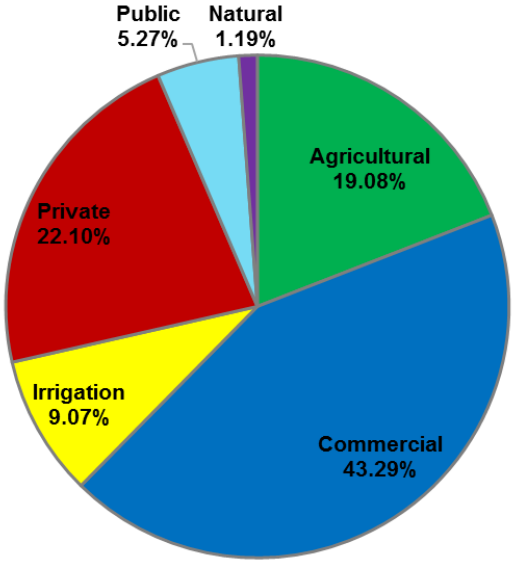


Figure 25: Percentage of location types treated with larvicide in 2019.

Nearly half of the applications were made to commercial locations, in large part due to the quantity of larvicide that is used for treatment in dairy lagoons. In fact, 69.70% of all larvicide application to commercial properties took place in dairy lagoons.

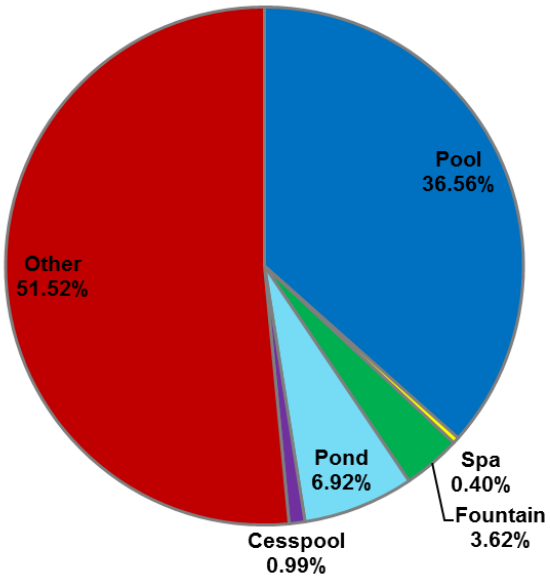


Figure 26: Percentage of different subcategories of private location types treated with larvicide in 2019.

The second largest category of source types were private sources, making up nearly a quarter of all larvicide applications. Private sources consist of pools, spas, fountains, ponds, cesspools and "other", with other being made up of everything from plant trays to decorative figurines. In 2019, "other" made up over 50% of all treatments, likely due to the increase of *Aedes aegypti* in the area.

Adulticides

The District applies adulticides when larval control has failed and the existing mosquito populations pose an increased disease threat or nuisance to residents. Increased adulticide activity was conducted in 2019 because of the elevated disease risk. Treatments were applied with backpack sprayers or as ultra-low volume (ULV) fogs by a truck mounted sprayer. The District currently uses natural pyrethrins (a chemical compound derived from chrysanthemum flowers) for ULV applications as well as synthetic permethrins for backpack applications. Application by truck mounted ULV typically take place before dawn, or sometimes after dusk, to maximize contact with target mosquitoes and minimize effect to nontarget organisms. These chemicals break down rapidly in sunlight and as such are considered non-persistent and have low toxicity to humans. Whereas backpack sprayer application may take place at any time of day and is focused on spraying nonflowering foliage that may provide harborage for the mosquitoes. These applications are very targeted to avoid nontarget organisms, and are similarly of low toxicity to humans.

There were 216 applications of ULV adulticide applied in 2019, using approximately 5,305 gallons of chemical over the course of 30 nights. The first treatment was in mid-July and the last treatment took place in mid-September.

Backpack sprayers were utilized 72 times to apply permethrin in 2019, using approximately 50 gallons of chemical over the course of 12 days. The first treatment was in mid-September and the last treatment took place in late October.

Service Requests

Working with Residents

The District offers many services to residents, including but not limited to:

⇒ Collecting dead birds for disease testing
⇒ Trapping and identifying mosquitoes
⇒ Providing mosquitofish for water sources
⇒ Educating homeowners about vectors
⇒ Presenting to schools or groups about vectors
⇒ Investigating mosquito presence
⇒ Treating breeding sources
⇒ Inspecting yards for breeding
⇒ Treating backyard pools
⇒ Identifying other arthropods

Service Requests

Delta Vector Control District provides ongoing preventative control work and surveillance as well as a variety of services directly to residents upon request. Service requests may be anonymous if the resident desires. Service requests traditionally fall into five categories: requests for fish, requests for an inspection, reporting of mosquito presence, reporting a source, and other. The "other" category includes non-mosquito vector complaints, requests to identify arthropod specimens, and any other requests that don't fall into the previous categories.

In 2019, there were a total of 1,530 service requests with reports of mosquito presence being the highest reported category of all service requests (Table 10).

This is a record high for the District, with the average for the past five years being 340 service requests. This is a percent change of almost 350% from the five year average and is a percent change of over 175% from last year, which was already a sharp increase from previous years. This increase is likely due in large part to the *Aedes aegypti* mosquitoes which was initially rediscovered in the District in 2017 and has been increasing its presence since. This can be seen in the dramatic increase in reports of mosquito presence, breeding and sources in 2019 (Figure 27).

2019	Fish	Inspection	Mosquito	Source	Other	Total
January	0	4	1	1	1	**7**
February	0	9	0	0	0	**9**
March	2	14	0	4	1	**21**
April	8	36	14	34	0	**92**
May	5	31	15	24	1	**76**
June	8	36	102	62	0	**208**
July	6	58	221	111	18	**414**
August	10	81	176	91	14	**372**
September	8	69	110	67	9	**263**
October	0	12	26	12	1	**51**
November	0	7	5	4	0	**16**
December	0	1	0	0	0	**1**
Total	**47**	**358**	**670**	**410**	**45**	**1,530**

Table 10: Number of Service Requests for 2019 by month and category.

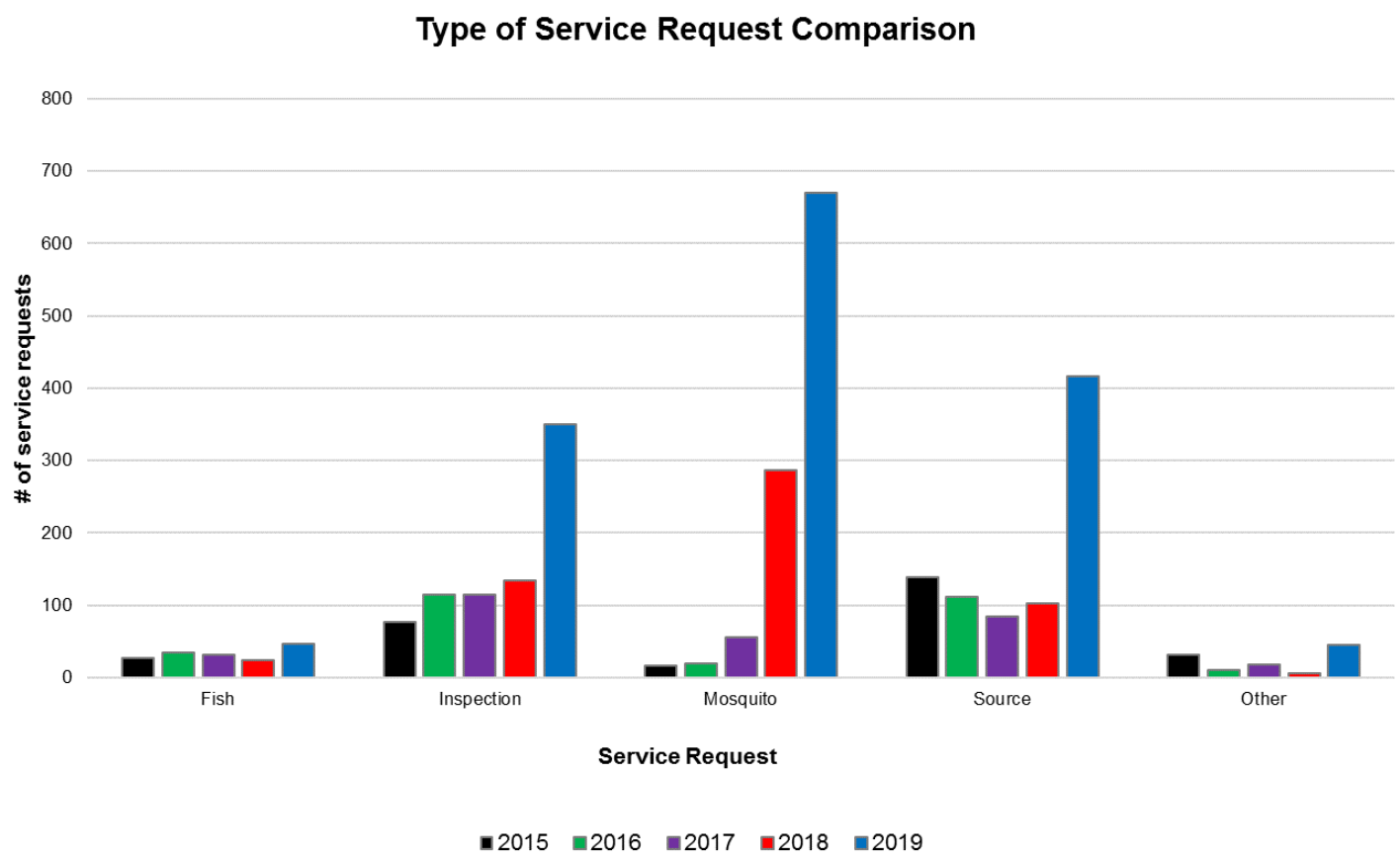


Figure 27: Comparison of the total number of different types of service requests for the past five years.

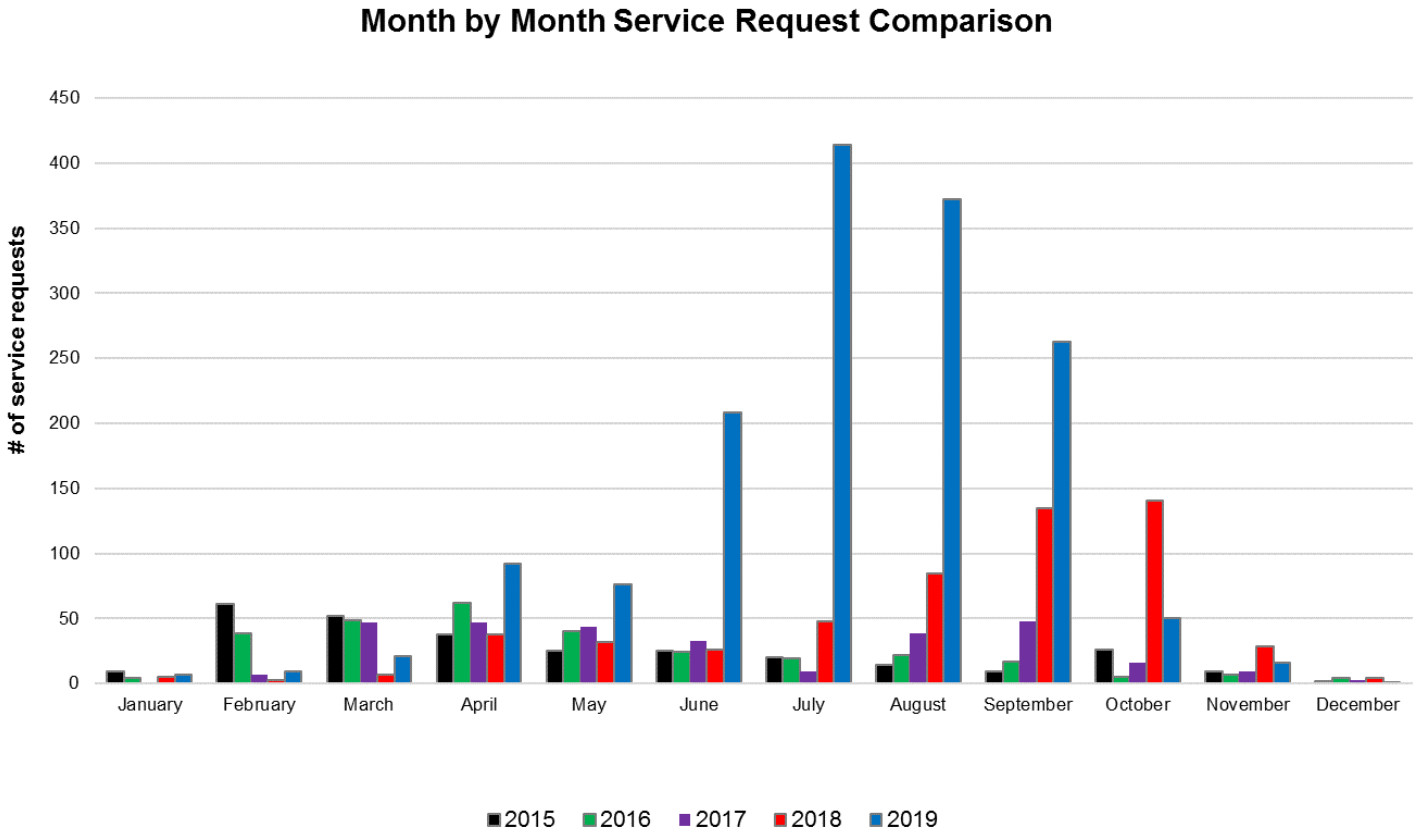


Figure 28: Comparison of the total number of service requests for the past five years by month

Community Outreach

The goal of public outreach is to increase resident participation in preventing nuisance biting and vector-borne disease by teaching residents how to reduce mosquito breeding sources and to use personal protection measures appropriately. Outreach is conducted through a variety of communication channels including newspaper, radio and DMV ads, social media, and in-person participation at community events.

For 2019, outreach messages focused largely on educating residents about potential mosquito breeding sources, reducing these sources, and bite prevention. Early messages focused on common native mosquito sources like neglected swimming pools and gradually shifted focus to invasive mosquito sources like plant trays later in the season.

The District started advertising at the Visalia Department of Motor Vehicle (DMV) office at the end of April. DMV advertising consisted of alternating 30 second English and Spanish ads that played every 15 minutes while the Visalia office was open. Additionally, radio advertisements began playing on May 10th across four English (KJUG, KIOO, KCRZ, KVMI) and two Spanish (La Preciosa, La Campesina) stations within the District. These 30 second radio ads ended on October 11th.

Print advertisements were placed in the Visalia Times-Delta, Exeter Sun-Gazette, Valley Voice, The Good Life, Live and Play Visalia, and Dinuba Sentinel (now Mid-Valley Times). Two of the print venues chosen, The Good Life and Live

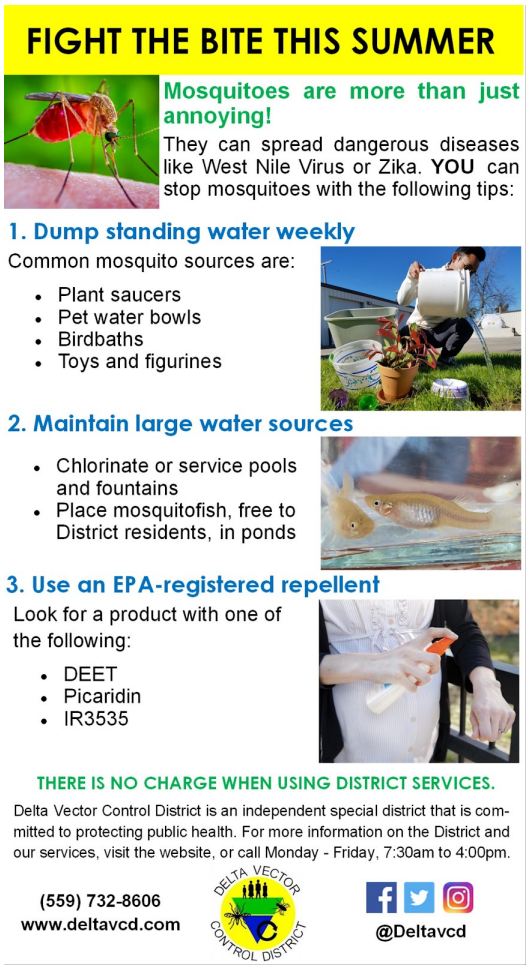
and Play Visalia, were aimed at audiences who were at high risk of developing neuroinvasive West Nile virus infections.

Social media has grown significantly over the 2019 mosquito season. As of December 17, followers have increased to 420 on Facebook, 427 on Twitter, and 183 on Instagram. This increase in followers has amplified the reach of our health messages across the District at no additional cost. During peak mosquito activity, July 15th to October 17th, Facebook posts reached 24,684 District residents who live in Visalia, 6,042 in Dinuba, 2,277 in Woodlake, 2,070 in Orosi, 1,594 in Farmersville, 1,441 in Exeter, 625 in Cutler, and 352 in Ivanhoe. The District also launched a LinkedIn account at the end of 2019 to increase our presence online, improve our professional associations, and better reach potential employees who are researching the District before applying.

The District also participated in a variety of outreach events in 2019, speaking to over 1,165 individuals across 17 outreach events. At least one event took place every month from April through October. Events took place in Dinuba, Exeter, Traver, Visalia, and Woodlake and included, but weren't limited to, a Senior Center open house, presentations at civic organizations, National Night Out, and health fairs.

If you have an event in your community or neighborhood that you would like a Delta Vector Control District representative to attend, please contact the District. The staff are always interested in increasing the District's involvement in local communities and we do not charge for outreach events or presentations.

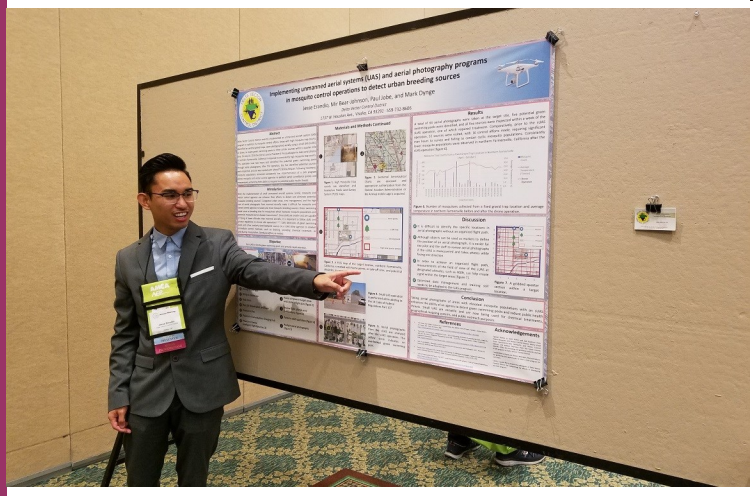
In 2020, the District plans to continue to focus messaging on how individual homeowners can prevent mosquito breeding on their property and bite prevention.



Research

In early 2019, the Scientific Program Manager presented at the Mosquito and Vector Control Association of California (MVCAC) Annual meeting. Her talk was titled “Triumphs and tribulations: year three of Delta Vector Control District’s expanded mosquito surveillance program” and discussed the changes that had to be made to the program with the *Aedes aegypti* mosquito being rediscovered in the district.

One of the Biologists, Jesse Erandio, presented a poster regarding the 2018 drone flight at the American Mosquito Control Association (AMCA) Annual meeting in Orlando, Florida. His poster outlined lessons learned and the advantages of using drones to identify sources.



During the 2019 season, data was gathered on a number of topics, all of which will be used to better enhance the District activities. Some of this information will be used in posters and presentations to share lessons learned with other mosquito and vector control associations across the U.S.

With the increase of *Aedes aegypti* in the District in 2019, novel control strategies had to be considered. In August the Scientific Program Manager visited Coachella Valley Mosquito and Vector Control District to observe their control methods and strategies as they have been dealing with these invasive Aedes mosquitoes for longer. As a result of that visit, an A-1 Super Duty wide area larviciding (WALs) sprayer was purchased as well as two backpack sprayers for the application of a BTI product.

After the A-1 Super Duty was calibrated to ensure appropriate application of BTI, a section of south eastern Visalia that was suffering from heavy *Aedes* infestation was chosen as a trial area. The WALs treatment took place in the early hours of the morning. Four homeowners were kind enough to allow early morning access to their backyards so that test cups could be placed. After the WALs application, the cups were collected and brought back to the lab for analysis. This experiment was conducted in quadruplicate with differing windspeeds and other environmental conditions.

Additionally, four houses were chosen across the District to serve as trials for the backpack sprayers. These locations were chosen in areas with *Aedes* problems on properties where weekly access to backyards was allowed for four weeks. Cups were placed in the backyards prior to the spray and picked up the following week.

Mortality in the larva exposed to the cups was seen, but full analysis has yet to be completed. The District intends to use both the A-1 Super Duty and back sprayer application of WALs in disease situations to help reduce numbers.

Laboratory staff partnered with Valent BioSciences to test a new larvicide treatment formulation for catch basins. Catch basins across the District are normally treated every thirty days with a methoprene-based product throughout the mosquito season. The new larvicide formulation would ideally remain active for three months, providing longer lasting mosquito control. Twenty catch basins in a single neighborhood within the District were chosen to participate in the trial for this chemical. These were checked weekly to ensure that the product continued to be effective. Unfortunately, due to the city cleaning out the catch basins and ergo removing the chemical, the trial lasted less than two months, although it did appear to be successful up to that point.

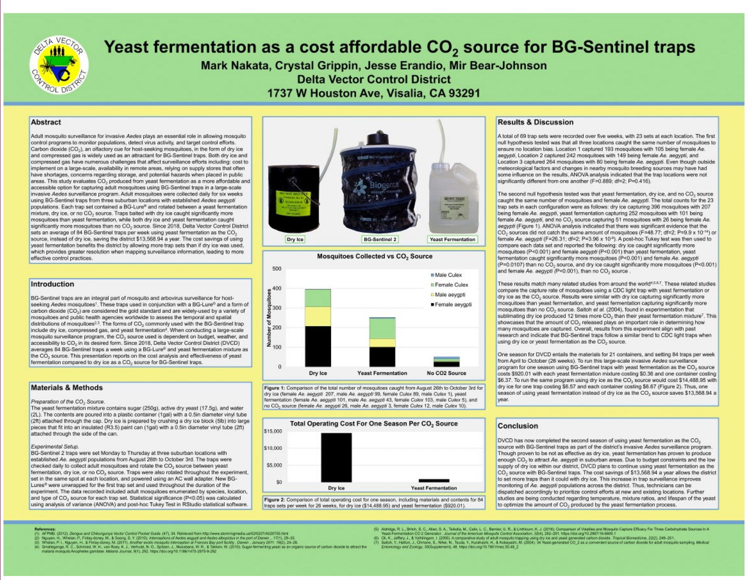
Gravid trap batteries were also tested for efficacy during the season. Normally, the same battery is used in each trap for an entire week of trapping. Mark Nakata, a District Biologist, wanted to determine if the traps were equally effective catching mosquitoes at the end of the week as they were at the beginning of the week. His tests revealed that there is a noticeable reduction in battery power by the end of the week that results a reduced fan speed and trap effectiveness. To account for this difference, the program for next year will need to include bi-weekly charging of the batteries. Additional batteries will also need to be purchased to allow the surveillance program to continue at full capacity.

As the third year of the *Aedes* infestation within the District, 2019 was also the first year that enough data has been available for any sort of analysis. One of the Biologists, Crystal Grippin, has spent considerable time analyzing the existing data to better serve the District. Answers she has found include the most common breeding sources, which can be used to better direct and focus control efforts, and the effectiveness of yard inspections. Her work on the effectiveness of yard inspections has given the District information on how best to prioritize inspections according to which properties are most likely to be breeding and potential ways to improve homeowner education to reduce future breeding. This work will be presented as a poster in 2020 at both the MVCAC and AMCA annual meetings.

Back in 2017 one of the -80°C freezers in the laboratory broke down after a power outage. This freezer had to then be used for the remainder of the season before it could be replaced. Concern over the state of the samples stored in the freezer, led Biologist Jesse Erandio to research the potential implications of temperature and storage conditions on virus detection in mosquito samples.

Throughout both the 2018 and 2019 mosquito season, he evaluated samples stored in the -80°C, -20°C, 4°C (fridge), room temperature, and those undergoing repeated freeze-thaw cycles. His results showed that virus was still detectable under all conditions, but was best detected in the fridge compared to the -80°C standard. This will help the District going forward if another issue with storage arises and brings peace of mind that the 2017 samples were not ruined from their experience. He will present his findings at both the MVCAC and AMCA annual meetings in 2020.

Another research project was undertake to analyze the use of sugar-yeast in water to produce carbon dioxide instead of dry ice or pressurized gas as a more cost-effective trap lure. Since 2017, the District has been using sugar-yeast in water to produce this bait, specifically for the BGs traps. Dry ice and pressurized gas are both expensive and potentially dangerous whereas sugar-yeast in water is inexpensive and safe. The experiment and analysis done by Biologist Mark Nakata has proven that, while sugar-yeast in water isn't quite as attractive as dry ice, it is still catches enough mosquitoes to be an effective attractant for vector surveillance programs and saves the district almost $14,000 a year. His work will be presented as a poster at both the MVCAC and AMCA annual meetings in 2020.



There will be more opportunities for research in 2020 as the District continues to serve residents. Studies are planned for insecticide resistance, to help guide control efforts, as well as further analysis of invasive *Aedes* responses.

Financial Statements

For the fiscal year ending June 30th, 2019

	Budgeted Amounts			Variance with
	Original	Final	Actual	Final Budget
REVENUES				
Property Taxes:				
Current secured	2,187,920	2,187,920	2,214,766	26,846
Current unsecured	128,239	128,239	130,159	1,920
Prior secured	46,828	46,828	41,151	(5,677)
Prior unsecured	2,036	2,036	7,977	5,941
State homeowner's property tax relief	20,197	20,197	19,407	(790)
Pass through income	295,468	295,468	340,442	44,974
Interest income	53,963	53,963	71,856	17,893
Charges for current service	-	-	5,102	5,102
Other governmental income	-	-	1,133	1,133
Assessments	120,771	120,771	135,442	14,671
Other income	47,372	47,372	35,074	(12,298)
Total revenues	2,902,794	2,902,794	3,002,509	99,715
EXPENDITURES				
Current				
Salaries & employee benefits	2,252,837	2,252,837	2,146,228	106,609
Services and supplies	669,095	669,095	659,753	9,342
Capital Outlay	170,266	170,266	132,714	37,552
Total expenditures	3,092,198	3,092,198	2,938,695	153,503
Excess (deficiency) of revenues over (under) expenditures	(189,404)	(189,404)	63,814	253,218
Net change in fund balance	(189,404)	(189,404)	63,814	253,218
Fund balance, July 1, 2018			3,683,926	
Fund balance, June 30, 2019			3,747,740	

	General Fund	Adjustments	Statement of Net Position
ASSETS			
Cash and cash equivalents	3,857,465	-	3,857,465
Accounts receivable	1,110	-	1,110
Capital assets, net of accumulated depreciation	-	2,820,471	2,820,471
Total assets	3,858,575	2,820,471	6,679,046
DEFERRED OUTFLOWS OF RESOURCES			
Pension deferrals	-	609,827	609,827
Other post emploment benefit deferals	-	50,567	50,567
Total deferred outflows of resources	-	660,394	660,394
LIABILITIES			
Accounts payable	86,374	-	86,374
Accrued expenses	9,884	-	9,884
Payroll liabilities	14,577	-	14,577
Other post employment benefit liability	-	64,104	64,104
Due in one year:			
Compensated absences	-	83,012	83,012
Due in more than one year:			
Compensated absences	-	55,343	55,343
Net pension liability	-	1,763,171	1,763,171
Total liabilities	110,835	1,965,630	2,076,465
DEFERRED INFLOWS OF RESOURCES			
Pension deferrals	-	196,096	196,096
Other post employment benefit deferrals	-	155,071	155,071
Total deferred inflows of resources	-	351,167	351,167
FUND BALANCE/NET POSITION			
Fund balance:			
Unassigned	3,747,740	(3,747,740)	-
Total fund balance	3,747,740	(3,747,740)	-
Net position			
Net investment in capital assets	-	2,820,471	2,820,471
Unrestricted	-	2,091,337	2,091,337
Total net position	-	4,911,808	4,911,808
Total fund balance/net position	3,747,740	1,164,068	4,911,808

For information about Delta Vector Control District, please contact us:

Physical
1737 W. Houston Ave.
Visalia CA, 93291

Mail
Delta VCD
P.O. Box 310
Visalia, CA. 93279-0310

Contact
Phone: 559-732-8606
Toll Free: 877-732-8606
Fax: 559-732-7441

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