

ANNUAL REPORT 2022



FOREWORD



Our Mission:
“To protect the public’s health from vector-borne disease and nuisance, through a comprehensive mosquito and vector control program focused on innovation, experience and efficiency.”

On behalf of the Shasta Mosquito and Vector Control District (SMVCD) Board of Trustees and staff, I am pleased to present the 2022 Annual Report. The SMVCD annual report is a testament to our organization’s unyielding dedication to public health and our commitment to excellence. It highlights the progress made in expanding our knowledge base through research and innovation, adopting advanced technologies, and embracing sustainable practices that ensure the preservation of our environment.

This year we experienced an unprecedented drought resulting in something we’ve never witnessed in our 103 years as an agency, the Anderson Cottonwood Irrigation District canal remained dry throughout the entire season and had no irrigation allocations throughout the District area. This development provided the District with a strange season with minimal activity in areas where agricultural operations often keep our staff busy throughout the mosquito months.

In addition to the unusual year, we continued to see increases in both abundance and distribution of our invasive species, *Aedes aegypti*, and to a lesser degree, *Aedes albopictus*. The District continues to be challenged, redirecting resources to the invasive species prevention program in an effort to eliminate these non-native populations. In 2023 we will reassess the invasive species program providing new direction to better manage potential risks associated with this increase in abundance.

In the pages that follow, you will find a detailed account of the initiatives, strategies, and outcomes that have defined our endeavors over the past year. Our dedicated staff, equipped with their expertise and relentless commitment, have implemented robust surveillance programs to monitor vector populations, identify potential breeding sites, and implement targeted control measures. I extend my deepest appreciation to the staff of the Shasta Mosquito and Vector Control District for their tireless dedication, as well as to our partners and the residents of Shasta County for their ongoing cooperation. Together, we will continue to safeguard the health and well-being of our community.

Finally, we must highlight the career and contributions of John Albright, our retiring Scientific Operations Manager. John started with the District in 1997, taking on the role of Biologist and Public Information Specialist. Over time his role and responsibilities evolved to his final title of Scientific Operations Manager. John brought a philosophy of innovation, dedication and consistency that moved our surveillance and research department to new heights. Thanks to his efforts, SMVCD is well known throughout California as a top-rated mosquito district. Thank you, John, for over 25 years of service. Enjoy your next adventure!

Sincerely,

Peter Bonkrude
District Manager

Philip Cramer
President

TABLE OF CONTENTS

FOREWORD	
Message from the District Manager	2
DISTRICT OVERVIEW	
Board & Staff	4
District History	6
Integrated Vector Management	6
COMMUNITY PARTICIPATION	
Service Requests	7
IMMATURE MOSQUITO CONTROL	
Physical Control	8
Biological Control	9
Chemical Control	10
Catch Basin Program	11
Swimming Pool Program	12
ADULT MOSQUITO CONTROL	
Chemical Control	13
RESEARCH & DEVELOPMENT	
New Information & Development	14
VECTOR SURVEILLANCE	
Tick Surveillance	16
Mosquito Surveillance	17
DISEASE SURVEILLANCE	
Local Disease Surveillance	18
Invasive Aedes	20
State Disease Surveillance	21
OUTREACH	
Public Education	22
FINANCIALS	
Finance Report Breakdown	23
John's Retirement	24

This Annual Report was made as an interdepartmental collaboration. Special thanks to Jenna Ingebretsen, Peter Bonkrude, Darcy Buckalew, Kendra Angel-Adkinson, Garrett Hawkinson, and Mike Alexander for their many contributions.

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DISTRICT HEADQUARTERS



DISTRICT STAFF

OPERATIONS STAFF

Monty Currier
Operations Manager

Kelly Cleland
Mike Alexander
Field Supervisors

Al Shabazian
Brady Benton
Corey Boyer
Darrell Bible
Haley Bastien
Reid Sheeks
Robert Ault
Vector Technicians



STAFF HIGHLIGHTS

191

TOTAL YEARS
OF SERVICE

16

FULL-TIME
STAFF

3

EMPLOYEES WITH
20+ YEARS OF SERVICE

8

EMPLOYEES WITH
10-19 YEARS OF SERVICE

12

AVERAGE
YEARS OF SERVICE

ADMINISTRATIVE STAFF

Peter Bonkrude, MS
District Manager

Darcy Buckalew
Administrative Manager

Jenna Ingebretsen
Administrative Analyst II

LABORATORY STAFF

John Albright
Scientific Operations Manager

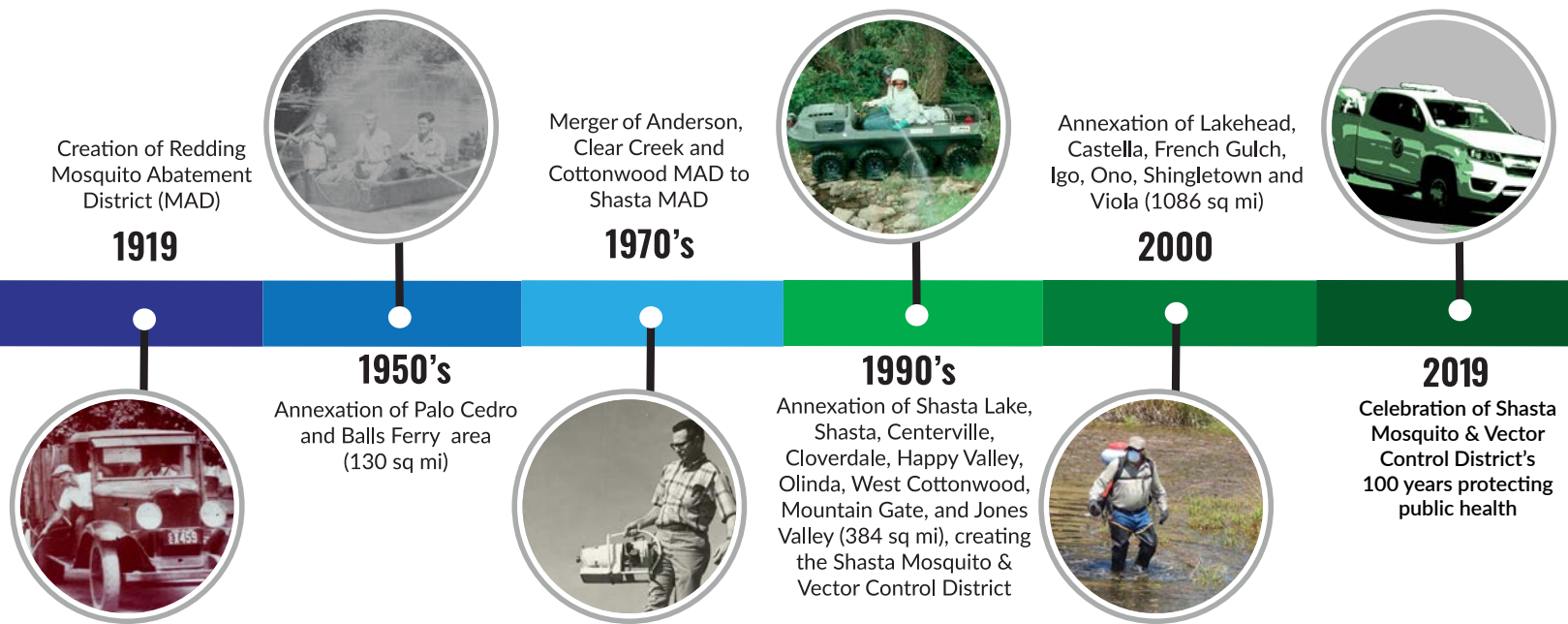
Kendra Angel-Adkinson
Vector Biologist

Garrett Hawkinson
Vector Biologist



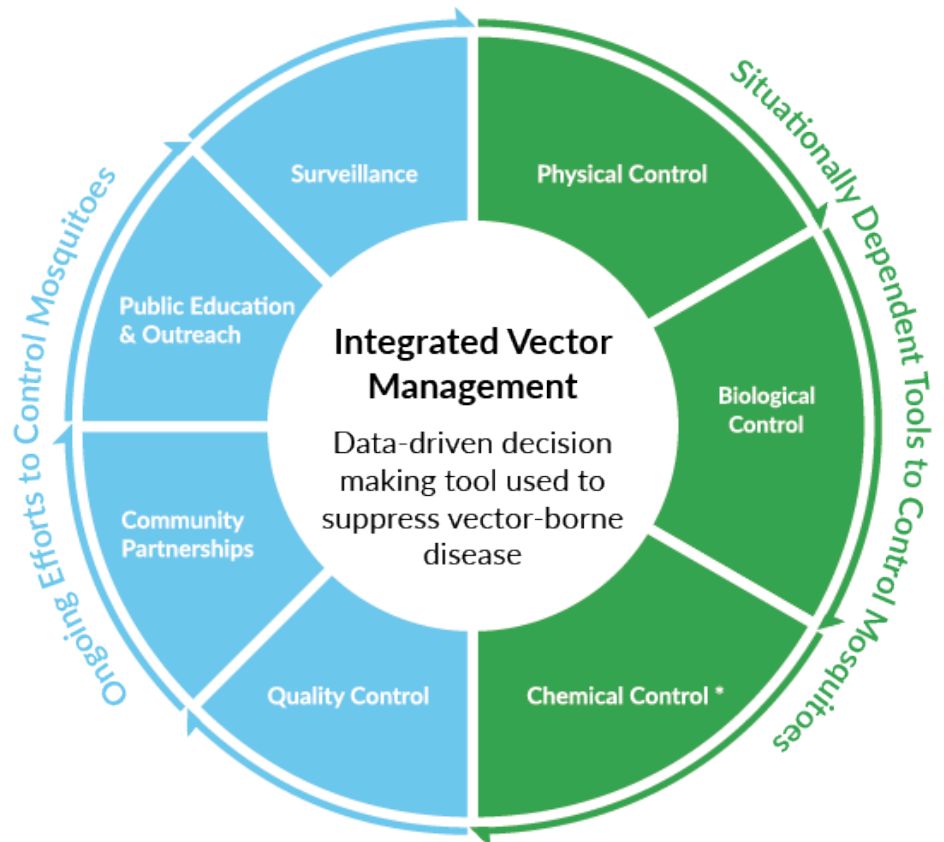
DISTRICT HISTORY

Protecting public health since 1919



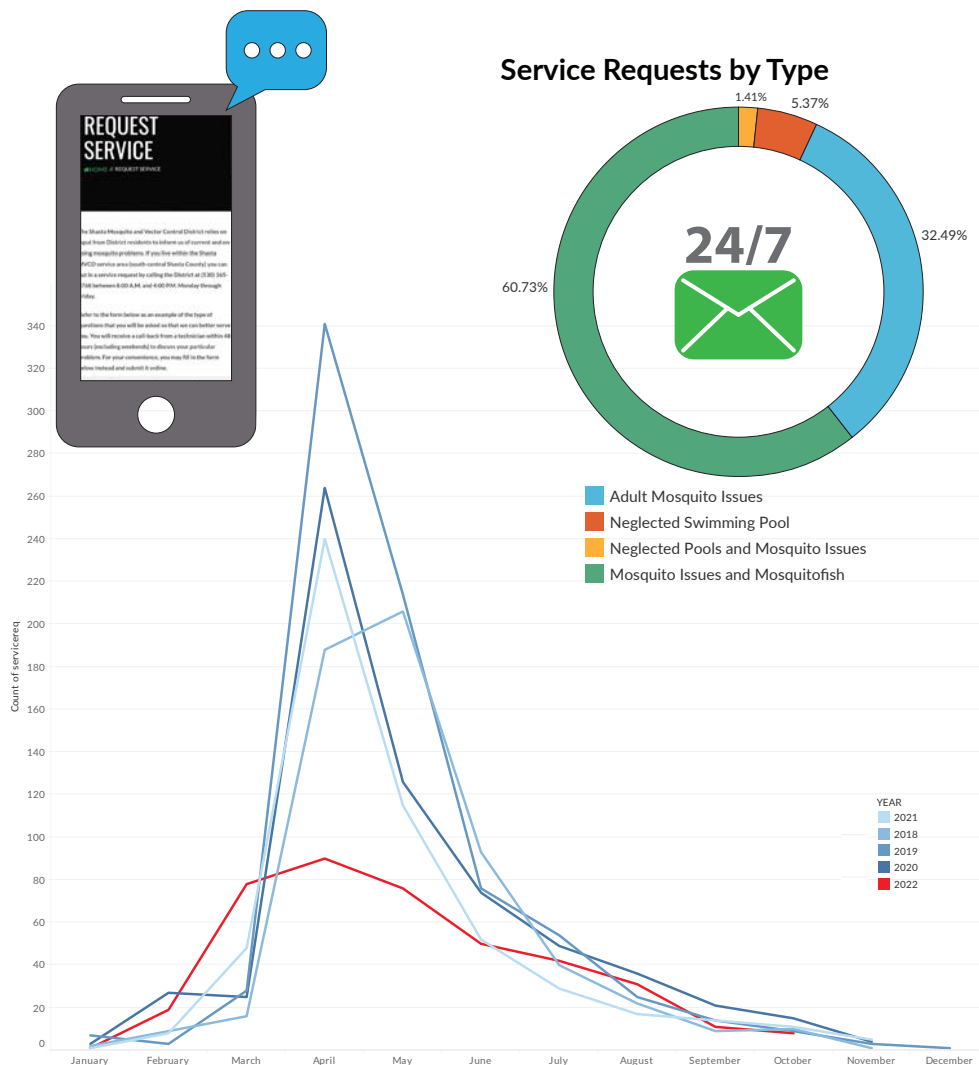
INTEGRATED VECTOR MANAGEMENT

Integrated Vector Management (IVM) is an evidence-based, data-driven decision-making process used to help protect the citizens of Shasta County. This strategy attempts to suppress vector-borne diseases. This approach prioritizes surveillance of mosquito populations, mosquito-borne disease testing, removal of breeding sites, public outreach and education, and research and quality control. IVM incorporates various tools to target mosquitoes at different life stages which can include physical control, biological control, and chemical control. These applications rely on a range of control interventions, separately or in combinations, with the goal of balancing cost and effectiveness.

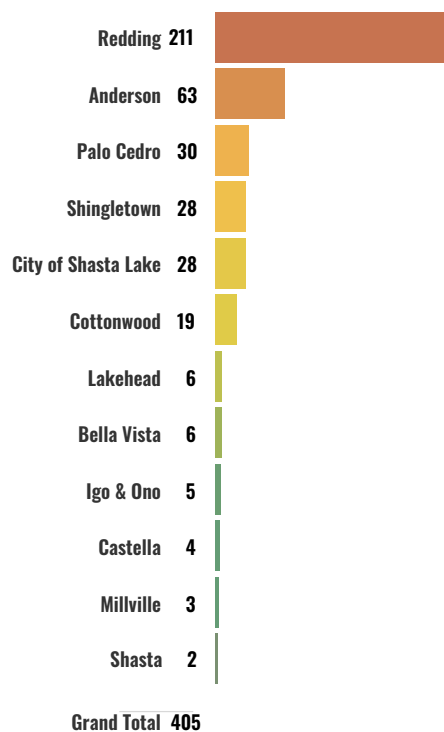


SERVICE REQUESTS

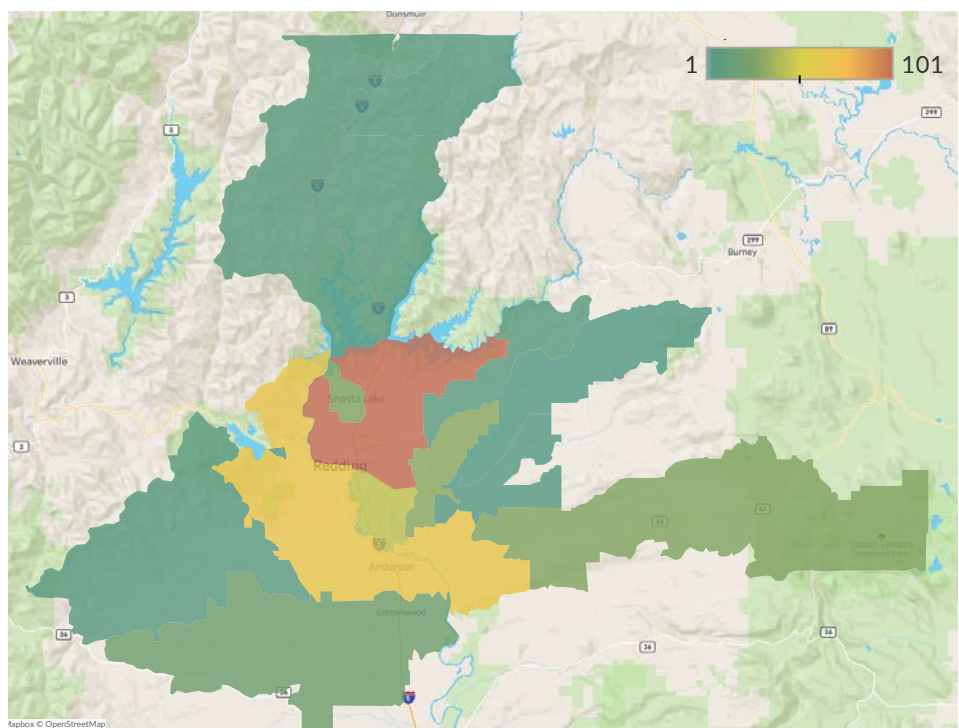
As part of our public health mission, District staff value and prioritize providing responsive and professional service to our District residents. Service requests serve as the first step for some of our surveillance efforts. During these service requests, we can learn from the public and hear their issues, while sharing our knowledge and expertise. We respond to a variety of requests for service including biting mosquitoes, mosquitofish requests, neglected swimming pool reports and insect identification inquiries. These requests help focus our efforts and provide information that is essential to our IVM response. This year we received 405 requests for service. On our website, the public can issue a service request 24/7, find information about our current mosquito conditions and response, and even find out where we are performing our adult mosquito control activities.



Service Requests by Community



Service Requests by Zipcode



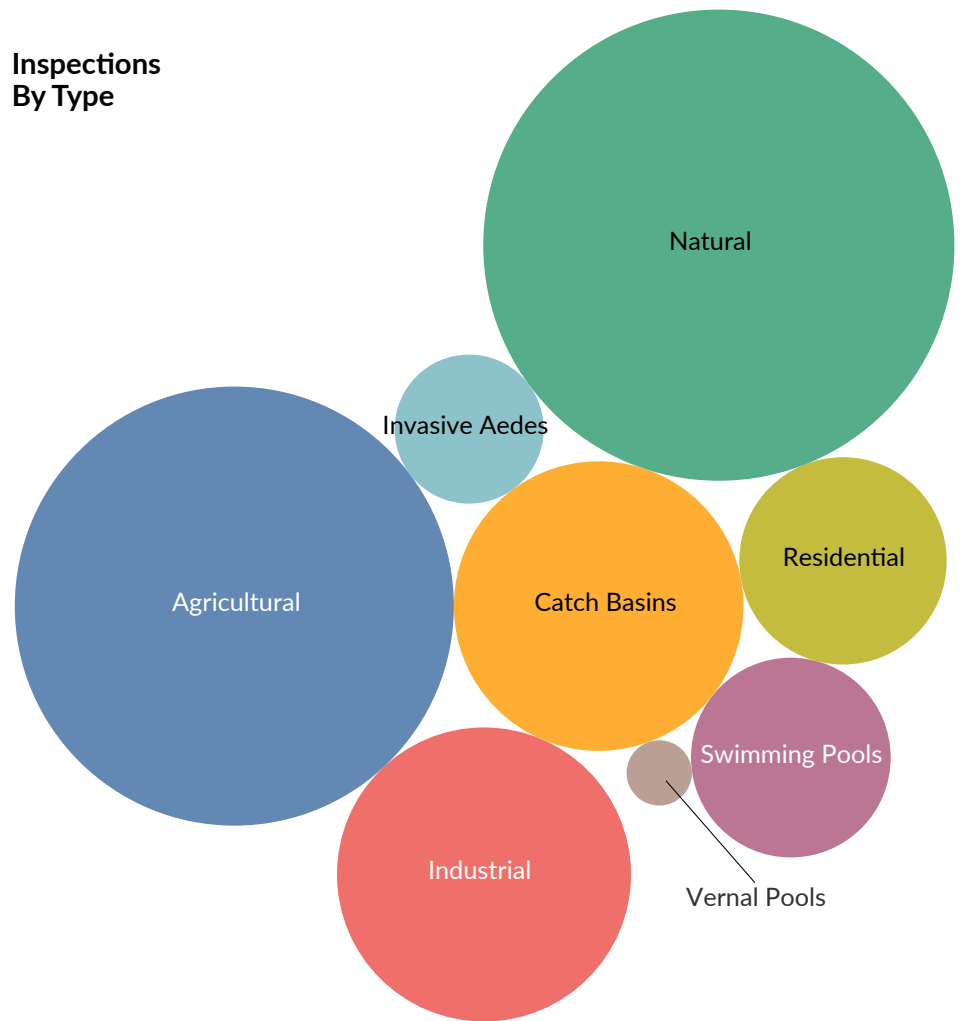
IMMATURE MOSQUITO CONTROL

Immature mosquito control begins with the elimination of mosquito larvae and pupae before development progresses and the mosquitoes emerge as breeding adults. This involves physical, biological, and chemical controls. Sources for these efforts typically include neglected swimming pools, untreated water catch basins, tree holes, seasonal creeks, residential, agriculture, and industrial areas.



Mosquito larvae, pupae, and adults in a hatching container.

Inspections By Type



PHYSICAL CONTROL

The most effective and long-lasting approach to control mosquitoes is the reduction of mosquito habitat. Modification or elimination of these habitats reduces sources that can

be exploited by mosquitoes for production. These techniques vary from clearing dense vegetation, to burning cleared debris piles, and modifying landscapes with heavy equipment. A big part of mosquito reduction involves the

use of heavy equipment as well as hand dug trenches. These physical control projects re-direct standing water, leading to easier biological and chemical controls by District technicians.

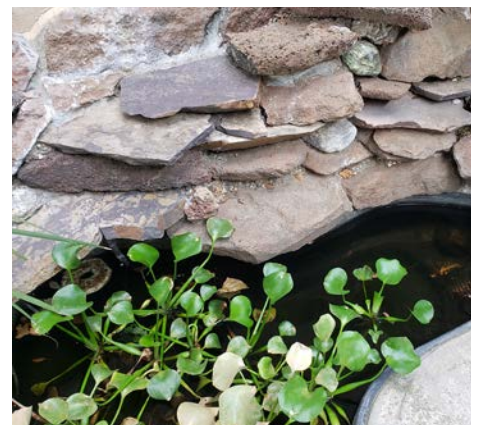
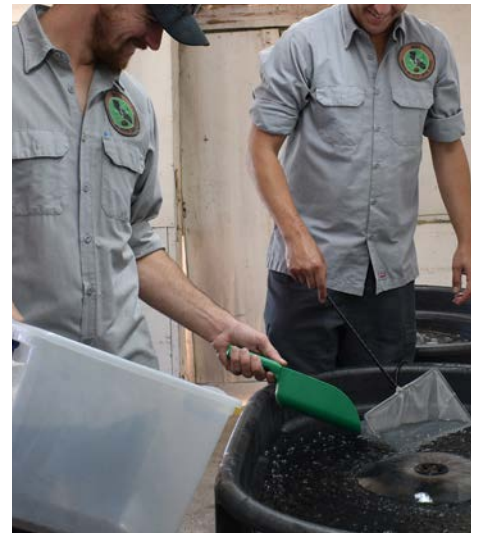
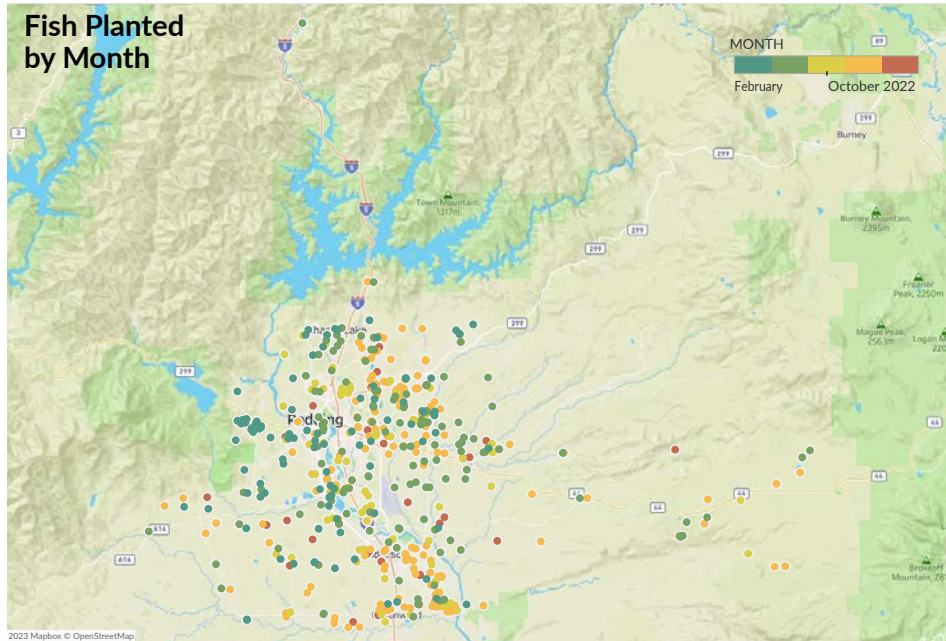


BIOLOGICAL CONTROL

Biological control at the District consists of the release of mosquitofish (*Gambusia affinis*). These fish are introduced into waters pre or post discovery of mosquito larvae living in a body of water. Mosquitofish are

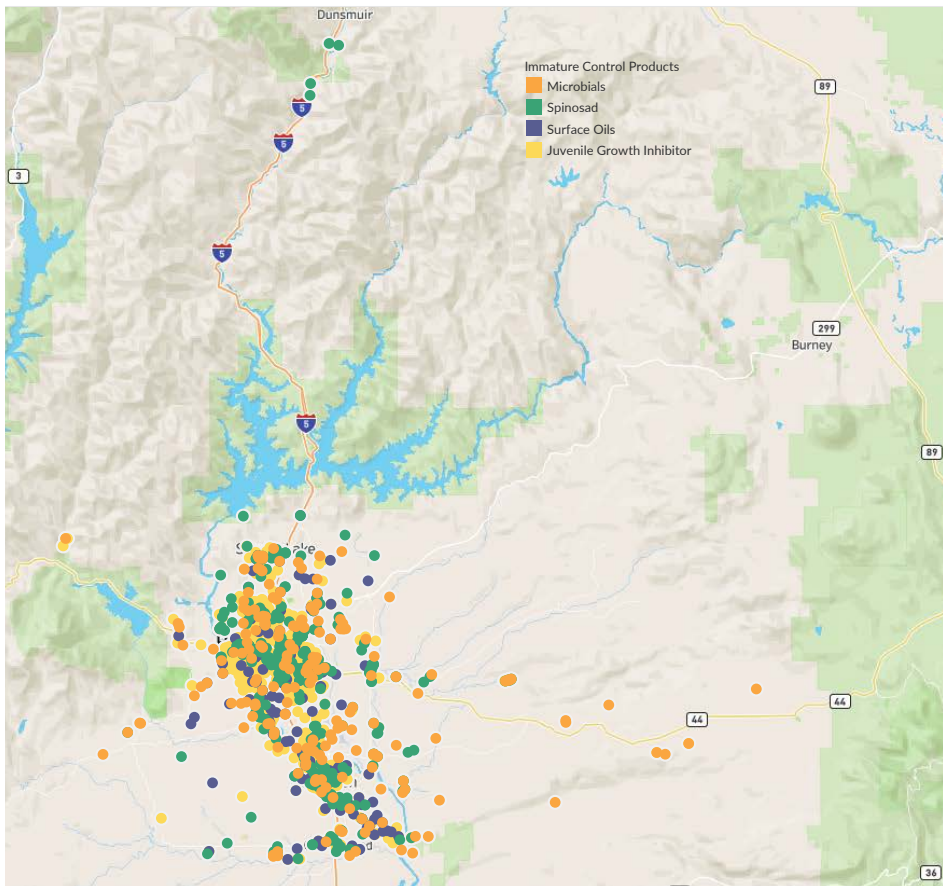
a useful tool that is proven to reduce or eliminate mosquitoes from aquatic spaces. These small-bodied, live-bearing fish have the strong ability to live in confined small spaces such as animal watering troughs. These adaptive fish benefit the District since they can live in various water conditions, reproduce frequently, and produce many young. The

usual life span for mosquitofish is relatively short and does not cause substantial competition for native fishes or aquatic life when planted in appropriate habitats. The District made 586 mosquito fish applications in 2022.



CHEMICAL CONTROL

The District uses a variety of target-specific chemical products to reduce the number of adult mosquitoes. The term larvicide



refers to any product that specifically targets mosquitoes in their larval stage. This is the most common control used by District staff. These larval chemicals target young mosquitoes before emerging into adulthood. Control products include microbial products, natural toxins, growth inhibitors and surface oils. Having a variety of chemical products to choose allows technicians to treat any habitat from large areas to small containers. In addition, the rotation of different chemical classes makes larval control more efficacious. Before treatment, staff calculate surface area/ volume with precisely the right type and prescribed amounts of material needed to eliminate vector promoting insects. In 2022, District staff made 2,775 applications to immature mosquitoes. Sources treated with chemical control products often need to be re-inspected regularly to ensure the product is still producing the level of control sufficient to prevent emerging adults.

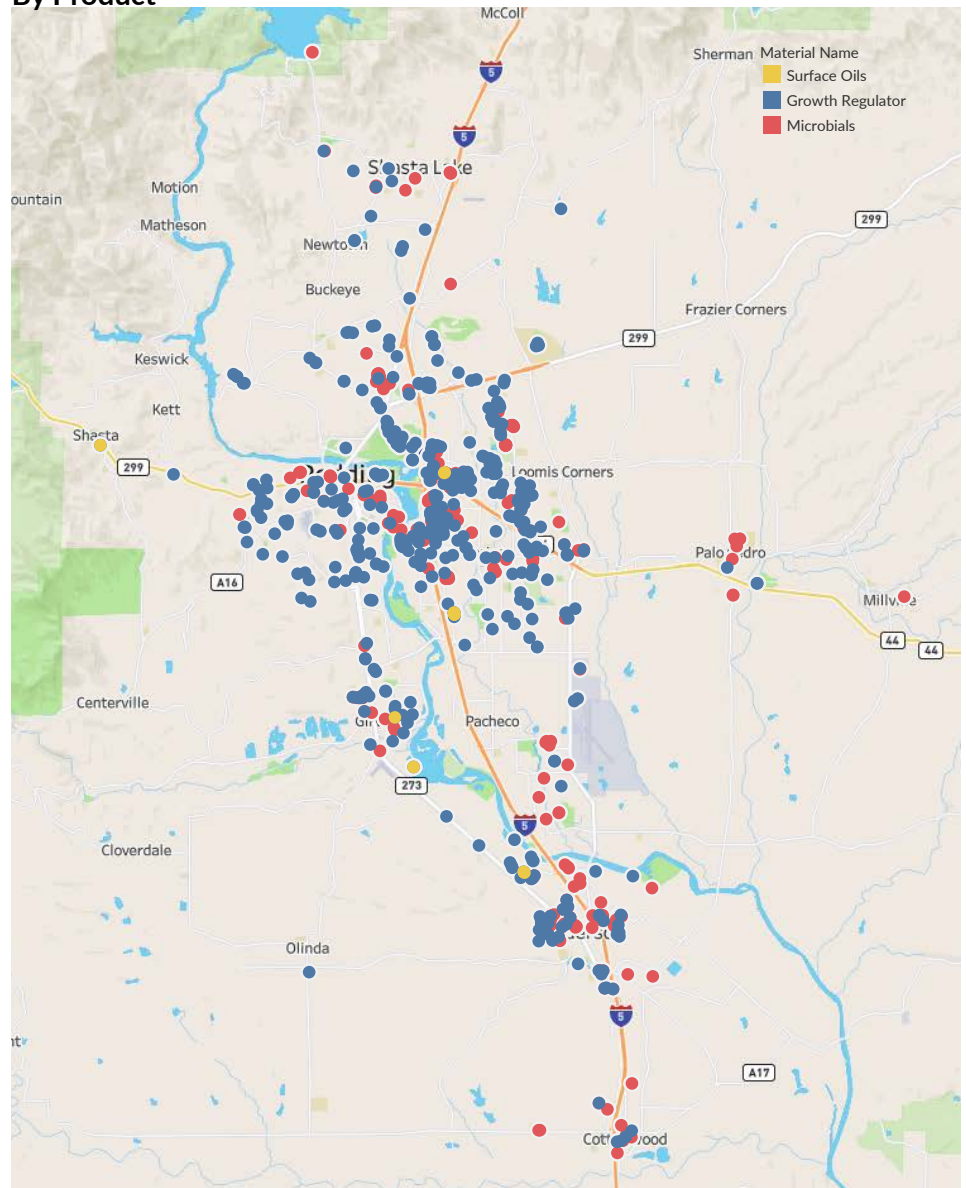


CATCH BASIN PROGRAM

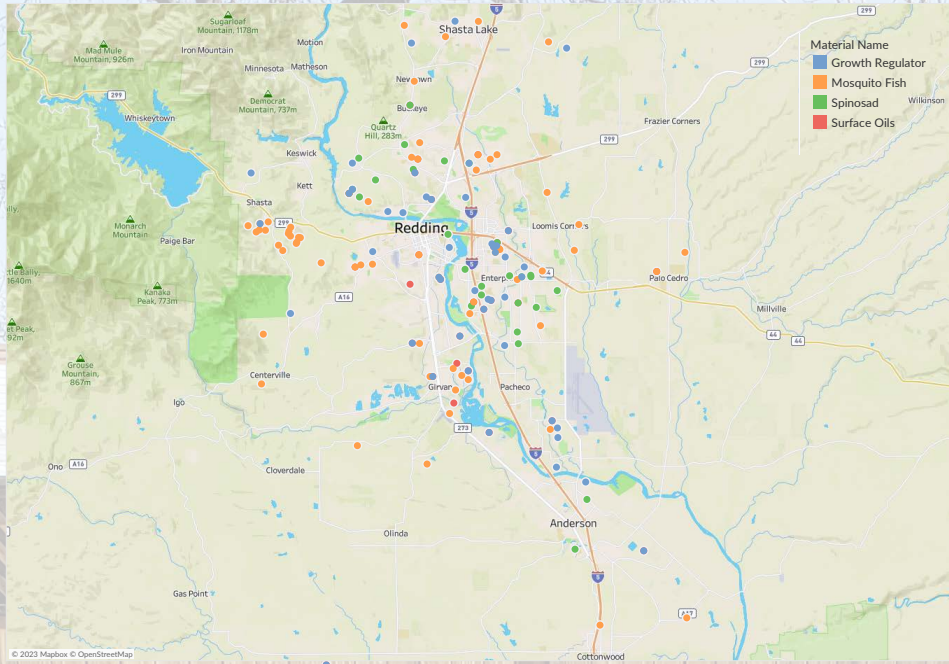
Catch basins, the underground section of storm drain systems in neighborhoods, streets, and parking lots, are an important habitat for the immature stages of disease mosquitoes, *Culex tarsalis* and *Culex pipiens*. The District has added about 10,000 catch basins to its records, and spends time each season inspecting and treating these areas. In May, our focus was specific to catch basins that have only been treated once in the previous 5 years, with the more problematic basins being treated in August and September. A total of nearly 1,500 basins were inspected; of those inspected, 1,027 needed treatments. Most of the treatments this year were with a mosquito growth regulator. Some catch basins were treated with a new product containing an extended release pouch with the same active ingredient which showed very promising results, lasting from three to five months, even in basins where other larvicides typically work for only 4-8 weeks.



Catch Basins Treated By Product



Pools Treated By Product



SWIMMING POOL PROGRAM

When a swimming pool is unmaintained it becomes a perfect place for mosquitoes to breed. One pool can breed millions of mosquitoes over the course of a summer, if left untreated. Our District identifies neglected swimming pools by using public reports, aerial imaging, and technician inspections.

Each year, the staff inspects 100's of pools and treats those that have mosquito breeding potential.

During the winter and early spring of 2022, staff treated 79 pools.

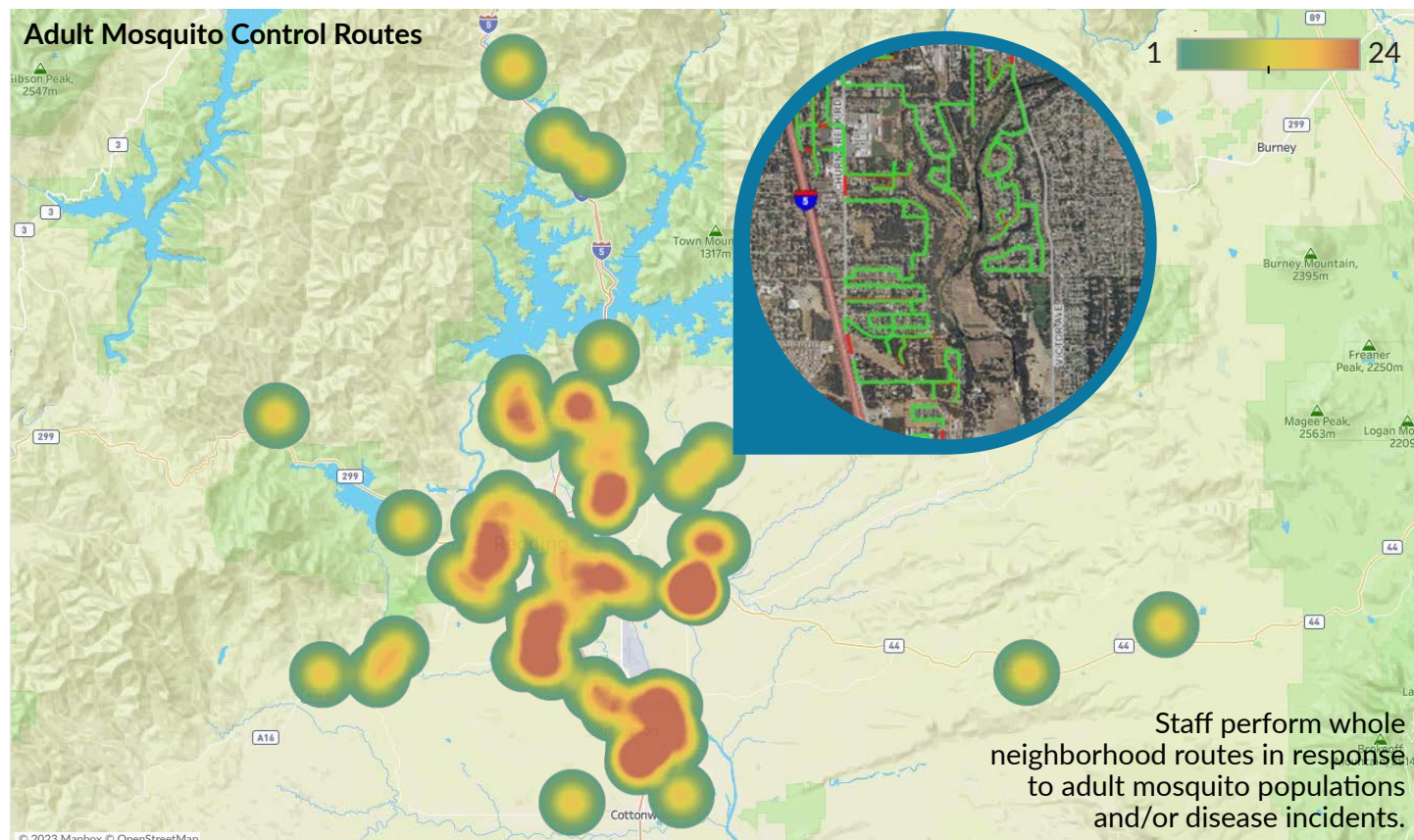
During the summer, our District contracted an aerial service provider to detect neglected swimming pools. A total of 91 pools were treated by staff with chemical control products and mosquito fish.

ADULT MOSQUITO CONTROL

Controlling adult mosquitoes is one of the most important tools to reduce disease transmission when active outbreaks are occurring. These applications can immediately reduce the number of biting mosquitoes in an area thereby lowering the risk of mosquito-borne disease transmission. This becomes essential when adult mosquito numbers reach high enough levels to jeopardize residents' health and quality of life. Although adult mosquito control has its limitations, it is still an important tool in disease prevention. These limitations mean the District must apply the adult mosquito control operations with several other IVM tools including an aggressive immature control program, increased community outreach for bite prevention, and as much mosquito source reduction as is feasible. No additional precautions are required for our residents during these control operations because of the low application rates,

typically less than 3 ounces per acre. Additionally, the size of the droplet, the time of application (dusk/dawn), and the knowledge of critical habitats mitigate non-target impacts. Our applications are made dynamically, in response to our adult surveillance. This could mean applications are made the same night or next day, as the trap data is processed. This level of responsiveness ensures

we can move fast enough to prevent human disease. This year due to the drought we only made 262 adult control routes covering over 49,000 acres, a 33% reduction. Residents can visit our website: www.shastamosquito.org to review where and when our adult mosquito control will be conducted, or to subscribe to our spray notifications via email or text message.



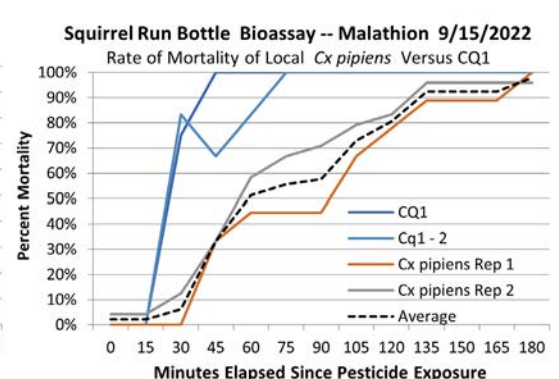
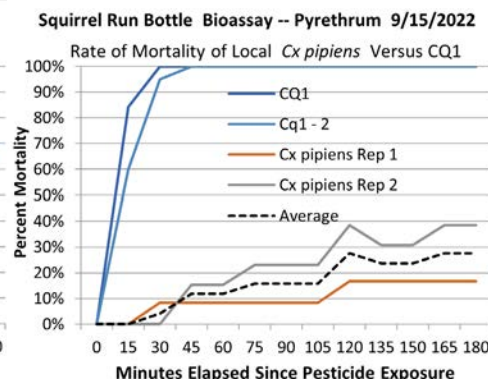
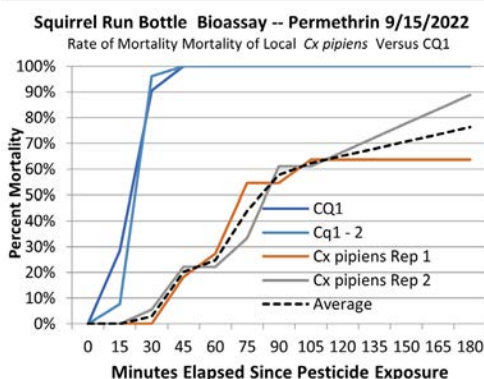
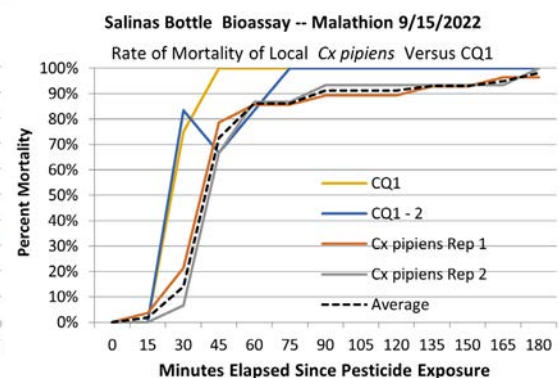
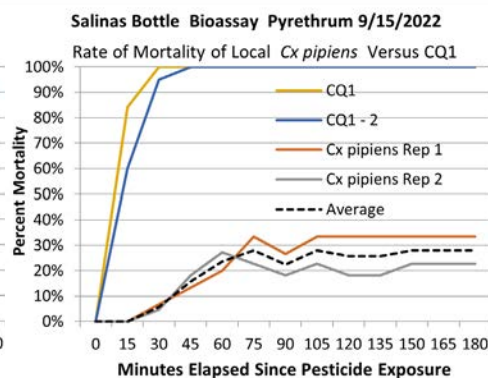
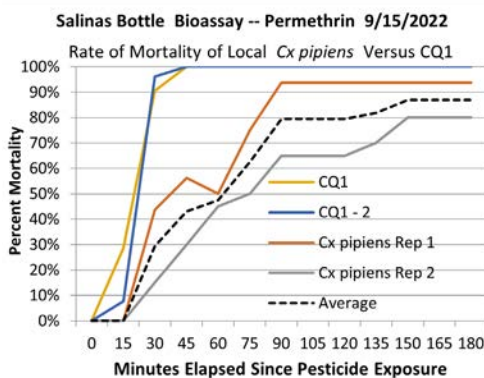
RESEARCH & DEVELOPMENT

BOTTLE BIOASSAYS

The CDC bottle bioassay allows the District to determine if resistance is present in a population before the efficacy of field applications are affected, allowing management decisions to be made in a timely enough manner to preserve susceptibility to that chemical. Bottle bioassays were developed as a rapid, simple, and economical way to determine if a particular adult control active ingredient is effective on local field collected mosquitoes. During the bioassay, a bottle is coated with a known amount of insecticide called the diagnostic dose. Mosquitoes are then placed into the bottle and observed for a period of time. The potential for resistance is determined by the percentage of mosquitoes that die. The time that it takes for the wild mosquitoes to die is compared to the susceptible mosquitoes.

In 2022, the District ran mosquitoes from two separate locations, analyzing three different adult control products, pyrethrum,

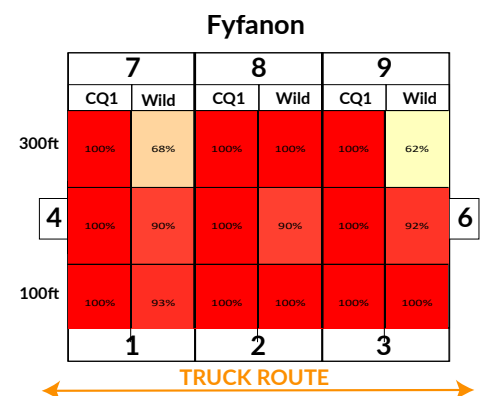
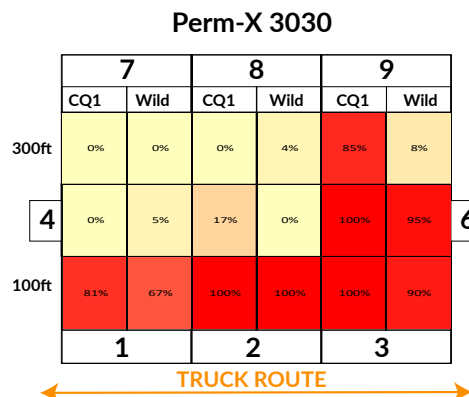
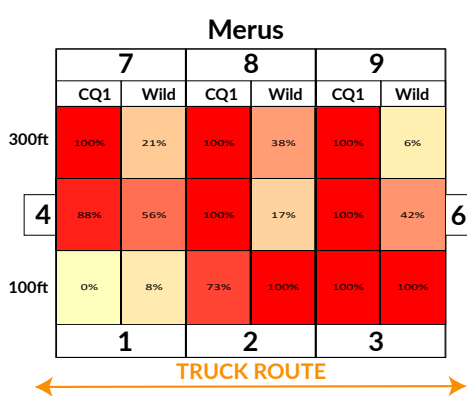
permethrin and malathion. Samples of *Culex pipiens* mosquitoes were tested. The largest level of potential tolerance occurred in the pyrethrum product. However, when cage trials are implemented with the synergized product, we still see adequate performance. To effectively assess whether resistance is impacting efficacy of adult mosquito control, actual formulated mosquito control products must be also tested under field conditions.



CAGE TRIALS

Cage trials are used to evaluate not only susceptibility in a wild mosquito population but also product efficacy under field conditions. Wild type mosquitoes and lab reared mosquitoes are each placed in separate mesh cages which are suspended on tripod stands. These tripods are placed on a predetermined grid, so each is a precise distance from the truck and each other. After evaluating

the weather conditions, the truck mounted ultra-low volume fogger applies an adulticide just as it does during control operations. The caged mosquitoes are exposed to the application, and then returned to the district grounds for staff to monitor and assess mortality. These trials take place over one to several evenings every year for comparison over time. In conjunction with bottle bioassays, the results provide insight into potential resistance in local mosquito populations.



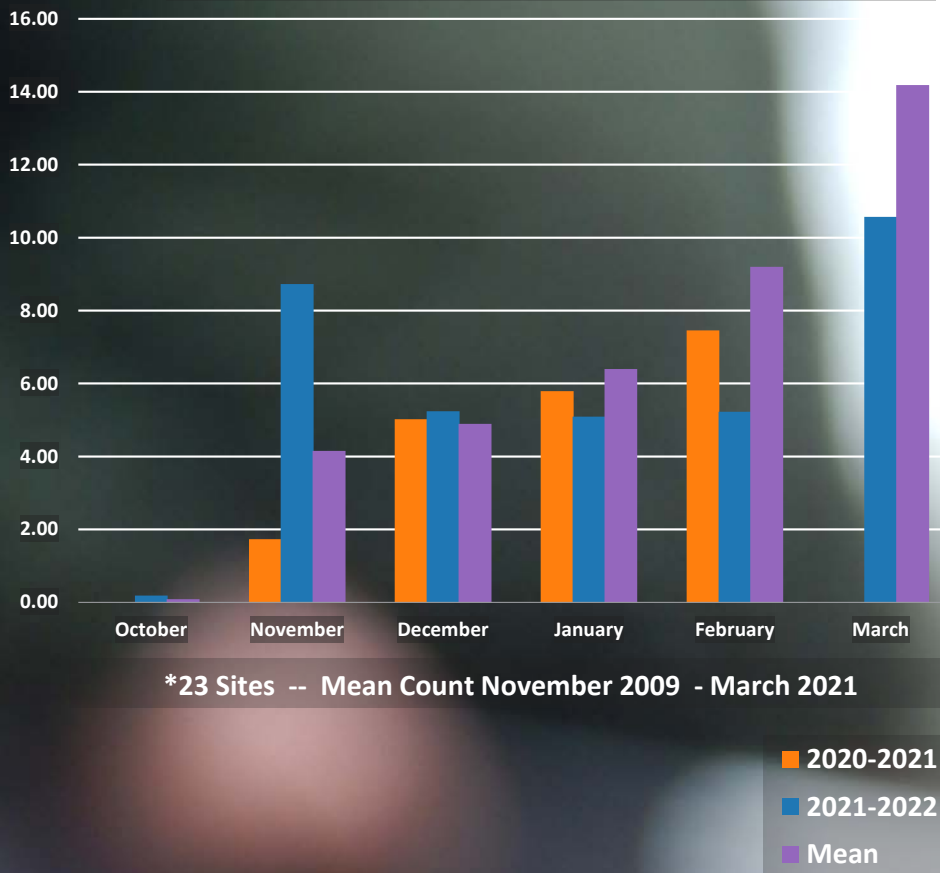
BIOGENTS COUNTER

The Biogents Counter (BGC) is an accessory device compatible with several Biogents (BG) traps commonly used by District staff. The advantage of the BGC is that it counts the number of mosquitoes entering the trap and reports the sum in 15-minute intervals. This provides an incredibly precise record of mosquito abundance at a fine temporal scale. The common

refrain of mosquito activity is that they are most active 'at dusk and dawn'. The BGC shows activity peaks whenever they occur- with occasionally surprising results. From March through October 2022, the BGC was affixed atop a BG trap where it monitored and reported the trap counts to a website.



2020-2022 Ticks per Hour vs Seasonal Average*



TICK SURVEILLANCE

The District monitors tick abundance and tick-borne pathogens within their populations. The western black legged tick (*Ixodes pacificus*) vectors *Borrelia burgdorferi* and *Borrelia miyamotoi* which can cause Lyme disease and relapsing fever in humans. These ticks are sampled regularly between October and March for these pathogens.

Ticks are collected from the environment using a one-by-one meter cloth attached to a dowel, colloquially called a tick 'flag' due to this construction. The cloth is dragged over microhabitats where ticks are likely to be, such as leaf litter and vegetation along trails. The flag picks up the ticks much like a passing animal would. From there, ticks are processed in the District lab and submitted for testing.

1,258
TICKS
TESTED

281
TICK
SAMPLES
TESTED

8
POSITIVE
SAMPLES



MOSQUITO SURVEILLANCE

ADULT MOSQUITO SURVEILLANCE

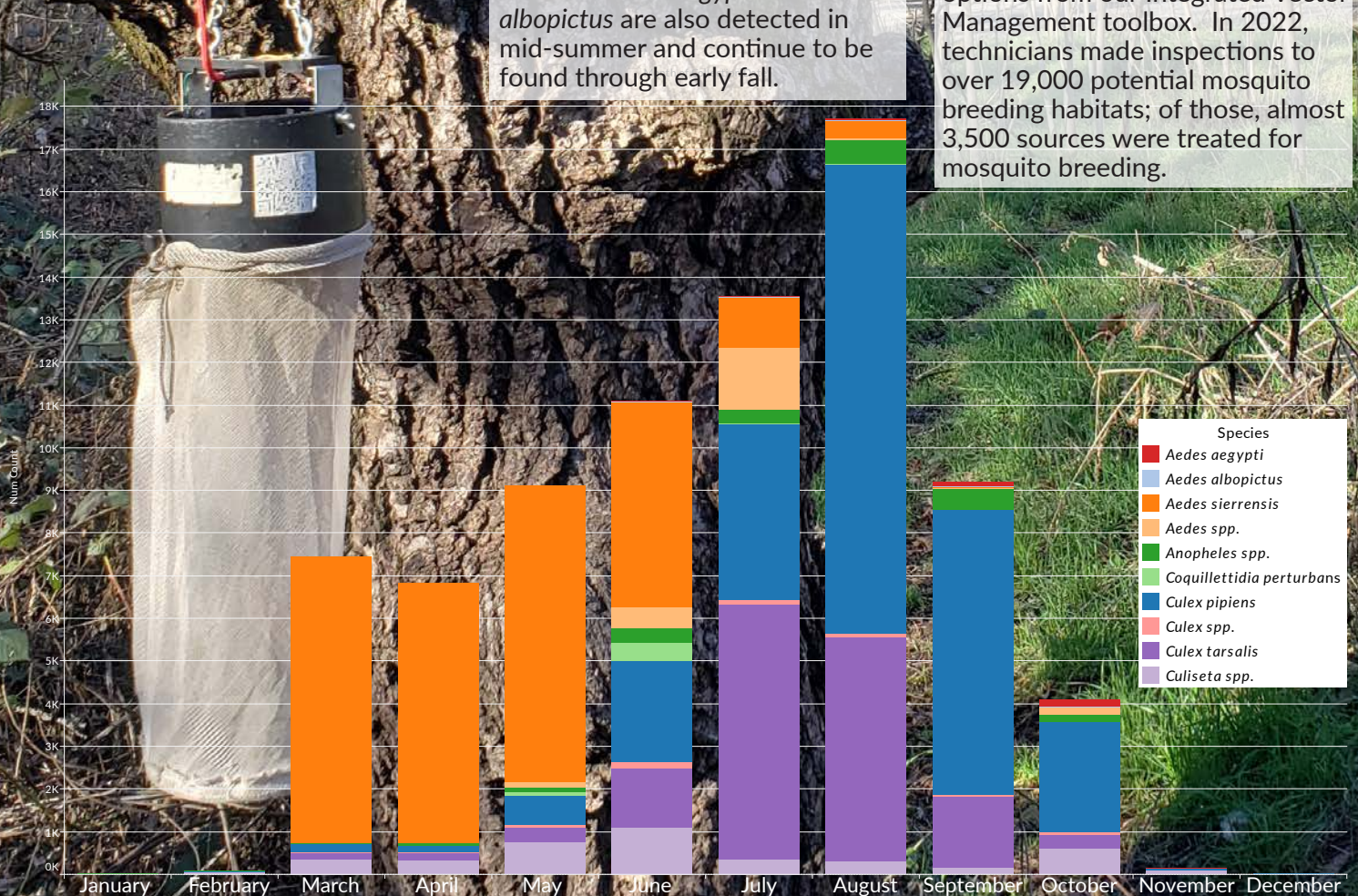
Adult surveillance is achieved by utilizing a variety of mosquito traps at dozens of different locations throughout the district. Staff identify every mosquito captured to sex and species to gain insight into the abundance and composition of the mosquito population throughout the district. Each collection is a snapshot of the mosquito population, and together the collections show how the population changes over time.

Nuisance mosquito situations can arise any time of year. Treehole mosquitoes (*Aedes sierrensis*) emerge between March and June, vexing residents with their abundance and persistent biting behavior. This species drives the majority of all requests for service received by the District. As the summer progresses, large populations of *Culex* spp mosquitoes emerge increasing the risk for West Nile virus. Invasive *Aedes aegypti* and *Aedes albopictus* are also detected in mid-summer and continue to be found through early fall.

LARVAL MOSQUITO SURVEILLANCE

Larval or immature mosquito surveillance is always a precursor to treatment of the source to eliminate the mosquitoes before they can cause harm. Immature mosquitoes can develop in an astonishing variety of natural and artificial water sources. As such, technicians must both inspect sources which habitually hold water and hunt for new or temporary sources that contain mosquitoes. This equates to hundreds, even thousands of individual inspections performed by each technician each year.

Reducing mosquito populations in their immature stages before they emerge as adults allows the District to be more efficient and effective in our control interventions. This control reduces mosquito bites and prevents human disease. Additionally, this allows the technician to choose from a greater variety of treatment options from our Integrated Vector Management toolbox. In 2022, technicians made inspections to over 19,000 potential mosquito breeding habitats; of those, almost 3,500 sources were treated for mosquito breeding.



LOCAL DISEASE SURVEILLANCE

How is disease detected?

Surveillance

Wild birds and mosquitoes maintain West Nile virus in the environment, passing it from infected bird to mosquito to a new bird in a cycle that ensures the virus persists in the bird population. The District monitors this cycle to evaluate the risk of transmission to humans. Mosquito samples, dead birds and sentinel chickens can all be sampled for the presence of West Nile and other viruses. A positive detection in any of these can indicate elevated risk to the public and prompt enhanced surveillance and control in the area.

SENTINEL CHICKEN SURVEILLANCE

The District utilized three flocks of eight sentinel chickens each to monitor virus transmission this year. The sentinel chickens are confined to their locations and blood samples are tested twice monthly for this purpose. This arrangement yields a more precise understanding of when and where transmission occurs. Three sentinel chickens became infected during the surveillance period in 2022; all positive chickens were located in the southern area of the District boundaries.

3 POSITIVE CHICKENS



1 POSITIVE DEAD BIRD



DEAD BIRD SURVEILLANCE

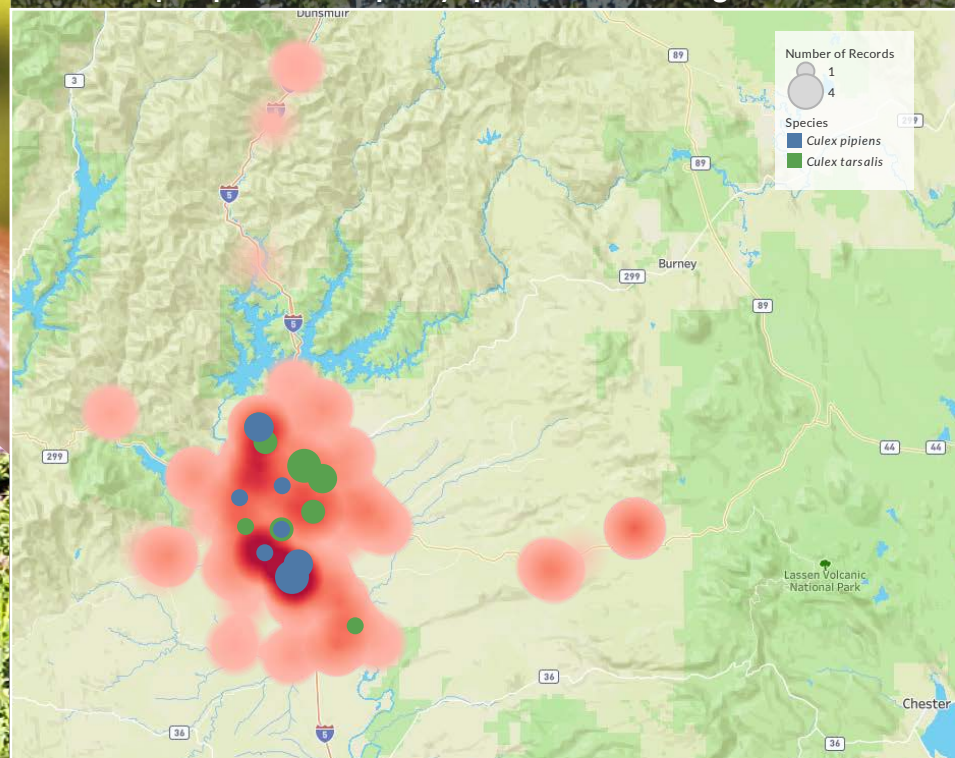
Bird species react differently to infection. Some do not experience any poor health effects, such as our sentinel chickens, while others will succumb to the virus. West Nile virus is especially lethal to Corvids such as crows and magpies. Residents can report recently dead Corvids found around their homes and neighborhoods. District staff retrieve and take a sample from the bird which is then sent to a regional lab for testing. The California Dead Bird Hotline received 28 reports of dead birds within the District's service area. Six of these reports were suitable for West Nile virus testing and one western scrub jay collected August 28th was positive for West Nile virus.

MOSQUITO TRAP SURVEILLANCE

In 2022, the District tested 15,891 mosquitoes, submitting 582 samples for mosquito-borne diseases. These were collected from six different trap types between March 8th and Oct 27th. The 582 mosquito samples suitable for virus testing were collected from 66 different sites within the District's service area. There were 39 samples which were positive for West Nile virus sourced from 16 unique locations. The earliest detection was from a sample gathered on June 28th and the last September 26th.



Heatmap showing the number of mosquitoes trapped in red, layered with map of positive sample by species in blue and green.



15,891
MOSQUITOES
TESTED

582
MOSQUITOES
SAMPLES
TESTED

39
POSITIVE
SAMPLES



INVASIVE MOSQUITOES

Invasive *Aedes* mosquitoes have continued to expand their distribution across the District in 2022. As we settle into the reality that *Aedes aegypti* and *Aedes albopictus* mosquitoes are a permanent part of our local ecosystem, ongoing surveillance and treatment continue. Currently, the viruses transmitted by these mosquitoes such as dengue fever, chikungunya and Zika were not reported in our District for 2022.

As we continue to collect data on our local invasive *Aedes* mosquitoes, we're better able to tailor and refine our surveillance and control program. Traps designed to target invasive *Aedes* mosquitoes are deployed throughout the district on a weekly basis. Our wide array of control options include deployment of autodissemination ovitraps, the application of larval control product through our wide area larviciding (WALS) technology, as well as Ultra Low Volume (ULV) fogging.

In 2022, detections occurred from Lake Blvd. in Redding to Ox Yoke Rd. in Anderson and were exclusively to the west of Interstate 5.

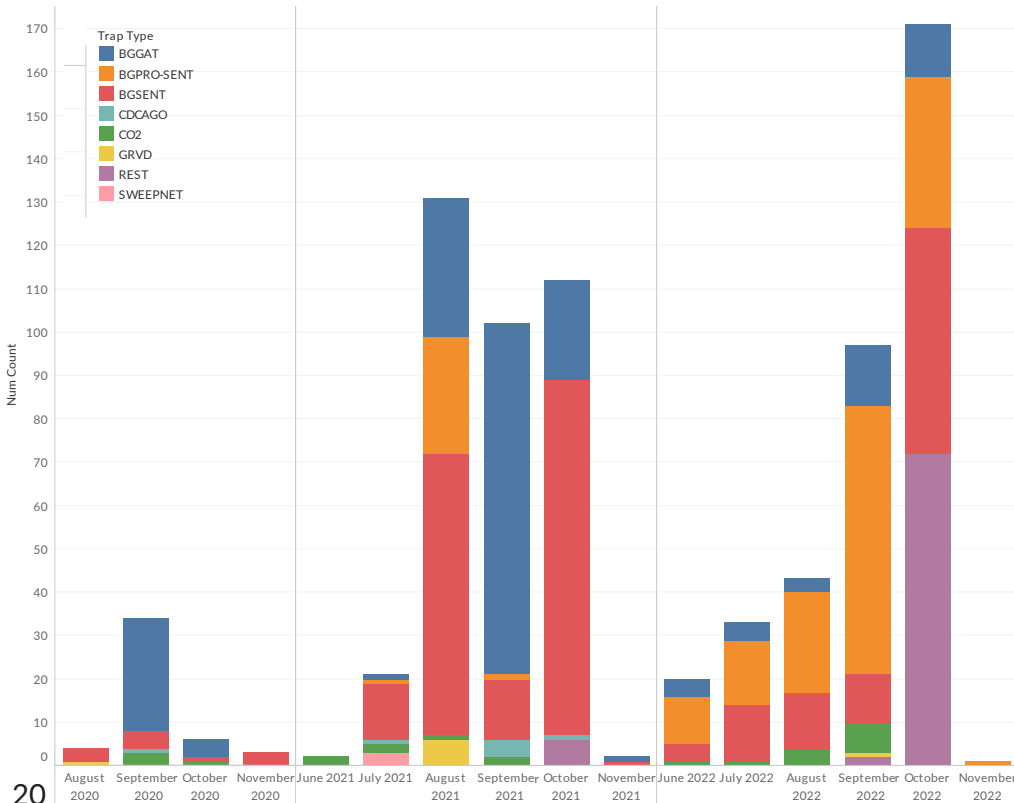
Staff placing an autodissemination ovitrap in a resident's yard



Adult Invasive Mosquitoes Found By Year



Adult Invasive Mosquitoes Found By Trap Type



OUTREACH & PUBLIC EDUCATION

As a key pillar in the District's Integrated Vector Management approach, the District's outreach and public education efforts have continued to develop, and this year is no exception. To improve awareness, we continue to maintain and update our device-responsive District website and social media platforms, to reach our community on a digital level. Our seasonally designated local radio and television PSAs continued to roll this year, including spots geo-targeted through OTT (Over-the-top) media streaming services to air our video PSAs via Roku, Amazon Fire TV, Samsung TV, and other streaming services.



A puppy as a mosquito larva about to be eaten by a mosquitofish at our outreach booth at the Palo Cedro Honeybee Festival.



Our Argo amphibious vehicle interactive display at the STEM Career Fair 2022.



Our mascot, Missy Keeto, at a National Night Out event with members of the Redding Fire Department present.

In addition to digital outreach, we also participated in several community events, providing informational booths manned by our District staff, where we distributed a wide variety of educational materials. These events also provide opportunities for our constituents to have one-on-one conversations with staff and learn about our District programs. Some community events, such as the STEM Career Fair, was both a virtual format as well as an in-person event at the Shasta Fairgrounds. District staff produced a STEM Career themed video and participated in the live event with a booth. Students got the experience of exploring the District's Argo amphibious vehicle.

This year also marked the first annual Lighting of the Bridge event held at the Sundial Bridge in Redding, where we had an event for California Mosquito Awareness Week and lit the bridge green! Additional pictures can be found on the cover and table of contents pages. Big thanks to the Shasta Public Libraries for partnering with us on that event to share our programs and engage with residents.

A member of the public wearing one of our 3D printed headbands with glowstick antennae at the Lighting of the Bridge event while the sun sets over the Sacramento River.





FINANCIAL REPORT

The Shasta Mosquito and Vector Control District depends on property tax revenues and benefit assessments to fund its operations. The District's objective is to be fiscally responsible in accordance with Generally Accepted Accounting Principles (GAAP), Governmental Accounting, Auditing and Financial Reporting (GAAFR), as well as State Controller reporting guidelines.

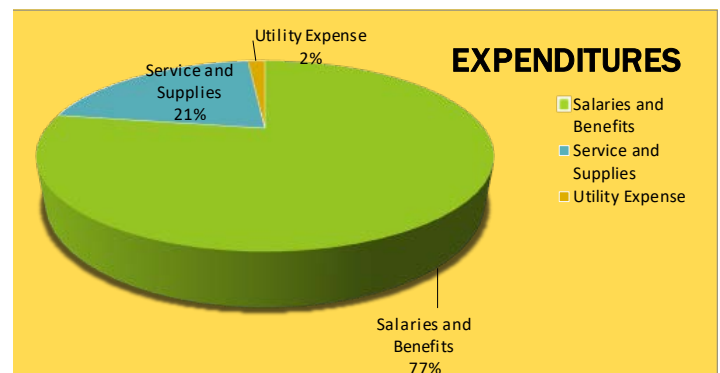
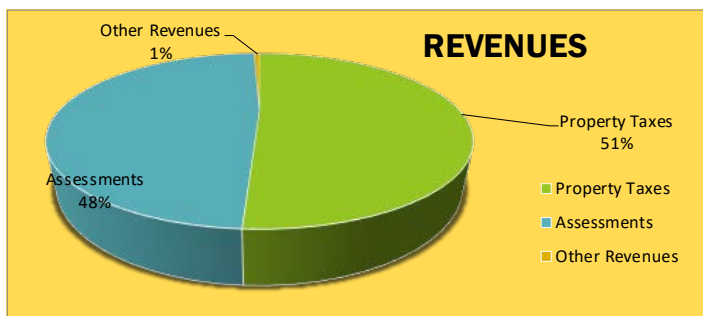
During the year, the District successfully used a cloud-based system for many aspects of day-to-day operations. This gives us the flexibility of working remotely, without impeding business practices. As a District we are always committed to the responsible management of public funds. We continue to utilize a transparent approach in our finances as well as all aspects of District operations. We continue to have successful filings of clean annual audits.


Staff is currently working on a Capital Improvements Plan which will take us into the next 5 years. In the past this was a successful experience and will continue to support planning for the future growth of the district.

Statement of Financial Position: FY 2021-2022 (June 30, 2022)	
Assets	
Cash and cash equivalents	\$3,262,576
Due from other governments	5,954
Inventories	163,939
Non-depreciable capital assets	51,273
Depreciable capital assets, net	1,060,335
TOTAL ASSETS	\$4,544,077
Long-Term Liabilities	
Note payable	\$107,979
Net pension liability	1,489,948
OPEB	15,518
Compensated Absences	117,693
TOTAL LIABILITIES	\$1,731,138

2021-2022 REVENUES		
Property Taxes	1,639,614	50.91%
Assessments	1,562,854	48.52%
Interest & Miscellaneous	18,421	0.57%
TOTAL REVENUE	3,220,889	100%

2021-2022 EXPENDITURES		
Salaries and Benefits	2,239,617	77.47%
Service and Supplies	604,473	20.91%
Utility Expense	46,907	1.62%
TOTAL EXPENDITURES	2,890,997	100%





Thank you
to John Albright
who shared over 25 years
of his career dedicating himself
to Shasta MVCD residents.
John loved to teach, learn,
and innovate - a set of values
our agency holds dear.
Happy retirement,
John!